3. EVALUATION OF PROGRAM FOR MUNICIPAL SEPARATE STORM SEWER SYSTEMS

This chapter evaluates the impact of the municipal separate storm sewer system (MS4) portion of the Phase I storm water management program. In preparing this Report to Congress, EPA considered a number of special characteristics of the program:

- The Phase I program provides municipalities with the flexibility to develop storm water management programs that address local needs and priorities.
- Implementation of the Phase I program continues to mature, shifting in focus from discharges to prevention and minimization of water quality impacts.
- A significant component of the Phase I program philosophy is problem avoidance. For many municipalities, storm water management means minimizing the impacts of future urbanization by managing residential, commercial, and industrial development activities in ways that are less destructive to water quality.
- Storm water monitoring performed under the Phase I program helps municipalities identify where storm water is and is not causing water quality impairment, thereby helping municipalities focus their storm water management efforts.

Section 3.1 of this chapter describes the Phase I requirements for MS4s. Section 3.2 presents a description of the general methodology and primary data sources. Section 3.3 presents the specific methods used to determine the impacts and the results of these analyses. Section 3.4 presents the overall findings, including a discussion of program elements considered successful and those considered unsuccessful.

3.1 STATEMENT OF PHASE I REQUIREMENTS

The Storm Water Phase I Rule (55 FR 47990; November 16, 1990) requires all operators of medium and large MS4s to:

- Obtain a National Pollutant Discharge Elimination System (NPDES) permit for discharges from the MS4 to waters of the United States.
- Develop a storm water management program that minimizes the pollutant discharges of MS4s into local water bodies whether the pollutants originate from storm water runoff or originate from direct dumping into the MS4.

3.1.1 MS4s Regulated Under the Phase I Program

As defined in the final Phase I regulations and as codified at 40 CFR 122.26(b), an MS4 is:

- A medium MS4 if the system serves, or is located in an area with, a population between 100,000 and 249,999.
- A large MS4 if the system serves, or is located in an area with, a population of 250,000 or more.

In addition, municipalities with populations under 100,000 may be designated on a case-by-case basis by an NPDES permitting authority (due in part to their interconnectedness with either a medium or large MS4).

The Phase I rule lists the incorporated places and counties that meet the population thresholds for medium and large MS4s. These lists were recently updated to reflect 1990 Census figures as part of the Storm Water Phase II rulemaking effort (64 FR 68722; December 8, 1999). All MS4s listed are automatically designated by the Phase I rule as medium and large MS4s, and their operators are required to comply with the storm water permit application requirements of 40 CFR 122.22(d) to obtain an NPDES individual permit.[7]

Some municipalities listed in the rule as operators of medium or large MS4s have combined sewer systems where sanitary wastewater and storm water runoff are conveyed through a single set of pipes to a publicly owned treatment works (POTW). Since the Phase I program for MS4s applies only to separate storm sewer systems, an MS4 is regulated by Phase I only if there is a separated portion of the system that serves more than 100,000 people.[8]

3.1.2 Permit Application Requirements For Medium And Large MS4s

EPA's approach for controlling discharges from MS4s focuses on development and implementation of a local, site-specific storm water management program. The resulting permit application requirements (found at 40 CFR 122.26(d)) reflect this approach and solicit information from the Phase I municipality related to the establishment of such a locally based program. The specific application requirements are divided into two parts. A Part 1 application contains several components:

- General information (name, address, etc.);

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[7]The final storm water Phase II rule freezes the definition of medium and large MS4s at those that qualify based on populations from the 1990 Census. In other words, the list of MS4s affected by the Phase I program requirements, will not change to reflect newer Census data in the future.

[8] Combined sewer systems are addressed in EPA's National Combined Sewer Overflow (CSO) Control Policy, issued on April 19, 1994 (59 FR 18688).

EPA requirements for an MS4 storm water management program include the development of measures that will:

- Identify major outfalls and pollutant loadings
- Detect and eliminate non-storm water discharges to the storm sewer system
- Reduce pollutants in runoff from industrial, commercial and residential areas
- Control storm water discharges from new development and redevelopment areas
- Meet the standard of "reducing pollutants to the Maximum Extent Practicable (MEP)."

- Description of existing legal authority to control discharges to the MS4 and any additional authorities needed (e.g., interagency agreements for joint applicants).
- Source identification information, including a topographic map, a description of historic use of ordinances or other controls that limited the non-storm water discharges to the MS4, the location of MS4 outfalls, the projected growth, the location of structural controls, and the location of waste disposal facilities.
- Discharge and representative outfall characterization (including mean monthly rain and snow fall estimates, field screening analysis for illicit connections, etc.) to assess the volume and quality of the storm water discharges), and identification of known water quality impacts associated with storm water discharges.
- Description of existing storm water management programs that prevent pollutants from entering the MS4 and identify non-storm water (illicit) connections to the system.
- Description of fiscal resources, including budget and resources for implementing storm water programs and for completing the Part 2 application.
- Characterization plan for further MS4 sampling under Part 2.

The components of the Part 2 application for MS4s include:

- Demonstration of adequate legal authority to control discharges, prohibit illicit discharges, require compliance, and carry out inspections.
- Source identification indicating the location of any major outfalls and identifying facilities that discharge storm water associated with industrial activity through the MS4.
- Discharge characterization data from representative locations in approved sampling plans.
- Description of the proposed storm water management program, including structural and source control measures, illicit discharge detection and removal, and construction site and industrial facility runoff monitoring and control.
- Measures to assess the effectiveness of the proposed storm water management program (including estimates of reduction in loadings of pollutants to the MS4 discharges).
- Fiscal analysis of necessary capital and operation and maintenance expenditures.

Medium MS4s were to submit their Part 1 applications to the NPDES permitting authority by May 18, 1992; applications for large MS4s were due November 11, 1991. Part 2 applications were to be submitted to the NPDES permitting authority within 1 year after submission of the Part 1 application (i.e., May 17, 1993, for medium MS4s and November 16, 1992, for large MS4s).

3.1.3 NPDES Permit Requirements

Once the NPDES permitting authority receives an MS4's Part 2 application, it issues an individual NPDES permit that incorporates the MS4's proposed storm water management plan. This permit requires implementation of the plan and may include other specific requirements necessary to ensure proper program management (e.g., conduct analytical monitoring and visual examinations). In addition, the Phase I rule specifically requires MS4s to submit annual reports that reflect the development of their local control programs. As stated in 40 CFR 122.42, the specific requirements for annual reports include.

- Status report on implementing the components of the local management program (as established in the NPDES permit).
- Proposed changes to the storm water management program and revisions, as necessary, to the assessment of controls and fiscal analysis reported in the Part 2 application.
- Summary of all data, including monitoring data, collected during the previous year.
- Annual expenditures and budget for the coming year.
- Summary of enforcement actions, inspections, and public education programs.
- Identification of water quality improvements or degradation.

The Phase I program acknowledges the inherent difficulty of regulating naturally occurring, episodic events and endeavors to provide the greatest degree of water quality protection with the least amount of regulatory burden. The requirement for MS4s to develop site-specific storm water management programs reflects that discharges from MS4s vary in their nature and impact on receiving water quality.

EPA expects that implementation of storm water management programs for Phase I MS4s will occur on a phased, iterative basis. On August 26, 1996, EPA published (61 FR 43761) a policy outlining an interim approach for incorporating water quality-based effluent limitations into NPDES permits. It allows the use of BMPs in the first round of storm water permits, followed by tailored BMPs as necessary in subsequent permits, to provide for attainment of water quality standards.

