Designation: ~~E3332 – 22~~ E3332 – 23

Standard Test Method for Determining Trash and/or Debris Capture Performance of Stormwater Control Measures[1]

This standard is issued under the fixed designation E3332; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The scope of this standard is to provide test criteria for the evaluation of Stormwater Control Measures (SCM), especially Manufactured stormwater Treatment Devices (MTDs), for the removal of trash and/or debris greater than 5 mm in at least two dimensions in a laboratory setting. The use of this standard in conjunction with an appropriate verification program allows for the publication of verified reporting for use in gaining certification by Authorities Having Jurisdiction (AHJs).

1.2 For the purpose of this method, a Trash Capture Device (TCD) is an SCM that has the capacity to capture and retain trash and or debris. This may be the primary objective of the device or it may be a secondary feature of a device designed primarily as a Hydrodynamic Separator (HDS) or a filter for capturing sediment particles. This protocol does not address the sediment removal of such devices.

1.3 *Units*—The values stated in inch-pound units are to be regarded as standard, except for methods to establish and report sediment concentration and particle size. It is convention to exclusively describe sediment concentration in mg/L and particle size in mm or µm, both of which are SI units. The SI units given in parentheses are mathematical conversions, which are provided for information purposes only and are not considered standard. Reporting of test results in units other than inch-pound units shall not be regarded as non-conformance with this test method.

1.4 Acceptance of test results attained according to this specification may be subject to specific requirements set by a Quality Assurance Project Plan (QAPP), a specific verification protocol, or AHJ. It is advised to review one or all of the above to ensure compliance

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

[1] This test method is under the jurisdiction of ASTM Committee E64 on Stormwater Control Measures and is the direct responsibility of Subcommittee E64.01 on Lab Evaluation.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

E3318 Terminology for Standards Relating to Stormwater Control Measures

2.2 *Other Documents:*

CTSW-RT-05-73-18.1 Laboratory Testing Of Gross Solids Removal Devices[3]

Caltrans Document No. CT-SW-RT-00-013 California Department of Transportation (Caltrans) District 7 Litter Management Pilot Study

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms used in this standard, refer to Terminology E3318.

NOTE 1—The terms and definitions related to this standard also relate to other standards currently being balloted. As such they are being balloted separately in a single terminology document ASTM E3318.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *Catch Basin Insert (CBI), n*—a device that is installed within a catch basin.

3.2.1.1 *Discussion*—

Aside from dimensioning, the operation of the CBI is independent of the hydraulic operation of the structure but may be dependent on the presence of sumps or inverted outlets.

3.2.2 *mesh, n*—in this document, mesh refers to a screen, net or filter that consists of openings of a defined size; in this document, the size of the mesh refers to the size of the largest opening.

3.2.3 *trash, n*—solids of anthropogenic origins greater than 0.2 in. (5.0 mm) in at least two dimensions.

3.2.3.1 *Discussion*—

Examples include plastic, paper, glass, metal. Trash can be floatable, neutrally buoyant or sinkable.

3.2.3.2 *Discussion*—

In this case, due to the California TMDL, 5.0 mm is the standard and 0.2 in. is actually the mathematical conversion.

3.2.4 *Trash Capture Device (TCD), n*—an MTD that is designed to remove trash and debris from stormwater runoff and, in some cases, wind-blown or saltating trash and debris.

3.2.5 *T&D, n*—trash and debris

4. Summary of Test Method

4.1 There are six test procedures described in this standard. Completion of all six procedures is not required for conformance to the standard, it is up to the AHJ to determine which procedures are followed.

4.1.1 *Hydraulic Evaluation (see 9.1)*—To establish head loss, develop a head loss versus discharge curve, and define points of bypass.

4.1.2 *Percent Restriction versus Flow Test (see 9.2)*—To develop a graphical representation of flow versus percent restriction. Restriction is established by manually blocking the flow path in a device in a fashion which mimics potential restriction in the field.

4.1.3 *Mass Loading Test for Trash (see 9.3)*—Uses a specified mixture of trash surrogates to evaluate how the device reacts to large volumes of trash in terms of clogging and holding capacity.

4.1.4 *Mass Loading Test for Trash and Debris (see 9.4)*—Uses a specified mixture of trash and debris surrogates to evaluate how the device reacts to large volumes of T&D in terms of clogging and holding capacity.

