
The **T**echnology **A**cceptance **R**eciprocity **P**artnership

Protocol for

Stormwater Best Management Practice Demonstrations

Endorsed by
California, Massachusetts, Maryland,
New Jersey, Pennsylvania, and Virginia

Final Protocol 8/01
Updated: 7/03



The TARP Protocol for Stormwater Best Management Practice Demonstrations

Endorsed by the Technology Acceptance Reciprocity Partnership (TARP) states of:
**California, Massachusetts, Maryland,
New Jersey, Pennsylvania, and Virginia**
Final—8/01, Updated: 7/03

Endorsement

For technology evaluations following the elements of this Protocol, the state partners in California, Massachusetts, Maryland, New Jersey, Pennsylvania, and Virginia have agreed to:

- 1. Address technology review and approval barriers in policy and regulations that do not advance knowledge of a technology's performance or recognize innovative approaches to meet environmental protection goals;*
- 2. Accept the performance tests and data, and acknowledge the approval results of a partner's review of a technology demonstration, as appropriate, in order to reduce subsequent review and approval time;*
- 3. Increase expertise in the applications and advantages of technologies that may have superior environmental and economic benefits for controlling stormwater pollution;*
- 4. Use the Protocol, as appropriate, for state-led initiatives, grants, and verification or certification programs where the objective is to document performance efficiency and cost of best management practices;*
- 5. Share technology information with potential users in the public and private sectors using existing state supported programs; and*
- 6. Monitor and evaluate the results of using this Protocol, and periodically review and revise the Protocol to maintain its viability.*

This Protocol describes a set of uniform criteria acceptable to the endorsing states. However, specific state requirements must be considered when applying for certification or verification of a stormwater BMP in a particular state. Each partner reserves the right to evaluate any application and request specific information as outlined in Appendix D in order to satisfy an individual state's requirements.

Any state, regional, or private entity interested in using the Protocol should contact the stormwater leads listed in Appendix D. States wishing to join the partnership and endorse this Protocol should contact Calvin Kirby, Pennsylvania Department of Environmental Protection; contact information is provided in Appendix D.

Table of Contents

1	<u>Introduction</u>	4
	1.1 Overview.....	4
	1.2 Purpose.....	4
2	<u>Preparing a Test QA Plan Scope for Validation Screening</u>	5-8
	2.1 Preparation	5
	2.2 Stormwater BMP Screening for Validation.....	5
	2.3 Technology Specifications.....	6
	2.4 Performance Claim.....	7
	2.5 Test QA Plan Scope.....	8
3	<u>Test QA Plan Contents</u>	8-14
	3.1 Standardized Test Methods and Procedures.....	8
	3.2 Data Quality Assurance Project Plan.....	9
	3.3 Stormwater Data Collection Guidance.....	9-14
	3.3.1.1 Storm event criteria to sample.....	10
	3.3.1.2 Identifying storms to sample.....	10
	3.3.1.3 Determining a representative data set.....	11
	3.3.2 Selecting stormwater sampling locations.....	11
	3.3.3 Stormwater sampling methods.....	12
	3.3.4 Stormwater flow measurement methods.....	12
	3.3.5 Sample data quality assurance and control.....	12
	3.3.6 Selection of parameters.....	12
	3.3.7 Analytical laboratory requirements.....	13
	3.3.8 Calculating BMP efficiencies and performance effectiveness..	13
	3.4 Statistical Testing of Data.....	14
4	<u>Health and Safety Plan</u>	14
5	<u>Cost Information</u>	15
6	<u>Report Contents for Verification/Certification</u>	15
7	<u>Protocol Limitations, Release of Liability, and Disclosure</u>	15
8	<u>Appendices</u>	16-35
	Appendix A: Performance Claim Test Plan Flowchart.....	16
	Appendix B: Applicable Standardized Parameters for Sampling.....	17
	Appendix C: List of Stormwater Parameters for Sampling.....	19
	Appendix D: States' Standards and Contacts.....	21
	Appendix E: Stormwater BMP Demonstration Summary Form.....	31
	Appendix F: QAPP Groups and Elements.....	33
	Appendix G: Web Sites for Developing Stormwater Test QA Plans.....	35
	Appendix H: Bibliography.....	36

1 Introduction

1.1 Overview

Stormwater pollution, especially in developed urban areas is a leading cause of water quality degradation in U.S. rivers, lakes, streams, and other surface waters. Water quality problems associated with nonpoint sources of pollution, particularly stormwater, are being addressed by federal mandates that affect all states. Expansion of the National Pollutant Discharge Elimination System (NPDES) Phase II, Storm Water Regulations, requires stormwater plans from thousands of municipalities nationwide, and a renewed focus on the total maximum daily load provisions (TMDL) in the Clean Water Act brings unprecedented attention and increased resources to stormwater control issues. These programs also are predicted to have a significant influence on the rate at which new technologies enter the marketplace.

To support responsible use of stormwater technologies, the Demonstration Protocol is designed to be flexible and inclusive of both structural and nonstructural best management practices (BMPs). The Protocol primarily deals with the demonstration of BMPs that are designed for one or more of the following: 1) directing and distributing flows; 2) reducing erosive velocities; and 3) removing contaminants such as suspended or dissolved pollutants from collected stormwater through physical and chemical processes such as settling, media-filtering, ion-exchange, carbon adsorption, and precipitation. Current BMPs used in industrial, municipal, and construction stormwater pollution control applications, include vegetated swales, detention basins, infiltration basins, wet ponds, constructed wetlands, media filtration, bioretention, and sedimentation units (e.g., hydrodynamic structures, oil/sediment separators, and screen separators).

1.2 Purpose

The purpose of the Protocol is to provide a uniform method for demonstrating stormwater technologies and developing test quality assurance (QA) plans for certification or verification of performance claims. The advantages of using the Demonstration Protocol are numerous. Technology proponents will reduce duplicative or overlapping demonstration and performance testing of technologies; maximize research and development dollars; certify or verify the technology in accordance with performance claims and state regulatory standards; demonstrate effectiveness, cost, and marketability; and achieve maximum market penetration.

Since current NPDES Phase I and II regulations require industrial and municipal permittees to provide stormwater discharge control through use of BMPs, specific BMP usage is not subject to regulation. Stormwater BMPs with demonstrated capability, i.e., BMPs with reliable removal rates based on field testing, are more likely to be used in NPDES required Stormwater Pollution Prevention Plans (SWPPP) to control stormwater discharges. Obtaining certification or verification of a stormwater BMP technology from participating states can assist the technology in gaining regulatory acceptance in this application.

The requirements for a stormwater BMP demonstration are minimized in the Protocol to a common set of uniform criteria, acceptable to all participating states. However, specific state requirements must be considered when a technology proponent is pursuing certification or verification of a stormwater BMP in that state; specific requirements for the endorsing states are described in, but are not limited by, Appendix D. In addition, the Protocol does not completely eliminate all state review or approval of projects proposing to use the stormwater technology, nor does it require any state to “rubber stamp” the approval or permit of another state or regulator.

2 Preparing a Test QA Plan Scope for Validation Screening

States endorsing this Protocol recognize that new information and approaches to stormwater control may warrant future adjustments to the Protocol. As acknowledged on page 1, states are committed to reviewing and revising the Protocol, as necessary, to maintain its viability.

2.1 Preparation

Prior to undertaking a Stormwater BMP Technology Demonstration, a proponent should research current developments in stormwater BMPs to compare a technology's capabilities with applicable field-tested BMPs or state-of-the-art standards. A major effort to develop a nationwide stormwater BMP database on the performance capabilities of structural and non-structural BMPs has been undertaken by the American Society of Civil Engineers (ASCE) and the U.S. Environmental Protection Agency (EPA). The database includes BMP removal efficiency data for specific contaminants, as well as site-specific data, area hydrologic data, and BMP specifications for locations throughout the U.S. This database can be accessed at the following Web site: <http://www.bmpdatabase.org/>.

If a proponent requires financial assistance for evaluating a technology, funding may be available through federal, state, or local government agencies. Financial assistance for evaluation testing of innovative environmental technology can be pursued through the EPA Office of Research and Development (ORD) program, National Center for Environmental Research Web site: <http://www.epa.gov/ncer/>.

