Procedure for Laboratory Testing of Oil-Grit Separators

Prepared by:

Toronto and Region Conservation Authority

For:

The Canadian Environmental Technology Verification Program

September 2013
Revised: **June 6**, 2014 - Version **3**.0

PREFACE

In Canada and other jurisdictions, different regulatory agencies and permitting authorities may 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 and authorities can benefit from scientifically defensible, verifiable performance data applicable to a range of possible end use requirements and operating conditions.

The intent of this "*Procedure for Laboratory Testing of Oil-Grit Separators*" prepared by Toronto and Region Conservation Authority for the Canadian Environmental Technology Verification Program is to provide a common procedure for testing and verifying the actual performance of treatment devices under controlled conditions, in an independent, transparent manner. It is anticipated that independent verification of the performance data will assist regulatory agencies, permitting authorities and other affected stakeholders in evaluating treatment technology options.

Although the proposed performance testing procedure is not intended to be a compulsory standard, it does represent an effective approach for conducting testing in order to produce verifiable performance data on specific technologies under defined operating conditions. Environment Canada's *Canadian ETV Program* supports the use of this protocol to reduce uncertainty and improve acceptance of independently generated performance data, thereby contributing to informed technology decisions.

It is understood that the ultimate decision to approve, select and implement a particular technology rests with the technology buyer, guided by the requirements of the respective permitting authorities within the affected jurisdiction(s). As stated in the document, "application of this procedure will assist in the calibration of hydraulic models that can be applied by regulators and the regulated community to predict the effectiveness of these devices in meeting regulatory goals and other storm water management requirements." The Canadian ETV Program *General Verification Protocol* (GVP) guides the verification process, accountabilities and related quality requirements.

ACKNOWLEDGEMENTS

This lab testing procedure was prepared by Toronto and Region Conservation, for the Canadian Environmental Technology Verification Program, with assistance from a Technical Advisory Committee made up of the following government and industry representatives:

John Antoszek – Ontario Ministry of the Environment
Derek Berg – Contech
Darryl Bonhower - City of Moncton
Nigel Bosworth- Point Source Processing
Martin Bouchard Valentine, Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs
Ted Bowering - City of Toronto
Graham Bryant – Hydroworks
Darlene Conway – City of Ottawa
Reagan Davidson – Imbrium Systems
Chris Denich, Aquafor Beech
Joel Garbon – Imbrium Systems
Bahram Gharabaghi - University of Guelph
Edward Graham - Civica Infrastructure
Jeff Guthrie - Environment Canada
Steve Hollingworth – The Municipal Infrastructure Group
Laurent Jolliet - City of Ottawa
David Kenth - City of Brampton
Patricia Lewis – Toronto and Region Conservation Authority
John Neate - Globe Performance Solutions
John Nemeth - Peel Region
Glenn MacMillan – Toronto and Region Conservation Authority
Jiri Marsalek - Environment Canada
John McMahon, District of West Vancouver
Chris Melanson - City of Ottawa
John Priamo - SCS Consulting
Rob Rainford - Echelon Environmental
Gilles Rivard – Genivar
JF Sabourin - JF Sabourin & Associates
Mark Smith – Canadian Infrastructure Products
Bert Van Duin - City of Calgary
Tim Van Seters – Toronto and Region Conservation
Mike Walters - Lake Simcoe Conservation

The procedure presented in this document builds on existing laboratory testing procedures for hydrodynamic separator manufactured treatment devices in the United States. The most notable of these is the *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device,* finalized on January 25, 2013.

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1.0 Introduction

This document specifies the technology performance testing laboratory procedures required for oil-grit separator (OGS) manufactured treatment devices (MTDs) seeking verification under the Canadian Environmental Technology Verification (ETV) Program. This document shall be adhered to by entities performing or overseeing the testing of an OGS MTD to meet the verification requirement. A glossary of terms used in this document is provided in Appendix A.

1.1 Objectives of the Procedure

This standardized testing procedure will be used as a basis for comparing the capacity of OGS MTDs to capture and retain sediment and light liquids under the specified test conditions. Application of this procedure will assist in the calibration of hydraulic models that can be applied by regulators and the regulated community to predict the effectiveness of these devices in meeting regulatory goals and other storm water management requirements.