A recent U.S. 9th Circuit Court Decision *(Defenders of Wildlife* et al. v. *Browner,* 191 F.3d 1159 (9th Cir. 1999), as amended, 197 F.3d 1035) supports EPA's phased approach to regulating discharges from MS4s under the Phase I program. In summary, the permitting actions for several MS4s were challenged because the NPDES permits did not contain provisions requiring numeric limitations to ensure compliance with State water quality standards. Specifically, the decision stated that "EPA has adopted an interim approach, which uses best management practices (BMPs) in first-round storm water permits. . .to provide for the attainment of water quality standards."

3.1.4 Current Status of Phase I MS4 Program

As shown in Figure 3-1, 1,059 municipal operators comprise the “universe” of permitted or potentially permitted Phase I MS4s. Of these, 1,017 MS4s have been issued, or are in the final stages of being issued, a Phase I MS4 permit. Appendix A lists these MS4s. Of the remaining 42, 9 MS4s are nonparticipants and 33 were exempted from the program upon finding that they operated both combined and separate storm sewer systems and that the population served solely by the separate storm sewer system was less than 100,000.

Of the 1,017 MS4s participating in the program, 216 were originally part of the Phase I rule (i.e., those municipalities that were listed in Appendices F, G, H, and I of the regulation as operators of medium or large MS4s). The remaining 801 (79 percent) permitted MS4s were designated into the program. Of these, 670 were co-permitted with a larger MS4 or specifically designated by the NPDES permitting authority. In addition to these municipal MS4s, 131 special districts are permitted under the Phase I program. These special districts include flood control districts, port authorities, departments of transportation (highways) and recreation (parks), and universities.

<table>
<tr><td colspan="4">Total Number of Permitted or Potentially Permitted MS4s under the Phase I Storm Water Program:
1,059</td></tr>
<tr><td colspan="2">Number of MS4s Designated by the 1990 Phase I Report to Congress:
252</td><td colspan="2">Number of Additional MS4s Identified Under Phase I:
807</td></tr>
<tr><td>Number of MS4s Participating in the Phase I Program:
216</td><td>Number of MS4s Not Participating in the Phase I Program:
36
CSO Exemptions: 33
Nonparticipants: 3</td><td>Number of Additional MS4s:
675
Phase I Participants: 670
Nonparticipants: 5</td><td>Number of Special District MS4s:
132
Phase I Participants: 131
Nonparticipants: 1</td></tr>
</table>

Figure 3-1. Summary of Large and Medium MS4s Regulated under the Phase I Storm Water Program

3.2 ANALYTICAL APPROACH

This section describes the processes used to evaluate the municipal component of the Phase I storm water program. As described in Section 2.1 of this Report, EPA measured the success of the Phase I program by looking at three measures: programmatic indicators, loading reductions, and water quality improvements. In evaluating the Phase I program for MS4s in accordance with these three measures, EPA used case studies and survey data.

The case studies described throughout this chapter provide snapshots of lessons learned, efficiencies gained, and positive public reactions attributable to the Phase I storm water program. Many of the MS4 case studies were identified in the Natural Resources Defense Council report *Stormwater Strategies: Community Responses to Runoff Pollution* (NRDC, 1999). In addition, EPA performed extensive literature, periodical, and Internet searches to identify other MS4 case study candidates.

For the past year, EPA has been investigating ways to measure success under the municipal component of the Phase I storm water program. The Agency expanded on these ongoing efforts as a way to provide more specific MS4 storm water management program data and information for use in this Report to Congress. The MS4 indicators project involved a two-step process:

1. First, EPA identified a suite of environmental and program indicators that could be used to measure the effectiveness of municipal storm water programs. The indicators were to communicate information about the environment and about human activities, drawing attention to emerging problems and the effectiveness of current policies. EPA developed the proposed indicators based on interviews with knowledgeable local staff at 11 MS4 communities.

2. Second, EPA used the indicators identified to actually measure conditions before and after the Phase I permitting process was initiated. In this process, the Agency made every effort to isolate those influences attributable to the Phase I storm water permitting program, subtracting out wherever possible the influences of other environmental programs.

For this Report to Congress, EPA re-interviewed nine of the 11 Phase I municipalities to measure and report on actual progress under the storm water program using the indicators developed. The indicator survey therefore assesses conditions for approximately 3 percent of the current MS4 permits.[9] Although the sample is small, it provides a starting point for assessing the attitudes of the regulated community related to:

- Identifying components of municipal storm water management programs considered successful and yielding the highest environmental benefit.
- Identifying components considered unsuccessful or not expected to yield a benefit to municipal storm water management programs.
- What environmental protection has been added because of storm water permit requirements.

EPA collected two different types of information from the nine MS4s:

1. Information designed to assist with measuring of programmatic improvements and estimated water quality improvements based on the best professional judgment of the MS4s operators; and

2. Data on load reductions, past and present, attributable to municipal Storm water management programs. The difference in annual pollutant reductions before and after implementation of the Phase I permit program serves as an indicator of loading reductions attributable to Phase I.

Appendix B describes the type of information collected from each of the nine MS4s.

In support of EPA's efforts to evaluate the effectiveness of the Phase I storm water program, the National Association of Flood and Stormwater Management Agencies (NAFSMA) conducted a survey of local government agencies affected by the Phase I program. The survey specifically solicited input related to the effectiveness of MS4 programs in improving water quality. A copy of the Phase I NAFSMA survey form is provided in Appendix C.

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[9] The small sample size is necessitated by the short time frame established for this Report to Congress (which does not allow for a broader, more detailed survey requiring Office of Management and Budget approval under the Paperwork Reduction Act).

3.3 SPECIFIC METHODS AND RESULTS

This section describes the methods used for the analyses and presents the results.

3.3.1 Programmatic Indicators

In this section, EPA summarizes case studies to demonstrate how specific permittees are innovatively meeting permit requirements and how permittees are learning and improving upon their early efforts. Then the Agency presents results of two limited surveys of Phase I MS4 permittees to illustrate that the permit requirements have resulted in new environmental protection efforts and have improved on efforts predating the Phase I rule.

3.3.1.1 Case Studies

This section discusses case studies that stress activities of maturing storm water programs or those that have demonstrated innovation early in their programs. The program features highlighted are:

- Public support for new storm water programs.
- Planning to avoid or minimize environmental problems.
- Targeting pollutants of concern.

Table 3-1 summarizes each case study. Appendix D contains all of the case studies used for this Report, including those used in other sections.

Table 3-1. Summary of Program Improvement Case Studies Related to Storm Water Management

Case Study Location	Feature(s)
San Francisco, CA	Tracking pollutants back to the sources has required iterative sampling and good detective work.
City of Charlotte and Mecklenburg County, NC	Permit requirements led to a new program to protect surface waters. The public supports a strong storm water management effort.
Portland, OR	Dry-weather pollutant sources once unknown have been identified and addressed. City's survey of public indicates increased understanding of storm water quality and willingness to change behavior.
Montgomery County, MD	Investigation of the quality of natural resources helps in setting management priorities.
Prince George's County, MD	Changing land use patterns through zoning and development design minimizes environmental impacts.
Los Angeles, CA	Distinguishing between storm water pollutants that do and do not contribute to water quality problems helps set local priorities
Sacramento, CA	Constituent of Concern Reduction Program identifies and prioritizes specific parameters causing impairment

Public Support for New Storm Water Programs

Grass-roots community investment in storm water protection is a measure of community commitment and recognition of public need. Three case studies illustrate where new efforts by Phase I permittees have received public support and are being effective in controlling storm water pollutants.

