Guidance on the Use and Application of Results from Verified Laboratory and Field Testing for Stormwater Manufactured Treatment Devices

A Publicly Available Specification

Prepared by:

Toronto and Region Conservation Authority

Supported by:

The Standards Council of Canada

June 2023

Publication Information

This Publicly Available Specification (PAS) was prepared by the Toronto and Region Conservation Authority (TRCA) with support from the Standards Council of Canada. As a Vocabulary this PAS takes the form of guidance and recommendations on policies, practices and approaches. The user should be aware that the process used to develop this document does not include the full consensus process normally associated with standards. It is the responsibility of the user of this document to judge the suitability of the document for the user's purpose. A PAS can be considered for further development as a Canadian Standard.

Citation: Toronto and Region Conservation Authority, 2023. *Guidance on the use and application of results from verified laboratory and field testing for stormwater manufactured treatment devices*. Toronto, Ontario.

The TRCA retains ownership and copyright of this PAS, which will be reviewed at intervals not exceeding 2 years. Any amendments arising from the review will be published as an amended PAS.

Aussi offert en français sous le titre *Guide d'utilisation et d'application des résultats d'essais en laboratoire et sur le terrain vérifiés pour les appareils de traitement fabriqués d'eaux pluviales*

Use of the Document

Users are responsible for the correct application of this PAS. Compliance with a PAS does not guarantee compliance with the law and cannot confer immunity from legal obligations. This PAS is a voluntary document and in itself has no legal status. There is no obligation to apply or comply with this PAS unless its application is directly required by third-parties. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading. Any user claiming compliance with this PAS is expected to be able to justify that claim together with any course of action that deviates from its recommendations. It has been assumed in the preparation of this PAS that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Developing a Publicly Available Specification

In collaboration with the SCC, the TRCA leveraged Canada's standardization system to bring together experts and organizations to define key terms and develop a PAS on how to apply these definitions.

This PAS builds on preliminary research and a series of public consultations with key experts, as well as those representing provincial agencies, municipalities, small and medium enterprises, large businesses, non-profit organizations, post-secondary institutions and others. Their comments on initial base documents, as well as written feedback and consultation transcripts, were analyzed. Suggestions were reviewed by the Steering Group and representatives from the SCC.

This PAS provides recommendations and guidance on policies, practices, and approaches for applying the data and information generated from verified performance testing to approval agency decisions on site stormwater treatment.

Acknowledgements

Acknowledgement is given to the following individuals and organizations that generously offered their time to review, advise and comment on the PAS as members of the Steering Group:

John Antoszek
Pollution Control Engineering Advisor
Ontario Ministry of the Environment, Conservation and Parks

Marc Arsenault
Wastewater Engineer
City of Moncton

Martin Bouchard-Valentine
Coordonnateur – Équipe gestion des débordements et des eaux pluviales
Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs, Québec

Joe Costa
Senior Scientist & Quality Manager
Good Harbour Laboratories Ltd. *
*(*Note: GHL was acquired by Oldcastle Infrastructure effective 11 April 2023)*

Christy Graham
Senior Coordinator, Sustainable Technologies
Toronto and Region Conservation Authority

Joel Haley
Environmental Coordinator
Halifax Water

Shad Hussain
Senior Engineer
Strategic Planning & Policy, Toronto Water
City of Toronto

Edith Laflamme
Directrice Générale
Centre des Technologies de l'eau

Glenn MacMillan
General Manager, Development, Engineering and Restoration
Lake Simcoe Regional Conservation Authority

John Neate
Managing Director
VerifiGlobal

Aaron Omelan, Engineer-in-Training
Infrastructure Engineer
Saskatoon Water
City of Saskatoon

Barbara Siembida-Lösch
Senior Research Scientist & Engineer
Centre for Advancement of Water and Wastewater Technologies
Fleming College,

Bert van Duin
Drainage Technical Lead
Water Resources Infrastructure Planning
City of Calgary

Tim Van Seters
Senior Manager, Sustainable Technologies
Toronto and Region Conservation Authority

Acknowledgement is also given to the many individuals and organizations that participated in the consultations and provided commentary including:

Bureau de normalisation du Québec)

CSA Group

Carleton University

Centre d'expertise et de recherche en infrastructures urbaines (CERIU)

City of Vancouver

City of Calgary

City of Ottawa

City of Pickering

City of Waterloo

City of Thunder Bay

City of Barrie

City of Montréal

City of Laval

Credit Valley Conservation

EPCOR Water Services

Globe Performance Solutions

Lake Simcoe Region Conservation Authority

Ministère des Transports et de la Mobilité durable du Québec

Ontario Ministry of the Environment, Conservation and Parks (MECP)

Region of Peel

Town of Richmond Hill

Town of Newmarket

Town of the Blue Mountains

Toronto Metropolitan University

University of Waterloo

University of Guelph

Industry organizations (i.e., technology companies, vendors, manufacturers, intellectual property owners, licensees)

Preface

In Canada and other jurisdictions, different approval agencies have different requirements and performance criteria for approval and acceptance of various stormwater treatment devices for specific applications and operating conditions. To support their decisions, these agencies can benefit from scientifically defensible, verifiable performance data applicable to a range of possible end use requirements and operating conditions.

Two testing *Procedures* for Oil Grit Separator and Filtration Manufactured Treatment Devices (MTDs) have been developed for use by Canadian approval agencies and other affected stakeholders in evaluating treatment technology options. The *Procedures* are intended to be used by various parties as the basis for stormwater treatment technology performance testing and subsequent verification following the requirements of the International Organization for Standardization (ISO) 14034:2016 Environmental Technology Verification (ETV) standard, published in November 2016. These requirements are outlined in Appendix B: Stormwater Technology Performance Testing and Verification - ISO 14034 ETV Requirements.

The principle objective of this document is to provide guidance on how performance data from verified testing can be interpreted and applied to support regulatory agency approval decisions. As such, the guidance will help promote cross jurisdictional consistency in the application of performance data for approvals and help ensure the verified performance data are being utilized appropriately to inform technology selection, sizing, siting and other important considerations.

It is understood that the ultimate decision to approve, select and implement a particular technology is the responsibility of the technology buyer, guided by the requirements of the respective approval agencies within the affected jurisdiction(s).

Table of Contents

1.0 Scope

This Canadian Publicly Available Specification (PAS) was developed under the Canadian Stormwater Environmental Technology Verification (SETV) project, which was established to develop publicly available specifications on testing and verification of stormwater Manufactured Treatment Devices (MTDs). This PAS provides guidance on how the data and information generated from verified laboratory and field testing of Oil Grit Separators (OGS) and Filtration Manufactured Treatment Devices (MTD) should be interpreted and factored into regulatory agency approvals and procurement decisions for stormwater management. Since regulatory criteria for stormwater management varies by jurisdiction, the guidance is meant to provide an overall framework for decisions that should be broadly applied while leaving latitude for agencies to refine and further specify requirements according to regulatory approval criteria relevant to their jurisdiction of operation.

The ultimate decision to select and implement a particular technology is the responsibility of the technology buyer, guided by the requirements of the respective regulatory agencies within the affected jurisdiction(s). Thus, it is important for OGS and Filtration MTD manufacturers to ensure that their technologies meet the applicable laws and regulatory requirements of the jurisdiction(s) in which their technologies are to be utilized. A glossary of terms and definitions referenced in this document is provided in Appendix A.

2.0 Normative References and Test Procedures

The following International Standardization Organization (ISO) documents are useful background information in the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- ISO 14034:2016, Environmental management — Environmental technology verification (ETV)
- ISO/IEC 17020, Conformity assessment - Requirements for the operation of various types of bodies performing inspection.
- ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories

An overview of the ISO 14034 Environmental Technology Verification (ETV) testing and verification requirements is provided in Appendix B.

This guidance document is intended to be used for MTD performance testing procedures conducted in accordance with the following two Publicly Available Specifications (PAS):

1. Canadian Procedure for Laboratory Testing of Oil-Grit Separators (TRCA, 2023a)
2. Canadian Procedure for Testing of Filtration Manufactured Treatment Devices (TRCA, 2023b)

The guidance will help to ensure that test results verified by third-party experts can be applied by regulatory approval agencies in a uniform and transparent manner that instills confidence in performance claims.

3.0 Technology Descriptions

This guidance document addresses OGS and Filtration MTDs. OGS technologies rely on gravity-based sedimentation for grit, phase separation for oil and flotation for floatables. They are typically installed as part of the storm sewer network with one or more inlets and a single outlet. The large inlet/outlet openings provide negligible flow attenuation and are not subject to clogging when maintained appropriately. OGS devices target removal of trash, debris, floatables, and the coarse sediment fraction of suspended solids in stormwater runoff. OGS may include debris screens but should not include filters. It is normally recommended that the devices be inspected once or twice a year and, if necessary, sediment is removed annually with a hydro-vacuum truck.

Filtration MTDs are structures consisting of one or more chambers with filtration media, membranes and/or filtration cartridges that remove solids and debris/trash from runoff. Some units may have oil separation functions and pre-treatment chambers for coarse sediment and debris. The filter components are designed to remove the coarse and fine sediment fraction of suspended solids and associated pollutants in stormwater runoff, and may also target removal of dissolved pollutants such as phosphorus or metals through biological and/or chemical processes. Since Filtration MTDs restrict flow either initially or over the maintenance cycle, they are normally designed for much lower hydraulic loading rates than OGS MTDs and have longer detention times. Flow restriction occurs due to the small pore size openings of filters and the clogging of pores and/or the formation of films either on the surface of the filter or within the filter matrix filter. For this reason, inspection and maintenance intervals for Filtration MTDs are normally shorter than for OGS MTDs. The method of maintenance typically involves sediment removal with a hydro vacuum truck as well as filter cleaning or replacement.

Other ISO 14034 verified technologies that rely on sedimentation as the primary treatment process have undergone rigorous testing based on a modified version of the OGS *Procedure* (*e.g*. water quality inlets). These tests are valid ETV verifications based on the specific testing programs undertaken, but the differences in technology operation and testing programs need to be carefully considered when comparing performance directly with OGS MTDs. While consideration of these other non-OGS sedimentation technologies is beyond the scope of this guidance document, it should be recognized that all treatment technology options should be considered by local authorities in developing site specific stormwater management plans.

4.0 MTD Selection and Siting Considerations

The preliminary screening and selection of one or more MTDs for a given stormwater treatment application should consider the position of the technology within the treatment train (if appropriate), upstream controls designed to limit flow rates to MTDs, downstream controls that may create tailwater conditions elevating the water level inside the MTD, desired performance for water quality parameters of interest and any site constraints that may limit the technology's application. Once the type of MTD has been selected, more detailed assessments of the hydraulic characteristics and treatment function/capabilities of specific models need to be considered in relation to site constraints and other factors. These considerations are discussed in section 5.0.

4.1 Location within the drainage system

Stormwater technologies intended for pre-treatment normally target trash, debris and coarse suspended solids (> 75 um), leaving downstream Best Management Practices (BMPs) to remove finer sediment particles and provide additional water quality polishing. OGS technologies are well suited for pre-treatment applications. Filtration MTDs are well suited for stand-alone applications because they generally achieve a higher level of total suspended solids (TSS) removal (often ≥80%), target more stormwater pollutants and benefit from upstream pre-treatment by extending the filter's maintenance frequency.

Use of sedimentation or Filtration MTDs as stand-alone technologies will depend on the level of water quality performance required, both in terms of the pollutants targeted and level of removal, site characteristics, as well as maintenance implications of the selected MTD.

In treatment trains, pre-treatment technologies such as OGS devices may be installed upstream of a Filtration MTDs or similar non-proprietary filtration technology such as bioretention since they remove coarse particles that contribute to filter clogging. Installation in reverse order is ineffective because effluents from Filtration MTDs are comprised mostly of fine particle size fractions that are not effectively removed by OGS sedimentation processes. The effect of tailwater conditions created by Filtration MTDs on upstream OGS devices (or other pre-treatment devices) needs to be considered in the overall drainage system design.

MTDs may be designed upstream or downstream of temporary flow controls (e.g. surface storage, pipe storage). MTDs located downstream of flow controls can use modified annual hydrology based on the storage discharge curve of upstream storage in the sizing of the MTD. It should be noted that upstream controls may not be used to increase the claimed removal efficiency of the MTD itself. Generally, a benefit in reduced sizing may be achieved with upstream storage if the storage controls frequent flows (i.e. < 1 year return period). Upstream storage for 2 year or less frequent quantity control designs will not have a significant impact on MTD sizing since the majority of the annual hydrology is less than the 2-year flow and will be unattenuated. In certain instances, an agency may mandate that a MTD be upstream of a measure that controls flows. In these cases, the tailwater from the control measure needs to be considered to determine which MTD is appropriate.

Since design criteria for the use of some upstream flow controls to reduce MTD sizing varies by jurisdiction, local authorities should be consulted on approved measures and design standards prior to implementation. For instance, it has been observed that orifice controlled roof drains are often removed by building maintenance staff when they begin to clog, prompting some agencies to reject these as a valid long term flow control measure for flat roofs.

MTDs that operate in series must be assessed differently since the upstream MTD will remove some of the pollutants which will change the particle size distribution, relative form (particulate/dissolved), and concentration of pollutants entering the downstream MTD. Accordingly, the pollutant removal calculations for the downstream MTD cannot be based on the original testing results for a stand-alone configuration. One approach for calculating removal efficiencies for treatment trains would be to apply the pollutant removal efficiency of the downstream treatment practice to the fraction of load remaining after passing through the first treatment practice (Massachusetts DEP, 1997; New Jersey DEP, 2004). These calculations assume that the practice removing only coarse size particles with lower overall removal efficiencies is placed upstream of the practices that target a wider particle size range with higher overall removal capacity.

