US EPA Stormwater Program's Webcast Series

Assessing the Effectiveness of Your Municipal Stormwater Program

MUNICIPAL PROGRAM EFFECTIVENESS RESOURCES

- **Municipal Stormwater Program Effectiveness Assessment Guidance** – Developed by the California Stormwater Quality Association (CASQA), this guide describes methods to better assess the effectiveness of municipal stormwater programs using data from all program elements at multiple outcome levels. Available for $30 by clicking on "Effectiveness Assessment" on the left navigation bar at the link below.
  www.casqa.org

- **EPA Measurable Goals Guidance** – A guidance to help small Phase II MS4s develop measurable goals for their stormwater program.
  www.epa.gov/npdes/stormwater/measurablegoals

- **Municipal Stormwater Program Evaluation Guide** – Developed to help both NPDES staff and permittees conduct evaluations of municipal stormwater programs.
  www.epa.gov/npdes/pubs/ms4guide_withappendixa.pdf and
  www.epa.gov/npdes/pubs/ms4guide_appendicesb-d.pdf

- **Municipal Stormwater Monitoring Data and the National Stormwater Quality Database** – Dr. Robert Pitt, University of Alabama, has collected stormwater monitoring data from a number of Phase I cites, counties, and DOTs.
  http://rpitt.eng.ua.edu/Research/ms4/mainms4.shtml

- **Water Environment Research Foundation (WERF) Reports** – Two WERF reports on "Controlling Pollution at Its Source: Wastewater and Stormwater Demonstration Projects" (stock number D12008) and "Tools to Measure Source Control Program Effectiveness" (stock number D00301) describe programs to measure effectiveness. Note that there is a charge for the reports for non-WERF subscribers.
  www.werf.org

ESSENTIAL ELEMENTS FOR MS4 STORMWATER PROGRAMS

- **Getting in Step: A Guide for Conducting Watershed Outreach Campaigns** and **Getting in Step: Engaging and Involving Stakeholders in Your Watershed –** The Getting in Step series provides to tools necessary to develop and implement an effective outreach plan and involve stakeholders throughout a watershed.
  www.epa.gov/owow/watershed/outreach/documents

- **Illicit Discharge Detection and Elimination Guidance Manual (Developed by the Center for Watershed Protection and Dr. Robert Pitt)** – Outlines practical, low cost, and effective techniques that can be used to detect and eliminate illicit discharges. www.epa.gov/npdes/idde

- **Managing Stormwater in Your Community: A Guide for Building an Effective Post-Construction Program** (manual coming soon) Similar to the IDDE Manual above, this guide will describe techniques municipalities can use to develop an effective post-construction program. Draft tools are available at www.cwp.org/webcast/postconstruction.htm

- **Manual 3: Urban Stormwater Retrofit Practices** - Detailed guidance from the Center for Watershed Protection on how to effectively retrofit urbanized subwatersheds. www.cwp.org/PublicationStore/USRM.htm#usrm3

- **Stormwater Maintenance Manual** (manual coming soon) – The Center for Watershed Protection is developing a set of web-based tools to help communities develop a state-of the art maintenance program. Available soon at www.cwp.org

- **EPA's Stormwater Website –** Your first stop for all of EPA's stormwater resources www.epa.gov/npdes/stormwater

- **Menu of BMPs -** Site containing over 120 BMP fact sheets on all stormwater program areas www.epa.gov/npdes/stormwater/menuofbmps

OTHER GENERAL STORMWATER RESOURCES

- **Stormwater Case Studies** - Over 35 different case studies describing how a Phase I or Phase II community has implemented a specific aspect of its stormwater program www.epa.gov/npdes/stormwater/casestudies

- **NPDES News** - Use this website to sign up for EPA's periodic email newsletter, NPDES News, at www.epa.gov/npdes/npdesnews

- **NPSINFO** - Nonpoint Source Pollution and stormwater information listserve is a forum for open discussion of nonpoint source and stormwater issues www.epa.gov/OWOW/info/NewsNotes/listsrv.htm

- **Center for Watershed Protection** - Stormwater Manager's Resource Center website has resources for stormwater codes, manuals, and BMP fact sheets www.cwp.org or www.stormwatercenter.net

- **CASQA Stormwater BMP Handbooks** – A series of stormwater BMP Handbooks addressing new development and redevelopment, construction, industrial and commercial, and municipal sources. Each handbook is available free online. www.cabmphandbooks.org

- **Urban BMP Tool** – Provides simple, easy access to stormwater BMP performance studies www.epa.gov/npdes/urbanbmptool

- **NPDES Compliance Monitoring Strategy** – Outlines inspection and compliance goals for the entire NPDES program, including stormwater.
  www.epa.gov/compliance/resources/policies/monitoring/cwa/npdescms.pdf

- **Nonpoint Source Outreach Toolbox**
  www.epa.gov/owow/nps/toolbox/

- **National Management Measures to Control Nonpoint Source Pollution from Urban Areas**
  www.epa.gov/owow/nps/urbanmm/index.html

- **EPA's Green Infrastructure Website**
  www.epa.gov/npdes/greeninfrastructure

California Stormwater Quality Association
An Introduction to Stormwater Program Effectiveness Assessment

A. Introduction

This paper introduces and discusses key concepts and provides a standardized terminology related to the development of a comprehensive framework for assessing the effectiveness of stormwater management programs. It briefly defines and categorizes potential outcomes, measures, and methods to be used in conducting assessments, and provides examples of how several programs are already utilizing these tools to assess their effectiveness. The California Stormwater Quality Association (CASQA) has also released a more detailed May 2007 *Municipal Stormwater Program Effectiveness Assessment Guidance*, which expands on and explores in greater detail the concepts presented in this paper.

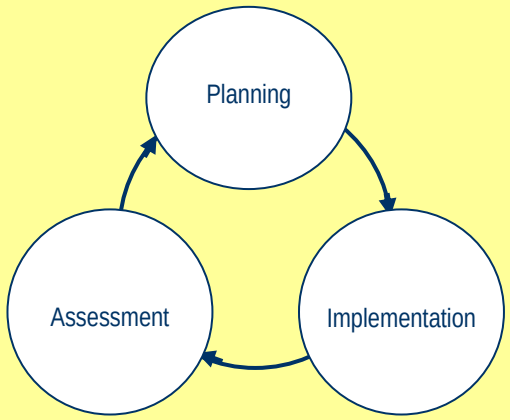

Figure 1 – Iterative Program Management Process

Effectiveness assessment is a fundamental and necessary component of developing and implementing successful programs. It begins with the establishment of goals, objectives, and desired outcomes during program planning, and continues throughout subsequent implementation and review stages. A well-executed assessment element can provide managers the feedback necessary to determine whether their programs are achieving intended outcomes (complying with permit requirements, increasing public awareness, changing behaviors, etc.), and ultimately whether continued implementation will result in water quality and/or habitat improvement. Figure 1 illustrates an idealized model in which each of three management elements continuously informs the next in an iterative cycle of feedback and improvement. While this model is useful for illustration, it bears emphasis that the most successful programs are those that address assessment during all stages of program activity, especially planning.

Municipal stormwater management programs in California are broadly focused on reducing pollutants in stormwater and non-stormwater discharges to the maximum extent practicable (MEP), and on ensuring that these discharges do not cause or contribute to violations of applicable water quality standards. To achieve these objectives, they employ a variety of strategies to bring about the implementation of best management practices (BMPs) in a manner that will most effectively and cost-efficiently achieve regulatory compliance and protect the beneficial uses of receiving waters. To ensure that programs are measurable and effective, most municipal separate storm sewer system (MS4) National Pollutant Discharge Elimination System (NPDES) stormwater permits contain specific requirements for periodic assessment. Most programs report on effectiveness as part of their annual report, but effectiveness assessment should be integral to the program and an ongoing process used throughout the year.