In **Portland, Oregon**, businesses and citizens increasingly understand storm water quality issues and have shown a willingness to change their behavior to protect water quality. More than 500 property owners have voluntarily disconnected the downspouts from their roof drains to divert the water onto lawns instead of to storm drains. With 60 percent voter approval, Portland has established a $135.6 million bond measure to acquire up to 6,000 acres of land area to better manage sensitive watersheds and ensure better protection of urban waterways.

In **Monterey, California**, community grass-roots efforts have assisted in identifying and implementing the necessary storm water management controls to protect the Monterey Bay National Marine Sanctuary, one of the most diverse marine environments in the United States. Volunteers contribute, on average, an estimated 1,500 annual hours to monitor for unacceptable dry weather discharges to the MS4. These efforts are reducing the amount of pollutants entering the ocean. Although Monterey is a Phase II community, its successful efforts demonstrate how similar Phase I requirements can successfully protect sensitive water bodies.

The **City of Charlotte, North Carolina** (Phase I permittee) and **Mecklenburg, County, North Carolina** (Phase II permittee) have created a multifaceted program to protect their local water bodies. The program has gained wide public support. These entities have emphasized the importance of a coordinated watershed management approach and the sharing of technical expertise to protect water quality. Local opinion surveys indicate 55 percent of respondents felt more money should be spent to maintain or restore the quality and usability of local water bodies. Furthermore, private citizens have volunteered to adopt more than 40 miles of streams for cleanup and to stencil hundreds of storm drains to discourage dumping.

Planning to Avoid or Minimize Environmental Problems

Many MS4s are seeking to avoid new environmental problems by shaping where and how new development occurs on their urban fringe. Storm water problem prevention focuses on minimizing directly connected impervious areas and integrating runoff treatment features into development designs. By sustaining the pre-development hydrology to the maximum extent possible, both the volume of runoff and the pollutant load can be minimized without affecting the ultimate utility of the property.

As a Phase I permittee, **Prince George's County, Maryland,** has evolved into a leader in using information management/analysis as a way to provide better storm water management. Its multi-faceted program uses advanced geographic information systems (GIS) and pollutant load models to better estimate pollutant loads, target watersheds for restoration, and provide support for restoration efforts. The county's multi-year assessment of storm water runoff is leading it to improve upon common land development techniques, creating a new site design process—Low-Impact Development (LID)—to control storm water runoff. The principal goal of LID is to provide the maximum protection to the existing stream ecology by maintaining the watershed's pre-developed hydrologic regime. LID allows the site planner/developer to use a wide array of simple, cost-effective techniques that focus on site-level hydrologic control. Several other Phase I permittees (e.g., Portland, Oregon) are actively following the development of LID techniques to help shape their future storm water management efforts.

Another Phase I permittee, **Montgomery County, Maryland**, is also seeking to prevent new storm water-related problems by changing zoning/development requirements to protect high quality habitat identified through an innovative biomonitoring effort. The County is using information from a baseline inventory of ecological conditions to establish local management priorities. The County has committed $20 million over six years to restore stream habitat degraded by past development, demonstrating that it understands the economic advantages of problem avoidance. At this time three Special Protection Areas (SPAs) designated in 1996 will receive additional protection from storm water impacts. All new development planned within

SPAs must measure water quality and stream conditions before, during, and after construction, providing information on the effectiveness of BMPs in these areas.

Targeting of Pollutants of Concern

For **San Francisco, California**, multiple years of study with other communities neighboring San Francisco Bay have yielded a clear understanding of where pesticides detected in the bay originate. Iterative water quality monitoring that started with large-scale sampling of ambient concentrations and ended with end-of-street storm water sampling has confirmed the connection between storm water originating from urban areas and pesticide concentrations in the Bay. Based on the findings of the sampling, San Francisco is focusing its outreach efforts to educate the public at large about pesticide use.

Before Phase I sampling of storm water outlets, communities were generally unaware of the pollutant constituents in their storm water. With Phase I permitting, communities performed sampling of these outfalls, characterizing their local storm water loads and establishing a baseline for subsequent management. With the maturing of individual programs (generally after the first five years under a permit), some Phase I permittees are starting to scale back their storm water sampling once they have confidently demonstrated which pollutants are important. One example of this effort to streamline monitoring efforts is in **Los Angeles, California**, where local current data are being used to limit future sampling and focus on its high priority pollutants.

Sacramento, California's Phase I program has meant assessing multiple pollutant sources and evaluating the impacts of storm water on a regional basis. To judge the effectiveness of the program, the city uses a storm water Effectiveness Evaluation Plan (EEP). As part of the EEP, the Constituent of Concern (COC) Reduction Program identifies and addresses specific storm water constituents shown to cause or have the potential to cause environmental problems. The city has prioritized its COCs: the Tier 1 (highest priority) constituents are chlorpyrifos, diazinon, fecal coliform, lead, and copper.

3.3.1.2 Survey of Permittees

As described in Section 3.2, EPA conducted a limited survey of approximately 3 percent of the current Phase I MS4 permits to assess pre-Phase 1 and current storm water management. Although the sample set is small, EPA believes its survey provides a starting point for assessing the effectiveness of municipal storm water management programs established under Phase I. To help investigate the influence of the Phase I requirements, MS4 survey participants were asked the question ***"Did the Phase I permit requirements either cause new or significantly refine activities under this element?"*** for the following 16 program elements:

(1) Construction planning process and construction inspections for erosion and sediment control
(2) Spill response to reported questionable discharges
(3) Public maintenance/inspection of structural storm water BMP controls

(4) Implementation of planning/zoning procedures for storm water management
(5) Storm water inspections of municipal facilities and industries
(6) Retrofit of flood management facilities for water quality benefits
(7) Collection of oil/household wastes
(8) Roadway maintenance to protect storm water (e.g., street sweeping, modified deicing activities)
(9) Field screening/inspection of storm sewers for illicit and other discharges
(10) General public storm water outreach/education activities
(11) Managing municipal use of pesticides, herbicides, and fertilizers to improve storm water quality
(12) Inventorying/mapping storm water systems and identification of pollutant sources (e.g., outfall and BMP mapping, source areas identification)
(13) Estimating/tracking storm water load generated within permitted area
(14) Chemical monitoring of MS4 storm water outfalls
(15) In-stream chemical monitoring for assessing storm water impacts
(16) Geomorphologic and biological monitoring of storm water.

This question helps identify where the Phase I program is responsible for *additional* environmental protection, as compared to protection already provided by existing programs or conditions where the influence of Phase I is unclear. Additional environmental protection can occur from either (1) communities implementing new storm water management elements, or (2) increased quality of individual storm water elements employed by MS4s.

The results of EPA's limited survey indicate that the Phase I program has had a positive effect on storm water management. Most MS4s reported that the Phase I program has led to the development or refinement of most of the 16 storm water elements described above.

It is important to note the strong influence of the Phase I program on two key program elements—

(1) Field screening/inspection of storm sewers for illicit and other discharges and
(2) General public storm water outreach/education activities.