4.1.5 *Scour Evaluation Test (see 9.5)*—Applies high flow rates to a fully loaded device to evaluate how extreme flows may or may not resuspend and pass T&D through the overflow.

[3] Available from: http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-05-073-18-1.pdf

4.1.6 *Bead Test (see 9.6)*—Uses 0.2 in. (5.0 mm) beads to establish that a unit can capture beads of 0.2 in. (5.0 mm) diameter of which equal portions are floating and sinking at full design flow prior to bypass.

5. Significance and Use

5.1 This standard, used in conjunction with a verification protocol can be used to gain certification for the purposes of the removal of trash and/or debris from stormwater runoff in order to meet regulatory and permit needs.

6. Test Apparatus

6.1 The test loop shall consist of a water source, such as a water supply tank, a pump, an inlet pipe with an opening for adding trash/debris/beads, and an outlet tank, with the TCD to be tested configured to simulate a typical installation between the inlet pipe and the outlet tank. The pump ~~should~~must be of sufficient capacity to achieve the required flow rates. A schematic of a test loop is given in Fig. 1.

6.1.1 Both the inlet pipe or channel and the outlet tank shall have openings large enough to allow for loading and recovery of trash and visual confirmation that all trash has been removed.

6.1.2 The inlet pipe shall be designed such that at all test flow rates the pipe is in open channel flow and that T&D will not be restricted and is easily transported into the test unit.

6.1.3 The outlet tank must be able to accommodate a net or screen at the end of the outlet pipe, or at the tank outlet, to allow for capture of any trash in the effluent flow. The net or screen shall not cause water back up into the outlet pipe.

6.1.3.1 The aperture of the effluent net or screen shall be 0.20 in. (5.0 mm) or less.

6.2 The test apparatus shall be constructed using a commercially available TCD or, for systems that rely on a mesh, a representative piece of mesh exposed to flow in the same way it would be in a commercial system may be used if the flow capacity of the smallest commercial system is too large to test.

6.2.1 If a representative mesh is used all flow rates shall be selected to achieve the same flux as ina commercial unit at the MTFR. All references to residence times shall mean the residence time of the smallest commercial unit.

6.2.2 For piped systems, the inlet straight pipe (without bends or restrictions) of minimum length equivalent to 5 pipe diameters or 20 ft (6 m), whichever is less, shall be used. The outlet pipe length is to be from 3-5 ft (1-1.5 m) with a free fall condition and no fitting at its downstream end. Inlet and outlet pipes shall have smooth interior walls and pipe slopes shall be 1 % - 2 %.

