

Appendix B

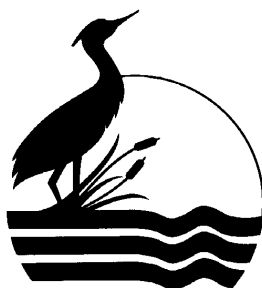
CITY OF PORTLAND, OREGON BUREAU OF ENVIRONMENTAL SERVICES

VENDOR SUBMISSION GUIDANCE

FOR

EVALUATING STORMWATER TREATMENT TECHNOLOGIES

February 2001, Updated September 1, 2004



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VENDOR SUBMISSION GUIDANCE FOR EVALUATING STORMWATER TREATMENT TECHNOLOGIES

February 20, 2001, Updated September 1, 2004

I. Introduction

The City of Portland's Stormwater Management Manual provides stormwater pollution reduction requirements and guidance. BES specifies design criteria, such as pollution reduction storm intensity and volume, and facility performance goals. Facilities need to be designed to satisfy those criteria as stand-alone systems or as part of a treatment train approach.

Chapter 2.0 presents stormwater pollution reduction facility designs and includes a section on manufactured stormwater treatment technologies. Stormwater treatment technologies and the knowledge base around them are rapidly evolving, and as such no proprietary facility names are included in the Stormwater Management Manual. Rather, BES will keep an updated list of technologies that have been approved for stand-alone and pretreatment uses.

This guidance is designed to provide a process of designating approval levels for manufactured treatment technologies. To be approved for use as a stand-alone stormwater pollution reduction facility, the protocols of this document must be followed. Results must indicate that the facility performs to Portland's design standards (see Performance Criteria section below, and Data Evaluation section, Page B-14).

This guidance will also define "TSS (Total Suspended Solids) removal", and provide the equations necessary to calculate it. Portland's method for evaluating test results, which includes provisions for influent concentration, is also included (See Data Evaluation section, Page B-14).

II. Performance Criteria

DESIGN STORM

Flow rate-based pollution reduction facilities shall be sized to treat 90% of the average annual Portland runoff. When used with the Rational Method, the following rainfall intensities will result in flow rates that achieve this goal (see Appendix E of the Stormwater Management Manual).

Site's Time of Concentration (Minutes)	Rainfall Intensity (Inches per Hour)
5	0.19
10	0.16
20	0.13

REQUIRED POLLUTION REDUCITON PERFORMANCE GOALS

Basic Pollution Reduction Performance Goal

The basic pollution reduction performance goal for the entire city is 70% TSS (Total Suspended Solids) removal from 90% of the average annual runoff. TSS is defined as "matter suspended in stormwater excluding litter, debris, and other gross solids exceeding 1 millimeter in diameter (larger than coarse sand, also see Distribution of Sediment Sizes Table, Page B-9).

Influent concentration of TSS is known to greatly impact the ability of a facility to remove 70% TSS, so it is important to specify limits to be used in performance tests. BES will use the "Line of Comparative

Performance©” method, developed by Dr. Gary Minton of Resource Planning Associates (See Charts 1 through 3 in the Data Evaluation section, Pages B-14 and 14) to determine whether or not a facility meets this requirement. These lines were generated from test data on the TSS removal efficiencies of grassy swales and sand filters and modified to account for Portland’s 70% TSS removal standard. The premise behind using these lines of performance is that grassy swales and sand filters have been widely accepted as adequate-performing treatment facilities. These, as well as other treatment BMPs, remove a higher percentage of TSS with higher TSS influent concentrations. It is not fair or practical to require 70% TSS removal from clean stormwater. This method of evaluation, however, accounts for this dilemma. Manufactured technologies will not be expected to outperform grassy swales and sand filters, but data points must be comparable, with a certain percentage falling above the “Line of Comparative Performance©” for the facility to be accepted as a “Presumptive Approach” in the Stormwater Manual. As a low-level baseline, a facility must also achieve an effluent goal of no more than 20 mg/l TSS for low influent concentrations (< 70 mg/l).

TMDL Enhanced Performance Goal

Certain watersheds within the City of Portland have established TMDLs (Total Maximum Daily Loads). The TMDLs apply specific pollution control requirements to designated pollutants of concern. To ensure that new development does not contribute pollutants of concern to a TMDL watershed, pollution reduction facilities are required to demonstrate specific removal rates for those specific pollutants.