The Phase I program's influence on illicit discharge control has been strongly correlated to improvements in dry-weather environmental quality (identifying ambient water quality improvements during dry-weather periods is easier and less expensive than identifying wet-weather improvements). All of the MS4s surveyed by EPA indicated they have created a new or upgraded effort to manage illicit discharges and dry-weather environmental quality as a result of the Phase I program.

The Phase I program's influence on public outreach has been correlated with positive changes in public behavior and water quality improvements in small-scale studies (discussed in greater detail in Section 3.3.1.1). A high percentage of MS4 permittees interviewed stressed that public outreach to prevent pollution at the source is the "way of the future." EPA's survey of MS4s about the influence of Phase I on MS4 outreach indicated that 86 percent of the communities had created new public outreach programs aimed at improving water quality or had significantly refined their public outreach efforts as a result of program requirements.

3.3.1.3 NAFSMA Survey Results

In support of EPA's efforts to evaluate the effectiveness of the Phase I storm water program, NAFSMA conducted a voluntary survey of local government agencies affected by the Phase I program. The survey specifically solicited input related to the effectiveness of municipal storm water programs in improving water quality. Appendix C provides a copy of the survey questionnaire NAFSMA used. Table 3-2 summarizes the responses. There were a total of ten respondents to the NAFSMA survey.

Table 3-2. Summary of Responses from the NAFSMA Phase I Survey

Survey Question[a]	Summary of Responses (Number of Respondents)[b]
1) How would you rate the overall effectiveness of the Phase I Storm Water Program in improving the quality and quantity of storm water discharges and protecting water quality in your jurisdiction?	Successful (5) Too early to tell (4) No comment (1) Additional Comments: Program has provided means to control illicit discharges (3) Program has increased public awareness (2) Quantitative water quality data have not shown degradation with increased population (1) Program provides justification to increase program funding (1)
2a) Please describe those specific components of your municipal stormwater program that have been effective in reducing the discharge of pollutants from your municipal storm sewer system or in improving water quality, and why you feel they have been effective.	Public outreach and education (6) Program for locating and eliminating illicit discharges (4) Inspection and enforcement (2) Storm sewer system mapping (1) Storm drain stenciling (1) Construction site management program (1) Urban retrofit (incl. use of low-impact development techniques) (1) Water quality models for planning (1) Additional Comments: Partnerships established that provide for efficient networking and collaboration (1) Organization and participation with watershed partners (1)
2b) Please describe the components that have not been effective	Monitoring program (5) Too early to tell (2) BMPs in redevelopment and residential areas (1) Illegal/illicit discharge program (1) Additional Comments: Monitoring data not useful for program management (2) Monitoring requirements do not account for geographical differences among municipalities (1) Illegal/illicit discharge program as required does not achieve desired results; need modification of procedures (1)
3) How would you rate the overall effectiveness of the Phase I Storm Water Program in improving the quality and quantity of storm water discharges and protecting water quality in your jurisdiction? In your opinion, did implementing the Phase I program in your jurisdiction result in protecting or restoring your watershed's physical, chemical, and/or biological quality?	
3a) The Phase I control program assisted in protecting the quality of my jurisdiction's watershed?	Yes (5) Uncertain (4) No comment (1) Additional Comments: Protection provided through illicit discharge elimination and BMP implementation (1)

Survey Question[a]	Summary of Responses (Number of Respondents)[b]
3b) The Phase I control program assisted in restoring the quality of my jurisdiction's watershed?	Yes (1) No (2) Uncertain (6) Additional Comments: Protection provided through illicit discharge elimination and BMP implementation (1) Restoration is possible if program flexibility is provided (1)
4) Can you suggest any potential changes EPA may want to make to improve the program's effectiveness or streamline its approach?	Integrate with EPA watershed approach and watershed permitting, including requiring co-permits on a watershed basis (3) Provide program with sufficient funds and resources; additional funds will assist in developing scientific basis for decision-making (3) Fund and promote research to identify new storm water control technologies and to determine BMP effectiveness (3) Integrate with other wet weather control and CWA programs (1) Require performance measures so program effectiveness can be tracked (1) Allow use of stream health assessments (bioassessments) (1) Revamp sampling parameters to parallel multi-sector general permit monitoring requirements (1) Provide examples of successful monitoring programs (1) Consider climatological and geographical locations of MS4s prior to producing costly regulations (1)
5) If you would like to share any other information relevant to the Phase I program, please feel free to use this space.	MS4 permits will assist in improving water quality; however, results will not be seen until we have completed our move from planning under the first permit to implementation under the second permit (1) The use of bioassessments to monitor biological communities should be advocated in lieu of chemical monitoring (1) Preserve the BMP approach as opposed to use of effluent limits (1)

[a] The questions provided in this table represent only those related to the effectiveness of the local Phase I program. The NAFSMA survey also included several additional questions on program implementation costs.
[b] Ten entities responded to the NAFSMA Phase I survey. The number of responses indicated in this table may exceed 10 because of the possibility for multiple answers to a question by one entity.

Overall, the limited NAFSMA survey independently confirms some conclusions from EPA's survey. In summary, NAFSMA respondents indicate the following:

- Either the Phase I program has been successful in improving local water quality or it is too early to determine the influence of the Phase I program.
- The most effective program elements were illicit discharge location/elimination and public outreach.
- Monitoring the constituents of Storm water discharges, while initially useful to characterize Storm water in the development of municipal programs, may not be the most effective use

of resources in the future. Standardized monitoring methods that help characterize receiving water quality (e.g., bioassessments) should be further explored.

- EPA needs to streamline its approach to support integrated watershed management that combines all pollutant sources and cuts across political boundaries.

The number of NAFSMA respondents indicating “too early to tell” about effects on water quality reinforces EPA’s conclusion that the Phase I MS4 program is continuing to mature.

3.3.2 Loading Reductions

One of the key surrogate indicators of water quality benefits attributable to the Phase I program is the amount of pollutant prevented from reaching the environment. A water quality improvement occurs when a Phase I municipality uses storm water BMPs with a proven capability to minimize or trap pollutants that could otherwise be conveyed through the MS4 to receiving waters.

This section uses case studies and the results of MS4 surveys to describe how the Phase I program has contributed to pollutant load reductions.

3.3.2.1 Case Studies

This section summarizes case studies that illustrate where specific Phase I MS4s are innovatively meeting permit requirements and improving on earlier, pre-Phase I efforts. The case studies include examples of nonstructural BMPs (which prevent contamination of storm water through measures such as better urban planning, good housekeeping, and household waste recycling) and structural BMPs (which intercept and remove pollutants in storm water runoff from new developments).

Table 3-3 summarizes the case studies used in this section and describes their relevance. (All of the case studies for this Report are in Appendix D.)

Table 3-3. Summary of Loading Reduction Case Studies

Case Study Location	Feature(s)
Montgomery County, MD	Nutrient reductions from structural BMPs help meet regional reduction goal.
Fort Worth, TX	An effective household waste collection program can safely dispose of large quantities of pollutants
Portland, OR	An aggressive inspection program results in significant amounts of pollutants being prevented from entering the environment.
Boston, MA (Charles River)	Phase I dry-weather inspections identify sources discharging thousands of pounds of pollutants.
Austin, TX	Installation of BMP protects the Colorado River.