Stormwater managers currently find themselves at an important crossroads. Faced with a continually increasing need to demonstrate measurability and accountability, they must have a reasonable expectation of success before committing resources toward specific activities. Therefore, good effectiveness assessment tools are critical. Managers have historically relied on a combination of programmatic or implementation evaluations and direct water quality evaluations to determine whether their efforts are effective in achieving intended outcomes. In addition, some program managers are still in need of basic information on useful assessment methods.

Developing consensus on how to continue improving these approaches and providing guidance on selecting and using applicable assessment methods must remain priorities. More importantly, a critical need has

emerged to work toward integration of assessment methods so that linkages between program activities and measurable changes in water quality can be definitively established and continually refined. A well-conceived integrated approach for assessing the effectiveness of stormwater programs is necessary to ensure their measurability and success in the future.

B. What is Effectiveness Assessment?

Clarifying what is meant by effectiveness assessment, as well as the factors that need to be considered when assessing programs, is an important first step toward developing useful methods and approaches.

Effectiveness Assessment is the process that managers use to evaluate whether their programs are resulting in desired outcomes, and whether these outcomes are being achieved efficiently and cost-effectively. The specific approach to be used in assessing effectiveness will depend on a variety of factors including the type of program element or activity being evaluated and the stage of program development (i.e., planning, implementation, completion). However, as noted earlier, a comprehensive effectiveness assessment strategy should evaluate program implementation and water quality, and seek to find the relationship between the two (Figure 2).

Implementation Assessment provides managers feedback on the effectiveness of their programs in achieving targeted objectives. This type of assessment is essential in determining whether priority sources of pollution are being effectively addressed. Implementation assessment is generally conducted at any of three levels of analysis: the overall program, the elements that comprise the program (construction sources, municipal sources, etc.), or the specific activities that are conducted within these program elements. Figure 3 shows these levels and provides examples to illustrate their relationship. While assessment strategies most commonly focus on specific activities such as inspections, street sweeping, debris collection, or implementation of best management practices, a comprehensive strategy should also encompass individual program elements and the overall program. Depending on the intended objectives at each level, assessment approaches will necessarily vary. These may range in complexity from simple activities such as verifying the completion of activities to more sophisticated techniques such as assessing the probable or actual locations of these activities and the significance of their spatial distribution.

Water Quality Assessment is the use of environmental data and related information to characterize the quality of non-stormwater or stormwater discharges, and the water bodies that receive these discharges. This can include a variety of chemical, biological, and physical parameters or outcomes. In instances where water quality assessment is used to draw conclusions about overall program effectiveness, results are usually very general and require extended periods of analysis.

Integrated Assessment is the process of evaluating whether stormwater program implementation is resulting in the protection or improvement of water quality. In this process, relationships between program activities and water quality improvements are explored and refined. Because of the number and variety of BMPs and control programs being implemented at any given time, and because many factors external to stormwater programs affect water quality, establishing these relationships is difficult. Efforts to date have included speculative or hypothetical exercises aimed at better understanding likely program outcomes and

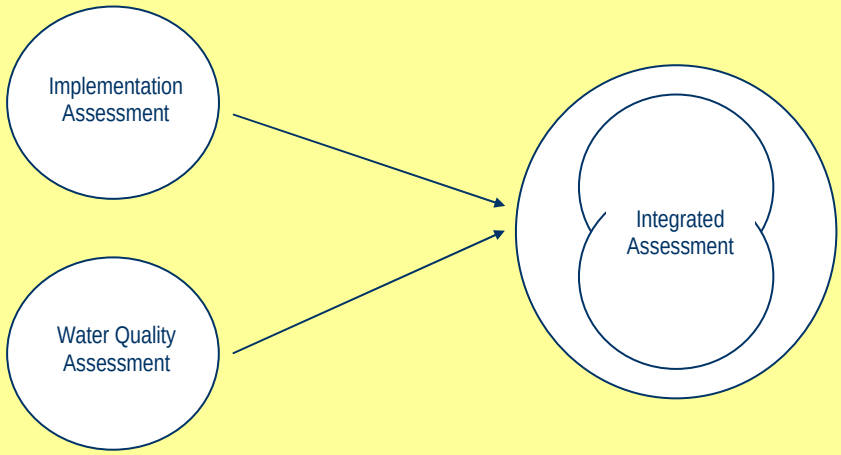

Figure 2 – The Relationship of Major Effectiveness Assessment Elements

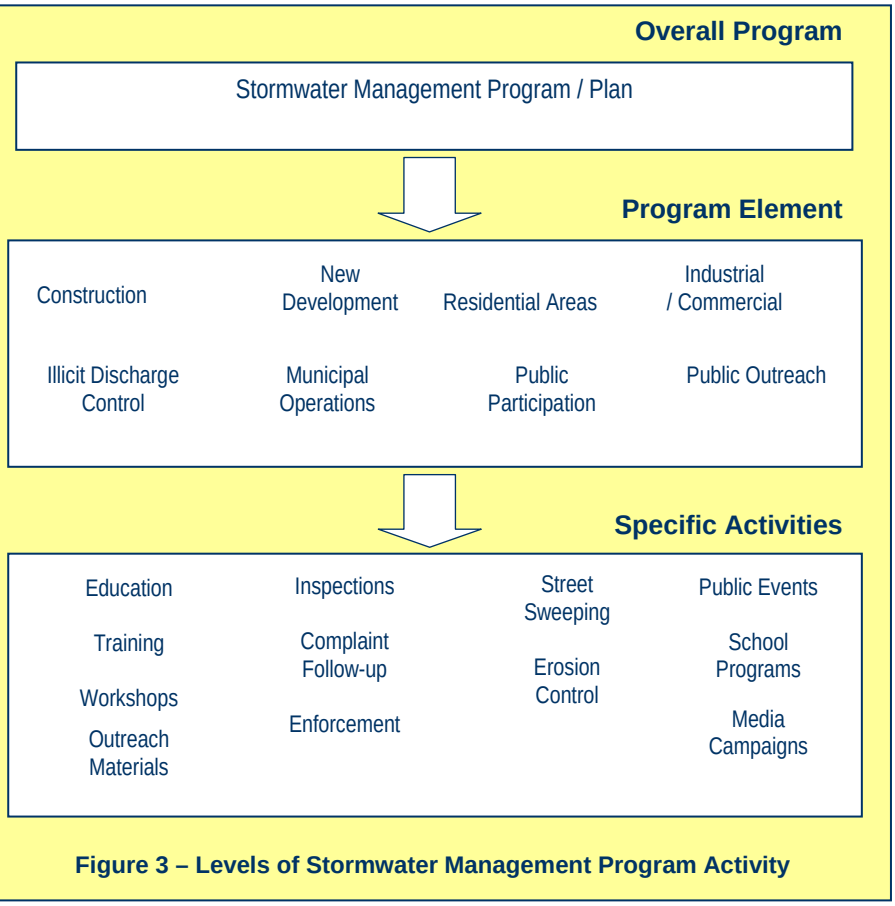

Figure 3 – Levels of Stormwater Management Program Activity

potential relationships to water quality. Quantitative "cause and effect" relationships will increasingly be sought in the future. This is a critical linkage because implementation assessment is, in many cases, simpler and less costly than water quality assessment. In addition, the time frame needed to see measurable results is shorter for implementation assessments. Over time, correlating water quality improvement to programmatic results will assist stormwater managers in identifying the most expedient and cost-effective approaches to planning and assessing their programs.

C. Types of Assessment Outcomes

Stormwater managers currently use a number of different approaches to draw conclusions about the effectiveness of their activities and programs. This involves the evaluation and measurement of various types of programmatic and environmental outcomes.