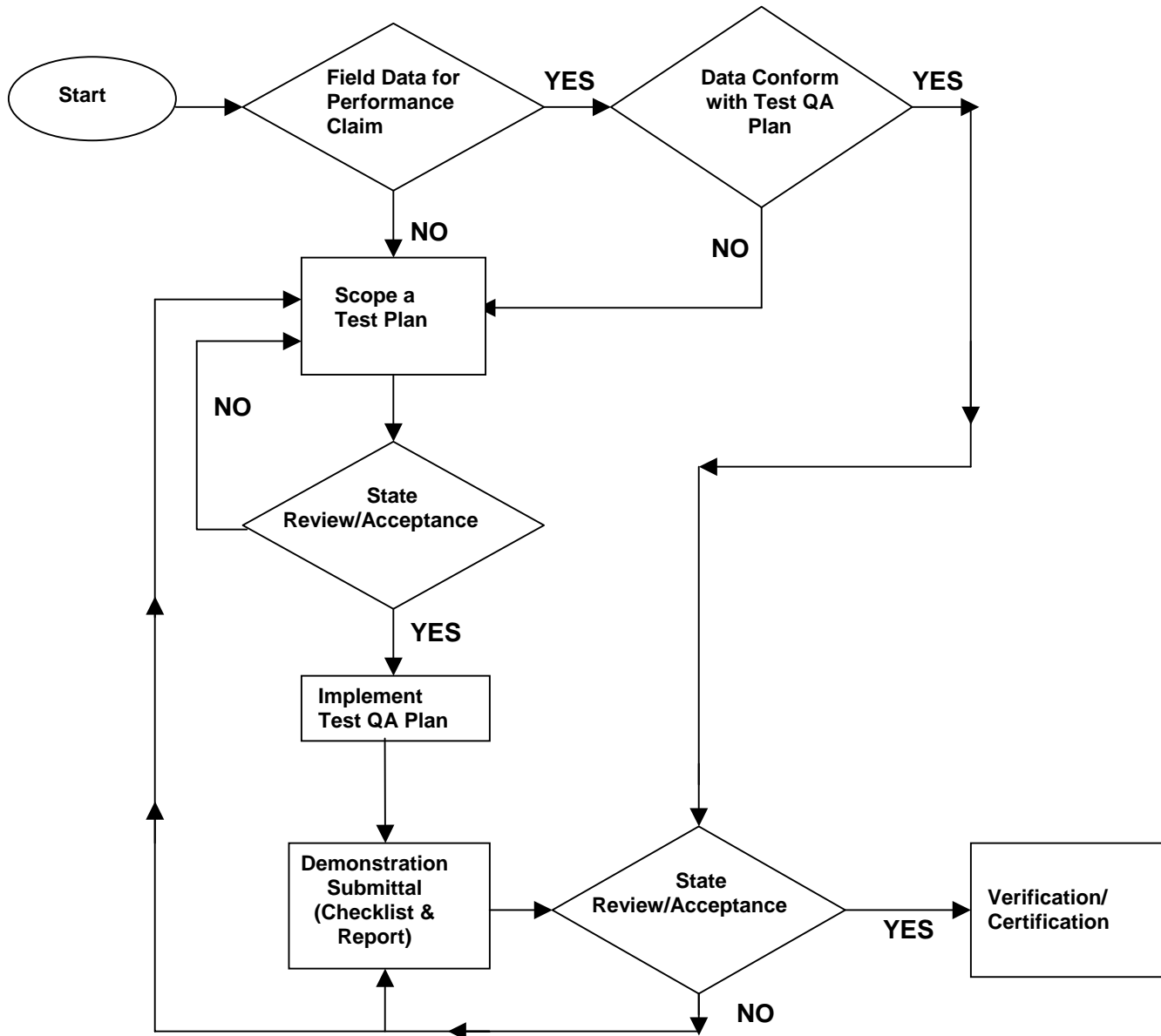
A technology proponent may use existing lab and field studies or other appropriate data to support claims about a technology's performance capabilities. Replication of field-testing under a variety of conditions (i.e., flow rates, contaminant loadings, antecedent moisture conditions, rainfall distribution, maintenance intervals, primary treatment device or treatment train approach, land use, percent imperviousness, and type of drainage system) is desirable for a Stormwater BMP Technology Demonstration. Therefore, field-testing in accordance with the Test QA Plan is required in addition to performance claim data, which may be available in lab and field studies.

The main focus of the states' technology verification and certification programs is the independent validation of data supporting specific technology performance claims. Although the emphasis of the Protocol is to provide guidance on the requirements for obtaining performance data through use of Test QA Plans, proponents with existing data can check their data to determine if the requirements of a Test QA Plan can be fulfilled. A flowchart of the test QA plan and field demonstration review process is shown in Figure 1.

2.2 Stormwater BMP Screening for Validation

Before undertaking a Stormwater BMP Demonstration, technology specifications, performance claims, the Test QA Plan scope, and performance claim data (if available) must be submitted for review and validation by verification/certification organizations. Technology specifications and existing data will be reviewed first to ensure that the technology meets program criteria, e.g., environmentally beneficial, commercially available, field-tested, and the product has been quality controlled.

Figure 1. Overview of the Test QA Plan and Field Demonstration Review Processes



The performance claim and Test QA Plan scope will be reviewed and validated based on elements in the Test QA Plan scope, including: test objectives, use of standardized test methods and procedures, a data quality assurance and control plan, data collection, and statistical tests of the data. Each test plan must have a quality assurance project plan (QAPP), meeting the requirements specified in Appendix F.

2.3 Technology Specifications

The technology, components, and all process units should be described completely. Generally, the technology specifications must include physical, chemical, and biological processes, operation and maintenance (O&M) requirements, process flow diagrams and algorithms, equipment drawings

and specifications, existing test plans, performance data, certifications, and a description of process inputs and outputs. More specifically, the following information should be provided in the specifications.

1. A summary of the underlying scientific and engineering principles for the technology.
2. Technology specifications, alternative technology configurations, and any associated disadvantages, such as physical constraints and limitations, weight and buoyancy, transportability, durability, energy requirements, and consumable materials.
3. Minimum siting and design specifications to achieve stated performance, including but not limited to: pollutants that should and could be addressed; minimum and maximum influent concentrations; pollutants that will not be addressed or that may be increased; and siting, location, land use, and land activity limitations or restrictions.
4. A discussion of the advantages of the technology when compared to conventional stormwater systems providing comparable stormwater control.
5. Standard drawings, including a schematic of the technology and a process flow diagram.
6. A discussion of technology hydraulics and system sizing to meet performance standards and goals (e.g., to handle the water quality volume, rate of runoff, type of storm, or recharge requirements).
7. Full range of operating conditions for the technology, including minimal, maximal, and optimal conditions to achieve the performance goals and standards, and for reliability of the technology.
8. Minimum maintenance requirements to sustain performance.
9. Significant modifications and technical advancements in the technology design.
10. Technology limitations, such as performance limits for control of certain water quality parameters, and predicted impacts from construction, operation, and maintenance of the technology.
11. Identified secondary impacts.
12. Discussion of the generation, handling, removal, and disposal of discharges, emissions, and waste byproducts in terms of mass balance, maintenance requirements, and cost.
13. Discussion of pretreatment and preconditioning of stormwater, if appropriate to achieve stated performance of the BMP.
14. Identification of any special licensing or hauling requirements, safety issues, and access requirements associated with operation or maintenance of the technology.

2.4 Performance Claim

In preparation for a technology demonstration, a proponent must make a performance claim that identifies the technology's intended use and predict the technology's capabilities to remove contaminants and/or control the quantity of stormwater runoff. Performance claims should be objective, quantifiable, replicable, and defensible. Claims that are overstated should be avoided, as they may not be achievable.

Stormwater BMP technologies are typically evaluated for contaminant removal efficiency, although pollution prevention claims also are possible. An example of a stormwater treatment BMP performance claim could be:

“The Model X system can capture and treat the first half-inch, 24-hour storm for a 10-acre runoff area. Under these conditions, a total suspended solid (TSS) removal rate of 85%± 5% (at a 95% confidence level) can be achieved with inflow TSS concentrations greater than 100 mg/l.”

2.5 Test QA Plan Scope

The procedures for a stormwater BMP field test must be described in the Test QA Plan scope, which will be reviewed and validated to ensure that the procedures for collecting, handling, and analyzing samples and data will be accurate, precise, representative, complete, and comparable. Elements in a Test QA Plan include test objectives, use of standardized test methods and procedures, a data quality assurance and control plan, data collection, and statistical tests of the data. Test objectives for performance claims should be clear, concise, quantitative, and unambiguous, such that standardized test methods and procedures can be applied. The entire range of technology performance capabilities should be tested in order to demonstrate the full potential of the technology.

3 Test QA Plan Contents

3.1 Standardized Test Methods and Procedures

Standardized test methods and procedures should be used to collect stormwater BMP data. For determining stormwater contaminant removal efficiencies or removal rates, BMP inlet and outlet flows and contaminant concentrations will need to be measured. Typical standardized test methods may include ASTM flow measurement methods, ASCE hydraulic flow estimation methods, and EPA test methods for water constituent analysis. Other nationally recognized organizations have produced standards, which may be used, such as American Water Works Association (AWWA), NSF International, and American Public Health Association (APHA) Standard Methods. The standards typically used for the specific field where a technology is applied should be specified, e.g., NSF International for water and wastewater treatment technologies. Use of standardized test methods and procedures have the advantages of being prepared by technology specific, expert subcommittees, and these standards typically incorporate peer-reviewed data QA/QC. Where standard methods are not appropriate and alternative methods are proposed, sufficient evidence to assure data quality must be developed and submitted for review. Under most test conditions, a unique sampling plan will be required and a standard operating procedure (SOP) must be developed.

Several sources of test plans, test methods, procedures, and standards are available for testing stormwater technologies. Test methods for measuring flow and water constituent analysis are provided in Appendices B and C. Some examples are:

- ◆ EPA Test Methods (Appendix C) for contaminant analysis, <http://www.epa.gov/epahome/index/nameindx.htm>
- ◆ ASME Standards and Practices (pressure flow measurements),
- ◆ ASCE Standards (hydraulic flow estimation methodologies),
- ◆ ASTM Standards (precision open-channel flow measurements/practices for water constituent analysis),
- ◆
- ◆ Wilde et al, 1998. National Field Manual for Collection of Water Quality Data, Techniques of Water Resources Investigations Book 9, USGS (ISBN:0-607-90623-5),
- ◆ Caltrans “Guidance Manual: Stormwater Monitoring Protocols,” <http://www.dot.ca.gov/hq/env/stormwater/special/index.htm> and

- ◆ Test QA Plans and Protocols for wet weather flow technologies are available on the Environmental Technology Verification (ETV) Web site sponsored by EPA and NSF International: <http://www.epa.gov/etv>.

3.2 Data Quality Assurance Project Plan

The test QA plan must show that the following practices and procedures will be followed in obtaining performance claim data to ensure data quality assurance and control:

- ◆ Prepare a Quality Assurance Project Plan (QAPP) and/or a sampling and analysis plan to ensure that performance claim data sets meet data quality objectives (DQOs) and are “defensible.” The QAPP and/or SAP should be prepared using either *Guidance for Quality Assurance Project Plans (QAPP)*, EPA QA/G-5, 1998 or *Standard Guide for Quality Planning and Field Implementation of a Water Quality Measurement Program, ASTM D5612-94*. Both EPA QA/G-5 and ASTM 5612-94 provide directions for developing a sampling and analysis plan, which includes all necessary requirements to obtain valid data for water monitoring. The guides cover development of sampling and analysis plans, sampling procedures, analytical requirements, data quality assurance/control requirements, and documentation. For a copy of EPA QA/G-5, see the EPA Web site: http://www.epa.gov/quality/qa_docs.html.
- ◆ The current national QAPP requirements are available in *Requirements for Quality Assurance Project Plans (EPA QA/R-5, 2001)*. The minimum elements of a QAPP in Appendix F are cited from EPA QA/R-5. This document can be downloaded from the EPA Quality System Documents Web page, <http://www.epa.gov/quality/qapps.html>.
 - ◆ Use standardized test methods and procedures where applicable (Appendix B).
 - ◆ Use qualified personnel in testing and data acquisition.
 - ◆ Prepare and coordinate a Stormwater Sampling and Analysis Plan (see Appendix C). Ensure Sampling and Analysis Plans include:
 - ◆ Data quality objectives (DQOs);
 - ◆ Sampling equipment and procedures (location and frequency) (ASTM D3694-96/D3370-95A);
 - ◆ Chain-of-custody procedures (ASTM D4840-99);
 - ◆ Sample preservation/holding times (ASTM D4841- 88/D4515-85/D3694-96);
 - ◆ QC sample protocol (splits and composites; field, trip, equipment blanks; spikes; duplicates) (ASTM D5612-94/D5810-96/D5788-95); and
 - ◆ Sample equipment decontamination.
 - ◆ Use certified or accredited laboratories for sample analysis. See the National Environmental Laboratory Accreditation Conference (NELAC) Program Web site: <http://www.epa.gov/ttn/nelac/>.
 - ◆ Use certified or accredited laboratories for testing (ASTM, ASCE). See the following ASTM laboratory listing Web site: <http://www.astm.org/labs>.
 - ◆ Test equipment and instrument calibration/certification.