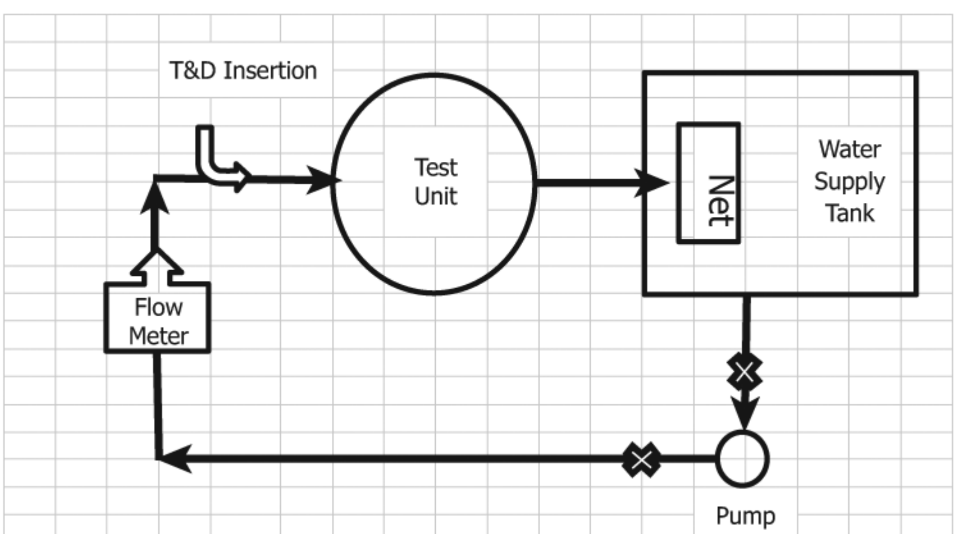

FIG. 1 Schematic of Test Loop

6.2.3 For curbed inlet systems or similar devices designed to receive sheet flow, an artificial streetscape will be at the upstream end of the TCD inlet pipe referenced above and connected to the TCD. The streetscape will typically be a 4 by 8 ft (1.2 by 2.4 m), or smaller, sheet of plywood or polymer with sidewalls to contain flow. Gutter slope shall be at 1 % ± 0.5 % longitudinal and 2 % ± 0.5 % cross slope. The TCD outlet pipe is to be in a standard configuration (for example, with or without a sump, inverted elbow) and equipped with the minimum outlet pipe diameter normally associated with the device. The streetscape must be designed to direct the flow to the inlet without dead zones which allow for the capture of test material on the streetscape.

6.2.4 For CBIs, the geometry of the supporting catch basin must be consistent with manufacturers design and installation guidelines.

6.3 Water source can be recirculated municipal water, well water, clear water from ponds, lakes, streams or rivers.

6.3.1 For water from ponds, lakes or streams, background particles greater than 0.04 in. (1 mm) are not allowed.

6.3.2 The presence and/or use of surfactants, flocculants or other added chemicals is not allowed.

6.4 *Flow Measurement*—A flow meter must be located upstream of the TCD in a full pipe condition. If a standpipe or similar is used, the head level in this tank must also be reported.

6.4.1 Flow measurements shall be made to an accuracy of ±1 % of measured flow. The average flow rate shall be within ±10 % of the target value for controlled laboratory testing. The acceptable coefficient of variation of measurements is 0.03. All flow meters must be located a sufficient distance away from any velocity or turbulence increasing devices (valves, pumps, elbows, flanges, etc.) to allow for proper operation, and mounted as required by the instrument manufacturer.

6.4.2 All flow meters used in this method must be calibrated annually and copies of flow meter calibrations shall be included in the final report. The flow meter data logger must record flows at a minimum of once per minute. The average flow rate over the test duration shall be reported.

6.5 *Water Surface Elevation (WSE)*—Pressure heads or water elevations shall be recorded to a minimum accuracy of 0.25 in. (6 mm) for each condition tested to determine the head elevations. The locations of elevation measurements shall be fixed for all flow conditions. Elevation measurements shall be recorded in the influent and effluent pipes at locations 1-2 pipe diameters upstream and downstream of the unit. Internal measurements shall be recorded at a location that allows determination of bypass flow. Measurements are to be recorded using a data acquisition (DA) system and differential pressure (DP) cell or point-gage system or pressure transdcuers adjusted to a known reference. Manual measurements using an engineer's scale are acceptable for estimated elevations and shall be recorded as such.

NOTE 2—When supercritical flow occurs in the outlet pipe, the energy head at the outlet may appear to exceed the energy head at the inlet leading to erroneous determination of a loss coefficient. Under this condition, the critical depth at the outlet shall be determined and used for calculation of the unit loss coefficient.

6.6 *Materials:*

6.6.1 The materials in Tables 1-3 are used to simulate Trash or Debris:

7. Preparation of Test Loop

7.1 Prior to commencement of the tests the test loop should be constructed and tested to be in compliance with this standard including:

7.1.1 Enough hydraulic capacity to convey the maximum test flows.

7.1.2 All instruments are operating within parameters set by this standard.

7.1.3 All data loggers are operational.

TABLE 1 Trash Removal Testing Materials

Component	Description	Dimensions ±10 %	% by Dry Mass
Cigarette Filter	regular cigarette filters (ex. OCB brand) ~0.32 oz (9.15 g)/100 filters	0.28 in. (7 mm) diameter by 0.59 in. (15 mm)	14
Disposable wipes	Standard baby wipes	7.5 in. by 2 in. (19 cm by 5 cm)	17[A]
Wood	Popsicle sticks	4.3 in. by 0.37 in. by 0.08 in. (11 cm by 0.95 cm by 0.2 cm)	11
Plastic-Moldable	PET/ PETE plastic, 0.01 in. - 0.02 in. (0.3 - 0.5 mm) thick, cut in strips	3.5 in. by 1.0 in. (9 cm by 2.5 cm)	23
Plastic-Film	Plastic shopping bag split in half and cut in strips	15.7 in x 3.1 in (40 cm x 8 cm)	8
Cardboard/Chipboard	Cardboard box cut in strips	9 in. by 1 in. (23 cm by 2.5 cm)	10
Cloth	Cotton linen fabric cut in strips	13.8 in. by 2 in. (35 cm by 5 cm)	6
Metal – Foil, Molded	Rigid aluminum, 0.01 in. - 0.02 in. (0.3-0.5 mm) thick, cut in strips	4 in. by 1 in. (10 cm by 2.5 cm)	7
Styrofoam	Standard "S"-shaped peanut packing material, non-disintegrating	1.2 in. by 1.4 in. by 0.7 in. (3 cm by 3.5 cm by 1.5 cm)	4

[A]Disposable wipes can be weighed as they come from the package, drying is not necessary.
Note—Trash can be re-used if the components still meet the size requirements outlined above.

TABLE 2 Bead Test

Component	Description	Dimensions ±10 %	% by Mass
Plastic Beads[A]	Plastic Beads with approximately ½ floating, ½ sinking SG range to 0.8 – 1.2, which will allow for PP/PE/acrylic/ nylon materials	Outside Diameter ≤0.22 in. (5.6 mm), with a D_{min} > 0.2 in. (5.0 mm)	100

[A]Note—Beads may have a hole through the center. (Possible source: hobby type acrylic perler beads and PE necklace beads.)

TABLE 3 Debris Test Materials

Components	Description	Dimensions	% by Mass
Leaves[A]	Artificial Leaves, polyester fabric	3 in. by 3 in. (75 mm by 75 mm) ± 1⁄10 in. (2 mm)	90
Trash	As specified in Table 1		10

[A]Notes on leaves—Most come in stacks and need to be separated by hand. They stink at first, but the smell eventually fades. They have a high static charge and need to be wetted prior to testing. They will dye the lab water.

8. Conditioning

8.1 Prior to the commencement of Mass Loading Testing (see 9.3 or 9.4), the T&D components need to be conditioned. Conditioning includes:

8.1.1 Prepare and weigh T&D components.

8.1.2 Mix the desired test mass into a visually homogenous mixture.

8.1.3 Presoak the mass for a period of ten minutes prior to dispensing into the inlet pipe during testing. Ensure all material goes into the inlet pipe.

9. Procedures

9.1 **Head Loss Testing**

9.1.1 Bring the system to steady state flow, that is, no change in flow rate or WSE, (within QA/QC limits defined in 6.4.1) for a period of five residence times or five minutes, whichever is greater.

9.1.2 Test and record system water surface elevations at 10 %, 25 %, 50 %, 75 %, 100 %, 125 % of MTFR. Continue to increase by 25 % increments after 125 % until the system reaches bypass flow or the maximum claimed flow is reached. Record bypass flow, if applicable.

9.1.3 Repeat 9.1.2 three (3) times.

9.1.4 If the headloss values at each flow rate are within 10 % for all three runs at all of the flow rates, then use the collected data to generate a head loss versus flow rate curve, as required in 12.7 on Reporting, otherwise adjust the apparatus and repeat the process.

9.2 **Percent Restriction Test**

9.2.1 Start with a clean and empty TCD and use water resistant tape or other method to block off the TCD in a proportional manner. Block 90 % of the screen or mesh, mimicking expected blockage in actual conditions and keeping in mind low flows are more common. For example, horizontal or vertical strips of tape on a screen, in a way which simulates proportional clogging. Refill the system and bring it to steady state at the MTFR for a period of five residence times or five minutes, whichever is greater. Once constant head is achieved, measure the water surface elevations consistent with the Head Loss test (9.1) and record the data.

NOTE 3—The blockage pattern must be justified prior to testing. One option for this is to run a Mass Loading Test (9.3 or 9.4) first and observe and record the pattern of blockage.

9.2.2 Repeat this test for 70 %, 50 %, 30 %, and 10 % restriction, removing material to simulate natural blockage.

9.2.3 Develop a family of curves showing head loss versus flow as a function of percent occlusion for at least three flow rates.