The specific objectives of the protocol are to:

- quantify the sediment removal performance, by particle size fraction, of a device under different surface loading rates;
- propose a methodology for scaling the performance results obtained from this testing procedure to larger or smaller untested devices in the same device classification;
- quantify the mass, by particle size fraction, of sediment particles that may be re-suspended and washed out of a MTD at high flow rates, and
- assess the quantity of light liquid that may be re-entrained and washed out from a MTD at high flow rates.

2.0 Performance Testing Laboratory and Verification Requirements

2.1 Technology Performance Testing Laboratory

The testing shall be conducted by an independent 3rd party technology performance testing laboratory approved by the Canadian ETV Program. The technology performance testing laboratory shall be familiar with the test and lab methods specified in this protocol and have the infrastructure and expertise needed to perform the full range of testing in a manner that generates reliable and repeatable results. In addition, testing laboratory staff must have a thorough understanding of the operation of OGS devices, acquired by lab or field work hydraulics (including particle settling) and stormwater sampling, including expertise in the statistical analysis of the data being collected.

2.2 Verification Organization

An independent, impartial verification organization (VO) is required to review the analysis and deliver a verification report, as per the Canadian ETV Program *General Verification Protocol*. The Toronto and Region

Conservation Authority (TRCA) has the available expertise to support this role. In this capacity, the TRCA will not generate the required data for any performance claim, as this would present a conflict of interest with respect to the verification. The Canadian ETV Program *General Verification Protocol* (GVP) guides the verification process, accountabilities and related quality requirements.

3.0 Sediment Removal Performance Test

The tested manufactured treatment device (MTD) must be a full scale, commercially available device with the same configuration and components as would be typical for an actual installation. The set-up for the sediment removal test requires the (MTD) to be in a condition comparable to that of a realistic in situ operating state. The test is then run on a clean system, with clean water that has a background total suspended solids concentration below 20 mg/L. A false floor must be installed to simulate having the sediment retention chamber filled to 50% of the manufacturer's recommended maximum sediment storage depth.

3.1 Test Sediment

The test sediment used for sediment removal performance testing shall be comprised of inorganic ground silica with a specific gravity of 2.65, uniformly mixed to meet the particle size distribution shown in Table 1. The PSD includes a broad range of particles from clay to coarse sand.

Table 1: Particle Size Distribution of Test Sediment

Particle Size (µm)	**Percent Less Than**	**Particle Size Fraction (µm)**	**Percent**
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Three samples of the well mixed test sediment shall be collected and analyzed for PSD in accordance with *Standard Test Method for the Particle Size Analysis of Soils* ASTM D422 – 63 (2007)e1. The PSD of the three sample average of the test sediment shall be allowed to vary from the specified percent less than value in Table 1 by six percentage points as long as the median particle size (d_{50}) does not exceed 75 µm.

In addition to the three samples of the test sediment batch, one sample of the test sediment used for each flow rate test shall be collected and analyzed for PSD in accordance with ASTM D422 – 63 (2007)e1. Although not a requirement of the Procedure, the PSD of each of these individual test run samples would be expected to meet the six percent allowance threshold. The individual test run PSD samples will be used to calculate removal efficiencies by particle size fraction, in conjunction with a single PSD sample from the retained sediment mass (see section 3.4). If the particle size percent less than values of an individual test run sample varies by more than six percentage points from the particle size percent less than values of the three sample average of the batch, the test lab shall report removal efficiencies by particle size fraction both for the individual flow test PSD sample and the three sample average PSD of the batch.

3.2 Test Conditions

The system shall be clean with no pre-loaded sediment. A false floor shall be set to 50% of the manufacturers recommended Maximum Sediment Storage Depth to mimic a partially filled device. The set-up of the test system needs to reflect realistic operation of a gravity flow device in the storm sewer. Manufacturer's installation recommendations shall be followed with a pipe of a diameter that is consistent with the manufacturer's recommendations. Temperature of the water used in the test shall not exceed 25 degrees Celsius

3.3 Test Parameters and Requirements

In order to obtain an accurate accounting of performance for sediment removal, tests must be conducted at each of the different test surface loading rates specified below. To achieve stabilized flows and sediment fluxes through the MTD, the tests shall be run for a minimum duration. A minimum mass of sediment must also be injected to limit analytical errors associated with mass balance testing.