3.3 Stormwater Data Collection Guidance

This section guides the selection of criteria for data collection; it is based in part on criteria currently used for NPDES permit compliance. The *NPDES Storm Water Sampling Guidance Document* (EPA 833-B-92-001) provides additional guidance for sampling and analyzing stormwater for compliance with industrial, municipal, and construction NPDES permits.

A copy can be downloaded from the EPA Web site: <http://www.epa.gov/npdes/pubs/owm0093.pdf>. Specific stormwater technologies should tailor data collection and analysis to their specific performance claim Test QA Plan. Although there are different approaches for collecting performance data, the following criteria are considered by the participating states to be necessary for obtaining scientifically valid data, particularly for field demonstrations.

3.3.1.1 Storm Event Criteria to Sample

The following criteria will need to be considered, in order to obtain representative contaminant loading data (flows and contaminant concentrations).

- ◆ Historic data: obtain monthly mean rainfall and snowfall data, for all 12 months over the period of record, from the nearest National Weather Service (NWS) station (airport). Rainfall data for a site may be obtained from local weather station records and almanacs. The National Climatic Data Center Web site can be accessed for rainfall data for locations throughout the U.S.: <http://www.ncdc.noaa.gov/oa/ncdc.html>.

Note: Precipitation data from a single, distant station may not accurately estimate local weather patterns. In this situation, use of data from several stations with appropriate averaging methodologies (e.g., isohyetal or Thiessen) may be necessary.

- ◆ Current weather forecast available on: <http://weather.gov/>. (Substitute any state's abbreviation for "MA" in the Web site address above.)
- ◆ Use continuous recording rain gauges to measure the intensity of the storm for its duration. Measurements in 15-minute increments are recommended for consistency with NWS reporting of precipitation intensity.

3.3.1.2 Identifying Storms to Sample

- ◆ More than 0.1 inch of total rainfall.
- ◆ A minimum inter-event period of 6 hours, where cessation of flow from the system begins the inter-event period.
- ◆ Obtain flow-weighted composite samples covering a minimum of 70 % of the total storm flow, including as much of the first 20 % of the storm as possible.

Note: Composite samples are not appropriate for all parameters.

- ◆ A minimum of 10 water quality samples (i.e., 10 influent and 10 effluent samples) should be collected per storm event. For composite samples, a minimum of 5 subsamples is acceptable (i.e., 2 composites with 5 subsamples = 10 water quality sample minimum or 1 composite sample with 10 subsamples = water quality sample minimum).

Note: If a storm is too small for 10 samples, an average of 10 samples per storm may be substituted. However, more than 10 samples per storm event should be collected wherever possible.

3.3.1.3 Determining a Representative Data Set

- ◆ Flow measurements should be taken to predict or calculate pollutant loads. The mass of pollutants in the discharge should be based on flow rates and pollutant concentrations or another reasonable approach.
- ◆ Data are needed to characterize the flow rate and flow volume for each storm event.
- ◆ The number of water quality sampling events should be representative of the storm events in the climatic region. At least 50 % of the total annual rainfall must be sampled, for a minimum of 15 inches of precipitation and at least 15, but preferably 20, storms. (Also see Appendix D for California's requirements.) Storm events should be consecutive, where practicable. One-year of water quality sampling is optimal to observe performance changes as a function of season. Collection of a representative number of water quality samples may take more than a year in some regions.
- ◆ Some sampling must be done during adverse weather conditions; for example, during spring snowmelt and heavy rainfall, when runoff and contaminant transport is expected to be greater. Data quantifying process inputs and outputs should be collected for use in mass balances and cost analysis.

3.3.2 Selecting Stormwater Sampling Locations

Sampling locations for stormwater BMPs should be taken in as close proximity as possible to the BMP inlet and outlet to avoid potential sources of contamination that would alter the BMP efficiency data. Typically, the inlet and outlet for a BMP should be sampled to obtain performance claim data.

Describe and provide a scaled plan view of the demonstration site, indicating all buildings, land uses, storm drain inlets, and other control devices. Include a description of the site drainage area, percent impervious area, percent area directly connected to the BMP, description of the path of storm water flow to the BMP, type of activities conducted, pollutant sources, soil type, geological and hydrological conditions, existing control structures, and a site drainage plan. Estimate the impervious area within the drainage area and show sample inflow and outflow points.

Specify the location of flow devices and samplers in relationship to the inlets and outlets of the stormwater technology. Demonstrate that flow devices and samplers are installed and positioned properly to ensure that samples are representative of influent runoff and effluent runoff, (i.e., sample the influent as close as possible to the inlet of the system and sample the total treated effluent). For systems that bypass runoff, the influent location will be directly upstream of the system and before the flow is split between the treatment system and the

bypass. The second, effluent sampling location will be directly downstream of the treated flow (i.e., the technology or treatment system outlet) and after the effluent joins the bypass. If the treated effluent flow does not join the bypass, the second location will allow sampling of the total flow after the treatment unit outlet.

Note: Sampling points used for NPDES permit compliance monitoring may not be appropriate for testing BMP technologies, e.g., if there is a contaminant source between the BMP and the outfall of a facility.

3.3.3 Stormwater Sampling Methods

Programmable automatic flow samplers with continuous flow measurements should be used unless it is demonstrated that alternate methods are superior or that automatic sampling is infeasible. Grab samples should only be used for certain constituents, in accordance with accepted standard sampling protocols, unless it is demonstrated that alternate methods are superior. Constituents that typically require grab sampling include: pH, temperature, cyanide, total phenols, residual chlorine, oil and grease, total petroleum hydrocarbons (TPH), *Escherichia coli*, total coliform, fecal coliform, fecal streptococci, and enterococci. Collection and flow-weighted composite sampling also should follow the NPDES guidance.

Note: Time-weighted composite samples are not acceptable, unless flow is monitored and the event mean concentration can be calculated from the data.

3.3.4 Stormwater Flow Measurement Methods

Primary and secondary flow measurement devices are required.

3.3.5 Sample Data Quality Assurance and Control

The following elements should be described in the Test QA Plans and Sampling and Analysis Plan (see III. B. Data QA Project Plan):

- ◆ Equipment decontamination,
- ◆ Preservation,
- ◆ Holding time,
- ◆ Volume,
- ◆ QC samples (spikes, blanks, splits, and field and lab duplicates),
- ◆ QA on sampling equipment (e.g., calibration of automatic samplers and flow measurement devices)
- ◆ Packaging and shipping,
- ◆ Identification and labeling, and
- ◆ Chain-of-custody.

3.3.6 Selection of Parameters

Parameter testing applies to stormwater quality control BMPs. Municipal and construction site parameters are generally the contaminants in runoff studies, such as total dissolved solids (TDS), total suspended solids (TSS), suspended sediment concentration (SSC), or total petroleum hydrocarbons (TPH), total Kjeldahl nitrogen (TKN), total nitrogen, total phosphorus, chemical oxygen

demand (COD), biochemical oxygen demand (BOD), *Escherichia coli*, total coliform, enterococci, pH, conductivity, temperature, and the following metals: lead, copper, zinc, and nickel. Runoff contaminant data from BMP evaluation studies can be found in the ASCE-EPA Nationwide Database. Also, data from parking lots and roadways can be found on the following Web site: <http://www.bmpdatabase.org/>.

In selecting test parameters, include total suspended solids (TSS) and suspended sediment concentration (SSC), at a minimum, and consider other parameters that support performance claims, including those listed in Appendix C. (If a parameter is not listed, obtain approval for testing during validation screening of the Test QA Plan scope (see Section II.B.).

For some technologies, TSS and SSC removal efficiency testing will be adequate. However, confirmation of testing requirements with the state reviewing the technology, or by consulting the BMP database, is recommended, as requirements may change over time. Before selecting parameters, also consider the advantages of a comprehensive demonstration. With comprehensive parameter testing, a technology is likely to gain broader acceptance and some relief from specific technology approval requirements of the individual states. A demonstration of removal effectiveness for bacteria, nutrients, or toxics will be available to all in an Internet database.

The results of parameter testing must be compared with influent concentrations to demonstrate removal efficiencies.

3.3.7. Analytical Laboratory Requirements

Laboratories used to perform stormwater sample analysis should be certified by a national or state agency regulating laboratory certification or accreditation programs. The National Environmental Laboratory Analysis Certification (NELAC) program or, the Environmental Laboratory Accreditation Program (ELAP) (in California) should be used to perform standardized test methods and procedures.

3.3.8. Calculating BMP Efficiencies (ASCE BMP Efficiencies Task 3.1)

Process efficiencies or removal rates should be determined from influent and effluent contaminant concentration and flow data to quantify the performance of the BMP technology.

ASCE and EPA have published a Technical Memorandum on determining removal efficiencies for stormwater BMPs. This document should be used in determining BMP efficiencies (Development of Performance Measures, Task 3.1 – Technical Memorandum, Determining Urban Stormwater Best Management (BMP) Removal Efficiencies). The paper can be downloaded from the following Web site: <http://www.bmpdatabase.org/docs.html>.