To be considered for use as a stand-alone facility in a TMDL watershed, a manufactured technology must demonstrate removal efficiencies for specific pollutants of concern, as well as TSS. See Section 1.5.2 of the Stormwater Management Manual for a current list of TMDL watersheds with corresponding pollutant parameters.

Oil and Grease Performance Goal

Certain site uses within the City of Portland, such as high-use or high-risk parking lots, require additional treatment for oil and grease. The Stormwater Manual currently only recognizes oil/water separators for the pretreatment of oil and grease. To be considered for use as an oil/water separator, a manufactured technology must demonstrate adequate performance. Adequate performance needs to include: the removal of oil droplets from 50 to 60 microns in size, and the ability to achieve effluent efficiencies of 10 ppm or mg/L for influent concentrations exceeding 50 ppm or mg/L.

Pretreatment Performance Goal

A facility may be approved for pretreatment use only. In this case, the facility would be constructed in conjunction with another pollution reduction facility as a “treatment train” to accomplish the basic or enhanced performance goal. To be approved as a pretreatment facility only, data pertaining to the assessment protocol should be submitted. However, the level of performance will not need to meet basic pollution reduction performance goals. The facility will need to demonstrate the ability to remove large debris and the larger range of TSS particle sizes (see Distribution of Sediment Sizes Chart on page B-9), as approved by BES.

REQUIRED PERFORMANCE

Manufactured technologies claiming effectiveness for the listed pollutants must demonstrate (based on data provided per the Technology Assessment Protocol described below) that the above treatment performance goals will be generally achieved. Facilities shall be designed to perform without maintenance for one full year. In addition, factors other than treatment performance are important and will be evaluated to determine appropriate use of the emerging technology. Technologies may be approved as “Presumptive Approaches”, which are then presumed to comply with the City’s basic pollution reduction performance goal, or as pre-treatment facilities, only accepted in combination with other facilities. Facilities demonstrating compliance with enhanced or oil and grease performance goals may be added to applicable

Stormwater Manual sections in future revisions. Facilities that don't demonstrate adequate maintainability (See Section E, Page B-11) will not be included in the Stormwater Management Manual and will not be accepted for use within the City.

III. Technology Assessment Protocol

This testing protocol is based on protocols developed by other jurisdictions in the northwest. The Washington Chapter of the American Public Works Association (APWA), the Washington Department of Ecology, the City of Olympia, and the City of Sacramento/ Sacramento County have all developed very similar protocols, and were all instrumental in the development of this one. In this document, BES has tailored various sections of these protocols to fit Portland's design standards. BES reserves the right to change or update this document at any time. As design standards change, compliance with this protocol does not "grandfather" any manufactured facilities into the Stormwater Manual. BES reserves the right to request additional information at any time, and may remove technologies from accepted status after gaining further experience with them, or as new data becomes available. If a vendor wishes to use a different protocol, it is highly recommended to submit protocol details to BES for review prior to initiating tests.

REQUIRED NUMBER AND TYPES OF STUDIES

For BES to adequately evaluate the performance of a facility, a sufficient number of data points, or tests, must be submitted by the manufacturer. The submission of at least 30 tests will be deemed adequate for review. A "test" is defined as a controlled study that meets the requirements set forth in this protocol and results in a single data point which can be plotted on an Influent TSS (mg/L) vs. Removal Efficiency (%) curve (see Chart 3, Page B-15). Removal efficiency shall be calculated using methods specified on page B-10 of this report. At least half of the tests must come from field installations; either field performance studies with real storms or field performance studies with artificial storms.

Testing by "Independent Entities"

Testing of technologies may be conducted by qualified "independent entities" such as consultants, universities, local, state, or federal agencies. Testing may also be sponsored by the manufacturers themselves, but actual sampling, testing, and laboratory reporting must come from a qualified laboratory.

A. FIELD PERFORMANCE STUDIES WITH REAL STORMS

For inclusion in the Stormwater Manual as a stand-alone "Presumptive Approach", at least 15 data points must be obtained from actual field installations. These can come from field studies with real or artificial storms. At least two different land-uses must be represented, including medium density residential, retail commercial, non-retail commercial, or industrial. Testing within transportation corridors, including public or private streets within these land-uses, is encouraged. The purpose of this is to obtain a range of influent concentrations representative of typical storm water runoff. While it is acknowledged to be more difficult and expensive than laboratory testing, field testing will ensure that situations existing in "real-life" will be mimicked to the maximum extent practicable.