However, in practice these calculations often overestimate the overall treatment train removal efficiency because they assume that the load into the downstream MTD has the same composition as the influent load to the upstream MTD. In most cases, the remaining load entering the downstream MTD will be altered in composition (e.g. the upstream MTD will remove coarse particles leaving only fine particles entering the downstream practice). Since the removal performance of the downstream MTD will change with input pollutant composition, the downstream MTD will not perform as well as this calculation predicts. Therefore, it is recommended that a conservative approach be applied such that the removal efficiency for an appropriately ordered treatment train (i.e. low performing upstream of high performing) is set equal to that of the highest performing MTD in the treatment train. For example, a treatment train with a sedimentation practice sized to achieve 50% TSS removal (all particles greater than 75 microns) followed by a Filtration MTD sized to remove 80% (all particles down to 10 microns) would be credited for 80% TSS removal overall, recognizing that the filter would remove all the coarse particles delivered to the OGS regardless of whether the OGS was present. As such, the benefit of the configuration would be to reduce the maintenance frequency of the filter, not to enhance overall pollutant removal.

4.2 Performance targets

It is important for local authorities to determine if, to what extent, and at what scale various drainage control measures must be accounted for in MTD design. Selection and sizing of treatment technologies will depend on the specific water quality parameters targeted for treatment and the desired level of performance for each of these parameters. For approval purposes, the performance level is typically designated as a removal rate for each target water quality parameter, but in some instances effluent concentrations or a combination of both effluent concentrations and removal efficiencies may also be of interest.

In general, Filtration MTDs or a combination of stormwater treatment technologies targeting a wide TSS particle size range are selected when an enhanced level performance (i.e. ≥ 80% removal) is desired. These practices also remove a portion of other pollutants that bind to solid particles. Some filtration MTDs contain specialized media designed to further enhance capture rates of specific water quality parameters, such as phosphorus or metals. Performance results from verified testing programs will determine whether a single MTD, or combination of MTDs is required for any given target level of pollutant removal.

OGS are tested for TSS removal and retention, and some have also been tested for oil capture and retention. If oil or light liquid treatment is required, OGS units that have undergone the laboratory light liquid simulation test may be considered based on performance results. Some Filtration MTDs may also have light liquid capture capabilities in pre-treatment chambers, although additional lab or field testing would be needed to verify the effectiveness of spill capture functions.

4.3 Site conditions

A variety of site-specific conditions will influence MTD selection and siting. These may include limitations related to upstream hydraulic grade lines or weeping tile elevations, outflow rate limitations to protect downstream infrastructure, high water table elevations and access constraints, all of which could affect the design or type of treatment technology selected. In some cases, modifications to existing designs may be required. For instance, upstream hydraulic grade line or weeping tile elevation limitations may require selection of an MTD with low head loss. Alternatively, high groundwater levels will require that extra precautions are made to seal MTD structures to avoid contamination and leakage. If temporary detention is required to control release rates, OGS and Filtration MTDs may need to be paired with other stormwater control practices that provide the necessary flow control through temporary detention and/or flow volume control.

4.4 Determination of equivalency

It has been common practice in many Canadian jurisdictions to list the MTD model approved by the design engineer for installation through the regulatory approval process as 'approved model name/number or equivalent'. This added condition of equivalency has, in practice, given the contractor or engineering design consultant the latitude to substitute the model approved through the development review process with a different manufacturer model at their discretion without seeking further agency review or approval. While substitutions may be necessary under some circumstances, the final technology selection and rationale for the proposed substitution should be reviewed and approved by the agency review team (including the design engineer proposing the substitution) to ensure decision makers are appropriately informed and have had an opportunity to comment on elements of the technology design and installation relevant to their expertise. Notes should be included on design drawing indicating 'approved model name/number or *approved* equivalent', with a footnote indicating the requirement to seek further input from the full design review team on the selected technology.

5.0 Performance Claims, Operational Parameters and Submission Review

The technology performance claims in ISO 14034 verification statements or technology acceptance certification documents provide a clear and concise description of the specific performance claims being made about the tested technology. Information on technology specific operational parameters, such as bypass rates, head loss coefficients and recommended maintenance frequencies, are provided in more recent verification documents. For older verifications, where not all operational parameters may have been reported in verification statements, the relevant verified lab or field test results may be requested by approval agencies from manufacturers, along with other information on model dimensions, maintenance procedures, installation manuals and other model specific information. In all cases, the proposed MTD should have the same design and include the same components (e.g. baffles, weirs, screens) as the tested MTD in order for the verification to be a valid representation of expected performance. Inlet and outlet pipe sizes and slopes may be different, as these are site specific.

Appropriate model data should be submitted by manufacturers to evaluate the effect of alternate pipe configurations on technology performance.

5.1 Oil-grit Separator Manufactured Treatment Devices

5.1.1 Content of Verification Statements

The ISO 14034 verification statements for each tested OGS MTD follow a common format, which includes:

- Statement of the general conditions under which testing was undertaken for each test. For example,
  - The sediment removal performance test: evaluated at 50% of manufacturers recommended sump storage depth, influent concentration of 200 mg/L;
  - The sediment scour and resuspension test: Depth of pre-loaded sediment, duration of flow at each surface loading rate (SLR).
- Sediment capture results: TSS removal efficiencies during the sediment capture test at each of a minimum seven SLRs (up to 1400 L min^{-1} m^{-2}), based on modified mass balance testing.
- Sediment scour and resuspension test: Effluent concentrations at each tested SLR (minimum five up to 2600 L min^{-1} m^{-2}), corrected for background concentrations and particle size distribution (where appropriate).
- Optional light liquid retention test: Retention of low-density polyethylene beads during pre-loading and at each tested SLRs.

Other useful information provided in verification statements include:

- Sediment removal by particle size (based on sub-sampling of injected and retained sediment)
- Observed bypass rate for OGS MTDs with internal bypasses
- Measured head loss at multiple flow rates
- Information on whether the test data may be applied to other model sizes based on scaling rules described in the two *Procedures*
- Variances from the Test Plan and/or the OGS Test *Procedure* and their expected impact on performance results.

As mentioned earlier, information on MTD hydraulic characteristics, unit scaling and bypass rates may not be included in older verification statements. In these instances, agencies may request the data from the manufacturers' ISO 14034 ETV Test Reports.

5.1.2 Process for selecting and applying an OGS to a site for stormwater treatment

Technology buyers utilizing the ISO 14034 MTD verifications for technology acceptance should follow a stepwise process for selecting and applying an OGS for stormwater treatment at a specific site. It is recommended that a standard form such as that provided in Appendix C is completed for all verified OGS MTDs to facilitate and expedite the process of OGS technology selection and review. The steps to be undertaken in the review and design/approvals process would typically include the following:

Step 1: Confirm that the OGS technology is suitable for the site in question or that it can be combined with other BMPs to serve the intended purpose of stormwater quality treatment enhancement. Typically, suitable sites are small (< 2 hectares) with highly impervious drainage areas (> 75%). OGS MTDs may also be used on larger sites and/or sites with lower impervious cover, when properly sized. Installing an OGS as pre-treatment to other stormwater or water pollution control technologies may extend the life/longevity of the downstream SWM facilities, the latter of which may be used to meet other site criteria, such as volume reductions, peak flow control and/or enhanced treatment. Since OGS technologies target the sand particle size range, they are generally not suitable as stand-alone practices where treatment objectives require TSS removal efficiencies of 80% or greater.

Step 2: Set treatment objectives for the site. These will include the desired TSS removal efficiency (e.g. 50% for pre-treatment applications), the need for light liquid (e.g. oil) retention, and may also include targets for other common stormwater pollutants such as floatables, nutrients and metals. Since performance claims are limited to TSS and light liquid removal, the regulatory authority will need to generate assumptions based on other research to assess how the measured TSS removal efficiency can be used to estimate removal of other pollutants. Since most other stormwater pollutants, such as metals and nutrients, have a particulate and dissolved fraction, the latter of which is not removed through sedimentation, removal efficiencies for these other pollutants are normally much lower than for TSS. Note that if light liquids are a treatment objective for the site, the ISO 14034 verification statement must include a claim for light liquid removal. Light liquid retention results from the simulated light liquid test shall be 85% or above for the unit to be regarded as a valid light liquid capture and retention MTD. This minimum level accounts for the unavoidable loss of oil and other light liquids that are emulsified in stormwater and attached to suspended solids and debris, both of which were not quantified in laboratory testing.

Step 3: Establish operational objectives and maintenance requirements or thresholds for the site and MTDs under consideration. These may include inspection and maintenance frequencies, maintenance cost, personnel requirements for maintenance, health and safety requirements for maintenance (e.g. confined space requirements, materials storage and handling), estimated MTD life cycle, device replacement cost and site restrictions imposed by factors such as hydraulic grade lines or weeping tile elevations.

Step 4: Compile relevant information from verified performance data and reports, manufacturer submissions, and jurisdictionally specific stormwater guidelines and criteria. Generate a short list of OGS devices based on the compiled information. Since the sediment removal efficiencies in verification statements are denominated based on SLRs, further modelling or analysis will be required to determine overall performance (see step 8 below). Therefore, OGS MTDs that remain on the short list would continue to be considered until further modelling or analysis has been completed.

Head loss and water level measurements during lab testing will indicate the flow conditions during which backwater conditions may be present in the upstream sewer. While all ISO 14034 verified OGS were tested for head loss, only the more recent verification statements include these values. Where absent, the values from the third-party lab test report may be obtained from the manufacturer. If certain OGS designs are unable to meet strict site criteria identified in step 4 regarding upstream hydraulic grade lines, weeping tile elevations, or hydraulic design considerations, they should be removed from consideration at this stage.

Step 5: Confirm whether the OGS technologies under consideration for the site are to be installed on-line or off-line. Off-line configurations ensure that flows up to the maximum treatment surface loading rate are routed into the treatment chamber of the MTD and all flows in excess of the maximum treatment surface loading rate are diverted around the treatment chamber of the MTD via an upstream bypass or diversion. Off-line configurations ensure flow rates that may cause scour of previously deposited sediments (as determined through verified laboratory testing) are routed around the MTD via an upstream bypass or diversion. On-line MTD configuration allows flows greater than the maximum treatment surface loading rate to be routed through the MTD treatment chamber. On-line installation requires that measured effluent concentrations during the laboratory sediment scour test were equal to or less than 30 mg/L for the tested SLRs, as indicated in the ISO 14034 verification statement for the unit under consideration. The threshold of 30 mg/L is based on the value of 25 mg/L from the Canadian Water Quality Guidelines for the protection of aquatic life (CCME, 1999) plus a margin of error for the test of 5 mg/L.

Internal bypass weirs that ensure flows greater than maximum treatment surface loading rates for the site bypass the sediment sump and other areas where sediment may be deposited should also be considered as a condition for on-line installation. Several OGS manufacturers include diversion weirs within the unit structure but some of these are only designed to change the path of high flows through the unit (i.e. reduce the potential for scour) and do not fully bypass the sump or other areas prone to sediment deposition (i.e. eliminate the potential for bypassed flow to scour). Therefore, where an internal bypass is established as a requirement for on-line installation, care should be taken to ensure that the unit both achieved scour levels below 30 mg/L for all tested SLRs during ISO 14034 testing and that the bypass component in the unit bypasses all deposition areas within the unit. Verification statements published after this PAS document will indicate whether the high flow diversion component bypasses all deposition areas within the unit or simply changes the flow path through the treatment chamber. In verification statements where this information is not explicitly stated, the function of bypass components in OGS MTDs can be visually evaluated from the schematic provided in verification statements and other detailed drawings provided by manufacturers.

Step 6: Confirm that either the proposed unit size is the same as the tested unit, or the larger or smaller unit meets the scaling rule stipulated in the *Canadian Procedure for Laboratory Testing of OGS* (TRCA, 2023), based on model size data submitted by the manufacturer. Note that new verifications after publication of the OGS PAS document (TRCA, 2023a) will include details on the models to which the verified test results may be applied based on the scaling rules. For earlier verifications, this information is to be provided by the manufacturers as part of the submission for the project in question. The scaling rule in section 8.0 of the *Procedure* states that:

> "*The sediment removal rate at the specified SLRs determined for the tested full scale, commercially available MTD may be applied to similar MTDs of smaller or larger size by proper scaling. Scaling the performance results of the tested MTD to other model sizes without completing additional testing is acceptable provided that:*

1. *The maximum treatment surface loading rate prior to the onset of bypass for the similar MTD shall be the same or less than the tested MTD;*
2. *The claimed sediment removal efficiencies for the similar MTD are the same or lower than the tested MTD at identical SLRs;* ***and***
3. *The similar MTD is scaled geometrically proportional to the tested unit in all inside dimensions of length and width and a minimum of 85% proportional in depth, where the depth dimension is measured from the outlet pipe invert to the floor of the unit. "*

This scaling rule helps ensure that the unit would achieve a level of performance similar to the tested unit despite differences in size. Performance claims provided in ISO 14034 verification statements cannot be applied to models that do not meet the scaling rules. Therefore, these models should be modified to meet the requirements (e.g. adding additional sump depth) or removed from consideration at this stage.