3.3.1 Flow rates and hydraulic characteristics

The flow rates tested should be sufficient to characterize the performance curve across different loading rates. A minimum of seven steady state surface loading rates shall be tested: 40, 80, 200, 400, 600, 1000 and 1400 Liters per minute (L/min) per square metre (m^2) of Effective Treatment Area, where the Effective Treatment Area is defined as the area in the MTD over which sedimentation occurs. Testing at additional surface loading rates may be conducted at the manufacturer's discretion. These shall be considered in the final verification report. The flow rates associated with each surface loading rate shall be determined based on the specified surface loading rates and the Effective Treatment Area of the tested MTD.

Flow rates from calibrated flow instruments shall be recorded at no longer than 30 second intervals over the duration of the test. Instrument calibration reports shall be submitted with the final technical evaluation report. Flow rates shall not vary from the target flow rate by more than ±10% and have a Coefficient of Variation (COV) of less than 0.04.

Head loss across the device shall be measured on a clean unit without sediment over the full range of operational flow rates using calibrated instruments installed at appropriate locations. The specific methodology for measuring head losses shall be determined by the independent test laboratory, and described clearly in the technical evaluation report. Loss coefficients shall be reported over the full range of test flow rates.

3.3.2 Test duration

The test is to continue for 25 minutes or the time required for 8 complete volume exchanges in the primary sedimentation chamber, whichever is greater. The test must also ensure that a minimum of 11.3 kg of sediment is fed into the MTD during the test, even if the duration and volume exchange criteria have been satisfied.

3.3.3 Influent sediment concentration

The test requires use of a calibrated sediment feed system that delivers a constant concentration of 200 mg/L (within ±25 mg/L) over the duration of the test. The test sediment shall be injected into the flow stream at the lesser of 3 metres or 5 pipe diameters upstream of the inlet to the MTD. Injection of test sediment shall be initiated only after a constant flow rate has been achieved. Six calibration samples shall be collected from the injection point at evenly spaced intervals over the duration of the test to verify that the test sediment is being injected at a constant rate. Calibration samples shall be a minimum 0.1 L or the collection interval shall not exceed one minute, whichever comes first. The samples shall be weighed to the nearest milligram and the concentration COV shall not exceed 0.10.

The average influent concentration during the test shall be determined based on the mass injected divided by the volume of water flowing through the unit during the period of sediment injection. The moisture content of the test sediment used for each flow rate test should be measured in accordance with ASTM Method D 4959- 07, *Standard Test Method for Determination of Water (Moisture) Content of Soil By Direct Heating*. The test sediment used in each test shall be sampled and analyzed for PSD in accordance with ASTM D422 – 63 (2007)e1, as described in section 3.1.

3.3.4 Modified mass balance

The influent sediment mass load and retained sediment mass shall be measured. The influent mass is equal to the mass of test sediment injected over the duration of the test. Sediment retained within the unit is to be collected at the end of the test for mass balance analysis. For this purpose, the water remaining in the unit after the test shall be decanted over a period not exceeding 30 hours after the end of the test. The decanted water shall be discarded. The remaining mixture of sediment and water in the MTD retention chamber shall be transferred to pre-weighed nonferrous trays for drying.

After drying and weighing following ASTM D 4959- 07, the sediment is to be evenly mixed and a sample of the well-mixed sediment shall be collected and analyzed for PSD in accordance with ASTM D422 – 63 (2007)e1.

3.3.5 Background samples

A minimum of 5 aqueous background samples of the source water shall be taken over the testing period at regular increments. Background samples should be collected on an hourly basis for all sediment removal tests greater than 5 hours. These samples are to be analyzed by the SSC method (ASTM D3977-97 (2013)). Suspended Solids concentrations of background samples shall be less than 20 mg/L.

