

State Transportation Agency Strategies to Address NPDES Phase II Requirements

Requested by:

American Association of State Highway
and Transportation Officials (AASHTO)

Standing Committee on the Environment

Prepared by:

Marie Venner, Venner Consulting, Inc.
Kelly Brennan, Parsons Brinckerhoff

February 2007

*The information contained in this report was prepared as part of NCHRP Project 25-25, Task 16,
National Cooperative Highway Research Program, Transportation Research Board.*

Acknowledgements

This study was requested by the American Association of State Highway and Transportation Officials (AASHTO), and conducted as part of the National Cooperative Highway Research Program (NCHRP) Project 25-25 Task 16. The NCHRP is supported by annual voluntary contributions from the state Departments of Transportation. Project 25-25 is intended to fund quick response studies on behalf of the AASHTO Standing Committee on the Environment. The report was prepared by Marie Venner and Kelly Brennan. The work was guided by a task group chaired by John Mettille which included Jerry Chaney, Shelby Jett, Debra Nelson, and Patricia Cazenias. The project was managed by Christopher Hedges, NCHRP Senior Program Officer.

Disclaimer

The opinions and conclusions expressed or implied are those of the research agency that performed the research and are not necessarily those of the Transportation Research Board or its sponsors. The information contained in this document was taken directly from the submission of the author(s). This document is not a report of the Transportation Research Board or of the National Research Council.

TABLE OF CONTENTS

ABSTRACT	VIII
EXECUTIVE SUMMARY	1
1 INTRODUCTION	2
1.1 Background.....	2
1.2 Study Purpose	2
1.3 Report Organization	3
2 NPDES PHASE II REQUIREMENTS FOR STATE DOTs	4
2.1 What is NPDES and the MS4 Program?	4
Phase I.....	4
Phase II	5
MS4 Requirements	5
2.2 Phase II's Six Minimum Measures for MS4s.....	6
3 SURVEY DEVELOPMENT AND DATA COLLECTION PROCESS.....	8
3.1 Survey Development Process.....	8
3.2 Data Collection Process	8
4 SURVEY RESULTS	11
4.1 General Survey results.....	11
State DOTs as MS4s and the Development of Stormwater Management Plans.....	11
5 PUBLIC EDUCATION AND OUTREACH.....	15
5.1 Public Education and Outreach Activities Undertaken by DOT Respondents.....	15
5.2 Strategies and BMPs.....	15
5.3 Links and Resources	17
6 PUBLIC PARTICIPATION AND INVOLVEMENT	20
6.1 Public Participation and Involvement Activities Undertaken by DOT Respondents.....	20
6.2 Strategies and BMPs.....	20
6.3 Links and Resources	22
7 ILLICIT DISCHARGE DETECTION AND ELIMINATION.....	23
7.1 Illicit Discharge Detection and Elimination Activities Undertaken by DOT Respondents	23
7.2 Strategies and BMPs.....	28
7.3 Links and References	28
8 CONSTRUCTION SITE STORMWATER RUNOFF CONTROL	31
8.1 Construction Site Stormwater Runoff Control Activities Undertaken by DOT Respondents	31
Establishing Policies and Other Mechanisms to Ensure Proper Implementation of Controls on Construction Sites	31
Construction SWPPP Review and Tracking.....	31
Site Inspection and Enforcement of Control Measures	34
Risk Assessment, Systematic Performance Evaluation and Tracking.....	34

8.2	<i>Strategies and BMPs</i>	37
	Establishing Policies and Other Mechanisms to Ensure Proper Implementation of Controls on Construction Sites	37
	Construction SWPPP Review and Tracking	37
	Site Inspection and Enforcement of Control Measures	38
	Enforcement/Contractor Compliance Control Mechanisms	38
	Risk Assessment, Systematic Performance Evaluation and Tracking	39
	Other Strategies	39
8.3	<i>DOT Examples</i>	40
	Establishing Policies and Other Mechanisms to Ensure Proper Implementation of Controls on Construction Sites	40
	Construction SWPPP Review and Tracking	41
	Site Inspection and Enforcement of Control Measures	42
	Enforcement/Contractor Compliance Control Mechanisms	42
	Risk Assessment, Systematic Performance Evaluation and Tracking	45
8.4	<i>Links and Resources</i>	45
	Other BMPs and Resources	48
9	POST-CONSTRUCTION STORMWATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT.....	50
9.1	<i>Post-Construction Stormwater Management Activities Undertaken by DOT Respondents</i>	50
	Assessing Impacts of Activities and Planning for Greater Control in Sensitive Areas	53
9.2	<i>Strategies and BMPs</i>	53
9.3	<i>DOT Examples</i>	53
9.4	<i>Links and Resources:</i>	55
10	POLLUTION PREVENTION/GOOD HOUSEKEEPING FOR DOT OPERATIONS AND FACILITIES	57
10.1	<i>Pollution Prevention and Good Housekeeping Activities Undertaken by DOT Respondents</i>	58
10.2	<i>Strategies and BMPs</i>	58
	Facilities Pollution Prevention & Good Housekeeping Practices in AASHTO’s Compendium of Environmental Stewardship Practices, Procedures, and Policies.....	58
	DOT Environmental Training and Inspection Resources with Stormwater Coverage	58
	Statewide Implementation	58
10.3	<i>DOT Examples</i>	62
	Facilities Good Housekeeping Checklists and Tracking	62
	Incorporating Stormwater Best Practice into Competency Based Training Programs	62
10.4	<i>Links and References</i>	67
	Guidance on Pollution Prevention and Good Housekeeping Activities	67
11	ORGANIZATIONAL APPROACHES TO NPDES MS4 COMPLIANCE.....	69
11.1	<i>Approaches to Meeting Additional Responsibilities Imposed by Phase II</i>	69
11.2	<i>Which Division Has Primary Responsibility? Who Else is Involved?</i>	69
	Increasing Ownership, Involvement, and Leadership by Construction and Maintenance	72
	Use of Internal Staff to Meet Requirements Ranged from “Sparing” to 100%	74
	Co-Permitting Approaches Can Be Found in the Least Populated States	74
	DOTs Report Inconsistent Effects on Workloads.....	75
11.3	<i>Tools To Support and Manage the NPDES Program, Activities, and Responsibilities</i>	75
	Environmental Strategic Plans Including Water Quality Objectives	78
	Use of Environmental Management Systems to Address NPDES MS4 Requirements	79
11.4	<i>DOT NPDES Phase II MS4 Funding and Budgets</i>	79
11.5	<i>Functional Area Roles and Responsibilities</i>	82

Reporting Requirements	82
Shared Responsibilities Across Many Sections	82
Development Program	83
11.6 <i>In-house and Contract Staffing, Capacity Building, and Training</i>	83
12 ANTICIPATED FUTURE CHALLENGES	85
12.1 <i>Funding</i>	85
DOT Funding for Stormwater Requirements	85
What Does MS4 Compliance Cost?	86
SAFETEA-LU Provisions Related to Stormwater Control	86
12.2 <i>Cracking Down on Sediment Pollution and Ineffective ESC Plans/SWMPs</i>	87
An Epidemic of DOT Stormwater Court Orders and Consent Decrees	87
12.3 <i>Getting Better Compliance and Adherence to Specifications by Contractors</i>	91
12.4 <i>Compliance Focused EMSs</i>	92
Elements EPA Has Requested in Recent Construction-Focused EMS	92
DOT Motivating Factors	94
12.5 <i>New Emphasis on NPDES Relationships to Endangered Species, Historic Resources, and Wetlands</i>	99
12.6 <i>BMP Effectiveness</i>	100
Maximum Extent Practicable (MEP) Standard	100
Monitoring	102
Narrative Effluent Limits	103
Numeric Effluent Limits	104
Programmatic Approaches to Standards Attainment	109
Antidegradation	110
Could SWPPPs Have to Be Reviewed By Permitting Authorities, in the Future?	113
DOT Research Programs on BMP Effectiveness	113
12.7 <i>TMDL Compliance and Interface with NPDES</i>	113
Response Strategies	114
Atmospheric Deposition	117
12.8 <i>Watershed Approaches to Water Quantity Issues, Treatment Location, and DOT Stewardship Commitments</i>	125
Increasing Attention to Watershed Needs and Managing Water Quantity As It Relates to Quality	127
Pollutant Trading	129
Climate Change Implications for Stormwater Control	130
Watershed Approaches to MS4 Compliance and TMDLs – Rising Staffing Requirements?	132
12.9 <i>Guidance for Work Near Streams</i>	132
Bioengineering Technique Selection	136
Sharing DOT Stormwater Management Plans and Reports	137
13 CONCLUSION	141
APPENDIX A – GLOSSARY	A-1
APPENDIX B – SAMPLE SURVEY	B-1
APPENDIX C – DOT NPDES RESOURCES BY STATE	C-1
APPENDIX D - SAMPLE STATE ACTIVITIES	D-1
CALTRANS Construction Inspection Program	D-1
Arizona’s Storm Water Action Team (SWAT) Program	D-7

Maryland State Highway Administration EMS	D-9
APPENDIX E – SAMPLE SWPPP CERTIFICATION AND FORMS	E-1
Sample SWPP Certification	E-1
Construction SWPPP Checklist	E-2
Grading and Stabilization Record	E-6
Sample Spill Report	E-8
Compliance Evaluation Report General Information	E-9
Sample Site Inspection Form	E-11
Sample Stormwater Monitoring Log	E-20
Sample Compliance Evaluation Report	E-23
BMP Maintenance and Repair Documentation	E-25
Independent Quality Assurance Erosion And Sediment Control Field Investigation Report	E-26
APPENDIX F – SAMPLE DOT ROLES AND RESPONSIBILITIES	F-1

TABLE OF FIGURES AND TABLES

Figure 1: Percent of Responding DOTs with Stormwater Management Plans Covering All 6 Minimum Measures	7
Table 1: Study Focus Group Members	9
Table 2: Dates of First Stormwater Management Plan Completion	13
Table 3: Date of Last SWMP Update	13
Figure 2: Date of Most Recent Stormwater Management Plan Update.....	14
Table 4: Some Public Education and Outreach Activities Undertaken by DOT Respondents ...	16
Table 5: Some Public Participation and Involvement Activities Undertaken by DOT Respondents	21
Table 6: Outfall Mapping And Inspection Program	25
Table 7: Prohibiting Non-Stormwater Discharges through the Adoption of DOT Policy and Enforcement Procedures	26
Table 8: Developing, Implementing, and Enforcing a Plan to Detect and Eliminate Illicit Discharges and Address Non-Stormwater Discharges Including Illegal Dumping.....	26
Table 9: Prohibiting Illicit Discharges from Entering DOT Drainage Facilities and ROW without Proper Permits	27
Figure 3: Wash Water from a Commercial Car Wash Discharging Down a Storm Drain—An Illicit Discharge.....	29
Table 10: DOT Activities to Establish Regulatory Mechanisms or Policies Requiring the Implementation of Proper Erosion and Sediment Controls, and Controls for Other Wastes, on Applicable Construction Sites.....	32
Table 11: Review of Construction Site Plans for Potential Water Quality Impacts.....	33
Table 12: Compliance Inspection Process, Staff, and Training.....	35
Table 13: Enforcement/Contractor Compliance Control Mechanisms.....	36
Figure 4 NCDOT Precipitation Estimator	44
Figure 5: Infiltration Islands Help Reduce and Filter Pavement Runoff.....	51
Table 14: Policies, Guidelines, and Training in Relation to Permanent BMPs.....	51
Table 15: Assessing Impacts of Activities and Planning for Greater Control in Sensitive Areas	52
Table 16: Pollution Prevention and Good Housekeeping Activities	59
Figure 6: How Significant Changes and Improvements to Stormwater Programs are Implemented	61
Table 17: Staffing Approaches to Meeting Additional Responsibilities Imposed by NPDES Phase II MS4 Program	70

Table 18: Locus of Primary Responsibility for NPDES MS4 Program, as Expressed by the DOT (often identifying more than one prime)	71
Table 19: Division(s) with “Primary Responsibility” for the NPDES MS4 Program at State DOTs.....	73
Figure 7: Tools Used to Support and Manage Positions and the NPDES Phase II MS4 Program	76
Table 20: Tools Identified by the DOT as in Use to Support and Manage the NPDES Program	76
Table 21: EMS Status	80
Figure 8: Who Prepares the SWMP Annual Plan Report	80
Example 1: Marina Del Ray TMDL	116
Table 22: Common Pesticides	120
Figure 8: North Carolina Stormwater Export Calculation (Estimation of Exported Nitrogen via Impervious Surface Estimation and BMP Effectiveness).....	131
Example 2: Environmentally Sensitive Channel & Bank-Protection Measures Included in NCHRP Rpt 554	138
Table 23: State DOT Stormwater Management Plans Available on the Web	140
Table 24: MS4 SWM Plans available on-line.....	140

ABSTRACT

The Clean Water Act classifies state departments of transportation (DOTs) as municipal separate storm sewer system (MS4) owners and operators subject to minimum requirements (40 CFR 122.32 and 122.34) to develop, implement, and enforce a stormwater program designed to reduce the discharge of pollutants to the maximum extent practicable. Regulatory guidance from the U.S. Environmental Protection Agency (EPA) has expanded stormwater management programs (SWMPs) under the National Point Source Discharge Elimination System (NPDES) MS4 program to encompass six minimum control measures: 1) public education and outreach on stormwater impacts, 2) public involvement/ participation, 3) illicit discharge detection and elimination, 4) construction site runoff control, 5) post-construction stormwater management in new development and redevelopment, and 6) pollution prevention/good housekeeping.

This research examines how states are meeting the requirements of the Phase II program, to determine and document how state transportation agencies have ensured compliance with National Pollutant Discharge Elimination System (NPDES) Phase II requirements, what approaches were used in this effort, and how the six minimum measures are being met. The range and distribution of strategies employed is examined, and leading practices in meeting some of the most pressing challenges are profiled throughout.

EXECUTIVE SUMMARY

The Clean Water Act classifies state departments of transportation (DOTs) as municipal separate storm sewer system (MS4) owners and operators subject to minimum requirements (40 CFR 122.32 and 122.34) to develop, implement, and enforce a stormwater program designed to reduce the discharge of pollutants to the maximum extent practicable. Regulatory guidance from the U.S. Environmental Protection Agency (EPA) has expanded stormwater management programs (SWMPs) under the National Point Source Discharge Elimination System (NPDES) MS4 program to encompass six minimum control measures: 1) public education and outreach on stormwater impacts, 2) public involvement/ participation, 3) illicit discharge detection and elimination, 4) construction site runoff control, 5) post-construction stormwater management in new development and redevelopment, and 6) pollution prevention/good housekeeping. States have developed a range of approaches for meeting these requirements and for efficiently using existing resources within and outside the agency. DOTs' most pressing challenges with the program have to do with funding and staffing; DOTs have primarily responded by adding responsibilities to existing staff, mainly in Design, Environmental specialists, Construction, and Maintenance.

This research examines how states are meeting the requirements of the Phase II program, to determine and document how state transportation agencies have ensured compliance with National Pollutant Discharge Elimination System (NPDES) Phase II requirements, what approaches were used in this effort, and how the six minimum measures are being met. The range and distribution of strategies employed is examined, and leading practices in meeting some of the most pressing challenges are profiled throughout.

Finally, we look at recent trends with regard to enforcement and methods for achieving compliance in some of DOTs historically most difficult areas. State DOT compliance inspection systems and environmental management systems are reviewed. Threats, challenges, and possible responses related to potential imposition of numeric effluent limits are discussed. The implications of a growing number of pollutant limits and increased requirements for Best Management Practices effectiveness are reviewed, as well as watershed approaches to respond to Total Maximum Daily Loads (TMDLs) and growing concerns regarding hydromodification and climate change. DOT strategies and responses are reviewed, and resources are attached as appendices.

1 INTRODUCTION

1.1 BACKGROUND

Phase II of the National Pollutant Discharge Elimination System (NPDES) program has greatly expanded workloads at state transportation agencies (DOTs). Whether such requirements have gone into effect with DOTs in permits over the past few years or whether such requirements were anticipated and incorporated into existing and sometimes substantial Phase I compliance programs, the effect of the body of NPDES regulations holds the potential to significantly alter the way DOTs plan, design, construct, and maintain transportation facilities.

Phase II mandates impose serious program requirements and challenges that DOTs have had to find ways to address. Coverage of construction sites one acre and larger has significantly increased DOTs' accountability requirements and the need for processes that deliver the desired environmental performance. Treatment of DOTs as municipal separate storm sewer system (MS4) owners and operators, subject to minimum requirements (40 CFR 122.32 and 122.34) to develop, implement, and enforce a stormwater program designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable has expanded stormwater management programs (SWMP) to encompass six minimum control measures: 1) public education and outreach on stormwater impacts, 2) public involvement/ participation, 3) illicit discharge detection and elimination, 4) construction site runoff control, 5) post-construction stormwater management in new development and redevelopment, and 6) pollution prevention/good housekeeping.

The effect of the Phase II regulations varies considerably from state to state. For states that have undertaken statewide outfall inventories and other actions to comply with Phase I, the addition of Phase II requirements has had a lesser impact in terms of organization and staffing. However, much can be learned in terms of program strategies from these states with early and extensive experience with NPDES program requirements. This study investigates how states have been impacted and are meeting the requirements of the new program; documents how state transportation agencies have ensured compliance with NPDES Phase II requirements; identified what approaches were used in this effort; provides examples of how the six minimum measures are being met; and provides states with proven ideas that can be incorporated into their states programs.

States have developed a range of approaches for meeting these requirements and for efficiently using existing resources within and outside the agency. DOTs have commonly "piggy-backed" or joined forces with other agencies to meet public education and involvement objectives.

This research examines how states are meeting the requirements of the Phase II program, to determine and document how state transportation agencies have ensured compliance with NPDES Phase II requirements, what approaches were used in this effort, and how the six minimum measures are being met.

1.2 STUDY PURPOSE

The purpose of this report is to find out how DOTs are meeting the requirements imposed by NPDES Phase II and to facilitate the sharing of that information between states. The objective of this project is to determine and document what strategies and approaches state transportation agencies are using to ensure compliance with NPDES Phase II. The research included surveys and interviews to discover how transportation agencies have addressed (and arranged and staffed their organizations to address) the six minimum control elements of the stormwater management program for MS4s. This report also provides practical information to help transportation practitioners better meet those needs,

handle the associated asset management and organization and staffing challenges, and ensure compliance with Phase II.

1.3 REPORT ORGANIZATION

This report is designed to help transportation practitioners understand the implications, opportunities, and requirements presented by NPDES Phase II, how those requirements are being met by DOTs, and how DOTs may be able to efficiently improve environmental performance.

It contains the following sections:

Chapter 2 briefly summarizes NPDES requirements for DOTs under Phase I and how it differs from Phase II. DOTs requirements as MS4s are introduced. Chapter 3 outlines the survey development and data collection process. Chapter 4 describes the survey results including overall organizational approaches. Chapters 5 through 10 contain detailed results for the six minimum measures. Organization approaches to NPDES compliance is covered in Chapter 11. Chapter 12 details current and future challenges and strategies for meeting those. And finally, Chapter 13 presents conclusions.

2 NPDES PHASE II REQUIREMENTS FOR STATE DOTs

2.1 WHAT IS NPDES AND THE MS4 PROGRAM?

[National Pollutant Discharge Elimination System \(NPDES\)](#) permits are states' primary way to implement pollutant limits and water quality standards for waters and watersheds. The 1977 Amendments to the Federal Water Pollution Control Act (commonly known as the Clean Water Act or CWA) prohibited the discharge of any pollutant to waters of the United States from a point source unless the discharge is authorized by an NPDES permit. At the time of the 1977 amendments to the CWA, sewage treatment plant outfalls and industrial process wastewater were easily identified as point sources¹ responsible for contributing to the degradation of water quality. However, as pollution control measures were instituted, it became evident that more diffuse sources, such as agricultural and urban stormwater runoff, were also contributing to the problem.

In response to this concern, the Water Quality Act of 1987 added Section 402(p) to the CWA and required EPA to establish a comprehensive two-phased approach to address stormwater discharges, through the NPDES permit program. The Clean Water Act amendments, Section 402(p) requires that discharges of stormwater from large and medium municipal separate storm sewer systems (MS4s) and discharges of stormwater associated with industrial activities be in compliance with NPDES permits. MS4 permits require that the discharge of pollutants be reduced to the maximum extent practicable (MEP). Many state DOTs have been classified as Phase I and/or Phase II MS4s.

Phase I

NPDES Phase I attempted to focus on the biggest problems and largest sources; all facilities which discharge pollutants from any point source into waters of the United States were required to obtain a permit. Typically point source discharges include discharges from publicly owned treatment plants, industrial facilities and discharges from urban runoff. DOTs were mainly covered under general permits. A general permit offers a cost-effective option for covering multiple facilities under a specific category or common element and maintaining a general permit. The Phase I regulation, developed in 1990, required all large and medium MS4s (as defined in 40 CFR 122.26 (b)(4) and (7), respectively) to have an NPDES permit covering discharges of stormwater (55 FR 47990). Phase I required NPDES permits for stormwater discharges from:

- “Medium” and “large” municipal separate storm sewer systems (MS4s) generally serving, or located in incorporated places or counties with populations of 100,000 or more people
- Eleven categories of industrial activity, one of which is construction activity that disturbs five acres of land or greater. An NPDES construction permit is required for all DOT construction activities identified in the NPDES General Permit for Stormwater Discharges From Construction Activities published in the Federal Register, Vol. 63, No. 61, Tuesday, March 31, 1998).

Discharges associated with industrial activities were required to meet the technology based standards of best available technology (BAT) economically achievable for toxic pollutants and best conventional pollutant control technology (BCT) for conventional pollutants. In addition, stormwater discharges were not to cause or contribute to the exceeding of water quality standards, as described in permit sections on receiving water limitations. The implementing regulations also described what was to

¹ Point sources discharge pollutants into waters of the United States from discrete conveyances, such as curb and gutters, pipes, drainage outfalls, or man-made ditches.

be included in permit applications and the programmatic elements for a permit and stormwater management program for MS4s or stormwater pollution prevention plan for industrial activities.

Phase II

Phase II required states to assess water quality, identify impaired waters, monitor and report biennially, and limit additional pollutant input. It explicitly included DOTs in its definition of a municipal separate storm sewer system or MS4. Phase II covers remaining smaller municipalities, state DOTs' stormwater conveyance systems, industries, and commercial establishments, and construction sites under five acres (60 FR 40230). The municipal portion of Phase II established a Best Management Practices (BMP) -based program.

In the preamble to the 1999 (Phase II) regulations, EPA recommended using general permits for the sources regulated by the rule. Permit authorities can require individual permits to address specific concerns, for instance, when there may be a question as to whether the permitted discharge will meet water quality standards.

State DOTs have pursued a variety of permitting approaches including:

- Phase II permits by urbanized area, as co-permittee with municipality
- Individual Phase II permit covering DOT MS4 activities in all applicable urbanized areas
- Combining Phase I and Phase II permits (in all applicable urbanized areas and/or statewide)
- Statewide Phase II MS4 permit (i.e. standards and compliance beyond the urbanized areas required under Phase II)
- Combining Phase II MS4 individual permit and construction general permit, statewide

EPA is authorized under the CWA to directly implement the NPDES Program; however, EPA may authorize states, territories, or tribes to implement all or parts of the national program. In such cases, the requirements mandated by the state, territory, or tribe must be at least as stringent as the federal regulations. In most cases, the NPDES permit program is administered by the state Department of public health or environmental quality.

MS4 Requirements

Runoff from roads in urbanized areas are regulated under NPDES permits for MS4s. Such permits must include a requirement to minimize non-stormwater discharges into the storm sewers and to reduce pollutant discharges to the maximum extent practicable (MEP). MS4s are to choose BMPs and "measurable" goals for public education/outreach on stormwater impacts, public involvement/participation, illicit discharge detection and elimination, construction site runoff controls, post-construction stormwater management (permanent BMPs), and pollution prevention/good housekeeping. Measurable goals must meet the MEP standard. Most "measurable goals" are program actions to occur within a particular year of the permit coverage period.

Programs or actions of state, local, and private entities can satisfy minimum control measures for the permittee, relieving the MS4 or DOT of obligation for implementing that control measure. EPA initially encouraged state-wide monitoring and public education programs to fulfill the MEP requirement. While EPA said at the time of publication of the NPDES Phase II rule that it expected no additional monitoring in the first round and limited monitoring in subsequent rounds, the MS4 program leaves the door open for Total Maximum Daily Load (TMDL) allocations and local programs to add requirements in future if standards not met. The same section provides that compliance with state, tribal, or local program can equate to compliance with NPDES. Thus the program enables covered small MS4s to "piggy-back"

on stormwater management program of an adjoining Phase I MS4, by referencing the other's management program.

2.2 PHASE II'S SIX MINIMUM MEASURES FOR MS4s

Phase II requires small MS4 owner/operators to design a stormwater management program to reduce the discharge of pollutants to protect water quality. The successful implementation of approved BMPs is generally considered to be compliance with the maximum extent practicable (MEP) standard. The Phase II Proposed Rule references "narrative effluent limitations" that require the implementation of BMPs and the achievement of measurable goals as the most appropriate form of effluent limitations to achieve the protection of water quality, rather than requiring stormwater discharges to meet numeric effluent limitations. EPA's approach, consistent with the agency's 1996 Interim Permitting Approach policy, calls for BMPs in first-round stormwater permits and expanded or better tailored BMPs in subsequent permits, where necessary, to provide for the attainment of water quality standards. In cases where information exists to develop more specific conditions or limitations to meet water quality standards, such conditions or limitations are sometimes incorporated into the stormwater permit. The Phase II regulation did not require monitoring, which was left to the discretion of the NPDES permitting authority, should it decide monitoring is necessary.

As owners/operators of regulated small MS4s, DOTs (or their co-permittees) are required to submit the following in their NOI or individual permit application:

- BMPs that will be implemented for each of the six minimum control measures:
 - Public education and outreach on stormwater impacts
 - Public participation/involvement
 - Illicit discharge detection and elimination
 - Construction site stormwater runoff control
 - Post-construction stormwater management in new development/redevelopment
 - Pollution prevention/good housekeeping for municipal operations
- Measurable goals for each minimum control measure (i.e., narrative or numeric standards used to gauge program effectiveness).
- Estimated months and years in which actions to implement each measure will be started and completed.
- The person or persons responsible for implementing or coordinating the stormwater program.

The vast majority of DOT Stormwater Management Plans cover all six minimum measure program areas required by EPA. Oregon is an interesting exception; the agency made the case that it did not have the funding to implement public education and involvement requirements, which were being already undertaken by other entities. Hence Oregon DOT's SWMP focuses on the remaining four measures.

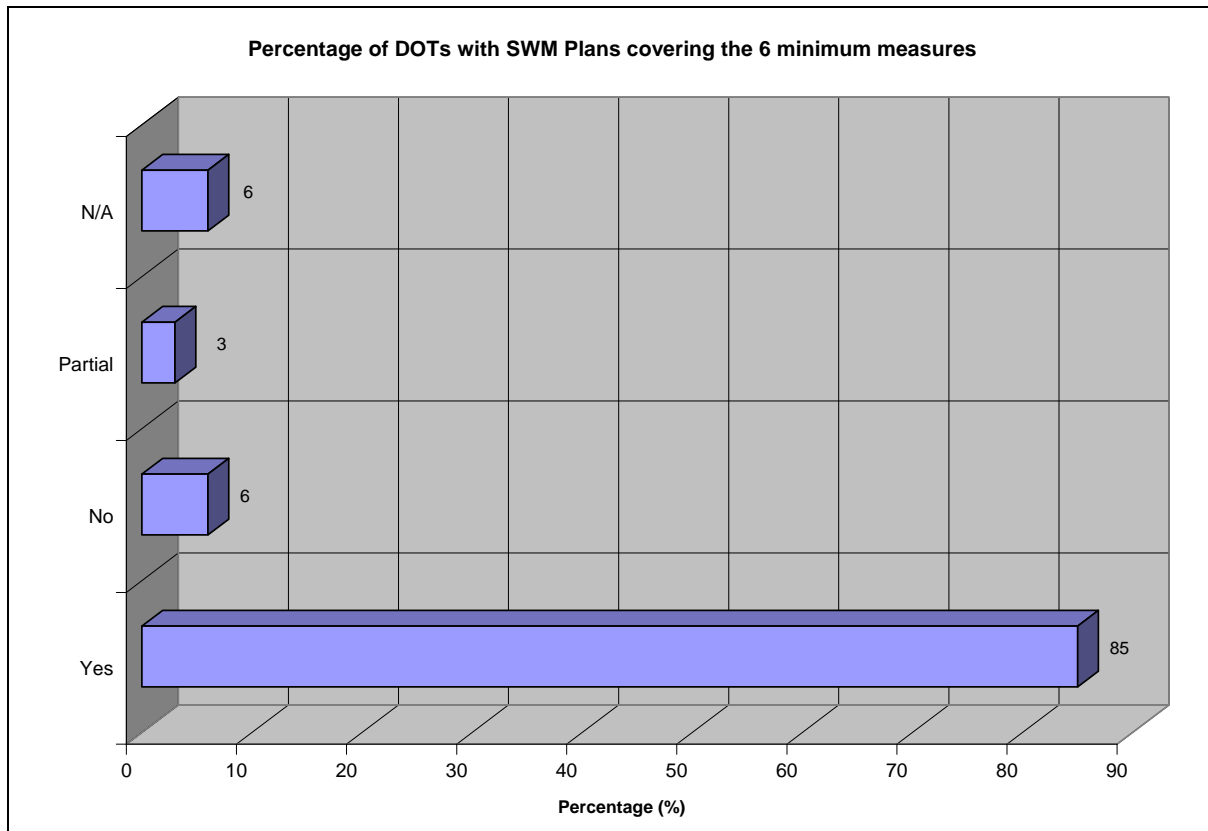


Figure 1: Percent of Responding DOTs with Stormwater Management Plans Covering All 6 Minimum Measures

3 SURVEY DEVELOPMENT AND DATA COLLECTION PROCESS

3.1 SURVEY DEVELOPMENT PROCESS

A focus group of environmental and NPDES program managers at state DOTs were assembled to contribute perspective in identifying some of the basic organizational models and staffing approaches that DOTs are using, including how planning, project development, design, construction, and maintenance staff are involved in various states. The focus group was used as a sounding board to explore various potential performance indicators that were used to discern the degree to which NPDES compliance has been “ensured.”

Members of the focus group were selected based upon the following criteria. Focus group members appear in Table 1.

- Levels of program complexity
- Different geographies
- Different NPDES program sizes
- Newer as well as more established programs
- Both “delegated” and “non-delegated states”
- States representing all 10 EPA Regions

The research team began the development of the survey by collecting a selection of DOT stormwater management plans, and reviewing approaches to the six minimum measures required by EPA, before beginning work with the focus group. This review was designed to help edit and refine the team’s list of potential DOT responsibilities by functional area (e.g. environment, design, construction, maintenance) and approaches to the six minimum measures.

After the preliminary review of several DOT stormwater management plans, a draft survey was provided to our focus group for comment. A delicate balance was achieved between keeping the survey as comprehensive as possible without requiring an excessive amount of energy from state DOTs to complete. The survey team provided both a paper survey and web based survey to help individual states complete the survey as efficiently as possible.

3.2 DATA COLLECTION PROCESS

After the development of the initial survey and review by the focus test groups, the survey was ready for distribution to state DOTs. Refer to Appendix A for a copy of the final survey. Initial survey distribution took place in October 2005. Primarily due to the size of the survey, limited responses were received. Follow up phone calls were placed to individual state DOTs to improve the survey response. Surveys were sent to environmental and NPDES managers for all 50 states, District of Columbia, and Puerto Rico.

The survey team assisted the state DOTs in filling out the survey and gathered sample documents such as copies of permits, annual reports and other DOT publications and manuals as supplements to the initial survey. Follow up phone call interviews were made with several state agencies who felt they could provide information beyond the initial survey data.