Outcomes are the results of implementing a stormwater control measure, program activity or element, or overall program. The discussion below characterizes the possible types of outcomes in terms of six levels. As illustrated in Figure 4, these levels represent a gradation from activity-based to water quality-based outcomes. Though each level has value in informing management decisions, it bears emphasis that not all are necessary or possible in every instance. For example, in many instances Level 2 or 3 Outcomes will be sufficient for evaluating the effectiveness of implementation of outreach or training programs.

The pyramidal structure of Figure 4 is intended to illustrate the progression of each successive step toward the ultimate goal of environmental improvement. In general, Levels 1 to 4 can be considered Implementation Outcomes, and Levels 5 and 6 Water Quality Outcomes. While an important objective of the effectiveness assessment process is to establish relationships between Levels 1 and 6, this often becomes increasingly difficult as one moves toward higher levels of assessment. It should also be noted that, while these levels are presented in sequence, efforts to address each are independent and ongoing. For example, increases in awareness and knowledge may continue to be assessed even as strategies are broadened to include load reduction estimates.

Level 1: Documenting Activities. Many specific activities are either prescribed by or established under stormwater NPDES permits. Examples include conducting education to encourage BMP implementation, inspecting facilities, and enforcing discharge prohibitions. The most basic means of assessing effectiveness is to determine compliance with activity-based permit requirements. Level 1 Outcomes may therefore take the form of a simple yes/no answer. They may also be quantified, counted, or tracked over time to demonstrate effort or progress. Level 1 Outcomes are assumed to be beneficial to water quality, but often lack a factual basis to support these assumptions. Their fundamental characteristic is that they reflect program activity only; they are not indicators of the effect of implementation on people or the environment.

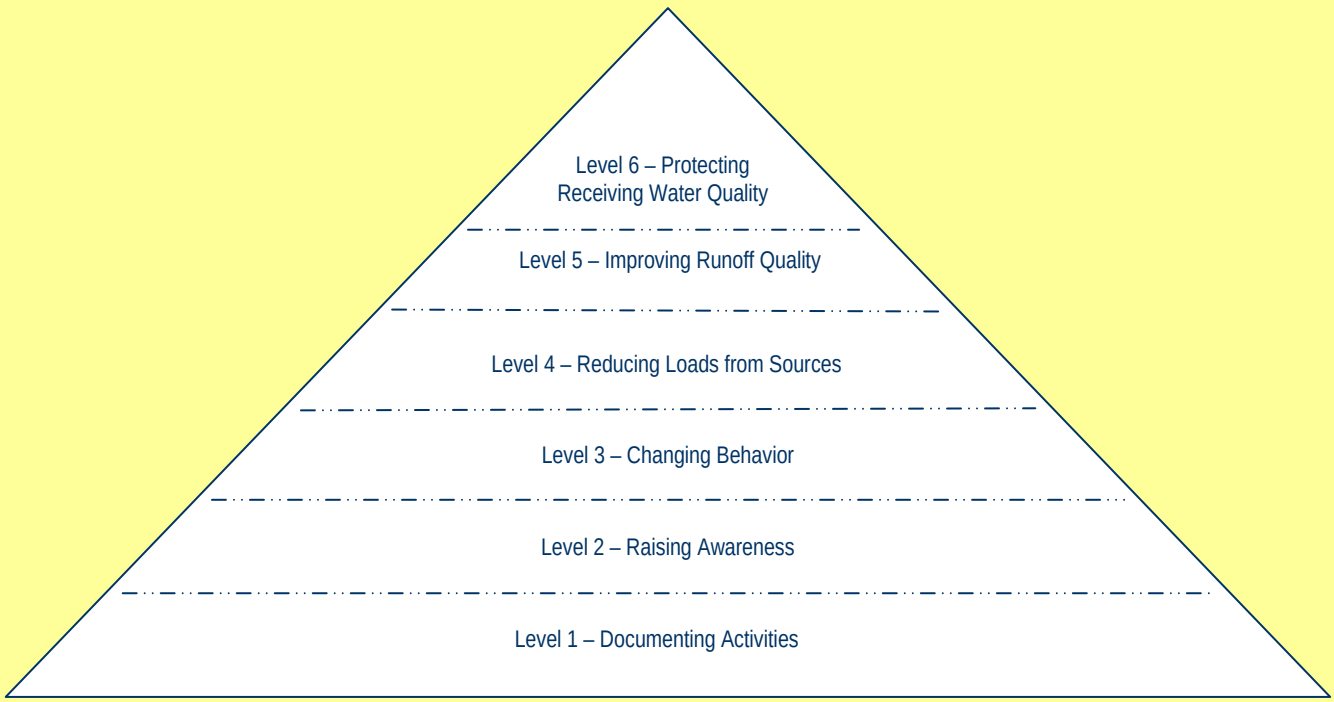

Figure 4 – General Classification of Outcome Types

-- Assessing Level 1 Outcomes --
Documenting Activities

Basic measurements of program activity are a crucial part of the overall assessment process. Level 1 Outcomes provide managers direct feedback on how well implementation is progressing and whether targeted goals and objectives are being met. Typical examples of targeted outcomes include the following:

- How many trainings or outreach events were conducted?
- How many people were reached?
- How many inspections were conducted?
- Were minimum inspection frequencies met?
- Did the number of inspections increase from previous years?
- How many illicit discharges were identified?
- How many were eliminated?
- Are illicit discharges increasing or decreasing over time?

Level 2: Raising Awareness. An important goal of stormwater programs is to increase the level of knowledge and awareness among target audiences such as residents, businesses, and municipal employees. Similar to the discussion above, augmenting awareness and changing attitudes about stormwater pollution and BMPs is generally assumed to be beneficial to the environment because increased awareness and attitudinal changes provide the basis for behavioral change. Measuring Level 2 Outcomes is a useful way of gauging whether educational efforts are progressing toward these changes.

Various methods and tools, both quantitative and qualitative, are currently utilized to measure changes in knowledge and awareness. These generally take the form of surveys and quizzes. Changes may also be inferred by tracking levels of public involvement (e.g., through complaints or requests for information received via stormwater hotlines). However, there may be limitations to using this method because many different factors influence levels of public involvement.

-- Assessing Level 2 Outcomes --
Raising Awareness

Understanding what people know and care about is the first step in developing effective outreach programs. Two programs in Northern California recently utilized surveys as a tool for refining and evaluating their outreach efforts.

Davis Healthy Gardens Program – During 2000, the City of Davis conducted phone and mail surveys to evaluate general levels of awareness and to help target potential behavioral changes for pesticide use and disposal. The City was able to use this information to determine if the basic program message was being effectively communicated, and which outreach methods and locations worked best for creating awareness and for changing behavior.

Woodland Oil and Grease Reduction Project – In 2000, the City of Woodland developed an outreach program to encourage the proper disposal of used cooking oil by residents. The primary means of assessing program effectiveness was the use of intercept surveys. These surveys provided vital information on whether outreach messages were understood, whether identifiable factors influenced the likelihood of improper disposal (e.g., family size, high density vs. low density neighborhoods, renting vs. owning, cooking habits, etc.), and ultimately on which outreach approaches worked the best (e.g., use of more than one language for outreach).

Level 3: Changing Behavior. Building on increases in knowledge and awareness, a key focus of management programs is to effect changes in behavior. Level 3 Outcomes measure the effectiveness of programs in motivating target audiences to change their behaviors and implement appropriate BMPs. Methods used to measure behavioral changes include those described above for Level 2 Outcomes, as well as direct observation via site visits and reporting by dischargers or third parties.

Level 4: Reducing Loads from Sources. Most activities implemented through stormwater programs are intended to reduce the loading of pollutants from targeted sources. Load reductions should in turn result in improvements to discharge and receiving water quality. Load reductions quantify changes in the amounts of pollutants associated with specific sources before and after a BMP or other control strategy is employed.

-- Assessing Level 3 Outcomes --
Changing Behavior

Managers are increasingly utilizing a variety of methods to determine whether program implementation is resulting in targeted behavioral changes such as decreases in discharges and increased BMP implementation.