Step 7: Ensure that the unit is sized appropriately based on ISO 14034 verified test data to meet or exceed the treatment objective established in step 3 above. Sizing methods should be simple, conservative and easily replicated and understood by approval agency reviewers. While more complex modelling methodologies may be used, the final sizing recommendation should be consistent with or more conservative than that generated using simple methods, as the latter often implicitly include factors of safety and assumptions are more transparent. If less conservative sizing results from more refined modelling methods are to be accepted, a clear and concise rationale should be provided by the proponent to explain the key differences in assumptions and input parameters. It is recommended that the sizing guidance provided below be automated through a model or spreadsheet tool to reduce review times and promote consistency in sizing methods and outcomes.

A common water quality treatment target for OGS and/or other stormwater treatment practices in Canada is to capture and treat at least 90% of the long-term average annual runoff for a site (*e.g.* Ontario Ministry of the Environment, 2003; Alberta Environment Protection, 1999). Some jurisdictions may also specify capture of particles above a designated threshold (*e.g*. Alberta Environment, 2001) and/or base sizing on the 90th percentile storm rather than 90% average annual runoff (*e.g.* Quebec, 2022). Treatment performance is often defined in terms of TSS removal efficiencies. A minimum 50% removal rate is generally acceptable for pre-treatment applications, while higher rates are specified for other applications. If the treatment target is denominated as a removal efficiency (e.g 60% TSS removal), modelling based on the site characteristics and verified lab test data will determine how much of the average annual runoff volume needs to be treated to meet the target. In general, specifying removal targets for OGS based on a minimum particle size threshold is not recommended because doing so introduces a margin of error that would otherwise not be present if the performance evaluation was based on the verified modified mass balance results (i.e. full sediment particle size distribution).

Assessing whether expected performance of OGS MTDs meet performance objectives for sites based on ISO 14034 verification will require the following information:

- Historical rainfall records (≤ 1 hour recording intervals; 15 minutes preferred where available) from the nearest long term meteorologic station for months when temperatures are predominantly above 0°C (minimum 10 years, 20 years or more preferred). Data should be filtered to account for the initial abstraction factor, which represents an assumed loss occurring during the initial phases of a storm and ends when the total rainfall depth equals the abstraction factor (*e.g.* 2 mm).
- Site drainage area size, impervious cover percentage and site runoff coefficient calculated based on pervious and impervious cover runoff coefficients relevant to the site drainage area characteristics (e.g. slope, soil texture) and jurisdiction.
- Treatment objective (percent TSS removal rate) and position in treatment train (i.e. stand alone or as pre-treatment to other downstream BMPs); indicate whether upstream flow control is provided, and if so, the type (*e.g.* parking lot storage, roof storage, pipe storage).
- Proposed model sizes (diameter or dimensions, internal sedimentation area, manufacturers' recommended maintenance sediment storage depth and maximum storage depth measured from the outlet invert to the bottom of the unit).
- ISO 14034 verification test results: sediment removal efficiencies for each of the tested SLRs; scour effluent concentrations for tested SLRs highlighting values greater than the 30 mg/L effluent threshold (to determine on-line or off-line installation as per the guidance provided above); oil test results highlighting overall removal relative to the 85% retention threshold (if required for the site; also confirm that the available oil storage volume in the MTD meets site requirements); bypass flow rate and head loss coefficients.

The *Rational Method* (see Appendix A for definition) can be employed to estimate flow rates for sites without upstream flow attenuation based on historical rainfall records and the selected recording interval (≤1 hour, 15 minute preferred where available). Note that the shorter the recording interval, the higher the rainfall intensity and MTD size needed to meet treatment objectives. These flow rates are in turn used to calculate SLRs for the selected OGS model and water quality treatment is subsequently determined from the ISO 14034 verification TSS removal test results assuming: (i) linear interpolation of TSS removal efficiencies for SLRs between tested SLRs; (ii) removal efficiencies at SLRs lower than the lowest tested SLR are assigned a removal efficiency equal to the tested SLR; and (iii) removal efficiencies at 400 L min^{-1} m^{-2} greater than the maximum tested SLR are assigned a value of zero. If the annual average removal efficiency calculated using this method is less than the target for the site, a larger model size will need to be selected. See Appendix D for a sample calculation.

The average annual TSS removal data can also be used to estimate annual sediment loads, sediment accumulation and maintenance frequency assuming an influent concentration of 225 mg/L (the upper limit of the allowable range specified in the OGS test *Procedure*) and a wet bulk density of 1230 kg/m^3 (OMOE, 2003). In some jurisdictions where sand or grit is used for winter maintenance of roads, the influent concentration should be set at a higher level for the purposes of assessing maintenance frequency. An additional 'safety factor' should be added for gross solids, debris and trash, which are not accounted for in the suspended solids load. This may be achieved in the model/calculations by artificially increasing the desired level of maintenance (*e.g.* 1 year) to a less frequent level (*e.g.* 1.5

years). Comparing the estimated sediment accumulation (including safety factor) to the manufacturers' recommended maintenance sediment storage depth for the selected model will provide an indication of whether the unit meets the minimum maintenance frequency set by the technology. If the available unit maintenance sediment storage capacity for the selected model will require more than the desired maintenance frequency, either a larger model can be selected or, if applicable, the sump depth can be extended. See Appendix D for a sample calculation.

It should be noted that a similar method can be used whether the treatment objectives for the site are based on 90% of the average annual runoff (volume based) or 90th percentile runoff value (storm ranking by size). It should be recognized that rainfall/runoff analysis based on the 90% average annual runoff volume criteria will generate considerably more conservative sizing results than rainfall/runoff analysis based on the 90th percentile storm. If design storms are used, the results may be even more conservative than either of the two aforementioned methods, depending on the design storm type and return period (e.g 2-year, one hour, AES storm).

5.2 Filtration Manufactured Treatment Devices

5.2.1 Content of Verification Statements or certification documents

Performance of Filtration MTDs is evaluated in field settings. Lab testing alone is an insufficient basis for the evaluation of Filtration MTDs primarily due to the variable sensitivity of different types of filters to the unique physical, chemical and biological composition of field sediment.

The *"Canadian Procedure for Field Testing of Stormwater Filtration Manufactured Treatment Devices*" is based on testing requirements stipulated in the State of Washington Department of Ecology's *Technology Assessment Protocol – Ecology* (TAPE), which was developed through an extensive peer review process targeted at a wide range of short detention time, proprietary and non-proprietary stormwater treatment technologies (TAPE, 2018). This *Procedure* is intended to be used by various parties as the basis for stormwater Filtration MTD performance field testing and subsequent verification following the requirements of the ISO 14034:2016 ETV standard, published in November 2016. The verification documents for Filtration MTDs will include, but are not limited, to the following:

- Water quality improvements expressed as a statistically significant difference between inlet and outlet concentrations/loads and a lower 95 percent confidence interval of mean removal efficiencies. Common water quality parameters evaluated may include TSS and/or suspended solids concentration (SSC), total phosphorus, phosphate, total copper, total zinc, dissolved copper (TAPE only), dissolved zinc (TAPE only) total petroleum hydrocarbons (TAPE only), and E.coli (TAPE only). If the Filtration MTD is not designed to reduce volumes, the removal efficiencies and statistical analyses are based on water quality concentrations, otherwise they are based on water quality loads.
- Effluent water quality, expressed as the upper 95th percent confidence interval of mean effluent concentrations/loads of the parameter of interest.
- Stormwater volume reductions for Filtration MTDs that are designed to reduce flow volumes, expressed as a change in flow volume entering and exiting the facility.

- Peak flow reductions and detention times for Filtration MTDs that provide temporary detention of stormwater. Bypass flow rates are also reported, with the claimed rate for the tested unit equal to the lowest observed rate over the field monitoring program.

Other information included in the verification/certification documents may include a discussion on the representativeness of the field data, flags on screening parameters (*e.g*. pH, hardness), measured head loss at measured flow rates, recommended maintenance intervals based on field testing, and a description and expected impact of any variances from the field test plan.

5.2.2 Process for selecting and applying Filtration MTDs to a site for stormwater treatment

As with OGS MTDs, technology buyers utilizing verified performance data (TAPE certification or ISO 14034 ETV verification) for technology acceptance should follow a stepwise process for selecting and applying Filtration MTDs for stormwater treatment at a specific site. It is recommended that a standard form provided in Appendix C is completed for all Filtration MTDs to facilitate and expedite the selection and review of Filtration MTDs for specific sites. The steps undertaken in the review and design/approvals process would typically include the following:

Step 1: Confirm that a Filtration MTD is suitable for the site in question or that it can be combined with other BMPs to serve the intended purpose of stormwater quality treatment. Site drainage areas for Filtration MTDs are often less than two hectares and are normally comprised of more than 75% impervious cover. Maintenance costs are often considerably higher than for OGS or other sedimentation technologies. Filtration MTDs may have specialized media that target less conventional stormwater pollutants, which would allow the technology to be tailored to sites with unique pollutant loading profiles. Further testing may be required if the pollutants of interest were not included in the field testing program. Since Filtration MTDs target the coarse and finer particle size range, they often can be installed as stand-alone technologies where regulations require TSS removal efficiencies of 80% or greater and/or mean TSS effluent concentrations less than 25 mg/L (or some combination of the two for influent TSS concentration ranges presented in step 7 below). Like OGS, they can also be beneficially installed in combination with other stormwater or water pollution control technologies as part of a treatment train. This may allow the combined technologies to meet a broader range of site stormwater control criteria than is achieved by the Filtration MTD on its own.

Step 2: Establish treatment performance objectives for the site. These may include objectives for TSS, total phosphorus (TP), orthophosphate (OP), copper (Cu), zinc (Zn), and other unique parameters that are not part of the required Filtration MTD testing. Including these unique parameters as performance objectives would either limit the MTD drainage area to portions of the site where these parameters are not a concern or limit the availability of MTDs for consideration to those that sampled and analyzed for these parameters in their field testing programs.

Step 3: Establish operational objectives and submission requirements for the proposed MTD and site. These may include inspection and maintenance frequencies, maintenance cost, personnel and health and safety requirements for maintenance (e.g. confined space requirements, materials storage and handling), estimated MTD life cycle, estimated filter life cycle and replacement costs, sourcing of replacement parts (e.g. local, overseas), and restrictions related to site characteristics such as hydraulic grade lines and weeping tile elevations.

Step 4: Compile relevant information from verified performance data and reports, manufacturer submissions, and jurisdictionally specific stormwater guidelines and criteria. Generate a short list of filtration devices based on the compiled information and the treatment performance and operational objectives for the site. Performance for each water quality parameter is expressed as a removal efficiency, effluent concentration/load, or both in testing reports and/or verification statements. The lower 95th percent confidence interval of the tested mean removal efficiencies must be equal to or greater than the removal efficiency treatment objectives and/or the upper 95th percent confidence interval of the tested mean effluent concentrations must be equal or less than the effluent concentration treatment objectives. Head loss and water level measurements in the upstream sewer during field testing will indicate the flow conditions during which water and sediment will back-up in the upstream sewer (assuming a similar pipe configuration).

Step 5: Confirm whether the Filtration MTDs under consideration for the site are to be installed on-line or off-line. On-line installation requires that the unit includes an internal bypass that diverts all flows above the maximum treatment SLR over or around the treatment chamber. The maximum treatment surface loading rate is determined during field testing and is equal to the highest measured flow rate that can be conveyed through the Filtration MTD prior to passing over the unit's bypass weir or diversion component. If the influent TSS concentration is found to be lower than the effluent TSS concentration during verified field testing, then scour occurs at the observed flow rate. In this instance, the unit would be installed off-line with a diversion structure upstream of the unit that diverts all flows greater than the flow rate during which scour was observed to be routed around the unit.

As with OGS, verification statements for Filtration MTDs published after this PAS document is released will indicate whether or not the flow diversion component allows flows exceeding the maximum treatment SLR to bypass all deposition areas within the unit, thereby reducing the potential for filter degradation or scour of previously captured sediment. If the verification statement does not include this information, the function of internal bypass components can be visually evaluated from the schematic provided in verification statements and other detailed drawings provided by manufacturers.

Step 6: Confirm that either the proposed unit size is the same as the tested unit, or the larger or smaller unit meets the scaling rule in section 6.0 of the *Canadian Procedure for Field Testing of Filtration MTDs* (which is based on NJDEP, 2022), as follows:

> *"The performance results determined for the tested full scale, commercially available filtration MTD may be applied to other model sizes of that filtration MTD provided that appropriate scaling principles are applied. Scaling the tested filtration MTD to determine other model sizes and performance without completing additional testing is acceptable provided that:*
>
> 1. *The depth, composition, bulk density and gradation of media remain constant. The nominal pore size of membrane based filters remain constant.*
> 2. *The ratio of the system treatment flow rate to effective filtration treatment area (filter surface area) is the same or less than the tested filtration MTD; and*

3. *The ratio of effective sedimentation treatment area to effective filtration treatment area is the same or greater than the tested filtration MTD; and*
4. *The ratio of wet volume to effective filtration treatment area is the same or greater than the tested filtration MTD."*

This scaling rule helps ensure that the unit would achieve a level of performance similar to that of the tested unit despite differences in size. Filtration MTD verification statements completed after this PAS is published will include an indication of the models to which the testing can apply based on the scaling rules. If this information is not available in verification statements, the detailed calculations and model information can be sourced from manufacturers as part of their submission. Performance claims provided in verification statements of TAPE certification documents cannot be applied to models that do not meet the scaling rules. Therefore, these models should be modified to meet the requirements (e.g. modifying media depth, wet volume, filter size, etc) or removed from consideration at this stage.

