PERFORMANCE EVALUATION 14

Advancement of our understanding of the relationship of performance to design criteria and to maintenance practices requires the evaluation of treatment systems in the field and laboratory. To be useful, the methods of research should allow for meaningful comparison of separate evaluations. Chapter 14 presents elements of field and laboratory evaluations, and provides the author's thoughts on how to compare performance data gathered in different studies.

14.1 ELEMENTS OF A FIELD PROGRAM

Recommendations on the appropriate elements of a monitoring program, including the characterization of the test facility and its drainage area, have been offered.[31,1054,1153,1257] Definitive sampling protocols are available.[621,760,782,1199] Recommended is the use of a Quality Assurance Project Plan (QAPP), based on guidance provided by the U.S. Environmental Protection Agency.[1150] Presented in this section is an introduction to the preparation and implementation of a QAPP from the perspective of the evaluation of stormwater treatment facilities.

Determine project objectives

Project objectives drive the structure of the monitoring plan. Possible objectives include:

- Determination of performance
- Determination of long-term performance capacity
- Evaluation of design criteria
- Evaluation of maintenance practices
- Comparison of performance to other facilities of the same type
- Comparison of performance to other types of treatment systems
- Regulatory action

We wish to compare the performance of several different facilities of the same treatment type (e.g., wet ponds) to ascertain the effect of different stormwater characteristics on performance, or to contrast the effect of different design criteria (e.g., length to width ratio). Alternatively, we may wish to compare the performance of one type of treatment to other types (e.g., wet ponds to wet vaults). The effort may be to evaluate one facility, comparing the resulting data to data collected at other facilities, or to evaluate several facilities simultaneously. Regulatory action may be the basis for the monitoring (i.e., whether a permit requirement is being met, or whether a particular treatment system is providing satisfactory protection of a receiving water). The professional literature should be thoroughly reviewed to ascertain the extent to which others have addressed the project objectives.

The project is enhanced by the development of a QAPP.[1150] A QAPP is a tool for project managers to document the project objectives, the type and quality of data needed to meet the objectives, and the methods for collecting and evaluating the data.

It describes the quality assurance and quality control plan (QA/QC). The possible content of a QAPP is presented in Table 14.1. A checklist to assist in the preparation of a QAPP is provided in Appendix E. The four major elements of a QAPP are introduced below.

- *Project management:* Addresses project history and objectives, roles and responsibilities of the participants, and the process and elements of interaction between the participants over the life of the study.
- *Data generation and acquisition:* Defines all aspects of project design and implementation, describing the methods of sample collection and analysis, equipment and QA/QCprocedures.
- *Assessment and oversight*: This part of the QAPP assesses how the project progress is monitored and whether data, as they are gathered, are meeting expectations; it defines the roles of the participants on this aspect; and management procedures for taking corrective actions.
- *Data validation and usability*: Addresses the Quality Assurance activities that occur as data collection is occurring, and after data acquisition is completed

TABLE 14.1
Content of a QAPP[1150]

Project management
• Title and approval page
• Table of contents
• Project organization
• Problem definition/background
• Tasks descriptions
• Quality objectives and criteria
• Documents and records
Data generation and acquisition
• Sampling process design
• Sampling methods
• Sample handling and custody
• Analytical methods
• Quality control
• Equipment testing, inspection, maintenance
• Equipment calibration and frequency
• Inspection/acceptance of supplies and consumables
• Non-direct measurements
• Data management
Assessment and oversight
• Assessments and response actions
• Reports to management
Data validation and usability
• Data review, verification, and validation
• Verification and validation methods
• Reconciliation with user requirements

Select the facility

The general criteria for selecting the test facility include the characteristics of the catchment area draining to the facility, the age of the facility, maintenance history, accessibility to and within the facility, and crew safety.

With respect to the selection of a catchment area, decision factors include land use and watershed activities insofar as they affect stormwater concentrations. Watersheds with significant open space or low density residential development may not generate concentrations sufficiently high to allow meaningful evaluation of performance. Influent concentrations too near the detection limit increase the uncertainty of the estimates of performance, if not invalidate the results. Urban highways are good candidates as they typically exhibit higher pollutant concentrations.

It may be desirable to avoid drainage areas with atypical industrial activities. These activities may generate a stormwater quality that is atypical. Furthermore, the industry may create episodic conditions that adversely affect the treatment facility, ruining several months of monitoring effort.

Facility age is particularly relevant to constructed wetlands and wet ponds. Vegetation infilling occurs in the first few years of operation during which time the soil chemistry also likely changes. If the interest is to monitor the effect of these changes on performance, a new facility should be selected. If, however, the interest is the performance of a mature facility, an older and more stable facility is appropriate.

With infiltration systems it may take many years for pollutants to reach groundwater aquifers. Age is of little consequence with systems in which neither soil nor vegetation are factors in pollutant removal (e.g., vortex separators). If the facility has not been properly maintained, it should not be selected unless one wishes to compare maintained and unmaintained facilities.

Access is important. The facility must be easily accessible by the sampling crew. Sampling points within the facility must be safely accessible in the dark.

Sampling individual unit operations

Most facilities contain more than one unit operation. Examples are: forebay and the main area of a wet pond; pretreatment vault followed by the sand filter, and several physically separate unit operations in series such as a swale-wet pond-wetland. The later is referred to as a "treatment train", although it is appropriate to give this name to all three examples.

The incremental performance of each must be monitored to evaluate the incremental benefit of each. Only in this manner can rational design criteria be developed for each. An example of such data is shown in Table 14.2. Little or no additional removal occurs in the wetland. Ammonia concentrations increase. The bulk of the removal occurs in the forebay which may suggest it is oversized. Similar results have been found by others.[1501] Pollutants tranform in treatment systems to forms difficult to remove in subsequent units. Examples are inorganic phosphorus and nitrogen to organic forms in wetlands.[1415]

TABLE 14.2
Aggregate efficiency[1894]

	FOREBAY	POND	WETLAND
TSS	79	92	95
Cu	75	84	85
Zn	83	87	87
NH_3	28	44	22
TP	61	76	89
Coli	90	99	99

Select parameters and analytical methods

Table 14.3 lists parameters commonly recommended with detection limits. Detection limits in Table 14.3 represent the Method Detection Limit (MDL). MDL is defined as the minimum concentration that can be measured and reported with 99 percent confidence that the analytic concentration is greater than zero. Practical Quantification Limit (PQL) is the minimum concentration of a parameter that can be accurately and precisely quantified. It is alternatively called the Reliable Detection Limit (RDL). The PQL is generally five to ten times the MDL, depending on the parameter.