The following storm characteristic requirements must be met for field tests with real storm events, and must be documented and submitted to BES for acceptance.

NUMBER AND CHARACTERISTICS OF SAMPLED STORMS

Minimum Number of Sampled Storms

For acceptance as a stand-alone “Presumptive Approach”, 5 storm events from three different sites must be submitted for a total of 15 storms. Real or artificial storm events can be used. At least two different land-uses must be represented, from either medium density residential, retail commercial, non-retail commercial, or industrial. Testing within transportation corridors, including public or private streets within these land-uses, is encouraged. The purpose of this is to obtain a range of influent concentrations representative of typical storm water runoff. For possible acceptance as a pretreatment device, at least 5 storm events must be submitted. To represent seasonal differences if only real storms are used, the tests shall occur throughout the calendar year. No more than 70% of the real storms may be sampled during the dry season (May through September) or during the wet season (October through April).

Minimum Storm Depth

The minimum total storm depth shall be 0.12 inches. As a guideline, at least 50% of the sampled storms should exceed 0.42 inches, and at least 10% of the sampled storms should exceed 0.83 inches.

Minimum Facility Flow Rate

Obtain data for a range of flows, from 10 to 100% of the design flow for off-line facilities, and from 10 to 125% for facilities designed to be flow-through, on-line facilities. Exceeding the design flow will demonstrate the facility’s ability to retain previously trapped pollutants during high-flow periods. This requirement will most likely be accomplished through field testing with artificial storms.

Start/ End of Storm Event: A storm event is preceded and followed by at least six hours of dry weather.

Minimum Runoff Duration: 6 Hours.

Minimum Average Rainfall Intensity

Minimum average rainfall intensity shall be 0.02 inches/ hour. As a guideline, at least 50% of the storms should exceed 0.03 inches/ hour, and at least 10% should exceed 0.05 inches/ hour.

Maximum Average Rainfall Intensity: Maximum average rainfall intensity shall be 0.1 inches/ hour.

SAMPLING SPECIFICATIONS

Type of Samples

Flow-weighted composite samples (Event Mean Concentration or EMC), except pollutants or technologies for which grab sampling is mandated by sampling protocols. Document all sample types for BES review.

Sampling Procedure

To the maximum extent practicable, sample the entire runoff period. As a guideline, sample at least 75% of the total volume of each storm. The final composite sample shall comprise at least 10 influent and 10 effluent sub-samples collected throughout the storm. Plot sampling times on a copy of the runoff hydrograph.

Sampling Locations

If Method #1, 2, or 3 (Page B-10) is used to calculate Removal Efficiency: Collect influent samples and measurements of flow rates and volumes at a point upstream of the treatment system, before any flow

bypasses. Collect effluent samples and measurements of flow rates and volumes at a point downstream of the treatment system after bypassed and treated flows are rejoined.

If Method #4 (Page 10) is used to calculate Removal Efficiency: Ensure that the unit has been thoroughly cleaned and all sediment removed prior to start of test. Collect influent samples and measurements of flow rates and volumes at a point upstream of the treatment system. Immediately after test, block incoming flows and remove collected pollution for analysis.

Document all sampling locations for BES review.

Parameters of Interest

Parameters of interest include: total suspended solids (TSS), total dissolved solids, BOD, temperature, pH, hardness, total recoverable and dissolved metals including zinc, copper, lead, and cadmium, total and ortho-phosphate, total nitrogen, total petroleum hydrocarbons (NWTPH-Dx and -Gx, silica gel), visible sheen, bacteria (E. coli), nitrate-N, and ammonia-N. The vendor may submit any additional parameters that are deemed to be relevant to facility performance.

The vendor should tailor its sampling procedure to support the treatment goal. To be included in the Stormwater Manual as a general "Presumptive Approach", TSS needs to be sampled. To be considered as an oil/ water separator, Total petroleum hydrocarbons (NWTPH-Dx and -Gx, silica gel) and visible sheen needs to be tested. To be considered for use in TMDL watersheds, other pollutants of concern must be addressed. Because pollution removal parameter requirements tend to change over time, it is in the vendor's best interest to evaluate as many pollutants as possible. Testing methods and procedures are not included in this document for all pollutants of interest, and therefore must be submitted to BES with any testing data.