In summary,

- ◆ Efficiencies can be calculated for four BMP categories: 1) BMPs with well defined inlets and outlets that depend on extended detention storage, 2) BMPs

with well-defined inlets and outlets that do not depend on significant storage of water, 3) BMPs that do not have well-defined inlets and outlets, and 4) widely distributed BMPs that use reference watersheds to determine effectiveness.

- ◆ Five methods are typically used to evaluate BMP efficiency: 1) Efficiency Ratio, 2) Summation of Loads, 3) Regression of Loads, 4) Mean Concentration, and 5) Efficiency of Individual Storm Loads.

Note: The Efficiency Ratio method is preferred. However, BMP efficiency also should be estimated, using the Summation of Loads method, where feasible.

- ◆ Data used to calculate efficiencies from the ASCE-EPA database are influent/effluent data of two principal types: 1) event mean concentration data (flow-weighted composite, weighted composite, and no flow or time weighting), and 2) discrete water samples (grab samples).
- ◆ Process efficiencies or removal rates should be determined from influent and effluent contaminant concentration and flow data to quantify the performance of the technology. Where applicable, the effect of bypass flow on process efficiency and system performance should be quantified.

3.4 Statistical Testing of Data (and Data Reduction)

Statistical testing should be performed on performance claim data to ensure that data are reliable, significant, and within confidence limits. When testing at specified ranges of flow and contaminant concentrations and when normal parametric statistical analysis is performed, coefficient of variation (CV) should be within $\pm 10\%$ for efficiency data, wherever possible. A larger range of CV may be allowed where justified. The vendor must demonstrate that the data set is normally distributed prior to using normal parametric statistical analysis. Data sets that are not normally distributed will need to be evaluated using nonparametric statistical analysis and may require further analysis and review.

The *Data Quality Assessment Guidance Manual*, EPA QA/G-9 includes an array of statistical methods, e.g., parametric analysis (mean, standard deviation, confidence intervals, and Z-statistic), comparison of populations (analysis of variance, box-whisker plots, and Tukey-tests), which can be used to compare and validate data sets. EPA QA-G9 can be downloaded from the following Web site: http://www.epa.gov/quality/qa_docs.html.

4 Health and Safety Plan

A health and safety plan should be developed and included with the Test QA Plan for a Stormwater BMP technology, covering installation, operation, and maintenance of the technology. Specifically, the plan should address hazard identification and mitigation, engineered controls and procedures, personal protective equipment, and training. Also, where related to the stormwater BMP technology, include: collecting stormwater samples in confined spaces (manholes, storm sewer lines, and utility vaults); collecting high flow stormwater samples from culverts, drainage channels, and sedimentation basins during storms; and chemical, biological or physical hazards associated with the technology.

5 Cost Information

Reliable cost information is an essential component of a stormwater technology demonstration. Consider capital expenses; annual operation and maintenance costs; one time and recurring costs of the design, construction, and operation associated with monitoring/measurement; and cost associated with conducting certification or verification tests. Also, include a discussion of the cost effectiveness of the technology, in terms of pollutant removal to achieve goals and applicable stormwater management standards. Although not required to evaluate the technology's performance claim, a vendor may consider performing a cost-benefit analysis for comparison to similar technology categories to determine the economic viability of the technology. Such an analysis may include capital costs, operations and maintenance costs, and aggregate costs (cost per gallon treated or BMP efficiency may be represented as a cost per pound of each pollutant removed).

6 Report Contents for Verification/Certification

The suggested format for a Stormwater BMP Demonstration Report is:

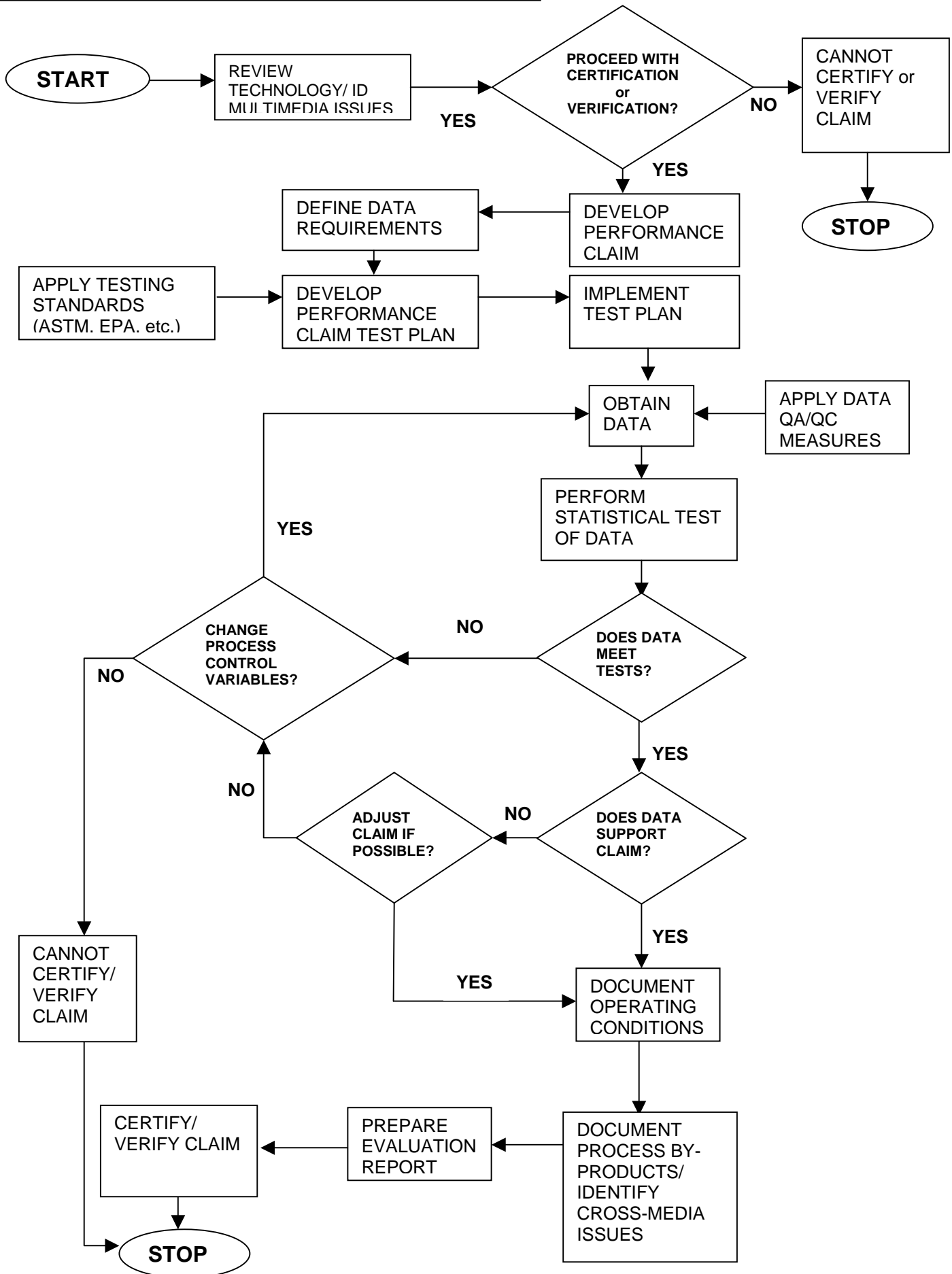
- ◆ Title/Purpose,
- ◆ Theory/Technology Description,
- ◆ Performance Claim,
- ◆ Test Methods and Procedures,
- ◆ Data Quality Assurance Project Plan (EPA QA-G5),
- ◆ Test Equipment and Apparatus,
- ◆ Verification/Certification Data and Analysis,
- ◆ Data Quality Assessment (EPA QA-G9),
- ◆ Conclusions/Recommendations/Limitations, and
- ◆ Cost Information.

In addition, the report should include a completed Stormwater BMP Demonstration Application Form (Appendix E), an executive summary, and a signed statement on the first page certifying that all information is accurate and true to the best of the proponent's knowledge.

7 Protocol Limitations, Release of Liability, and Disclosure

This protocol has been published for the purpose of evaluating or generating performance claim data for stormwater BMP technologies for environmental certification and verification programs. The Technology Acceptance and Reciprocity Partnership (TARP) accepts no responsibility or liability for performance of stormwater technologies being evaluated using this Protocol.

Appendix A: Performance Claim Test Plan Flowchart



Appendix B: List of Applicable Test Methods and Procedures

ASTM Methods

D3370, Practices for Sampling Water.

D4840, Guide for Sampling Chain of Custody Procedures.

D4841, Practice for Estimation of Holding Time for Water Samples Containing Organic and Inorganic Constituents.

D5612-94 (1998), Standard Guide for Quality Planning and Field Implementation of a Water Quality Measurement Program.

D5847-99a , Standard Practice for Writing Quality Control Specifications for Standard Test Methods for Water Analysis.

D5851-95, Standard Guide for Planning and Implementing a Water Monitoring Program.

D6145097, Standard Guide for Monitoring Sediments in Watersheds.

D3977-97, Standard Test Method for Determining Sediment Concentration in Water Samples.

D5907-96a, Standard Test Method for Filterable and Non-filterable Matter in Water.

D4841-88 (1998), Standard Practice for Estimation of Holding Time for Water Samples containing Organic and Inorganic Constituents.

PS74-98, Provisional Standard Test Method for Oil and Grease (Solvent Extractable Substances in Water by Gravimetric Determination.

D5790-95, Standard Test Method for Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectroscopy.

D6362-98, Standard Practice for Certificates of Reference Materials for Water Analysis.

D6104-97, Standard Practice for Determining the Performance of Oil/Water Separators Subjected to Surface Water Run-off.

F625-94, Standard Practice for Classifying Water Bodies for Spill Control Systems.

D5906-96, Standard Guide for Measuring Horizontal Positioning During Measurements of Surface Water Depths.

D5073-90 (1996), Standard Practice for Depth Measurement of Surface Water.

D5413-93 (1997), Standard Test Methods for Measurement of Water Levels in Open-Water Bodies.

D5243-92 (1996), Standard Test Method for Open-Channel Flow Measurement of Water Indirectly at Culverts.

D5130-95, Standard Test Method for Open-Channel Flow Measurement of Water Indirectly by Slope-Area Method.