ACCWP Evaluation of Effectiveness Business Inspections – In 2000, the Alameda Countywide Clean Water Program (ACCWP) completed a comprehensive assessment of its facility inspection program using data collected between 1996 and 1999. Data were assessed to determine how well program objectives were being met, whether program implementation was resulting in corresponding behavioral changes, and to provide recommendations for prioritizing facilities and improving inspections. At the end of the four-year study, ACCWP staff was able to determine that non-stormwater discharges had decreased and BMP implementation increased at regulated businesses.

San Francisco Mercury Reduction Project – To evaluate the effectiveness of efforts to educate the public regarding the environmental impact of improperly disposing of mercury fever thermometers, San Francisco Water Pollution Prevention Program staff conducted intercept surveys and tracked the number of thermometers turned in at collection events. A random-digit-dial phone survey was also used to evaluate overall program effectiveness in discouraging the use of thermometers. A separate element of the project utilized site visits to assess whether outreach to dentists is facilitating proper amalgam waste management. This project provides an excellent example of how a variety of simple, low cost approaches to evaluating behavioral change can be used to evaluate the effectiveness of specific activities.

They are most valuable for making broad comparisons or for helping managers to distinguish where resource allocations are likely to be most useful. Developing a baseline of data and information to support load reduction estimates is key to their application. In the future, it is hoped that the development of such a baseline, as well as approaches for incorporating direct measurement, will enable a significant expansion of the use of load reduction estimates.

Level 5: Improving Runoff Quality. As discussed above, a primary focus of stormwater management programs is to reduce pollutants in stormwater and non-stormwater discharges to the maximum extent

-- Assessing Level 4 Outcomes --
Reducing Loads from Sources

Load reduction estimates provide an important focal point for determining whether program implementation is achieving, or likely to achieve, meaningful outcomes. In recent years, many jurisdictions have increasingly used such methods to estimate the benefits of implementation and to prioritize program spending.

ACCWP Street Sweeping Assessment – As part of their annual reporting process, Alameda Countywide Clean Water Program (ACCWP) copermittees track the amount of street sweeping waste collected. ACCWP combines this information with PCB and mercury concentrations measured in sediment samples taken from inlets, catch basins, and pump stations to estimate the loads of these compounds diverted from the storm drain system as a result of street sweeping. Results allow the identification of potential improvements to street sweeping operations (e.g., to determine whether load diversions could be increased relative to costs), as well as comparison to results from storm drain cleaning and desilting operations.

County of San Diego Construction Activities Assessment – From FY 2002-03 through 2004-05, the County of San Diego estimated load reductions resulting from BMP implementation at construction sites. Because of the extremely large number of permitted sites open throughout the year, the County determined that the collection and analysis of detailed site-specific data and information would generally be infeasible. Instead, the County employed a less direct approach of estimating levels of site protection and projecting loading rates before and after BMP implementation. In other words, reductions were calculated as the difference between completely unprotected and completely protected sites. This analysis exercise was somewhat static in that it relied heavily on the use of literature values and assumptions about site conditions.

practicable, and to ensure that these discharges do not cause or contribute to violations of water quality standards in receiving waters. In many respects, Level 5 Outcomes are the most direct expression of successful program implementation. They may be measured as reductions in one or more specific pollutants, and may reflect effectiveness at a variety of scales ranging from site-specific to programmatic.

Level 6: Protecting Receiving Water Quality. The ultimate objective of stormwater management programs is the protection of water bodies receiving discharges from MS4s. Changes to receiving water

-- Assessing Level 5 Outcomes --
Improving Runoff Quality

Measuring changes in the quality of urban runoff and conveyance system discharges (before the water reaches receiving waters) is possibly the most direct expression of program effectiveness.

Davis Healthy Gardens Outreach Program – Pesticide levels in runoff from a residential outfall decreased over the same time frame that the Healthy Gardens Outreach Program was implemented in Davis, California. In general, spatial and temporal variability in pollutant concentrations in stormwater make it difficult to establish such cause and effect relationships. In this example, it was possible to isolate a residential area in Davis that had been targeted by the outreach program. This is not always the case. Outfalls typically drain large urbanized areas and the effects of activities and programs implemented are generally not seen in discharge quality measurements.

Ventura Countywide Stormwater Quality Management Program trend analysis - Ventura County has been able to assess long term impacts based on trend analysis. In 2003, all runoff monitoring data collected since 1993 was used to evaluate trends in water quality. While some organics and metals appeared problematic at sampling locations throughout the watershed, the number of detected organics had decreased significantly since the Program was implemented. More importantly, an analysis of Pollutants of Concern (POCs) showed that Sediment/Total Suspended Solids (TSS), initially identified as a POC in 1998, was no longer of concern. This improvement was attributed to the efforts of the copermittees to decrease sediment contributions from construction sites to stormwater runoff. In addition, Mercury and PAHs were no longer top-ranked POCs.

and environmental quality may be expressed through a variety of outcomes such as compliance with regulatory benchmarks, protection of biological integrity, and beneficial use attainment. Regardless of the outcomes targeted, it is useful to keep in mind that receiving water quality often reflects more than the quality of stormwater discharges alone.

D. Assessment Measures and Methods

Once the desired outcomes of program implementation have been clearly defined, specific measures and methods can be developed for evaluating success in achieving them. **Assessment Measures** are established to determine whether or how successfully a

-- Assessing Level 6 Outcomes --
Protecting Receiving Water Quality

Improvements in environmental and water quality represent the ultimate goal of stormwater programs. Observable changes in receiving waters may require long time frames to be measurable.

Lead reductions in gasoline – Lead levels in gasoline were reduced by greater than 90% in the 1980s. This drastic source control action cascaded through the environment as evidenced by an approximate reduction of 90% in lead levels in air by the 1990s. Similarly, there has been an approximate 90% reduction in lead–related lung diseases and approximate 90% reduction in lead levels in runoff. As is often the case with environmental improvements resulting from source control, the time frame over which this was observed was several years.

Diazinon phase-out – In the mid-1990's aquatic toxicity in San Francisco Bay Urban Creeks was substantial and linked to relatively high concentrations of the organophosphate pesticide diazinon. Consequently, these creeks were listed as impaired on the 303(d) list as impaired. To address this impairment, wastewater and stormwater programs throughout Northern California conducted extensive outreach and education programs regarding the impacts of diazinon and alternative pest control methods. In addition, the wastewater and stormwater programs worked with EPA, Department of Pesticide Regulation, and the diazinon manufacturers to identify solutions to the impairment. In 2000, the USEPA announced the phase out of diazinon products and since then, the amount of reported diazinon applications has decreased substantially. In turn, aquatic toxicity and diazinon concentration in urban creeks have decreased dramatically.

programmatic or water quality outcome has been achieved. They may be qualitative (e.g., yes / no) or quantitative (% of targeted audience reached, % reduction in a constituent level, etc.). All priority outcomes should have at least one assessment measure associated with them, but some may have multiple measures. As discussed in Section B above, assessment measures can be focused on implementation or water quality assessment.

They should be selected based on their ability to provide useful information to the program manager. Attributes of an ideal assessment measure include:

- Measurability (statistically measurable on a frequent basis)
- Relevance (significant, demonstrable relation to strategy and objectives)
- Reliability (easily documented and reproducible)
- Availability (based upon data obtainable at reasonable cost)
- Scientific Validity (based on sound science)
- Replicability (capable of being regularly updated)
- Appropriate Focus (ideally measures outcomes, not inputs or outputs)

As noted above in the discussion of outcome levels, some effectiveness measures are based on assumptions and will have significant uncertainties associated with them. Other measures may be more statistically significant, allowing assessment of central tendencies (e.g., mean or median values) and data variability (e.g., standard deviations). Clearly, measuring the impact of stormwater programs is much easier and more meaningful if baseline levels can be established. It is therefore useful to evaluate available data at each outcome level prior to implementing a program (e.g., awareness levels before an outreach campaign is conducted, water quality before a series of BMPs is implemented). Example assessment measures are listed in Table 1 and are categorized by assessment method.