Sample Handling and Reporting

The methods of sample preservation and analysis are to be documented and submitted with test results. A qualified laboratory shall analyze samples. Results shall be analyzed and reported by entities independent of the vendor. The report shall discuss any discarded samples, QA/QC, duplicates, and ignored data. Analyzation techniques should not employ very minute samples, such as the "10 ml technique".

ACCUMULATED SEDIMENT TESTING

At the end of the test period, remove, weigh, and analyze accumulated sediment. Evaluate the sediment for the following: total dry weight, moisture content, particle size distribution, organic content, TPH, total phosphorus, and total zinc, copper, cadmium, and lead. Analyze particle size distribution using both wet and dry sieve test procedures following ASTM methods. Analyzing particle size distribution is very important in determining a facility's ability to remove the full range of sediment sizes (see table on page B-9). Quantify or otherwise document gross solids (debris, litter, and other particles exceeding 1 mm in diameter) and oil accumulations.

GROSS SOLIDS TESTING

At the end of the test period, remove, weigh, and describe accumulated gross solids. Compare gross solids collected in the facility with gross solids bypassed downstream, measured through collection in mesh bags with one-millimeter openings.

RAINFALL MONITORING

Rainfall shall be measured at a representative site. Document site location and distance from facility.

GEOGRAPHIC SETTING

Sites in the Pacific Northwest (SCS Type 1A Rainfall Distribution) are preferred, but not required, as long as rainfall and runoff measurements are within tolerances specified on page B-7.

B. FIELD PERFORMANCE STUDIES WITH ARTIFICIAL STORMS

Field performance studies with artificial storms may be submitted by vendors. The procedures described above for "real" storms must be followed, and additional data on the methods used to calculate and field-distribute the artificial storms must be documented and submitted. An artificial hydrograph or series of constant flow rates must be formulated and followed during the field test. It is highly recommended that the vendor submit this artificial hydrograph to BES for review prior to field testing.

C. LABORATORY PERFORMANCE STUDIES

BES recognizes that laboratory testing provides useful information under controlled conditions. Vendors may submit laboratory performance studies for consideration. Up to one-half (15) of the performance studies may be performed in the laboratory.

Removal rates for tests using potable water, spiked with pollutants, have generally been shown to be higher than tests using "real" storm water. Real storm water is therefore preferred when laboratory testing is employed, and should be used for at least half of the tests. When real storm water is used, one performance study shall be comprised of at least 10 influent and 10 effluent samples collected throughout the testing period (treatment efficiency calculation method #1, Page B-10), or 10 influent samples collected throughout the testing period and one final captured load mass (treatment efficiency calculation method #4, Page B-10). Documentation of the method of acquisition of test water must be submitted to BES for approval.

Spiked test water may be used for up to seven studies. When spiked test water is used, one study shall consist of either; 1) a test performed on water loaded with the full range of particle sizes, or 2) a series of tests on each separate particle size. Treatment efficiency calculation method #4 on page B-10 shall be used in either case. TSS added to laboratory water shall conform to the particle size distribution shown in the table below. Documentation of the composition of test water must be submitted to BES for approval.

TABLE: DISTRIBUTION OF SEDIMENT SIZES (STANDARD SIEVE)

PARTICLE DIAMETER	% LESS THAN (WEIGHT)
< 1,000 micron	100%
< 707 micron (coarse sand)	95 to 100%
< 595 micron	90 to 95%
< 420 micron (medium sand)	85 to 90%
< 297 micron	80 to 85%
< 177 micron (fine sand)	75 to 80%
< 88 micron (very fine sand)	50 to 75%
< 44 micron (coarse silt)	25 to 50%
< 16 micron (medium silt)	0 to 25%
<8 micron (fine silt)	0%

D. TREATMENT EFFICIENCY

There are many different methods used to calculate treatment efficiency, four of which are shown below. Method #1 and #4 calculate efficiencies for individual storms, while method #2 and #3 calculate average

efficiencies over a number of storms. While any of these described methods are acceptable for use, methods 1 and 4 require fewer storm events to be sampled and are therefore easier to perform. Describe which treatment efficiency methods below were used and include calculations. All are expressed as percentages. Any samples analyzed below detection limits may either be included at the detection limit, or be excluded (with a notation to that effect).

Method #1: Removal in each storm calculated as:

$$100(\text{flow-weighted influent concentration} - \text{flow-weighted effluent concentration}) / \text{flow-weighted influent concentration}$$

Where: All concentrations are averages of the 10 flow-weighted sub-samples.