D5129-95, Standard Test Method for Open Channel flow Measurement of Water Indirectly by Using Width Constrictions.

D3858-95, Standard Test Method for Open-Channel flow Measurement of Water by Velocity-Area Method.

D5614-94 (1998), Standard Test Method for Open Channel Flow Measurement of Water with Broad-Crested Weirs.

D5242-92 (1996), Standard Test Method for Open-Channel Flow Measurement of Water with Thin-Plate Weirs.

D5640-955, Standard Guide for Selection of Weirs and Flumes for Open-Channel Flow Measurement of Water.

D5089-95, Standard Test Method for Velocity Measurements of Water in Open Channels with Electromagnetic Current Meters.

D4409-95, Standard Test Method for Velocity Measurements of Water in Open Channels with Rotating Element Current Meters.

D5390-93 (1997), Standard Test Method for Open Channel Flow Measurement of Water with Palmer-Bowlus Flumes.

D1941-91 (1996), Standard Test Method for Open Channel Flow Measurement of Water with the Parshall Flume.

D4375-96, Standard Practice for Basic Statistics in Committee D-19 on Water.

E178, Practice for Dealing with Outlying Observations.

F1779-97, Standard Practice for Reporting Visual Observations of Oil on Water.

F1084-90 (1995), Standard Guide for Sampling Oil/Water Mixtures for Oil Spill Recovery Equipment.

Appendix C: List of Parameters for Sampling

Pollutant	Target Pollutant	Incidental Pollutant	Not Addressed
SOLIDS			
• Floating solids and debris			
• 0.062 mm – 0.0250 mm			
• 0.250 mm – 1.0 mm			
• Larger than 1.0 mm			
• Total Suspended Solids ^a			
• BOD, COD, TOC, TDS			
• Hydrocarbons			
• Oil & Grease			
• TPH by IR			
• Total PAH			
• Floating oil			
METALS			
• Copper (total/dissolved)			
• Lead (total/dissolved)			
• Zinc (total/dissolved)			
• Chromium (total/dissolved)			
• Cadmium (total/dissolved)			
• Other (e.g., cyanide, nickel) _____			
NUTRIENTS			
• Total Phosphorus			
• Total Dissolved Phosphorus			
• Nitrate/nitrite			
• Ammonium			
• Total Kjeldahl nitrogen			
• Total nitrogen			
BACTERIA (<i>E. coli</i> , total coliform), Enterocci			
TEMPERATURE EFFECTS			

NOTES

Target Pollutant -- Pollutant directly addressed by the design of the device; Incidental Pollutant – Pollutant incidentally addressed by device; Not Addressed -- Pollutant not addressed by device

All pollutants with performance claims must be tested. If no test result is provided, EVALUATOR will assume the pollutant is not addressed by the device.

a – assumes that sufficient data has been provided to demonstrate that TSS and SSC of untreated/inflow samples is consistent with the total load and particle size distribution of typical urban runoff (i.e., consistent with the NURP study data distribution.)

Instructions

1. Indicate L if demonstrated in laboratory and F if demonstrated in field evaluation.
2. Provide supporting data for all target and incidental pollutants tested in field or laboratory as outlined below.
3. For metals indicate whether total and/or dissolved forms were evaluated.

DOCUMENTATION OF TESTING RESULTS SHOULD, AT A MINIMUM, INCLUDE:

For laboratory testing:

Testing should demonstrate performance under a range of operating conditions, including high stress conditions. Specify hydraulic loading rates and concentrations of pollutants tested. Also, provide documentation of device performance under flows exceeding design capacity (i.e., we are interested in learning whether captured pollutants are flushed out by extreme events).

For field testing:

Description of site use (e.g., commercial parking lot, roadway, construction site, and pertinent characteristics of area being treated (e.g., total area and percent impervious). List number storms tested peak rates, and total volumes treated by device; for each storm tested provide information on total storm size, duration, intensity, and antecedent dry period. Results should be presented for each storm individually and summarized statistically for all storms.

Appendix D: States' Standards and Contacts

Pennsylvania

Pennsylvania's erosion and sediment control requirements stipulate that temporary best management practices (BMPs) should be designed for a 2-year frequency storm, 5-year frequency storm for special protection watersheds, and a 10-year frequency storm for permanent BMPs. The permanent BMP criteria relate to the structural integrity of the BMP rather than the pollutant removal requirements. Pollutant (sediment) removal requires design of erosion and sediment control BMPs according to the established standards in the Pennsylvania Erosion and Sediment Control Program Manual or other criteria equal or greater than these standards.

The regulation of post-construction stormwater runoff from new development activities and associated groundwater recharge/infiltration and water quality are specified in NPDES Permits for Stormwater Discharges Associated with Construction Activities Municipal Separate Storm Sewer System (MS4) Permits, and watershed stormwater plans prepared and adopted by counties in accordance with the PA Stormwater Management Act, (Act 167 of 1978).

Fundamentally, the goal of Pennsylvania's Comprehensive Stormwater Policy is to improve and sustain ground and surface water quality and quantity through the use of planning practices and BMPs that minimize the generation of stormwater runoff, provide ground water recharge, and minimize the adverse effects of stormwater discharges on ground and surface water resources. Pennsylvania's highest quality surface waters are designated as either Exceptional Value (EV) and High Quality (HQ) or special protection waters. These water uses are protected on a waterbody segment when the Department issues a permit or approval for an activity which may impact the use.

The BMPs for post-construction stormwater management must include design features that will manage and control runoff volume and velocity, infiltrate stormwater, and filter sediments, nutrients and other pollutants from a 2-year/24-hour storm event for any location in Pennsylvania.

PADEP supports reciprocity by accepting data, analyses, and findings: 1) from other TARP states that verify (or certify) stormwater technologies' performance in accordance with the TARP Stormwater BMP Demonstration Protocol; and 2) from organizations with qualifying protocols and technology evaluation programs that generate technology verifications (or certifications), in conformance with accepted protocols. PADEP generally supports the efforts of EPA's Environmental Technology Verification (ETV) and the state of Washington's program protocols. PADEP does not completely eliminate state review of data or approval of projects proposing to use the stormwater technology for reciprocity in Pennsylvania.

For more information on Pennsylvania's Comprehensive Stormwater Management Policy (Technical Guidance # 392-0300-002), or other technical guidance or program information please refer to the Department's website at: <http://www.dep.state.pa.us> or the stormwater homepage at: <http://www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/stormwatermanagement.htm>

For further information, contact: Kenneth Murin, Bureau of Watershed Management, Rachel Carson State Office Building, P.O. Box 8775, Harrisburg, PA 17105-8775, Phone: 717-772-5975, Fax: 717-772-5986, E-mail: kmurin@state.pa.us; or

Dennis Stum, Bureau of Watershed Management, Rachel Carson State Office Building, P.O. Box 8775, Harrisburg, PA 17105-8775, Phone: 717-772-5963, Fax: 717-772-5986, E-mail: dstum@state.pa.us ; or

Calvin Kirby, PA DEP, Office of Pollution Prevention and Compliance Assistance, 15th Floor-RCSBO, 400 Market Street, Harrisburg, PA 17105-8772, Phone: 717/772-5834, Fax: 717/783-2703, E-mail: ckirby@state.pa.us.

Massachusetts

Massachusetts seeks stormwater BMP demonstrations that show effectiveness in terms of the Commonwealth's Stormwater Management Standards in the Stormwater Management Policy. The Stormwater Management Policy and supporting handbooks are available on the Massachusetts Department of Environmental Protection Web site:

<http://www.state.ma.us/dep/stomwtr/stormpub.htm>. The handbooks can be downloaded from the DEP Stormwater publication list.

For water quality control: The volume of runoff to be treated for discharges to critical areas is calculated as 1.0 inch of runoff times the total impervious area of the post-development project site. For all other discharges, the volume to be treated is calculated as 0.5 inches of runoff times the total impervious area of the post-development project site.

(Critical areas are Outstanding Resource Waters (ORWs), shellfish beds, swimming beaches, cold water fisheries, and recharge areas for public water supplies.)

For stormwater management systems, the Massachusetts Stormwater Management Standard 4 is 80 percent removal of the annual load of total suspended solids (TSS). This standard applies to new development and is presumed to met when:

- a) Suitable nonstructural practices for source control and pollution prevention are implemented;
- b) Stormwater management best management practices (BMPs) are sized to capture the previously prescribed runoff volume; and
- c) Stormwater management BMPs are maintained as designed.

Stormwater technology vendors interested in field testing technologies in MA to evaluate performance claims should contact Linda Benevides, (Director of the Strategic Envirotechnology Partnership, Suite 900, 251 Causeway Street, Boston, MA 02114, Phone: 617-626-1197, Fax: 617-626-1180, email: linda.benevides@state.ma.us.) and the STEP Web site:

<http://www.state.ma.us/envir/pollution/step.htm>.

The Strategic Envirotechnology Partnership prepares technology verifications for performance demonstrations that adhere to the TARP Tier II Protocol. STEP verification reports and summary fact sheets will be provided to participating TARP states and organizations recognized in this Protocol so that they can initiate the reciprocity process. The MA publications also will be available for end-users and public officials on the STEP Website: <http://www.stepsite.org/>.

Massachusetts supports reciprocity by accepting data, analyses, and findings 1) from other TARP states that verify (or certify) stormwater technologies' performance in accordance with the

TARP Stormwater BMP Demonstration Protocol; and 2) from organizations with qualifying protocols and technology evaluation programs that generate technology verifications (or certifications), in conformance with accepted protocols. At this time, the Environmental Technology Verification (ETV) program and the state of Washington have qualifying protocols and programs, which are eligible for reciprocity in Massachusetts.

Reciprocity will be granted to conforming performance evaluations by the Strategic Envirotechnology Partnership (STEP) in collaboration with the Department (Division) of Environmental Protection (DEP). Re-issuance or conditional re-issuance of a performance verification, in formats conducive for public outreach, will be necessary to confer reciprocity for evaluated stormwater technologies. It is anticipated that, in most cases, a fact sheet will be issued, based on the verification report from another participating state or eligible organization. Reciprocity summary fact sheets will be provided to TARP states upon completion of the process, and these publications also will be available on the STEP and TARP Websites.