Loading Reductions with Nonstructural BMPs

The influence of nonstructural BMPs often cannot be established through monitoring of ambient water quality. For example, public education that prevents illicit dumping into storm drains, household waste collections, and zoning changes that affect future development prevent a *rise* in ambient pollutant levels as well as lowering them in some cases. However, their influence can be difficult to identify because successful monitoring would require long-term, costly, and extensive networks to note decreases in intermittent pollutant discharges. In addition, if a pollutant is never discharged as a result of prevention efforts, monitoring would only establish the lack of change in ambient conditions.

Three case studies help illustrate how nonstructural BMPs affect pollutant loadings in storm water.

The case study of the **Charles River** in Massachusetts demonstrates how storm sewer inspections and dry-weather monitoring (nonstructural BMPs) yield a reduction in pollutant discharge through the storm sewer system. Boston, a Phase I permittee, is a major participant in a multi-jurisdictional effort to improve water quality in the Charles River. As required by its Phase I MS4 storm water permit, Boston is inspecting its storm sewer system for cross-connections (i.e., points where sanitary sewers inappropriately discharge into storm water sewers). Boston has identified and eliminated a number of cross-connections, the largest of which discharged an average of 70,000 gallons per day of raw sewage into the storm drain system. Because of Boston's efforts and the efforts of other upstream municipalities, dry-weather water quality has improved, as has the opportunity for secondary-contact recreation.

In **Portland, Oregon**, regular monitoring has prevented a variety of wastes and waste types from reaching receiving waters. In an effort unusual for most MS4s, Portland estimated the pollutant load prevented from reaching the environment in a single year due to the illicit discharge monitoring program. Although many MS4s inspect for and remove illicit discharges, the vast majority do not collect and record data on the resulting pollutant load reduction. Portland estimated that in 1996 alone its inspection efforts prevented the discharge of 250 pounds each of TSS and BOD, 40 pounds of total nitrogen, and 10 pounds of phosphorus from its MS4.

Within each MS4 the types of wastes illicitly discharged to the storm sewer vary. They can include washwater discharges, industrial wastes, and fluids washed from accident/spill areas. Again, Portland estimated load reductions attributed to its Phase I program for these types of discharges. Portland estimates in 1996 that the effects of a 400-pound diesel fuel spill were averted. With respect to washwater, 100 pounds of TSS, 80 pounds of BOD, 4 pounds of oil and grease, and less than 1 pound of copper, lead, and zinc were prevented from entering the MS4.

The **Fort Worth, Texas,** case study illustrates the effectiveness of the pollution prevention elements encouraged under the Phase I storm water program. Identifying household waste as one of the local priorities in its storm water management program, Fort Worth now *annually* destroys or recycles 50,000 gallons of toxic liquid waste and keeps it out of the environment. A recent behavior study indicates environmentally unacceptable disposal practices are used by 5 to 39 percent of surveyed homeowners, depending on the type of waste (Sacramento, 1999). As a result, EPA believes Fort Worth's new household waste collection prevents a significant amount of pollutants from affecting the water bodies around Fort Worth. After only 2 years of operation, 3 percent of area households are now using the regional household waste drop-off center operated by Fort Worth and surrounding communities. This is a significant increase compared to the city's earlier efforts.

Loading Reduction with Structural BMPs

Structural BMPs typically provide for detention or infiltration of storm water runoff and have been evaluated widely as a means to reduce pollutant loadings. The actual load reduction varies as a function of the type of pollutant measured, but it is common to see pollutant reductions reported in literature of between 20 and 80 percent for the area served. Pollutants are removed in one of two ways: (1) by natural processes that degrade or recycle pollutants; or (2) by physical removal through BMP maintenance efforts (e.g., removal of accumulated sediment/sludge).

Two case studies are presented here that illustrate pollutant load reductions for Phase I communities using structural BMPs. The first (Austin, TX) examines a single BMP installation and the second (Montgomery County, Maryland) illustrates pollutant reductions on a jurisdiction-wide basis.

In **Austin, Texas**, a joint public/private enterprise between the State of Texas and a private developer is installing storm water detention ponds to minimize the impacts of a mixed-use development while providing aesthetic and economic benefits. The resulting pollutant load reduction for the detention ponds has been estimated based on local rainfall patterns, design parameters used in the pond, and removal efficiencies typical of detention ponds. Compared to an unmanaged condition, the ponds will reduce the sediment discharged annually from the site by several tons and will reduce nutrients discharged by between 44 and 65 percent. By capturing 300,000 cubic feet of rainfall runoff, the ponds annually remove 36,400 to 50,000 pounds per year of sediment, 55 to 275 pounds of nitrate/nitrite, 55 to 2000 pounds of phosphorus, 5 to 50 pounds of lead, and 10 to 150 pounds of zinc. Additional downstream benefits include improved oxygenation (from constructed waterfalls in the park) and flooding and erosion control (due to the slow release of captured runoff).

As a regular part of the annual reporting for its Phase I permit, **Montgomery County, Maryland,** estimates the number of pounds of pollutant removed using structural BMPs. The county estimated in 1998 that structural BMPs prevented 23 percent of the sediment load and 27 percent of the nitrogen load from the area within its jurisdiction from entering streams. These countywide load reductions are particularly impressive given that extensive portions of the county were developed before the storm water requirements. Reductions in sediment load are important because Montgomery County is now paying millions of dollars annually to restore streams affected by urbanization and the resulting excessive in-stream sediment loads. Reductions in nutrient loads are also important because Montgomery County is a party to a multi-jurisdictional effort to minimize nutrient loadings into the Chesapeake Bay. Several municipalities in Montgomery County (e.g., Rockville and Gaithersburg) have developed public service announcements highlighting storm water management activities. These have been shown on the dedicated city government channels on the local TV cable system.

3.3.2.2. National Storm Water BMP Database

Recently, a national storm water BMP database was produced under a cooperative agreement between the American Society of Civil Engineers (ASCE) and EPA. The purpose of this project was to provide a mechanism for sharing consistent and transferable information on storm water BMPs. The database (summarized in Appendix D) contains load reduction information from 60 studies contributed by 30 municipalities in 11 States. For each of these studies, the permittee established a test location, monitored the water quality upstream and downstream of the BMP, and assessed the pollutant load reduction.

The ASCE/EPA BMP database reports how various BMP technologies reduce pollutants, details individual BMP installations, and describes limitations of each BMP technology. Monitoring summaries of individual BMP installations demonstrate a wide range of storm water pollutants are reduced by properly designed and installed structural BMPs including oil and grease, TSS, nitrogen, phosphorus, pathogens, lead, copper, zinc, and other metals. While the actual pollutant removals vary with the BMP, the pollutant, and the size of the rainfall event, the BMP database reports pollutant reductions generally fall in the range between 15 and 65 percent.

3.3.2.3 Survey of Loadings Averted

As described in Section 3.2, EPA performed a limited survey of approximately 3 percent of current Phase I permits distributed throughout the United States. One of the purposes of the survey was to collect information on *changes* in storm water pollutant loadings attributable to Phase I program requirements. A change in loadings was generally defined as the difference in pollutants collected or captured through a storm water management element. For example, a 5,000-pound load reduction would occur if a permittee reported that annual street sweeping removed 10,000 pounds in 1989 and 15,000 pounds in 1999. It should be noted that EPA counted load reduction only if MS4 permittees indicated Phase I permit requirements were responsible for their upgraded storm water control efforts.