Table 1: Study Focus Group Members

Name	Agency	Region	EPA Region	Delegated (D) or Non-delegated (N)	Panelist (P) or not (N)	Program Notes
Sonal Songavi	MDSHA	Mid-Atlantic	3	D	N	➤ National model for drainage system and water quality facility evaluation
Steve Borroum	Former Caltrans	West	9	D	N	➤ Caltrans is one of most comprehensive NPDES programs ➤ Program overhaul required as result of CWA lawsuit
Carol Forrest	URS	Consultant				➤ Experience with MS4 programs of multiple sizes.
Deb Nelson	NYSDOT	Northeast	2	D	P	➤ Panel member
Jerry Chaney	UDOT	Arid Mtn West	8	D	P	➤ Panel member
Pat Cazenias	FHWA	National	N/A	N/A	P	➤ Panel member, FHWA
John Mettille and Shelby Jett	KYTC and Wilbur Smith	Central	4	D	P	➤ Panel members
Doug Delaney and John Hewitt	TDOT	Central/South	4	D	N	➤ In process of overhauling stormwater program due to CWA lawsuit ➤ Implementing EMS
Patty Lynch and Ken Stone	WSDOT	Northwest	10	D	N	➤ TMDL and ESA aspects ➤ Exploring off-site BMPs for water quality ➤ Construction compliance program
Duncan Stewart or designee	TX	Southwest	6	D	N	➤ Large new construction program
Pat Trombly and Henry Barbaro	MA	Northeast	1	N	N	➤ Construction compliance program ➤ EMS extends to NPDES?
Dominique Leukenhoff	EPA	National, regulatory	3	N/A	N	➤ Familiar with DOTs and interested in national performance standards
Dean Yanagisawa	Hawaii DOT	Pacific Islands	9	D	N	➤ In process of overhauling stormwater program due to CWA lawsuit

While all of the state DOTs felt that the survey results would be a very valuable resource, the initial response to the survey was poor. With the large demands on project staff, most DOTs were unable to complete the survey within the short survey period. After speaking with many of the DOTs, most were willing to complete the survey if more time had been available. Therefore, the survey was reissued in December 2005. Because many state staff take time off during the holidays, the survey period was extended through February 2006 to encourage greater participation. During the spring of 2006, 42 states had responded in whole or part to the survey.

4 SURVEY RESULTS

As part of their Phase II requirement to reduce the discharge of pollutants to the “maximum extent practicable” (MEP) and to protect water quality, DOTs and other small MS4s develop stormwater plans addressing public education, public involvement, illicit discharge detection and elimination, construction and post-construction stormwater runoff control, and pollution prevention or good housekeeping measures. Forty-two state DOTs participated in this research effort, sharing what they have already implemented or are planning to implement in the next two years. These strategies to comply with the six Phase II “minimum measure” areas are presented here, including organization approaches, further resources, strategies, and DOT program highlights with regard to how Phase II requirements can be met.

Chapter 4 contains general survey results. Because of the large quantity of information collected, Chapters 5 through 12 will focus on the results related to each of the 6 minimum measures and DOT organizational approaches.

4.1 GENERAL SURVEY RESULTS

State DOTs as MS4s and the Development of Stormwater Management Plans

Almost 75% of responding DOTs (74% - 34 DOTs) self-identified as being regulated as a Phase II MS4. A similar number are automatically designated by the state. Seventy percent of responding DOTs (32 states) said they were delivering a stormwater program prior to Phase II implementation. Six state DOTs said they were not designated as MS4s.

For most DOTs, compliance as an MS4 entails the following requirements:

- Implement programs and practices to control polluted stormwater runoff
- Design stormwater management program
- Satisfy applicable CWA water quality requirements and technology standards
- Include development and implementation of BMPs
- Contain measurable goals for six minimum measures
- Include evaluation and reporting efforts

Major elements include:

- Source identification
- Inventory of drainage systems
- Discharge characterization
- Monitoring and sampling
- Management programs
- Stormwater management facilities inspection & remediation
- Illicit discharges program
- Cooperation with local municipalities

Some actions are identified for immediate or short-term implementation while others are to be undertaken over the long-term. Over the short and long terms, DOTs are expected to be working on

identifying and solving “hot spot” areas of risk and water quality performance, conducting appropriate education and outreach around those areas, and developing strategies for fixing long term problems. Over the longer term, DOTs are expected to evolve their educational programs, retrofit water quality systems, correct illicit discharge problems, restore floodplains, and upgrade septic systems in some cases.

The states listed in Table 2 were able to provide a date when their first Stormwater Management Plan was completed. State DOTs (and consultants) sometimes make use of more recently developed stormwater management plans when updating a plan.

Almost all states responding to this study effort have updated their plans in the last five years. State DOT stormwater management plans often build on the innovations and presentation insights of earlier plans. Given the common business of state DOTs and stormwater management needs, much of this information can be and is duplicated from plan to plan and state to state, an organizational and strategic cost savings.

Approximately half of responding DOTs have updated their Stormwater Management Plans in the past two years (see Figure 2).

Table 2: Dates of First Stormwater Management Plan Completion

First DOT SWMP Completed	State DOTs
1990	CA
1992	AL
1992	CO
1992	UT
1995	TX
1995	OR
1996	MO
1998	AK
1999	NC
2001	MI
2002	SD
2002	SC
2003	DE, IN, KY, LA, MS, ND, NM, NY, VT
2004	MA, ME, MN, RI
2005	AZ, NH
2006	AR

Table 3: Date of Last SWMP Update

Date of Last SWMP Update	State DOT
1999	OR
2002	SC, SD
2003	DE, IN, KY, MI, MS, UT, VA, VT
2004	AK, CA, WV
2005	AL, AZ, LA, MA, ME, NC, ND, NM, OH, TX
2006	AR, CO, RI
In Process	VA, TN, HI, KY

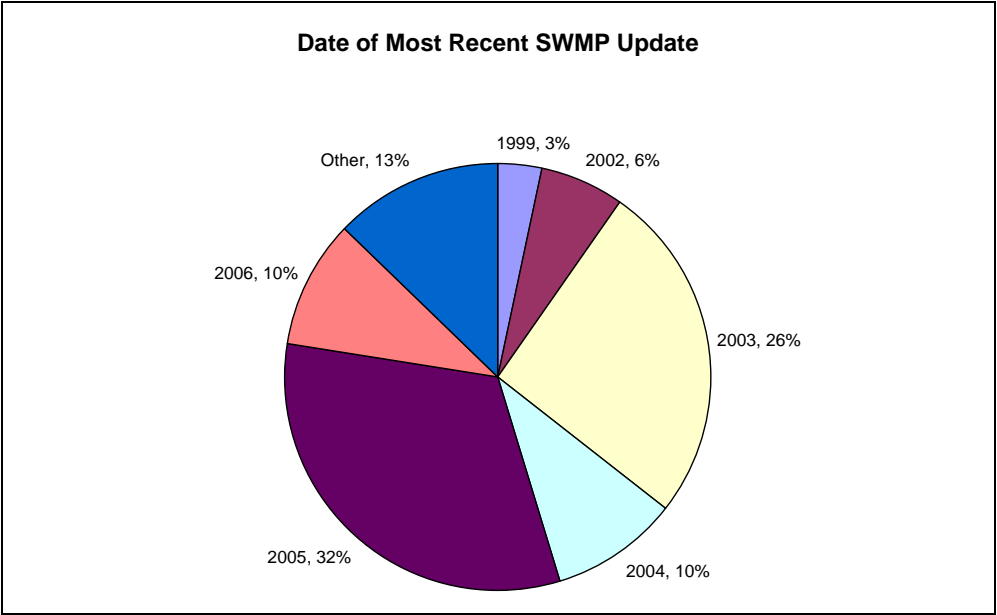


Figure 2: Date of Most Recent Stormwater Management Plan Update

5 PUBLIC EDUCATION AND OUTREACH

EPA's public education and outreach minimum measure for MS4s requires implementation of a public education program. This often involves distributing educational materials or other outreach about the impacts of stormwater discharges on water bodies and informing the public of steps they can take to reduce pollutants in stormwater runoff. The idea is that by working together, state and local agencies can deliver a consistent, coordinated message and be more effective in reducing stormwater pollution. DOTs may be able to leverage the participation, partnership, and combined efforts of other groups in the community. The public involvement minimum measure is intended to build on community capital—interested citizens and groups—to learn about impacts and how to minimize them, to help spread the message, to undertake group activities that highlight storm drain pollution, and to contribute volunteer community actions to restore and protect local water resources.

Phase II MS4s are required to educate their community on the pollution potential of common activities and increase awareness of the direct links between land activities, rainfall-runoff, storm drains, and their local water resources. Such education is supposed to give the public clear guidance on steps and specific actions that they can take to reduce their stormwater pollution-potential. To meet the public education and outreach minimum measure, MS4s:

- Provide education/ training for “municipal” operations
- Distribute educational materials and perform outreach to inform citizens about the impacts polluted stormwater runoff discharges can have on water quality
- Determine appropriate BMPs and measurable goals
- Form partnerships with other entities
- Utilize existing materials and strategies
- Target diverse audiences

5.1 PUBLIC EDUCATION AND OUTREACH ACTIVITIES UNDERTAKEN BY DOT RESPONDENTS

Almost all DOTs offer internal employee training on MS4 requirements and responsibilities. Two-thirds of responding DOTs offer such training for consultants and/or municipalities as well. A similar number of responding DOTs partner with other agencies to meet education and outreach objectives. Around half of respondents distribute information posters, brochures, and fact sheets to employees to improve awareness and assist compliance. Forty-three percent of responding DOTs have established or are establishing a stormwater coordinator for each DOT functional unit, to serve as an education, training, and compliance resource internally.

5.2 STRATEGIES AND BMPs

DOTs have undertaken a wide array of public outreach and education strategies. For example, Delaware DOT (DelDOT) has developed brochures, a website, watershed training, a bookmark, and billing inserts. The agency has conducted outreach events and stormwater presentations for community groups. DelDOT continues to coordinate an “Adopt-a-Highway” program and has also developed a “Delaware nonpoint source materials and educational survey” manual. The agency has produced and distributed a public service announcement and restaurant placemats on stormwater runoff and pollution prevention.

DOTs often partner with other agencies on stormwater education and information campaigns, to maximize cost efficiencies. Each MS4 takes products developed from such an effort and promotes storm

Table 4: Some Public Education and Outreach Activities Undertaken by DOT Respondents

Activity	States Currently Offering	Planned in Next 2 Years	Total	% of DOTs Responding
DOT offers internal employee training	(36) – AK, AL, AZ, CA, CO, DE, HI, ID, IL, IN, KS, KY, LA, MA, MD, ME, MN, MO, MS, MT, NC, ND, NE, NM, NY, OH, OR, RI, SC, SD, TN, TX, UT, VT, WV, WY	(3) – AZ, NJ, VA	39	93%
DOT offers training for municipalities & consultants	(25) – AK, AL, AZ, CO, HI, ID, IL, KY, MA, MD, ME, MN, MO, MT, NC, NM, ND, OH, OR, RI, SC, SD, UT, VT, WV	(3) - MS, NE, VA	28	67%
Informational posters, brochures, fact sheets distributed to employees	(19) – CA, CO, DE, IL, KS, MA, MD, MN, MO, NC, ND, NJ, NY, OH, SD, TX, UT, VT, WV,	(5) - HI, ID, LA, NM, RI	24	57%
Established stormwater coordinator for each DOT functional unit	(16) – AL, CA, CO, HI, ID, IL, KY, MD,ND, NE, NH, NJ, RI, SC, TX, VT	(2) – NM, VA	18	43%
DOT partners with other agencies	(23) – AK, AL, AZ, CA, CO, DE, HI, ID, KS, KY, MD, ME, MN, NC, ND, NH, NM, NY, OH, OR, SC, VT, WY	(4) – AR, NE, RI, VA	27	64%

water awareness in their communities (NY, SD).

Caltrans “Don’t Trash California” Storm Water Public Education Campaign, the agency’s 22-month statewide effort to reduce the amount of pollutants (including litter) that enter the highway storm drains, is based on the agency’s successful three-year, public education pilot program completed in the Fresno Metropolitan Area in 2003. Using a comprehensive, multicultural approach, the “Don’t Trash California” campaign “targets primary offenders of highway littering, as well as the general public, to create a social mindset in California that this State does not tolerate polluting our freeways and highways. The campaign implements proven strategies, including media advocacy, special events, partnerships, paid media and community outreach, to raise the level of awareness of the effects of littering and encourage the public to avoid littering.”

Public input has also been solicited to try to gather information to address pollutant limits imposed by TMDLs. For example Caltrans, the Los Angeles Department of Public Works, the City of LA, Santa Monica BayKeeper, and others have sponsored a public survey to help identify bacterial pollution sources going into Marina del Rey Harbor. An online questionnaire includes questions on the public’s observations of boat maintenance and sanitary pump-outs, irrigation runoff, sanitary sewer overflows, pet wastes, birds (a common source of elevated bacteria in runoff), garbage management, and other sources. Source control is generally the preferred approach for controlling bacteria in runoff since treatment BMPs for bacteria are not generally available.¹

Some other DOT strategies and BMPs are highlighted below:

- **Getting Public Information Officers More Involved.** Some DOTs have begun educating the DOTs’ public information officers about DOT Stormwater Management Practices. NPDES program staff are also coordinating with public information officers to help distribute stormwater educational materials.
- **Stamping Catch Basins with a Pollution Prevention Message.** Since painted messages or images on storm drains ultimately wear off, Ohio DOT has gone to metal stamping. In 2005, ODOT installed 1,675 catch basins stamped with a pollution prevention message.
- **Increased Focus on Personal Appearances, Rest Areas, and Web Communication.** More DOTs are using websites to disseminate stormwater management information. Paper environmental newsletters have been discontinued at NCDOT and others. However, DOTs are still distributing and displaying stormwater materials at community events, fairs, and rest areas. Educational signs related to watersheds have been developed for rest areas and/or posted on the side of the road for further awareness of the general populace.

5.3 LINKS AND RESOURCES

Internal Staff Awareness Building

Some DOT internal awareness building programs include the following

- NY: <http://www.dot.state.ny.us/eab/training/stormwater.pdf>, general overview
- OH: <http://www.dot.state.oh.us/LTAP/Stormwater/1610-1636.pdf>, awareness building for engineers

Promoting the Stormwater Message

EPA assembled the following resources to assist in public outreach beyond notification:²

- [Developing an Outreach Strategy](#)

- [Getting in Step: A Guide for Conducting Watershed Outreach Campaigns \[EPA 841-B-03-002\]](#) - provides many of the tools you will need to develop and implement an effective watershed outreach plan.

The following resources can be adapted and distributed by DOTs.

- [Adopt-A-Stream Programs](#)
- [Reforestation Programs](#)
- [Storm Drain Marking](#)
- [Stream Cleanup and Monitoring](#)
- [Volunteer Monitoring](#)
- [Wetland Plantings](#)
- [Classroom Education on Stormwater](#)
- [Stormwater Outreach for Commercial Businesses](#)
- [Tailoring Outreach Programs to Minority and Disadvantaged Communities and Children](#)
- [Using the Media](#)

Stormwater Outreach Materials

- [Stormwater Outreach Materials and Reference Documents](#) provides outreach materials that municipalities, watershed groups, state, and local governments can customize and use for their own stormwater outreach campaigns, including [Educational Displays, Pamphlets, Booklets, and Bill Inserts](#), [Promotional Giveaways](#), and [Stormwater Outreach Materials](#)
- Pamphlet guidance on [Alternatives to Toxic Substances](#), [Chlorinated Water Discharge Options](#), [Landscaping and Lawn Care](#), [Pest Control](#), [Pet Waste Management](#), [Proper Disposal of Household Hazardous Wastes](#), [Residential Car Washing](#), and [Water Conservation Practices for Homeowners](#).

Other Internet Resources:

- [Indiana Storm Drain Marking Program](#) offers resources to help communities mark storm drains with a “no dumping” or similar message.
- [Charlotte-Mecklenburg Storm Drain Marking Program](#) offers information on ready-made storm drain marking kits for community groups.
- [Upper Chattahoochee Riverkeeper’s Get the Dirt Out](#) works with citizens, developers, and local governments to investigate and study Georgia’s measures to reduce stormwater pollution from construction sites.
- [Nonpoint Source Outreach Digital Toolbox](#) includes a catalog of over 700+ materials (TV/print/radio/give-aways/mascots/ public attitude surveys, evaluations of public response to media campaigns) that can be used in a stormwater public education campaign. (Release date: Fall 2006)
- [After the Storm](#) is a half-hour television special produced by EPA and The Weather Channel on how polluted runoff threatens watersheds. The video is intended for educational and communication purposes in classrooms, conferences, public meetings, public access cable stations etc.
- [Stormwater Education Toolkit](#) from the University of Central Florida (Stormwater Management Academy) includes thousands of educational products organized by target audience, and type of activity that can impact stormwater pollution.

- City of Grand Rapids Environmental Protection Services Department - [Water Spots](#) includes over twenty different radio spots created to educate the public on different aspects of stormwater pollution prevention.
- [Santa Clara Valley Urban Runoff Pollution Prevention Program Watershed Watch Education Site](#) includes numerous downloadable materials and kits.
- City of San Diego's [Think Blue Program](#) is an award-winning multi media campaign on preventing polluted runoff.
- Cooperative Extension's [National Extension Water Outreach Education](#) includes information on improving outreach efforts using "Best Education Practices."
- Kentucky Transportation Cabinet's [Clean Stormwater](#) web page provides links for the general information and education, partner community, and contractors/designers. The latest news link documents the strides Kentucky has made in their MS4 workgroup during the past year.

6 PUBLIC PARTICIPATION AND INVOLVEMENT

Public involvement can include participation in developing and/or implementing a DOT's MS4 program. DOTs may facilitate opportunities for direct action, educational, and volunteer programs such as riparian planting days, volunteer monitoring programs, storm drain marking, or stream-clean up programs. Groups such as watershed groups and conservation corps teams who want to participate in promoting environmental causes are often encouraged and offered opportunities to participate in the stormwater management program.

6.1 PUBLIC PARTICIPATION AND INVOLVEMENT ACTIVITIES UNDERTAKEN BY DOT RESPONDENTS

Sixteen of responding DOTs currently send their stormwater management program elements out for public review, through a public notification process. Two more are planning to begin to do so, for an overall total of 43 percent of respondents. Only 26 percent have community/stakeholder task forces in place to address stormwater issues, but 57 percent hold public hearings or open houses on plan elements. Increasing numbers of DOTs (now 43 percent of the 42 responding DOTs) are providing stormwater program briefings for public officials, either within the DOT or other management, along with informational materials. The same percentage of DOTs provide litter and/or pollution hot lines (direct telephone or internet access to report litter, spills, etc.) for public reporting. Various groups of DOT employees have been trained to watch for pollutant identification in four of the responding states, and four more will be implementing this practice in the next two years (19 percent of respondents). The DOT coordinates or is beginning coordination with Highway Patrol/State Police regarding public complaints or notification by patrol of stormwater issues in a third of responding DOTs. (See Table 5)

6.2 STRATEGIES AND BMPs

In terms of internal education resources, Caltrans' monthly stormwater bulletins are among the best. These one page resources with photos and simply presented information are useful in "tailgate" training sessions or just in staying up-to-date through a quick read. Bulletins were developed for and distributed to Project Development, Design, Construction, and Maintenance staff and are available for other DOTs to use and adapt. Some series were discontinued in 2002, as most of the information had been incorporated into existing processes by then. The bulletins continue to be available on-line as a reference for Caltrans staff and for use by others. The Maintenance pollution prevention bulletin continues to be published every other month. Interested parties can find the series at the links below:

- [Construction Storm Water Pollution Prevention Bulletin](#) A monthly bulletin prepared by the Storm Water Compliance Review Task Force to aid all projects and operations in maintaining compliance with regulatory permit requirements.
- [Post Construction Storm Water Pollution Prevention Bulletin](#) Published every other month, this publication is prepared by the Post Construction Inspection Team to aid all projects and operations in maintaining compliance with regulatory permit requirements.
- [Maintenance Storm Water Pollution Prevention Bulletin](#) Published by the Storm Water Compliance Review Task Force to support the Caltrans maintenance staff in its efforts to achieve and maintain compliance with regulatory requirements for storm water pollution prevention.
- [Project Development Bulletin](#) Prepared as an information resource on storm water quality issues related to the planning and design of transportation infrastructure.

Table 5: Some Public Participation and Involvement Activities Undertaken by DOT Respondents

Activity	States Currently Offering	Planned in Next 2 Years	Total	% of All DOT Respondents
DOT provides public notification and review of program elements	(16) - AZ, CA, HI, ID, LA, ME, MI, MN, MS, NC, NM, NJ, NY, TN, VT, WV	(2) - AR, RI	18	43%
DOT holds public hearings and open houses	(23) - AK, AL, AZ, CA, HI, ID, IL, LA, MD, ME, MN, MS, NC, ND, NH, NJ, NM, NY, UT, VA, VT, WV, WY	(1)- RI	24	57%
DOT has community/stakeholder task forces in place to address stormwater issues	(8) - ID, MD, ME, MI, NH, NY, RI, WY	(3) - HI, MN, NM	11	26%
DOT provides stormwater program informational brochures and briefings for public officials (DOT management, politicians)	(12) - CO, IL, KS, KY, MD, ME, NC, ND, OH, RI, SC, WV,	(6) - CA, HI, ID, MN, NM, SD	18	43%
DOT provides litter and/or pollution hot lines (direct telephone or internet access to report litter, spills, etc.) for public reporting	(14) - AK, AL, AR, AZ, CO, DE, MN, MS, NC, NM, OR, TN, TX, WY,	(4) - HI, ID, LA, SD	18	43%
DOT coordinates with Highway Patrol / State Police regarding public complaints or notifies patrol of stormwater issues	(10) - AL, AR, CO, KS, MS, NC, NM, MS, UT, VA	(4) - CA, HI, ID, SD	14	33%
DOT employee watch groups for pollutant identification	(4) - CO, MS, NC, NM	(4) - HI, ID, SC, UT	8	19%

6.3 LINKS AND RESOURCES

Soliciting Public Opinion

- [Attitude Surveys](#)
- [Stakeholder Meetings](#)
- [Watershed Organizations](#)

EPA Internet Resources:

- [Stormwater case studies on public involvement](#) includes case studies of how a Phase I or Phase II community has implemented the public involvement requirements.
- [EPA's Volunteer Monitoring Program](#) provides information on developing and implementing a volunteer monitoring program.
- [Getting in Step: Engaging and Involving Stakeholders in Your Watershed](#) [PDF - 1.34MB - 80 pp] provides the tools needed to effectively identify, engage, and involve stakeholders throughout a watershed to restore and maintain healthy environmental conditions.

7 ILLICIT DISCHARGE DETECTION AND ELIMINATION

Illicit discharges are generally any discharge into a storm drain system that is not composed entirely of stormwater. The exceptions include water from firefighting activities and discharges from facilities already under an NPDES permit. Unlike wastewater which flows to a wastewater treatment plant, illicit discharges enter stormwater flow waterways, without any treatment. Such discharges often include pathogens, nutrients, surfactants, and various toxic pollutants.

Phase II MS4s are required to develop a program to detect and eliminate these illicit discharges. This primarily includes developing:

- A storm sewer system map (e.g. permanent drainage structures and controls, outfalls, etc.)
- Plans to detect and address these illicit discharges (including training for inspectors) and appropriate referrals to enforcement agencies.

Municipalities are encouraged to develop ordinances prohibiting discharges and education programs on the hazards associated with illicit discharges. DOTs are expected to help control such discharges through hook-up and encroachment policies.

Regulatory agencies expect both proactive and reactive elements of an illicit discharge program. The program must respond to discovered spills and other illicit discharges to the storm drain system. The program must also be proactive in preventing and eliminating illicit discharges through education and training of inspectors, and enforcement.

A few DOTs indicated that they were ahead of the curve on MS4 program implementation in general, and that “the only minimum measure we have had to put an effort into is Illicit Discharge Detection and Elimination (IDDE). The rest has been documenting our standard procedures.” The IDDE area typically requires more effort by DOTs. The multiple actions that can go into DOT development of an IDDE program are described below.

7.1 ILLICIT DISCHARGE DETECTION AND ELIMINATION ACTIVITIES UNDERTAKEN BY DOT RESPONDENTS

One of the key activities DOTs must undertake with regard to Illicit Discharge Detection and Elimination is development of a storm sewer map showing the location of all outfalls and the names and locations of all waters of the U.S. that receive discharges from those outfalls. DOTs are well on their way to meeting stormwater management requirements in this area. Almost 70 percent of respondents have GIS/electronic mapping in place. Sixty-two percent either have or are developing a database of storm drain outfalls. A similar number already have or are conducting field surveys to verify inlet and outfall locations.

Forty-one percent of responding DOTs are mapping their entire drainage system. “As-built” plans and existing drainage plans are being reviewed by a little over half of respondents. Six of the 42 responding states said all of their drainage and GIS maps are up-to-date (AZ, KS, LA, MD, ME, NM). Thirteen others have plans to achieve this in the next two years, for a total of 45 percent of respondents overall. Over half of responding DOTs are working with or have plans to work with other MS4s on storm drain mapping requirements.

Half of responding DOTs have an inspection program in place to regularly assess outfall and drainage system conditions. Alabama, Kansas, Maryland, Mississippi, New Mexico, and Rhode Island track outfalls that drain to sensitive watersheds differently than others, to facilitate implementation of a greater level of control in those watersheds. Seven other states are adding this capacity (AZ, CA, HI, ID, MA, NC, OH); however, this still totals less than a third of responding states.

DOTs that have not yet developed outlet screening protocols can use protocols already in place by 12 responding states (AR, CA, DE, MD, MI, NH, NJ, NM, NY, OH, RI, SC) as a base reference. During inspections for IDDE, field inspectors assess whether structures are in need of repair or retrofit in 19 responding states. Six others plan to include this in the future. Nevertheless, fewer than 20 percent of responding state DOTs incorporate identified retrofit needs into maintenance budgets (DE, MD, MN, NM, VA). Hawaii, Idaho, and Rhode Island plan to begin doing this in the next two years. (see Table 6)

Fifteen of the 42 responding DOTs have the authority in place to establish and/or enforce state regulatory mechanisms prohibiting illicit discharges. Four other DOTs are in the process of getting such authority. Though 45 percent of respondents are increasing these abilities, other creative approaches are being employed where this does not exist. For example, NCDOT has implemented an on-line form that can be filled out by staff or the public, which is automatically submitted to the regulatory agency. DOTs have adopted ordinances or codes established by applicable local jurisdictions in eight states. Approximately a quarter of DOTs overall are implementing or plan to implement this approach. Two-thirds of states have regulations in place or in process to prohibit non-stormwater discharges. (See Table 7)

Almost 75 percent of responding DOTs have an encroachment permitting process in place or in the works. Caltrans will have one in place in the next two years. Two-thirds have protocols in place to address illicit discharges in a timely manner after they are discovered or are in the process of developing such protocols. Only three respondents (AK, MD, NY) currently track encroachment permits and violations tracked in a GIS or database system; however, 10 more DOTs plan to implement such a system in the next two years (totaling 31% of the 42 responding DOTs). Almost half of DOTs have education programs in place or planned in the next two years, to inform public employees, businesses and the general public about the hazards associated with illicit discharges and improper disposal of waste.

Two-thirds of responding DOTs have an Illicit Discharge Detection and Elimination (IDDE) plan in place or planned for implementation in the next two years. In almost half of responding DOTs, the plan is identifying illicit discharges through a formal program that regularly investigates and identifies suspected sources of illicit connections and improper disposal.

In 60 percent of responding DOTs, the IDDE plan includes training for DOT staff in identification of illicit discharges and reporting/documentation procedures. The same percentage of DOTs has established partnerships with local stormwater agencies. Fifty-seven percent have or are developing plans to remove or correct illicit connections when they are found.

Table 6: Outfall Mapping And Inspection Program

Activity	States Currently Offering	Planned in Next 2 Years	Total	% of DOT Respondents
Hard copy mapping in-place	(14) - AK, AL, AZ, CA, DE, MD, ME, MI, NC, NJ, NM, TN, UT, WV,	(10) - CO, HI, ID, MA, MN, NE, NY, OH, SC TX,	24	57%
GIS / electronic mapping in place	(13) - AK, AR, CA, DE, LA, MD, NC, NM, NH, RI, TN, VT, WY	(16) - AZ, CO, HI, ID, IL, MA, ME, MN, MS, NJ, NY, OH, OR, SC, TX, VA	29	69%
DOT maps its entire drainage system	(5) - AL, AR, KS, MD, ME	(12) - AK, AZ, CO, DE, HI, ID, MN, NJ, NM, OR, RI, WV,	17	41%
As-builts / existing drainage plans have been reviewed	(11) - AL, CA, DE, MD, MI, NE, NM, OH, SC, VT, WV	(11) - AK, CO, HI, ID, MA, ME, MN, NJ, NY, RI, TX	22	52%
A database of storm drain outfalls exists	(14) - AR, CA, DE, KS, LA, MD, ME, MI, NC, NH, NM, OH, UT, VT	(12) - AK, AR, AZ, CO, HI, ID, MA, MN, NJ, NY, RI, TX	26	62%
A field survey has been conducted to verify inlet and outfall locations	(16) -AR, AZ, CA, DE, MD, MI, NH, NJ, NM, OH, UT, VT, WV, WY	(11) - AK, AR, CO, HI, ID, MA, NY, MN, OR, RI, TX	27	64%
DOT has outfall screening protocols	(12) - AR, CA, DE, KS, MD, ME, MI, NH, NJ, NM, NY, OH, RI, SC,	(10) - CO, HI, ID, LA, MA, ME, TX, UT, VT, WV	22	52%
During field surveys inspectors look for structures in need of repair or retrofit	(19) - AK, AL, AR, AZ, DE, KS, MD, MI, MN, ND, NH, NJ, NM, NY, OR, RI, SD, TN, VT	(6) - CO, HI, ID, MA, SC, TX	25	60%
Repair and retrofits are incorporated into the overall SWM budget	(5) - DE, MD, MN, NM, VA	(3) - HI, ID, RI	8	19%
Drainage and GIS maps are up to date	(6) - AZ, KS, LA, MD, ME, NM	(13) - AK, CA, CO, DE, HI, ID, MN, MS, NC, NY, RI, TX, VT	19	45%
Outfalls that drain to sensitive watersheds are tracked differently	(6) - AL, KS, MD, MS, NM, RI	(7) - AZ, CA, HI, ID, MA, NC, OH	13	31%
Agency partners with other MS4s with NPDES storm drain mapping requirements	(15) - AL, AR, AZ, CA, ID, KS, KY, MD, ME, NH, NM, SC, TN, VT, WY	(8) - AK, AZ, CO, HI, MA, NY, RI, SD	23	55%
DOT has an inspection program in place to regularly assess outfall and drainage system conditions	(10) - AL, AR, AZ, MD, MI, MN, NJ, NM, WV, WY	(11) - AK, CA, CO, DE, HI, ID, MA, ME, RI, UT, VT	21	50%

Table 7: Prohibiting Non-Stormwater Discharges through the Adoption of DOT Policy and Enforcement Procedures

Activity	States	Planned in Next 2 Years	Total	Percent of Responding DOTs
DOT has the authority in place to establish and/or enforce state regulatory mechanisms prohibiting illicit discharges	(15) - AL, CA, DE, KS, LA, MD, MI, NE, NM, OH, OR, SD, TN, UT, VT	(4) - HI, ID, MA, NY	19	45%
State has regulations in place prohibiting non-stormwater discharges	(25) - AK, AL, AR, CA, CO, DE, HI, ID, KY, LA, MD, ME, MN, MS, NC, ND, NE, NM, OH, OR, RI, SC, SD, VT, WY	(3) - MA, NY, WV	28	67%
DOT adopts ordinances/codes established by applicable local jurisdictions	(8) - AL, AZ, LA, MN, MO, ND, NM, SD	(3) - AK, HI, ID	11	26%

Table 8: Developing, Implementing, and Enforcing a Plan to Detect and Eliminate Illicit Discharges and Address Non-Stormwater Discharges Including Illegal Dumping

Activity	States	Planned in Next 2 Years	Total	% of DOTs Responding
DOT has an encroachment permitting process	(30) - AK, AL, AZ, HI, ID, IL, KY, LA, MA, MD, ME, MI, MN, MO, MT, NC, NE, NJ, NM, NY, OH, OR, RI, SC, TX, UT, VA, VT, WV, WY	(1) - CA	31	74%
Protocols are in place to address illicit discharges in a timely manner after they are discovered	(16) - AL, CA, CO, DE, LA, MD, ME, MI, MS, NE, NH, NJ, NM, OR, WV, WY	(12) - AK, AR, AZ, HI, ID, MA, NY, OH, RI, SC, TX, VT,	28	67%
Encroachment permits and violations are tracked in a GIS or database system	(3) - AK, MD, NY	(10) - AR, CA, CO, HI, ID, MN, NM, RI, SC, TX	13	31%
Education programs are in place to inform public employees, businesses and the general public about the hazards associated with illicit discharges and improper disposal of waste	(12) - CO, DE, ME, MI, MS, NC, NJ, NM, OH, UT, VT, WV	(8) - AK, AR, AZ, HI, ID, MN, RI, TX	20	48%

Table 9: Prohibiting Illicit Discharges from Entering DOT Drainage Facilities and ROW without Proper Permits

Activity	States	Planned in Next 2 Years	Total	% of DOTs Responding
DOT has an illicit discharge detection and elimination plan	(16) - AL, AZ, CA, CO, DE, MA, MD, MI, MS, NC, NH, NJ, NM, OR, SC, WV	(12) - AK, AR, HI, ID, LA, ME, NY, OH, RI, TX, UT, VT,	28	67%
The elimination plan identifies illicit discharges through a formal program that regularly investigates and identifies suspected sources of illicit connections and improper disposal	(11) - AL, DE, MD, MI, MS, NC, NJ, NM, OR, SC, WV	(9) - AR, AZ, CA, CO, HI, ID, RI, UT, VT	20	48%
DOT has a plan to remove/correct illicit connections	(11) - AL, CA, DE, KY, MD, ME, MI, NM, OR, SC, WV	(13) - AR, AZ, CO, HI, ID, MA, NJ, NY, OH, RI, TX, UT, VT	24	57%
The elimination plan includes training for DOT staff in identification of illicit discharges and reporting/documentation procedures	(10) - AL, CO, DE, MD, MI, NH, NM, OR, SC, WV	(15) - AR, AZ, CA, HI, ID, LA, MA, ME, NJ, NY, OH, RI, TX, UT, VT	25	60%
DOT has established partnerships with local stormwater agencies	(20) - AK, AL, AZ, DE, KY, MD, ME, MN, MS, NC, ND, NH, NM, NY, OR, SC, UT, VA, VT, WY	(5) - AR, HI, ID, LA, RI	25	60%

7.2 STRATEGIES AND BMPs

Right-of-Way Access Permitting

After getting a low response to inquiries to local health and permitting departments, Ohio DOT decided that right-of-way (ROW) access permitting process was the most effective and efficient method for the DOT to control new and existing non-stormwater discharges to its storm sewer system. ODOT has modified the process for issuing ROW use permits to account for new regulations from the Ohio Department of Health as well as future NPDES permits for Household Sewage Treatment System (HSTS) discharges. Guidance was developed and distributed to ODOT staff responsible for issuing these permits. ODOT plans to use the issuance of right-of-way use permits, in addition to the available HSTS health department data, as a means of tracking and producing a map of HSTS discharges into ODOT's MS4. ODOT called this BMP "Appropriate Permitting and Mapping of Non-Stormwater Discharges."