3.4 Sediment removal calculation

The sediment removal efficiency shall be calculated based on the influent mass load and retained mass load, as follows:

$$Removal\ Efficiency\ (\%) = \left(\frac{Total\ Mass\ Retained}{Inlet\ Mass\ Injected}\right) * 100$$

where the mass retained is the mass collected from the device after completion of the test, including any residual sediment accumulated in the inlet pipe. The mass of sediment accumulated in the inlet pipe shall be measured and reported separately.

Sediment removal results shall be reported as a percentage of influent mass retained, both for the total mass and by individual particle size fractions. The particle size distribution of the samples taken from each of the influent and retained mass, as described previously, shall be used as the basis for reporting removal efficiencies by particle size fraction. The size fractions used for reporting of removal efficiencies shall include, at a minimum, the following:

< 5 µm
5 µm - 8 µm
8 µm - 20 µm
20 µm - 50 µm
50 µm - 75 µm
75 µm - 100 µm
100 µm - 150 µm
150 µm - 250 µm
250 µm - 500 µm
> 500 µm

Lab results may be graphically or statistically interpolated for the purposes of reporting sediment removal results in the size fractions shown above. However, to minimize errors, interpolations of analytical laboratory data should be based on as many discrete size fractions as is practically feasible.

4.0 Sediment Scour and Re-suspension Test

Sediment scour and re-suspension testing is done on the same unit tested for sediment removal to determine the mass and range of particle sizes that are re-suspended and washed out during high flows. The test sediment is the same as that used in the sediment removal test, and effluent results are reported by total mass load and particle size fraction. The re-suspension test requires the MTD to be set up in an operating condition to mimic a device filled to half of the maximum recommended sediment storage depth. A false floor can be used, with a specified quantity of test sediment on top of the false floor. For the purposes of assessing the potential for sediment re-suspension, test results are to be interpreted in relation to the particle size fractions retained by the device during the sediment removal performance tests.

4.1 Test Sediment

The test sediment preloaded in the sedimentation chamber shall be the same test sediment used in the sediment removal test (see Table 1, Section 3.1). The three sample average of the batch shall be considered to be representative of the PSD of the preloaded test sediment.

4.2 Test Conditions

This test is run with clean water at temperatures not exceeding 25 degrees Celsius. The false floor, if used, is set to a minimum of 10.2 cm below 50% of the maximum recommended sediment storage depth and covered with the required quantity of test sediment to achieve the 50% capacity level. The sediment shall be evenly distributed and leveled.

The MTD shall be filled with clear water to a normal operating depth prior to initiating flows. Background concentrations of the clear water used to fill the device shall be less than 20 mg/L. The test shall be initiated within 96 hours of pre-loading of the unit.

4.3 Test Parameters and Requirements

4.3.1 Flow Rates

Re- suspension and washout of sediments is determined at five surface loading rates that shall be increased in 5 minute intervals from 200 to 800 to 1400 to 2000 to 2600 L/min/m^2. Higher surface loading rates may be tested at the manufacturer's discretion. If the manufacturer wishes to test additional surface loading rates less than 2600 L/min/m^2, these must be conducted as a separate test. The results of these additional tests shall be considered in the verification report. Flows shall be measured with calibrated instruments. Flow rates shall be recorded at no longer than 30 second intervals over the duration of the test and be maintained within ±10% of the target flow rate with a COV less than 0.04. The time for flows to increase initially, and from one rate to the next, shall not exceed 1 minute. Thus the maximum duration of the test for the 5 surface loading rates shall not exceed 30 minutes.

4.3.2 Sampling and analysis

Paired effluent samples shall be collected throughout the test at 1 minute sampling intervals starting no longer than 1 minute from the initiation of flow and no longer than 1 minute after the start of flow increase from one target flow rate to the next (*i.e:* sampling should start as soon as the target flow rate is achieved). The effluent concentration will be determined based on any of the three effluent sampling methods cited in the *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device*-January 25, 2013 (reproduced in Appendix B for reference). Alternative effluent sampling methods, or variants of the NJDEP methods, may be employed, pending approval by the Canadian ETV program prior to testing. Only flows that have passed through the MTD treatment chamber(s) shall be sampled.