Step 7: Ensure the unit is sized appropriately based on verified test data to meet or exceed the treatment objective established in Step 2 above. Sizing methods should be simple, conservative and easily replicated and understood by approval agency reviewers. While more complex modelling methodologies may be used, the final sizing recommendation should be consistent with or more conservative than that generated using simple methods, as the latter often implicitly include factors of safety and assumptions are more transparent. If less conservative sizing results from more refined modelling methods are to be accepted, a clear and concise rationale should be provided by the proponent to explain the key differences in assumptions and input parameters. If standard spreadsheet tools or models are used for sizing, these must adequately account for the considerable variation in design of Filtration MTDs.

A common treatment target for MTDs in Canada is to capture and treat at least 90% of the long term average annual runoff for a site (MOE, 2003, Alberta, 1999). Some jurisdictions may also base sizing on the 90th percentile storm (ranked by storm size) rather than 90% average annual runoff (volume based). As with OGS, sizing may vary considerably depending on the method used - 90% average annual runoff volume criteria, 90th percentile storm or design storms. If the treatment target is denominated as a removal efficiency (e.g 80% TSS removal), modelling based on the site characteristics, historical meteorologic data, and verified field test data will determine how much of the average annual runoff volume needs to be treated to meet the target.

Treatment performance for TSS is characterized within the testing *Procedure* (TRCA, 2023b) in terms of removal efficiencies and effluent concentrations, depending on the storm event influent concentration (Table 5.1). For instance, removal efficiencies would be calculated for storms with TSS influent concentrations between 100 to 200 mg/L with the goal that the lower 95th percent confidence interval of the mean TSS removal efficiency for these events is ≥80%. Similarly, events with TSS influent concentrations between 20 and 100 mg/L (or 50 to 100 mg/L for pre-treatment applications) would meet the performance target if the upper 95th percent confidence interval of the mean effluent concentration is ≤20 mg/L (or ≤50 mg/L for pre-treatment applications). Performance claims for TSS would also meet the treatment target regardless of removal efficiencies if the upper 95th precent confidence interval of the mean pollutant effluent concentration for all monitored events was ≤20 mg/L (or ≤50 mg/L for pre-treatment applications). For all parameters other than TSS the performance evaluation is based on the manufacturer performance claim either meeting the removal efficiency metric or the effluent concentration metric specified in Table 5.1 since there is only one influent concentration range specified.

Table 5.1: Performance criteria for removal efficiency (RE) and effluent concentration (EC) metrics at indicated influent concentration ranges

Parameter	**Influent Concentration Range (mg/L)**[1]	**Performance Criteria**[2]	
		Stand-alone	**Pre-treatment**
TSS or SSC	100 to 200	RE: ≥80%	RE: ≥50%
	20 to 100	EC: ≤25 mg/L	EC: ≤50 mg/L
Total Phosphorous (TP)	0.1 to 0.5	RE: ≥50%	RE: ≥30%
	same	EC: ≤0.03 mg/L	EC: ≤0.07 mg/L
Orthophosphate	0.04 to 0.3	RE: ≥50%	RE: ≥30%
	same	EC: ≤0.02 mg/L	EC: ≤0.05 mg/L
Total Nitrogen[3]	0.06 to 4.0	RE: ≥40%	RE: ≥25%
	same	EC: ≤0.05 mg/L	EC: ≤0.10 mg/L
Total Copper	0.005 to 0.02	RE: ≥50%	RE: ≥30%
	same	EC: ≤0.005 mg/L	EC: ≤0.010 mg/L
Total Zinc	0.020 to 0.3	RE: ≥60%	RE: ≥40%
	same	EC: ≤0.020 mg/L	EC: ≤0.040 mg/L

[1] As indicated in the field testing *Procedure* for Filtration MTDs, samples greater than the upper limit of the range may be used to calculate removal efficiencies by artificially setting the sample Event Mean Concentration (EMC) at the upper limit value. Including samples with influent EMCs greater than the upper limit is optional but if the option is chosen, all samples collected over the monitoring period that exceeded the upper limit value are included. Similarly, Samples of TP, TN, OP and metals with influent EMCs below the lower limit may be included as long as a well-reasoned rationale for a change in the specified lower limit is provided and the new lower limit is applied across the entire data set.

[2] Performance criteria for TSS are determined based on (i) RE and EC metrics for the indicated influent concentrated ranges, <u>or</u> (ii) the EC metric for all TSS samples at the 20 to 200 mg/L influent concentration range. For all other water quality parameters, the performance goal is met if the RE metric meets the goal <u>or</u> the EC metric meets the goal. Metrics are represented by the lower 95% confidence intervals of the mean value for RE and the upper 95% confidence of the mean value for EC. Verifications based on Washington TAPE certifications may only include performance assessments for dissolved metals, in which case a lower 30% RE value may be accepted for stand-alone treatment of dissolved copper.

[3] Total nitrogen is calculated as nitrate (NO_3-N) + nitrite (NO_2-N) + Total Kjeldhal Nitrogen (TKN)

Assessing whether performance of Filtration MTDs meets performance objectives for the site based on verified testing reports will require the following information:

- Historical rainfall records (≤ 1 hour recording intervals, 15 minute preferred where available) from the nearest long term meteorologic station for months when temperatures are predominantly above 0°C. Data should be filtered to remove rainfall records less than the jurisdictionally relevant initial abstraction factor (e.g. 2 mm/h);

- Site drainage area size, impervious cover percentage and site runoff coefficient calculated based on pervious and impervious cover runoff coefficients relevant to the site drainage area (e.g. slope, soil texture) and jurisdiction;
- Treatment objective (normally denominated as a removal efficiency for water quality parameters of concern, but some jurisdictions may use effluent concentrations either in addition or instead of removal efficiencies) and location in drainage system (i.e. stand alone or as pre-treatment to other downstream BMPs); indicate whether upstream flow control is provided, and if so, the type (e.g. parking lot storage, roof storage, pipe storage);
- Proposed model sizes and specifications (diameter or dimensions, internal sedimentation area, manufacturers recommended maintenance sediment storage depth, chamber depth, filter type and number, media composition – if relevant);
- Verification test results: lower 95^{th} percent confidence interval of mean pollutant removal efficiency for each water quality parameter; upper 95^{th} percent confidence interval of mean effluent concentration for each parameter; lowest measured bypass flow rate, head loss data, and other relevant operational parameters.
- Design TSS runoff concentration for the site or jurisdiction

As with OGS, the *Rational Method* can be employed to estimate flow rates discharged to the MTD for the site in question based on historical rainfall records and the selected recording interval (≤1 hour, 15 minute preferred where available). These flow rates are in turn used to calculate hydraulic and sediment mass loading to the selected Filtration MTD model.

The verified performance claims for water quality parameters of interest may be used for the proposed unit as long as the 90% long term average annual flow rate is below the maximum treatment flow rate measured during field testing, the installation adheres to the same design parameters measured in the field test (see Table 5.2), and is scaled appropriately using the rules noted above. The design TSS runoff concentration may vary from the field test depending on the site and jurisdiction in which the unit is installed. The design TSS runoff concentration will affect sediment mass loading to the unit, inspection/maintenance frequency and filtration flux rates, which will need to be considered in the site specific MTD sizing calculations.

Table 5.2 lists key system design parameters that need to be considered in the application, sizing and scaling of devices for media and membrane filtration systems. For proposed projects, these design parameters (with the exception of the TSS runoff concentration) should match those determined through the verified testing program.

Table 5.2: Key system design parameters

Design Parameter	Description
System treatment flow rate	The treatment flow rate represents the maximum flow rate that was conveyed through the treatment chamber during field testing without bypassing. The system bypass rate is greater than the system treatment flow rate. When the system treatment flow rate is expressed per unit sedimentation area, it is referred to as the system treatment surface loading rate.
Maximum filtration flux rate or media infiltration rate	The maximum filtration flux rate is a measure of the maximum treatment flow rate per unit filter surface area. For devices with membrane or media cartridges the rate is provided both per cartridge and for the total filtration surface area (multiple cartridges). For devices with media filters where flows are conveyed vertically from top to bottom the rate is expressed as an infiltration rate for the system. In both instances, the maximum filtration flux rate is determined from field testing as the lowest measured treatment flow rate prior to the onset of bypass, which would typically occur just before required filter maintenance.
Minimum and maximum driving head requirements	The driving head represents the hydraulic head required for flow to be conveyed through the filtration system. The maximum driving head is the head required to convey flow at the maximum system treatment flow rate. The minimum and maximum driving head values are determined from head loss measurements during field testing.
Detention time	The detention time is the time required for water to be conveyed through the MTD at a given flow rate. It is influenced by the wet volume, or maximum volume in the MTD at a specified flow rate.
Design total suspended solids (TSS) runoff concentration	The suspended solids concentration in site runoff that is used to calculate sediment mass loading to the unit over the course of an average precipitation year.
Maintenance sediment storage depth and volume	The maintenance sediment storage depth/volume represents the storage depth/volume available for sedimentation either on top of the media filter or within the chamber housing the filter cartridges and pre-treatment chamber(s) (if applicable), as recommended by the manufacturer and confirmed through field testing. The sump depth is constant across different unit sizes, but the sump volume increases in relation to the effective filtration area, as per the scaling rule noted above.

The recommended maintenance frequency must adhere to the findings in the field test report or be shown through detailed design calculations to meet the approval agency maintenance interval requirements, with a buffer of safety added for uncertainties in site specific loads of sediment, gross solids and debris. MTD inspections may need to be more frequent at sites where the site runoff quality is likely to lead to faster clogging of system filtration components than was observed in the field test. Some runoff quality parameters that may enhance clogging potential relative to the field test results may include the presence of a larger mass of finer particles (silts and clays), higher organic matter content or hydrocarbon loading, and higher bacterial loads, which can enhance the development of biofilms. The presence of more trash and debris than was observed in the field test may also warrant increasing the frequency of inspection and maintenance.

6.0 Limitations of the Guidance Document

This PAS provides guidance on how verified performance data for OGS and Filtration MTDs should be interpreted and considered in regulatory approval and procurement decisions for stormwater treatment applications. As such, the document does not specify jurisdictional criteria, nor should the recommendations be regarded as definitive. It is recognized that there may be contexts where the guidance needs to be supplemented or refined to account for site specific requirements or integrate with pre-existing approval criteria in certain jurisdictions. For instance, if regulatory criteria specify the use of a design storm for sizing and application of MTDs, the agency specified performance objective would need to be modelled based on verified performance data for the selected design storm rather than historical precipitation records, which would involve different calculations and procedures than provided in this PAS.

Further, the focus in this document on only two classes of technologies – OGS and Filtration MTDs – should not be interpreted as an endorsement of these technologies or suggest that other available stormwater practices would not be better suited to meet treatment objectives for a specific site. All available options should be considered and compared when evaluating how site specific stormwater goals can be met in a manner that optimizes achievement of performance criteria as well as other financial, social and technical considerations for the site in question.

7.0 References

Alberta Environmental Protection, 1999. *Stormwater Management Guidelines for the Province of Alberta*, Municipal Program Development Branch, Environmental Sciences Division. Pub No. T/378

Alberta Environment, 2001. *Municipal Policies and Procedures Manual*. Environmental Services, Environmental Sciences Division, Municipal Programs Branch. Edmonton. Alberta

Canadian Council of Ministers of the Environment (CCME), 1999. *Canadian Water Quality Guidelines for the Protection of Aquatic Life: Total Particulate Matter*, CCME, 1999. Publication No: 1299

ISO 14034:2016, Environmental management — Environmental technology verification (ETV)

ISO/IEC 17020, Conformity assessment - Requirements for the operation of various types of bodies performing inspection.

ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories

Massachusetts Department of Environmental Protection. 1997. *Stormwater Management Volume Two: Stormwater Technical Handbook*. Massachusetts.

New Jersey Department of Environmental Protection, 2022. Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device, New Jersey.

New Jersey Department of Environmental Protection, 2004. *New Jersey Stormwater Management Best Practices Manual, chapter 4. Stormwater Pollutant Removal Criteria*. New Jersey.

Ontario Ministry of the Environment, 2003. *Stormwater Management Planning and Design Manual*, Queen's Printer for Ontario.

Quebec, 2022. *Design Code of a Stormwater Management System Eligible for a Declaration of Compliance*. Environmental Quality Act, chapter Q-2, s. 31.0.6. Quebec Official Publisher.

Toronto and Region Conservation Authority, 2023. *Canadian Procedure for Laboratory Testing of Oil Grit Separators*: *A Publicly Available Specification*, Toronto, Ontario.

Toronto and Region Conservation Authority, 2023. *Canadian Procedure for Field Testing of Filtration Manufactured Treatment Devices: A Publicly Available Specification*, Toronto, Ontario.

Washington State Department of Ecology, 2018. *Guidance for Evaluating Emerging Stormwater Treatment Technologies-Technology Assessment Protocol—Ecology (TAPE)*, Olympia, Washington.

Appendix A: Terms and Definitions

Best Management Practice: Activities or structural improvements that help reduce the quantity and/or improve the quality of stormwater runoff.

Biofilm: A layer of bacteria, algae or other micro-organisms that forms on the surface of filter media and membrane filters. Biofilm formation can accelerate clogging of filters.

Bypass: An MTD design feature or upstream diversion structure that allows flow rates or flow volumes higher than a predetermined flow rate to be routed past the stormwater treatment technology without receiving treatment.