Method #2: Aggregate removal of the storms sampled as:

$$100(A-B) / A$$

Where: $A = (\text{influent concentration Storm 1})(\text{flow of Storm 1}) + (\text{influent concentration of Storm 2})(\text{flow of Storm 2}) + \dots (\text{influent concentration of Storm N})(\text{flow of Storm N})$

$$B = (\text{effluent concentration of Storm 1})(\text{flow of Storm 1}) + (\text{effluent concentration of Storm 2})(\text{flow of Storm 2}) + \dots (\text{effluent concentration of Storm N})(\text{flow of Storm N})$$

Where concentrations are flow-weighted, and flow = average storm flow or total storm volume (vendor's choice).

Method #3: Efficiency based on geometric mean:

$$100(A-B) / A$$

Where: $A = \text{Geometric mean of all products of flow-weighted influent concentration times average storm flow or total storm volume.}$

$B = \text{Geometric mean of all products of flow-weighted effluent concentration times average storm flow or total storm volume.}$

Method #4: Removal in each storm calculated as:

$$\text{Efficiency} = 100(\text{Captured load mass}) / (\text{Influent load mass over entire storm})$$

Where: Captured load mass = Mass of accumulated TSS in the treatment facility during testing period

Influent load mass over entire storm = Flow-weighted influent concentration times total storm volume through facility, or for laboratory tests with spiked water, total mass of added TSS. Note: TSS gradation must comply with table on page B-9.

E. FACTORS OTHER THAN TREATMENT PERFORMANCE

BES staff must make reasoned decisions about storm water treatment technologies. To do so, all relevant factors need to be evaluated, while recognizing the critical importance of the technology's verified treatment performance for a target group of pollutants. Given the limited experience with emerging technologies, this is an arena where "best professional judgement" based on the weight of evidence is appropriate. To be accepted as a publicly owned and maintained facility, the vendor must present the following data to BES's *Standards and Practices Committee*, and receive their official consent. To be accepted for use as private facilities, the vendor must submit the following data to the BES address on page B-13.

Applications

- 1) How does the facility work? How does it remove pollutants?
- 2) For which applications (e.g. land uses, pollutants) does the vendor recommend this technology? Why?
- 3) How many systems are installed in the United States? Provide at least three references with names and telephone numbers. Provide specific model numbers.
- 4) Provide information on at least three units owned and maintained by public municipalities and information on the oldest units installed to date. Provide specific model numbers.

Site Characteristics

- 5) Do any of these site characteristics or safety considerations favor or limit the technology's use: steep slopes, high groundwater, baseflows, soils, proximity to wells, septic systems and buildings, facility depth limits for access and safety, risk of hazardous materials spills, and driving head requirements? How?

Design Criteria

- 6) Pollutant removal at design flow and for representative storm water characteristics (e.g. TSS particle size distribution)
- 7) Stormwater constituent limitations, pollutants and other constituents, including fouling factors
- 8) Design hydraulics (treatment and hydraulic design flows, by-pass flow, hydraulic grade line, scour velocities, etc.)
- 9) Design residence time, vertical/ horizontal velocities, etc.
- 10) Specific flow rate for media
- 11) Head loss curves for media
- 12) Minimum contact time and minimum thickness for media
- 13) Design life of system or components of the system before major overhaul is projected; describe fully
- 14) Media specifications to ensure that adequate quality of each medium is supplied to the user at all times. A list of all the physical/ chemical and impurity specifications should be provided
- 15) Structural, water tightness, buoyancy, and constructability
- 16) Design sizing and cost information for units designed to perform without maintenance for one full-year, and over-designed to last three years before the first cleaning.
- 17) Pretreatment requirements if any
- 18) Materials used to construct facility

Construction

- 19) What role does the vendor take in design and construction? Will a vendor representative be available to the contractor in the field? A letter from the vendor is required with every facility accepted to be publicly owned and maintained. This letter must confirm that the facility is being designed per manufacturer specifications to meet City of Portland requirements.
- 20) List the steps taken to install the technology. How long does it take?
- 21) How are factors such as structural integrity, water tightness, and buoyancy addressed?
- 22) What types of problems can occur in designing and installing the technology?

- 23) How are potential problems diagnosed and corrected, and by whom?
- 24) If problems go uncorrected, how does this affect the technology's effectiveness? What will cause complete facility failure?
- 25) How available is the technology (e.g. where do the major components come from and how much lead-time is needed?)