The samples are to be analyzed for suspended sediment concentrations using the Suspended Solids Concentration (SSC) analytical method (ASTM D3977-97 (2013)). The PSD of the samples shall be determined in accordance with ISO 13320(2009). Discrete samples collected for PSD analysis may be combined to form two composite samples at each surface loading rate.

The scour test results for suspended solids, PSD and suspended sediment loads shall be reported for each of the surface loading rates tested. In addition to effluent samples, a minimum of 5 aqueous background samples of the clear water shall be taken over the testing period at regular increments. Concentrations of background samples shall be less than 20 mg/L, and effluent sample concentrations shall be adjusted accordingly.

4.4 Sediment Scour Test Analysis

To assess the potential for sediment scour, the effluent suspended solids concentration shall be adjusted based on the results of the sediment performance removal tests. Any scoured suspended solid particles that are finer than those removed by the MTD during the 40 $L/min/m^2$ removal test should be excluded from the scour results. As such, the adjusted effluent concentration would only include sediment particle size fractions that were retained by the MTD. The technical evaluation report shall include the particle size fractions removed and scoured by the MTD, as well as the scour effluent concentrations before and after adjustment of results.

5.0 Light Liquid Re-entrainment Simulation Test

The light liquid re-entrainment simulation test is done on the same unit tested for sediment removal to assess whether light liquids captured in the MTD after a spill are effectively retained at high flow rates. The test uses low density polyethylene (LDPE) plastic beads as a surrogate for light liquids. The test is optional depending on whether the vendor is making a claim that light liquids trapped in the MTD are effectively retained. The flow rates and duration of the test are the same as in the scour test.

5.1 LDPE Plastic Beads Specification

LDPE plastic beads used in the test shall have a specific gravity similar to motor oil, since oil spills are the most common type of light liquid spill. The specified test material shall be Dow Chemical Dowlex™ 2517 (s.g. = 0.917). Should the specified test material become unavailable, the alternate test material shall be Dow Chemical Dowlex™ 722 (s.g. = 0.918). The density of the test material shall be independently measured and reported by the technology performance testing laboratory.

5.2 Test Conditions

This test is run with clean water on a device with a false floor set at 50% of the maximum recommended sediment storage depth to ensure hydrodynamics of the MTD are representative of an average condition. If additional oil capture features are added to the device, these same features must also be present during the sediment removal performance test. Water temperatures shall not exceed 25 degrees Celsius.

The MTD shall be preloaded with a known volume and mass of plastic beads to a depth of 5 cm over an area equivalent to the MTD sedimentation area, also referred to in this document as the Effective Treatment Area. Thus smaller units shall use a smaller volume of plastic beads than larger units, however, the depth of plastic beads shall remain identical. If the MTD separates oil over an area smaller than its sedimentation area, the depth of plastic beads preloaded in the smaller oil separation area shall exceed 5 cm, since the preloaded volume of plastic beads shall be based on a 5 cm depth over the sedimentation area. This ensures that MTDs with equal sedimentation area are preloaded with equal volumes of plastic beads, representing oil spill capture of identical volume. MTDs with a maximum light liquid storage depth of less than 5 cm over the sedimentation area shall preload with plastic beads to a depth equal to the maximum light liquid storage depth.

5.3 Test Parameters and Requirements

5.3.1 Flow Rates

The potential for oil re-entrainment and washout is determined at five surface loading rates that shall be increased in 5 minute intervals from 200 to 800 to 1400 to 2000 to 2600 L/min/m^2. Higher surface loading rates may be tested at the manufacturer's discretion. If the manufacturer wishes to test additional surface loading rates less than 2600 L/min/m^2, these must be conducted as a separate test. The results of these additional tests shall be considered in the verification report. Flows shall be measured with calibrated instruments. Flow rates shall be recorded at no longer than 30 second intervals over the duration of the test and be maintained within ±10% of the target flow rate with a COV less than 0.04. The time for flows to increase initially, and from one rate to the next, shall not exceed 1 minute. Thus the maximum duration of the test for the 5 surface loading rates shall not exceed 30 minutes.