Assessment Methods are the specific activities, actions, or processes used to obtain and evaluate assessment data or information. Depending on the particular outcome in question, numerous assessment methods may be possible. Reasons for selecting a particular method include cost, ease of use, need for statistical rigor, applicability, and clarity in communicating progress to the general public. For example, headline indicators are objective measurements that reflect in simple terms how a stormwater program is progressing towards its goals. They are based on fundamental factors determining environmental quality and how easily they are understood. Many types of assessment methods can be used, including the following activities:

- **Confirmation** consists of documenting whether an activity or task has been completed. It is always expressed as a positive or negative outcome (i.e., yes or no), and should be used almost exclusively at Outcome Level 1.

Table 1 -- Examples of Assessment Methods and Measures by Outcome Level

	Outcome Level	Assessment Method Type	Assessment Measure Type	Examples
1	Documenting Activities	Confirmation	o Task completion (Y/N)	o Completed update of source inventory
		Tabulation	o Implementation (# or %) o Change	o Number of inspections completed o Increase since 2001
2	Raising Awareness	Survey	o Knowledge	o Knowledge of storm drain vs. sanitary sewer
		Tabulation	o Change o Action o Change	o Increase in awareness since last survey o Number of hotline calls/ website hits o Increase over last year
3	Changing Behavior	Inspection	o Implementation (# or %) o Change	o Installation of berms around trash areas o Increase since beginning of program
		Reporting (discharger)	o Implementation (# or %) o Change	o Installation of storm drain inserts o % increase
		Reporting (3rd party)	o Implementation / non-compliance (# or %) o Change	o No. of Complaints reported o Decrease since beginning of program
		Survey	o Implementation (# or %) o Change	o No. of people picking up pet waste o Increase over last year
4	Reducing Loads from Sources	Quantification	o Loading o Change	o Copper released from brake pads o Decrease since 1996
		Monitoring (Sampling)	o Loading o Change	o Diazinon loading from lawns o Decrease since 2002
5	Improving Runoff Quality	Monitoring (Sampling)	o Benchmark	o Comparison of Cu to Water Quality Objective
			o Loading o Change	o Phosphorous loading to MS4 o Increase since 1993
			o Concentration o Change	o TSS levels in runoff o Increase since 1995
6	Protecting Receiving Water Quality	Monitoring (Sampling)	o Benchmark	o Comparison of Zn to Water Quality Standard
			o Concentration	o Nitrate concentration in Rainbow Creek
		Monitoring (Observation)	o Biological condition o Physical habitat	o Stream biodiversity o Scouring of Stream bank
			o Biological condition o Physical habitat	o Loss of riparian canopy o Erosion of stream bank

- **Tabulation** consists of simple accounting, and can be expressed in both absolute (e.g., the number of people participating in an event) and relative terms (e.g., percent increase in pounds of household hazardous waste collected). Tabulation is an extremely common and useful method for assessing activities at Outcome Levels 1 through 3.

- **Surveying** encompasses a variety of methods (e.g., random-digit-dial phone surveys, intercept surveys in a shopping mall) designed to discern the knowledge, attitudes, awareness, or behaviors of a specific population (residents, schoolchildren, automotive enthusiasts, etc.). Surveys vary greatly in the degree to which they are quantitative and statistically valid. Surveys are applicable for Outcome Levels 2 and 3.

- **Quantification** applies primarily to Outcome Levels 4-6 and refers to efforts to quantify reductions in loading or runoff discharges, or to improvements in environmental quality. Often, particularly at Outcome Level 4, quantification requires the use of estimates that are based on various untested assumptions. Estimation will remain a highly utilized method until many of these assumptions can be verified or refined.

- **Inspections or Site Visits** include any method utilized to directly observe or assess practices used by a targeted audience. They may be regulatory or conducted as part of an information gathering exercise or educational outreach effort. Inspections may be proactive or reactive. Proactive, or scheduled, inspections are most commonly conducted to assess practices at commercial or industrial facilities, construction sites, and municipal facilities. In addition to each of these source types, reactive, or complaint-initiated, inspections are also conducted at residences in addition to commercial and industrial sites.

- **Reporting** is the receipt of implementation, compliance, or other assessment-related information generated by parties other than stormwater program staff. This may include discharger reporting or third party audits.

- **Monitoring** is the measurement of environmental or water quality conditions, including changes over time. Monitoring methods apply exclusively to Outcome Levels 4, 5, and 6. Monitoring is accomplished through sampling or through observation. Sampling includes collecting water, sediment, or biota in order to directly measure pollutant levels in the environment. Observation includes visual surveys of habitat condition and the use of remote sensing to assess environmental conditions such as vegetative cover or imperviousness.

E. Effectiveness Assessment Needs and Future Directions

The mission of the CASQA Effectiveness Assessment Subcommittee is to continue developing consensus on general approaches, and to further the development of specific tools that will improve the state-of-the-art in this field. Stormwater program managers need guidance on which assessment methods are effective and how to use them to ensure that useful information will be obtained. To evaluate managers' needs, a survey of CASQA members was conducted in 2005. Survey findings, which continue to inform the direction of the Subcommittee, include the following:

- The most common reason stormwater management programs conduct effectiveness assessments is to demonstrate compliance with NPDES permit requirements, but several programs reported using assessment results to plan their program activities.

- Although most stormwater NPDES permits include direct measures of effectiveness, management programs predominantly rely on the use of indirect measures. In particular, programs are most likely to measure the implementation of program elements rather than the impacts resulting from them.

- Managers need guidance across all program elements and outcome levels (e.g., methods to measure pollutant load reductions, changes in public knowledge and awareness, stormwater discharge quality, and behavioral change and BMP implementation). Respondents indicated a particularly strong need for additional guidance on assessing post-construction stormwater runoff, water quality monitoring, and watershed health.

As noted, there are certain levels at which evaluation is difficult due to resource limitations or the complexity of the measurement needs. Certain evaluation measures, particularly those associated with monitoring or measurement over long time frames, would benefit from development and research conducted on a regional or statewide level. Identification of these evaluation measures, approaches to developing such measures so they are more widely useful, and identification of funding mechanisms to facilitate their development, may be appropriate tasks for CASQA or other organizations with similar interests or goals.

Processes and methods for conducting integrated assessment need to be established. As noted above, assessment methods at higher outcome levels (i.e., levels 4-6) may be costly and require longer timeframes. The cost-effectiveness of assessment is a

critical factor. Assessment tools that are more costly than the program or activity being evaluated are not practical. Therefore, efforts to pool resources and to develop low cost tools are needed. It may be possible to identify correlations between effective implementation and water quality improvement. This would allow program managers to use implementation assessments (which are simpler and less costly) as indicators of water quality and environmental improvement. Approaches to more definitively linking stormwater program implementation to resulting environmental improvements may also benefit from a regional or statewide approach making this another potential future priority.

Future efforts should include the following:

- Ongoing development and updating of guidance documents and materials as necessary to facilitate the continued improvement of effectiveness assessment methods, measures, and approaches.

- Identification of cost-effective approaches to assessment measurement. One of the critical roles of assessment measurement is to assist program managers in optimizing their resources when developing successful programs.

- Development of cost-effective water quality assessment tools. Most stormwater programs are required to directly measure improvements in water quality. However, this type of assessment is conducted to a far lesser extent than implementation assessment, often due to a lack of readily available and understandable methods.

- Creation of opportunities for stormwater programs to pool their resources to develop the tools, data, and information needed to assess program costs effectively. Specifically, statewide efforts should be initiated to develop the methods needed to correlate water quality and environmental assessment with implementation assessments.

