4 Innovative Technology: Use and Evaluation

The development and use of innovative, cost-effective stormwater management technologies are encouraged. Implementation of BMPs not discussed in this manual must be approved by the Executive Director of the TCEQ. Approval will be contingent on submission of objective, verifiable data that supports the claimed TSS removal efficiency. If such data does not exist, a single site may be approved subject to the constraint that a monitoring program will be initiated in the first year of operation to document the TSS removal of the device or measure.

This section presents a testing protocol based on that adopted by the State of Washington to assess the performance of new stormwater treatment technologies. The objectives of this protocol are to characterize, with a reasonable level of statistical confidence, an emerging technology's effectiveness in removing pollutants from stormwater runoff for an intended application and to compare test results with vendor's claims.

4.1 Quality Assurance Project Plan (QAPP)

Vendors/manufacturers need to carefully plan and execute monitoring programs. Before initiating testing, a quality assurance project plan (QAPP) must be prepared based on this protocol. The QAPP must be submitted for TCEQ review before conducting field tests.

The QAPP must specify the procedures to be followed to ensure the validity of the test results and conclusions. A person with good understanding of analytical chemistry methods should develop the QAPP in consultation with the analytical laboratory. The QAPP author should also be knowledgeable about field sampling and data validation procedures.
QAPP guidance includes the following basic elements:

- Title Page;
- Table of contents;
- Project organization and schedule;
- Background information and information about the technology to be tested;
- Sampling design, including field procedures, sampling methods;
- Method quality objectives, including statistical goals;
- Laboratory procedures;
- Field and laboratory quality control;
- Data management procedures;
- Data review, verifications and validation; and
- Interim progress report(s) during the testing program.

The QAPP must specify the name, address, and contact information for each organization and individual participating in the performance testing. Include project manager, test site owner/manager, field personnel, consultant oversight participants, and analytical

laboratory that will perform the sample analyses. Identify each study participant's roles and responsibilities and provide key personnel resumes. In addition, provide a schedule documenting when the vendor's equipment will be installed, the expected field testing start date, projected field sampling completion, and final project report submittal. The TCEQ will review and approve the QAPP prior to the start of field testing. It is recommended that time be allocated for initial startup and testing of the treatment system and monitoring equipment. Vendors should allow up to three months for QAPP review and approval.

4.2 Information about the Technology

At a minimum, include the following information to support the assessment of the technology:

- Describe how the technology functions in treating stormwater runoff. Include information about physical, chemical, or biological treatment processes such as filtration, adsorption/absorption, settling, or inertial separation that may be involved in the treatment process.

- Physically describe each treatment system component. Include a description of the specific unit to be tested as well as information about how this unit relates to other units offered by the vendor. The physical description should include: 1) engineering plans/diagrams showing each of the functional components, construction materials (including filter media, absorbent, or other media that may be part of the treatment system), equipment dimensions, and each component's capacity (e.g., hydraulic capacity, sediment storage, floatables/debris storage); 2) explain any site or installation requirements such as necessary soil characteristics, hydraulic grade requirements, depth to groundwater limitations, or utility requirements; and 3) pretreatment recommendations, if necessary.

- Summarize available performance information. This section should state the vendor's claims regarding the system's ability to remove or reduce specific stormwater pollutants for specific land uses. Include any bench-scale testing to support the performance claims. Wherever possible, include information about anticipated performance in relation to climate, design storm, and/or site conditions.

- Describe the manufacturer's recommended operation and maintenance procedures, including both preventative maintenance procedures to be implemented during the course of the field test as well as long-term maintenance. Provide a description of personnel, supplies, replacement materials and/or parts availability (e.g., filter media) and equipment needed to operate and maintain the facility. Include a recommended maintenance schedule and identify access ports and dimensions provided to facilitate maintenance. Also, identify any special

disposal requirements associated with spent media, absorbents, or other material to be generated during routine cleaning/maintenance operations.

- Include raw material specifications for all treatment media to ensure the quality control of this fundamental component.

- Summarize any limitations or pretreatment requirements of the technology, as well as any advantages over approved technologies.

- Identify any restrictions related to the size of the catchment area.

Sampling Design Considerations

This section describes test procedures that can be used to evaluate vendor's performance claims. This protocol specifies that field testing be conducted for at least 12 rainfall events. Sizing of the test facility must be based on meeting applicable performance goals at the design flow rate coinciding with treating at least 90 percent of runoff volume. It is recommended that sampling events be evenly distributed over the monitoring period to capture seasonal influences on storm conditions and system performance.