Costs

- 26) Provide materials (capital) and installation costs for complete system(s), indicating total costs and costs per cfs treated (not per cfs hydraulic capacity)
- 27) What is estimated useful facility life before replacement is needed?

Operation and Maintenance: For a typical installation with typical stormwater, discuss each of the following:

- 28) How are inspections performed and how often?
- 29) How do you tell or forecast when maintenance will be needed, i.e., what is the "trigger" for determining when maintenance is needed and why?
- 30) How is maintenance performed? Specify equipment, materials, and man-hours necessary
- 31) Are all maintenance areas accessible by people and equipment? Are special equipment or methods needed for access? Any confined space entry areas?
- 32) What is the estimated maintenance frequency and on what information/ tests do you base this estimate?
- 33) What role does the vendor take in maintenance/ How much does the vendor charge for maintenance service?
- 34) Can the technology be damaged due to delayed maintenance, and if so, how is it restored?
- 35) How many years have you been in business? If vendor goes out of business or product model changes, how/ where will facility owner find needed parts, materials, and service?
- 36) Provide information on how other public jurisdictions clean and maintain their units.
- 37) Is there a standardized Operations and Maintenance plan available? If so, please provide a copy.

Reliability

- 38) Assuming the technology is designed and installed correctly, what factors can cause it not to perform as designed?
- 39) Can the technology add, transform, or release accumulated pollutants?
- 40) Does the filter medium decompose or is it subject to slime/ bacteria growth/
- 41) Is the technology sensitive to heavy or fine sediment loadings- is pretreatment required?
- 42) How is under-performance diagnosed and treated?
- 43) What is the warranty?
- 44) What initial/ ongoing user support is provided? Does the vendor charge for support?

Other Factors

- 45) Does the technology provide benefits or present challenges in other potentially relevant areas, such as groundwater recharge, thermal effects on surface waters, habitat creation, aesthetics, vectors, safety, community acceptance, and recreational use?

IV. REPORTING

Vendors seeking BES approval of manufactured stormwater treatment facilities must submit the specified test data in report format, and must include answers to the “Factors Other than Treatment Performance” section above. While treatment performance is the most obvious factor in determining facility acceptance, others such as maintainability and reliability are equally important.

All relevant data should be included in the report, including but not limited to: test site locations with maps, dates and times of sampling, topography maps outlining drainage basins, system plans showing all relevant stormwater piping and pollution reduction facilities, expected flow calculations for various storm events, beginning and end times of all storm events and samplings, rainfall data from specified rain gage, measured flows through the system at various times (submit calculated hydrographs), and history of the facility (when constructed, when last maintenance/ cleaning occurred, etc.). All data pertaining to characteristics of storms and sampling procedures must be submitted to show conformance with previous specifications.

All reports should be submitted to ATTN: Steve Fancher, PE
Bureau of Environmental Services, C.O.P.
1120 SW 5th Ave. Room 1100
Portland, OR 97204-1972

BES will evaluate the data and report findings to the vendor within 60 days of the submittal.

V. DATA EVALUATION

BES will evaluate the data submitted by the vendors, and group each technology into one or more of the following classifications:

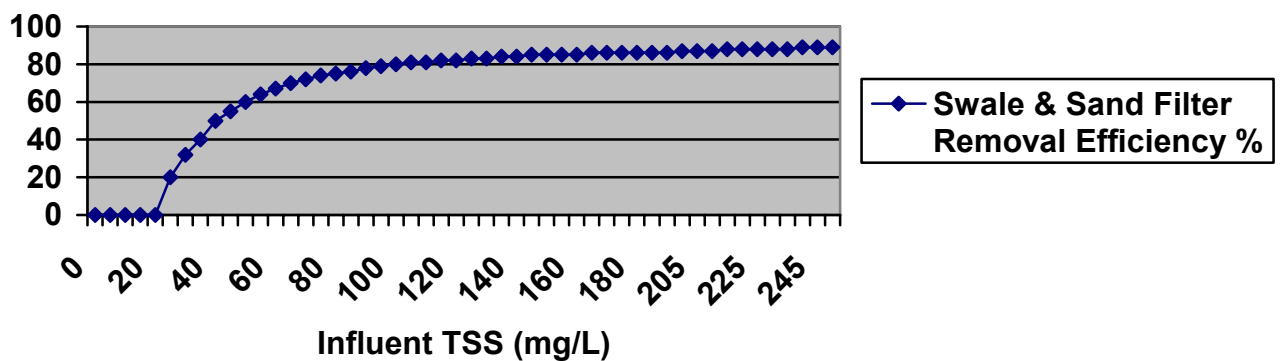
- Presumptive Approach (TSS)
- Pretreatment Only
- Oil/ Water Separation
- Specific Pollutants of Concern (TMDL pollutants)
- Acceptable as Public Facility
- Private Facility Only
- Not Approved for Any Application
- Insufficient Information, Provide Additional Data