Current data on annual load reductions are usually provided in the annual reports produced by permittees as required in the Phase I regulations. However, retrospective data (baseline load reductions before the rulemaking) are not always available for all permittees for all BMPs of interest. To help produce a fair comparison of pre- and post-rulemaking conditions, EPA asked all respondents to estimate pre-Phase I load reduction. Appendix B contains the form used to collect data on load reductions, past and present, from the respondents. Six of nine MS4s returned surveys with information on load reduction histories.

It should be noted that not all information provided by surveyed MS4s is expressed in terms of pounds of pollutant prevented from reaching the environment. Based on earlier investigation, EPA determined that for some program elements MS4s seldom collect and report load reductions, but instead use a surrogate measure (e.g., numbers of illicit discharges corrected). Where load reduction data are unavailable, EPA has collected information on surrogate measures to help demonstrate the potential increase in load reductions. Often several surrogate measures are available to demonstrate the positive influence of the Phase I program.

Table 3-4 provides two sets of values calculated by totaling all responses of the surveyed MS4s. Most values in Table 3-4 are presented in terms of annual pounds of pollutant managed: (1) before; and (2) as of 1999.

As demonstrated in **Palo Alto, California**, pollution prevention planning and engineering can result in a decrease in pollutant concentrations originating from vehicle service facilities. Concentrations of metals in storm water runoff decrease significantly with use of BMPs as demonstrated through several years of regular monitoring. From 1993 to 1996 the quality of storm water discharges from vehicle service facilities improved: concentrations of copper dropped 89 percent; lead, 96 percent; nickel, 93 percent; and zinc, 77 percent.

As demonstrated in **Prince George's County, Maryland,** developers can select from among a suite of storm water control BMPs. Integrating the BMPs produces increased storm water protection and greater reduction in pollutant concentrations where storm water leaves the urban area. Actual pollutant removals measured at test installations indicate that storm water pollutant concentrations decrease as a result of structural BMPs by 20 and 80 percent for nutrients and 40 to 99 percent for metals.

Table 3-4. Total Reported Load Reductions Attributed to Phase I Permitting as Reported by Surveyed Permittees

Load Reduction Element	Pre-Phase I Values	Values Reported as of 1999
Fort Worth, TX: Household Waste Collection Efforts		
Actual Number of Drop-offs at Collection Facilities	1,498	27,664
Households with the Option to Drop-off HHW	349,624	1,105,314
Volume of Paint Collected Annually (Gal.)	27,487	184,250
Volume of Auto-fluids Collected Annually (Gal.)	12,527	111,647
Volume of Pesticides/ Herbicides (Gal.)	0	6,257
Volume of Other Liquids Collected Annually (Gal.) (Gal.)	13,064	28,816
Number of Flood Prevention Facilities Inspected and Modified to Gain Water Quality Improvements		
Annual Inspections	442	1,500
Total Modifications	1	30
Acreage Served by Retrofitted Flood Prevention Facilities as of the Year Reported		
Acres Now with Some Water Quality Protection	801	153,223
Estimated Annual Reductions in the Year Reported Due to New Policies for Public Agency -- Pesticides, Herbicides, and Fertilizers Use		
Pounds of Herbicides	0	0
Pounds of Pesticides	0	996
Pounds of Fertilizers	0	196
Estimated Annual Volume of Vehicle Fluids Captured Due to Spill Response in the Year Reported		
Gallons Captured	8,842	21,795
Pounds Captured	70,762	90,951
Number of Illicit Discharge Investigations and Discharges Addressed		
Investigations Performed Annually	2,521	15,329
Illicit Discharges Addressed Annually	1,046	1,663
Pounds of Trash/Sediment Removed from Roadways in the Year Reported		
Pounds of Trash/Sediment Collected	34,179,545	49,254,560

The values in Table 3-4 indicate that, for the surveyed MS4S, Phase I requirements resulted in a significant increase in pollution prevention activities and the amount of pollutant loadings averted. This is particularly notable for the spill management and street maintenance elements of the program. Most program elements in Table 3-4 entail nonstructural BMPs and involve activities that are dispersed and difficult to track. As a result, EPA believes the actual pollutant load reduction generally is under-reported in the MS4 community, and multiple examples can be found in the MS4 case studies in Appendix D.

As one example, EPA has already described (see Section 3.3.1) that MS4 permittees identifying and remediating illicit discharges in their sewer systems rarely report on the frequency, nature, or volume of illicit discharges they manage. Because of the lack of this information, EPA used the number of illicit discharge investigations and the number of illicit discharges stopped as surrogate measures to demonstrate the benefits of the Phase I program.

Another example of the difficulty of reporting pollutant load reductions is the use of pesticides by public agencies. Survey respondents indicate that public management of pesticides, herbicides, and fertilizer appears to be one of the areas least affected by the Phase I requirements. In part this might be the case because pesticide use under a single permit is typically distributed throughout multiple public agencies, leading to decentralized record keeping and variations in annual use on an agency-to-agency basis. Furthermore, a single permit might include 10 co-permittees, each of which has four organizations that individually use a spectrum of chemicals. So, most respondents' programs appear to focus on training staff to correctly apply these chemicals and do not track the amount or location of chemical application. However, certain major municipalities (e.g., Fort Worth, Texas; King County, Washington; and San Francisco, California) are aggressively exploring a no-use or limited use pesticide policy, which might result in future load reductions.

In summary, the limited MS4 survey results indicate that the Phase I program has resulted in pollutant load reductions from a wide variety of storm water management program elements. For those elements where actual pollutant reductions cannot be reported, surrogate measures clearly indicate management improvements since the promulgation of the Phase I rule. In addition, MS4 load reductions reported by permittees are not as high as they will eventually be because most permittees report that their programs are not yet fully implemented.

3.3.3 Water Quality Indicators

This section describes the water quality benefits attributable to the Phase I program.

3.3.3.1 Case Studies

Table 3-5 summarizes the case studies that indicate water quality improvements. The examples from Phase I MS4S are augmented with other case studies (e.g., those from Phase II MS4 communities or professional literature) where they exemplify the benefits of storm water controls similar to those required under Phase I.

The case studies listed in Table 3-5 illustrate some of the water quality and environmental benefits that have resulted from the Phase I permitting program. The case studies selected stress different features, including MS4 efforts to prevent environmental problems and to reduce pollutant concentrations.

Table 3-5. Summary of Water Quality Improvement Case Studies

Case Study Location	Feature(s)
Boston, MA	Phase I dry-weather inspections lead to additional recreational water use and higher water quality.
Dover, NH (Pending Phase II City)	Dry-weather inspections lead to higher water quality.
Minneapolis, MN (Pending Phase I City)	Public education diminishes concentrations of pesticides; linked to general household uses.
Prince George's County, MD	Nutrient reductions from structural BMPs help meet regional reduction goal.

Some of the case studies indicate potential water quality benefits expected as new management efforts are created to address the storm water pollutants/problems just now being identified by Phase I permittees. Isolating water quality improvements related to Phase I MS4 permitting is often complicated by overlapping efforts with other regulatory efforts, including the Coastal Zone Management Act, Clean Lakes Program, National Estuary Program, and Endangered Species Act. Point and nonpoint source pollutant discharges, natural variation in rainfall patterns, phasing-in of storm water BMPs, and limits on science and funding all complicate reporting of the direct water quality benefits of the Phase I program. However, storm water quality improvements related to structural and nonstructural BMPs are demonstrated through local monitoring and reporting from both Phase I and non-Phase I communities. The following subsections discuss how case studies demonstrate the effectiveness of Phase I permit elements.