Stormwater Outfall Inventories

Pilot Stormwater Outfall Inventories have been completed in many states, and DOTs are now embarking on full data collection efforts. Ohio DOT launched a statewide MS4 area stormwater outfall inventory after development of a web-based data collection tool for outfall data, completion of a comprehensive manual on how to perform the inventory, and selection of consultant teams to inventory defined areas. As part of its outfall inventory effort, the Ohio DOT developed and is making available the DOT's [Outfall Inventory Manual](#). Some state DOTs (including NMDOT) utilized students to help with field inventory efforts. Other states completed a significant portion of their outfall inventories under NPDES Phase I, and have moved on to develop stormwater drainage infrastructure evaluation systems for DOT asset management, which are conducted at the same time that illicit discharge detection monitoring occurs. These are described in more detail under Post-Construction controls.

Maryland SHA's BMP and stormwater drainage asset evaluation program is considered a model in the country, and MDSHA has offered to share their protocols with other DOTs. These resources are not available on the web.

7.3 LINKS AND REFERENCES

A key reference for Illicit Discharge Detection and Elimination is the Guidance developed by the Center for Watershed Protection: [Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments](#), which outlines practical, low cost, and effective techniques for stormwater program managers and practitioners. The guidelines include details on creating and managing an IDDE program, timelines that estimate how long program implementation will take, information on estimating program costs in terms of capital and personnel expenses, and types of testing used to detect stormwater illicit discharges. This manual provides valuable guidance for communities and others seeking to establish IDDE programs.

EPA's online resources include:³

- [Developing a Used Oil Recycling Program](#)
- [Illegal Dumping Control](#)
- [Trash Management](#)
- [Preventing Septic System Failure](#)
- [Community Hotlines](#)
- [Stormwater case studies on illicit discharge detection and elimination](#) includes case studies of how a Phase I or Phase II community has implemented the illicit discharge requirements.



Figure 3: Wash Water from a Commercial Car Wash Discharging Down a Storm Drain–An Illicit Discharge.

- [Non-Stormwater Discharges](#) is a fact sheet on controlling Non-Stormwater Discharges to the storm drain system.
- [EPA Region 5 Illegal Dumping Prevention Program](#) was established to exchange information and establish partnerships to develop and implement strategies to combat illegal dumping.

8 CONSTRUCTION SITE STORMWATER RUNOFF CONTROL

Construction Site Stormwater Runoff Control is designed to avoid damage to rivers, lakes and estuaries from peak flows, sediment, and pollutants sorbed to sediments. Sediment from construction sites can clog fish gills, smother aquatic habitat and spawning areas, impede navigation, and reduce the amount of sunlight reaching aquatic plants.

DOTs and other Phase II MS4s are required to develop and implement an effective program to reduce pollutants in runoff to stormwater conveyances (e.g. gutters, drains, etc.) from construction sites of one acre or more. DOTs sometimes apply such standards statewide, with an exception process for activities that do not remove groundcover. A construction site stormwater runoff control program includes:

- Requirements to implement erosion and sediment control BMPs
- Requirements to control other waste at the construction site
- Procedures for reviewing construction site plans
- Procedures to receive and consider information submitted by the public
- Procedures for inspections and enforcement of stormwater requirements at construction sites

In addition to the stormwater requirements that Phase II MS4s place on construction sites, construction owners or operators must also apply for NPDES permit coverage if their project disturbs at least one acre and discharges to a water body, usually under a construction general permit. Caltrans has combined the agency's MS4 and construction general permit in one overarching document and program.

8.1 CONSTRUCTION SITE STORMWATER RUNOFF CONTROL ACTIVITIES UNDERTAKEN BY DOT RESPONDENTS

Establishing Policies and Other Mechanisms to Ensure Proper Implementation of Controls on Construction Sites

Virtually all DOTs have standard construction specifications for stormwater, erosion control and grading and standard specs and special conditions for specific BMPs. Over 80 percent of responding DOTs have a Construction BMP manual tailored to their own agency. Over 85 percent have a DOT erosion and sedimentation control manual. In over half of responding DOTs, this manual has been approved by the state or local regulatory agency. Over 80 percent of responding DOTs have regular stormwater training programs planned or in place for DOT employees, consultants and contractors working on DOT projects.

Construction SWPPP Review and Tracking

Virtually all DOTs conduct site plan reviews for construction stormwater compliance as part of the plan review process. Forty-one percent have a state compliance database or other tracking system in place, or planned for implementation by 2007. Such databases track active permitted projects and completed projects. At 24 percent of responding DOTs, the database is also used to track the area of disturbance and impervious area created or such capacity is being added. Alabama, Delaware, Idaho, Maryland, Minnesota, and Vermont already have systems with this ability. California, Colorado, Hawaii, and New Mexico are adding it.

Table 10: DOT Activities to Establish Regulatory Mechanisms or Policies Requiring the Implementation of Proper Erosion and Sediment Controls, and Controls for Other Wastes, on Applicable Construction Sites

Activity	States	Planned in Next 2 Years	Total	% of All DOT Respondents
DOT Standard Construction Specifications for Stormwater, Erosion Control and Grading	(42) - AK, AL, AR, AZ, CA, CO, DE, GA, HI, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NY, OH, OR, RI, SC, SD, TN, TX, UT, VA, VT, WV, WY,	0	42	100%
DOT Standard Specs/Special Conditions for specific BMPs	(38) - AL, AR, AZ, CA, CO, DE, GA, HI, ID, IL, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, ND, NE, NH, NM, NY, OH, OR, RI, SC, SD, TN, TX, UT, VA, VT, WV, WY,	(3) - IN, NC, NJ	41	98%
DOT approved Construction BMP Manual	(31) - AK, AL, AZ, CA, CO, DE, GA, HI, ID, KS, KY, MA, MD, ME, MI, MN, MO, MT, ND, NE, NH, NM, OR, RI, SC, SD, TN, UT, VA, WV, TX	(3) - IN, NC, VT	34	81%
DOT approved Erosion & Sediment Control Manual	(32) - AK, AL, AR, AZ, CA, CO, DE, GA, HI, ID, IN, KS, KY, MD, ME, MI, MN, MO, MT, NC, NE, NH, NJ, NM, OR, RI, SC, SD, TX, UT, VA, WV	(4) - LA, MA, TN, VT	36	86%
DOT BMP & Erosion Sediment Control Manuals are approved by local environmental regulatory agencies	(21) - AL, AZ, CA, CO, DE, GA, HI, ID, KS, MD, ME, MI, MN, MT, NC, NM, RI, SD, TN, UT, VA	(3) - LA, OR, VT	24	57%
Regular Stormwater training programs are in place for DOT employees, consultants and contractors working on DOT projects	(30) - AK, AL, AZ, CA, CO, DE, GA, ID, IL, KY, MA, MD, ME, MN, MO, MT, NC, NH, NM, NY, OR, RI, SC, SD, TX, UT, VA, VT, WV, WY	(5) - AR, AZ, HI, IN, NE	35	83%

Table 11: Review of Construction Site Plans for Potential Water Quality Impacts

Activity	States	Planned in Next 2 Years	Total	% of All DOT Respondents
DOT conducts site plan reviews for construction stormwater compliance as part of review process	(36) – AL, AZ, CA, CO, DE, GA, ID, IL, IN, KS, KY, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NY, OR, RI, SC, SD, TN, UT, VA, VT, WV, WY	(1) HI	37	88%
DOT has a state compliance database/tracking system	(10) – AL, DE, LA, MD, MN, MO, MT, ND, TN, VT	(7) – AZ, CA, CO, HI, ID, NE, NM	17	41%
DOT database tracks active permitted projects	(11) – AL, AR, DE, MA, MD, MO, MN, MT, TN, VT, WV	(5) – CO, HI, ID, NE, NM	16	38%
DOT database tracks completed projects	(9) – AR, LA, MD, MT, ND, NJ, TN, VT, WV	(7) – CA, CO, HI, ID, MN, NE, NM	16	38%
DOT database tracks area of disturbance and impervious area created	(6) – AL, DE, ID, MD, MN, VT	(4) – CA, CO, HI, NM	10	24%
SWPPP reviews are conducted during construction inspection to ensure plan conformance	(36) – AK, AL, AR, AZ, CA, CO, DE, GA, ID, IL, KS, MA, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NY, OR, RI, SC, SD, TN, TX, UT, VA, VT, WV, WY	(1) - HI	37	88%
DOT administers construction NPDES program for projects in DOT right of way	(28) – AL, AK, AZ, CO, DE, GA, HI, ID, IL, KS, LA, MA, MD, ME, MN, MO, MS, NC, ND, NE, NH, NM, OH, OR, SC, SD, UT, WV	(0)	28	67%
DOT has standardized SWPPP templates for typical DOT projects	(29) – AL, AZ, CA, CO, DE, GA, ID, IL, KS, MA, MD, ME, MN, MO, MS, MT, NC, NH, NJ, NM, OH, SC, SD, TN, TX, UT, VA, VT, WV	(4) – HI, NE, NY, OR	33	79%

Almost 90 percent of responding DOTs conduct reviews of stormwater pollution prevention plans (SWPPPs) during construction to ensure plan conformance. Two-thirds of responding DOTs administer the construction NPDES program for projects in the DOT right-of-way. Almost eighty percent have standardized SWPPP templates for typical DOT projects available or in process.

Site Inspection and Enforcement of Control Measures

Two-thirds of responding DOTs have established NPDES compliance inspectors at the DOT. Almost 75 percent train DOT field engineers to perform NPDES compliance inspections. Over 70 percent have trained or are developing training for design staff (engineers, landscape architects) in construction methods for BMPs.

The same percentage (71 percent of respondents) manage and prioritize erosion and sedimentation control inspections. Sixty percent provide contractor training and outreach. Forty-eight percent of responding DOTs either have or are developing a certification process to ensure BMPs are constructed according to design requirements. Forty-five require contractors to be pre-certified to perform design or construction of BMPs.

Over three-quarters of DOTs provide construction oversight during BMPs construction. Sixty percent say they have QA/QC programs in place to ensure that BMPs are designed according to plans and specifications and functioning as intended.

Enforcement/Contractor Compliance Control Mechanisms

About 70 percent of DOTs have or are implementing an established code or policy for runoff control from construction sites; however, almost all DOTs have standard specifications for erosion control, stabilization, or grading. Approximately 30 percent of responding DOTs have a stormwater hotline or other mechanism to receive public/state patrol complaints regarding construction violations. A similar number of DOTs have a complaint tracking system.

Compliance inspectors can issue “stop work” orders in around 60 percent of responding DOTs. They can issue fines for non-compliance in just over a quarter. The DOT issues sanctions non-compliance with erosion and sediment control practices during construction and civil and criminal penalties can be passed along to the Contractor for non-compliance in about half of responding DOTs; three more DOTs with recent consent orders are adding this capability.

Risk Assessment, Systematic Performance Evaluation and Tracking

Decision Support for Risk Assessment and Performance Tracking

Database and decision support systems are assisting DOTs in assessing risk and directing resources where they can hone in on potential problem areas and efficiently improve performance. Nearly forty percent of responding DOTs said they have a state compliance database or other tracking system in place or planned for implementation by 2007. Such databases track active permitted projects and completed projects. At 25 percent of responding DOTs, the database is also used to track the area of disturbance and impervious area created or such capacity is being added. Alabama, Delaware, Idaho, Maryland, Minnesota, and Vermont already have systems with this ability. California, Colorado, Hawaii, and New Mexico are adding it.

Table 12: Compliance Inspection Process, Staff, and Training

Activity	States	Planned in Next 2 Years	Total	Percent of States Answering Yes
There are established NPDES compliance inspectors	(25) - AL, AR, AZ, CA, CO, DE, GA, ID, MD, ME, MN, MO, MT, NC, NH, NM, NY, OR, SC, TN, TX, UT, VA, VT, WV	(3) - HI, NE, NJ	28	67%
Design staff (engineers, landscape architects) are trained in the construction methods for BMPs	(26) - AL, AR, AZ, CO, CA, DE, GA, ID, IL, IN, KY, MD, ME, MN, MO, MT, NM, OR, SC, SD, TX, UT, VA, VT, WV, WY	(4) - AZ, HI, NE, RI	30	71%
DOT field engineers are trained to perform NPDES compliance inspections	(27) - AL, AR, AZ, CA, CO, DE, GA, ID, IL, MA, MD, ME, MN, MO, MT, NJ, NM, NY, OR, SC, SD, TX, UT, VA, VT, WV, WY,	(4) - HI, IN, NE, RI	31	74%
Regular contractor training and outreach provided	(20) - AL, AZ, CO, DE, GA, ID, KY, MD, ME, MN, MT, NC, NM, RI, SC, SD, UT, VA, WV, VT	(5) - AR, HI, IN, NE, OR	25	60%
DOT manages and prioritizes ESC inspections	(26) - AL, AR, AZ, CA, CO, DE, GA, ID, MA, MD, ME, MN, MT, NC, NH, NM, NY, OR, RI, SC, SD, TN, UT, VA, WV, VT	(4) - HI, IN, NE, NJ	30	71%
There is a certification process to ensure BMPs are constructed according to design requirements	(16) - AL, AZ, CO, DE, GA, ID, MD, ME, MN, MT, NM, NY, SC, SD, UT, VA	(4) - HI, KY, NE, OR	20	48%
Contractors are required to be pre-certified to perform design or construction of BMPs	(15) - AL, AZ, CA, CO, DE, GA, ID, MD, ME, MN, NH, NM, RI, UT, VA	(4) - HI, MA, OR, SD	19	45%
DOT provides construction oversight during BMPs construction	(31) - AK, AL, AR, AZ, CA, CO, DE, GA, ID, KY, MA, MD, ME, MN, MO, MT, ND, NE, NH, NM, NY, OR, RI, SC, SD, TN, UT, VA, VT, WV, WY	(1) – HI	32	76%
There are QA/QC programs in place to ensure that the BMP is designed according to plans/specs and that it is functioning as intended	(20) - AL, AZ, CA, CO, DE, MA, MD, ME, MN, MT, NH, NM, NY, RI, SC, TN, UT, VA, VT, WV	(5) - AZ, HI, ID, NE, OR	25	60%

Table 13: Enforcement/Contractor Compliance Control Mechanisms

Activity	States	Planned in Next 2 Years	Total	% of DOTs Responding
There is an established Code or Policy	(28) - AK, AL, CA, CO, DE, GA, HI, ID, IL, KS, KY, MD, ME, MN, MO, MT, NH, NM, NY, OH, OR, SC, SD, TN, VT, UT, WV, WY	(2) - NE, RI	30	71%
There are established Standard Construction Specifications for Stormwater, Erosion Control, or Grading	(36) - AK, AL, AR, CA, CO, DE, GA, HI, ID, IL, IN, KS, KY, MA, MD, ME, MN, MO, MT, NC, NE, NH, NM, NY, OH, OR, RI, SC, SD, TN, TX, UT, VA, VT, WV, WY	(1) - NJ	37	88%
Compliance inspectors issue stop work orders	(22) - AK, AL, CA, DE, IN, IL, KS, KY, MD, MO, MT, NC, NH, NJ, NM, NY, OR, SC, SD, UT, VT, WY	(2) - HI, ID	24	57%
Compliance inspectors issue fines for non-compliance with SWPPP	(9) - CA, CO, IL, MD, MN, NM, OR, SD, UT	(2) - HI, ID	11	26%
Civil and criminal penalties are passed along to Contractor for non-compliance	(22) - AK, CA, CO, DE, GA, IL, KS, KY, MA, MD, ME, MN, MT, ND, NM, OR, SC, SD, TN, UT, WV, WY	(3) - HI, ID, NE	25	60%
DOT issues sanctions for non-compliance with erosion and sediment control practices during construction	(20) - AK, AL, AR, CA, DE, GA, IL, KY, MA, MD, ME, MO, NM, NY, OR, SD, TN, UT, VA, WV	(3) - ID, NE, RI	23	55%
There is a stormwater hotline or other mechanism to receive public / state patrol complaints regarding construction violations	(8) - AL, AR, CO, DE, MS, NC, NM, UT	(4) - HI, ID, OR, SD	12	29%
There is a complaint tracking system	(8) - AL, AR, CO, MD, ME NC, NM, UT,	(5) - HI, ID, NE, OR, SD	13	31%

8.2 STRATEGIES AND BMPs

Establishing Policies and Other Mechanisms to Ensure Proper Implementation of Controls on Construction Sites

Training and Compliance Assistance

Almost all DOTs provide or arrange for provision of erosion and sedimentation control training, as training and continuing education of the Department's field personnel are considered key to long-term compliance. On-site training is used to reinforce classroom training and for communicating information about current water pollution control issues and practices.

Informal on-the-job training occurs during inspections to provide immediate site-specific guidance to Resident Engineers, construction inspectors, and contractor staff. Inspectors generally allot time to discuss observations and recommend solutions while on the site.

In California, the Construction Project Assistance Program provides a general overview of water pollution control requirements and more in-depth training related to specific project requirements. Compliance Assistance Program staff discuss methods for implementing, managing, and monitoring water pollution control BMPs on site with the project REs, construction inspectors, and contractor staff. DOTs respond to special requests and compliance assistance needs, either through internal resources or consultants, such as the following:

- Review and provide comments on SWPPPs as requested.
- Evaluate contractor compliance with hazardous waste and hazardous material management requirements. Provided technical memorandum on findings.
- Review stability of project slopes reviewed and provide recommendations for repair.
- Evaluate project sediment dewatering system.
- Review project documentation, SWPPP, amendments, and submittals.
- Conduct site reviews with RE, inspectors, and contractor personnel and provide verbal recommendations.
- Review SWPPP Preparation manual to ensure consistency with the SWMP and Permit.
- Review of SWPPPs and Encroachment permit applications for the district's encroachment division and include results in Encroachment Permit Tracking System database.

Construction SWPPP Review and Tracking

Specification Revisions and Erosion Control Warranties and Disincentive Specifications

DOTs are experimenting with a variety of ways to try to ensure contractor compliance with erosion and sedimentation control requirements and to build further incentives into the contracting process. Incentive and disincentive specifications are one approach. Thirteen state DOTs have implemented contractor disincentive specifications, allowing fines or withholdings in case of inadequate installation or maintenance of erosion and sedimentation control BMPs. One example is that of the Colorado DOT, which is available in Section 208 of the department's specifications: [CDOT Erosion Control Contractor Disincentive Specification on page 28](#) of this link.

Willingness to make use of disincentive specs is still an issue in a number of states; this is where leadership enters the equation. Several DOT Chief Engineers at the summer 2006 AASHTO Construction Meeting emphasized that they try to promote usage of such provisions by conveying the expectation that if any erosion and sedimentation control problems are occurring, the project engineer will have used all available means to get the contractor to comply in a timely fashion.

Utah DOT has a \$500.00 penalty each calendar day during which the project is in non-compliance with permits and regulations. The fine is above and beyond that assessed by regulatory agencies. Furthermore, no extension of contract time is allowed for any project delay resulting directly or indirectly from a violation.⁴ Unfortunately, some DOTs have found that the large incentives contractors sometimes have for early completion of a project, especially on mega-projects, may dwarf environmental penalties.

Indiana DOT is conducting research on the implementation of an Erosion Control Warranty specification, to be completed in 2009.⁵

Site Inspection and Enforcement of Control Measures

Construction Inspection Programs and Performance Monitoring Systems

In addition to revising specifications, DOTs are increasingly taking a further step of implementing comprehensive inspection programs, to achieve more reliable compliance with erosion and sedimentation control (ESC) objectives.

Erosion & Sedimentation Control Performance Assessment and Revocable Certification for Designers, Inspectors, and Contractors

DOTs have begun training and certifying erosion and sediment control professionals. In addition to leadership and communication of the agency's commitment, MDSHA has implemented a certification program for inspectors, contractors, and designers. The certification requires refresher courses (at 3 year intervals) and certification can be lost or revoked for poor performance. MDSHA is working with private industry and will be training contractors as well as staff.

Enforcement/Contractor Compliance Control Mechanisms

Incentives for Professional Certification in Stormwater Quality and ES&C

One of NCDOT's strategic goals is to strive to provide workplace development opportunities for its employees. The Department launched a career development and training program for its Transportation Technicians known as the Transportation Technician Skill Based Pay Program. Transportation Technicians obtain training in specialty areas and demonstrate these skills in performing their core job responsibilities over a designated time period. The program is designed to train and develop employees to reach the market reference rate or the amount competitors compensate employees with similar skill sets.

To support the goal of providing workplace development opportunities and to further improve environmental performance, NCDOT incorporated the Certified Professional in Erosion and Sediment Control (CPESC) and the Certified Professional in Stormwater Quality (CPSWQ) programs into its staff development initiative. The Certified Professionals' programs provide an opportunity for employees to demonstrate their expertise in the erosion and sediment control and stormwater disciplines. Advanced Transportation Technicians who perform erosion control and stormwater site evaluations can obtain registration as a CPESC, incorporate the skill sets obtained into their key responsibilities, and become eligible for a compensatory skill block that is added to their annual salary.

Registrants as CPESCs or CPSWQs can also benefit under another Department workforce development pilot initiative for its Roadside Environmental Engineers. The Engineer Competency Based

Pay Program targets Engineers, Engineering Supervisors, and Engineering Managers for training and development. In addition to obtaining key competencies in each of the above roles, engineers are evaluated for the scarce skills that they possess and utilize in their profession. Scarce skills are those skills and proficiencies that are unique for one's professional specialty area and add significant value to the core mission of the organization. The CPESC and CPSWQ registration are included in the scarce skills inventory for NCDOT's Roadside Environmental Engineers who design erosion and sediment control plans and those who provide engineering oversight on erosion and sediment control /stormwater implementation during project construction. Certified Professionals are eligible for salary supplements under this portion of the Department's career development program. In 2004, NCDOT had 25 CPESC registrants. Many pursued CPSWQ registration in 2005. The Department provides resource materials for employees to prepare themselves to sit for examination. In addition, review classes are held each year to provide training and instruction opportunities.

North Carolina's Land Quality regulatory section for erosion and sediment control also endorsed the CPESC and CPSWQ program. Several North Carolina municipalities who enforce local erosion and sediment control/ stormwater ordinances require their employees to obtain CPESC or CPSWQ registration as a condition of employment.

One of NCDOT's 2004 environmental goals was to provide timely program delivery of transportation projects with environmental excellence. The Department was able to let to contract over \$1 billion of land disturbing highway construction activities without any erosion and sediment control or stormwater violations from regulatory agencies. Dedicated employees, many of whom are Certified Professionals, working together to build trusting relationships with the regulatory community helped to make the goal a reality.

Risk Assessment, Systematic Performance Evaluation and Tracking

Other Strategies

International Scan of Techniques to Measure and Act on Soil Erosion

An extensive review of techniques for measuring soil erosion was assembled for the New Zealand Ministry for the Environment and Regional Councils' Land Monitoring Group, to assist in the development and choice of techniques for regional soil erosion monitoring programs. Soil erosion and monitoring techniques identified in that literature review included: 6

- Field measurement with survey instruments
- Field measurement with global positioning systems
- Approximate field measurement with various other devices
- Field measurement with tracers
- Field measurement by soil profile description
- Field measurement by soil probe or auger
- Aerial photographic measurement with stereoplotters
- Aerial photographic measurement by digital techniques
- Approximate aerial photographic measurement by various methods
- Point sample measurement from aerial photographs
- Interactive measurement from satellite images
- Digital classification of satellite images
- Measurement from runoff plots
- Measurement from stream discharge
- Measurement from vegetation

8.3 DOT EXAMPLES

Establishing Policies and Other Mechanisms to Ensure Proper Implementation of Controls on Construction Sites

Firm Management Leadership and Commitment + Compliance Assurance System

Maryland SHA Administrator Neil Pederson decided that the agency should achieve 100 percent compliance with erosion and sedimentation control requirements on all MD SHA construction projects. While compliance does not sound “above and beyond,” Pederson was tackling an area of performance that is generally one of the most intractable for DOTs, given the production pressures and the many layers of subcontractors through transportation construction occurs.

To assess compliance, MDSHA implemented a six-layer system that includes independent quality assurance ratings for each project. Certified Quality Assurance inspectors inspect projects biweekly and rate the sediment controls on a letter grade scale. Projects can be shut down based on these inspections. Ratings for all projects are summarized quarterly and annually to comply with the MDSHA Business Plan. In the past the agency has pursued ratings of B or better on 95 percent of construction projects annually. As part of a primary agency commitment though, the Chief Administrator is seeking to improve performance to achieve 100 percent compliance in construction.

WSDOT Application of ISO 14001 to Erosion and Sedimentation Control

The Washington State Department of Transportation (WSDOT) Erosion Control Program has been working on applying the standards of an Environmental Management System (EMS) and ISO 14001 to proactively plan, implement, and monitor effective Temporary Erosion and Sediment Control (TESC) efforts. To do so, the Erosion Control Program performed an inventory and analysis of existing internal policies, procedures, and guidance documents. This allowed the Program to provide clarity and consistency with new regulations and erosion control technologies throughout the entire agency. To date, WSDOT has updated the Plans Preparation Manual, [Standard Specifications for Erosion Control \(Section 8-01\)](#), [Standard Plans Section I - Erosion Control](#), [Highway Runoff Manual](#), [Design Manual](#), [Construction Manual](#), and [Roadside Manual](#), to integrate Program improvements into existing WSDOT directional documents.

The second step involved establishing operational controls to address needs identified in the environmental aspect review process. Analysis revealed inadequate statewide standardization with WSDOT’s erosion control plans that address a comprehensive set of 13 minimum requirements. Internal discussions led to improved BMP selection, quality of erosion control planning, and consistency with resource agency guidance. A variety of training resources were developed.

The third step entailed development of a Temporary Erosion and Sedimentation Control (TESC) assessment database, which incorporates compliance evaluation measures to monitor performance, analyzes data, and reports on the Program’s effectiveness. As part of this compliance effort, WSDOT identifies and makes compliance visits to all construction project sites in the state that possess a reasonable potential for erosion problems. Site assessments evaluate the quality of plans, implementation of the contract, and effectiveness of the BMPs. The assessment is viewed as an educational opportunity and the assessor works closely with project staff to solve any problems observed in the field. Program tools include the [Daily Data Record Form](#) and [Excel Summary and Monitoring Report Forms](#).

All assessment results are stored in the TESC Assessment Database, providing Environmental Management System document control. The database generates reports on 150 questions for use at the project, regional, and state levels. Recommendations are clearly identified and associated with precise

standard specifications to be applied in addressing concerns. This report is the Program's primary technical assistance tool, providing the respective agency managers with a summary of all projects assessed and trends associated with the state's 13 minimum planning requirements.

The state report provides the State Design Engineer and the State Construction Engineer with an overall picture of how the various regions are performing. In addition, the database generates two other reports specifically for use at the Erosion Control Program management level. First, the minimum requirements report determines how well the required planning components are being satisfied, in addition to other key issues that are instrumental in improving the Program. This is accomplished by applying database filters not used with the project, regional, or state reports. Second, the BMP report reveals the frequency of use, correct application, maintenance, and overall effectiveness of BMPs in use.

WSDOT found that the most effective method of achieving change in construction is in partnership with the agency Construction Office and with the construction industry and by documenting the necessary changes and required practices in those directional documents that govern the construction process and in individual construction contracts. Applying ISO 14001 Environmental Management System standards provides compliance documentation and a feedback mechanism.

The TESC Assessment Program provides an audit component, identifying 1) how well WSDOT is protecting water quality; 2) what specific areas need improvement; 3) what strategies should be used to make improvements. The complete Erosion Control Program approach was developed with input and broad support of multiple stakeholders and reflects agency-wide ownership of the solution. The program has been accepted and institutionalized into the daily activities at all levels of those responsible for designing and building the state's transportation system. As a result, WSDOT expects agency-wide performance to continually improve.⁷

Construction SWPPP Review and Tracking

NCDOT Delegated Erosion and Sedimentation Control Performance Tracking

NCDOT has its own sediment and erosion control program as delegated by the N.C. Sedimentation Control Committee and the North Carolina Department of Environment and Natural Resources. The Delegation Agreement has a self-monitoring component that requires NCDOT to inspect its projects for compliance with sediment pollution laws.