LINES OF COMPARABLE PERFORMANCE

As mentioned earlier, BES will use the “Line of Comparative Performance©” method to evaluate a treatment technology’s ability to remove TSS. The following table describes the data points that form the approximate grassy swale/ sand filter comparison line:

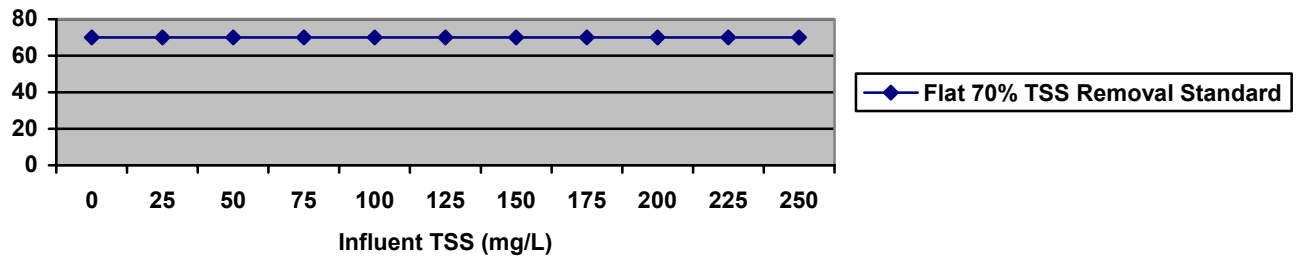
INFLUENT TSS (mg/L)	REMOVAL EFFICIENCY
20	0 %
25	20 %
50	60 %
75	74 %
100	80 %
125	83 %
150	85 %
175	87 %
200	88 %
250	89 %

Chart 1: Grassy Swale/ Sand Filter Line of Performance



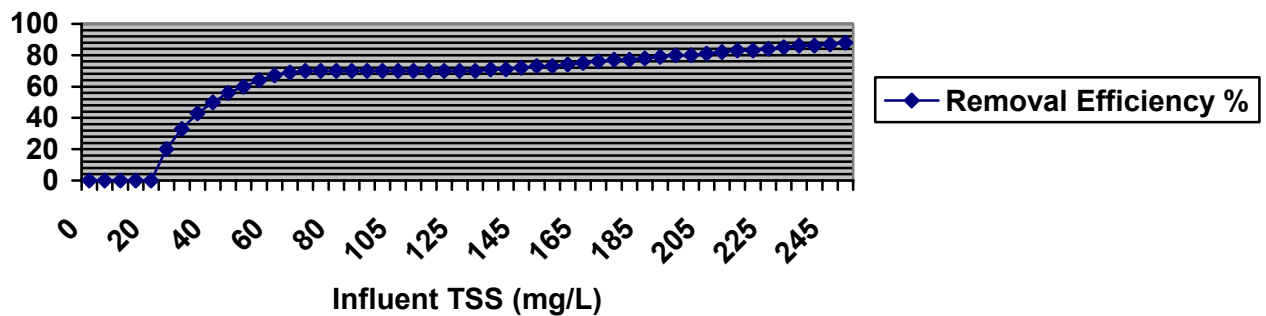
The following chart represents a flat “70% TSS Removal” standard:

Chart 2: Flat 70% TSS Removal Line



The following performance line is consistent with the City of Portland’s 70% TSS removal standard and takes into account influent TSS concentrations:

Chart 3: Portland's Modified Performance Standard Line



According to Section 403 Report to Congress, U.S. EPA, 1995, “Typical” stormwater contains about 100 mg/L TSS. This line specifies 70% TSS removal for a range 30% below and 30% above 100 mg/L. For every point with less than 70 mg/L influent TSS, it is assumed that the effluent will be the minimum allowed 20 mg/L. For influent concentrations greater than 130 mg/L, the points rise linearly to 88% removal at 250 mg/L, which is a point shared with the swale/ sand filter comparison line.