Public and Business Outreach Efforts

Public outreach covers a range of elements including mass media information on household waste collection, marking of storm drains, and industry-specific education. Correlating outreach with improvements in water quality is difficult because outreach primarily affects the behavior of persons who pollute in a dispersed or intermittent manner (e.g., dumping of used oil down a storm sewer). This behavior typically is difficult to detect on a regular basis or analyze with traditional water quality models. Nevertheless, two case studies help illustrate how outreach has affected water quality.

As illustrated in the **Minneapolis, Minnesota,** case study, outreach efforts can be correlated to reductions in pollutants; specifically, pesticide concentrations in storm water can be reduced through public outreach efforts. Concentrations of various pesticides in a Minneapolis lake dropped by between 59 and 86 percent due to an outreach effort. These results are commensurate with the outreach efforts of other Phase I cities (e.g., San Francisco) that recognize the benefit of public education in protecting storm water quality. Although the effectiveness of public outreach typically can be measured only in terms of changes in public awareness and behavior, the Minneapolis case study demonstrates that water quality improvement can occur as a result of public outreach efforts.[10]

Outreach/education efforts by Phase I cities also focus on businesses such as auto yards or carpet cleaners that produce high volumes of liquid wastes with the potential to pollute storm water. **Sacramento, California,** has introduced an innovative program to reduce wash water discharges from carpet cleaning businesses. Through a "Clean Business" certification program, businesses get credit for correct disposal of wash water, homeowners have a chance to win prizes through a lottery, and wash water is treated fully at the wastewater treatment plant. Although thousands of gallons of wash water are now successfully treated, monitoring to measure the water quality impact has not been funded.

Water Quality Improvements from Structural Storm Water BMPs

It is not possible to quantify, nationally, the improvement in ambient water quality resulting from structural storm water BMPs installed as a result of the Phase I storm water program. Many MS4s are still investigating BMP applicability and phasing the installation of BMP networks. Phase I communities are at the forefront of developing/employing structural BMPs to protect water quality and to meet their local environmental protection objectives. Case studies identified by EPA illustrate the water quality improvements possible with installation and implementation of various BMPs.

Illicit Connections/System Inspection

Under the Phase I regulations, municipal permittees are required to develop storm water management plans that, among other things, provide for detection and control of illicit discharges to their MS4s. In many cases, it is technically simple to detect dry-weather flow problems, although controlling the source can require extensive and expensive rehabilitation.

The case studies of **Boston, Massachusetts,** and **Dover, New Hampshire,** illustrate how sanitary sewer cross-connections to the storm sewer system affect water quality. In Boston, the contributions of the Phase I-required sewer inspection program are being discussed in the context of a large-scale, multi-year, multi-community effort to restore designated uses to the Lower Charles River. Although Dover is not a Phase I community, its case study indicates, on a smaller

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[10] As indicated previously, Minneapolis has not yet been issued its Phase I permit.

scale, what happens to pollutant concentrations in a single storm sewer pipe when cross-connections to the storm sewer are removed. Once the cross-connection had been identified and repaired, the water quality of discharges from the single storm sewer near beaches and shellfish beds improved by over 99 percent based on measured enterococci bacteria.

Monitoring Efforts

As stressed in Section 3.3.1, most Phase I communities are still defining the general ambient water quality of their water bodies, identifying the storm water pollutants-of-concern (POCs) for their local settings, and quantifying sources of POCs. Given the relatively short time period of record, it is generally not possible to demonstrate through direct measure/statistical analysis of ambient water quality levels the changes due to the Phase I program. However, EPA anticipates that the expanding pool of ambient data and ongoing characterization of storm water quality will yield a more comprehensive water quality assessment in future years. At this time, EPA expects that a minimum of ten years of monitoring of both ambient and storm water discharges is necessary for each MS4 to be characterized (the time required to account for natural variation and to characterize other pollutant sources).

The following two case studies are intended to show different aspects of ongoing storm water monitoring. The **Los Angeles, California,** case study indicates how the results of end-of-pipe monitoring can help communities refine their storm water monitoring efforts. With successive years of storm water monitoring, it is possible to separate POCs from non-POCs for local waterways. Los Angeles, a Phase I permittee, is currently identifying locations where certain storm water pollutants need no longer be monitored because the pollutant is not frequently found within storm water. Sufficient data exist to indicate where storm water is *not* contributing to impairments. The main pollutants found to cause water quality impairments are certain heavy metals, coliform bacteria, enteric viruses, pesticides, nutrients, polycyclic aromatic hydrocarbons, trash, debris, algae, scum, sediments, and odor. With this understanding, Los Angeles County is now proposing to discontinue monitoring where these pollutants have not been found to pose a threat.

In **Sacramento, California,** storm water monitoring results are combined with environmental data to demonstrate what fraction of the pollutant load in key water bodies originates from storm water. By demonstrating through area wide monitoring that the bulk of the pollutant load originates from upstream sources, Sacramento can better understand the impacts of its storm water discharge.

Demonstrating Avoidance of Future Water Quality Problems

It is likely that much of the benefit associated with the Phase I MS4 permitting program will be measured in terms of problem avoidance rather than an actual decrease in pollutant concentrations in a water body. In the case of **Prince George's County, Maryland**, zoning changes that decrease percent imperviousness combined with BMPs that infiltrate storm water runoff from new developments will mean local streams will retain their current natural condition. The county's use of low-impact development (LID) techniques will decrease runoff generation by between 75 and 95 percent from current land development designs. Use of LID will yield a pollutant load reduction simply because less runoff will occur. The estimated pollutant load reduction from BMPs that are integrated to create a LID design is over 80 percent for nutrient and metal pollutants.

Under LID, the bulk of the runoff generated infiltrates into the ground and becomes baseflow for local streams. As demonstrated by the case study for **Montgomery County, Maryland,** the benefit of zoning/design-based BMPs that maintain the pre-development hydrology will stem from dollars *not* spent restoring habitat adversely affected by unmanaged runoff. Extensive stream restoration is being used to repair and stabilize urban streams that are poor supporters of aquatic life.

3.3.3.2 Survey of MS4s for Water Quality Improvements

EPA used the survey data from a limited number of MS4 permittees to evaluate the water quality benefits associated with the storm water management elements under the Phase I program. The survey requested that MS4s indicate the degree to which the development and implementation of each storm water management element is beneficial to protection of water quality.

MS4s were asked separately about water quality benefits realized to date and those expected from continued use. As described in Section 3.3.1.2, many MS4s report that they have not yet fully implemented their programs, so future benefits may be significantly greater than past benefits. Table 3-6 summarizes the overall response for past and future benefits of the Phase I MS4 program.

Table 3-6. Summary of MS4 Water Quality Grades for Storm Water Management Elements

Grade	Benefits Realized Since First Permitted (Percent)[a]	Expected Future Benefit From Continued Use (Percent) [a]
General Benefit Observed	10	33
Beneficial In Some Places	17	28
Probably Beneficial, Not Documented	51	27
Benefit Unlikely	6	5
Inconclusive Benefit	14	6
No Response	2	2

[a] Percentages based on 107 total numeric grades received for all program elements evaluated plus 5 "No Response" grades

As Table 3-6 shows, 78 percent of the MS4s surveyed responded that Phase I requirements had been "Probably Beneficial," "Beneficial in Some Places," or "Generally Beneficial" for their management areas since program initiation. When asked to grade *future* environmental benefits, the total grade for these responses increased to 88 percent.