EXCERPT ONLY

MAY 2007

CALIFORNIA STORMWATER QUALITY ASSOCIATION

Municipal Stormwater Program Effectiveness Assessment Guidance

Industrial/
Commercial

Public Education

Municipal
Operations

Illegal Discharges/
Illicit Connections

New Development

Construction

The Municipal Stormwater Program Effectiveness Assessment Guidance document (Guidance document) is an evolving document. As municipalities complete annual program assessments, additional data will become available that will assist in verifying links between program wide Best Management Practice implementation, stormwater generated pollutant load reduction, and eventual receiving water quality improvements. The California Stormwater Quality Association encourages users of the Guidance document to provide general feedback regarding the utility of the document, submit program effectiveness assessment results, and program success stories for inclusion in future updates of the Guidance document.

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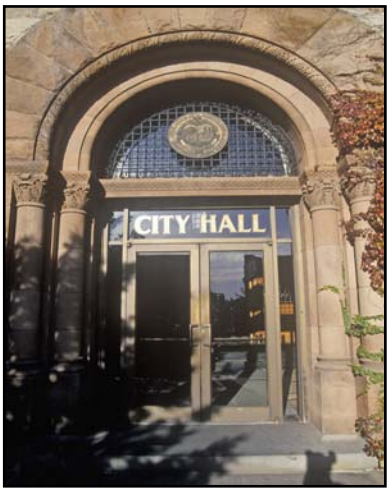
Municipal Operations Program Element



Applicable Outcome Levels	
Level 1 – Documenting Activities	x
Level 2 – Raising Awareness	x
Level 3 – Changing Behavior	x
Level 4 – Reducing Loads from Sources	x
Level 5 – Improving Runoff Quality	*
Level 6 – Protecting Receiving Water Quality	*

*Levels 5 & 6 discussed in Section 6

PURPOSE OF PROGRAM ELEMENT

Municipalities conduct various activities that can generate or mobilize pollutants in stormwater runoff. The purpose of the Municipal Operations Program Element is to reduce pollutants from these operations and maintenance activities (e.g. small construction improvement projects, street sweeping, storm drain cleaning, corporation yard operation, etc.) through the development and implementation of control measures and best management practices. In addition, storm drain maintenance field crews are responsible for flood control and customer complaint issues. These tasks are generally accomplished by incorporating the following control measures into the local Stormwater Management Plan (SWMP):

- Pollution prevention measures at corporation yards / municipal facilities.
- Storm drain system maintenance
- Street sweeping and maintenance
- Parking lots maintenance
- Maintenance of regional/municipal BMPs
- Landscape and pest management including pesticide/herbicide management
- Sanitary sewer overflow response and prevention
- Pollution prevention measures at municipal construction sites
- Education and training

Most municipal stormwater programs incorporate the above control measures and related performance standards as a part of a comprehensive Municipal Operations Program Element within the SWMP. This fact sheet identifies how stormwater program managers can:

- Establish Effectiveness Assessment Goals and Baselines;
- Select Effectiveness Assessment Methods; and
- Analyze the Data and Present the Information

ESTABLISHING EFFECTIVENESS ASSESSMENT GOALS AND BASELINES

Assessing the effectiveness of a stormwater program starts with the process of program planning and developing associated control measures, performance standards and identifying desired goals/outcomes. Examples of Goals and Outcomes for the Municipal Operations Program Element by Outcome Level are provided below.

Outcome Level	Goal	Example Outcomes
1 – Documenting Activities	Program development and implementation and basic compliance with the NPDES permit requirements.	• Perform street sweeping at a defined frequency and coverage • # of storm drain inlets cleaned • # of responses to complaints/ flood notifications
2 – Raising Awareness	Raise a target audience's awareness and understanding of an issue	• Develop a Facility Pollution Prevention Plan (FPPP) for Corporation Yard • % field maintenance staff who understood training concepts
3 – Changing Behavior	Change a target audience's behavior which results in the implementation of recommended BMPs	• Implementation of FPPP at corporation yard. • Proper handling and disposal of street sweeping waste.
4 – Reducing Loads from Sources	Reduce the load of pollutants from sources to the storm drain system	• Estimates of pounds of pollutant removed by cleaning of storm drain inlets and sumps • Tons of dry waste removed from street sweeping

For new programs seeking to evaluate municipal operations management tasks, the early focus should be on identifying and categorizing all municipal facilities and activities and establishing baseline numbers for a variety of activities related to each task (e.g. tracking the number of curb miles swept, catch basins cleaned, field maintenance staff compliance with erosion and sediment control BMPs, parking lot cleaning frequency, etc.). These numbers will not mean much in the first few years but establishing these baseline numbers will be valuable when they are compared year to year as the program develops.

Additionally, it is important to identify how these numbers will be related to other assessment methods. For example, it may be possible to connect the number of municipal facility inspections conducted (Level 1) with an increase in staff understanding about stormwater regulations as they relate municipal operations (Level 2) or increases in the number of BMPs implemented (Level 3). For programs that may already have some existing data these data can be used to determine the appropriate baseline amounts by which future reductions can be measured. Survey results and ride alongs with field maintenance staff may also serve as a way to establish baseline information on current knowledge and practices of municipal staff.

Another important goal of this program element is educating municipal employees. Exams and survey results may serve as a way to establish baseline information on current knowledge and practices.

Some example goals, targets (where applicable) and projected timeframes are identified below. The targets and goals in the table below are examples. Each stormwater program will need to decide what goals and targets are most applicable to their program.

Goals	Target	Projected Timeframe
Change a target audience's behavior which results in the implementation of recommended BMPs – Increase the implementation of proper protocols for storm drain cleaning.	All (or some feasible annual percentage) storm drains are inspected and cleaned consistent with prioritized schedule.	Within 2 years
Reduce the load of pollutants from sources to the storm drain system – Decrease chemical use for landscape maintenance.	Decrease pesticide use by 20% (taking in to account weather patterns and other factors) in targeted locations.	Within 3 years

The following questions may also be used to assist in identifying/ establishing goals and baselines:

- Is the program element/control measure being implemented in accordance with the Permit Provisions, SWMP control measures and performance standards (Level 1 Outcome)?
- Does the program element/control measure raise the target audience's awareness of an issue (Level 2 Outcome)?
- Does the program element/control measure change a target audience's behavior which will result in the implementation of recommended BMPs (Level 3 Outcome)?
- Does the program element/control measure reduce the load of pollutants from the sources to the storm drain system (Level 4 Outcome)?

SELECTING EFFECTIVENESS ASSESSMENT METHODS

An assessment strategy consists of defining desired Outcomes (goals/objectives), identifying applicable Outcome Levels, selecting assessment methods and comparisons to baseline conditions. Since, for a given program element, there may be more than one Outcome Level to be evaluated, there are a variety of assessment methods that should be utilized. Although the assessment will vary from one program to another, several assessment methods are presented below that may be used for a typical municipal operations program.