To meet the City of Portland’s basic pollution reduction standard, at least 50% of a technology’s data points should fall above this line of performance, as approved by BES. Efficiency calculation methods on page B-9 and 10 shall be used to plot points on the chart. Facilities will be required to remove more than 70% for high (<130 mg/L) influent concentrations, while being allowed to remove less than 70% for low (<70 mg/L) influent concentrations. This will result in facilities being evaluated as they actually perform in the field, with those that average 70% TSS removal during the design storm of 0.83 inches over 24 hours receiving acceptable performance evaluations.

SAMPLE DATA COLLECTION SHEET

FIELD SITE #1

TEST 1= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 2= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 3= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 4= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 5= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____

FIELD SITE #2

TEST 1= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 2= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 3= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 4= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 5= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____

FIELD SITE #3

TEST 1= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 2= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 3= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 4= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 5= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____

LABORATORY STUDIES WITH “REAL” STORMWATER

TEST 1= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 2= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 3= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 4= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 5= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 6= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 7= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____
TEST 8= 10 sub-samples: ave. influent conc.=____; ave. effluent conc.=____; efficiency=____

LABORATORY STUDIES WITH SPIKED WATER

TEST 1: influent load mass over entire storm=____; captured load mass=____; efficiency=____
TEST 2: influent load mass over entire storm=____; captured load mass=____; efficiency=____
TEST 3: influent load mass over entire storm=____; captured load mass=____; efficiency=____
TEST 4: influent load mass over entire storm=____; captured load mass=____; efficiency=____
TEST 5: influent load mass over entire storm=____; captured load mass=____; efficiency=____
TEST 6: influent load mass over entire storm=____; captured load mass=____; efficiency=____
TEST 7: influent load mass over entire storm=____; captured load mass=____; efficiency=____

VI. REFERENCES

Washington Department of Ecology, “Draft 4: Vendor Submission Guidance for Evaluating Emerging Stormwater Treatment Technologies”, October 2000

Puget Sound Watershed, “Final Draft: Protocol for the Acceptance of Unapproved Stormwater Treatment Technologies for Use in the Puget Sound Watershed”, APWA Task Committee, November 1999

The County of Sacramento and Cities of Citrus Heights, Folsom, Galt, and Sacramento, “Investigation of Structural Control Measures for New Development”, November 1999

Boyd, Gail, URS Corporation, personal communication

Technical Update #1

Subject: **Vendor Submission Guidance for Evaluating Stormwater Treatment Technologies: Clarification Regarding “TSS” versus “SSC” Testing Methods**

Date: **July 5, 2001**

The recently released USGS policy regarding the collection and use of total suspended solids data in determining the suspended sediment load in stormwater runoff was recently brought to our attention. We have been reviewing the USGS “Comparability of Suspended-Sediment Concentration and Total Suspended Solids Data” document dated August of 2000, and would like to clarify our sampling specifications, as listed in the above mentioned “Vendor Submission Guidance for Evaluating Stormwater Treatment Technologies”.

By using “Total Suspended Solids” or “TSS” terminology, we may have implied that the *Total Suspended Solids Analytical Method*, as described by the American Public Health Association, American Water Works Association, and Water Pollution Control Federation should be used to analyze test samples. According to the USGS study (Water-Resources Investigations Report 00-4191 by John R. Gray, G. Douglas Glysson, Lisa M. Turcios, and Gregory E. Schwarz) this method, which uses predetermined sub-sample volumes from an original water sample obtained while the sample is being mixed, is fundamentally unreliable for the analysis of natural-water samples. Methods used in the withdrawal of an aliquot of the original sample are inconsistent and often non-representative of the sample.

The *Suspended-Sediment Concentration Analytical Method*, however, measures all sediment and the mass of the entire water-sediment mixture. ASTM Standard Test Method D 3977-97 lists three methods that result in a determination of SSC values in water and wastewater samples: Test Method A- Evaporation, Test Method B- Filtration, and Test Method C- Wet-sieving filtration. The percentage of sand-size and finer material can be determined as part of the SSC method, but not as part of the TSS method. Overall, the SSC method “produces relatively reliable results for samples of natural water, regardless of the amount or percentage of sand-size material in the samples”.

We would like to see the *Suspended-Sediment Concentration Analytical Method* used, as described in ASTM D 3977-97 for analysis of suspended sediment load in stormwater runoff.