Composite sample: Used to determine "average" loadings or concentrations of pollutants, such samples are collected at specified intervals, and pooled into one large sample. They can be developed based on time, flow volume, or flow rate.

Detention time: The theoretical time required to displace the contents of a stormwater treatment facility at a given rate of discharge (volume divided by rate of discharge).

Event Mean Concentration: Pollutant concentration of a composite of multiple samples (aliquots) collected during the course of a storm. The Event Mean Concentration (EMC) is proportioned according to flow and depicts pollutant levels from site over an entire runoff event.

Effective filtration treatment area: The surface area of the filtration media or membrane perpendicular to the flow path. For vertical media filters where flow enters from the top, it is the surface area of the filter.

Effective sedimentation treatment area: The entire area within the MTD where sedimentation occurs, including any pre-treatment chambers or areas where sediment is known to collect outside of the primary sediment capture and storage location.

Filtration: Use of media such as sand, perlite, zeolite, and carbon, or membranes to remove total suspended solids (TSS) and associated pollutants from runoff through mechanical processes and adsorption. Some media such as activated carbon or zeolite can enhance the removal of hydrocarbons and soluble metals. Filter systems can be configured as basins, trenches, cartridges or membranes.

Filtration Manufactured Treatment Devices: Filtration MTDs are structures with one or more chambers with filtration media, membranes and/or filtration cartridges that remove solids and debris/trash from runoff. Some units may have oil separation functions and pre-treatment chambers for coarse sediment and debris. The filter components are designed to remove the coarse and fine sediment fraction of suspended solids and associated pollutants in stormwater runoff and may also target removal of dissolved pollutants such as phosphorus or metals through biological and/or chemical processes.

Head Loss: The difference in static water pressure upstream and downstream of a structure. Head loss is influenced by material roughness, flow velocity, system eddies, direction of flow and flow path length.

Initial Abstraction: The initial abstraction for a given catchment is an assumed stormwater loss, measured as a depth of rainfall over the catchment, which occurs during the initial stages of the storm and continues until the total rainfall equals the assumed initial abstraction or loss. The runoff generated from an impervious catchment is equal to the rainfall minus the initial abstraction factor.

International Organization for Standardization (ISO) Environmental Technology Verification (ETV) Standard: ISO 14034:2016 specifies principles, procedures and requirements for ETV and was developed and published by the *International Organization for Standardization (ISO)*. The ISO ETV standard specifies that technology operating conditions must be clearly specified, and the performance parameters must be measurable using quality-assured test procedures and analytical techniques. The objective of ETV is to provide credible, reliable, and independent verification of the performance of environmental technologies. An environmental technology is a technology that either results in an environmental added value or measures parameters that indicate an environmental impact.

Light Liquid: Liquid with a density no greater than 0.95 g/cm^3, which is completely, or nearly insoluble and unsaponifiable.

Maintenance Sediment Storage Depth and Volume: The maintenance sediment storage depth and volume of a MTD represents the amount of sediment that can accumulate in the MTD prior to maintenance, as recommended by the manufacturer or approval agency.

Method detection limit: The smallest concentration at which the true physical and chemical characteristics of a target analyte or parameter can be measured and statistically distinguished from zero at a specified confidence level (usually 99%).

Off-line: An MTD configuration in which flow rates greater than a set value are routed around the MTD via an upstream bypass or diversion structure.

Oil-Grit Separator: Treatment devices consisting of one or more chambers with internal components that remove high specific gravity particulates by sedimentation and low specific gravity liquids and debris by floatation. These devices are also referred to as hydrodynamic separators.

On-line: An MTD configuration in which flow rates in excess of the maximum treatment surface loading rate are permitted to flow through the treatment chamber of the MTD.

Particle size: The effective diameter of a particle as measured by sedimentation, sieving, or micrometric methods.

Particle size distribution: The particle-size distribution (PSD) of a material, or particles dispersed in fluid, is a list of values that defines the relative amount, typically by mass, of particles present according to size.

Quality Assurance: The planned and systematic activities implemented within a quality system that can be demonstrated to provide confidence that a product or service will fulfill requirements for quality. ISO 14034:2016 ETV refers to a test plan with quality-assured test procedures and analytical techniques. The quality assurance components of the field test plan are the procedures and methods used to collect and analyze monitoring data to ensure results are scientifically defensible and meet the objectives outlined in the verification plan. The State of Washington Department of Ecology's *Technology Assessment Protocol – Ecology* (TAPE) uses the term "*Quality Assurance Project Plan*" (QAPP).

Rational Method: The Rational Method expresses the relationship between rainfall intensity and drainage area as independent variables to the peak runoff rate resulting from rainfall as the dependent variable. The method has been used for over 100 years and is useful for estimating runoff from simple, usually small drainage areas such as parking lots. The method calculates the peak rate of runoff from an area using the following formula:

$Q = 2.78\ C \cdot I \cdot A$

where Q is the Peak flow (L/s), A is the area (ha), C is run-off coefficient (dimensionless), and I is average rainfall (mm/h) for a duration equal to the time of concentration for a particular storm frequency.

Stormwater Hot Spots: Areas where there are activities or practices that have the potential to generate high levels of stormwater pollutants.

Sump: The primary sediment capture and storage location in the MTD

Surface Loading Rate: Surface Loading Rate (SLR) - The SLR is a hydraulic loading factor expressed in terms of flow per surface area. This factor is also referred to as the surface settling rate, surface overflow rate or hydraulic loading rate. The SLR is computed as follows:

$$Surface\ Loading\ Rate = \frac{Flow(\frac{L}{minute})}{Effective\ Treatment\ Area\ of\ the\ Device\ (m^2)}$$

where the effective treatment area is the area in the MTD where sedimentation occurs.

Suspended Solids Concentration (SSC): The concentration of suspended sediments in a water column as defined by analytical testing in accordance with ASTM D3977.

System treatment flow rate: For filtration MTDs, the system treatment flow rate is the lowest measured flow rate prior to the onset of bypass, which is typically just before filter maintenance is required. For oil-grit separators, the system treatment flow rate is the maximum flow rate prior to the onset of bypass. Treatment flow rates are also expressed as treatment surface loading rates where the surface loading rate is the treatment flow rate per unit sedimentation area.

Technology Manufacturer: Technology intellectual property owner or licensee.

Test Plan: Prepared by the third-party Test Body and submitted to the Verification Body for review by the Verification Expert prior to the initiation of monitoring or technology performance testing. The term "Technology Specific Test Plan" (TSTP) is also used.

Total Suspended Solids (TSS): The concentration of suspended solids in a water column as defined by analytical testing in accordance with SM2504B/D. The TSS method is differentiated from the SSC method (see above) in that the former collects a sub-sample using a pipette from the whole sample container after stirring whereas the SSC method uses the whole sample.

Treatment System Bypass Rate: The rate at which flow begins to bypass the treatment chamber. The rate is often expressed as flow per surface sedimentation area.

Verification Body: The Verification Body (VB) is a third-party organization that administers the testing and verification process and acts as the point of contact for all questions relating to the verification. The VB and Verification Expert must meet the conformity requirements of ISO 17020 or equivalent.

Verification Expert: The Verification Expert (VE) is the third-party, impartial technical reviewer sub-contracted by the ISO 14034 VB to supply assessment and validation expertise and services. The VE may not both generate the required data and then assess/validate that same data for any one performance claim, as this would present a conflict of interest with respect to that verification. The VB and VE must meet the conformity requirements of ISO 17020 or equivalent.

Verification Plan: Prepared by the Verification Body to guide the verification process, specifying accountabilities and related quality requirements in accordance with the ISO 14034 ETV standard.

Verifier: The verifier is the organization that performs environmental technology verification (as defined in ISO 14034:2016). The term can apply to a Verification Body, a Verification Expert, or a combination of the two.

Wet Volume: The maximum water volume measured in the MTD during flow events monitored over the entire maintenance cycle.

Appendix B: Stormwater Technology Performance Testing and Verification - ISO 14034 ETV Requirements

1 INTRODUCTION

In November 2016, the International Organization for Standardization (ISO) published the standard, "ISO 14034:2016 Environmental management — Environmental technology verification (ETV)", specifying the principles, procedures and requirements for ETV. The ETV process provides independent confirmation of the performance of environmental technologies based on objective evidence, thereby supporting informed decision-making and facilitating market uptake of innovative technology-based solutions.

To ensure that verifications are performed and reported accurately in a manner useful to stakeholders, the ISO 14034 ETV Standard incorporates a number of key principles, including flexibility, credibility and transparency:

- **Flexibility** in specifying relevant performance parameters and test methods;
- **Credibility** in generating reliable performance data using robust, quality-assured test procedures;
- **Transparency** in assessing the evidence and verification results in reports that are clear, complete, and objective.

This summary provides information on applying the ISO 14034:2016 ETV Standard, including:

- A description of the ISO 14034 ETV process (Section 2); and
- An outline of roles and responsibilities in conducting ISO 14034 verification (Section 3).

It also includes guidance on:

- Submitting an application or request for ISO 14034 verification of technologies (Section 4);
- Preparing a suitable Verification Plan for verifying technologies (Section 5);
- Conducting third-party ISO 14034 verification of technology performance test results (Section 6); and
- Post-verification considerations (Section 7)

Independent, third-party verification of technologies using the ISO 14034 Standard offers a quality-assured, evidence-based process for evaluating the performance of technologies, thereby enhancing the effective demonstration and deployment of innovative technology-based solutions.

2 THE ISO 14034 ETV PROCESS

innovative environmental technologies provide technical solutions to address specific environmental challenges such as:

- Pollution prevention, control and remediation;
- Efficient use of resources, including their recovery and recycling;
- Climate change resiliency, adaptation and mitigation; and
- Environmental monitoring and surveillance.

ETV provides a credible, impartial account of the performance of technologies which contribute to the attainment of environmental objectives through:

- Specific, quantifiable environmental benefits (e.g., technologies with more beneficial or less adverse environmental impacts); or
- Superior measurement of environmental impacts (e.g., environmental monitoring and surveillance technologies).

The ISO 14034 ETV Standard provides a flexible pathway and user-friendly process to help innovators and developers gain stakeholder recognition and market acceptance of their technologies. At the same time, it is a useful tool which supports sustainability by providing credible, verified information on the performance of environmental technologies. The process is particularly effective for verifying the performance of technologies whose innovative features or technical and/or environmental benefits are not fully reflected in existing product standards. It is widely accepted that maximizing the relevance and usefulness of ETV results requires engagement and dialogue among technology proponents, verifiers and other affected stakeholders.

Figure 1 below illustrates the basic steps in the ISO 14034 ETV process. There are essentially five stages: Application, Pre-verification, Verification, Reporting, and Post-verification.

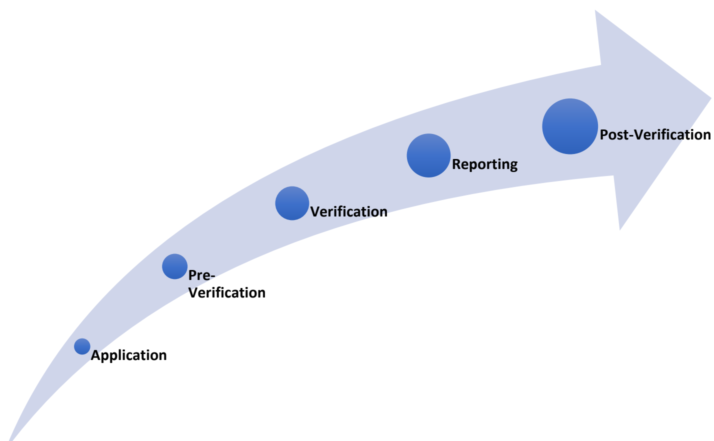

Figure 1 - ISO 14034:2016 ETV Process - Basic Stages (simplified)

The **Application** stage requires that sufficient information on the technology be provided in relation to specific performance parameters of interest, such that an initial verifiable technology performance claim can be formulated.

The **Pre-verification** stage focuses on the verifiability of the technology performance claim, the preparation of a suitable verification plan and the specification of test data requirements, including acceptable test procedures to generate the necessary data to support the technology performance claim.

The **Verification** stage involves acceptance of existing test data and/or the generation of additional test data (if needed), and confirmation of the technology performance claim based on the evidence obtained through the generation of independent test data.

The **Reporting** stage involves preparation of a verification report by an independent verifier. The verification report provides the essential information to be included in a verification statement.

The **Post-verification** stage is where the verification statement is issued, along with specific instructions on the conditions of use.

3 ROLES AND RESPONSIBILITIES WHEN CONDUCTING ISO 14034 VERIFICATION

3.1 Verifier

The verifier implements the verification process in accordance with the ISO 14034 standard. Beside the implementation of the verification procedures as specified in ISO 14034, performing verification includes:

- Receiving requests for verifications and conducting preliminary reviews of potential applications;
- Ensuring compliance of the verification process with the relevant Verification Plan and the proposed test requirements contained therein for any verifications;
- Where appropriate, requiring or validating test methods, witnessing tests, assessing and accepting test data provided by a test body, or by an applicant in the case of in-house testing, as compliant with the requirements set in the ISO 14034 and the relevant Verification Plan;
- Ensuring that all aspects related to confidentiality are addressed as required as per ISO 17020:2012;
- Providing technical advice to applicants in the context of the ETV procedures, as well as the definition of the performance claim, the choice of test bodies and the use of the Verification Statement within limits required to remain impartial in accordance with ISO/IEC 17020.