NCDOT's Roadside Environmental Unit oversees the agency's Erosion and Sedimentation Control Program. Roadside Environmental Engineers and Technicians visit all projects over one acre and bridge/culvert projects less than one acre (TIP and maintenance projects) on a monthly basis for a "third party" evaluation. Each job is given a numeric score. Projects found out of compliance are issued an immediate corrective action (ICA) requiring the contractor to mobilize within 24 hours the needed workers and equipment to resolve the erosion and sedimentation control/stormwater issue. This notifies project personnel that corrective procedures should be performed to resolve identified problems immediately. ICAs and NOV's are tracked and measured electronically. Projects with permit issues receive a PCN or Permit Consultation Needed alerting the Lead Engineer and Environmental Permit Office to provide the necessary technical assistance to resolve the issue.

Approximately 7,000 reviews were entered in 2005 into NCDOT's ERCON database for approx. \$1.5 billion of highway/bridge construction.⁸ ERCON generates reports for number of active projects and cost of projects, to manage workload. Reports can also be generated for projects requiring dewatering, projects in High Quality Waters or Trout Waters, and Contractor Report Cards (i.e. their score on environmental compliance as related to E&SC/SW). NCDOT has significantly raised environmental stewardship statewide through the program.

Delaware DOT's Delegated Sediment Control Program

Delaware DOT also has a delegated sediment control program. There the Department of Natural Resources and Environmental Control delegated the authority to administer a sediment and stormwater program. DelDOT's satisfactory performance of the delegated responsibilities is considered compliance with this component of the SWMP.

Site Inspection and Enforcement of Control Measures

NCDOT Rainfall Multi-Sensor Precipitation Estimator Notifies When Inspection is Needed

NCDOT, in cooperation with North Carolina State University and the state climate office, has developed a [rainfall multi-sensor precipitation estimator](#). Using NEXRAD Doppler radar signals combined with ground-truthing, the system can estimate rainfall amounts anywhere in the state. NCDOT has found the data very useful both in their compliance and their research programs. For erosion and sedimentation control compliance, particularly on the secondary roads that NCDOT maintains, the system automatically sends e-mails to the appropriate parties to check on BMPs after each time it rains more than a ½ inch or other specified amounts.

Since radar precipitation estimates can be grossly inaccurate, radar-based precipitation values are calibrated with the routinely available hourly surface gages. The combined product provides the spatial resolution of radar with the increased accuracy of surface gage networks. These gage-calibrated radar estimates are known as Multi-sensor Precipitation Estimates, or MPE. The system is performing accurately for frontal storms, though it can be slightly off for convective storms, which interfere with the radar. A study by the State Climate Office of North Carolina suggests that MPE compares well with an independent daily precipitation gage network over the Carolinas. The annual regional average root mean square error (RMSE) is 0.023 inches over a 24-hour period. The MPE grids used in this tool are routinely produced by the National Weather Service and National Centers for Environmental Prediction.

A simple mapping application enables users to visually see accumulated MPE estimates over time. When zoomed in, roads, water features, and town names can be overlaid for reference (first image above). Additionally, project sites can be noted on the map for reference purposes. The past 6, 12, 24, 48, and 72 hours are available to view spatially. One-week, 30- and 90-day options are also available (middle image). Another view shows a list of all projects for which the user is subscribed to receive precipitation alerts (last image). Each project has a list of associated sites. Accumulated MPE values are listed for all sites in text format.

Caltrans Construction Inspection Program

The California Department of Transportation (Caltrans) construction inspection program employs multiple layers of oversight to ensure compliance from its staff and contractors. Caltrans requires inspections to be conducted by the contractor, the Resident Engineer (RE), and consultant inspectors. These multiple levels of construction inspectors ensure compliance with erosion and sediment controls requirements and provides additional assurance that inspections are being conducted and BMP have been installed and are effective. Each inspection type is discussed in Appendix B:

Enforcement/Contractor Compliance Control Mechanisms

Colorado DOT Erosion Control Contractor Disincentive Specification

The specification states "Temporary erosion and pollution control measures required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the work as scheduled or ordered by the Engineer or for the Contractor's

convenience, shall be performed at the Contractor's expense. In the case of repeated failures on the part of the Contractor in controlling erosion, sedimentation, or water

44

pollution, the Engineer reserves the right to employ outside assistance or to use Department forces to provide the necessary corrective measures. Such incurred direct costs, plus project engineering costs, will be charged to the Contractor, and appropriate deduction will be made from the Contractor's monthly progress estimate. Accepted work performed to install measures for the control of erosion and sedimentation, and water pollution, not originally included in the Contract will be paid for as extra work in accordance with subsection 104.03."

Risk Assessment, Systematic Performance Evaluation and Tracking

WSDOT Erosion Control Program Assessment Database

At the Washington State DOT, all construction sites are evaluated and characterized based on inherent risk of erosion (size, timing and duration of work, soils, slopes, groundwater levels, need for in-water work); the runoff from 20 percent of projects that meet the risk criteria is tested during storm events and during critical periods of in-water work. Monitoring results are used to evaluate project performance and to validate results of the TESC assessment database.

WSDOT's Temporary Erosion and Sedimentation Control (TESC) database provides managers with a summary of all projects assessed and trends associated with the state's 13 minimum planning requirements. An audit component identifies how well WSDOT is protecting water quality; 2) what specific areas need improvement; 3) what strategies should be used to make improvements. The state report gives the State Design Engineer and the State Construction Engineer an overall picture of how the various regions are performing and provides support for decisions regarding management action that may be needed.

The database also provides decision support at the Erosion Control Program management level. First, the minimum requirements report determines how well the required planning components are being satisfied, in addition to other key issues that are instrumental in improving the Program. This is accomplished by applying database filters not used with the project, regional, or state reports. Second, the BMP report reveals the frequency of use, correct application, maintenance, and overall effectiveness of 37 practices. WSDOT found that the most effective method of achieving change in construction is in partnership with the agency Construction Office and with the construction industry and by documenting the necessary changes and required practices in directional documents that govern the construction process and in individual construction contracts.⁹

WSDOT is also developing environmental cost assessment tools for project development through the Environmental GIS Program. The agency has also developed a Maintenance Accountability Process that includes tracking of some environmental conditions and deficiencies, in addition to other internal evaluation and monitoring programs.

8.4 LINKS AND RESOURCES

State Sponsored Stormwater BMP Manuals – Design, Construction, and Maintenance

Almost every state DOT has a guide to development of such plans and design of stormwater BMPs. Some states have developed manuals for Maintenance as well. The U.S. EPA Region 10: The Pacific Northwest provides web links to [Stormwater BMP manuals](#) from various State agencies: According to a 2003 survey by the author, 54 percent of all the states have developed a Highway Runoff Manual; Caltrans, FDOT, Illinois DOT, MoDOT, Ohio DOT, and TxDOT completed revisions in the last two years. Almost 30 percent of state DOTs have developed manuals for stormwater management at non-highway facilities (AR, CA, FL, GA, HI, MO, MT, NH, NV, WA) and stormwater manuals for

construction(AR, CA, FL, GA, HI, IA, IN, LA, MI, MO, MT, NM, OH, WA.)¹⁰ Following is list of manuals available on-line:

California

- [California Stormwater Quality Association Stormwater BMP Handbooks](#)
- [Los Angeles Stormwater Program](#) (click “Publications”)
- [California Department of Transportation \(Caltrans\) Stormwater Quality Handbooks](#)
- [Stormwater Quality Handbook - Project Planning and Design Guide](#)
- [Caltrans Construction Manual](#) includes details for a wide array of construction drawings and standard water quality BMPs.
- Caltrans [Maintenance Manual](#) and [Maintenance Stormwater Staff Guide](#)

Georgia

- [Georgia Stormwater Management Manual](#)

Idaho

- [Idaho Department of Transportation \(IDT\) Design Manual](#) (July 2001)

Illinois

- Illinois Department of Transportation. Erosion and Sediment Control NPDES for Standard Specifications for Road & Bridge Construction.

Maine

- [Erosion & Sedimentation BMP Manual](#)

Maryland

- [Maryland Stormwater Design Manual, Volumes I & II](#)

Massachusetts

- [Massachusetts Department of Environmental Protection Stormwater Handbooks](#)

Michigan

- [DEQ Index of BMPs/Individual BMPs](#)
- [Michigan DOT Drainage Manual](#)

Minnesota

- [Protecting Water Quality in Urban Areas: A Manual](#)
- [Urban Small Sites Best Management Practice Manual](#)

Missouri

- [Protecting Water Quality: A Construction Site Water Quality Field Guide](#)

Montana

- [Montana Department of Water Quality – Stormwater Program – BMPs and Erosion Control Plans](#)

New Hampshire

- [Innovative Stormwater Treatment Technologies Best Management Practices Manual](#)
- [Best Management Practices for Routine Roadway Maintenance](#)

New Jersey

- [New Jersey Stormwater Best Management Practices Manual](#)

New York

- [New York State Stormwater Management Design Manual](#)
- [NYSDOT Highway Design Manual](#)
- [New York State Standards and Specifications for Erosion and Sediment Control](#)

North Carolina

- [North Carolina Department of Environment and Natural Resources](#)

Ohio

- [Ohio EPA Stormwater Program Index](#)

Oregon

- [Department of Environmental Quality Guides](#)
- [Oregon Department of Transportation. Field Manual for Erosion and Sediment Control](#) (2000). The reference for the field guide is the ODOT Hydraulic Manual Volume 2 entitled Erosion and Sediment Control, which provides a source of more in-depth information.

Pennsylvania

- [Pennsylvania Handbook of Best Management Practices](#)

South Carolina

- [NPDES Stormwater Program Guide](#)
- [Sediment, Erosion and Stormwater Management Program Index to Guides](#)

Tennessee

- [Tennessee Department of Environment and Conservation Water Pollution Index to Guides](#)
- [City of Knoxville, Best Management Practices Manual](#)

Texas

- [Texas Nonpoint Sourcebook](#)
- [“Stormwater Management Guidelines for Construction Activities Manual.”](#) Texas Department of Transportation (2002)

Utah

- [Utah Department of Environmental Quality Stormwater Program Index to Guides](#)
- [West Valley City Stormwater Utility Best Management Practices](#)
- [Utah DOT Roadway Drainage Manual of Instruction](#)

Virginia

- [Virginia DOT 2004 Erosion and Sedimentation Control and Post-Construction Stormwater Management Manual](#)
- [Northern Virginia Regional Commission Best Management Practices](#)
- [Virginia Department of Conservation & Recreation BMP Guides](#)
- [Virginia DOT Drainage Manual](#)

Washington

- [WSDOT 2004 Standard Specifications for Erosion Control \(Section 8-01\)](#)
- [WSDOT Standard Plans Section I - Erosion Control](#)

- [WSDOT Temporary Erosion Sedimentation Control \(TESC\) Plan Template](#)
- [WSDOT When is a TESC plan needed?](#)
- [WSDOT 2004 Highway Runoff Manual](#)
- [WSDOT Hydraulics Manual](#)

Wisconsin

- [Wisconsin Construction Site Erosion Control and Stormwater Management Procedures](#)

Wyoming

- [Urban Best Management Practices for Nonpoint Source Pollution](#)

Other BMPs and Resources

Guidance and sample practices for DOTs in the following activity areas are available in [AASHTO's Compendium of Environmental Stewardship Practices, Policies, and Procedures](#). The following resources assembled by EPA may also be useful:

- [Construction Phase Plan Review](#) BMP fact sheet
- [Contractor Training and Certification](#) BMP fact sheet
- [Construction Inspection Program](#) BMP fact sheet
- [Construction Industry Compliance Assistance website](#) provides plain language information on environmental rules, including stormwater, for the construction industry.
- [Construction Sequencing](#)
- [Construction Site Operator BMP Inspection and Maintenance](#)
- [Land Grading](#)
- [Preserving Natural Vegetation](#)

The following BMP fact sheets contain a description of the BMP, pictures, applicability considerations, limitations, siting and design considerations, installation directions, and recent research (up to 2005).¹¹

Erosion Control

[Chemical Stabilization](#)

[Compost Blankets](#)

[Dust Control](#)

[Geotextiles](#)

[Gradient Terraces](#)

[Mulching](#)

[Riprap](#)

[Seeding](#)

[Sodding](#)

[Soil Retention](#)

[Soil Roughening](#)

[Temporary Slope Drain](#)

[Temporary Stream Crossings](#)

[Wind Fences and Sand Fences](#)

Runoff Control

[Check Dams](#)

[Grass-Lined Channels](#)

[Permanent Slope Diversions](#)

[Temporary Diversion Dikes](#)

Sediment Control

[Brush Barrier](#)

[Compost Filter Berms](#)

[Compost Filter Socks](#)

[Construction Entrances](#)

[Fiber Rolls](#)

[Filter Berms](#)

[Sediment Basins and Rock Dams](#)

[Sediment Filters and Sediment Chambers](#)

[Sediment Traps](#)

[Silt Fences](#)

[Storm Drain Inlet Protection](#)

[Straw or Hay Bales](#)

[Vegetated Buffers](#)

Good Housekeeping/Materials Management

[Concrete Washout](#)

[General Construction Site Waste Mgmt](#)

[Spill Prevention and Control Plan](#)

[Vehicle Maintenance and Washing Areas at Construction Sites](#)

- [EPA 1992 Guidance on Developing Pollution Prevention Plans and BMPs for Construction Activities](#) describes the steps necessary to develop a stormwater pollution prevention plan for construction activity.
- [Stormwater outreach materials for the construction industry](#) including brochures in English and Spanish, and a poster are available for download.
- [Construction Industry Compliance Assistance Web Site](#) provides plain language information on environmental rules, including stormwater, for the construction industry.
- [Minnesota Pollution Control Agency](#) stormwater guidance.
- [Stormwater Construction Inspection Guide](#) describes how municipal inspectors should conduct construction site inspections.
- [Stormwater Compliance Assistance Tool Kit for Small Construction Operators](#) provides guidance to help small construction operators comply with their stormwater requirements.
- Kentucky Erosion Prevention and Sediment Control Field Guide is available for download in three parts from the [Kentucky Division of Water's Stormwater website](#).
- [2005 Stormwater Management Manual for Western Washington: Volume II -- Construction Stormwater Pollution Prevention](#) describes 12 elements of construction SWPPPs and BMP standards and specifications.
- [Storm Water Resource Locator](#) - This resource is designed to help companies in the construction industry know about and comply with the storm water rules in their area.

9 POST-CONSTRUCTION STORMWATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT

Over the past two decades, the rate of development has been twice that of population growth. Post-Construction Stormwater Management in New Development and Redevelopment controls address the rapid expansion of developed areas and impervious surface, and associated increase in polluted runoff and damaging peak flows. Post-construction or permanent BMPs treat, store, and infiltrate runoff onsite before it can affect water bodies downstream. Low impact development site designs may disperse stormwater throughout a site in rain gardens to achieve the goals of reducing flows and improving water quality. DOTs can use and model low impact designs, as well as provide information on the benefits of such designs to new developers wishing to hook up to DOT drainage systems.

DOTs and other Phase II MS4s are required to address post-construction stormwater runoff from new development and redevelopments that disturb one or more acres, including development of:

- Strategies to implement a combination of structural and non-structural BMPs
- A program to ensure adequate long-term operation and maintenance of BMPs

9.1 POST-CONSTRUCTION STORMWATER MANAGEMENT ACTIVITIES UNDERTAKEN BY DOT RESPONDENTS

Thirteen of the 42 responding DOTs have a research and testing program for permanent BMPs. Five more DOTs are adding such programs, for a total of 43 percent of responding states. Around three-quarters have established policies, design guidelines, and procedures for implementing permanent BMPs. About forty percent have or are implementing monitoring requirements (BMP performance and effectiveness) for newly constructed BMPs. Regulatory coordination is required for BMP implementation is just less than a third of responding states.

Alabama, Delaware, and Maryland DOTs have begun to use stormwater trading, crediting, or banking in deciding the best locations for permanent BMPs while addressing watershed needs. California, Hawaii, Idaho, New York and Oregon estimate they will have such a system in place in the next two years. Permanent BMPs are incorporated into the project design and review process in about 90 percent of state DOTs. A number of states have invested considerable effort in developing guidelines and tools to assist engineers in selecting BMPs. Where such guidance is not already in use, it is being developed; 76 percent of DOTs have it or will have it shortly.

In 60 percent of DOTs there are established maintenance guidelines for these BMPs and also training for this maintenance.

Requirements for post-construction controls are established in the state DOT's Stormwater Management Plan in over half of responding DOTs, who in turn generally include that in contract requirements for outside design services.

Sixty percent of responding DOTs have established or are establishing maintenance guidelines for permanent BMPs. The same percentage from training for state forces in implementation of such maintenance practices. Maintenance considerations are increasingly evaluated from an early point in the process; however, only about a quarter of responding DOTs have implemented a capital budget allocation for long-term BMP maintenance.



Figure 5: Infiltration Islands Help Reduce and Filter Pavement Runoff

Table 14: Policies, Guidelines, and Training in Relation to Permanent BMPs

Activity	States	Planned in Next 2 Years	Total	% of DOTs Responding
DOT has a research and testing program for permanent BMPs	(13) - AL, CA, DE, KS, MD, ME, MI, MN, NC, NM, SC, TX, WV	(5) - HI, ID, NE, OR, VT	18	43%
There are established policies and procedures for implementing permanent BMPs	(26) - AL, CA, CO, DE, HI, ID, KS, KY, MA, MD, ME, MI, MN, NE, NH, NM, OH, RI, SC, TN, TX, UT, VA, VT, WV, WY	(5) - AZ, NC, NJ, NY, OR	31	74%
There are established design guidelines for permanent BMPs	(28) - AK, AL, AZ, CA, CO, DE, ID, KS, MA, MD, MN, MO, ND, NE, NH, NM, NY, OH, RI, SC, SD, TN, TX, UT, VA, VT, WV, WY	(4) - HI, NC, NJ, OR	32	76%
There are monitoring requirements (BMP performance and effectiveness) for newly constructed BMPs	(12) - AK, AL, ID, MD, ME, MN, ND, NM, NE, UT, VA, VT	(5) - AZ, HI, NC, NJ, OR	17	41%
Regulatory coordination is required for BMP implementation	(11) - AL, CA, DE, HI, MD, MN, NE, NH, NM, UT, VT	(2) - ID, OR	13	31%
DOT employs a stormwater crediting, trading or banking system	(3) - AL, DE, MD	(5) - CA, HI, ID, NY, OR	8	19%

Activity	States	Planned in Next 2 Years	Total	% of DOTs Responding
Permanent BMPs are incorporated into the project design and review process	(35) - AK, AL, AZ, CA, CO, DE, GA, ID, IL, KS, KY, MA, MD, ME, MI, MN, MO, MT, NC, ND, NE, NH, NJ, NM, NY, OH, RI, SC, SD, TX, UT, VA, VT, WV, WY	(3) - HI, IN, OR	38	91%
DOT provides guidelines and tools to in-house and consulting engineers to assist in selecting BMPs	(25) - AL, AZ, CA, CO, DE, ID, IL, KS, MA, MD, MI, MN, MO, MT, NE, NH, NM, OH, OR, RI, SC, SD, UT, VA, WV,	(7) - GA, HI, IN, NC, NH, NJ, NY, VT	32	76%
Requirements are established in SWMP	(17) - AK, AL, CA, CO, DE, MA, MD, MI, NC, ND, NM, OH, RI, UT, VA, VT, WV	(5) - HI, ID, IN, SC, TX	22	52%
Design of permanent BMPs included in the contract requirements for outside design services	(20) - AK, AL, CA, CO, DE, ID, IL, MA, MD, MO, ND, NM, NY, OR, RI, SC, SD, UT, VA, VT	(1) - HI	21	50%
There are established maintenance guidelines for permanent BMPs	(18) - AK, AL, CA, DE, ID, IL, MA, MD, ME, MT, NJ, NM, NY, SC, TX, UT, VA, VT	(7) - AR, AZ, HI, MN, NC, NE, RI	25	60%
There is DOT training for maintenance of permanent BMPs	(17) - AL, CA, CO, DE, ID, IL, MD, ME, MT, NH, NM, SC, UT, VA, VT, WV, WY	(8) - AR, AZ, HI, MN, MS, NE, NJ, RI,	25	60%
There is a capital budget allocation for long-term maintenance	(8) - CA, DE, MD, NH, NY, NM, SC, VT	(3) - HI, ID, VA	11	26%

Table 15: Assessing Impacts of Activities and Planning for Greater Control in Sensitive Areas

Activity	States	Planned in Next 2 Years	Total	% of DOTs Responding
DOT evaluates activities to assess stormwater impacts including maintenance activities (roadway maintenance, vehicle maintenance, etc.)	(22) - AL, CA, DE, ID, KS, MA, MD, ME, MI, NC, ND, NH, NJ, NM, NY, OR, RI, TN, UT, VA, VT, WY	(5) - AK, AZ, CO, HI, MN	27	64%
DOT specifically identifies maintenance activities that occur within sensitive or impaired water bodies	(8) - AR, ID, KY, NM, OR, RI, VA, WV	(6) - AZ, HI, MD, MN, NJ, VT	14	33%
There are specific requirements for maintenance activities that occur within a sensitive or impaired water body	(8) - AZ, ID, KY, NC, NM, OR, RI, VA	(8) - AR, AZ, CO, HI, MD, MN, NJ, VT	16	38%

Assessing Impacts of Activities and Planning for Greater Control in Sensitive Areas

Almost two-thirds of responding DOTs are evaluating activities to assess stormwater impacts including maintenance activities (roadway maintenance, vehicle maintenance, etc.). A third are now identifying maintenance activities that occur within or adjacent to sensitive or impaired watersheds or water bodies. Approximately 40% of the responding DOTs are developing specific requirements for maintenance activities within sensitive or impaired watersheds.

The California State Water Resources Control Board prohibits the discharge of stormwater in *Areas of Special Biological Significance*. Caltrans and the Board developed an exception process for discharges to continue on a conditional basis.¹²

9.2 STRATEGIES AND BMPs

In addition to the activities listed in section 9.1, the following strategies and BMPs are in use by several states. Refer to section 9.3 for more details.

- Drainage Infrastructure Evaluation
- Maintenance, and
- Retrofits for water quality improvement

9.3 DOT EXAMPLES

NHDOT Stormwater Quality Retrofits

NHDOT staff regularly attend meetings with the Chocorua Lake Association and other partners to monitor past accomplishments, plan and program new initiatives, and to share concerns and solutions with regard to future DOT projects. After installation of BMPs at several highway culverts, they showed a reduction of phosphorus input by over 80 percent. The partners decided a long term commitment would best serve environmental stewardship goals. The stakeholders developed an agreement to protect and preserve the water quality of Chocorua Lake for the indefinite future with regard to stormwater management, requiring BMPs in both construction and maintenance activities. The Memorandum of Understanding was the first of its kind between the NH Department of Transportation and a private organization. NHDOT anticipates using this MOU as a model for future partnerships with other similar environmental groups as opportunities become available.

Maryland State Highway Administration Drainage System Inventory and Evaluation

The Maryland State Highway Administration (MDSHA) may have the most advanced culvert management system of any state transportation agency. The agency has developed a thorough and duplicable grade-based rating system for stormwater management facilities and has developed an inventory, database, and photo record of all facilities statewide and their maintenance status. Under the rating system, those graded A or B are considered functionally adequate. As of late 2003, between 73 and 75 percent of MDSHA stormwater management facilities were functionally adequate (A=everything fine, working fine, no maintenance required, B= minor maintenance, need mowing or trash removal), leaving approximately 25 percent needing maintenance or retrofitting to achieve functional requirements. MDSHA aims to have 80 percent or more of SHA stormwater management facilities rated functionally adequate by 2006, and 95 percent of facilities by 2010.

MDSHA's drainage system GIS is designed to be used for planning level computations and operations level activities, rather than for design or simulation modeling. The database is used to

determine the general location of systems and drainage areas, to track maintenance activities, and address public complaints. Information in the database is intended to be sufficient enough to identify, locate, and evaluate every BMP to provide an overall assessment of MDSHA's BMP inventory. The information in MDSHA's drainage management system assists the agency with decisions on inspection, maintenance, repair, and retrofit of BMP facilities, in addition to supporting compliance with MDSHA's MS4 permit. The drainage management system is able to perform queries within a graphic environment for systems in the following categories:¹³

- Individual structure or system and BMPs e.g., pipes, inlets, manholes, endwalls, etc. and their associated data attributes.
- By outfall (size, type, etc.)
- Within a drainage area
- Within a watershed
- Within a jurisdiction
- Statewide
- Roadway contract

Ultimately MDSHA's EIM&DSS will be capable of hydrologic analysis of the drainage systems for the preparation of estimates of the quantity and quality of storm water runoff from the SHA right-of-way. The models should be capable of analyzing the effects of changes in stormwater management practices.

MDSHA has also extended the agency's "context sensitive solutions" program into its drainage system asset management, combining principles of landscape architecture with hydraulics engineering to design stormwater facilities that enhance communities and landscapes. MDSHA has developed and incorporated a visual and environmental quality and safety review and comment process for all stormwater management designs associated with projects in the state, which is now a part of facility drainage inspection and maintenance prioritization. The revised process targets visually, culturally, and environmentally sensitive areas for more intensive review and design scrutiny. Facilities are being retrofitted to improve environmental and aesthetic attributes as well as ease of maintenance. The effort has also involved training workshops for design and maintenance personnel, an internal web page, and development of Visual and Environmental Quality and Safety guidelines. The latter encourages practices that reduce impacts to communities, such as selecting the appropriate type of facilities for the context; eliminating standing water to reduce mosquitoes; conducting site visits to the potential stormwater management site to assess the surrounding character and visibility; careful vegetation management including native vegetation; and designing the facilities using more naturalistic, "curvilinear" landforms. Visual and safety objectives are being enhanced as a result of the agency's "no-fencing" initiative—incorporating features such as 15-footwide submerged benches and maximum steepness at slopes of 4:1. These features also allow easier access to maintenance crews.¹⁴

Mn/DOT Drainage System Inventory and Cleaning Process

Minnesota DOT (Mn/DOT) is inventorying MS4 system components in a systematic fashion, in a highly streamlined and cost-effective program. Mn/DOT Metro Water Resources collects GPS location and condition information on structures; those in need of cleaning were broken into Priority 1, 2, or 3.

Priority 1, 2, and 3 projects sites were uploaded to mobile GPS units allowing workers to navigate to project sites. Personnel were designated as "Locators" who marked locations of projects in the field as requested, starting with Priority 1. Sub-area personnel cleaned structures and notified the Locator, who would then return to the location to obtain additional GPS information.

Group One consists of hydraulic structures such as catch basins, manholes, aprons and pipes. Records were kept on the drain cleaning, percentage filled, and erosion and sedimentation control

measures. Group Two consisted of Special Pollution Control Devices (SPCD) such as grit chambers, skimmers, and weirs. The locations of SPCDs to be cleaned were collected and the SPCDs were field-inspected. Cleanings were performed by Maintenance Personnel. Now the Mn/DOT Metro District Water Resources Office is currently locating and identifying all ponds (Group 3). An initial dataset was formed using GIS and aerial photography, and then refined to only include ponds within Mn/DOT right-of-way that are maintained by Mn/DOT. Pond cleaning is done by either internal forces or by a contract based on:

- Size and location of pond
- Special equipment needed
- Vegetation restoration
- Pond lining
- Proximity to Waters of the State and
- Workload and other priorities

This work is occurring as part of a cyclical process. New datasets are given to Maintenance Water Resources, which updates them as maintenance occurs. [ArcIMS](#) is used for tracking of [routine maintenance activities](#). Mn/DOT also developed training for Routine Maintenance Activities. Training Workshops were given to Subarea Supervisors and an information packet was handed out, including:

- A copy of the MS4 general permit
- Definitions of special waters of the state
- Priority 1, 2, & 3 cleaning projects
- A list of the watershed Districts within Metro
- Photo examples good and poor project work
- A erosion and sediment control pocket guide
- A list of erosion control contract vendors
- Plan sheets showing ditch typical sections
- The Locator for their Sub Area
- A data flow diagram

9.4 LINKS AND RESOURCES:

Guidance on DOT performance of the following activities is also available in [AASHTO's Compendium of Environmental Stewardship Practices, Policies, and Procedures](#). The following resources may also be useful for DOTs in designing post-construction stormwater management activities:¹⁵

- [Post-Construction Plan Review](#)
- [BMP Inspection and Maintenance](#)
- [Low Impact Development \(LID\) and Other Green Designs](#). EPA's [Low-Impact Development](#) website provides guidance and information on LID from many other sources. The [Low Impact Development Center](#) is a non-profit organization dedicated to the advancement of Low Impact Development technology.
- [EPA's Smart Growth program](#) includes many resources on smart growth.
- [Stormwater Manager's Resource Center](#), created and maintained by the [Center for Watershed Protection](#), provides information to stormwater practitioners, local government officials and others that need technical assistance on stormwater management issues.
- [BMP Inspection and Maintenance](#)
- [California New Development and Redevelopment BMP Handbook](#) includes a series of BMP fact sheets on various BMPs to control stormwater runoff from new developments.
- [NAHB Research Center's Pamphlets: Builder's Guide to Low Impact Development](#) is a two-page pamphlet describing the benefits of LID for developers.

- [Prince George's County Bioretention Manual](#) describes how to use bioretention to improve infiltration on a site level.
- [Puget Sound Action Team Low Impact Development](#) includes resources and an LID Technical Guidance Manual for the Puget Sound area.
- [Department of Housing and Urban Development's The Practice of Low Impact Development](#) is a report on LID and alternatives to conventional design approaches.

Innovative BMPs for Site Plans and Facilities

[Alternative Pavers](#)

[Alternative Turnarounds](#)

[Conservation Easements](#)

[Development Districts](#)

[Eliminating Curbs and Gutters](#)

[Green Parking](#)

[Green Roofs](#)

[Infrastructure Planning](#)

[Low Impact Development \(LID\) and Other Green Design Strategies](#)

[Narrower Residential Streets](#)

[Open Space Design](#)

[Protection of Natural Features](#)

[Redevelopment](#)

[Riparian/Forested Buffer](#)

[Street Design and Patterns](#)

[Urban Forestry](#)

Infiltration

[Grassed Swales](#)

[Infiltration Basin](#)

[Infiltration Trench](#)

[Porous Pavement](#)

Filtration

[Bioretention \(Rain Gardens\)](#)

[Catch Basin Inserts](#)

[Sand and Organic Filters](#)

[Vegetated Filter Strip](#)

Retention/Detention

[Dry Detention Ponds](#)

[In-Line Storage](#)

[On-Lot Treatment](#)

[Stormwater Wetland](#)

[Wet Ponds](#)

[Manufactured Products for Stormwater Inlets](#)

Other:

[Alum Injection](#)

10 POLLUTION PREVENTION/GOOD HOUSEKEEPING FOR DOT OPERATIONS AND FACILITIES

EPA regulations have long required facilities to obtain National Pollution Discharge Elimination System (NPDES) permits for discharges, especially washbay and shop floor drain effluent discharges to the waters of the State under Industrial permits. Yard maintenance and pollution prevention for stormwater falls under the NPDES Phase II MS4 program.

Facilities management and stormwater pollution prevention encompasses a broad range of activities, including:

- Storage, repair, and maintenance of vehicles, equipment, and related support materials
- Fueling and washing of vehicles and equipment
- Maintenance of buildings, stormwater drainage systems and landscaping
- Storage of sand, salt, asphalt, rock, and pesticides
- Storage of wastes generated on site
- Bulk storage of sediment, litter and debris generated by road maintenance activities

Environmental stewardship in the course of these activities requires both structural and non-structural management practices. Examples of non-structural practices include procedures for performing operational activities, such as salt/sand mixing/loading that requires removal of all salt from the area surface after loading. The installation of a physical device that alters the release, transport, or discharge of pollutants from surface storm or melt water or facility-generated shop floor drain or washbay effluent is a structural practice.