Task	Data Collected	Outcome Level	Assessment Method and Comparison with Goals and Baselines
Pollution Prevention at Municipal Facilities			
Implement pollution prevention measures at corporation yards and/or municipal facilities	Develop Facility Pollution Prevention Plan (FPPP) for site.	1-2	Confirmation • Confirm that FPPP was developed and present on site. • Identify if audit/inspection was conducted Tabulation • #, type, and location of BMPs • # and type of non-stormwater discharges • # non-stormwater discharges eliminated Inspections • Identify # BMPs implemented and maintained, % year to year
	Identify pollutant generating activities and develop site map	2	
	Implement BMPs for pollutant generating activities.	3	
	Identify and eliminate non-stormwater discharges	2-3	
	Conduct audit of site for conformance with stormwater management plan.	1-3	
Storm Drain System Maintenance			
Inventory drainage system (by drainage area or sub-watershed)	Develop inventory/map of drainage system. Identify the location and size of drainage system including catch basins, pump stations, detention basins, etc.	1	Confirmation • Identify that the inventory was developed Tabulation • Identify total # catch basins and number directly draining to receiving water • Provide map of drainage system
	Compile cleaning records for drainage system	1	
Prioritize drainage system by threat to water quality for cleaning purposes	Quantify drain system for cleaning frequency	1	Confirmation • Identify that prioritization was completed Tabulation • Identify linear feet of drain pipe, # of catch basins and pump stations for high, medium, low priority cleaning • Provide map overlay of prioritized areas

Task	Data Collected	Outcome Level	Assessment Method and Comparison with Goals and Baselines
Storm Drain System Maintenance, continued			
Develop and implement cleaning schedule and protocols	Develop protocols for cleaning	1-2	Confirmation • Identify that protocols were developed Tabulation/Quantification • # cleaned and estimate of waste removed.
	Number of catch basins, drain pipe, pump stations, etc. cleaned	2 – 4	
Street Sweeping and Maintenance			
Inventory street cleaning program (by drainage area or sub-watershed)	Location and frequency of street cleaning.	1	Confirmation • Identify that the inventory was developed Tabulation • Provide map overlay of street cleaning areas
	Compile street sweeping records	1	
Prioritize streets by threat to water quality and aesthetics for cleaning purposes	Prioritize street segments and corresponding cleaning frequency	2	Confirmation • Identify that prioritization was completed Tabulation • Identify # of streets/segments proposed for prioritized cleaning.
Develop and implement cleaning schedule and protocols	Develop protocols for cleaning	2	Confirmation • Identify that protocols were developed Tabulation • # street miles cleaned Quantification • Estimate of waste removed. • Quantity of material collected per mile Monitoring • Discharge quality (reduced TSS or other constituents)
	Number of street miles cleaned	3	
	Estimates of waste removed through implementation of program	4	
	Improvement in runoff/ MS4 discharge quality	5	

Task	Data Collected	Outcome Level	Assessment Method and Comparison with Goals and Baselines
Parking Lot Maintenance			
Develop inventory of parking lots	Number, size, and type of parking lots	1	Confirmation • Identify that the inventory was developed Tabulation • Provide map overlay of area maintained
	Determine frequency of cleaning	2	
Develop and implement cleaning schedule and protocols	Develop protocols for cleaning	2	Confirmation • Identify that protocols were developed Tabulation • Area of parking lot cleaned and estimate of waste removed. Quantification
	Quantify area cleaned	3	
	Estimates of waste removed through implementation of program	4	
Landscape and Pest Management			
Develop pesticide, herbicide, and fertilizer application protocols	Develop application protocols for municipal staff and contractors	1-2	Confirmation • Verify that protocols were developed • Audit implementation by contractors Tabulation • #s materials applied and total acreage Inspections • Identify if protocols were implemented Quantification • Estimates of materials applied and reductions over time
	Track annual use of herbicides and pesticides by active ingredient and total area for application	2 - 4	
	Track annual use of fertilizers by element (e.g. nitrogen) applied and total area for application	2 - 4	
	Audit implementation of protocols	3	
Develop and implement integrated pest management program	Develop IPM strategy/protocols for municipal staff and contractors	1-2	Confirmation • Verify that protocols were developed Tabulation • Track IPM use by total area applied and types of IPM • Provide map overlay of areas Inspections • Identify if protocols were implemented
	Track areas and types of IPM measures that are being implemented	2 - 3	

Task	Data Collected	Outcome Level	Assessment Method and Comparison with Goals and Baselines
Landscape and Pest Management, continued			
Develop and implement green waste reuse and erosion control program	Implement program for force account work and contracted work	1	Confirmation • Verify that program was developed and implemented Tabulation • Tonnage of green waste used and percentage of open space with adequate erosion controls
	Track use (tonnage and area served) of green waste compost and implementation of erosion controls	3	
Sanitary Sewer Overflow Response and Prevention (for municipalities that own/operate sewage collection system); Response to Flood Control and other complaints.			
Develop and implement sanitary sewer overflow protocols	Develop sewage overflow response protocols	1-2	Confirmation • Verify that protocols were developed • Audit implementation of protocols Tabulation • Track locations and frequency of SSOs • Track calls and corresponding outreach effort or training program. • Track compliance rates with grease trap requirements Quantification • Estimate reduction of sewage discharge from implementation protocols.
	Track # hotline calls and public employee initiated calls regarding location, types and sources	2	
	Track SSO spill estimates and identify amount captured and returned to the sewer system, amount to storm drain and amount to receiving waters	3 - 4	
	Conduct sewer system analysis and identify, if appropriate, Capital Improvement Program for correction of capacity limitations	2	
	Restaurant/ grease trap inspections	3	

Task	Data Collected	Outcome Level	Assessment Method and Comparison with Goals and Baselines
Pollution Prevention at Municipal Construction Sites			
Require municipal capital improvement projects (CIP) to comply with New Development standards	Track review of CIP with New Development Standards	1-2	Confirmation • Verify that standards are included in CIP review checklist • Audit implementation of standards Tabulation • Track % compliance of CIP with standards
	Track CIP compliance with New Development Standards	3	
Require municipal construction projects to comply with construction general permit	Track review of CIP with construction general permit requirements	3	Confirmation • Verify that general permit requirements are included in CIP review checklist • Audit implementation of requirements Tabulation • Track % compliance of CIP with requirements • Identify common non-compliance issues
	Inspect CIP compliance with construction general permit	3	
Develop minimum erosion and sediment control measures for small force account projects.	Establish control measures (BMPs)	2	Confirmation • Verify that control measures were developed Tabulation • Track % compliance of projects with measures • Identify common non-compliance issues
	Inspect projects for conformance with control measures	3	

Task	Data Collected	Outcome Level	Assessment Method and Comparison with Goals and Baselines
Education and Training			
Provide reference material for municipal field staff based on involvement in activities listed above	BMP fact sheets/protocols developed	1	Confirmation • Identify that the BMP Fact Sheets were developed • Used survey results to modify/improve the fact sheets Surveys • % increase in awareness before and after fact sheets
	BMP fact sheets distributed	2	
	Survey users regarding usefulness of educational materials	2	
Conduct training modules for municipal staff involved in activities listed above	Training modules developed	1	Confirmation • Identify training modules were developed Tabulation • Identify # attendees at training sessions • Results from evaluation forms, quizzes Surveys • % increase in awareness before and after the training • % awareness from year to year
	Number of attendees at training session(s)	1	
	Results of evaluation forms from attendees (was presentation effective?)	2	
	Results from classroom and/or field quizzes	2	
	Percent improved based on scores from before and after survey/quiz	2	

ANALYZING THE DATA AND PRESENTING INFORMATION

Analyzing the data assists stormwater program managers in assessing the effectiveness of the Municipal Operations Program tasks and determining what changes to the program are necessary. Analyses range from documenting program implementation, determining trends that assist in modifying programs to address targeted audiences, and estimating pollutant load reductions.

Data Analysis

Assessment results can be evaluated directly by compiling the information collected, by comparing and grouping results, or analyzing trends over time.

Direct Compilation

Direct compilation of information from an assessment of Municipal Operations Program control measures may include the following types of results:

- The number of street miles cleaned (Level 1)
- An increase in planning level review of CIP with new development standards (Level 2)
- Increases in the number of municipal construction sites implementing and maintaining BMPs (Level 3)
- Estimations of the pollutant load reductions from storm drain system cleaning (Level 4)

Comparisons

Results can also be evaluated by making comparisons. For example:

- Is there a relationship between proper implementation of BMPs at a municipal facility and an audit of the facility?
- Does implementation of new development standards for CIP relate to the training of plan checkers?

Another comparison that is useful for municipal operations is comparing BMP implementation to load reductions. If municipal operations are properly implementing BMPs there should be a direct connection with Level 4 Outcomes. For example, a decrease in loads should be apparent from the storm drain system due to catch basin cleaning.