9.3 **Mass Load Testing for Trash**

9.3.1 Clean all trash, debris or beads from the test apparatus, if necessary.

9.3.2 Prepare a sufficient amount of mass load testing materials designated in Table 1 to test the unit to failure or the maximum storage capacity claimed by the manufacturer.

9.3.3 Condition the material as outlined in Section 8 (Conditioning)

9.3.4 Bring the TCD to steady state at MTFR for a period of five residence times or five minutes, whichever is greater.

9.3.5 Begin to dispense the conditioned test mass into the inlet pipe in such a manner that a relatively steady stream of trash is added and no trash gets caught in the pipe.

9.3.6 Continue to dispense the test mass until the unit reaches bypass or test mass begins to bypass the unit. Any material that does not leave the inlet pipe should be dried, weighed and recorded. Note that it may be necessary to condition additional material during the course of the test

9.3.7 During the test record the following data:

9.3.7.1 Flow Rate.

9.3.7.2 Upstream and downstream WSE.

9.3.7.3 Rate of mass applied in lbs/min or kg/minute.

9.3.7.4 Amount of mass, if any, trapped in the pipe.

9.3.7.5 Total mass added at the time of bypass or when test mass begins to bypass or overflow the TCD, as evidenced by material greater than 5 mm trapped in the downstream net or screen.

NOTE 4—Mass input should be on a dry basis, that is, prior to conditioning. Trapped mass should be dried before weighing and reporting.

9.3.7.6 Prepare a graphical representation of mass load versus head loss.

9.3.7.7 Repeat this test three times. Repeatability of total mass/volume should be plus or minus 20 % due to the nature of mass load application and behavior of the material. If repeatability is not achieved additional tests shall be run in order to get three tests that meet the requirement.

9.4 **Mass Load Testing for Trash and Debris**

9.4.1 Many AHJs are in latitudes where leaves from deciduous trees are problematic for TCDs. The additional T&D test can be done to demonstrate effectiveness or susceptibility to heavy debris loading.

9.4.2 This test follows the same procedure as Mass Loading for Trash (9.3) with the following exceptions:

9.4.2.1 The mass load composition is described in Table 3.

9.4.2.2 Apply the T&D into the inlet pipe in such a manner that a relatively steady stream of material is added and no material gets caught in the pipe.

9.5 **Scour Test**

9.5.1 Once the mass load test is complete and all data are collected the scour test can be completed.

9.5.2 For units installed offline the scour test will be conducted at 125 % of the MTFR.

9.5.3 For units in an online configuration the unit will be tested at 200 % of the MTFR.

9.5.4 Pre-load the system with an amount of trash, or trash and debris, equal to 50 % of the system capacity as determined during mass load testing. The test should be run within 24 hours of pre-loading.

9.5.5 Over a period no more than three minutes, increase the flow rate to the designated scour test flow rate.

9.5.6 Allow the system to operate at the scour flow rate for a period of five residence times or five minutes, whichever is greater.

9.5.7 Stop the system.

9.5.8 Collect, dry and measure the mass of Trash or Trash and Debris captured on the outlet net or screen, excluding material such as paper pulp which has disintegrated during the test procedures. Measure discrete particles only.

9.6 **Five Millimeter Bead Test**

9.6.1 Prepare a sample of 5 mm beads as described in Table 2 with a volume equivalent to 5% of the storage capacity of the unit. Dry and weigh the beads the beads prior to testing.

9.6.2 Bring the TCD to 100 % steady state design flow.

9.6.3 For a period of five minutes add beads in the same manner as for the T&D in the Mass Loading Test, 9.3.

9.6.4 Once the bead insertion is complete let the system continue to operate at design flow for five additional minutes or three detention times, whichever is greater.

9.6.5 Shut the system down and inspect the outlet tank netting for any beads which have bypassed the system. Leave the beads in the system for the scour test in 9.6.6.

9.6.5.1 If beads are found in the outlet, dry and measure or sieve to confirm diameter is ≥0.2 in. (5.0 mm) ± 0.10 in. (0.2 mm). Weigh any beads with D ≥0.20 in. (5.0 mm) ± 0.10 in. (0.2 mm) and report the mass % not captured.

9.6.6 Once beads in effluent, if any, are recorded, the scour test can be run.