5.3.2 Effluent Screening and Analysis

All effluent shall be screened for the entire duration of the test. Appropriate screen mesh size shall be used such that all plastic beads washed out of the MTD are retained on the screens while allowing water to pass through. Screening methodology shall provide for the collection and quantification of plastic beads washed out of the MTD during the flow interval associated with each specified surface loading rate. The volume, mass, and percentage of plastic beads washed out of the MTD shall be determined for each surface loading rate. Additionally, these values shall be summed to determine the cumulative volume, mass, and percentage of plastic beads washed out of the MTD for the entire test duration.

6.0 Scaling

The sediment removal rate at the specified surface loading rates 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 claimed sediment removal efficiencies for the similar MTD are the same or lower than the tested MTD at identical surface loading rates; **and**
2. 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.

If requirements (1) and (2) are not met, then three full scale, commercially available MTDs of different sizes are required to be tested to validate the alternative scaling methodology. Testing of the similar models shall follow the same sediment removal performance testing procedures described in Section 3.0.

7.0 Analytical Methods

All analytical laboratories performing sample analysis shall be accredited to ISO 17025 or equivalent. The following analytical methods shall be used in the test procedure.

7.1 Suspended Solids

The SSC test method shall be used on aqueous samples: *Standard Test Methods for Determining Sediment Concentration in Water Samples* ASTM D3977-97 (2013)e1

7.2 Particle Size Distribution

Test Sediment shall be analyzed in accordance with *Standard Test method for the Particle Size Analysis of Soils* ASTM D422 - 63(2007)e1
Aqueous samples shall be analyzed for PSD using laser diffraction following ISO 13320:2009 *Particle Size Analysis – Laser Diffraction Methods*:

7.3 Sediment Drying

ASTM Method D 4959- 07, *Standard Test Method for Determination of Water (Moisture) Content of Soil By Direct Heating*.

8.0 Reporting

The third party technology performance testing laboratory responsible for testing prepares a Quality Assurance Project Plan and Technical Evaluation report. As the Verification Organization, the Toronto and Region Conservation Authority shall review the laboratory documents and prepare a verification report.

The report prepared by the technology performance testing laboratory should address, at a minimum, the following topics:

1. Laboratory and staff qualifications
2. Description of the technology – function, operation and basic design hydraulic parameters (e.g. design head loss, maximum hydraulic capacity)
3. Experimental set-up – test equipment descriptions, data acquisition and management procedures and equipment calibration reports
4. Testing procedures - preparation of test sediment, sampling and analytical laboratory methods, and the quality assurance and control plan
5. Results of Sediment Removal Performance Test, reported by total mass and particle size fraction
6. Results of Sediment Re-suspension Test, reported by effluent concentration, mass load and particle size fraction
7. Results of Light Liquid Re-entrainment Simulation Test, reported by concentration and load
8. Potential sources of error for each of the tests
9. Signatures from performance testing laboratory staff verifying that the testing was carried out in accordance with the Canadian ETV Program OGS test protocol.

Further guidance on the required content of the technical evaluation report is provided in Appendix C.

APPENDIX A: Terms and Definitions

Oil-Grit Separator

Oil and grit separators are structures consisting of one or more chambers that remove sediment, screen debris, and separate oil from stormwater. These devices are also referred to as hydrodynamic separators.

Effective Treatment Area

The area within the Manufactured Treatment Device where sedimentation occurs.

General Verification Protocol

The General Verification Protocol (GVP) provides guidance on Environmental Verification Program procedures and data requirements. The GVP specifies that technology operating conditions must be clearly specified and the performance parameters must be measurable using quality-assured test procedures and analytical techniques

Head Loss

A measure of the reduction in total head of the liquid as it moves through the system

Light Liquid

Liquid with a density no greater than 0.95 g/cm3, which is completely, or nearly insoluble and unsaponifiable.

Modified Mass Balance Test Method

The method to determine sediment removal rates by comparing a known influent mass of test sediment to the mass of test sediment retained by the MTD.

Maximum Sediment Storage Depth and Volume

The maximum 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. This term is also referred to as the *maintenance sediment storage depth and volume*.