Groupings

Information can be grouped to optimize program implementation. For example, the municipal storm drain system can be grouped by size of pipe, land use, soil surrounding soil conditions, geographic location, sub-watershed. Can BMPs be optimized based on the characteristics of the storm drain system? This can direct future program efforts to focus on that particular area.

Trend Analysis

Results can also be evaluated over time. Many of the assessment methods should be analyzed from year to year to evaluate and identify possible trends. Some examples include:

- Tracking the number of attendees at training sessions from year to year
- Tracking the percentage of CIP in compliance with construction general permit
- Determining if the rate of storm drain cleaning protocols are being followed

Presentation

Results of effectiveness assessments are used to evaluate a program or control measure's progress toward achieving goals and to present the results to interested parties including regulators, the general public, and/or public officials. Presentations of the data analysis results using graphics should be developed and included in annual reports to the Regional Board or in press releases or other types of communications to the public to identify how the stormwater program has been effective.

Outcome Level 1 – Documenting Activities

Many control measures are either prescribed by or established as a result of NPDES permit requirements. Level 1 Outcomes provide program managers with feedback on how well the development and implementation of the SWMP is progressing and whether targeted goals and objectives are being met. Indicators of effectiveness with respect to documenting BMPs would include confirmation that guidance has been developed and that training sessions have been conducted.

San Joaquin County Stormwater Program – The San Joaquin County municipal stormwater program implements a comprehensive municipal operations program to ensure that the operations and maintenance activities are performed in a way that minimizes the pollutants generated. As a part of the program they track a number of parameters to assist them in identifying if the program is being implemented in accordance with the SWMP and related performance standards. A few of the parameters that they track include the following:

Landscape and Pest Management

- *The development and implementation of protocols for the use of pesticides, herbicides, and fertilizers.*
- *Total number of acres treated with pesticides, fertilizers, and under the IPM program*
- *Total pounds of nitrogen, phosphorous, and active pesticide ingredient applied*
- *Types of IPM practices conducted*
- *Storm Drain System Maintenance*
- *Total number of catch basins and number of high and low priority basins*
- *Number of catch basins inspected and number of catch basins cleaned*
- *Amount (cubic yards) of material/debris removed from the catch basins*
- *Total number of catch basins stenciled to date, for the first time and re-stenciled*

In addition to tracking this information and reporting the results on an annual basis they also look at trends from year to year to determine if progress is being made and/or if modifications are necessary.

(Source: 2005-2006 Annual Report, Section 4 Municipal Operations. For more information visit the County of San Joaquin website http://www.co.san-joaquin.ca.us/pubworks/STORM%20WATER/StormwaterHomePage.htm)

Outcome Level 2 – Raising Awareness

An important goal of the stormwater program is to increase the level of knowledge and awareness among target audiences such as residents, businesses and municipal employees. Level 2 Outcomes provide program managers with feedback on how effective various control measures have been in raising awareness and changing attitudes of the target audiences. Assessment may be accomplished by tracking actions taken by municipal staff or in response to municipal staff efforts that indicate knowledge and awareness of requirements. Quizzes at training sessions can assess understanding of program requirements. Evaluation forms can assess a training program's effectiveness in increasing awareness or knowledge.

San Joaquin County Stormwater Program – The San Joaquin County municipal stormwater program implements a comprehensive municipal operations program to ensure that the operations and maintenance activities are performed in a way that minimizes the pollutants generated. As a part of the program they track a number of parameters to assist them in identifying if the program is increasing the awareness of municipal staff involved in the program. One way that they identify awareness is by tracking the implementation of the construction requirements for the municipal capital improvement projects.

The County requires that all capital improvement projects must be reviewed by stormwater staff to ensure that the construction BMPs and new development standards are incorporated during the design stage. As such, the County tracks the following:

- *Total number of CIP plans reviewed*
- *Total number of CIP plans requiring revisions*
- *Total number of active public construction sites*
- *Total number of active public construction sites > one acre*
- *Total number of active public construction sites that submitted a Notice of Intent (NOI)*

Since 2003 all of the construction projects ≥ one acre had submitted a copy of the NOI. During 2004-2005 42% of the CIP plans reviewed required revisions. However, during 2005-2006 only 25% of the CIP plans reviewed required revisions. These two parameters indicate that County staff involved in the design and construction of the County CIP projects are aware of the program requirements and are implementing the necessary BMPs and that the overall awareness of the staff is increasing.

(Source: 2005-2006 Annual Report, Section 4 Municipal Operations. For more information visit the County of San Joaquin website http://www.co.san-joaquin.ca.us/pubworks/STORM%20WATER/StormwaterHomePage.htm)

Outcome Level 3 - Changing Behavior

A key focus of the stormwater management program is to effect changes in behavior. Level 3 Outcomes provide program managers with feedback on how effective the program has been in motivating target audiences to change their behavior and implement appropriate BMPs. Many control measures of a municipal program can be assessed through inspections. Compliance rates observed during inspections/audits and the need for and results of follow-up inspections are the most often used tools. Municipal operations may be assessed based on area covered; for example the acreage being treated by a structural BMP. Street sweeping may be assessed by street miles covered or frequency of street sweeping. Pest management programs may be assessed based on acreage covered by less toxic methods.

Fresno Metropolitan Flood Control District assesses its corporation yard compliance using site inspection results. For example, since 2002, Fresno has observed an increase in BMP implementation in their corporation yard and a decrease in the number of areas needing additional source control BMPs.

(Source: 2005-06, Fresno/Clovis Storm Water Quality Management Program Annual Progress Report - Section 2- Illicit Discharge. For more information contact FMFCD at info@ fresnofloodcontrol.org)

City of Sacramento Stormwater Quality Improvement Program - Sacramento uses field maintenance ride-alongs to assess the level of compliance by field crews. As a result, the City determined that 50% o f the municipal maintenance sites are in compliance. Specific instances of compliance and non-compliance were documented through photographs.

(Source: City of Sacramento Municipal Operations Training Effectiveness Evaluation. Presented at CASQA conference, October 5,2006)

Outcome Level 4 – Reducing Loads from Sources

If a large enough portion of the target audience is motivated into taking action and implementing BMPs, loads into and from the storm drain system are prevented. Level 4 Outcomes provide program managers with feedback regarding reductions in the amounts of pollutants associated with proper implementation of BMPs or maintenance protocols.

The Santa Clara Valley Water District evaluates its channel desilting program at this Outcome Level based on cubic yards of sediment removed. The amount removed from 1996 to 1999 ranged from 2,900 cubic yards to 132,300 cubic yards annually.

Source: Santa Clara Urban Runoff Pollution Prevention Program; www.scvurppp.com/pdfs/0506/exec_sum_fy04

Contra Costa Clean Water Program (CCWP) - The Contra Costa Clean Water Program track the amount of street sweeping waste collected and estimate specific pollutant removals. It estimates the mass of copper, nickel, zinc and petroleum hydrocarbons removed each year through street sweeping activities. Typical concentrations values for these pollutants were established through field sampling and laboratory analysis. The volume of street sweeping material removed by each municipality is recorded monthly. These data are combined to estimate the mass of pollutants removed annually by this activity. Pollutant removal via street sweeping has been steady for over five years.

(Source: Contra Costa Clean Water Program (2006). Fiscal Year 2005-2006 Annual Report Submittal. Volume I. Martinez, CA)

REFERENCES

San Joaquin County Stormwater Program; http://www.co.san-joaquin.ca.us/pubworks/STORM%20WATER/StormwaterHomePage.htm

Fresno Metropolitan Flood Control District at info@fresnofloodcontrol.org

Santa Clara Urban Runoff Pollution Prevention Program; www.scvurppp.org

City of Sacramento Stormwater Quality Improvement Program; www.sacstormwater.org

Contra Costa Clean Water Program; www.cccleanwater.org