Select field test sites that are consistent with the technology's intended applications (land uses) that will provide influent concentrations typical of stormwater for those land use types. Describe how the treatment technology was selected and designed for the specific field test site. Include manufacturer sizing methodology and any deviations from sizing methods. Include the following information on the test site:

- Field test site catchment area, land uses (roadway, commercial, high-use site, residential, industrial, etc.) and impervious cover.

- Describe potential pollutant sources in the catchment area (e.g, parking lots, roofs, landscaped areas, sediment sources, exterior storage or process areas).

- Baseline stormwater quality information to characterize conditions at the site. For sites that have already been developed, it is recommended that baseline data be collected to provide a sizing basis for the device, and to determine whether site conditions and runoff quality are conducive to performance testing.

- Site map showing catchment area, drainage system layout, and treatment device and sampling equipment locations.

- Catchment flow rates (i.e., water quality design flow and 2-year rate).

- Make, model, and capacity of the treatment device.

- Identify bypass flow rates and/or flow splitter designs necessary to accommodate the treatment technology.

- Describe pretreatment system, if required by site conditions or technology operation.

- Determine site adequacy for sampling, flow measurement access, and telephone/AC power, if needed.

- Describe any known adverse site conditions such high ground water, erosion, high spill potential, illicit connections to stormwater catchment areas, industrial runoff, etc.

The following vendor equipment field testing criteria have been established:

Feature	Criteria
Number of storm events, minimum	At least 12 events
Minimum storm depth for any rain event	0.15 inches
Antecedent dry-period	72 hours minimum with less than 0.1 inches of rain
Minimum storm duration	None, as long as above criteria are met
Minimum storm intensity	None, as long as above criteria are met

4.3 Stormwater Field Sampling Procedures

This section describes field sampling procedures that will be implemented to ensure the quality and representativeness of the collected samples. Included in this discussion are sampling methodology (e.g., discrete versus composite sampling), flow monitoring, sample handling, and field QA/QC.

Sampling methods. Samples must be collected using automatic samplers. The responsible project professional should certify that the sampling equipment and their location are likely to achieve the desired sample representativeness, aliquots, frequency, and compositing at the desired influent/effluent flow conditions.

The effectiveness of new treatment technologies will be determined using automatic flow-weighted composite sampling. Samples are to be collected over the storm event duration and composited in proportion to flow. This sampling method will generate an event mean concentration and can be used to determine the TSS removal on an average annual basis. For this method, samples should be collected over the entire runoff period. As a guideline, at least 10 aliquots should be composited, covering at least 75 percent of each storm's total runoff volume up to the design storm volume.

Sampling locations. Provide a site map showing all monitoring/sampling station locations and identify the equipment to be installed at each site. To accurately measure system performance, samples must be collected from both the inlet and outlet from the treatment system. Sample the influent to the treatment technology as close as possible to

the treatment device inlet. Samples should represent the total runoff from the catchment area and should not include debris and large particles. To ensure that samples represent site conditions, design the test site so that influent samples can be collected from a pipe that conveys the total influent to the unit. To avoid skewing influent pollutant concentrations, sample the influent at a location unaffected by accumulated or stored pollutants in, or adjacent to, the treatment device.

Sample the effluent at a location that represents the treated effluent. If bypass occurs, bypass flows must be measured and bypass loadings calculated using the pollutant concentrations measured at the influent station. In addition, be aware that the settleable or floating solids, and their related bound pollutants, may become stratified across the flow column in the absence of adequate mixing. Samples should be collected at a location where the stormwater flow is well-mixed.

Sampler installation, operation, and maintenance. In this section, provide a detailed sampling equipment description (make and model) as well as equipment installation, operation, and maintenance procedures. Discuss sampler installation (e.g., suction tube intake location relative to flow conditions at all sampling locations, field equipment security and protection), how the automatic sampler will be programmed (e.g., proposed sampling triggers and flow pacing scheme), and equipment maintenance procedures. Samplers must be installed and maintained in accordance with manufacturer's recommendations. Indicate any deviations from manufacturer's recommendations. Provide a sampling equipment maintenance schedule. When developing the field plan, pay particular attention to managing the equipment power supply to minimize the potential for equipment failure during a sampling event.