3.4 FINDINGS OF THE REVIEW OF THE PHASE I PROGRAM FOR MUNICIPAL SEPARATE STORM SEWER SYSTEMS

This section summarizes EPA's review and analysis of the Phase I program for MS4s. It first describes successful components of the Phase I program and then discusses program components that EPA might need to address to improve the effectiveness part of future storm management programs.

3.4.1 Successful Attributes of the Phase I Program for MS4s

In this section EPA describes specific MS4 program elements that have been effective in controlling storm water discharges from MS4s and protecting water quality.

<u>Development of Effective Storm Water Management</u>

EPA's limited survey of MS4 communities indicates that the Phase I program has increased the number of communities implementing storm water management elements and the number of communities whose programs have evolved to full implementation. For example, the number of surveyed communities now served with erosion and sediment controls has doubled since the rulemaking, and the number of communities with household waste collection programs has increased by 50 percent. EPA notes, however, that these results are based on a small sample.

NAFSMA survey respondents indicated that public outreach and training has been the most effective component of municipal storm water programs in reducing the discharge of pollutants or improving water quality. Increasing the awareness of public agencies, businesses, and individuals of their role in pollution prevention has led to reductions of pollutants in storm water runoff from residential and commercial areas.

<u>Characterizing Storm Water Pollutants and Impacts</u>

Water quality monitoring over several years by San Francisco and other Bay-area communities has confirmed the connection between storm water originating from urban areas and pesticide concentrations in the bay. Based on the findings of the sampling, San Francisco is focusing its outreach efforts on educating the public at large about pesticide use. It also is reconsidering the use of pesticides by its public agencies.

Monitoring of dry-weather discharges in storm water systems has indicated the presence of pollutants of concern for many Phase I permittees. Fort Worth, Texas, for example, is developing management activities to meet a 20 percent reduction goal in detection of soapy wash water. Portland, Oregon's dry-weather monitoring led to a local program that has prevented the discharge of hundreds of pounds of pollutants and is helping to prevent new pollutant discharges.

The ongoing Constituent of Concern Reduction Program employed in Sacramento, California, addresses specific constituents found in storm water that have been shown to cause or have the potential to cause pollution in creeks and rivers. Although the program's impacts on the beneficial uses of the rivers and creeks are not yet known, Sacramento is shaping current management efforts based on the monitoring data available.

Illicit Discharge Detection and Control

Independent surveys of MS4 communities by NAFSMA and EPA both highlight the effectiveness of illicit discharge control programs in protecting storm water quality.

- As a result of Phase I requirements, Boston has identified and corrected a number of cross-connections, the largest of which discharged raw sewage into the storm drain system at an average rate of 70,000 gallons per day.

- Fort Worth's household waste collection program now *annually* destroys or recycles 50,000 gallons of toxic liquid waste, thus keeping it out of the environment.

- Portland, Oregon's Phase I program has reduced pollutant loads from illicit connections, wash water discharges, accidental spills, and erosion/sedimentation by 1,980 pounds of TSS, 330 pounds of BOD, 40 pounds of nitrogen, 10 pounds of phosphorus, 400 pounds of diesel fuel, 4 pounds of oil and grease, and less than a pound of the more toxic metals copper, lead, and zinc.

- BMPs at vehicle service facilities in Palo Alto, California, have reduced copper concentrations in storm water by 89 percent; lead, 96 percent; nickel, 93 percent, and zinc, 77 percent.

- Prince George's County, Maryland's low-impact development (LID) program uses a wide array of simple, cost-effective BMPs that infiltrate storm water runoff from new developments. LID techniques decrease runoff generation by between 75 and 95 percent from current land development designs, and, on a composite basis, are estimated to reduce nutrient and metal pollutant loadings by over 80 percent.

- Montgomery County, Maryland's structural BMPs prevented an estimated 23 percent of the sediment load and 27 percent of the nitrogen load in the permit area from entering streams in 1998.

- Three storm water ponds in Austin, Texas's Central Park area provide environmental, economic, and aesthetic benefits. By capturing 300,000 cubic feet of rainfall runoff, the ponds annually remove 36,400 to 50,000 pounds per year of sediment, 55 to 275 pounds of nitrate/nitrite, 55 to 2000 pounds of phosphorus, 5 to 50 pounds of lead, and 10 to 150 pounds of zinc. Additional downstream benefits include improved oxygenation (from constructed waterfalls in the park) and flooding and erosion control (due to the slow release of captured runoff).

3.4.2 Components of the Phase I Program That May Need to be Addressed

While collecting and analyzing information for this Report EPA identified several components of the Phase I program that might not be effective in the form in which they are required. The results described in this section were based primarily on input received directly from MS4s through the EPA and NAFSMA surveys. (See related discussion in Section 3.2.)

Monitoring

- There are no mechanisms in place to directly demonstrate the effectiveness of the Phase I MS4 program on improving water quality at a national level.

- Currently, it appears in some communities that the Phase I monitoring requirements have resulted in a significant expenditure of resources without a commensurate return from the resource investment (return in terms of storm water management program or direct water quality benefits). These inefficiencies were particularly noted in areas where the standard Phase I end-of-pipe monitoring was considered inappropriate for the specific geographic and climatological locations of some MS4s (e.g., areas that experience infrequent rainfall events). Several communities noted that the Phase I monitoring requirements should also provide more flexibility to acknowledge the site-specific nature of storm water quality as well as local priorities.

- Currently, the data gathered to meet Phase I monitoring requirements might not adequately characterize the potential impacts of storm water discharges on ambient water quality. Several MS4s suggested that storm water impacts might be better measured using bioassessment techniques instead of pollutant-specific monitoring.

Setting Performance Standards for Storm Water BMPs

- Whether discussing structural or nonstructural BMPs, there are no minimum performance standards currently set for permitted entities. One of the NAFSMA survey respondents requested that performance measures be developed so that program effectiveness can be tracked. Without such measures, it is difficult to report on a regional or national level what the benefits of Phase I program elements actually are. This is a significant problem when one of the major techniques used to assess program effectiveness is the pounds of pollutant prevented from reaching the environment.

Better Watershed Management/Integration

- One significant finding of the NAFSMA survey was the need for better integration of wet-weather controls on a watershed basis.

- As shown in the case studies researched for this Report, storm water management is a key component in multi-jurisdictional, multi-watershed efforts to protect high-profile streams, rivers, lakes, and estuaries (e.g., Monterey Bay). However, several MS4s expressed concern about the general lack of integration of the Phase I program with EPA's watershed protection approach, including watershed permitting. This was particularly the case where watersheds are impacted by non-Phase I discharges (e.g., industrial and Phase II storm water permittees). EPA also noted a past concern among some Phase I permittees was the absence of storm water management requirements in neighboring non-Phase I communities. Phase I communities were initially at a disadvantage because (1) development in adjacent unpermitted communities affected water quality within the Phase I boundaries, and (2) development opportunities for the Phase I community were lost because developers elected to build in nearby unregulated communities.

Need for Additional Technical Research and Outreach

- When interviewed and surveyed, several Phase I MS4 permittees indicated additional EPA support is needed on storm water control technology research and development. Active Federal coordination is desired to minimize redundant research among MS4s and to standardize reporting of effectiveness. In addition, EPA cofunding of milestone research is desired to offset the cost to MS4s of trying to develop innovative solutions.