Other DOT activities and material storage practices occur away from maintenance yards, but could pose a threat to water quality if practices and procedures were not in place to prevent pollutants from entering the storm sewer system. Such activities include winter road maintenance, minor road repairs and other infrastructure work, automobile fleet maintenance, and landscaping and vegetation management. In addition, activities such as street sweeping and storm drain system cleaning help keep pollutants out of the system.

DOTs and other Phase II MS4s are required to train staff on ways to protect stormwater, particularly when maintaining MS4 infrastructure and performing daily maintenance activities. Training programs should include a general stormwater awareness message, [pollution prevention/good housekeeping measures](#), [Spill Response and Prevention](#), and information about the [operation and maintenance of structural best management practices \(BMPs\)](#). Training programs also should include information on stormwater pollution prevention plans (SWPPPs) for maintenance yards and other DOT facilities and BMPs recommended for use in the field to prevent contaminated discharges. Finally, maintenance staff should be trained to recognize, track, and report illicit discharges.

The MS4 minimum measure for Pollution Prevention and Good Housekeeping generally includes:

- Developing inspection and maintenance procedures and schedules for stormwater BMPs.
- Implementing BMPs to treat pollutants from transportation infrastructure, maintenance areas, storage yards, sand and salt storage areas, and waste transfer stations.
- Establishing standard operating that incorporate stormwater BMPs for common DOT maintenance activities, garnering input from both managers and field crews to determine the most appropriate and effective BMPs for each situation.

- Establishing procedures for properly disposing of pollutants removed from drainages, culverts, and other elements of the storm sewer system.
- Identifying ways to incorporate water quality controls into new and existing water quantity control measures.

10.1 POLLUTION PREVENTION AND GOOD HOUSEKEEPING ACTIVITIES UNDERTAKEN BY DOT RESPONDENTS

Facility Pollution Prevention Plans (FPPP) are typically developed for each maintenance facility owned or operated by a DOT.

In order to facilitate pollution prevention and in some cases the development of EMSs, 43 percent of responding DOTs have developed a priority list of maintenance operations that minimize stormwater impacts. Almost half of responding DOTs have developed DOT BMP Maintenance manuals for the agency, or have such manuals in process. Six states have ensured that their manual is consistent with municipalities and country government guidelines. Four more are working on that. Almost 70 percent of responding DOTs install and maintains structural BMPs at maintenance facilities.

10.2 STRATEGIES AND BMPs

Facilities Pollution Prevention & Good Housekeeping Practices in AASHTO's Compendium of Environmental Stewardship Practices, Procedures, and Policies

Many practices were identified by the author for AASHTO's *Compendium of Environmental Stewardship Practices, Policies, and Procedures for Construction and Maintenance* (http://environment.transportation.org/environmental_issues/construct_maint_prac/compendium/manual/). AASHTO continually updates the guide and it is a good source for DOTs in development of stormwater management plans.

DOT Environmental Training and Inspection Resources with Stormwater Coverage

The key BMP to addressing the good housekeeping minimum measure is the development of an employee training and education program. A number of DOT training programs that provide guidance with regard to stormwater management are described in section 10.3.

Statewide Implementation

Many DOTs have pursued statewide implementation of MS4 standards and/or BMPs, for more consistent and effective training and implementation of pollution prevention activities across the agency. In the early 1990s, Florida DOT embarked on an inventory of all outfalls and simultaneously supported the development of statewide GIS resources, shared among the agencies. Caltrans also implemented a statewide MS4 program and combined it with the agency's Construction General Permit (CGP).

A few states were able to provide percentage of the SWMP program that was implemented. In general, state DOTs indicated they were on schedule in terms of implementing the SWMP program. Those who supplied percentages were 50-90%+ completed for programs that went up to 2008. DOTs generally felt they were on the right track.

Table 16: Pollution Prevention and Good Housekeeping Activities

Activity	States	Planned in Next 2 Years	Total	% of DOTs Responding
DOT has developed a priority list of maintenance operations that minimize stormwater impacts	(12) - AZ, CA, MA, MD, ME, MI, NC, NJ, NM, OR, RI, UT	(6) - AK, AZ, HI, ID, MN, VT	18	43%
DOT has developed a DOT Maintenance BMP Manual	(14) - AR, AZ, CA, KY, ME, MD, MI, MT, ND, NM, NY, OR, SC, VA,	(6) - AK, HI, ID, MN, UT, VT	20	48%
The manual is consistent with local municipalities and county government guidelines	(6) – KY, MD, MI, ND, NM, OR	(4) - AK, HI, ID, MN	10	24%
DOT installs and maintains structural BMPs at maintenance facilities	(25) - AL, AZ, CA, CO, DE, ID, KY, MA, MD, ME, NC, ND, NE, NH, NJ, NM, NY, OR, SC, TN, UT, VA, VT, WV, WY	(4) - AR, HI, MN, RI	29	69%
DOT installs and maintains source control BMPs at maintenance facilities	(23) - AL, AZ, CA, CO, DE, ID, KY, MA, MD, ME, NC, ND, NE, NH, NJ, NM, NY, OR, SC, TN, UT, VT, WV	(4) - AR, HI, MN, RI	27	64%
Snow removal and deicing practices	(25) - AK, AL, AZ, CA, ID, IL, IN, KY, MA, MD, ME, MN, MO, MT, NC, ND, NH, NM, NY, RI, SC, TN, UT, VA, VT	(3) - NE, NJ, SD	28	67%
Salt pile storage facility	(28) - AK, AL, AZ, CA, DE, ID, IL, IN, KS, KY, MD, ME, MN, MO, NC, ND, NE, NH, NM, NY, SC, SD, TN, UT, VA, VT, WV, WY	(2) - NJ, RI	30	71%
Street sweeping	(21) - AK, AL, AZ, CA, CO ID, IL, KS, KY, MD, ME, MN, MT, ND, NM, SC, TN, TX, VT, UT, WY,	(4) - HI, IN, NJ, SD	25	60%
Spill prevention and response plan	(30) - AL, AZ, CA, CO, DE, ID, IN, KS, MA, MD, ME, MN, MO, MT, NC, ND, NE, NH, NM, NY, RI, SC, SD, TN, TX, UT, VA, VT, WV, WY	(3) - HI, KY, NJ	33	79%
Herbicide application	(30) - AL, AR, AZ, CA, CO, DE, ID, IL, IN, KS, KY, MD ME, MN, MO, MS, MT, NC, ND, NE, NM, NY, OR, SC, TN, TX, UT, VA, VT, WV	(3) - HI, NJ, SD	33	79%
Landscaping and lawn care	(17) - AZ, CA, CO, ID, IL, IN, MD, MN, NC, ND, NM, NY, SC, TN, TX, UT, VT	(4) - HI, NE, NJ, SD	21	50%
Vehicle maintenance	(28) - AL, AZ, CA, DE, ID, IN, KS, KY, MA, MD, ME, MN, MO, NC, ND, NE, NH, NM, NY, RI, SC, SD, TN, TX, UT, VA, WV, VT	(2) - HI, NJ	30	71%

Some states combined Phase I and Phase II permits. Other states had submitted Phase I and Phase II applications but had not yet received an MS4 permit. Responses with regard to implementation success ranged from one state that said “We don’t know how successful we are” to those with highly structured accountability mechanisms. A state that received NOV and a consent order said “we do very little compliance checking. This is done by the counties...that have enough population.” In some cases, states that are still awaiting issuance of their permits have voluntarily lowered thresholds for use of BMPs to any earth disturbance and have already done internal surveys of Maintenance and created a compliance program, including Stormwater Pollution Prevention Plans.

Oregon estimated their NPDES compliance is “at the 95 percent level or higher with almost no formal water quality violation notices. The agency has attained this due to management valuing and emphasizing the importance of compliance activities. The most important accomplishment has been a balanced program that has been able to keep pace with the major outsourcing of project work occurring over the last five years.” Caltrans noted that outside audits by GAO, the state, and USEPA have all been positive.

Build on Existing Programs

For both MS4 compliance and the development of EMSs, DOTs build upon existing programs. For example, the Rhode Island DOT noted it had many programs in place related to stormwater management, and RIDOT “has achieved compliance primarily through these ongoing programs (ex/ Adopt-a-Spot/Highway, Winter Training, Annual Road Sweeping, Annual Catchbasin Cleaning...)”

Regular Program Updates and Enhancement

DOTs revise their statewide Stormwater Management Plans on a regular basis and are identifying ways to continually improve. Many of the DOTs generate changes to their programs through review feedback

(17%), the annual report process (25%), or discussions with other Divisions, likely regulatory (25%). This indicates that regulatory agency input is a significant generator of program revisions. Given that EPA provides guidance to state regulatory agencies and the guidance is based on the best practice in the field, as observed by EPA, and that EPA then often requests that best practice be added in program revisions, DOTs may take greater control of the process by considering the best practices shared within this report and choosing those that seem most practical to them, proactively.

DOTs are developing and expanding asset management systems, including storm drain, outfall, permanent BMPs, and other stormwater management infrastructure.

Stormwater Advisory Teams (SWAT)

A number of states have used cross-functional teams to guide issue identification and SWMP development, including AZ, CA, CO, NY, VA, and VT. At Caltrans, Stormwater Advisory Teams (SWATs) are a major component of the overall stormwater management program. SWATs are internal teams composed of District and Headquarter representatives from one or more Department functional units (Water Quality, Project Design, Maintenance, Construction, and Encroachment Permit) that work together to gather and disseminate new program information, review BMPs, track progress, and improve communication and coordination.

Arizona developed SWATs in every functional area of the DOT;¹⁶ Refer to Appendix B for details of Arizona’s SWAT program.

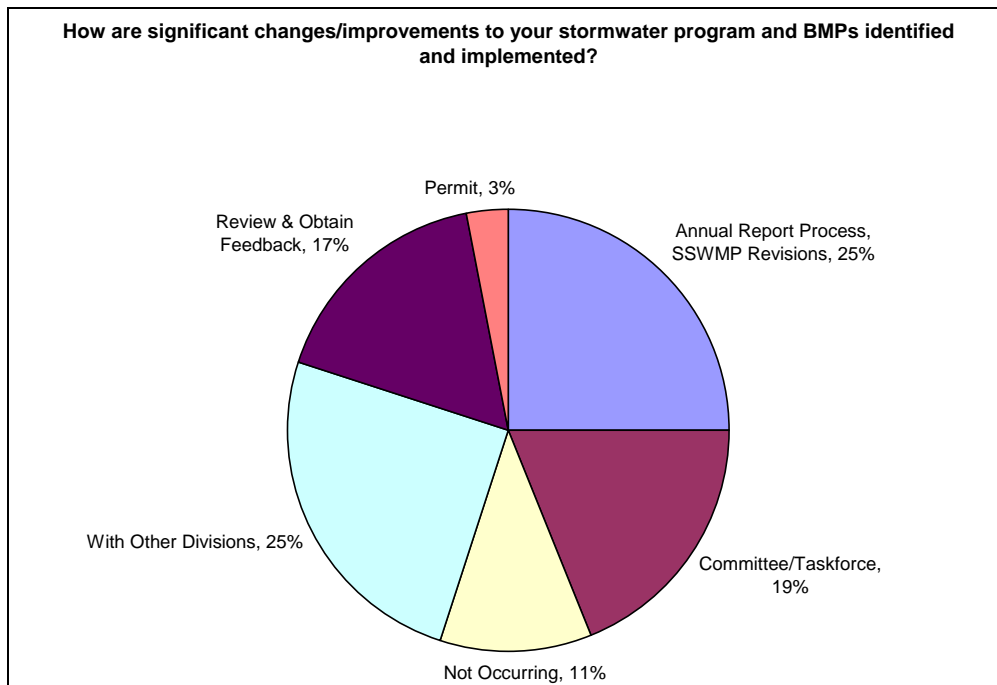


Figure 6: How Significant Changes and Improvements to Stormwater Programs are Implemented

10.3 DOT EXAMPLES

Facilities Good Housekeeping Checklists and Tracking

DOTs have been able to produce dramatic improvements in environmental performance with the development and use of simple, often short checklists by DOT maintenance staff, at maintenance yards. The following tools are good examples.

- [MoDOT Facilities Good Housekeeping Checklist](#)
- [PennDOT Stockpile Quality Assurance Responsibilities](#)
- [PennDOT 15-Minute Stockpile Walkaround](#) – Monthly
- [PennDOT Stockpile “Snapshot” Quick Inspection](#) – Weekly
- [PennDOT Maintenance Stockpile Activity Protocol](#)
- [PennDOT Post-Storm Salt Management Tracking Responsibilities](#)

Incorporating Stormwater Best Practice into Competency Based Training Programs

PennDOT’s Center for Performance Excellence (CPE)

PennDOT created a Center for Performance Excellence (CPE) for managing employee development and linking education to strategic goals.¹⁷ One of CPE’s main programs is PennDOT’s Transportation University, a virtual university designed on the corporate learning model. The Transportation University is focused on competency-based training and employees’ professional growth. Experts throughout the agency provide most of the instruction. Necessary tasks, skills, and competencies for each job classification are identified by a team of top performers in each job class, and training has been structured around those competencies. Top performers incorporate environmental best practice into their work. The CPE works with instructors, training coordinators and subject matter experts to develop the courses and tracks associated with particular knowledge. PennDOT feels this approach ensures maximum return on invested training monies by focusing on relevant competencies and required skills for advancement of the trainee.

Lead positions in the Transportation University are filled by senior DOT staff, Bureau Directors, and Deputy Secretaries. Specialized schools and colleges cover various areas of expertise, and are supported by a team of volunteer experts from throughout the Department. Each school has an operating committee of agency leaders and volunteers that meets three times a year to develop and align needed learning experiences to identified competency needs and performance priorities, and to ensure that courses are evaluated at the appropriate level. Non-traditional learning approaches such as on-the-job training and combination approaches supplement traditional training courses. For example, the School of Transportation Professions is looking at giving credit for winter operations preparation such as the winter dry run. Such exercises are very important in calibrating salt usage.

PennDOT’s College of Transportation Professions serves the Design, Operations, and Construction communities and includes a School of Technical Specialties and a School of Workforce Development. PennDOT is developing Position Analysis Workbooks for 90 percent of the positions in the agency. The Position Analysis Workbooks detail all the job duties and tasks, and the skills, knowledge, and competencies required to perform them well. Tasks and competencies are also linked to courses that PennDOT has available and courses that need to be developed. The workbooks are used by the Transportation University and training committees are used as guides for developing educational opportunities targeted to workplace needs. Training and other learning experiences are also required to

support agency strategic objectives. Employees are able to use the workbooks as a planning tool for their own professional development, cross-training experiences and promotional opportunities. Supervisors, mentors and coaches can use the workbooks to orient new employees and to ensure employees receive appropriate learning experiences. Position analyses have already been developed for Assistant Maintenance Managers, Diesel Mechanics, Transportation Equipment Operators, Diesel Mechanics, Quality Coordinators, Training Coordinators, District Safety Coordinators, Construction Inspectors, Equipment Operators A, Equipment Operators B, Highway Maintenance Worker, Laborer, Semi-Skilled Laborer, Equipment Operator Trainee, Equipment Operator Instructor, Automotive Mechanic, Tradesman Helper, Motor Carrier Enforcement Officer, Highway Foremen, Welders, Customer Service Leadership, Managing Partners, Tunnel Maintainer, Maintenance Repairman (includes Building Trades — Carpenter, Electrician, Mason, Painter), District Equipment Managers, County Equipment Managers, and Equipment Body Repairer & Painter.

PennDOT also developed an internet-based learning management system that provides an online resource for employee training records, official transcripts, course and program catalogues, out service and on-the-job training information, class schedules and current enrollments. Working with their supervisors, employees are able to schedule training courses as part of their individual development plans using this tool, which the agency calls Training Partner 2000. More information on [PennDOT's Transportation University](#) may be found online.

Oregon DOT Environmental Outreach and Training for Maintenance Staff

ODOT has an extensive outreach/training program for its maintenance personnel on environmental issues. Elements of this program include environmental orientation for new employees, monthly/quarterly manager team meetings, winter pass foremen annual meetings, annual field visits, hazardous materials training, erosion and sediment control training, fish passage training, and training on ODOT's Resource and Restricted Activities Zone maps for district roads. The department also relies on participation in professional symposiums, conferences and videos it has developed, including "Road to Recovery: Transportation Related Activities and Impacts on Salmon," and a new video being made on calcium magnesium acetate (CMA): "CMA: A valuable tool for winter operations and total storm management." ODOT also trains staff through continuing education classes and systematic trials of new products.

Montana (MDT) Environmental Training for Maintenance Field Staff

The Montana Department of Transportation is actively training field personnel to identify ramifications of maintenance in their work on all aspects of the environment. The most recent and on-going training for winter maintenance is to identify PM-10, TMDL and Endangered Species issues.¹⁸

Alabama DOT's Waste Management and Hazardous Materials Awareness Training

Alabama DOT (ALDOT) started a training program for ALDOT employees and trained 407 personnel in Hazardous Materials Awareness and 371 in Waste Management Awareness. Another 150 personnel will be trained in Hazardous Materials Awareness as part of the accelerated university. The training program emerged from ALDOT's evaluation of DOT processes, using EMS as a guide. An oversight committee including one from each Division and selected Bureaus reviewed departmental processes that were of concern; 18 subcommittee meetings then examined issues such as training, product purchasing, waste paint, wash water, construction stormwater, and universal waste (used oil, batteries, fluorescent bulbs, etc.). To support this effort, ALDOT also established a product purchasing program to try and determine what hazardous materials are purchased, who are the purchasers, the amounts purchased, and other information. ALDOT's goal is to reduce the amount of hazardous waste generated by limiting purchases of products that may ultimately become hazardous waste. ALDOT also committed \$10 million in improvements to Lands and Buildings, with the goal of improving all facilities that manage

or store hazardous materials which could significantly impact the environment should there be a spill of those chemicals.¹⁹

Caltrans Environmental & Equipment Training for Construction and Maintenance

Caltrans has developed the following environmental training modules and resources for construction personnel, focused on minimizing stormwater impacts. [Caltrans Stormwater Pollution Prevention Training](#) resources are available in multiple media: video, DVD, PowerPoint presentations, hard copy, and on-line, as follows.

- [Water Pollution Controls While You Work: Temporary BMPs on Highway Construction Sites](#) 23-minute Video Presentation
- [Field Application Training for Erosion and Sediment Control BMPs](#) PowerPoint Presentation
- [Erosion Control BMP Implementation](#) PowerPoint Presentation Part A
- [Sediment Control BMPs](#) PowerPoint Presentation Part B
- [Field Application Training Class Exercises](#) PowerPoint Presentation exercises
- [SWPPP and WPCP Preparation Workshop](#)
- [Water Pollution Control - Compliance for Construction Sites for Resident Engineers](#)
- [Inspecting for Water Pollution Control on Construction Sites](#)
- [Water Quality Sampling and Analysis on Construction Sites Part 1](#)
- [Water Quality Sampling and Analysis on Construction Sites Part 2](#)
- [Management of Construction Site Dewatering Operations](#)
- [Introduction to Construction \(Boot Camp\) - Stormwater Module](#) 1 hour
- [Introduction to Construction \(Boot Camp\) - Stormwater Module](#) 2 hours
- [Introduction to Construction \(Boot Camp\) - Stormwater Module](#) 4 hours
- [Introduction to Construction \(Boot Camp\) - Stormwater Module](#) 6 hours

Caltrans has also developed and implemented similar training for Maintenance personnel, including [Maintenance Staff Guide](#) and Stormwater BMP Training Presentations in non-linear DVD and PowerPoint formats. Caltrans also tracks and provides information on continuing education courses available at universities and community colleges around the state that are recommended for staff; these include: Erosion & Sediment Control, Water Pollution Control, Regulations, Asbestos/Lead Abatement, Water & Natural Resources Management, Land Use Management, Water Quality Sampling, Hazardous Materials Management, and Emergency Response.²⁰

Caltrans includes some environmental training in classes for maintenance forces, which include orientation, a variety of Hazardous Materials handling courses, Lead Paint Removal and Abatement, Herbicide/Pesticide safety, Stormwater Pollution Prevention Plans, and Water Treatment Certification. Of particular interest to other DOTs may be Caltrans' Equipment Management Responsibility course, taught as part of Caltrans' Maintenance Equipment Training Academy (META) to maintenance leadworkers, with an expanded version for supervisors and superintendents. Caltrans Maintenance Equipment Training Simulator (CMETS) program is offered on a traveling basis in an 18-wheeler statewide. CMETS was developed in an effort to reduce vehicle accidents, extend equipment life (and

thus reduce resource usage), use appropriate materials amounts, and enhance the overall safety of field maintenance employees.²¹

VTrans Regional Environmental Training Workshops

The Vermont Agency of Transportation (VTrans) has begun to offer Environmental Training workshops for Construction staff on a regional basis. Topics covered include general environmental permits, erosion control and what responsibility field personnel have (changes in specifications, flowchart, payment, etc.), waste area information submittal and clearance, archaeological site discovery, stormwater management – illicit discharges and changes to drainage.²²

VTrans has also begun to offer environmental support for maintenance, complimented by planning, training, and staffing support. The training includes:

- Introduction to VTrans environmental responsibilities and roles of the Environmental Section and the Districts:
 - Understanding the need to comply with State and Federal regulations.
 - Roles and responsibilities of Environmental Section personnel.
 - Environmental responsibilities, roles and goals identified by the Districts.
 - Support capabilities and preferred contact protocols, including guidance and information available in District offices and on the web, development of environmental checklists, etc.
- Guidelines for Environmental Review of Maintenance Projects: Distribution and discussion of the Guidelines, including an explanation of the purpose of environmental review and the list of exempt and non-exempt projects.
- Basic introduction to Environmental Resource identification and assessment: How to use indicators such as types of landforms, topography, water resources, land use, plant and animal habitat features, physical structures and types of property likely to be significant; as well as guidance on how to conduct a review, estimate resource sensitivity and document information; plus examples of resources found in different regions of Vermont.
- Archaeology and Historic (these concerns must be addressed in site-specific/construction stormwater permits):
 - Discussion of the Guidelines for Environmental Review of Maintenance Projects: including the list of exempt and non-exempt projects and some training on environmental review of some of each.
 - Basics about determining archaeological sensitivity, such as general area landforms likely to contain significant sites, information needed to conduct a review, and examples of sites found in Vermont.
 - PowerPoint presentation elaborating on the above (tailored to address situations identified by District staff).
 - Historic Preservation Law - a discussion of the laws and regulations, including Federal Section 106, Section 4(f) and Vermont Title 22.
 - What is the National Register? – a discussion of what it is, what it includes and what National Register status means.
 - Identifying Historic Resources - Historic Districts, Buildings and other structures and resources.
 - What You Need to Know - following the Guidelines for Environmental Review of Maintenance Projects plus Examples and Case Studies
- Biology, Wildlife Awareness, and Threatened and Endangered Species (these concerns must be addressed in site-specific/construction stormwater permits):

- Discussion of Natural Resource Considerations for District Transportation Projects.
- Use of resource maps, GIS and other reference sources.
- Identifying resources in the field, types of wetlands, functions and values of wetlands, buffers etc.
- Wetland and waterway regulations, the ANR and the COE.
- Avoidance, minimization and mitigation in project design and permit acquisition.
- Wildlife Awareness: Introducing VTrans Wildlife and Habitat Connectivity Initiative and how Maintenance can contribute to its success.
- Construction issues and procedures.
 - Enforcement and Monitoring.
 - Stormwater Management:
 - Introduction to Draft Illicit Discharge Policy. Introducing the concept that VTrans is responsible for the quality of water that leaves our ROW before it discharges into a surface water.
 - Introduction to Stormwater Management Systems and Protecting Vermont's Streams. How District Technicians can plan for erosion prevention and sediment control as they plan projects.
 - Training in Erosion Prevention and Sediment Control pertaining to maintenance activities. How District forces can help protect water quality on a daily basis.

Mississippi DOT Maintenance Training for Facility Environmental Compliance and Illicit Discharge Detection and Elimination

Mississippi DOT is developing training for all maintenance employees as part of a proactive facility environmental auditing program, to ensure that environmental standards are maintained. Topics will include shop “housekeeping” practices, grounds, stockpiles, hazardous material disposal and storage, recycling, and other maintenance practices. MDOT has also developed training courses for maintenance pertaining to erosion control and illicit discharge detection and elimination. MDOT is scheduled to start an inspection plan for locating and eliminating illicit discharge coming onto MDOT right-of-way in nine counties in the state, as part of NPDES Phase II compliance.²³

WSDOT Environmental Training for Construction Inspection and Maintenance

WSDOT has an environmental training program that encompasses all WSDOT staff. For the purposes of this report the focus will be on environmental training for construction inspectors and maintenance staff. The training program for construction staff supports inspectors tasked with oversight of environmental compliance issues on project sites. The Endangered Species Act (ESA) Maintenance Training Program gives maintenance staff the skills to stay in compliance while performing maintenance activities on the roadway. The [WSDOT Environmental Policy Statement](#) and the WSDOT Environmental Management System guide the environmental training program. The Policy, among other things, commits WSDOT to comply with all applicable environmental laws and regulations as well as to provide staff with appropriate training targeted to the Department's environmental responsibilities.

Environmental Training Opportunities for Construction Staff:

- [Temporary Erosion & Sedimentation Control Certification](#)
- Wetlands Recognition, Regulations, Resource Value
- Overview of Environmental Permits
- [Spill Prevention Program](#)

- Environmental Compliance Training for Inspectors (available late Winter 2005)
 - General Environmental Awareness (under development)
 - Environmental Considerations for Bridge: A Training Series on Bridge Programmatic Permits (under development)
 - [Drainage Inspection](#) (a construction course that environmental information was added)
 - [Excavation and Embankment Inspection](#) (a construction course that environmental information was added)
- Maintenance Endangered Species Act 4(d) Training Program
- ESA 4(d) Executive Summary
 - ESA 4(d) Field Maintenance Crew Overview
 - ESA 4(d) Sediment and Erosion Control
 - ESA 4(d) Emergency Response
 - ESA 4(d) Roadside Landscape Maintenance
 - ESA 4(d) Channel Maintenance
 - ESA 4(d) Snow and Ice Control
 - ESA 4(d) Bridge and Urban Tunnel Maintenance
 - ESA 4(d) Stormwater Facilities
 - ESA 4(d) Slope Repair

Ohio DOT's Statewide Implementation

Ohio's approach, as indicated in their March 2006 MS4 program Report, is representative of many other DOTs:²⁴

Most BMPs are implemented on a statewide basis instead of being limited to the MS4 regulated area. BMPs for Minimum Control Measures (MCM) 1 and 2 (public education and involvement) are largely aimed at an audience of approximately 5,800 ODOT employees. Providing water quality related training and establishing an awareness of stormwater pollution are core components of this effort. For Illicit Discharge Detection and Elimination, ODOT is inventorying outfalls statewide and identifying outfalls that have potential illicit discharges. In addition, the process for issuing right-of-way use permits was improved by limiting acceptable non-stormwater discharges into our storm sewer system. Management of construction site runoff (MCM 4) and post construction stormwater (MCM 5) are tied to requirements of the statewide NPDES Construction Stormwater General Permit and other efforts. For MCM 6, various pollution prevention and good housekeeping items have been incorporated into maintenance and facility management activities.

10.4 LINKS AND REFERENCES

Guidance on Pollution Prevention and Good Housekeeping Activities

Guidance on DOT performance of the following activities is also available in [AASHTO's Compendium of Environmental Stewardship Practices, Policies, and Procedures](#).

Activities

- [Landscaping](#)
- [Vehicle Fueling](#)

- [Vehicle and Equipment Maintenance](#)
- [Vehicle and Equipment Washing](#)
- [Parking Lot and Street Cleaning](#)
- [Road Salt Application and Storage](#)
- [Roadway and Bridge Maintenance](#)
- [Storm Drain System Cleaning](#)

Facilities

- [Hazardous Materials Storage](#)
- [Materials Management](#)
- [Facilities Management](#)
- [Spill Response and Prevention](#)

General

- [Stormwater case studies on good housekeeping](#) includes case studies of how a Phase I or Phase II community has implemented the good housekeeping requirements.
- [Urban Management Measures Guidance](#) Chapters 7, 9 and 11 address some of the issues found in this minimum measure.
- [California Stormwater BMP Handbook](#)
- [2005 Stormwater Management Manual for Western Washington : Volume IV -- Source Control BMPs](#)
- [Example Good Housekeeping Practices - Alameda Countywide Clean Water Program](#)
- [Example guidance document for municipality pollution prevention/good housekeeping best management techniques - Erie County Department of Environment and Planning](#)
- [Example guideline for street sweepings and catch basin cleanings – State of Connecticut Department of Environmental Protection](#)

In 2005, Caltrans initiated a \$6.5 million multimedia public education campaign to reduce the amount of trash deposited on roadways and elsewhere. “Don’t Trash California” audio (radio) and theater slides will be used statewide. Information on the [Caltrans public education effort](#) is posted online. Also of interest, Caltrans completed a [Public Education Research Study](#) at Fresno to determine the effectiveness of public education as a BMP for reducing pollutants entering the storm drain system.

11 ORGANIZATIONAL APPROACHES TO NPDES MS4 COMPLIANCE

DOTs in states which already had significant stormwater regulation or were already complying with Phase I anticipated that Phase II would not greatly add to their obligations. In such states, DOTs were already performing regularly scheduled outfall inventories and had set up the systems and databases to track their monitoring. For instance, DOT staff in Florida estimated that doubling or tripling the area covered by their outfall inspection program would only raise costs by 15-25 percent.^{xxv} Furthermore, FDOT staff said some requirements were reduced in Phase II. Phase I required the development of a long-term monitoring plan that retained characteristics of the National Urban Runoff Program (NURP), such as determination of the pollutants in runoff from all land uses. The Phase II program dropped these long term monitoring goals that were part of Phase I. Project-level costs of moving from coverage of 75 percent of construction sites to 100 percent were absorbed in construction budgets.

In other states, such as North Carolina, large rural areas and less environmental regulation meant that roadway drainage had been regulated only in a few large municipalities, with little effect until Phase II. To respond to the Phase II requirements and environmental needs, the state environmental agency and NCDOT jointly developed a single individual stormwater permit covering roadway drainage throughout the state.

The following sections outline how DOTs have assumed and distributed the new responsibilities imposed by MS4, and how those new requirements add to the work of various functional areas within a DOT.

11.1 APPROACHES TO MEETING ADDITIONAL RESPONSIBILITIES IMPOSED BY PHASE II

The primary way DOTs have coped with the additional responsibilities imposed by NPDES Phase II has been to add further responsibilities to those already managed by existing staff (29 percent of responding DOTs). Just under a quarter of these hired new employees. Approximately 20 percent noted they made no adjustments at all. Nineteen percent of respondents indicated they had hired consultants to assist them. Specific budget allocations helped in California, Colorado, and Delaware. Ten percent of responding states created a new section. A similar percentage designated a program coordinator. Another 10 percent relied on on-the-job training. Seven percent said requirements were already being addressed or their efforts had been consistent over the years.

11.2 WHICH DIVISION HAS PRIMARY RESPONSIBILITY? WHO ELSE IS INVOLVED?

The headquarters environmental program, usually containing the NPDES program or program manager, typically coordinates the NPDES program on a statewide basis. Ohio's approach, as indicated in their March 2006 MS4 program Report, is representative of many other DOTs:^{xxvi}

Coordination of BMP implementation and Stormwater Management Program activities are led by the Office of Environmental Services. Implementation of the Stormwater Management Plan is carried out by a wide variety of Offices designated as responsible parties for particular BMPs.

Headquarters staff involved include, those from the Offices of Communications, Construction Administration, Environmental Services, Equipment, Facilities, Maintenance Administration, Software Production, Structural Engineering, Systems Planning & Program Management, Technical Services, and Training. District participants included Highway Management, Planning & Programs, and Public Information offices. Despite headquarters environmental office coordination of activities, program management, education, or other services, many such program leads are quick to stress that the program is a cooperative effort across the agency and leadership responsibility is shared.