For further information, contact: Nancy Baker, Massachusetts Department of Environmental Protection, 1 Winter Street, Boston MA 02108, Phone: 617/654-6524, Fax: 617/ 292-5850, E-mail: nancy.baker@state.ma.us.

Claire Barker, Massachusetts Department of Environmental Protection, Bureau of Resource Protection, Phone: 617/556-1128, Fax: 617/292/5696, E-mail: claire.barker@state.ma.us.

New Jersey

Regulation of stormwater runoff by the New Jersey Department of Environmental Protection (NJDEP) presently occurs in three different programs: Stormwater Management, Stormwater Permitting, and Land Use Regulation. The accepted water quality design storm utilized for evaluation is 1.25 inches of rainfall falling in two hours. This testing criterion is applicable to all post construction residential and commercial BMP applications. In addition, stormwater management systems are expected to reduce total suspended solids (TSS), to the maximum extent possible, from stormwater runoff generated from the water quality design storm.

The Division of Watershed Management's (DWM) Nonpoint Source and Stormwater Management Program establishes rules for stormwater discharges from new construction of residential and commercial development. This program is largely implemented through the development of municipal and county stormwater management plans, and municipal stormwater ordinances. The program is also linked to the Department of Community Affairs Residential Site Improvement Regulations. Information on BMPs acceptable for use in this program are contained in the Department's Stormwater Best Management Practices Manual (currently being amended) and available on the NJDEP, DWM Website (Appendix F).

The Bureau of Nonpoint Pollution Control issues permits for discharges of stormwater to surface water from industrial and construction activities under the New Jersey Pollutant Discharge Elimination System (NJPDES). Water quality criteria for industrial applications will vary depending on site activity and adopted federal or state effluent limitation guidelines for targeted pollutants. Generally, the testing criteria established for commercial BMP applications will be sufficient. However, this office should be consulted to determine if specific-testing criteria are applicable to evaluate BMP performance intended for industrial applications. NJPDES permits from the NJDEP for construction activities are coordinated with the local Soil Conservation

Districts. Proposed measures for erosion and sediment control associated with construction or agricultural activities are referred to the New Jersey State Soil Conservation Committee for inclusion into the Standards for Soil Erosion and Sediment Control in New Jersey.

The Land Use Regulation Program reviews certain stormwater discharges from new development and generally approves manufactured devices on a case by case basis utilizing the following criteria:

- a. 80% TSS removal
- b. Removal of Oil and Grease and Floatables
- c. Removal of Heavy Metals
- d. Device must operate automatically with no need for someone to activate it during a rain event.
- e. Device must have relatively low maintenance with agreements on who will maintain it.

The NJDEP is presently developing amendments to its NJPDES Regulations and its Stormwater Management Regulations that will establish a consistent basis for applying stormwater BMPs in all of its regulatory programs. In addition, the New Jersey Stormwater BMP Manual is being developed to provide guidance to address the requirements in the proposed Stormwater Management Rules, N.J.A.C. 7:8. One chapter in the proposed manual provides criteria for certifying manufactured devices and their pollutant removal rates. The final certification of a pollutant removal rate would be based upon one of the following:

1. Verification of the device's pollutant removal rates by the N.J. Corporation for Advanced Technology (NJCAT) in accordance with the New Jersey Energy and Environmental Technology Verification Program (NJSA 13:D-134 et seq). This verification must be conducted in accordance with the protocol "Stormwater Best Management Practices Demonstration Tier II Protocol for Interstate Reciprocity" as developed under the Environmental Council of States (ECOS) and Technology Acceptance and Reciprocity Partnership (TARP).
2. Verification of the device's pollutant removal rates by another TARP State, or another state or government agency that is recognized by New Jersey through a formal reciprocity agreement, provided that such verification is conducted in accordance with the protocol "Stormwater Best Management Practices Demonstration Tier II Protocol for Interstate Reciprocity."
3. Verification of the device's pollutant removal rates by other third party testing organizations (i.e., NSF), provided that such verification is conducted in accordance with the protocol "Stormwater Best Management Practices Demonstration Tier II Protocol for Interstate Reciprocity." Other testing protocols may be considered if it is determined by the NJDEP to be equivalent to the Tier II Protocol.

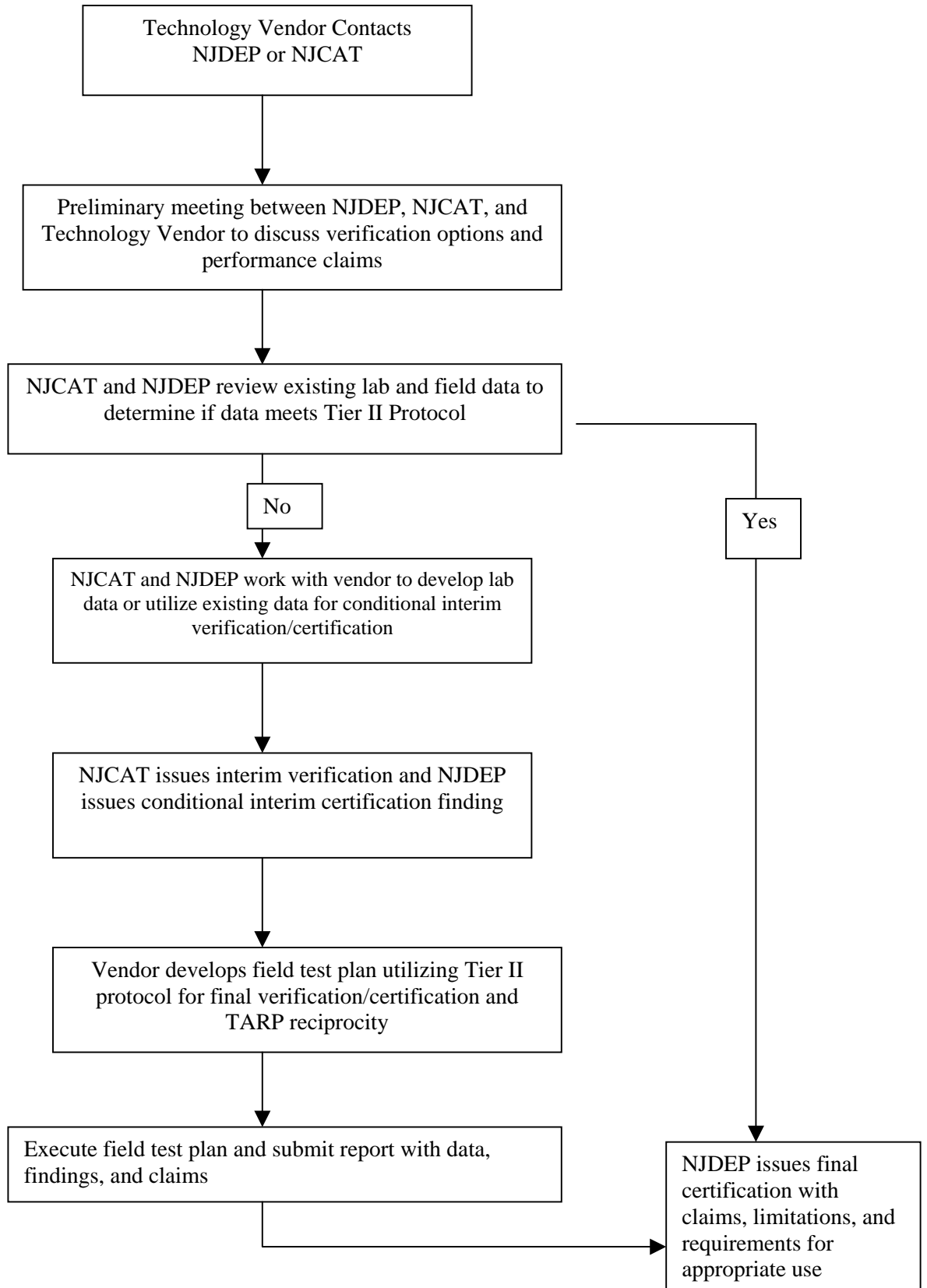
It should be noted that the pollutant removal rates for a manufactured treatment device may be granted interim conditional certification by the NJDEP provided that the manufacturer submits an interim verification report through NJCAT and further agrees to apply for and complete the final certification process described above. All interim certifications are effective for only a limited time period, as determined on a case-by-case basis by the NJDEP.

For further information, contact: Manny Patel, New Jersey Department of Environmental Protection, Division of Science, Research & Technology, Office of Innovative Technology and Market Development, P.O. Box 409, Trenton, New Jersey 08625, phone: 609/292-0231, Fax: 609/292-7340, E-mail: mpatel@dep.state.nj.us.

Brian McLendon, New Jersey Department of Environmental Protection, Division of Water Quality, Bureau of Nonpoint Pollution Control, P.O. Box 029, Trenton, New Jersey 08625-0029, phone: 609/633-7021, Fax: 609/984-2147, E-mail: bmclendo@dep.state.nj.us.

Sandy Blick, New Jersey Department of Environmental Protection, Division of Watershed Management, NPS Program, P.O. Box 418, Trenton, New Jersey 08625, phone 609/633-1441, E-mail: sblick@dep.state.nj.us.

New Jersey Stormwater Verification/Certification Process in Conjunction with NJCAT



California

The State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCBs) are seeking technologies for use in California's Storm Water Pollution Prevention Plans (SWPPPs) and Storm Water Management Plans (SWMPs). The SWRCB and RWQCBs reserve the right to request additional data from a technology proponent in order to satisfy state requirements and environmental conditions, and to refuse a technology for evaluation based on state needs and available resources. California specific conditions/regulations include, but are not limited to, the following:

- 1) A minimum inter-event period of 72 hours from the previously measurable storm event should be used. Additional testing/data could be required for technologies that are verified using 6 hours as the minimum inter-event period. This inter-event period is required by Federal Regulation, 40 CFR 122.21 (g)(7), for industrial sites.
- 2) Water quality samples should be collected from a representative number of storm events to ensure that 80 to 90% of the average yearly rainfall amount, up to a maximum of 15 inches, is captured over a period of one calendar year. A one-year demonstration is optimal to observe performance changes as a function of season. This sampling condition is more reflective of wet weather patterns in California than the conditions specified in section C.1 of this protocol.