New Jersey Department of Environmental Protection

The New Jersey Department of Environmental Protection (NJDEP) is a government agency in the U.S. state of New Jersey that is responsible for managing the state's natural resources and addressing issues related to pollution.

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.

Surface Loading Rate

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

Verification Organization

For the purposes of this document, the Verification Organization (VO) is the third party, impartial technical reviewer sub-contracted by the Canadian ETV Program to supply assessment and validation expertise and services. The VO 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.

APPENDIX B: Effluent Sampling Procedures prescribed by the New Jersey Department of Environmental Protection

For ease of reference, the following description of effluent sampling methods has been reproduced from the *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device*-January 25, 2013. Where relevant, units have been converted to metric.

Effluent sampling shall be performed through the use of one of the following methods; depending on flow rate: the Effluent Grab Sampling Method, Isokinetic Sampling Method or the Automatic Effluent Sampling Method. For flows less than 14 L/s the Effluent Grab Sampling Method must be utilized. For flow greater than 14 L/s, either the Isokinetic Sampling Method or the Automatic Effluent Sampling Method may be employed. These sampling methods are used to establish an MTD's sediment removal efficiency under the following conditions:

1. The average influent suspended solids concentration shall be calculated using the total mass of the test sediment added during dosing divided by the volume of water that flowed through the MTD during dosing as follows: The volume of water that flows through the MTD shall be calculated by multiplying the average flow rate by the time of sediment injection only.

2. Once a constant feed of test sediment and flow rate are established, the first effluent sample shall be collected after a minimum of three MTD detention times have passed;

3. The time interval between sequential samples shall be evenly spaced during the test sediment feed period to achieve 15 samples. However if the test sediment feed is interrupted for measurement, the next effluent sample shall be collected following a minimum of three MTD detention times;

4. A minimum of 15 effluent samples shall be taken downstream of the MTD such that any internally bypassed water is also sampled; and

5. All effluent samples shall be analyzed for SSC in accordance with *Standard Test Methods for Determining Sediment Concentration in Water Samples*: ASTM D3977-97 (2013)

3.2.6.1 Effluent Grab Sampling Method

This method allows for conducting manual sample collection procedures. The effluent sample location shall be either end of pipe or in-line, and should consider the distance from the MTD, sample container size to minimize the potential for spilling, and sediment capture method (e.g., sweeping motion).

3.2.6.2 Isokinetic Sampling Method

The use of isokinetic sampling procedures may be applicable for this method depending on water depth in the effluent piping. This procedure must include a minimum of three evenly spaced, vertically and centrally aligned sampling tubes. Flows from the tubes shall be composited. With isokinetic sampling, the tube intake flow velocity is equal to the pipe flow velocity at the sample tube location. For flows greater than 14 L/s, three intake points must be used in the pipe. For flows less than 14 L/s, only the Effluent Grab Sampling Method is acceptable.

3.2.6.3 Automatic effluent sampling method

This method allows for the use of automated sampling equipment positioned downstream of the MTD. This procedure requires three automatic samplers each having its own inlet tube. The three inlet tubes shall be evenly spaced, vertically aligned and centrally located. The intake elevations shall be at approximately 25, 50 and 75% of flow depth.

The sampling equipment shall be positioned at a distance of no more than three feet from the outlet of the MTD. Each sample container within the automatic sampler shall be at least one liter in size.

The automatic sampler equipment shall be calibrated and properly cleaned in compliance with the manufacturer’s recommendations.