Table 17: Staffing Approaches to Meeting Additional Responsibilities Imposed by NPDES Phase II MS4 Program

Methods Responding State DOTs Used	State DOTs	Total	%
Additional responsibilities for existing staff	HI, MD, OR, NM, WV, AL, UT, WY, OH, VT, KY, MN	12	29%
Hired new employees	HI, MD, CO, RI, AL, DE, AR, NC, NY, VT	10	24%
Nothing was done/no adjustments	IN, MS, LA, SD, ME, UT, TN, MN	8	19%
Hired consultant	HI, KY, MD, OR, MA, NH, AZ, OH	8	19%
Designated a coordinator	KY, CO, CA, NC	4	10%
On the job training	OR, AL, UT, NE	4	10%
Created new section	WV, NE, NC, NY	4	10%
Specific budget allocations	CO, CA, DE	3	7%
Requirements already being addressed	CA, WV	2	5%
Team approach	VA, AZ	2	5%
Reorganized program structure	HI	1	2%
Efforts have been consistent over the years	MO	1	2%
Need training	ID	1	2%
Contractors are responsible	KS	1	2%
Identified a leader	SC	1	2%
Positions filled as needed	SC	1	2%
Co-permittee with municipalities	MT	1	2%
Readjust priorities	NJ	1	2%
Transferred positions	NC	1	2%

Table 18: Locus of Primary Responsibility for NPDES MS4 Program, as Expressed by the DOT (often identifying more than one prime)

Division in the Agency with Primary Responsibility for the NPDES Program	State DOTs	No.	Percent of Respondents
Construction	MI, OR, AZ	3	7.1%
Construction + Environmental	GA, WY	2	4.8%
Construction + Maintenance	KS, MS	2	4.8%
Design and/or Hydraulics/Drainage	AL, MD, MO, ND, NM, SC, SD, VA, WV	8	21.4%
Design + Environmental	NC	1	2.4%
District	HI, MN	2	4.8%
District + Environmental	MT	1	2.4%
Environmental	AR, CA, CO, GA, ID, IN, KY, LA, MA, ME, NE, NJ, NY, OH, RI, TN, TX, UT, VT	19	45.2%
Maintenance and Operations	AK, DE	2	4.8%

In describing which Division or functional area had “primary responsibility” for the NPDES program, DOTs answered as shown in Table 19:

These characterizations do not always get at the complexity of distribution of responsibilities. Delaware DOT, for example, has an NPDES section with three staff members, a program manager who conducts overall program administration, an environmental scientist who performs monitoring, and an environmental engineer who works on retrofits of permanent BMPs and the industrial portion of the program, including construction activities. Stormwater erosion and sedimentation control for construction and post-construction are handled by Construction. Maintenance staff handle training, quarterly pollution prevention inspections, sweeping, and maintenance of the stormwater system. Still, DelDOT characterizes Maintenance as having primary responsibility for the NPDES MS4 program.

Increasing Ownership, Involvement, and Leadership by Construction and Maintenance

When NPDES programs arose, they were introduced by environmental staff. Engineers receiving the information often viewed it as separate from their work and as an imposition. Environmental staff, usually at headquarters, still have primary responsibility for most DOT NPDES MS4 programs, especially program development and reporting; however, Construction and Maintenance are playing an increasing role. Leadership of the NPDES program by Construction and Maintenance staff, who are in the field and oversee, cause, or prevent the vast majority of a DOT’s stormwater runoff, can increase ownership.

Arizona DOT is one example of a DOT that has made this transition, though an EMS will add more accountability to the program and reincorporate a degree of centralization.^{xxvii}

Initially, the ADOT stormwater program was located in the Environmental & Enhancement Group (EEG). Later a portion of the responsibility for the permit was transferred to Statewide Maintenance Planning, with headquarters environmental staff retaining MS4 reporting requirements and the construction stormwater program. In FY 2001–2002, Statewide Maintenance Planning created a new full-time position to manage the MS4 program, and all responsibility for the MS4 permit was transferred to Statewide Maintenance Planning. Subsequently, in 2003, responsibility for the construction project stormwater program was transferred to the Roadside Development Section, where it currently resides.

Stormwater Action Teams (SWATs) were created in 2004 to coordinate all activities necessary for the creation and implementation of a SSWMP. Each of these teams is made up of a broad cross-section of personnel who are engaged in various stormwater activities. The SWATs are organized along functional responsibilities within ADOT, such as design, construction, maintenance, training, etc. Communication is facilitated by the State Engineer’s office. Until a new ADOT EMS is put into place, stormwater management activities will be addressed by the SWATs and facilitated by a consultant. The Intermodal Transportation Division (ITD) Deputy State Engineer for Operations will provide oversight.

Table 20 indicates (all of) the different functional divisions of a DOT that state respondents indicated as having “primary responsibility” for the NPDES MS4 program. This illustrates the important roles that Design, Construction, and Maintenance have assumed in leadership of the NPDES MS4 program.

Table 19: Division(s) with “Primary Responsibility” for the NPDES MS4 Program at State DOTs

DOT Division	State DOTs	No.	Percent of Respondents
Construction	MI, OR, AZ, GA, WY, KS, MS	7	16.7%
Design	AL, MD, MO, NC, ND, NM, SC, SD, VA, WV	10	23.8%
District	CA, HI, MN, MT	4	9.5%
Environmental	AR, CA, CO, GA, ID, IN, KY, LA, MA, ME, MT, NC, NE, NJ, NY, OH, RI, TN, TX, UT, VT, WY	23	54.8%
Maintenance and Operations	AK, DE, KS, MS	4	9.5%

Use of Internal Staff to Meet Requirements Ranged from “Sparing” to 100%

DOT responses on the degree to which they used internal staff to meet the requirements imposed by NPDES Phase II for MS4s ranged from “sparing” use of internal staff to 100 percent reliance on existing staff. Utah and Wyoming were among those states getting by with existing staff, “primarily in the environmental sections, to participate in and document NPDES compliance activities.”(UT) Nebraska Department of Roads also used only existing FTEs, at the outset. Now a new unit has been created, with a Program Manager, a Landscape Architect, and a Biologist, whose responsibilities include stormwater permitting, roadside stabilization and seeding. Construction Project Managers are in charge of site inspection requirements. At TxDOT, the Environmental Division provides training and guidance and the District staff carries out the program. Only a couple state DOTs were able to split out a percentage, such as 20 percent internal staff and 80 percent consultants (NC); the latter indicated the agency is building internal resources, so the consultant percentage should drop.

In general, states found creative ways to mobilize additional staff from various divisions. In some cases, position descriptions were totally re-written to fill the gaps. VTrans “fully changed one position description, modified 4 others and added responsibilities to others under ‘additional duties as assigned.’” Tennessee DOT “transferred one person from water quality permits to stormwater permits and added one person to help with Phase 1 and Consent Order Requirements.”

Other states have added staff through new hires. New hires for NPDES Phase II ranged from one additional staff person (CO, NH, OH, RI, TN, WV) to a couple. California, on whose program the Clean Water Act was allegedly based, has added and devoted many staff members to the task. Following the agency’s consent decree, Tennessee DOT plans to add 4-6 staff members to meet requirements. A few states indicated they could use more assistance. Some state DOTs have used summer interns to perform water quality sampling (IN) or inventory structures or roadsides (NM).

Many state DOT NPDES MS4 program leaders and/or consultants operate under the guidance of a central, cross-disciplinary, cross-division stormwater advisory or technical team (CO, NY, VA). At Mn/DOT “District hydraulic engineers have started the process and have worked on the various pieces. Our central office environmental services group has been providing some limited assistance.” A few states have added environmental or water quality coordinators or engineers in each Construction or Maintenance District/Region (CA, MT, NC, NY, VA, WV) or added an erosion control unit.

Co-Permitting Approaches Can Be Found in the Least Populated States

A number of DOTs in the least populous states chose to work with other governmental entities as a co-permittee, by referencing parts of each other’s plans. Co-permitting can help resolve issues that may arise where multiple regulated jurisdictions exist in the same area and reduce overall reporting requirements.

South Dakota has an existing operative policy agreement, “South Dakota Department of Highways Guidelines for Maintenance of Primary and Secondary System,” with the South Dakota Municipal League that essentially grants responsibility for maintenance of the state trunk highway system within city boundaries to cities with populations of 2500 and above, unless there is a written agreement stating otherwise. The policy specifically states that maintenance of all drop inlets and storm sewers is the responsibility of the city, as is all drainage in rural sections and snow and ice removal except for, sections where a mutual agreement in writing between the city and the SD DOT has been approved. SDDOT interprets this policy to apply to all maintenance activities on the state trunk highway system, and as many of the controls that are established under the EPA Phase II permit program fall under the category of maintenance; these responsibilities are thereby the responsibility of the individual cities in South Dakota. SDDOT is playing a secondary role in Phase II’s 10 regulated urbanized areas.^{xxviii}

DOTs Report Inconsistent Effects on Workloads

State DOTs did not report consistent effects on workloads, nationwide. A few states indicated that the additional work was a burden on particular positions and/or they were managing with pre-existing staffing levels, without consultant support. In many cases, the DOT has hired additional staff for NPDES program development, oversight, and reporting. Coordinators in Districts/Regions have been hired to work with Maintenance or Construction staff in a number of cases, and compliance assistance related to water quality comprises a large part of their duties. Over half of states have sought assistance from consultants, particularly in developing stormwater management program plans and in annual reporting.

Many DOTs highlighted that divisions from design to maintenance were involved, inevitably leading to additional duties in many of these locations. Such additional duties have required the development of additional training programs and considerable thought about how to get staff attention and commitment. Fines and/or Notices of Violation (NOVs) have effectively garnered attention in some cases. Prospective and/or actual fines have also provided effective justification for the addition of staff. In other states, Chief Executives have initiated organization wide environmental excellence efforts with specific runoff compliance objectives.

11.3 TOOLS TO SUPPORT AND MANAGE THE NPDES PROGRAM, ACTIVITIES, AND RESPONSIBILITIES

DOTs generally lacked databases or project or workflow management tools to support and help manage the NPDES program and the positions involved. Only a quarter of respondents indicated they are using GIS systems for outfall mapping, surveying, and sampling and/or asset management. Of those, only a couple DOTs had extended such systems or added applications to support project prioritization and workflow planning and management. Still technologies (software/GIS/web applications) collectively represent the largest single area of tools mentioned by DOTs. The next largest category was “none.” See Figure 7.

Cross-functional management teams are identifying relevant issues, assisting implementation, and providing feedback from their respective areas in six responding states. Management commitment and budget support were considered a key tool in five states. Likewise, five states have added environmental support staff in Construction and/or Maintenance. Five states have very active research programs that address water quality issues, technologies, and effectiveness.

Arizona, Colorado Hawaii, Tennessee, Texas, Massachusetts and North Carolina mentioned consultants, when asked what tools are in use in their DOT to support and manage the NPDES program and the positions involved. The first five of these states are making revisions to their program in light of recent consent decrees; often consent decrees specify a negotiated amount to be spent making such program upgrades. Table 21 lists more specifically the tools that DOTs described.

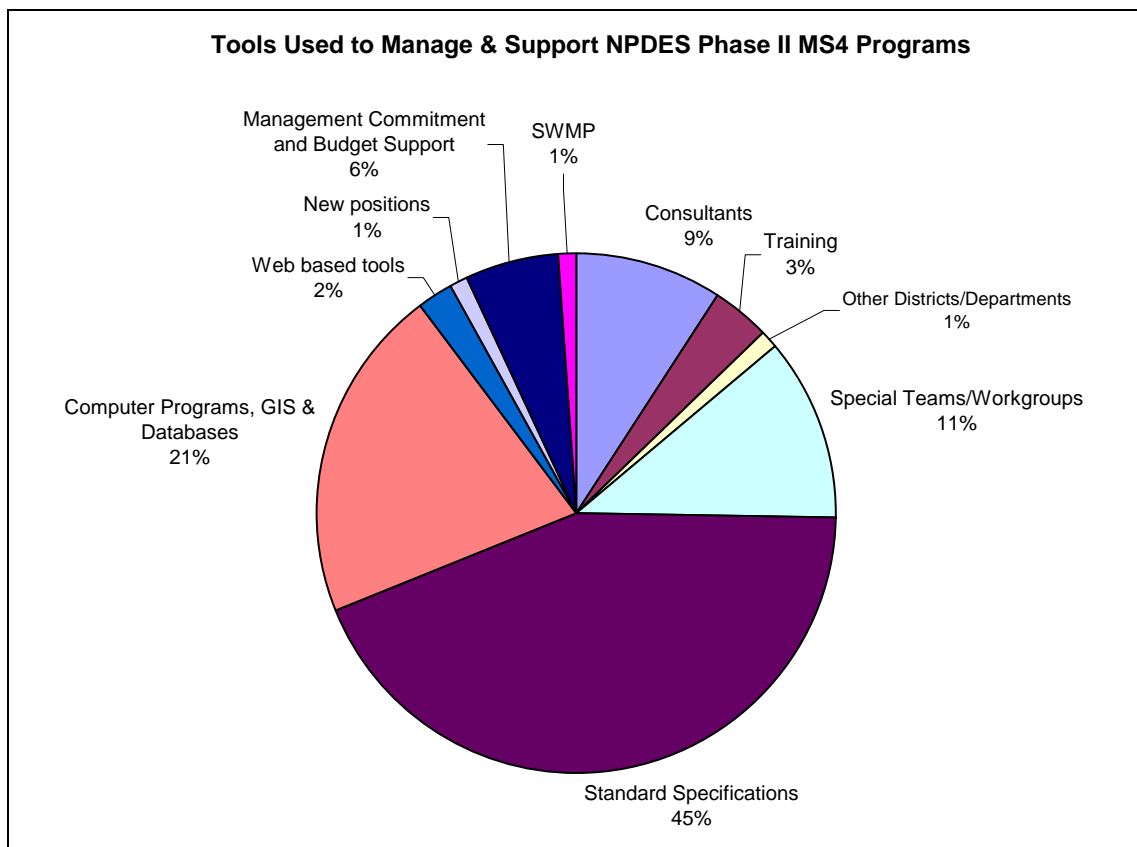


Figure 7: Tools Used to Support and Manage Positions and the NPDES Phase II MS4 Program

Table 20: Tools Identified by the DOT as in Use to Support and Manage the NPDES Program

Tools in Use within the DOT to Support and Manage the NPDES Program and the Positions Involved	State DOTs
None	HI, KS, ME, UT
Consultants	AZ, CO, HI, KY, MA, NC, TN For TX - EMS only
Training	CO, IN, MS
Management commitment & budget support	CA, MD, NC, OR, VT
QA/QC Procedures	OR
Cross-Functional Stormwater Team, Advisory Committee, or Statewide Erosion Control Committee	CA, CO, NY, OR, VA, VT
Quarterly meetings	MS
Design and Construction guides, Standard Specs	Almost all
Numerous standard plan sheets and revised specifications	MN, OH
Coordination/cooperation with Districts and Regulatory Agencies	NM

Tools in Use within the DOT to Support and Manage the NPDES Program and the Positions Involved	State DOTs
DOT Stormwater Management Plan	MA
Maintenance forces and equipment	LA, MA, MD
Drainage infrastructure Asset Management/GIS database for evaluation, tracking, maintenance, prioritization and funding. (e.g. HyInfo 3) A web-based outfall inventory database for contractors to submit and manage data.	CO, DE, FL, MD, MS, NC, OH, RI, SC, TX OH
Software used to identify and maintain an inventory of outfalls	FL, LA
Databases to track projects containing erosion control plans	LA, WA
Environmental Compliance Bureau	GA, KS
Using internally developed programs to track and report construction inspections and maintenance activities that deal with NPDES requirements.	SC
Electronic submittal of inspection reports and data via CPMS (computerized project management system)	AL
DOT restructuring will add support to the NPDES program.	SC
Work order system (Maximo) to track and repair drainage system assets.	DE
Stormwater Action (SWAT) Teams to develop manuals, check list, action plans, specifications, training. Engineers, Landscape Architects, Scientist, Staff and Consultants have been assigned to address issues, develop protocols, update specifications, and develop guidance manuals.	AZ
Standard computer e-mail, word processing and spreadsheet software	UT
MMS used to generate annual reporting input on maintenance of regulated features.	NJ
“Site Manager Database,” others in development	NE
Research	CA, MN, NC, TX, WA
Web applications – unspecified	NC
Environmental Specialists in Regional Construction & Maintenance Departments	CA, MT, NC, NY, VA
Yet to be signed but already implemented Memorandum of Agreement between VTrans and the state resource agency, Vermont Agency of Natural Resources.	VT
Expanding the Environmental Division and redefining roles and responsibilities.	TN

Environmental Strategic Plans Including Water Quality Objectives

Very few DOTs incorporate NPDES goals, objectives, and targets into the business plan of the agency; however, MDSHA is one that does. MDSHA's Environmental Stewardship Strategic Plan comprehensively addresses MDSHA environmental activities and establishes measurable outcomes. MDSHA is also working on combining management systems, including their permit tracking system, maintenance, and other management systems, to further the agency's ability to track and measure environmental performance. MDSHA's current environmental targets and measures are to:

- **Meet 100 percent of environmental commitments.** MDSHA is working on this objective or target on two levels. First the agency is making a list of all commitments made in the NEPA Record of Decision and tracking whether they are implemented in design. The next stage is making sure the commitments are implemented in construction and implementation is confirmed or evaluated after construction.
- **Create and restore 200 acres of wetlands and restore 5 miles of streams by the end of 2006.** This stewardship commitment helps the state achieve regional, watershed, and statewide conservation objectives and is above and beyond what the agency is doing to satisfy Clean Water Act requirements. MDSHA is using transportation enhancement and other dedicated funds to enable the agency to achieve this objective.
- **Annual "in compliance" rating on NPDES statewide permit.** Every January, MDSHA submits an annual report and receives review and comment from the state water quality oversight agency. MDSHA seeks to maintain the agency's reputation as a leader in the field nationally.
- **80 percent or more of MDSHA stormwater management facilities rated functionally adequate by end of 2006.** MDSHA has developed a thorough and duplicable grade-based rating system for stormwater management facilities and has developed an inventory, database, and photo record of all facilities statewide and their maintenance status. Under the rating system, those graded A or B are considered functionally adequate. As of late 2003, between 73 and 75 percent of MDSHA stormwater were functionally adequate (A=everything fine, working fine, no maintenance required, B= minor maintenance, need mowing or trash removal), leaving approximately 25 percent needing maintenance or retrofitting to achieve functional requirements. By 2010 MDSHA is aiming for 95 percent of facilities functioning adequately.
- **Accomplish 35 percent of needed industrial facility improvements by end of 2006.** MDSHA has assessed shortcomings at industrial facilities from an NPDES or water quality standpoint. The agency is committed to rectifying those deficiencies and is aiming for 100 percent completion by 2010.
- **Achieve 100 percent compliance with erosion and sedimentation control requirements on all MDSHA construction projects.** MDSHA believes the agency maintains one of the better DOT enforcement systems in the country. To assess compliance, MDSHA implemented a six-layer system that includes independent quality assurance ratings for each project. Certified Quality Assurance inspectors inspect projects biweekly and rate the sediment controls on a letter grade scale. Projects can be shut down based on these inspections. Ratings for all projects are summarized quarterly and annually to comply with the MDSHA Business Plan. In the past the agency has pursued ratings of B or better on 95 percent of construction projects annually. Although, as part of a primary agency commitment, the Chief Administrator is seeking to improve performance to achievement of 100 percent compliance in construction.

The Managing For Results (MFR) portion of MDSHA's business and stewardship plan is being used to measure the progress and success of MDSHA's environmental stewardship and to define timelines and milestones for the numerous elements of the program. Using the MFR approach, progress is measured every month for each of the major elements, and every six months for all the elements of the

program. An example of this is the stormwater management retrofits that needed to be completed by December 2003. The retrofit completion progress was tracked every month and new strategies were developed continuously. As a result, this requirement was exceeded by 300 percent. Individual projects, such as watershed retrofits, stormwater improvements and watershed partnerships that are generated as a part of the program are managed using MS Project and milestone reviews.

For maintenance facilities, the discharge sampling of the outfalls is a direct method for measurement of success, which is defined based on state and federal requirements. As a stewardship measure, MDSHA tracks implementation of strategic upgrades to the facilities identified during the pollution prevention plan development and needed changes in systems identified by the independent inspection program.

Charts are developed for all the major programs to visually demonstrate successes and progress. Once a year, an annual report summarizing all the activities, including compliance with the NPDES program is prepared and submitted for review to the Maryland Department of the Environment (MDE). So far, every report was thoroughly reviewed and approved by MDE, which means MDSHA remains in compliance and is actually being commended for showing stewardship by exceeding the permit requirements.

Use of Environmental Management Systems to Address NPDES MS4 Requirements

Environmental management systems, some proactively developed, others begun after consent decrees mandated their development, have predominantly focused on water quality issues at DOTs in the U.S. Over half of responding DOTs are handling or considering handling some part of their stormwater management program within the context of an EMS:

An EMS entails identification of specific environmental responsibilities of the various positions involved, often entailing adjustments to resources, level of involvement, and communication to address NPDES and effectively implement the necessary practices and procedures. Refer to Appendix B for information on MDSHA's EMS.

11.4 DOT NPDES PHASE II MS4 FUNDING AND BUDGETS

Most DOTs were not able to provide budget figures for their NPDES MS4 programs as Phase II compliance was not considered a separate item. In cases where some tracking of expenditures did occur, those were rarely readily accessible. Budget/expense identification difficulties differed by functional area or general category of responsibilities:

- **Design:** Specific stormwater figures are usually not available for the design process, where design for erosion and sedimentation control is considered an integral part of the design process and overall project cost. When asked how much they spent annually on BMP design and construction, most DOTs were not able to estimate. Some pointed out that it varies. Those who did provide estimates said 1-15 percent of project costs. One DOT estimated \$6 million for the state; another estimated \$5 million.
- **Construction:** Construction has specific pay items for erosion and sediment control and some of the permanent features; however, the items that are integral to stormwater control and protection may have another primary purpose. Even where figures exist, "it may be difficult to relate an accurate expenditure for construction costs of stormwater related items." Stormwater costs associated with construction also vary greatly depending upon the number and scope of projects in a given construction season.

Table 21: EMS Status

EMS Status	Percent of DOTs
Currently working on an EMS	14%
Discussing work on an EMS	5%
Have an EMS-like program in place	7%
Have an independent program	2%
Compliance reporting system	2%
Using EMS for “Good housekeeping” portion	5%

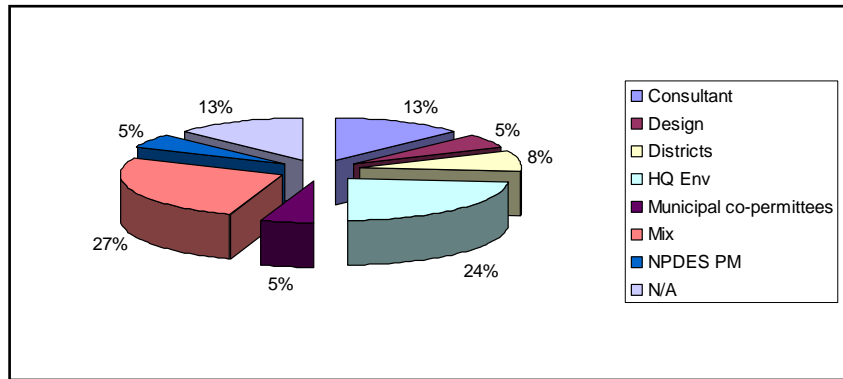


Figure 8: Who Prepares the SWMP Annual Plan Report

- **Maintenance:** Maintenance costs are usually tracked via activity code and thus are not specific to stormwater in many cases.
- **Central Program:** Likewise, most states did not know or have a General Program/Plan development budget. Four states identified an amount for the latter, which ranged from \$680,000 to \$2.61 million, with a median of \$1.5 million. With regard to how much money is spent annually on permit reviews, policy development, fee collection and permit compliance, three states answered in the \$50-\$150,000 range. Annual reporting ranged from \$50-\$250,000 generally.
- **Public Education and Outreach:** DOTs often partner with other agencies on stormwater education and information campaigns, to maximize cost efficiencies. Each MS4 takes products developed from such an effort and promotes stormwater awareness in their communities.(NY, SD) Partners may contribute funds and offer in-kind services. Public education expenditures ranged from \$10,000 annually on the low end to \$6.5 million for Caltrans “Don’t Trash California” Storm Water Public Education Campaign.

Given that most DOTs were not able to provide financial information, the following should not be taken as representative of other states. The lowest number provided for the NPDES Phase II MS4 program was \$500,000. This ranged up to \$9.5 million for two DOTs at the high end. Most DOTs said that information was not known or available, as NPDES compliance costs were either absorbed into other budgets or not tracked, or research would need to be done across contract specific items.

- NCDOT allocates \$1.5 million annually to program management and development, \$500,000 to industrial activities, \$1 million for salt storage improvements (temporary), and \$600,000 for retrofit construction.
- NYSDOT estimated that the agency’s total budget for stormwater control is \$9.5 million out of a total DOT program budget of \$1.65 billion.
 - \$5 million is spent annually on BMP Design and Construction. \$3.6 million is spent annually on erosion and sedimentation control (design, implementation, and monitoring).
 - \$100,000 is spent on permit reviews, policy development, fee collection and permit compliance.
 - \$85,000 is spent annually on reporting and inspection.
 - \$70,000 is the annual cost for the illicit discharge detection and elimination program.
 - \$400,000 per year is spent on GIS development and implementation.
 - \$4,000/year is spent on BMP evaluations.
 - \$80,000 is the annual budget for public education.
 - \$150,000 is spent annually on BMP maintenance.

NYSDEC has a database of all projects covered under the state stormwater construction permit. This includes completed projects, and areas of disturbance and impervious areas. The capital budget allocation for BMP maintenance occurs at the regional level. Not all regions have made such allocations in the capital program.

- Delaware spends \$2.61 million annually on their general NPDES program and plan development. DelDOT estimates the agency spends \$250,000 each, annually on BMP Design & Construction, BMP evaluations, and the illicit discharge detection and elimination programs. DelDOT spends \$60,000 annually on public education. Storm system inventory and inspection costs \$700,000 annually and mosquito control work in stormwater ponds adds \$50,000 annually.

- Hawaii DOT is spending \$2.2 million to improve their Erosion and Sedimentation control, including stormwater management maintenance facilities- \$19,000, Debris Removal- \$2.1 million, Construction BMPs- \$0.639 million, Chemical control - \$10,020, Flood control- \$12,000, New development/redevelopment BMPs- \$1.05 million, and Industrial discharges- \$3400. Hawaii DOT is operating under a consent decree.
- Kentucky Transportation cabinet has leveraged an extensive community partnering program to keep their NPDES expenses relatively low. Between 2003 and 2005 they spent an average of \$100,000. Due to the addition of several new programs, the program is expected to grow to \$2 to \$3 million per year between 2008 and 2012.
- Missouri said they have a \$2.8 million NPDES Phase II program.
- Minnesota estimates 7 percent of project expenses go to erosion and sedimentation control.
- Maine's stormwater program costs \$750,000 per year, with an estimated \$1.5 million spent on BMP design and construction; \$50,000 is spent annually on permit reviews, policy development, fee collection and permit compliance; \$250,000 is spent per year on Reporting & Inspection, and \$50,000 per year is spent on inspection and monitoring. The agency spends \$10,000 annually on BMP evaluation and the same amount on public education.
- West Virginia notes that there is "no specific budget - funds that go toward illicit detections & elimination come from the same monies allocated for road maintenance. There is not any magic pot of money out there to cover these issues." The agency anticipates an additional \$700,000 for stormwater sampling and testing at Maintenance Facilities.

11.5 FUNCTIONAL AREA ROLES AND RESPONSIBILITIES

To integrate water quality management across the agency, DOTs have involved nearly every functional area. The first example is from a small DOT MS4 program. South Dakota's is small and is conducted as a co-permittee with municipalities. On the other end of the scale is [California's Stormwater Management Program](#) and distribution of responsibilities, which can be viewed on their website. The remainder of this section identifies water quality roles and responsibilities of common DOT sections or groups in a medium-sized DOT and MS4 program, and may be utilized or adapted to individual DOTs as a portion of their MS4 permits and/or in developing the roles and responsibilities portion of an EMS. An EMS goes into further detail on how specific positions will carry out and be responsible for implementation of particular water quality assurance activities—whether outreach, planning, development of standards or procedures, inspection and monitoring, evaluation and reporting, and management or program revision.

Reporting Requirements

When asked what their NPDES program reporting requirements consist of and how they handle them, over two-thirds of the responding DOTs indicated they produce annual reports. Just one state performed quarterly reporting or mid-year reporting. California produces regional work plans as its main reporting mechanisms. Four state DOTs indicated they had produced no reports to date.

Shared Responsibilities Across Many Sections

DOTs reported shared responsibilities across many sections. Whereas the central environmental office would have prepared the annual report at one point (and still does in the case of 24 percent of responding DOTs), now the most common arrangement is "mixed" responsibility of multiple sections or divisions (27 percent of responding DOTs). Consultants prepare approximately 13 percent of Stormwater Management Plan reports. (See Figure 8)

Development Program

The Development Program provides for the coordination of the Statewide Program preconstruction engineering functions. The functions include project management and technical support as provided by the groups such as the following (names vary slightly in each DOT): Statewide Project Management Group, Right-of-Way Group, Engineering Technical Group, Roadway Engineering Group, Environmental & Enhancement Group, Bridge Group, and Traffic Engineering Group.

The Project Development and Delivery Stormwater Management Program addresses the processes, procedures, and responsibilities for incorporating selected BMPs into the planning, design, and construction of new projects and significant development or redevelopment of existing facilities. The program includes responsibilities for a DOT's design and construction personnel as well as construction contractors. Project Development and Delivery personnel assess the need for and opportunities to incorporate BMPs during the initial planning phases of new facilities and significant redevelopment of existing facilities.

Consideration and selection of BMPs may be incorporated into existing DOT project delivery procedures and milestones such as 30, 60, 95, and 100 percent design (Stages I-IV). Permanent structures are designed in the final two phases. Conceptual temporary erosion control plans are included in the plans to provide guidance to the contractor for SWPPP preparation. Project specifications and special provisions provide the basis for the project bid documents and are typically prepared by the DOT Contracts and Specifications Section during Stages III and IV. The DOT's current stormwater controls and BMP requirements are contained in the DOT's Standard Specifications for Road and Bridge Construction. The overall Project Development and Delivery process is documented in the DOT Project Development Process Manual.

11.6 IN-HOUSE AND CONTRACT STAFFING, CAPACITY BUILDING, AND TRAINING

Most DOTs develop new policies, procedures, guidance documents and training to implement a Phase II compliant stormwater program in their organization. Some outsourcing of construction site inspections, guidance manuals, and training has been observed where these cannot be developed with existing staff resources. Manuals and training focus on planning, design, project development, construction, maintenance, and operations procedures and incorporate water quality considerations at every level.

Training often focuses on design and construction engineers and inspectors, contractors, and sometimes municipalities; however, more extensive approaches have required varying staffing arrangements and organizational structures, involving a commitment of significant resources. For example, the Hawaii DOT Highways Division developed three NPDES stormwater training courses tailored to the different in-house personnel who needed NPDES Training. Over a 3-week period, 27 classes were presented on four islands and attended by 870 people. Developed courses included NPDES Stormwater Training Courses for Maintenance Personnel, Engineers, Inspectors, Designers, Project Managers, and Plan Reviewers. Caltrans built an in-house, statewide network of 75 individuals who have classroom and field training and experience in effective erosion and sediment control. The participants in the program include representatives from the DOT functional units relevant to stormwater quality, including planning and design, hydraulics, environmental, construction, landscape architecture, and maintenance, with representatives from all 12 DOT districts as well as the headquarters. An initial weeklong course was followed by day long, quarterly training on specialized topics, such as "Biotechnical Soil Stabilization" and "Repair and Rehabilitation of Erosion-Damaged Soils." The network used conference calls to discuss ongoing projects, issues, problems, and potential solutions and oversaw one-page bulletin-style newsletters to reach out to Design, Construction, and Maintenance. The program goal was "to develop an in-house network of erosion and sediment control experts whose training and

experience are consistent and comprehensive and who are integrated into all aspects of project planning, design, construction, and maintenance.”