Flow monitoring: Flow into and out of the treatment device must be measured and recorded on a continuous basis over the sampling event duration. Depth-measurement devices and area/velocity measurement devices are the most commonly used flow measurement equipment. The appropriate flow measurement method depends on the nature of the test site and the conveyance system. For offline systems or those with bypasses, it may be necessary to measure flow at the bypass as well as at the inlet and outlet. Describe the flow monitoring equipment (manufacturer and model number), maintenance frequency and methods, and expected flow conditions (e.g., gravity flow or pressure flow) at the test site. For offline flow describe the flow splitter to be used and specify the bypass flow set point. Identify site conditions, such as backwater conditions that could affect sample collection or flow measurement accuracy. It is recommended that sampling/monitoring sites be established at locations where gravity flow conditions exist, because it is difficult to obtain accurate flow measurements with existing flow measuring equipment under backwater conditions. Flow should be logged at a 5-minute intervals.

Note: For flow-through type devices, flow measurement at the inlet may be used to represent outlet flow.

Rainfall monitoring: Rainfall should be measured and recorded at 5-minute intervals during each storm event from a representative site. Indicate the type of rain gauge that will be used (e.g., an automatic recording electronic rain gauge, such as a tipping bucket connected to a data logger, that records rainfall depths in 0.01 inch increments), provide a map showing the rain gauge location in relation to the test site, and describe rain gauge inspection and calibration procedures and schedule. Equipment must be installed and calibrated in accordance with manufacturer's instructions. At a minimum, the rain gauge should be inspected and if necessary, maintained monthly. If the onsite rainfall monitoring equipment fails during a storm sampling event, data from the next-closest representative monitoring station may be used to determine whether the event meets the defined storm criteria. Any deviations from the protocol must be clearly identified.

Sampling for TSS: This protocol defines TSS as matter suspended in stormwater, excluding litter, debris, and other gross solids exceeding 500 microns in diameter (larger than medium-sized sand). Conceptually this is consistent with the "Standard Methods" approach for analyzing suspended solids, which excludes large particles if it is determined that their inclusion is not desired.

To determine percent TSS reduction, the samples must represent the vertical cross section (be a homogeneous or well-mixed sample) of the sampled water at the influent and the effluent of the device. The selection of the sampling location, its homogeneity, and placement of and sizing of the sampler tubing in the stormwater must be conducted with care to ensure the desired representativeness of the sample and the stormwater stream.

Particle Size Distribution (PSD): Treatment technologies must be capable of removing TSS across the size fraction range typically found in urban runoff. Field data show most TSS particles are smaller than 125 microns.

If there is any question about the representativeness of a proposed site, the vendor may analyze TSS and PSD prior to installing the treatment device. The PSD results of this test program will then be compared with the PSD used in sizing the treatment device to confirm the design basis of the device.

Of the analytical procedures available, the Coulter Counter (model 3) is recommended, although the newer laser-diffraction instruments may also provide sufficient sensitivity for particle sizes below 250 microns. Sieves may be also be used to quantify the particulate fraction beyond the range of the instruments.

Accumulated Sediment Sampling Procedures

As appropriate to demonstrate facility performance, and to confirm the stormwater sampling-based percent removal data, measure the sediment accumulation rate. Practical measurement methods would suffice, such as measuring sediment depth, immediately before each sediment cleaning and when testing is completed.

The sediment sample should be a composite from several grab samples (at least four) collected from various locations within the treatment system to ensure that the sample represents the total sediment volume in the treatment system. For QA/QC purposes, collect a field duplicate sample (see following section on field QA/QC). The sediment sample should be kept at 4° C during transport and storage prior to analysis. If possible, remove and weigh (or otherwise quantify) the sediment deposited in the system. Quantify or otherwise document gross solids (debris, litter, and other large material). Volumetric sediment measurements and analyses should be useful in determining maintenance requirements, TSS mass balance, and whether the sediment quality and quantity are typical for the application.

Field QA/QC

The field QA/QC section describes the measures that will be employed to ensure the representativeness, comparability, and quality of field samples. Field QA/QC should include the elements listed below:

Equipment calibration. Describe the field equipment calibration schedule and methods, including automatic samplers, flow monitors, and rainfall monitors. The accuracy of the flow meters is very important so their calibration should be carefully conducted by the site professional in accordance with manufacturer's recommendations.