APPENDIX C: Technical Evaluation Report Template

Sections/subsections	Brief Content Description	Tables and/or Figures
Table of Contents and List of Figures and Tables		
1.0 Introduction	Overview of the scope and purpose of testing	
2.0 Manufactured Treatment Device Description	Description of the MTD, including overview of device function, operation, design hydraulic parameters (e.g. design head loss, maximum hydraulic capacity), number of chambers, chamber dimensions, baffle configurations, inlet and outlet pipe diameters and invert elevations, bypass weir (if applicable), and other components.	Figures: Schematic showing MTD dimensions and pipe/baffle locations/sizes. Photo of MTD installed in the laboratory.
3.0 Materials and Methods 3.1 Experimental Design	Describes the test parameters and procedures and deviations from the procedure (if any).[1]	Figure: Schematics showing set -up of experimental test apparatus in plan and profile views, including location of valves, pumps, storage tanks and measurement equipment.
3.2 Description of instrumentation and measurement methods	Describes equipment used to pump water, inject sediment, measure flow and temperature, collect samples, perform mass balance testing and measure other components as needed.	Photos of instrumentation as needed to clarify test methodologies
3.3 Data management and acquisition	Describes methods and equipment used to record and manage data. Includes details on data measurement and recording frequencies.	
3.4 Preparation of test sediment.	Provides details on how the test sediment was prepared and analyzed, and the results relative to the NJDEP PSD.	Table and Figure: PSD test results verifying that the particles were uniformly distributed based on the three sample test, and that the PSD meets the required specification.
3.5 Data Analysis	Describes the equations and procedures used to analyze the data.	
3.6 Laboratory Analysis	Description of laboratory methods used to analyze aqueous samples and particulate matter (sediment and oil).	

[1] Known deviations from the procedure should be discussed with ETV Canada staff prior to testing

3.7 Quality Assurance and Control	Describes methods used to ensure measurement accuracy and quantify potential errors.	
4.0 Results and Discussion 4.1 Sediment Removal Performance	Presents and discusses treatment efficiency from the modified mass balance test as a function of flow rate. Sediment removal results are reported as a percentage of influent mass retained, both for the total mass and the mass of individual particle size fractions. Measurements of hydraulic capacity and hydraulic characteristics can be included as a separate subsection.	Table(s): operational parameters and treatment results, including surface loading rate, flow rate (target and actual) test duration, turnover rate, treated volume and influent mass, sediment concentration, captured mass, calculated effluent mass and treatment efficiency. Figures: Cumulative particle size distribution (percent finer than) of the influent and captured PSDs for all surface loading rates. Figures: Removal efficiency as a function of surface loading rate – both for total sediment mass and for mass by particle size class.
4.2 Sediment Re-suspension and Washout	Presents and discusses effluent sediment concentrations for the re-suspension and washout test as a function of surface loading rate. Re-suspension test results are discussed in relation to the particle size distribution of captured material during the sediment removal test. Calculate the effluent sediment load and concentration of particles larger than the smallest particles captured during the sediment removal test, and express as a percentage of the total effluent load and concentration at each surface loading rate.	Figure: Surface loading rate vs time. Figure: Effluent sediment concentration over time for each surface loading rate. Table and Figure: Average effluent concentration by surface loading rate. Observed and adjusted based on the sediment particles captured during the sediment removal test. Table and Figure: cumulative particle size distributions by surface loading rate. Figure: Comparison of the PSD of sediment captured during the sediment removal test and PSD of sediment discharged from the MTD during the sediment re-suspension test. (The graph is to be formatted in a manner that makes it clear where there is overlap)
4.3 Light Liquid Re-entrainment Simulation Test	Describes the type and density of plastic beads used to pre-load the unit in relation to test requirements. Presents and discusses wash out of plastic beads as a function of surface	Figure: Surface loading rate vs time. Table and Figure(s): Mass, volume and percentage of glass beads discharged by surface loading rate,

	loading rate. The volume, mass and percentage of plastic beads discharged from the unit are presented and discussed in relation to each flow rate tested and cumulatively over the full test duration.	and cumulatively over the full test duration.
5.0 Conclusions	Summarize key results and conclusions	
Nomenclature and Abbreviations	Defines symbols and abbreviations used in the report	
References	Full citation of all documents referenced in the report	
Appendix A	Summary of laboratory and staff qualifications	
Appendix B	Instrument calibration reports	Table and Figures as needed
Appendix C	Signatures from performance testing laboratory staff verifying that the testing was carried out in accordance with the Canadian ETV Program OGS test protocol.	
Appendix D	Manufacturer Treatment Device specifications	Table from the manufacturer at the time of testing showing all unit sizes (depth and diameter/length/width), treatment flow rates, and sediment/oil capacities.