When asked if the DOT provides guidance for the public, engineers and developers, maintenance staff, construction companies, and others, of the 42 responding DOTs:

- 55 percent provide guidance materials for the public – mainly websites but also presentations, handouts at meetings, and brochures.
- 62 percent provide guidance materials for engineers and developers – including NPDES compliance and erosion and sedimentation control guidance, training presentations and meetings, design memoranda, instruction at project sites, website, and guidance for construction inspectors.
- 71 percent provide guidance for maintenance staff – including environmental handbook/guidance for maintenance activities, basic training on NPDES compliance, Stormwater Pollution Prevention Plans and training, in-stream training, spill prevention and pollution control, training through a secure website.
- 64 percent provide guidance for construction companies – BMP standard plans, speaking at meetings and project sites, training for inspectors, erosion and sedimentation construction manual and training program.
- Other: guidance provided through plan sheets and special provisions, development of specially tailored training modules, certification training provided through university, overview training provided to DOT and consultant staff, with mandatory training for Erosion Control Coordinators.

12 ANTICIPATED FUTURE CHALLENGES

The three top future challenges anticipated by responding DOTs were:

- Total Maximum Daily Loads (TMDLs) and the more stringent requirements imposed on NPDES permittees where TMDLs are in effect.
- Permit issues, in particular rising expectations with regard to BMP effectiveness, monitoring, and enforcement.
- Funding and staffing.

Information management, documentation, standardization, and management systems were also identified as concerns. Two DOTs indicated concerns with regard to coordination with their regulatory counterpart. Several DOTs said they were not anticipating any particular challenges or difficulties at this point.

12.1 FUNDING

Funding is DOTs' number one area of concern. DOTs have been challenged to come up with the funding to cover the mandates emerging from the NPDES MS4 program. On federal-aid construction projects, the additional erosion and sedimentation control costs can be rolled into the project budget; however, compliance requires significant efforts in the areas of maintenance, planning, and public involvement. These efforts are typically funded out of state dollars.

DOT Funding for Stormwater Requirements

DOTs fund MS4 program requirements in a variety of different ways; however, the most common pattern is as follows:

Project Development and Delivery Program

The Project Development and Delivery program includes both development (design and preconstruction activities) and construction. Stormwater activities include review and selection of permanent and temporary BMPs. The Five Year Transportation Facilities Construction Program is reviewed on an annual basis and new projects and modifications are made monthly to the existing program. Several federal, state, and local sources are identified to fund the construction program, with a major source of funding being the highway users tax. The project approval process consists of identification of the project and funding requirements and submittal to the Priority Planning Committee, and then, in turn, to the Transportation Board for final approval. The program is adopted each fiscal year. Expenditures on stormwater controls vary by project. Those projects in close proximity to protected waters can incur higher erosion and sediment control costs.

Highway Maintenance Program

Stormwater issues related to maintenance are typically funded under the Highway Maintenance Program, which is entirely state-funded. Maintenance issues and costs are identified and submitted for approval every year. A portion of this budget is spent to maintain stormwater control structures such as detention impoundments, drainage structures, canals, tunnels, and pumphouses. As maintenance costs associated with stormwater control structures have increased with the implementation of Phase II of the stormwater program and DOT MS4 permits, maintenance programs typically are in need of more funding for maintenance BMPs.

MS4 Program Expenditures

Expenditures directly attributable to the MS4 program often receive a special allocation from the state-funded DOT administrative budget, similar to the Highway Maintenance Program. The Administrative Budget may cover stormwater management support services such as data management, employee training, research, drafting and facilitating joint project agreements with local jurisdictions, community relations, project planning and budgeting assistance, staff technical assistance, and providing on-call consultants when projects require consultants to be brought on quickly. This budget also may include funds for permanent stormwater controls located at DOT physical plant facilities.

What Does MS4 Compliance Cost?

Little research has been done on the costs of DOT compliance with NPDES MS4 requirements; such calculations are difficult because the costs of the program are split among multiple functional areas and funding sources. The most significant research to date has occurred on a municipal level. Estimates have ranged from \$19 to \$48/household.^{xxix}

An Economic Impact Evaluation of Proposed Stormwater Treatment for Los Angeles County (Gordon et al., 2002), performed by engineers and economists at the University of Southern California (USC), estimated that it would cost about \$44 billion to treat flows from 70 percent of the average annual storm events in the LA area and 6 times that much to treat 97 percent of the flows.^{xxx} These costs were so high because the study assumed that most stormwater would need to be collected and sent to advanced treatment facilities in order to comply with water quality standards including TMDL requirements. This treatment assumption has been disputed. A second study, completed in 2005 by USC and UCLA looked at the issue differently and assumed non-treatment approaches would be adequate for stormwater quality control. Rather than estimating costs for stormwater treatment controls, this effort looked at source control as the primary stormwater management alternative including litter control and improved street cleaning. The study suggested that these measures “may constitute sufficient control for runoff coming from residential areas, so that these areas will require no further action.”^{xxxi} The study also noted that, “Where non-structural BMPs will not be adequate, or where implementation is very expensive, efforts must expand to include regional wetlands and stormwater parks (multiple-use infiltration basins).”^{xxxii} Infiltration (percolation into the soil) is also projected for higher density urban areas. Based on these assumptions that the relatively low-cost source controls will be adequate, the total LA area costs for stormwater management are estimated at \$2.8 to 7.4B.^{xxxiii} Despite these lower estimates, the report goes on to state that because of TMDLs and increasingly strict NPDES Permit requirements, “It is quite feasible, indeed likely, that the ultimate public policy result to these simultaneous requirements will be advanced treatment of stormwater and urban runoff,” with actual costs closer to the first report.^{xxxiv}

SAFETEA-LU Provisions Related to Stormwater Control

The Safe, Accountable, Flexible and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) continued the pollution abatement and environmental restoration provided under TEA-21 and extended it to the National Highway System (NHS). FHWA is developing guidance on 23 U.S.C. Section 328 discussing the expanded eligibility of Federal-aid funds for environmental restoration and pollution abatement to minimize or mitigate the impacts of any transportation project funded under Title 23.

The new law expands the eligibility for retrofits to mitigate impacts caused by or contributed to, by any transportation project, not just those projects undergoing reconstruction, rehabilitation, resurfacing or restoration. Furthermore, the new flexibility allows the use of funds for mitigation as stand-alone projects, as long as the measures are for impacts caused by or contributed to by a project funded under Title 23. The eligibility is still limited to 20 percent of the total project cost for transportation projects undergoing reconstruction, rehabilitation, resurfacing or restoration.

According to FHWA's guidance, issued August 17, 2006, the provision primarily deals with the impacts of transportation facilities that were built prior to the current requirements for abatement of stormwater runoff. "These transportation facilities may have been constructed with limited or no stormwater treatment controls. The SAFETEA-LU provides the means to fund retrofits and the construction of stormwater treatment systems to address water pollution and environmental degradation that is caused in whole or in part by a transportation facility." Measures may be implemented under two scenarios:

- A stand-alone project that is developed solely to address stormwater concerns and is not associated with a transportation project that is being developed or is under construction; or
- In conjunction with a project that is currently being developed for the reconstruction, rehabilitation, resurfacing, or restoration of a transportation facility. In this case, the costs for environmental restoration and pollution abatement may not exceed 20 percent of the total cost of the project.

A stand-alone project would likely be considered in a situation when an existing highway is identified as contributing to a water quality issue in a watershed, and there is no highway project currently under development or planned in the foreseeable future in the area. In such cases, if one of the sources of pollution is a transportation facility eligible for funding under Title 23, SAFETEA-LU provides that activities such as retrofitting and construction of stormwater treatment systems to meet State and local requirements may be carried out using STP or NHS funds, depending on the facility.

Most reconstruction, rehabilitation, resurfacing and restoration projects are large enough to require the implementation of stormwater BMPs as part of the project design to meet current NPDES requirements. The 20 percent limitation applied to projects undergoing reconstruction, rehabilitation, resurfacing and restoration would apply in a case where the transportation project improvements being planned are not extensive enough to require the retrofit of a stormwater feature, but the project sponsor determines that there is an opportunity to provide a retrofit to address water pollution or environmental degradation. Sample types of environmental restoration projects that could be eligible for funding include:

- Establishment of buffers or areas to protect riparian habitat along drainage ways and stream corridors.
- Removing impervious surfaces such as concrete lined ditches, underground storm sewer systems, and impervious paving surfaces to restore natural components of the watershed.
- Stormwater quality retrofit measures (detention, infiltration, and pervious pavements).
- Purchase of streetsweeping equipment to address pollutant loadings.
- Wetlands and natural habitat mitigation, restoration, and preservation.

12.2 CRACKING DOWN ON SEDIMENT POLLUTION AND INEFFECTIVE ESC PLANS/SWMPs

An Epidemic of DOT Stormwater Court Orders and Consent Decrees

EPA had undertaken few large cases against developers before the agency took on Walmart construction sites in several states. Walmart is one of the largest retail construction developers in the country, building well over 200 stores each year across the United States under the brand names Walmart Stores, Walmart Supercenters, and Sam's Clubs. In 2001, Walmart settled claims that it had violated the stormwater requirements at 17 sites across the country. That settlement called for payment of a \$1 million penalty and a compliance and training program; however, follow-up inspections after the settlement at 24 Walmart stores revealed that violations continued. Specifically, EPA and state inspectors found:

- Failure to obtain permits for some sites

- Discharges of excessive sediment to sensitive water ways
- Failure to install and/or maintain adequate sediment and erosion control devices
- Failure to develop and/or implement a stormwater pollution prevention plan
- Failure to inspect sediment control devices to ensure adequacy and condition and that operating properly
- Failure to develop an adequate plan for controlling sediment and minimizing erosion

Walmart agreed to a settlement with the United States, the State of Utah, and the State of Tennessee to resolve these violations. This settlement addresses violations at over 24 sites in 9 states (California, Colorado, Delaware, Michigan, New Jersey, South Dakota, Tennessee, Texas, and Utah). Under the settlement published on May 12, 2004, Walmart agreed to pay the largest civil penalty ever paid for violations of the stormwater regulations – \$3.1 million to be divided between the United States, Tennessee and Utah – and perform a supplemental environmental project that will result in the protection of sensitive wetlands or waterways in one of the affected states; and develop an extensive compliance program to provide better oversight of the contractors. Walmart agreed to undertake an extensive training program including: an annual seminar to educate its employees and contractors on stormwater controls; a certification program for construction site employees to ensure they know how to prevent excessive discharges; and provision of training materials to site employees. Furthermore, Walmart committed to careful oversight of its contractors through: regular and frequent inspections by contractor and Walmart employees; documentation of the compliance efforts; and imposition of sanctions by Walmart on its contractors for failure to comply with the stormwater requirements. In the 2004 settlement, EPA said that “In the next few months, we will undertake additional enforcement actions against other nationwide construction customers.”^{xxxv}

DOTs were next.

Hawaii DOT: Hawaii DOT agreed to pay \$52 million in one of the nation’s largest stormwater violation settlements.^{xxxvi} As part of a consent decree with the U.S. Environmental Protection Agency and the state Department of Health, the DOT paid a \$1 million fine, another \$1 million for a program to assess its environmental responsibilities and \$50 million over five years to resolve violations of the federal Clean Water Act at highways and airports. Hawaii DOT also pledged to include clean water and the environment in the earliest stages of planning for new highways, harbors and airports, and as key factors in maintenance of its facilities. Specific violations that led to the settlement include a wide array of facilities and construction projects such as oily water running into airport drains and into nearshore waters on O’ahu, Maui and Kaua’i; sediment-laden runoff from DOT roadway construction sites on O’ahu and Kaua’i; and runoff from the construction of the department’s own baseyard and office complex in Lihu’e. The \$1 million fine in the Hawai’i consent decree is exceeded nationally only by last year’s \$3.1 million Wal-Mart settlement to control stormwater flow from the retailer’s stores nationwide, said John Kemmerer, associate director of the water division for the EPA’s Region 9.

Other recent DOT consent decrees deal largely with construction site erosion and sedimentation control deficiencies.**(Arizona, Colorado, Idaho, Tennessee, and Texas).**

Colorado and Tennessee DOTs received Notices of Violations (NOVs) and consent decrees due to a number of common problems: 1) erosion prevention and sediment controls largely lacking, 2) repeated failures to fix a significant esc problem, 3) installed BMPs ineffective, 4) lack of bmp maintenance, and 5) problems on target site said to be indicative of larger problems. Consent decree requirements, in the case of Tennessee go considerably beyond the initial problem. The DOT was asked to programmatically implement the following, in addition to fixing problems noted on the site with the NOV:

- Prepare and submit plan to assess the degree of sediment contribution from the site, change in pollutant concentrations in a stream
- Prepare and submit restoration plans for polluted streams and drainage ways
- Stream conditions, runoff turbidity/opacity, sediment accumulation
- Inclusion of special provisions for ESC supervisor
- Commitment to attend public hearings on DOT permits
- Determine BMP effectiveness. Use in-stream gauges. If NTU rise above 25 NTU or other method determined by DEQ from the level of upstream control, DOT will revise BMP strategy.
- DOT will collect stormwater samples during storms exceeding .5" and evaluate for TSS. If more than 40 mg/l, DOT will revise BMP strategy.
- Establish QA/QC teams and monthly visits
- 401 certification pending performance on the above
- Pre-construction walk-through and stream surveys, one upstream and 4 downstream. Biologist to evaluate

In addition, DOTs are being asked to develop a systemic process to prevent future violations, typically a [compliance focused EMS](#), as defined by EPA.(**Colorado, Tennessee, Texas**)

Texas DOT: Inspections conducted in 2003 and 2004 resulted in EPA enforcement actions against TxDOT for multiple construction violations for stormwater discharges. Multiple construction projects in the Dallas, Fort Worth and Yoakum Districts were cited. Settlement terms included a civil penalty in the amount of \$34,375.00 and implementation of a Supplemental Environmental Project (SEP), to cost at least \$1 million. For TxDOT, the compliance focused EMS required as a SEP was to have six combined EMS elements: a policy statement; defined roles and responsibilities; identification of environmental requirements; assessment, prevention and control procedures; training, awareness procedures, and competency standards; and documentation control procedures. Re-evaluation occurs as part of EPA's permitting process. TxDOT already had an audit program in place.

Arizona DOT: As a result of a consent order between the ADOT and ADEQ (Consent Order, ADOT 2004), ADOT has resubmitted their MS4 individual permit application that includes all ADOT stormwater activities. A key element of the State Stormwater Management Plan (SSWMP) is the establishment of a manageable, comprehensive statewide program that includes all ADOT activities and functional units. ADOT developed a program with a shared commitment and understanding of requirements within ADOT and with contractors; with redundant accountability mechanisms; an electronic system to collect data, such as plans, outfalls, sampling data, and inspections; BMPs and the reduction/prevention of hazards going into waterways; auditing for compliance; training; and communication. ADOT's revised SSWMP is a model with regard to its detailed allocation of responsibilities.

Idaho DOT: The Idaho Transportation Department (ITD) and contractor Scarsella Brothers, Inc. agreed to pay \$895,000 for violations of the Clean Water Act during the construction of the Bellgrove-Mica realignment of Highway 95 near Lake Coeur d'Alene in Northern Idaho, concluding a lawsuit which began in 2004, alleging failure to provide adequate stormwater controls for a large highway project that later deposited many tons of sediment in Mica Creek, which flows into Mica Bay in Lake Coeur d'Alene. As part of the settlement, ITD and Scarsella Brothers also agreed to send their engineers and environmental inspectors to a certified stormwater management training, and ITD agreed to implement new construction management practices to help avoid future violations of the stormwater regulations. "Runoff from construction sites is a major contributor to water quality impairment in the U.S. The EPA is aggressively enforcing federal regulations to help control this problem," said Granta Y. Nakayama, EPA's

Assistant Administrator for the Office of Enforcement and Compliance Assurance. The penalty in these two cases is the largest EPA Region 10 has imposed to date as part of its regional stormwater compliance initiative. Although the initiative began in 2001, it was not until 2005, after EPA stepped up its inspection and enforcement efforts, that the region saw a dramatic increase in compliance rates. Since the initiative began, EPA has brought cases against more than 100 operators.^{xxxvii}

Over the past couple of years, EPA and delegated agencies have issued an increasing number of consent decrees to DOTs, almost all for water quality issues. Maintenance facilities were an issue for the **Maryland DOT's Transit Administration**. Now the **MDSHA** is developing an Environmental Management System (EMS) around water quality for their maintenance facilities as well. Earlier consent decrees typically had other drivers, either other media, such as waste management, or were more frequently initiated by third party environmental groups.

Earlier TxDOT experience: In the 1990s in Texas, the Barton Springs/Edwards Aquifer Conservation District (District) and several environmentally oriented organizations became concerned about the potential for contamination of the Edwards aquifer as a result of proposed highway construction activities over the recharge zone of the aquifer. The proposed highway construction corridor crossed and paralleled three creeks and overlaid a portion of the recharge zone of the Edwards aquifer that feeds Barton Springs. This concern resulted in litigation involving TxDOT and FHWA, which temporarily halted construction activities on the project site. Prior to this halt in construction, the District and TxDOT negotiated a settlement, the Consent Decree, which was approved by the U. S. District Court. The District removed itself from the litigation and TxDOT began implementing certain actions and practices to answer the concerns of the District. The cooperative efforts of the two agencies were effective in preventing and reducing pollution from both point and nonpoint sources during roadway construction activities. In addition, many improvements and innovations were developed for structural and non-structural BMPs. The Consent Decree also ordered a study of the water quality and quantity of highway runoff and the effects of highway construction and operation on the quality of receiving waters. TxDOT and the District agreed to have the study conducted by the Center for Research in Water Resources (CRWR) at The University of Texas at Austin. A technical review committee consisting of three representatives of the District, two from TxDOT, and two from the CRWR met quarterly to review activities and progress reports. The committee provided input and guidance to the CRWR project personnel dealing with the overall study, its procedures, equipment, and future work efforts. The construction of the new highway allowed the evaluation of the hydrologic changes to creeks in the recharge zone. Effectiveness of temporary runoff control measures were evaluated in the field during the construction process. In addition, field scale laboratory experiments were conducted to determine the hydraulic properties and sediment removal effectiveness of silt fences under realistic operating conditions. The quality of highway stormwater runoff was measured at three sites along an existing segment of highway to determine runoff characteristics, the probable impact of the new highway segments, and to identify treatment systems to mitigate adverse water quality impacts. A rainfall simulator was operated along a section of active highway to determine the factors which affect the quality of highway runoff. The effectiveness of sand and other media for filtration of runoff was evaluated in laboratory experiments and the performance of permanent runoff treatment systems was monitored after completion of the highway.

MassHighway developed an EMS in the 1990s, driven by waste management issues, but with water quality elements. After federal inspectors discovered nearly 200 aging barrels of hazardous waste outside maintenance facilities, MassHighway agreed to a \$20 million dollar waste clean up plan. The consent order also required an audit of MassHighway facilities. That audit discovered over 6,000 compliance issues which MassHighway subsequently placed into the following compliance programs for handling and resolution: hazardous waste, hazardous materials, water quality, solid waste, tanks, wetlands, and asbestos. At that point, the audit found no training, dedicated budget, or clearly defined roles and responsibilities. EPA did find incomplete knowledge of regulatory applicability to agency

operations. MassHighway rectified these findings in the systematic approach it developed to improve knowledge, change procedure and behavior, and track and improve performance.

MassHighway identified common maintenance activities and environmental aspects/risks and cross-relationships from those, as follows, so that the activity areas and process improvements could be dealt with in relation to each relevant compliance program and its particular regulations. In each case 50-120 facilities were performing the activities, giving a scope of the issues and their significance:

- Vehicle Washing: water quality
- Vehicle Maintenance: hazardous materials, hazardous waste, solid waste, water quality, and tanks
- Fuel Dispensing: hazardous materials, hazardous waste, water quality, tanks
- Salt and Sand Storage: hazardous materials, water quality, wetlands
- Street Sweepings and Catchbasin Cleanings Storage: hazardous waste, solid waste, water quality, wetlands
- Equipment and Material: solid waste, wetlands
- Roadside and Construction Debris Storage: hazardous waste, solid waste wetlands

The implementation plan developed as part of the EMS identified the schedule and funding required to implement the program over several budget cycles. The clean-up and reorganization required \$50 million over 6 fiscal years. Today, only 55 of the initial 6,000 issues remain open. Those are mainly wetland restoration and solid waste capping projects due to previously buried debris.

Caltrans: On August 19, 1999, the State Water Resources Control Board (SWRCB) reissued the General Construction Stormwater Permit (Water Quality Order 99-08-DWQ referred to as “General Permit”). The San Francisco BayKeeper, Santa Monica BayKeeper, San Diego BayKeeper, and Orange Coast Keeper filed a petition for writ of mandate challenging the General Permit in the Superior Court, County of Sacramento. The Court issued a judgment and writ of mandate on September 15, 2000. The Court directed the SWRCB to modify the provisions of the General Permit to require permittees to implement specific sampling and analytical procedures to determine whether BMPs implemented on a construction site are: (1) preventing further impairment by sediment in stormwaters discharged directly into waters listed as impaired for sediment or silt, and (2) preventing other pollutants, that are known or should be known by permittees to occur on construction sites and that are not visually detectable in stormwater discharges, from causing or contributing to exceedances of water quality objectives. The monitoring provisions in the General Permit were modified pursuant to the court order.

12.3 GETTING BETTER COMPLIANCE AND ADHERENCE TO SPECIFICATIONS BY CONTRACTORS

In addition to the construction inspection systems discussed in Section 4.4, DOTs are sharing information on and searching for ways to improve and facilitate better contractor performance. For example, the AASHTO Subcommittee on Construction will be conducting a survey of Chief Engineers, including the following questions, in fall 2006.

The following survey is intended to summarize the status methods for payment for work related to erosion control to meet NPDES/SWPPP regulatory requirements. This survey is intended for construction projects only.

1. How do you pay for erosion control and maintenance for erosion control?
 - a. Temporary minor devices (silt fence, beams, etc.), (Show example bid items, list applicable, example)

- b. Maintenance of temporary minor devices (If applicable, show bid items, example)
 - c. Major devices temporary or permanent (e.g. retention structures and filter ponds)
 - d. Maintenance of major devices
 - e. Other (If question structure does not apply)
2. Do you use incentives/disincentives to promote compliance?
- a. Do you use bonus penalty provisions? (Send specification with applicable language and check list spreadsheets)
 - b. Do you withhold payment for erosion control items or withhold entire estimates for noncompliance (Send specification with applicable language)?
- Discuss:
3. Do you have issues with contractor unbalanced bids for this type of work?
- Discuss:
4. Do you have problems with enforcement related to payment? (For example, does the payment method create noncompliance choices by the contractor because the cost of the compliance exceeds the penalty for noncompliance?)
5. Discuss effectiveness of your payment provisions.

12.4 COMPLIANCE FOCUSED EMSs

Most EMSs that have been in the early stages of development the past couple years at DOTs are compliance focused EMSs. As such, a primary emphasis of the EMS is on managing environmental compliance risk and liability and improving the systems and processes that will prevent violations. Several are being developed in response to consent orders or decrees and Supplemental Environmental Projects (SEPs), usually related to water quality violations.

DOT EMSs rarely follow the strict outlines of ISO14001, especially in its 2004 incarnation, and would be considered incomplete if evaluated by that standard. Nor does EPA require that (see the following section on elements requested by EPA in recent construction-focused EMS). However, the EMSs are systems for improved environmental performance and accountability in an area of focus. An EMS provides a structure and process to identify and address needs and opportunities, ensuring consistency in approach and resulting actions.

Elements EPA Has Requested in Recent Construction-Focused EMS

Key EMS management elements requested by EPA include:^{xxxviii}

1. **Policy Statement** – The policy must clearly communicate management’s commitment to achieving compliance with applicable environmental requirements, minimizing risks to the environment and continual improvement in environmental performance. The policy should also state management’s intent to provide adequate personnel and other resources for the EMS.
2. **Roles and Responsibilities** – Clearly defines and communicates to all applicable organizational units within the Department’s organizational structure and, as applicable, to Contractors their roles and responsibilities associated with an environmental requirement. Also, clearly defines and communicates for applicable Department personnel the expected roles and responsibilities related to any environmental requirement. As a minimum, roles and responsibilities with respect to compliance with environmental requirements shall be described for the following positions:

District Engineer, Engineer, District Environmental Quality Coordinator (DEQC), Department Construction Inspector, and Contractor Superintendent.

3. **Environmental Requirements** - Contains a protocol that sets forth procedures to identify, interpret, document, and communicate to affected personnel those environmental requirements applicable to each Department roadway construction project during field operations occurring within the Right-of-Way. Further, the protocol shall provide for monitoring construction activities occurring within the Right-of-Way for conformance to those requirements. The protocol shall also address identifying, obtaining, and evaluating information about changes and proposed changes in environmental requirements that could potentially apply to and/or impact construction operations. The protocol shall describe, at a minimum, the following elements:
 - The process for initially identifying applicable and potentially applicable environmental requirements.
 - The process for interpretation and assessment of applicability, as necessary, through an identified network of designated knowledgeable individuals, defined as those environmental professionals within the Environmental Affairs Division, other divisions, if applicable, and the three pilot districts, who are familiar with roadway construction, environmental requirements, and other aspects of operations that could affect the environment and/or compliance.
 - The implementation process shall include a communication procedure for disseminating information on applicable and/or potentially applicable environmental requirements to, as a minimum, the respective DEQC, Engineer, Construction Inspector, and the Contractor's Superintendent.
4. **Assessment, Prevention, and Control** - An ongoing process for assessing construction operations for the purpose of maintaining compliance with statutory and regulatory environmental requirements. This includes the following:
 - a. Monitoring and measurements procedures, as appropriate, to ensure sustained compliance. This shall include metrics for which data will be collected during the pilot phase that will be used for program evaluation at the conclusion of the pilot phase.
 - b. The process for identifying operations and activities where documented standard operating practices (SOPs) are needed to assure compliance with an environmental requirement.
 - c. A uniform process for developing, approving and implementing necessary SOPs to assure compliance with an environmental requirement.
 - d. A system for conducting and documenting routine, objective, self inspections by trained Department personnel and trained construction contractor personnel to check for malfunctions, deterioration, worker adherence to SOPs, and potential noncompliance with an environmental requirement.
 - e. Describes a process to ensure operational changes noted during ongoing construction projects that are required to meet environmental requirements are conveyed to the design staff for incorporation into future project designs.
5. **Training, Awareness, and Competence** - Procedure to identify specific education and training required for applicable Department and Contractor personnel, as well as, processes for documenting completion of training.
 - a. Identify appropriate training to ensure that applicable Department and Contractor personnel are aware of the Department's EMS and supporting environmental policies and procedures, environmental requirements, and their roles and responsibilities within the EMS.
 - b. Describe procedures for ensuring that Department and Contractor personnel responsible for meeting and maintaining compliance with environmental requirements are competent on the

basis of appropriate education, training, and/or experience. Specifically, the procedures shall contain a Training Matrix that presents environmental and other related training required for all Department and Contractor personnel directly involved in road construction projects. The procedures shall provide for updating the Training Matrix at least annually. Positions to be addressed in the Training Matrix include at least the following: District Engineer, Engineer, DEQC, Construction Inspector, and Contractor Superintendent. Trainer qualification requirements for each identified course shall also be identified as well as a requirement for developing an annual training plan for presenting the course(s) identified in the Training Matrix. The procedure should also contain a description of how the training will be reinforced on road construction projects in order to maintain increased employee and contractor awareness and involvement in meeting applicable environmental requirements. A description of how a periodic (minimum of at least one annually) evaluation of the training program, including the procedure for identifying training needs, will occur and how Department plans to incorporate the results into program improvements should also be included.

6. **Maintenance of Records and Documentation** - Identify the types of records developed in support of the EMS (including assessments and reviews), who maintains them and where, and procedures for responding to inquiries and requests for release of information. Specify document control procedures.

DOT Motivating Factors

DOTs have their own reasons for implementing EMSs. For example, the Maryland State Highway Administration recently formulated the following reasons to develop and fund a substantial EMS effort in the agency: ^{xxxix}

- **Improve Environmental Performance** – an EMS gives us the ability to directly incorporate environmental requirements into our daily operations and hold ourselves accountable for achieving environmental goals
- **Ensure Ongoing Compliance** – we could just identify environmental deficiencies now and fix them, but without putting programs in place to identify root causes for problems and ensure ongoing compliance, we'd likely have to address (and pay for) the same issues again down the road.
- **Save Money** – an EMS helps us reduce the risk of highly expensive cleanups and regulatory fines.
- **Train our Employees** – an EMS will help us achieve and/or improve employee awareness of environmental issues and responsibilities.
- **Do the Right Thing** – it is everyone's collective responsibility to ensure that our air, water, soil, and natural resources are protected for future generations. An EMS will give us the procedures and tools to help protect our environment.

Texas DOT EMS for Construction Stormwater Runoff

The Supplemental Environmental Project required by TxDOT's consent decree involves the development and implementation of a statewide EMS for TxDOT's internal operations that focuses on improving environmental compliance and performance at all TxDOT road construction projects. Due to EPA SEP policy, the statewide management system is called a Construction Oversight Program (COP) in the Settlement and not (technically) an EMS; however, TxDOT refers to it as an EMS.

TxDOT organized an EMS development team, completed a gap analysis, and developed a pilot EMS implementation plan. TxDOT is now implementing and evaluating the pilot EMSs, in preparation for development, implementation, and evaluation of a statewide EMS.

TxDOT's EMS Development Team was primarily internal, with a thorough knowledge of TxDOT construction operations and a good working knowledge of environmental laws and regulations. Included on the team were members from the following areas and/or with the following expertise: District and Division management, Area Engineer functions and duties, District construction offices, Division and District environmental staff, Design, Environmental Quality Control (DEQC), and Construction inspection. All team members had worked for TxDOT long enough to have a good understanding of TxDOT's general organization, operations and culture. TxDOT devoted particular effort to identifying aspects of operations that trigger environmental requirements, systematically identifying environmental requirements and the construction Operations that might potentially trigger an environmental requirement (any applicable federal, state and local environmental statutes and regulations that must be addressed during a Department Road Construction Project).

TxDOT's EMS:

- Builds upon the many successful environmental programs and initiatives already in place within the Department.
- Has procedures integrated as much as possible into the Department's current routine practices.
- "De-mystifies" environmental compliance for TxDOT and contractor personnel.
- Complies with all of the Settlement's requirements.

The Gap Analysis reviewed and evaluated the current environmental management practices and systems against EPA's six key EMS elements. Work sessions focused on specific key elements of the EMS, gathered information needed to prepare the EMS implementation plan and schedule, and drafted processes and procedures that became the system, subsystem and tasks for the specific key elements. Throughout the Work Sessions, the Project Coordinator and Consultant Advisory Team compiled the information from the work sessions and began developing/drafting SOPs, training programs and monitoring programs that will become part of the systems used to support the EMS. The Project Coordinator met with EPA staff for the purpose of identifying and resolving issues or concerns EPA staff had regarding the project's progress and/or EMS development concepts.

Phased implementation of the EMS as a pilot in the three districts began upon EPA's approval of the Implementation Plan. Twelve months of data on program implementation is being collected to evaluate and improve the program before statewide implementation. In particular, TxDOT and EPA are examining whether the EMS has been effectively implemented and whether it improved environmental compliance and performance at road construction projects. The Statewide EMS was designed to include systems, subsystems, programs, and tasks consistent with the six key elements developed for the pilot district EMS, and to build upon the learning acquired through the 3 pilots.

The Implementation Plan describes how activities or programs will be:

- Established as a formal system.
- Integrated into ongoing Department construction projects; and
- Continuously evaluated and improved.