The verifier must be capable of conducting technology verification in a competent, credible manner.

To ensure consistency, reliability, objectivity and traceability in its work, the verifier should:

- Be a legal entity that is able to enter into contractual arrangement with the applicant;
- Comply with the requirements of ISO/IEC 17020 or by other means demonstrate compliance to section 4.2 of ISO 14034 to perform ETV;
- Be a third-party body independent of the applicant and of any other party interested in the verification. It is recommended that the verifier demonstrates its independence by meeting the requirements for Type A inspection bodies as defined in the normative Annex A of ISO/IEC 17020;
- Not be directly involved in the design, manufacture or construction, marketing, installation, use or maintenance of the specific environmental technologies submitted for verification, or represent the parties engaged in those activities. This pertains to the verifier, its top-level management and the personnel responsible for carrying out verification tasks. This should not preclude the use of environmental technologies that are necessary for the operations of the verifier or the use of environmental technologies for personal purposes;
- Ensure that the activities of its subsidiaries or subcontractors do not affect the confidentiality, objectivity or impartiality of its verification activities;
- Ensure that a process is in place to assess the quality of test data;

- Be capable of carrying out all the tasks assigned to it in the technology areas for which it is operating, whether those tasks are carried out by the verifier itself or by another entity on its behalf and under its responsibility;
- Take responsibility for the tasks performed by subcontractors and subsidiaries as agreed by the applicant.

The verifier may implement parts of the verification process through subsidiaries or sub-contractors, or as specified in ISO /IEC 17020:2012.

3.2 Test Body

The test body is an organization providing the means for test implementation, including performing and reporting on the testing of an environmental technology for the purposes of verification as specified in ISO 14034. A test body is responsible for:

- Entering into contractual arrangement with the applicant;
- Drafting the test plan, in accordance with the requirements included in the Verification Plan and in agreement with the verifier and the applicant. When several test bodies are involved without subcontracting arrangements between them, the verifier and the applicant may agree that one of the test bodies be given a coordinating role (for example, taking samples and elaborating a general test plan that applies to all test bodies).
- Performing the tests according to the test plan ensuring the level of quality required by ISO/IEC 17025 and the Verification Plan;
- Performing analyses, ensuring the level of quality required by ISO/IEC 17025 and the Verification Plan; and,
- Drafting the report on tests performed and providing it to the applicant and the verifier. The report on the quality of analytical data should include an analysis of measurement uncertainties and limits of detection.

To ensure consistency, reliability, objectivity and traceability in its work, the test body should:

- Be a legal entity that is able to enter into contractual arrangements;
- Have a management system in place capable of supporting and demonstrating the consistent achievement of the requirements of ISO/IEC 17025 relevant for the tests to be performed and assuring the quality of the test results. This includes documenting its procedures to the extent necessary to ensure competent, impartial and consistent testing and validity of the test results;
- Demonstrate compliance with ISO/IEC 17025 for the relevant analytical methods and analyses used for performance testing. The Verification Plan may add further testing requirements, if necessary, to ensure the quality of these tests and test data for the technology to be verified;
- Make available to the verifier upon request routine analytical quality control data;
- Participate in proficiency tests for the analyses used;
- Have competent test personnel that are independent of the verifier. In the case where the applicant performs the necessary tests in-house, the applicant is expected to fulfil the requirements described above for test bodies. The verifier should confirm this, for example by means of an audit;

- Be capable of carrying out all the tasks assigned to it in the technology areas for which it is operating, whether those tasks are carried out by the test body itself or by another entity on its behalf and under its responsibility;
- Ensure that the activities of its subsidiaries or subcontractors do not affect the confidentiality, objectivity or impartiality of its testing activities;
- Take responsibility for the tasks performed by subcontractors and subsidiaries.

It is important to note that the applicant in consultation with the verifier can designate the test body, to perform tests if needed. Although the designation of the test body is a decision made by the applicant, the applicant should consult with the verifier to ensure that the qualifications described above are met.

3.3 Applicant

The applicant initiates the ETV process upon initial contact with the verifier. The applicant is responsible for:

- Drafting the application for verification, providing the information necessary to plan and implement the verification process as specified in the ISO 14034 standard;
- Reviewing and agreeing to the Verification Plan and test plan(s);
- Providing timely access to the technology, accessories, user manuals and training related to the use and operation of the technology, if relevant;
- Reaching a consensus with the verifier in defining, as a minimum, the final set of parameters, their numerical values and ranges to be verified as well as the requirements, including testing methods, conditions and limitations for the verification to be included in the Verification Plan;
- Reviewing the test report(s), verification report and Verification Statement;
- Complying with the requirements pertaining to the use of the Verification Statement;
- Selecting and contracting with the test body.

If the assessment of the existing test data results in the need for further tests to be done, the applicant may need to perform the necessary tests. In the case when the applicant will perform the testing in-house, the applicant must comply with the roles and responsibilities of a test body described in 3.2 above.

The applicant can be any legal entity or person, which can be the technology developer, manufacturer, provider, or legally authorized representative.

With the consent of the technology developer/provider/manufacturer, the applicant can be another stakeholder undertaking a verification process involving several technologies (e.g., as part of a pre-procurement procedure).

4 ISO 14034 VERIFICATION APPLICATION REQUIREMENTS

4.1 Submission of an Application or Request for Verification

As indicated in Figure 1, the Application stage is the first step in the ISO 14034 verification process. It requires that sufficient information on the technology be provided in relation to specific performance parameters of interest, such that a verifiable technology performance claim can be formulated. The use of an "Application for Verification" form is an effective way to document the essential information required for ISO 14034 verification.

ISO 14034 verification of a technology performance claim requires the applicant or proponent (i.e., technology developer/provider/manufacturer) to provide reliable, high quality data on the technology. For a technology to be eligible for ISO 14034 verification, the performance claim must be specific and unambiguous. The claim must clearly specify the minimum and maximum performance that is achievable with the technology. The performance claim must also specify the applicable operating conditions and be measurable using acceptable test procedures and analytical techniques. An independent, third-party testing organization must collect the data and an independent accredited laboratory must analyze test samples.

The procedure for applying for or requesting ISO 14034 verification requires that the applicant and the verifier take into account the following:

- The completeness, relevance and quality of the technical documentation supporting the description of the technology;
- The innovativeness of the technology and its market readiness;
- The environmental added value of the technology;
- The performance parameters to be verified and the quality of the performance claim;
- The availability of test methods to generate verifiable performance data;
- The establishment of contractual arrangement between the verifier and the applicant.

Stakeholder engagement and involvement are important for ensuring that local needs and related social impacts are adequately addressed in the determination of relevant performance parameters for performance verification.

A documented "Application for Verification" helps ensure that the technology is verifiable in relation to performance parameters that are relevant and sufficient under defined operating conditions. Technical information provided by the applicant as part of its application, may include:

- The conceptual design of the technology and a description of the technical and scientific principles relevant to the performance and operation of the technology;
- Manufacturing drawings or similar schematics presenting components, sub-assemblies, circuits, etc., with descriptions and explanations necessary for the understanding of those drawings and schematics and the operation of the technology;
- Relevance, validity and precision of the operating conditions and limitations for which the minimum claimed performance is achieved;
- A description of the measures taken to ensure the consistency of the performance of the technology under normal conditions of production when the technology is available on the market;
- Technology operation and maintenance manual or marketing materials when the technology is ready for market but not yet available on the market;

- Health and safety requirements during installation, start-up, operation, maintenance and/or shutdown of technology, including safety data sheet of chemicals to be used.

The application procedure typically involves establishment of a contractual arrangement between the applicant and the verifier. The contract ensures that the conclusions made during the review of the application are clearly established and the roles and responsibilities of both parties in the verification process are clearly defined. Moreover, the contract should ensure that there is a clear and demonstrable understanding between the verifier and the applicant about the scope of the work to be performed when conducting the verification.

Prior to initiating an application for verification, the verifier may choose to consult with the applicant. The consultation should be conducted in a practical and efficient manner that does not duplicate the activities and requirements of the application procedure. It may involve an on-line form or a questionnaire to be completed by the applicant.

Objectives of the “pre-consultation” would be to obtain background information on the technology from the applicant to allow the verifier to make a decision on the ability of the verifier to enter into a contractual arrangement to conduct the verification. This would include determining whether the technology considered for verification falls under the verifier's area of technological expertise. If the verifier does not possess the necessary expertise or resources to verify a specific technology, the applicant should be referred to another verifier with the relevant technology scope and capabilities.

Additionally, the preliminary consultation could help the verifier make an initial assessment as to whether or not the technology is likely to meet the requirements of the application process, as well as understand the applicant’s expectations concerning the performance of the technology to be verified. The consultation may also provide the applicant with some initial indications about the complexity of the verification process including the possible requirements for additional testing to generate data for verifying the performance claim, the potential range of costs of the verification, and whether the technology would benefit from undergoing ETV.

4.2 Reviewing the Application or Request for Verification

When reviewing the information submitted by an applicant and checking for compliance with the requirements specified in the ISO 14034 standard, the verifier should consider if the information provided by the applicant is sufficient to properly determine the market readiness of the technology, and its operation and performance in relation to its intended application and the performance to be verified. The verifier may request the applicant to provide additional technical documentation supporting the description of the technology in order to assess the adequacy of the technology design, its operation and performance in relation to the performance claim.

To meet the requirements specified in ISO 14034, the verifier needs to consider the quality of the performance claim. The primary objective is to ensure that the performance claim includes performance parameters and numerical values that are relevant to the interested parties, possibly considering relevant regulatory requirements, intended applications, key environmental impacts and the performance of technologies that feature similar functions or are currently used in similar situations.

When assessing the quality of the performance claim, the verifier should ensure that there is sufficient information to assess:

- Completeness and relevance of the performance parameters in relation to the environmental impacts of a technology and/or results of its intended application;
- Clarity in the way the parameters are expressed;
- Reference of the parameters to existing standards and the possible relevant regulatory framework specific for the technology, as well as the state-of-the-art performance of similar technologies;
- Relevance, validity and precision of the operating conditions for which the minimum claimed performance is achieved;
- The performance and impact information needs of the interested parties, including additional parameters which do not support the performance claim but may provide information relevant for the user.

The result of the assessment should help the verifier ensure that the performance claim provided by the applicant is complete, properly expressed and sufficient to perform verification, as well as establish the performance parameters and their numerical values to be verified. The assessment should also allow the verifier to specify, in conjunction with the applicant, the technical and operational details of the planned verification within the context of a Verification Plan (as required in ISO 14034). Requirements for the testing conditions should be representative of the operating conditions under which the minimum claimed performance is achievable. Any conclusions on the need to modify or supplement the performance claim (e.g., limitations or conditions under which the performance claim will be considered valid), should be communicated to the applicant and further considered during the specification of the performance parameters to be verified in support of the claim.

Assessing the environmental added value of a technology determines whether the technology complies with the definition of an environmental technology. When reviewing the application, the verifier should assess the adequacy of the information provided by the applicant concerning the significant environmental impacts of the technology relative to relevant alternatives at their different stages of life, taking into account the differences in parameters relevant to those impacts.

The applicant should define the life stages relevant for demonstrating the environmental impacts (both positive and negative) of the technology to be verified in comparison to the relevant alternative(s) in dialogue with the verifier. Individual life stages to be considered may include:

- Acquisition of materials and natural resources needed to manufacture the technology;
- The way the technology is designed, manufactured, used and operated; and
- The end-of-use stage of the technology.

Examples of the environmental impacts considered at the life stages of a technology to be verified in relation to the relative alternative(s) may include:

- Consumption of natural resources;
- Water and energy consumption;
- Emissions to air, water and soil;
- Generation of waste (including. hazardous waste); and
- Noise.

Whenever possible, the significant environmental impacts considered should be expressed as parameters with quantitative information, particularly in relation to the manufacturing and use stages of the technology. If quantitative information is not available, qualitative information may be provided.

Assessment of the environmental added value may supplement the specification of the performance to be verified during verification planning by identifying environmental parameters that are relevant for the technology that may not have been provided by the applicant as part of the Application for Verification. Moreover, the assessment may indicate additional environmental parameters of the technology relevant to the interested parties that, although not verified, could be included in the statement of verification (e.g., ease of dismantling for the purpose of recycling and recovery of materials at the end-of-use stage).

It is also possible that a technology may, despite significant environmental added value, result in negative environmental impacts. When the assessment shows that the positive environmental impacts of a technology do not at least balance its negative impacts compared to a relative alternative, the verifier and the applicant should mutually determine if the verification should proceed.

4.3 Feedback to the Applicant/Proponent

The final outcome of the assessment should contribute to the final decision of the verifier to: Recommend the technology for verification; or Not recommend technology for verification, with an explanation justifying the decision. As noted above in 4.2, any conclusions on the need to modify or supplement the performance claim should be communicated to the applicant.

5 ISO 14034 VERIFICATION PLAN REQUIREMENTS

Upon confirmation that the applicant wishes to proceed with technology verification, a Verification Plan consistent with the ISO 14034 Standard is developed by the verifier. The Verification Plan describes the verification procedure specific to the technology and the performance to be verified. It explains how the verification is to be conducted, including the performance to be verified, and all relevant requirements on tests and test data (e.g. test method selection, test design, data quality, data assessment, etc.). The following information should be included in the Verification Plan:

- Date of issue;

- Identification of the verifier;
- Identification of the applicant;
- Description of the technology;
- List of performance parameters and their assigned numerical values and the description of how they will be verified;
- Technical and operational details of the planned verification;
- Specification of the requirements for the test data, including quality and quantity and testing conditions;
- Description of methods for the assessment of the test data and their quality.