The SWRCB has been delegated the NPDES permitting authority in California. The NPDES permitting program is administered by the SWRCB through the nine RWQCBs. For industrial facilities and construction activities, the SWRCB has issued statewide general permits that apply to all stormwater discharges requiring a NPDES permit. In addition to the stormwater general permits, the RWQCBs may, at their discretion, issue industry or regional specific permits, as well as individual permits. Municipal stormwater permits are issued by the individual RWQCBs, with the exception of the municipal permit issued to the State of California's Department of Transportation (Caltrans). Caltrans has been issued a statewide municipal permit by the SWRCB.

The types of permits issued to industrial, construction and municipal operators are different, but the requirements of the permit are similar in that they require the permittees to develop and implement plans to reduce pollutants in stormwater runoff and protect water quality. The plans describe the BMPs that will be implemented to comply with the applicable stormwater permit. Like the permit, the type of plan to be developed also varies by the type of operator.

Construction and industrial operators that are required to obtain an NPDES permit need to file a Notice of Intent (NOI) with SWRCB before commencement of construction or industrial activity. The NOI requirements are intended to establish a mechanism that can be used to clearly identify the responsible parties, locations, scope of discharges, and to document the operator's knowledge of the requirements for SWPPP. The construction and industrial operators that are required to obtain an NPDES permit need to develop and implement the SWPPP that describes the BMPs and other measures to be implemented to reduce pollutants in runoff and protect water quality.

Operators of municipal separate storm sewer systems are required to submit comprehensive SWMPs as part of the permit application. SWMPs describe the BMPs to be implemented throughout the permitted area to reduce pollutants and protect water quality. The federal stormwater regulations require SWMPs, in part, to include BMPs to address industrial, commercial and construction activities, new development and major redevelopment and municipal activities.

For further information on stormwater permits and/or application of a permit, contact: Storm Water Section, State Water Resources Control Board, Division of Water Quality, P.O. Box 100, Sacramento, CA 95812, phone: 916/341-5455, email: stormwater@dwq.swrcb.ca.gov.

Questions on the California Certification process for stormwater technologies should be addressed to:

Greg Williams, P.E., California Environmental Protection Agency, Department of Toxic Substances Control, Office of Pollution Prevention and Technology Development, P.O. Box 806, Sacramento, CA 95812-0806, Phone: 916/322-0453, Fax: 916/327-4494, E-mail: g.williams@dtsc.ca.gov.

Bruce Fujimoto, Senior Water Resources Control Engineer, Division of Water Quality, State Water Resources Control Board, 1001 I Street, P.O. Box 100, Sacramento, CA 95812-0806, Phone: 916/341-5523, E-mail: FUJIB@dwq.swrcb.ca.gov.

Xavier Swamikannu, Storm Water Program, CalEPA - RWQCB LA Region, 320 W. 4th Street, Suite 200, Los Angeles, CA 90013, Phone: (213) 6202094, Fax: (213) 576-5777 E-mail: xswami@rb4.swrcb.ca.gov.

Maryland

Title 4, Subtitle 2 of the Environment Article, Annotated Code of Maryland states that "...the management of stormwater runoff is necessary to reduce stream channel erosion, pollution, siltation and sedimentation, and local flooding, all of which have adverse impacts on the water and land resources of Maryland." The program designed in the early 1980's to address this finding of the General Assembly concentrated primarily on controlling runoff increases associated with new development. On October 2, 2000, the Maryland Department of the Environment (MDE) adopted new stormwater regulations [Code of Maryland Regulations (COMAR) 26.17.02] including the 2000 Maryland Stormwater Design Manual, Vol. I and II (the Design Manual). These regulations represent a more comprehensive approach to stormwater design.

The Design Manual recognizes the importance and encourages the principles of environmentally sustainable design. Accordingly, Maryland has developed fourteen performance standards that must be met at development sites. These standards, as set forth in Section 1.2 of the Design Manual, apply to any construction activity disturbing 5,000 or more square feet of earth unless specifically exempted by COMAR. While providing incentives for total site design and nonstructural practices, these performance standards also address the design of structural best management practices (BMPs) to mitigate water quality and channel stability impacts.

Currently, the different structural BMP designs used in Maryland are assigned into five general categories (see Figure 1) for stormwater quality control. Chapter 3 of the Design Manual outlines performance criteria based on general feasibility, conveyance, pretreatment, geometry, environmental and landscaping requirements, and maintenance concerns for these five groups. BMPs that may be classified into one of these five groups may be used as stand-alone water quality devices if designed and constructed in accordance with the methods and specifications detailed in the Design Manual. BMPs that cannot be classified into one of the five categories cannot be used for stand-alone water quality treatment until independent pollutant removal performance data are submitted. MDE uses these data to determine conformance with State criteria for treatment, maintenance, and environmental impact.

Stormwater Ponds	Stormwater Filtering Systems
<ul style="list-style-type: none"> • Micropool Extended-Detention (ED) Ponds • Wet Ponds • Wet ED Ponds • Multiple Pond Systems • "Pocket" Ponds 	<ul style="list-style-type: none"> • Surface Sand Filters • Underground Sand Filters • Perimeter Sand Filters • Organic Filters • Pocket Sand Filters • Bioretention
<ul style="list-style-type: none"> • Stormwater Wetlands • Shallow Wetland • ED Shallow Wetland • Pond/Wetland System • "Pocket" Wetland 	<ul style="list-style-type: none"> • Open Channel Systems • Dry Swale • Wet Swale
<ul style="list-style-type: none"> • Stormwater Infiltration • Infiltration Trench • Infiltration Basin 	

Figure 1. Structural BMPs that may be used for "stand-alone" water quality treatment in Maryland

Maryland supports reciprocity by accepting data and analyses that have been collected and prepared in conformance with the TARP Stormwater BMP Demonstration Protocol. However, Maryland reserves the right to request specific information as necessary to evaluate stormwater management BMPs for conformance with the Design Manual and COMAR.

The **2000 Maryland Stormwater Design Manual, Vol. I and II** and related information are available on MDE's website – <http://www.mde.state.md.us/>. For more information, please contact Stewart Comstock of MDE's Nonpoint Source Program at 410-537-3543 or email (scomstock@mde.state.md.us).

Virginia

The Virginia Stormwater Management Regulation Water Quality Criteria (4 VAC 3-20-71) requires compliance by applying *performance-based* criteria or *technology-based* criteria. Both criteria require the control or management of the water quality volume (or multiple water quality volumes (WQV), depending on the BMP, i.e., 2 x WQV), defined as the first one-half (½) inch of runoff from impervious surfaces.

Specific test performance claims may be insufficient to support the general acceptance of the technology. Rather, an attempt should be made to transfer the specific test results to an average annual removal efficiency (for phosphorus and/or associated NPS pollutants) based on Virginia's annual rainfall characteristics and typical runoff pollutant concentrations associated with conventional land development practices.

To simplify the calculation procedures for water quality compliance, a "keystone pollutant" is selected. In Virginia, phosphorus has been selected as the keystone pollutant because: 1) phosphorus has a well defined adverse impact on the Chesapeake Bay and its tributaries; 2) phosphorus exists in a "composite" form, i.e., roughly an equal split between particulate and soluble phases; and 3) adequate research exists to provide a reasonable basis for estimating how phosphorus loads change in response to development and to current stormwater control practices. Performance claims should be based on test results for phosphorus, as well as the "overall" performance at removing typical urban pollutants such as sediment, nitrogen, bacteria, BOD/COD, oil/grease, zinc, lead, and toxics.

Additional information on the Virginia Law and Regulations, Handbooks, etc., can be found at the Department of Conservation and Recreation, Division of Soil and Water Conservation Web site: <http://www.dcr.state.va.us/sw>.

(PLEASE NOTE: WE ANTICIPATE CHANGES TO THE WEB SITE TO ACCOMMODATE DOWNLOADABLE VERSIONS OF THE STORMWATER LAW, REGULATIONS, HANDBOOKS, AND OTHER POLICY GUIDANCE.)

For further information contact:

Burt Tuxford, Virginia Department of Environmental Quality, P.O. Box 10009 Richmond, VA 23240-0009, Phone: 804/698-4086, Fax: 804/698-4032, E-mail: brtuxford@deq.state.va.us.

Larry Gavan, Urban Programs Manager, Virginia Department of Conservation and Recreation, 203 Governor Street, Suite 206, Richmond, Virginia 23219, Phone: 804/786-4508, Fax: 804/371-2630, E-mail: lgavan@dcr.state.va.us.

Catherine Harold, Environmental Engineer, Chesapeake Bay Local Assistance Department, James Monroe Building, 101 14th Street, 17th Floor, Richmond, VA 23219, Phone: 804/371-7501, Fax: 804/225-3447, E-mail: CHarold@cblad.state.va.us.

Washington

Although the state of Washington is not currently a participating TARP state, the Department of Ecology will consider data, analyses, and performance evaluations undertaken with test plans that follow the TARP Protocol. Ecology also plans to inform TARP of all applications received for review and approval of a technology, Ecology decisions on use level designations for each technology and related supporting data. The status of Ecology designation decisions and ongoing reviews are located at Ecology's web site at: <http://www.ecy.wa.gov/programs/wq/stormwater/newtech/>.

For further information contact: Stanley J. Ciuba, P.E., Dept. of Ecology, Water Quality Program, PO Box 47696, Olympia, WA 98504-7696, (360)407-6435, E-mail: sciu461@ecy.wa.gov.

Stormwater BMP Demonstration Summary

Fill out the following form and submit it in print and electronically with the Stormwater BMP Demonstration Report.
The information in this application will be used in the etarp BMP database.