Recordkeeping. Maintain a field logbook to record any relevant information noted at the collection time or during site visits. Include notations about any activities or issues that could affect the sample quality (e.g. sample integrity, test site alterations, maintenance activities, and improperly functioning equipment). At a minimum, the field notebook should include the date and time, field staff names, weather conditions, number of samples collected, sample description and label information, field measurements, field QC sample identification, and sampling equipment condition. Also, record measurements tracking sediment accumulation. In particular, note any conditions in the tributary basin that could affect sample quality (e.g., construction activities, reported spills, other pollutant sources). Provide a sample field data form in the QAPP.

4.4 Full-Scale Laboratory Studies

Except as discussed in the paragraphs below, laboratory testing may precede or augment but cannot entirely replace field testing. Laboratory data are generally useful because data can be generated under controlled conditions, in considerably less time than field tests, and under easily modified design conditions.

Laboratory testing can be conducted to demonstrate TSS removal at peak design flow rates. The vendor should provide detailed test facility descriptions (photos, illustrations, process/flow diagrams), including all relevant factors such as treatment and hydraulic design flow and loading rates on a unit basis (e.g., gallons per minute per square foot), dead storage/detention volumes, inspection protocols to determine when maintenance is needed, maintenance performed during testing, and media type/quantity/thickness.

Laboratory tests should be conducted under the following conditions:

- Constant flow rates of 75, 100, and 125 percent, plus or minus 10 percent, of the manufacturer's facility design hydraulic loading rate or design hydraulic velocity rate.

- For TSS removal testing, the TSS added to laboratory water should approximate "typical" runoff PSDs for the treatment application (land use). U.S. Silica Sil-Co-Sil 106 ground silica can be used to represent a typical PSD. Other materials that more closely simulate "typical" runoff PSD can also be used.

- At a minimum, complete two tests each at 100 and 200 mg/L TSS influent concentration range.

Do not clean filters or settling chambers between tests, unless required under vendor's normal maintenance schedule. Comply with testing and reporting protocols described above. After the TSS tests are completed, test the facility's maximum hydraulic loading rate to check for TSS resuspension and washout (negative removal efficiency). This test shall be conducted with the facility's treatment capability fully utilized (that is, at the time maintenance would be normally be performed, such as when the sediment settling area is full or filter media is saturated). If washout occurs, determine the flow rate where washout begins, and provide for bypassing flows exceeding this flow rate in design guidelines.

4.5 Laboratory QA Procedures

Laboratories performing stormwater sample analysis must be certified by a national or state agency regulating laboratory certification or accreditation programs. Each laboratory sheet should include the sampling date, the preservation date if applicable, the analysis date, and whether the sample is a QC sample. A table should be provided that shows how laboratory numbers correspond to each site.

4.6 Data Management Procedures

Include a quality assurance summary with a detailed case narrative that discusses problems with the analyses, corrective actions if applicable, deviations from analytical methods, QC results, and a complete definitions list for each qualifier used. Specify field/laboratory electronic data transfer protocols (state the percent of data that will undergo QC review) and describe corrective procedures. Corrections to data entries should include initials of the person making the correction and the date it was corrected. Indicate where and how the data will be stored.

4.7 Data Review, Verification, and Validation

Describe procedures for reviewing the collection and handling of the field samples. Establish the approach that will be used to determine whether samples meet all flow sampling and rainfall criteria.

Describe laboratory data review procedures. Validation requires thoroughly examining data quality for errors and omissions. Establish the process for determining whether data quality objectives have been met. Include a table indicating percent recovery (%R) and relative standard deviation (RSD) for all QC samples. Determine whether precision and bias goals have been met. Establish a procedure to review reporting limits to determine whether non-detected values exceed reporting limit requirements.

REPORTING

The sampling results must be presented in the project report and include the following:

- Date, time, locations where samples were collected (include a site plan);
- Rainfall data (include antecedent dry period, total rainfall during sampling event, and rainfall duration);
- Comparison of rainfall data to rainfall criteria
- Comparison of collected aliquots to sampling criteria;
- Comparison of influent to effluent pollutant concentrations;
- Statistical data evaluation;
- Discussion of whether the QAPP objectives were met;
- Discussion on deviations from any sampling procedures and reasons why any collected data or analyses were not included;
- Data quality assurance summary package (field and laboratory QA/QC results);
- Maintenance performed during the study period, including:
    - Type of maintenance conducted and frequency;
    - Total amount of sediment and floatables removed and sediment depth prior to each cleaning; and
    - Media replacement and/or cleaning, if applicable.
- Discussion of results; and
- Executive Summary.