5.1 Specification of Performance to be Verified

Specification of performance to be verified is central to the Verification Plan as it determines further procedures related to the verification process, including the testing requirements and, if applicable, the need to generate additional test data. As a result of its review of the Application for Verification, the verifier may determine the need to modify or supplement the performance parameters to be verified originally proposed by the applicant.

5.2 Specification of Test Data Requirements

An essential component of the Verification Plan is the definition of the requirements for test data. The details in the Verification Plan should be sufficient for the verifier to assess the test data provided by the applicant. The data should be relevant to the application and performance of the technology. If this is not the case, the Verification Plan should include provisions for testing. To enable the final data assessment and completion of the verification process, the test data requirements in the Verification Plan should address:

- Overall description of the test activities (e.g., continuous or batch tests, scale, test methods etc.);
- Scale (i.e., laboratory/simulated environment/field) and actual matrix used for tests, that should be the same matrix for which the verification parameters have been defined;
- Specific parameters to be measured;
- Methods to be used, including sampling, equipment requirements (e.g., calibrations type and frequency), analytical sample blanks or standards, test and calculation methods, determination of uncertainty and statistical methods;
- Testing conditions;
- Data management;
- Quality assurance, including the possibility of test system audit where applicable.

Whenever possible the test methods used should be standardized (internationally or nationally) or provided in specifications recognized otherwise. In the absence of such standards, the test method should be determined by other means through dialogue with the applicant, the verifier and the test body. To the extent possible, the choice of the method should be explained, especially where several methods are applicable. If specific requirements for analytical methods or their performance have been identified as necessary, these should be provided.

If a non-standardized test method is to be applied, the means of its validation should be described (e.g. based on relevant ISO/IEC 17025 requirements for test method validation).

The Verification Plan should specify parameters for testing and verification that relate to the intended application of the technology. These may include:

- Specific parameters pertaining to the characteristics of the material(s) that the technology is intended to address;
- Operational parameters, together with their numerical values, typically provided in ranges which should be controlled and measured during testing; and
- Limitations and constraints that apply to the testing.

The verifier should ensure that the test site(s) is defined by the test body in accordance with the requirements specified in the Verification Plan. The verifier should ensure that the test plan includes a description of the test site(s) and the reasons for selecting the test site in relation to the targeted application(s) and material(s) that the technology is intended to address, taking into account the purpose of the technology and the operational parameters defined for the verification. The description should include any information required for the test staff to access the site.

If the technology under verification is installed and operated at a field site, the verifier should ensure that the test body's choice of site implies no commercial or other interests possibly influencing the test results. In particular, the verifier should ensure that the field site is not dependent upon the applicant. If a site dependent upon the applicant is the only option available, the use of that site should be justified in the test plan, and the verifier should ensure that the test body implements precautions such as access logging to ensure and document that the test results were not under undue influence.

5.3 Interested Parties

In some cases, the expectations of the interested parties (e.g. regulatory bodies, end-users, funding bodies, policy makers, industrial associations, etc.) may be different than the effective values specified in the performance claim proposed by the applicant. Interested parties may be interested in additional performance parameters and operational requirements. Therefore, the verifier should assess if the information provided by the applicant, including the technology performance parameters to be verified, is sufficient to address the needs of the interested parties and the requirements within the intended target market. This may be the case for the procurement of innovative technologies, or for identifying technologies that address the specific needs of a target group. In such cases, the verifier may propose modifications to the performance parameters.

It is not the verifier's role to assess compliance with legal requirements in the jurisdiction(s) where the technology is being marketed or sold; this is the responsibility of the applicant. Therefore, caution is recommended to avoid verifying technologies that do not comply with the regulatory requirements in the intended target markets.

5.4 Constraints and Limitations

During verification planning, the verifier in consultation with the applicant should determine the constraints and limitations that apply to the technology use, operation and performance to be verified. The constraints and limitations will have an impact on specifying the requirements for the test data supporting the performance to be verified.

The Verification Plan should specify the intended application and operational conditions. These should be identical to those conditions for which the test data is produced. Examples of possible constraints and limitations may include minimum capacity requirement for the technology to operate, ambient temperature ranges, servicing and maintenance requirements, detection limits, etc.

The Verification Plan should also include information on health, safety and environmental considerations, including possible training requirements to ensure that safety procedures are in place throughout the verification process to ensure protection of operators, the public and the environment.

5.5 Verification Schedule

The Verification Plan should include a schedule which can be used to monitor verification activities and track any deviations to the plan which ensures that system performance monitoring occurs during representative operating conditions. The schedule should allow for tracking of deliverables to maintain an efficient verification process within planned budgetary and resource allocations. Appropriate time should be factored into the schedule to address potential delays which might occur.

6 ISO 14034 VERIFICATION OF TECHNOLOGY PERFORMANCE RESULTS

Within the context of ISO 14034, a Verification Body must be recognized or accredited as competent to work to specified standards. ISO 14034 specifies that, when verifying the performance of environmental technologies, the requirements of ISO 14034:2016 and ISO/IEC17020:2012 “shall be applied and demonstrated”. As such, it is essential for verifiers to demonstrate the necessary capabilities for their defined scope and deal with the practical issues involved in conducting verifications, preparing verification reports and issuing Verification Statements.

Many of the criteria to determine competence in applying ISO 14034 are technical in nature. Judgment on whether a verification organization meets the requirements of ISO 14034 and ISO 17020 requires assessment by individuals with sufficient technical expertise. Currently, there are two options for demonstrating conformity with the requirements of ISO 14034 and ISO 17020:

- Through a peer assessment process designed in accordance with the requirements of ISO 17040 (General requirements for peer assessment of conformity assessment bodies and accreditation bodies); and
- Through ISO 17020 accreditation by a National Accreditation Body that is a member of ILAC. [1]

Pursuant to this, it is necessary for a Verification Body to have in place a framework and guidance to assist verifiers in verifying technology performance claims in a manner that aligns with the ISO 14034:2016 ETV standard. This includes guidance and specific procedures to be followed when performing independent verification of technology performance claims at the highest level of quality and credibility.

Specific tasks undertaken when verifying technology performance results include:

- Review of the Application for Verification;
- Detailed review of the technology;
- Review of the test plan and its implementation, including raw data sheets, sample security and chain-of-custody;
- Performance data review, analysis and interpretation;
- Confirmation of performance calculations;
- Analysis of measurement uncertainty and statistical analysis of the data in relation to the technology performance claim;
- Review of supporting documentation, including compliance with codes and standards, patents (where applicable), operations & maintenance manuals, certificates of analytical/test laboratory accreditation, other.

6.1 Confirmation of Data Quality

The verifier should evaluate the quality of the test data against the requirements defined in the Verification Plan as specified in the ISO 14034 standard and the general requirements specified in ISO/IEC 17025 that directly contribute to or influence the validity and quality of the tests and the resulting test data.

Requirements on data and data quality should refer to the quality level (e.g., reproducibility, repeatability, ranges of confidence, accuracy, and uncertainties) generally accepted by the scientific community for the technology, or in the industrial sector concerned. Relevant technical references should be provided, including applicable standardized test methods (preferably international standards) used for test data generation. In validating the test methods and the operational and statistical significance of the test data, the verifier should confirm the assumptions and the applicability of the statistical tools used to evaluate the test data.

[1] ILAC (International Laboratory Accreditation Cooperation) is the international organization for accreditation bodies operating in accordance with ISO/IEC 17011 and involved in the accreditation of conformity assessment bodies including calibration laboratories (using ISO/IEC 17025), testing laboratories (using ISO/IEC 17025), medical testing laboratories (using ISO 15189), inspection bodies (using ISO/IEC 17020) and proficiency testing providers using ISO/IEC 17043.

This refers to both the reporting of existing test data and new test data generated during the verification process. In the case of existing test data, the verifier should confirm the quality of the test data by checking documentation, including the test plan used for data generation, raw test data, quality control during data generation, and the test report.

If relevant, the verifier may perform an assessment of the test system that generated the test data. When performing test system assessment, the verifier should focus in particular on the issues specified in ISO /IEC 17025 that may directly contribute to or influence the quality and validity of the tests and produced test data, for example:

- Resources, including - Personnel involved in the testing; facilities and equipment used for testing; metrological traceability; environmental conditions of test performance; and use of externally provided products and services if applicable (as in the case of subcontracting).
- Process requirements, including - Validation of methods; sampling; handling of test or calibration samples; maintenance of technical records; evaluation of measurement uncertainty; validation of test results; reporting of results; control of data; and information management.

In the event that the test body producing the test data was accredited according to ISO/IEC 17025 for the relevant methods of testing and calibration at the time of production of these test data, it may be presumed to comply with the requirements of ISO/IEC 17025.

6.2 Confirmation of Technology Performance

The verifier reviews the performance claim and the test data to determine whether the data meet the objectives of the verification process and the requirements as outlined in the Verification Plan. The data related to the technology performance must be of sufficient quality and quantity to permit statistical analysis of the data in relation to the performance claim. The verifier should confirm the assumptions and the applicability of the statistical tools used to evaluate the test data.

The result of the verification should be a confirmation of the performance of the technology, achieved under the same conditions, constraints and limitations as those specified in the Verification Plan.

In some cases, the technology performance achieved, as verified using the test data qualified to be used for verification, may not match the performance originally anticipated by the applicant in the performance claim provided in the application. In such a case, the actually achieved performance should be considered the verified performance and be confirmed and documented by the verifier.

6.3 Verification Report

The verification report compiles or summarizes all information relevant for the verification and includes all relevant documents produced during verification process as appendices. If the verification procedure is not completed, the applicant is informed of this.

In some instances, it may be of use to include information regarding the technology, its applications, or other information that may provide context for the market or interested parties. In many cases, the verifier will not verify this additional, supplementary information. When such information is included in a report and is not verified it must be clearly identified to ensure that the user of the report does not assume it has been verified.

7 POST VERIFICATION

7.1 Verification Statement

The Verification Statement should include any information necessary to understand and use the verified performance claim. If the statement includes any additional information not verified during the ETV process, this should be clearly stated and explained.

The following information should be included in the Verification Statement:

- Unique identification of the statement and date of issue;
- Identification of verifier;
- Identification of applicant;
- Summary description of technology;
- Summary of how Verification Plan requirements were met;
- Summary of deviations (if any);
- Summary of verification results including verified performance;
- Other information to understand and use the verification statement;
- Signature of verification body.

The Verification Statement may include a disclaimer related to legal compliance of the verified technology (e.g., "Unless stated otherwise, this verification has not evaluated and cannot guarantee compliance with specific legal requirements. Ensuring legal and regulatory compliance is the responsibility of the applicant").

When the verification procedure is not completed, a Verification Statement is not produced.

7.2 Publication and Posting of the Verification Statement

This section on publication refers principally on the availability of the verification statement for key stakeholders but also for public disclosure. The availability of this information is mandatory. There are no specific requirements on how it should be made publicly available, but the verification statement could be posted on the verifier's website and the applicant's website, as well as by other parties involved in the verification. Making the verification statement available in different ways can assist in generating awareness about and marketing the verified technology.

Although it is not specifically mentioned in ISO 14034, logos or trademarks could also be used for marketing purposes. It is understood that the legal usage of any potential logos would be included in any contractual arrangements with the applicant and the party owning the rights to the logo. The owner of the logo rights would follow-up and enforce the proper use of these in contractual agreements. For example, follow-up and enforcement of verified technologies can include ensuring the proper use of ETV logos or setting time limits on license agreements for usage of logos. It is however important to indicate that the value of ETV does not lie within a logo or a trademark. Being “ETV verified” has no meaning without the clear mention to what has been verified which information is part of the verification statement.

Therefore, the logo should be used in well-defined conditions, specifying clearly what has been verified. The proposer would therefore not use the ETV logo alone either on products or on published (printed, web or other) matter, other than with the verification. Consequently, the logo could be used on publications together with reference to the verification statement as long as the meaning of ETV is correctly reflected by the publication, avoiding confusion with endorsement or approval of the technology.

7.3 Validity of the Verification Statement

A primary objective post-verification is to ensure that all parties have confidence in the verification process and the validity of the Verification Statement.

Often, verified technologies change over time due to ongoing improvements and upgrades. Within that context, the role of the verifier is to ensure that appropriate mechanisms are communicated to the applicant such that the applicant is informed that the verification statement remains valid and applies only to the same technology that was originally verified, and that the applicant should monitor their technology and inform the verifier of changes that may impact the verification statement. This could be done by inclusion of appropriate provisions in the contractual arrangements with the applicant.

There are various valid approaches and methods to ensuring validity of verification is maintained, which include, for example, establishing verification expiration dates or contractual notification requirements. It is up to the verifier to establish these requirements and ensure applicants are aware and obligated to perform them.

Appendix C: Information Forms for Verified MTDs

The following two forms may be used to list important performance and operational data for verified stormwater treatment MTDs in order to help facilitate the process of selection, design review and approvals. The forms would require updating when new products complete ETV verifications.