Technology Name _____	Technology Category _____ (e.g.,structural, non-structural; detention pond, sand filter)	Date _____
-----------------------	---	------------

1. Contact Information

Vendor Name _____
Contact Name _____
Address (street, city, state, zip) _____
Address (street, city, state, zip) _____
Phone, Fax, e-mail address _____

2. Test Site Information

Site Name _____
Address (street, city, state, zip) _____
Land Use:
 Commercial/Office Residential Industrial Open Other (specify)
Total Contributing Drainage Area _____

3. Watershed Information

Watershed Name _____
Total Watershed Area _____
Percent of Impervious Area in Watershed _____

4. Precipitation Information

Regional Climate Station _____
Average Number of Storms Year _____
Average Annual Rainfall (cm) _____
Monthly Average Rainfall at Test Site (cm) (During Testing) _____
Storm Events Start and End Times (During Testing) _____
Storm Precipitation (For Each Storm Event During Testing) _____

Stormwater BMP Demonstration Summary

Technology Name _____	Technology Category _____ (e.g., structural, non-structural; detention pond, sand filter)	Date _____
-----------------------	--	------------

5. BMP Information

Date System Installed _____
Dates Tested/Sampled _____
Test Events Start and End Times (For Each Event) _____
Total Storm Flow Volume Into BMP (For Each Event) _____
Total Storm Flow Volume Bypassed (For Each Event) _____
Type of Samples Collected (e.g., flow-weighted, composite) _____
Parameters and Units Measured _____
Analysis Method _____

6. Report Submittal Checklist *(Use the checklist to affirm that the Stormwater BMP Demonstration Report conforms with the protocol.)*

_____ Executive Summary
_____ Title/Purpose
_____ Theory/Technology Description
_____ Performance Claim
_____ Test Methods and Procedures
_____ Data Quality Assurance Project Plan
_____ Test Equipment and Apparatus
_____ Verification/Certification Data and Analysis
_____ Data Quality Assessment
_____ Conclusions/Recommendations/Limitations
_____ Cost Information

7. Certification

I certify that all information submitted is true and correct and was accumulated using approved methods specified in the Stormwater BMP Demonstration Protocol. I understand that any misrepresentation or misuse of information will result in immediate denial of the technology being demonstrated and may prohibit me or, the company I represent from seeking future approvals.

Signature / Date

Appendix F: QAPP Groups and Elements

The elements of a QAPP are categorized into "groups" according to their function. Specifications for each element are found in *EPA Guidance for Quality Assurance Project Plans*, EPA QA/G-5 (EPA/600/R-98/018). Details of each requirement of the elements from that document available at http://www.epa.gov/quality/qa_docs.html.

The elements of a QAPP are:

Group A: Project Management

This group of QAPP elements covers the general areas of project management, project history and objectives, and roles and responsibilities of the participants. The following 9 elements ensure that the project's goals are clearly stated, that all participants understand the goals and the approach to be used, and that project planning is documented:

A1 Title and Approval Sheet

A2 Table of Contents and Document Control Format

A3 Distribution List

A4 Project/Task Organization and Schedule

A5 Problem Definition/Background

A6 Project/Task Description

A7 Quality Objectives and Criteria for Measurement Data

A8 Special Training Requirements/Certification

A9 Documentation and Records

- ◆ date of event,
- ◆ time and duration of the storm event,
- ◆ size of the storm event,
- ◆ inches of rain and intensity,
- ◆ number of days since preceding storm event,
- ◆ total volume of runoff treated and volume bypassed,
- ◆ time into event and conditions when BMP was bypassed,
- ◆ condition of the drainage area prior to and during the event,
- ◆ activities being conducted,
- ◆ chemicals, materials, equipment, or vehicles stored or handled in drainage area,
- ◆ good housekeeping measures implemented prior to event,
- ◆ upset, spills, or leaks in drainage area, including the material or chemical,
- ◆ construction or maintenance activities in the drainage area, and
- ◆ any other information needed to adequately characterize the contributing areas to the BMP.)

Group B: Measurement/Data Acquisition

This group of QAPP elements covers all of the aspects of measurement system design and implementation, ensuring that appropriate methods for sampling, analysis, data handling, and QC are employed and will be thoroughly documented:

-
- B1 Sampling Process Design (Experimental Design)
 - B2 Sampling Methods Requirements
 - B3 Sample Handling and Custody Requirements
 - B4 Analytical Methods Requirements
 - B5 Quality Control Requirements
 - B6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements
 - B7 Instrument Calibration and Frequency
 - B8 Inspection/Acceptance Requirements for Supplies and Consumables
 - B9 Data Acquisition Requirements (Non-Direct Measurements)
 - B10 Data Management

Group C: Assessment/Oversight

The purpose of assessment is to ensure that the QAPP is implemented as prescribed. This group of QAPP elements addresses the activities for assessing the effectiveness of the implementation of the project and the associated QA/QC activities:

- C1 Assessments and Response Actions
- C2 Reports to Management

Group D: Data Validation and Usability

Implementation of Group D elements ensures that the individual data elements conform to the specified criteria, thus enabling reconciliation with the project's objectives. This group of elements covers the QA activities that occur after the data collection phase of the project has been completed:

- D1 Data Review, Validation, and Verification Requirements
- D2 Validation and Verification Methods
- D3 Reconciliation with Data Quality Objectives

Appendix G: Web Sites for Developing Stormwater Test QA Plans

40 CFR SUBCHAPTER D (1995--1999) - WATER PROGRAMS

<http://www.epa.gov/epacfr40/chapt-I.info/>

40 CFR Part 122: National Pollutant Discharge Elimination System
Select Subchapter D, Part 122 at the referenced Web site.

American Society of Civil Engineers (ASCE) Web site, "ASCE/EPA Stormwater Best Management Practices Nationwide Database," <http://bmpdatabase.org/>

ASTM Store, Search for Standards Web site (List, Title & Description for ASTM Methods) (see ASTM appendix for specific methods applicable to Stormwater Technologies)

<http://www.astm.org/>

CALTRANS - CSU Sacramento - UC Davis Storm Water Project Web site

<http://www.stormwater.water-programs.com/>

CALTRANS Stormwater Management Program

<http://www.dot.ca.gov/hq/env/stormwater/index.htm>

EPA Web site: Water Quality Standards (Total Maximum Daily Limits)

<http://www.epa.gov/OWOW/tmdl/index.html>

EPA's Stormwater Program Web site

http://cfpub.epa.gov/npdes/home.cfm?program_id=6

EPA Test Method Index (List of EPA Test Methods)

<http://www.epa.gov/epahome/index/nameindx.htm>

NJDEP Bureau of Nonpoint Pollution Control – Industrial Stormwater Permitting Program

<http://www.state.nj.us/dep/dwq/stormw.htm>

NJDEP Nonpoint Source and Stormwater Management Program – Best Management Practices for Control of Nonpoint Source Pollution from Stormwater is available in the publications list.

<http://www.state.nj.us/dep/watershedmgt/>

Appendix H: Bibliography

American Society of Testing and Materials. 1995. *D5851-95 Standard Guide for Planning and Implementing a Water Monitoring Program*. West Conshohocken, PA.

American Society of Testing and Materials. 1994. *D5612-94 Standard Guide for Quality Planning and Field Implementation of a Water Quality Measurement Program*. West Conshohocken, PA.

APHA. 1998. *Standard Methods for the Examination of Water and Wastewater*. 20th Edition. American Public Health Association, New York.

California Regional Water Quality Control Board. 2000. *Staff Report and Record of Decision: Standard Urban Storm Water Mitigation Plans and Numerical Design Standards for Best Management Practices*. Los Angeles, CA.

California State University. 1999. *CALTRANS Load Assessment Report*. CTSW-RT-99-078. CSU Office of Water Programs, Sacramento, CA.

ETV Verification Protocol Stormwater Source Area Treatment Technologies, Draft 4.0, March 2000.

Larry Walker Associates, Inc. for the Sacramento Stormwater Management Program. 1999. *Investigation of Structural Control Measures for New Development*. Sacramento, CA.

Massachusetts Department of Environmental Protection and Office of Coastal Zone Management. 1997. *Stormwater Management, Volume One: Stormwater Policy Handbook and Volume Two: Stormwater Technical Handbook*. Boston, MA.

New Jersey State Soil Conservation Committee. 1999. *Standards for Soil Erosion and Sediment Control in New Jersey*. Trenton, NJ.

Environmental Technology Acceptance and Reciprocity Partnership (ETARP). 1999. *Strategy, Reciprocal State Acceptance of Environmental Technologies*. Trenton, NJ.

Environmental Technology Acceptance and Reciprocity Partnership (ETARP). 2000. *Six State MOU, Interstate Reciprocity Technology Acceptance, Tier I Guidance*.

Environmental Technology Acceptance and Reciprocity Partnership (ETARP). 1998. *Reciprocal State Acceptance of Environmental Technologies*.

United States Department of the Interior, U.S. Geological Survey. 2000. *Comparability of Suspended-Sediment Concentration and Total Suspended Solids Data*. WRIR 00-4191. Reston, Virginia.

United States Environmental Protection Agency. 1993. *Handbook of Urban Runoff Pollution Prevention and Control Planning*. EPA/625/R-93/004. Washington, D.C.

United States Environmental Protection Agency. 1992. *NPDES Storm Water Sampling Guidance Document*. EPA/833-B-92-001. Washington, D.C.

United States Environmental Protection Agency. 1983. *Methods for the Chemical Analysis of Water and Waste*. EPA-600/4-79-020. Environmental Monitoring and Support Laboratory, Cincinnati, OH.

United States Environmental Protection Agency. 1998a. *Data Quality Assessment Guidance Manual*, (QA/G-9) EPA/600/R-96/084. Washington, D.C.

United States Environmental Protection Agency. 1998b. *Guidance for Quality Assurance Project Plans*. (QA/G-5) EPA/600/R-98/018. Washington, D.C.

United States Environmental Protection Agency. 2001. *EPA Requirements for Quality Assurance Project Plans*. (QA/R-5) EPA/240/B-01/003 Washington, D.C.

Urbonas, Ben R. 1996. *EPA-ASCE Cooperative Agreement, Determining Urban Stormwater Best Management Practices (BMP) Removal Efficiencies. Task 2.2 – Recommend the Needed Information/Data Tables and Suggested Data Base Structure*.

URS Greiner Woodward Clyde, Urban Water Resources Research Council of the American Society of Civil Engineer, Environmental Protection Agency. 1999. *Development of Performance Measures, Task 3.1 – Technical Memorandum, Determining Urban Stormwater Best Management (BMP) Removal Efficiencies*.

Wilde et al, 1998. *National Field Manual for Collection of Water Quality Data, Techniques of Water Resources Investigations Book 9*, USGS (ISBN:0-607-90623-5).