Oil Grit Separator MTDs: ISO 14034 ETV Performance Results and Operational Parameters

Parameter		OGS A	OGS B	OGS C	OGS D etc..
Verification Date					
Model Tested					
Sediment Removal Testing					
Surface Loading Rate (L min^{-1} m^{-2})	40				
	80				
	200				
	400				
	600				
	1000				
	1400				
	optional				
Sediment Scour Testing					
Surface Loading Rate (L min^{-1} m^{-2})	200				
	800				
	1400				
	2000				
	2600				
Light Liquid Retention Testing					
Result or Not Tested					
Operational Parameters					
Head Loss (mm) as a function of surface loading rate (L min^{-1} m^{-2})					
Stage discharge curve					
Bypass Rate					
Internal Bypass (yes/no)					
Internal Bypass provides complete bypass of sedimentation areas and filter components? (yes/no)					
Floatables/ light liquid capture chamber volume per unit sedimentation area (m^3 m^{-2})					
Maintenance Access Requirements					
Specify models that meet scaling requirements (all models or list of models)					

Maximum number of inlets				
Restricted uses (e.g. stormwater 'hot spots', high water table, units with submerged inlets or temporary backwater may interfere with hydraulic grade lines, etc)				
Maintenance Considerations				
Inspection Frequency (months)				
Maintenance Frequency (months)				
Maintenance Access Requirements				
Specialized components that may require more frequent inspection and/or maintenance (*e.g.* debris screens, inserts, weirs)				
Maintenance Personnel requirements				
Health and Safety Considerations				
Annual O&M cost per MTD sedimentation area				

Filtration MTDs: ISO 14034 ETV or TAPE Performance Results and Operational Parameters

Parameter	**A**	**B**	**C**	**D etc.**
Verification Date				
Verification Program				
Reports submitted				
Model tested				
Filter type (e.g. media, membrane)				
Water Quality Performance				
Lower 95th percent confidence interval of mean TSS removal efficiency				
Upper 95th percent confidence interval of mean TSS effluent concentration				
Lower 95th percent confidence interval of mean TP removal efficiency				
Upper 95th percent confidence interval of mean TP effluent concentration				
Lower 95th percent confidence interval of mean OP removal efficiency				
Upper 95th percent confidence interval of mean OP effluent concentration				
Lower 95th percent confidence interval of mean Nitrate removal efficiency				
Upper 95th percent confidence interval of mean Nitrate effluent concentration				

Lower 95th percent confidence interval of mean TKN removal efficiency				
Upper 95th percent confidence interval of mean TKN effluent concentration				
Lower 95th percent confidence interval of mean Cu removal efficiency				
Upper 95th percent confidence interval of mean Cu effluent concentration				
Lower 95th percent confidence interval of mean Zn removal efficiency				
Upper 95th percent confidence interval of mean Zn effluent concentration				
Operational Parameters				
System treatment flow rate (L sec^{-1})				
System treatment surface loading rate (L sec^{-1} m^{-2})				
Maximum and Maintenance Sediment Storage Depth (m) and Volume (m^3)				
Maximum filtration flux rate (per cartridge) or media infiltration rate (L sec^{-1} m^{-2})				
Minimum and maximum driving head requirements (mm)				
Head Loss (mm) as a function of flow rate (L sec^{-1}				
Stage discharge curve				
Detention time (min)				
Inlet type (e.g. surface or subsurface; option for multiple inlets)				
Internal Bypass (yes/no)				
Oil spill/floatables retention chamber (yes/no)				
Pre-treatment chamber (yes/no)				
Infiltration design option (yes/no)				
Filter type (e.g. media filter, membrane filter)				
Available models meet scaling requirements (all models or list of models)				
For tested unit, (i) depth of media, composition of media, gradation of media (if relevant)				
(ii) ratio of maximum treatment flow rate to effective filtration treatment area				

(iii) ratio of effective sedimentation area to effective filtration treatment area				
(iv) ratio of wet volume to effective filtration treatment area				
Use Restrictions (*e.g.* stormwater hot spots, high water table, areas with backwater conditions in sewers, others that may be specific to unit design)				
Maintenance Considerations				
Inspection Frequency (months)				
Maintenance Frequency (as tested in months)				
Maintenance Access Requirements				
Maintenance Personnel requirements				
Health and Safety Considerations				
Annual O&M cost per MTD filter and per sedimentation area				
Filter replacement frequency and cost per filter				

Appendix D: Sample OGS Sizing Calculations

This appendix provides a sample method for sizing OGS. Some jurisdictions may have sizing procedures that differ from those provided here. Regardless of the specific procedures, they should incorporate laboratory results from ISO 14034 verifications and be based on historical rainfall records.

To evaluate whether a Proposed OGS Model will meet TSS Removal Claims based on the results of a Laboratory Tested Model the following calculations must be performed.

Rainfall analysis

1. Use hourly rainfall data for May 1 – October 31, for each available year (15 minutes if available)
2. Storm start (antecedent dry-period) and Storm end (post storm dry period) - 6 hours minimum with less than 1.0 mm of rain
3. Correct for abstraction for each storm event (eg. 2 mm)
4. Calculate percent volume for each hourly rainfall volume (15 minutes if available)
5. Calculate cumulative percent rainfall volume
6. Determine design intensity (mm/hr) for each 5% volume

To calculate design intensity first rank the rainfall intensity data (from lowest to highest). Then calculate the percent volume for each hour (or 15 minutes if available) as follows:

$$Percent\ volume\ = RFV\ /SUM(ARV)$$

where:
RFV = Rainfall volume (m^3)
ARV = All rainfall volume (m^3)

Calculate the cumulative percent volume by adding each percent volume to all those above it. Record the rainfall intensities for each 5% interval, this is your Design Intensity (see Table D1).

Table D1: Summary table showing the Design Intensity (mm/hr) for each 5% interval

Cumulative % Rainfall Volume	% Rainfall Volume	Design Intensity [mm/hr]
0%	5%	0
5%	5%	1.30
10%	5%	1.50
15%	5%	1.70
20%	5%	2.00
25%	5%	2.30
30%	5%	2.60
35%	5%	2.90
40%	5%	3.30
45%	5%	3.80
50%	5%	4.20
55%	5%	4.80
60%	5%	5.40
65%	5%	6.10
70%	5%	7.10
75%	5%	8.20
80%	5%	10.20
85%	5%	12.60
90%	5%	16.30
95%	5%	23.10
100%	5%	35.20

Performance Evaluation

This section will detail the calculations needed to determine the Cumulative TSS Removal (%) for a Proposed OGS Model. Calculations covered include:

1. *Peak Runoff Flow (L/s)*
2. *Design Flow to MTD (L/s)*
3. *Design Surface Loading Rate (L min^{-1} m^{-2})*
4. *TSS Removal: Evaluated TSS Removal (%) or Off-Line TSS Removal (%)*
5. *Incremental Removal (%)*
6. *Cumulative Removal (%)*

Peak Runoff Flow using the Rational Method

$$Peak\ Runoff\ Flow = CDA * RC * DI * 2.78$$

where:
CDA = Contributing Drainage Area (hectares)
RC = Runoff Coefficient (%)[1]
DI = Design Intensity (mm/hr)

[1]Runoff Coefficient is calculated based on the % Imperviousness of the CDA. Assume Runoff Coefficient of 90% for Impervious Surfaces and 30% for Pervious Surfaces.

Design Flow to MTD

Based on the MTD design the Peak Runoff Flow can be converted to the Design Flow to MTD (L/s) as follows:

- If installed in-line with NO flow attenuation/reduction, Design Inflow to MTD = Peak Runoff Flow
- If installed off-line OR WITH flow upstream attenuation/reduction,
  - When, Peak Runoff Flow < Max Treatment Flow, Design Flow = Peak Runoff Flow
  - When, Peak Runoff Flow >= Max Treatment Flow, Design Flow = Max Treatment Flow

Design Surface Loading Rate

The Design Surface Loading Rate (SLR) (L min^{-1} m^{-2}) can be calculated as follows:

$$Design\ Surface\ Loading\ Rate\ = DF\ * 60 * OGS\ SA$$

where:
DF = Design Flow (L/s)
OGS SA = OGS model Sedimentation Area (m^2)

TSS Removal

Based on the MTD design, the Total Suspended Solids (TSS) Removal (%) can be calculated as follows:

- If installed in-line, Evaluated TSS Removal (%) for each Design SLR interpolated from Tested % TSS Removal vs Tested SLR
  - Exception 1 - For Design SLR < Min Tested SLR, Evaluated TSS Removal = TSS Removal at Min Tested SLR
  - Exception 2 - For Design SLR > Max Tested SLR. In this case, removal efficiencies at 400 L min^{-1} m-^{2} greater than the maximum tested SLR are assigned a value of zero, the Evaluated TSS Removal is calculated as follows:

$$Evaluated\ TSS\ Removal\ = MT\ SLR * MT\ TSS/D\ SLR$$

where:
MT SLR = Maximum Tested Surface Loading Rate
MT TSS = Minimum Tested Total Suspended Solids Removal
DSLR = Design Surface Loading Rate

- If installed off-line calculate Off-Line TSS Removal (%) as follows:
  - When Design Flow to MTD = Peak Runoff Flow then Off-line % TSS Removal is equal to the Evaluated % TSS Removal
  - When Design Flow to MTD is less than Peak Runoff Flow, then Off-line % TSS Removal is calculated as follows:

$$Off-line\ TSS\ Removal\ = ETR * DSLR/PRF$$

where:

ETR = Evaluated TSS Removal (%)
DSLR = Design Surface Loading Rate (L min^{-1} m^{-2})
PRF = Peak Runoff Flow (L/s)

Incremental Removal

For incremental removal (%) the calculation is as follows:

$$Incremental\ Removal = RV * TR$$

where:
RV = % Rainfall Volume
TR = Evaluated TSS Removal (%) for In-line installations, Off-Line TSS Removal for Off-line installations (whichever is applicable)

Cumulative Removal

For Cumulative Removal (%) add the total each row to the sum total of the rows above it.

The Cumulative Removal for 100% of the rainfall is the Average Year TSS Removal Claim for the Proposed OGS Model (see Table D2).

Table D2: Calculation table

Average Year TSS Removal Claim			62.0%						
I	II	III	IV	V	VI	VII	VIII	IX	X
Cumulative % Rainfall Volume	% Rainfall Volume	Design Intensity [mm/hr]	Peak Runoff Flow [L/s]	Design Flow to MTD [L/s]	Design SLR [L/min/m^2]	Evaluated TSS Removal [%]	Off-Line TSS Removal [%]	Incremental Removal [%]	Cumulative Removal [%]
5%	5%	1.3	0.6	0.6	30	70%	N/A	4%	4%
10%	5%	1.5	0.7	0.7	35	70%	N/A	4%	7.0%
15%	5%	1.7	0.7	0.7	39	70%	N/A	4%	10.5%
20%	5%	2.0	0.9	0.9	46	67%	N/A	3%	13.8%
25%	5%	2.3	1.0	1.0	53	68%	N/A	3%	17.3%
30%	5%	2.6	1.1	1.1	60	66%	N/A	3%	20.6%
35%	5%	2.9	1.3	1.3	67	67%	N/A	3%	23.9%
40%	5%	3.3	1.4	1.4	76	66%	N/A	3%	27.2%
45%	5%	3.8	1.6	1.6	88	65%	N/A	3%	30.4%
50%	5%	4.2	1.8	1.8	97	65%	N/A	3%	33.6%
55%	5%	4.8	2.1	2.1	111	63%	N/A	3%	36.8%
60%	5%	5.4	2.3	2.3	124	64%	N/A	3%	40.0%
65%	5%	6.1	2.6	2.6	140	61%	N/A	3%	43.1%
70%	5%	7.1	3.1	3.1	163	63%	N/A	3%	46.2%
75%	5%	8.2	3.6	3.6	189	58%	N/A	3%	49.1%
80%	5%	10.2	4.4	4.4	235	60%	N/A	3%	52.1%
85%	5%	12.6	5.5	5.5	290	56%	N/A	3%	55.0%
90%	5%	16.3	7.1	7.1	375	56%	N/A	3%	57.7%
95%	5%	23.1	10.0	10.0	532	45%	N/A	2%	60.0%
100%	5%	35.2	15.3	15.3	811	41%	N/A	2%	62.0%

Verifying maintenance requirement

Verifying that a Proposed OGS Model will meet the approval agency maintenance requirements based on the results of a Laboratory Tested Model the Annual Sediment Volume (m^3) must be calculated as follows:

$$Annual\ Sediment\ Volume = SF * TSS\ RC * EMC * AAP * CA * 0.001/WD$$

Where;

SF = Safety Factor for clean out frequency (years) [a]

TSS RC = Average Year TSS Removal Claim (%) (see above)

EMC = Event Mean Concentration of 225 mg/L [b]

AAP = Average Annual Precipitation (m) for the closest Canadian Climate Normal to your location

CA = Catchment Area (m^2)

WD = Wet Density ($kg\ m^{-3}$) [c]

[a] Use 1.5 for operation and maintenance clean out target of once per year recognizing that the influent load includes gross solids and debris in addition to suspended solids

[b] Upper limit of influent TSS concentration used in the ISO 14034/ETV lab test of OGS MTDs

[c] Use 1230 based on MECP (2003) - SWMPD - Table 6.3 - Annual Sediment Loadings

Then the available storage volume of the Proposed Model must be calculated as follows:

$$Available\ storage\ volume = OGS\ SA * MRSAD$$

Where;

OGS SA = OGS model Sedimentation Area (m^2)

MRSAD: Manufacturer Recommended Sediment Accumulation Depth (m).

If the Annual Sediment Volume is less than the Available Storage Volume, then the Proposed OGS model meets the maintenance requirements.