Overall, TxDOT scheduled 65 months to complete full statewide implementation, including almost three years for the gap analysis and initial implementation and evaluation of the pilot EMSs. Another 32 months was allowed to complete the Statewide EMS implementation, not including time for final evaluation. The primary program cost to TxDOT is personnel time spent on the development. The settlement requires that TxDOT track and report cost associated with the SEP, including internal labor and travel costs.

Gap Analysis

In order to gauge the Department's current environmental management practices against the six key EMS elements described in the Settlement, TxDOT completed a Gap Analysis in the three TxDOT pilot Districts and within select Divisions, consisting of a critical review of TxDOT's current construction-related environmental compliance management practices to identify where systems or subsystems have not been adequately developed or implemented. Secondary objectives of the Gap Analysis included:^{xl}

- Identifying existing organizational structure, resources, programs and activities that could serve as the foundation from which to build a construction focused EMS.
- Determine if TxDOT has defined the environmental goals and objectives it hopes to achieve and the means to achieve them during construction operations.
- Determine how TxDOT tracks its use of internal resources to comply with environmental requirements.
- Determine what the contractor's current role is during TxDOT construction projects for compliance with existing environmental requirements, programs and practices.
- Determine how TxDOT measures its performance relative to environmental issues (i.e., what metrics are in place).

A Gap Analysis Protocol (Protocol) was prepared to address environmental requirements associated with road construction work activities identified in the Settlement (earthwork, concrete, asphalt, steel, masonry, demolition, excavation, fill, land clearing, painting, soil stabilization, equipment operation, dewatering, material storage, waste disposal, and waste recycling) and EPA's six key EMS elements. The process was designed to be interactive, to prompt conversation with TxDOT personnel in a manner that supports data collection and assessment of current construction operation activities from an environmental perspective. Questions asked addressed issues such as typical field practices, availability and applicability of existing policies and procedures, prevention and control of non-compliance activities, roles and responsibilities of TxDOT and other personnel, applicable training, current documentation practices and records management, and understanding of environmental requirements related to tasks. Copies of existing environmental policies, procedures, crew manuals, and records generated during construction were reviewed.

Site visits were held at each of the three pilot Districts and select Divisions. During the site visits, TxDOT conducted administrative and operational reviews to assess construction compliance-related processes, information systems and policies currently in place. During the site visits, existing TxDOT systems, policies, plans, and procedures were identified for adaptation and inclusion in the pilot EMS. Gaps that exist between the existing system and the Settlement's requirements were identified, examining the following areas:

- Existing organizational structure and lines of responsibility for environmental management among the Divisions (as applicable), and the TxDOT Districts.
- Existing TxDOT and District/ Division specific management systems, policies, plans, and procedures (including environmental compliance programs).
- All existing environmental management practices, procedures and related documentation.
- TxDOT's current environmental documentation designed to identify and meet compliance requirements.
- Each District's emergency preparedness and response programs.

- Existing environmental auditing, monitoring, measurement and corrective/preventive action systems and historic data.
- Assessment of the current environmental and organizational performance measures and standards.
- Existing environmental management, training/awareness and communication structures.
- Existing computer-based documentation support tools to plan and implement Department activities, services and processes.
- Environmental policies and procedures at Area Offices, and coordination with the District office.

Following the site visits at the Districts and Divisions, a draft and final report were prepared to document the findings of the Gap Analysis, including a description of the current District and Division compliance and management approaches, areas that are recommended for development or improvement, prioritization of identified areas, recommended “action items” list, and responsible “owners” for all identified actions. This information is being used to develop a pilot EMS implementation plan, consisting of a comprehensive, step-by-step EMS planning and implementation “road map” and schedule that incorporates TxDOT’s internal organizational objectives. This will be used to help define the expected resources and time required to implement the pilot EMS.

Maryland SHA’s EMS and Self-Audit Program for Maintenance and Facilities

Maryland State Highway’s EMS Framework fits within the context of the SHA’s Environmental Stewardship Framework. In September 2005, Maryland’s Governor directed each Cabinet Secretary to evaluate their agency’s environmental compliance obligations and designate an Executive/Senior Management level individual responsible for oversight and implementation of environmental compliance efforts.

EMS positions in Districts will help implement the changes and a new Environmental Compliance Division at headquarters will provide support. MDSHA is in the process of creating the new Division to lead CFEMS development and implementation at SHA, develop and administer the Self-Audit Program, and centralize support for the Administration of long-term environmental compliance and stewardship goals. The agency’s long range goal is improved environmental performance through the EMS process, with results seen in improved environmental performance, renewed commitment, and stakeholder and management confidence. Consistent with the agency’s business plan, MDSHA intends to conduct more monitoring and measurement of progress than a typical DOT. MDSHA plans to assess improvements in five outcome areas:

- Compliance Performance
- Cost Effective Strategies
- Best Management Practices
- Intergovernmental Relationships
- Stakeholder Confidence

Challenges MDSHA anticipates include handling intensive up-front activities with limited staff, quantifying resource requirements, developing agency-wide EMS metrics, EMS implementation at the agency and program level, incorporation with existing business systems, determining how EMS will apply to contractors, and establishing and measuring EMS Objectives and Targets consistent with various organizational priorities. Maryland plans to turn to contractor support in these areas.

MSDHA has committed to participate in EPA’s self-audit program. (“Incentives for Self Policing: Discovery, Correction, and Prevention of Violations” 65 Federal Register 19618, April 11, 2000).

Organizations often agree to an audit program based on the experiences of other organizations, consequences of an inspection, the potential for an inspection, the timeframe the organization will need to achieve compliance, and for protection from inspection. An organization also has to grapple with the time, effort, expense to do the audits; cost of corrective actions; resources to maintain compliance; and potential for adverse publicity, which could be more or less under the audit program. An audit program can help an organization tackle the root causes of noncompliance, including in an insufficient compliance attainment/maintenance culture, lack of systems to achieve compliance, and lack of adequate audit / oversight functions. In addition to increasing staff experience and collaborative relationships with regulatory agencies, the audit program can confer environmental protection by identifying violations and having them corrected, preserve scarce resources by avoiding fines. An audit program often serves as a catalyst for change in an organization.

EPA's audit policy involves:

- Auditing and disclosing violations
- Certification that all violations are corrected
- Commitment to mechanisms to prevent recurrence

Conditions include systematic discovery, voluntary discovery, prompt disclosure, independent of government/third party, exclusion of other violations (serious harm), correction and remediation, prevention of recurrence, no repeat violations, and cooperation in the process. Adherence to these conditions can greatly reduce or even eliminate fines.

MDSHA intends to develop a program manual, self-audit checklists, auditor training, internal and third-party audits, root cause analysis and corrective action, remediation projects, and process improvement. Various regulatory programs and disclosure reports fall under the self-audit framework:

- Clean Air Act – Ozone depleting substances/CFCs – requirements: Log use of CFC, list of equipment > 50 lbs., certify mechanics, register recycle equipment
- TSCA – PCBs requirements: Annual log of activity, disposal, storage, and labeling
- Lead Based Paint Requirements: Occupant Notification, Licensed Contractors, Prevent LBP hazards
- Underground Storage Tanks: Upgrades, fuel reconciliation, system testing, closures
- NESHAPS – Asbestos: Requirements: Notifications to EPA, wet methods for removal, Disposal at licensed facility
- Spill Prevention, Control, and Countermeasure Plans: Requirements: Plan, identify responsibilities, spill equipment, tank testing, inspection, records, containment for deliveries and above ground tanks
- Resource Conservation and Recovery Act requirements: Container management, TSD facility, waste manifests, drain disposal, contingency plans, and training.
- FIFRA – Pesticides requirements: Worker Protection standards, training, emergency equipment, etc.
- Risk Management Plans reviewing use and storage of hazardous materials and plans to prevent release

At MDSHA, that means the program will affect:

- Districts – Shops Ops + Other Facilities Ops,
- Utility Permits

- Maintenance – Facilities, Highway Ops, Lead Paint, HazMat, Pesticide requirements, SPCC
- Construction – E&SC, Construction Site Activities
- Materials Testing – Lab Operations, Subsurface issues (USTs, HazMat)
- Real Estate - Excess Land, Asbestos/Lead, (USTs, HazMat)
- Emergency Spill Response
- Access Permits, NPDES

An executive level steering committee will provide direction and guidance throughout the process, as well as periodic management review. Multidisciplinary work groups will focus on specific operations, media or resources. Program development is beginning this year (2006).

North Carolina DOT ISO 14001-style EMS for the State Ferry System

NCDOT developed an ISO14001 style EMS for the state's Ferry System as part of a consent decree. As of 2006, the Ferry Division had identified aspects and impacts and decided to set a boundary at dredging and fueling activities. The Division's EMS effort identified 9 procedures that need to be written, along with objectives and targets. NCDOT anticipates completion of internal and external audits by July 2007, after which other areas will be evaluated for potential improvement. The effort provided models for AASHTO's Center for Environmental Excellence in some areas.

12.5 NEW EMPHASIS ON NPDES RELATIONSHIPS TO ENDANGERED SPECIES, HISTORIC RESOURCES, AND WETLANDS

EPA's new emphasis on prerequisite compliance with the Endangered Species Act, historic resource protection requirements, and wetland protection is reflected in the agency's new guidance to inspectors and requirements of some DOTs under recent consent decrees. The following are actions specified to be taken care of by a DOT headquarter environmental section, to ensure compliance in these areas for the Statewide Stormwater Management Plan and SWPPPs.

- Headquarters environmental staff will develop and integrate procedures as needed that address potential stormwater impacts to endangered species through the environmental clearance process into the SWPPPs/SSWMP.
 - Determine how to address requirements in environmental documents.
 - Determine how this information will be incorporated into the threatened and endangered species section of the environmental document and who will be responsible for evaluating information for inclusion in the CE/ED. (See Federal CGP Appendix C and Subpart 1.3.C.6.) (See Federal MSGP Section V.C. and Addendum A for guidance.) Use this language as guidance for preparation of the NOI.
 - Develop instructional language in the Headquarters environmental staff guidelines for environmental documents and reports.
 - The DOT Roadside Development Section will incorporate this information, as appropriate, into portions of the SWPPP that the DOT includes in the construction documents.
 - This information will be incorporated into appropriate environmental and biological guidance documents, which will be revised as needed.
- Headquarters environmental staff will develop and integrate procedures that address potential stormwater impacts to historic preservation and cultural resources, as needed, through the environmental clearance process into the SWPPPs/SSWMP.

- Determine how this information will be incorporated into the cultural resources section of environmental documents and cultural resource reports and who will be responsible for evaluating information for inclusion in the CE/ED. (See Federal MSGP Section V.B. and Addendum B for guidance.) Use this language as guidance for preparation of the NOI.
- Develop instructional language in the Headquarters environmental staff guidelines for document and report preparation.
- The DOT Roadside Development Section will incorporate this information as appropriate into portions of the SWPPPs that the DOT includes in the construction documents.
- Incorporate this information into appropriate environmental and cultural resource documents and revise as needed.
- Determine and document stormwater impacts to, and mitigation measures for, historic preservation and incorporate that information into the contract specification package for the contractor to ensure compliance.
- Headquarters environmental staff will develop and integrate procedures that address potential stormwater impacts to jurisdictional wetlands through the environmental clearance process into the SWPPPs/SSWMP.
 - Reviewed and understood the requirements in the permits (NPDES, CGPs, and MSGPs) that relate to complying with discharges to jurisdictional wetland requirements as contained in the CWA.
 - Determine how this information will be incorporated into the wetland section of environmental documents and Corps 404 permits, and who will be responsible for evaluating information for inclusion in CE/ED and 404 permits. Use this language as guidance for 404 permitting.
 - Develop instructional language in the Headquarters environmental staff guidelines for document, report, and 404 permit preparation.
 - Work with DOT Roadside Development Section to determine how this information will be incorporated into portions of the SWPPPs that the DOT includes in the construction documents.
 - Incorporate this information into appropriate environmental documents and reports and 404 processes, and revise as needed based on feedback from other DOT responsible parties and Corps.
 - Determine and document stormwater impacts to, and mitigation for, jurisdictional wetlands and provide that information to the contractor for each project. Incorporate that information in the contract specification package to ensure compliance.

12.6 BMP EFFECTIVENESS

BMP effectiveness is an issue for DOTs who want to ensure the public funds are not wasted and permit and stewardship obligations are met. Water quality (and thus BMP effectiveness) is a concern of the public and regulatory agencies charged with enforcing the Clean Water Act.

Maximum Extent Practicable (MEP) Standard

The federal Clean Water Act (CWA) requires municipal storm sewers to reduce the discharge of pollutants to the maximum extent practicable (MEP), including management practices, control techniques and system, design and engineering methods, and such other provisions as EPA or the State determines

appropriate for the control of such pollutants. Some MS4 permits contain provisions such as “Discharges shall not cause or contribute to an exceedance of water quality standards contained in a Statewide Water Quality Control Plan or watershed plans.” The permittee is then required to comply with this provision through an iterative process of implementing BMPs and then improving on the BMPs until the discharge meets the requirements. Still, the term “exceedance” is rarely defined, and although municipal permittees monitor their stormwater discharges, there is limited guidance on how to interpret the results. For other types of discharges, compliance with water quality standards is determined using measurements in the receiving water or, more often, by comparison with a calculated, numeric water quality-based effluent limit. The availability of “mixing zones” at end of pipe is also in question. The availability of monitoring data indicates that urban stormwater runoff will have difficulty attaining “end-of-pipe” compliance using conventional BMPs, even if mixing zones are allowed.

MEP is a “technology-based” control standard currently used in the existing municipal stormwater program against which permit writers and permittees assess whether or not an adequate level of control has been proposed in the stormwater management program. When EPA was in the process of drafting the regulation, the Urban Wet Weather Flows Federal Advisory Committee recommended to EPA that MEP be applied to all permits issued to MS4s, to achieve greater cooperation and consistency, reduce conflicts and confusion, and improve economies of scale in the efforts of municipalities to manage stormwater pollution. According to the President’s Clean Water Initiative, the maximum extent practicable standard should be applied in a site-specific, flexible manner, taking into account cost considerations as well as water quality effects.^{xli}

According to the 1999 regulation, MS4 permittees “reduce(s) the pollutants to the MEP through implementation of the (six) minimum control measures... Under the proposed approach, implementation of BMPs consistent with stormwater management program requirements at Sec. 122.34 and permit provisions at Sec. 122.33 would constitute compliance with the standard of “reducing pollutants to the maximum extent practicable.”^{xlii} MEP would be determined through a series of steps associated with identification and implementation of the minimum control measures, for which permittees/DOTs identify the BMPs and associated measurable goals.

The pollutant reductions that represent MEP may be different for each municipality, given the unique stormwater concerns that may exist and the differing possible remedies. Therefore, each permittee would determine the specific details in each of the six minimum control measures that represent MEP through an evaluative process. In this process, permittees and permit writers would evaluate the proposed stormwater management controls to determine whether reduction of pollutants to the MEP could be achieved with the identified BMPs. EPA envisions that this evaluative process would consider such factors as conditions of receiving waters, specific local concerns, and other aspects included in a comprehensive watershed plan.(FR p. 1574, II.H.3. definitions)

Evaluative MEP criteria considered by EPA include: 1) The effectiveness to address the pollutant(s) of concern, 2) public acceptance, 3) cost, 4) technical feasibility, and 5) compliance with Federal, State and local laws and regulations.

If technology-based controls are not sufficient for the water body to support the water quality standards that States or Tribes adopted for their waters, more stringent permit limits and control programs may be required to ensure compliance with water quality standards. A state regulatory agency, at its own discretion, may mandate that MS4s comply with water quality standards even though this may require control methods more stringent than MEP.

States and Tribes adopt water quality standards for waters within their jurisdictions. Water quality standards define a use for a water body and describe the specific water quality criteria to achieve that use. Examples of designated uses are recreation and protection of aquatic life. Water quality criteria can include chemical, physical, or

biological parameters, expressed as either numeric limits or narrative statements. The water quality standards also contain antidegradation policies to protect existing uses and high quality water. The antidegradation policy ensures that water quality improvements are conserved, maintained, and protected. States and Tribes review their water quality standards every 3 years and, if appropriate, revise them. Water quality standards provide the goals for the water body, serve as the regulatory basis of water quality management programs, and are benchmarks by which success is ultimately gauged for a given water body or watershed.... Controls on urban runoff, however, represent an opportunity to prevent or capture a significant portion of the pollutants that are causing or contributing to violations of water quality standards, including impairment of designated uses...(and also addresses) municipal representatives' expressed concern that municipalities not be liable for loadings attributable to other sources. (FR pp.1594-5, II.L.1.)

For DOTs, MEP applies only to MS4s and the stormwater management plan. For all other "point source" discharges (construction sites, maintenance yards, rest areas) the CWA requires pollutant removal, depending on the type of pollutant, that represents best conventional pollutant control technology (BCT) or best available technology economically achievable (BAT). In addition, these other point sources are required to comply with local water quality standards if they happen to be higher, even if this means controls beyond BCT/BAT, such as "all known available and reasonable" technology or methods of pollution prevention (AKART). BCT and BAT are numerically defined for most industries but not for construction site runoff. This has meant that construction site requirements, as well as those for municipal runoff, have been something of a moving target.

As EPA declined to provide any further clarification of MEP, state regulatory entities have come up with their own definitions in some cases. For example, in California, the State Water Resources Control Board says MEP has been achieved "if a permittee employs all applicable BMPs except those where it can show that they are not technically feasible in the locality, or whose cost would exceed any benefit to be derived."^{xliii} The [document](#) does not provide guidance on cost/benefit analysis. The document notes that BMPs should target pollutants of concern (POCs). The document also includes an explanation of "How do you do 'more than MEP'?" to achieve compliance with receiving water limitations (in other words, comply with water quality standards). Neither EPA nor states have comprehensively evaluated and established estimated costs for the development and implementation of a MS4 stormwater program to achieve MEP and protect water quality.

Monitoring

In the initial rule EPA recommended no monitoring duties for small MS4s during the first permit terms, but noted that "in the second and subsequent permit terms...some limited ambient monitoring might be appropriately required for perhaps half of the regulated small MS4s...only in several discrete locations for relatively few pollutants of concern. EPA does not anticipate 'end-of-pipe' monitoring requirements for regulated small MS4s."(FR 1596, II.L.4)...rather "EPA encourages permitting authorities to carefully examine existing ambient water quality and assess data needs." (FR 1580, II.H.C.) Examples EPA cited of narrative effluent limits included inspection of or cleaning of a fixed number of storm drain inlets per year or a stipulation for no visible sheen on water bodies.

Though monitoring may be done by other jurisdictions and some DOTs already have outfall monitoring systems in place, many DOTs lack funding for such programs. DOTs have a particular interest in promoting the coordination of monitoring activities and comparability of data among other agencies and monitoring entities.^{xliv}

WSDOT Water Quality Sampling Protocol for Construction Projects

WSDOT's [Instructional Letter 4049](#), *Water Quality Sampling and Reporting for Construction Projects*, established monitoring protocols to document whether WSDOT's most difficult projects meet water quality standards, during the most sensitive parts of construction and under the most challenging weather conditions. WSDOT plans to incorporate the content of this Instructional Letter into the WSDOT *Construction Manual* during its next revision. All construction sites are evaluated and categorized based on their inherent risk of erosion. Risk factors include size; timing and duration of work; soils; slopes; groundwater levels; and the need for in-water work. Runoff water from twenty percent of the projects that meet the risk criteria is tested during storm events and during critical periods of in-water work. Monitoring results are used to both evaluate specific project performance and validate results of the TESC Assessment Database. The results from the TESC Assessment Database and the water quality monitoring are published and widely distributed in WSDOT's *Measures, Markers and Mileposts*, a quarterly document that tracks various agency performance and accountability measures. WSDOT's statewide performance with the 13 erosion control minimum requirements is available on-line in [Bar Graph](#) form.

Automated Instream Monitoring at NCDOT

NCDOT is among those DOTs that have installed automated in-stream monitoring equipment to verify that the DOT is not contributing to a rise in turbidity, where water quality standards are such that no additional discharges worsening the TSS problem in local streams are allowable.

Narrative Effluent Limits

As previously discussed, NPDES permits for stormwater discharges must meet all applicable provisions of sections 301 and 402 of the CWA, which require control of pollutant discharges to the Maximum Extent Practicable (MEP) for the MS4 permit requirements and to the standard of Best Available Technology Economically Achievable/Best Conventional Technology (BAT/BCT) for Construction General Permit requirements, as well as to implement more stringent controls, if necessary, to meet water quality standards.

The regulatory approach for managing stormwater differs significantly from the regulatory methods used to control industrial wastewater, sewage treatment plant discharges and even air emissions and pesticide residues. In these non-stormwater environmental protection efforts, the focus is on numeric standards. For example, a typical effluent limit in a sewage treatment plant permit would specify that total suspended solids (TSS) in the discharge could not exceed an average of 45 mg/l per day over a 7-day period. In this case, compliance is performance-based. Regulatory agencies are not generally concerned with what processes the sewage treatment plant uses as long as the effluent consistently complies with the numeric limits.

For stormwater, however, requirements are primarily process-based. The stormwater permittee is in compliance if it is implementing the control measures (BMPs) contained in a stormwater management plan (for municipal-type runoff) or stormwater pollution prevention plan (for construction site runoff). An evaluation of the compliance status requires a subjective judgment regarding whether the appropriate mix of BMPs has been selected and whether they are being correctly implemented. The performance of the BMPs, whether they produce stormwater with 20 mg/l TSS or 200 mg/l, is not necessarily relevant. Because of variability in runoff pollutants and lack of information on impacts, neither EPA nor states have developed a set of universally applicable (i.e. regardless of location) technology-based effluent limits for stormwater.

In the Phase II regulation, EPA said that "[n]arrative effluent limitations requiring implementation of BMPs would generally be considered the most appropriate form of effluent limitations when designed to satisfy technology requirements, including reductions of pollutants to the maximum extent practicable, and water quality-based requirements of the CWA. Examples of narrative effluent limitations include no

floatables in stormwater discharges and no visible sheen on water bodies.(FR 1580, II.H.3.) EPA allowed that “if after implementing the six minimum control measures there is still a water quality problem associated with discharges from the municipal separate storm sewer system, the municipality would need to expand or better tailor its BMPs within the scope of the six minimum control measures for each subsequent permit. EPA envisions that this process would take two to three permit terms,” during which time, EPA envisioned revisiting the regulations for the municipal stormwater program. Additional stipulations are likely to be the result of TMDLs. EPA said that

If additional specific measures to protect water quality were imposed, they would likely be the result of an assessment based on TMDLs, or the equivalent of TMDLs, where the proper allocations would be made to all contributing sources. EPA believes that the municipality’s additional requirements, if any, should be guided by its equitable share based on a variety of considerations, such as cost effectiveness, proportionate contribution of pollutants, and ability to reasonably assume wasteload reductions. Narrative effluent limitations requiring implementation of BMPs are generally the most appropriate form of effluent limitations when designed to satisfy technology requirements, including reductions of pollutants to the maximum extent practicable, and water quality-based requirements of the Clean Water Act. See Section II.L, Water Quality Issues, for further discussion of this approach to permitting, consistent with EPA’s interim permitting guidance.”(FR p. 1573, II.H.3.)

Numeric Effluent Limits

Traditionally, DOTs and municipalities have maintained that numeric water quality-based limits are not feasible for stormwater. Due to the unique nature of storm events and stormwater discharges, any numeric limit that is placed in a stormwater permit must take into consideration the episodic nature of storm events and be truly representative of stormwater discharges. In addition, DOTs have noted that they have little or no means to control polluted stormwater that “runs on” to the DOT site or conveyance. In general EPA has maintained that numeric effluent limits are impractical and/or inappropriate for stormwater regulation, but the issue continues to be discussed and reviewed by states and the courts.

Thus far, EPA has avoided specifying technology-based limits for stormwater BMPs. Currently, stormwater permits issued for DOT/MS4-type discharges generally require that stormwater management plans be designed to achieve compliance with water quality standards. The permits also require compliance with standards through an “iterative process” in which exceedances of standards are supposed to trigger implementation of improved BMPs. In practice, cost-effective BMPs are lacking for many pollutants and stormwater runoff often exceeds standards at the point of discharge. A few regions and states and the District of Columbia have considered the feasibility of establishing numeric effluent limits or other quantifiable limits for use in stormwater permits.

Significant Court Rulings on MEP and Numeric Effluent Limits for MS4s

Of federal court rulings regarding the NPDES Stormwater program, one of the most significant is a 1999 decision from the 9th District Court of Appeals. In *Defenders of Wildlife vs. Browner*, the Court held that MS4 permits need not require strict compliance with water quality standards. Compliance was to be based upon what was practicable, according to the MEP standard; however, the permitting authority could at their option require compliance with standards. (Further information on the court case is available in AASHTO Natural Resources ETAP Alerts from the period.) In some cases, permitting authorities subsequently required that the discharges from MS4s meet water quality standards, while still stating that compliance with numeric standards could be achieved through the implementation of BMPs in an iterative fashion. The Browner decision also found that discharges of stormwater associated with industrial activities (including construction activities) must be in strict compliance with water quality standards.

More recently, the U.S. District Court for the Central District of California ruled on June 28, 2006, that Federal regulators' failure to establish stormwater pollution standards for construction and development sites violates the Clean Water Act.^{xlv} The lawsuit was filed as a result of EPA deciding not to put out regulations or national effluent guidelines or performance standards for stormwater runoff from construction sites. Rejecting EPA's argument that the law allows it discretion in determining whether national guidelines are appropriate for construction sites, the court held that 33 U.S.C. Section 1314(m) requires the agency to set standards for all identified point sources of toxic and nonconventional pollutants. The court also rejected EPA's contention that the law allows it other mechanisms to control runoff at the sites, specifically through locally administered National Pollutant Discharge and Elimination System permits. Under the Clean Water Act, the EPA administrator may issue NPDES permits under two conditions, the court said. "Such permits may be issued if they are in conformity with the standards, such as [national effluent guidelines and new source performance standards], established through other sections of the Act," the court said. Also, permits not subject to national effluent guidelines and new source performance standards may be issued on an interim basis, pending the promulgation of guidelines, limitations, and standards, according to the court. Even if EPA's mandatory duty to promulgate effluent limitation guidelines for the construction industry were not clear under the statute and legislative history, the court said EPA's interpretation of the law "is not reasonable."

Scientific Review of the Feasibility and Desirability of Numeric Effluent Limits for Stormwater

In 2005, the California's State Water Resources Control Board convened an expert panel on numeric effluent limits, which decided that numeric limits or target levels were technically feasible for common pollutants such as total suspended solids and turbidity, at least for larger projects. In almost all cases though, the water control authority has stopped short of setting numeric effluent criteria for BMPs and urban discharges.

But instead of recommending application of numeric effluent limits the panel suggested selection and design of BMPs "much more rigorously with respect to the physical, chemical and/or biological processes that take place within them, Depending on the pollutants and parameters of concern and BMP choices, it is very likely that treatment trains of structural BMPs will be required in many cases."^{xlvi} The panel also proposed Action Levels to identify "bad actor" catchments (e.g., dissolved copper at 100 mg/l). The panel's report discusses very specific approaches for identifying appropriate BMPs.^{xlvii}

The panel observed that effluent limits may not address the main issues. "Effluent limit approaches usually focus only on conventional water quality constituents that may not be solely or at all responsible for the receiving water beneficial use impairments in urban receiving waters; the important stressors that affect many use impairments can include one or more of the following and may vary in importance from system to system:^{xlviii}

- The effect of increased flows and/or volumes (i.e. hydromodification) that can lead to stream channel erosion/sedimentation with resulting habitat destruction.
- Sediment contamination (such as enrichment of urban stream sediments with fine-grained heavily polluted particulates; large organic debris masses causing low sediment dissolved oxygen; settled bacteria causing large bacteria gradients with sediment depth etc.).
- Impaired aesthetic value (caused by gross floatables, noxious sediments, etc.).
- Unsafe conditions (caused by dangerous debris, highly fluctuating stream flows and stages, etc.).
- Dissolved and suspended pollutants that are bioavailable in the water column and/or result in downstream sediment contamination.
- Elevated temperatures from urban heating effects on runoff and on open conveyances and permanent pool BMPs.

The panel's Findings on Feasibility of Numeric Effluent Limits Applicable to Municipal Activities: Municipal Observations were as follows: ^{xlix}

1. The current practice for permitting, designing, and maintaining municipal stormwater treatment facilities (called BMPs herein) on the urban landscape does not lend itself to reliable and efficient performance of the BMPs because:
 - Permitting agencies, including EPA, States, and local governments, have rarely developed BMP design requirements that consider the pollutants and/or parameters of concern, the form(s) that the pollutants or parameters are in, the hydrologic and hydraulic nature of how they pollutants and flow arrive, and then the resulting unit processes (treatment and/or flow management processes) that would be required to address these pollutants or parameters.
 - The permitting agencies generally are not accountable for the performance of the BMP, and thus give much leeway to the developer with respect to the type of BMPs to be constructed, and to the details of the design, although some states do have detailed design standards and have conducted performance tests to identify acceptable devices for their area.
 - The developer is not responsible in most all cases for the performance of the BMP, so the treatment facilities are designed to minimize the cost and/or area of the facility and/or ease of permitting, not maximize the pollutant removal efficiency and/or flow management of the BMP.
 - Because BMPs are not held to any, or very few, long-term performance criteria, they are typically not maintained except for aesthetic purposes. Very few stormwater agencies are responsible for BMP maintenance on private property, and public facilities are maintained mostly in response to clogging and/or resultant drainage or aesthetic problems. Even for stormwater agency facilities, maintenance is often limited.
2. The principal reasons for the failure of BMP performance is improper BMP selection, design and/or lack of maintenance.
 - Generally, BMP Handbooks and other local requirements leave too much of the BMP selection and design to the discretion of the designer, and thus do not address many if not all of the receiving water quality issues.
 - BMPs need to be designed to facilitate maintenance; this is rarely done because it costs the developer money and the BMP designer is rarely responsible for the maintenance.
 - Given the amount of debris in urban runoff, and the fact that the hydraulic capacity of many BMPs may be exceeded from several to many times per year, BMPs require more maintenance than other types of stormwater control facilities. Since urban BMP maintenance is generally (inadequately or) untrained... personnel... inadequate maintenance is a near certainty. Even stormwater agencies often do not have and/or apply the resources necessary to maintain agency owned BMPs.
3. Improvements in the design of municipal BMPs, including residential and commercial as well as municipally owned facilities are necessary to ensure better performance (i.e. sizing, geometry, inlet and outlet design, etc.) and to specifically target receiving water quality issues.

Variability Makes Numeric Effluent Limits Problematic to Use, Monitor, or Enforce

In summary, the panel concluded that “it is very difficult to determine specific causative agents or the level of control needed, for a specific beneficial use impairment in a receiving water body... Although expensive, comprehensive investigations such as these (of specific receiving waters and catchment areas) should be considered an investment to help minimize wasteful expenditures due to the application of inappropriate control practices in a watershed.”¹

- Monitoring for enforcement of numeric effluent limits would also be challenging. While spot checks could be made at some of the many outfalls in an area, there is wide variation in stormwater quality from place to place, facility to facility, and storm to storm. Coefficients of variation approaching 1 or higher are not uncommon and there are few factors that can be used to significantly reduce this variation.
- Analysis of the National Stormwater Quality Database indicates that geographical location and land use are the most important factors affecting stormwater quality for most constituents. Some are also affected by the antecedent dry period before the rain and more highly developed watersheds (containing large fractions of impervious areas) often show elevated “first-flush” concentrations in the first portion of the storms for some, but not all pollutants.
- Since the storm-to-storm variation at any outfall can be high, it may be unreasonable to expect all events to be below a numeric value. In a similar circumstance, there are a number of storms each year that are sufficiently large in volume and/or intensity, to exceed the design capacity volume or flow rates of most BMPs. Assessing compliance during these larger events represents yet another challenge to regulators and the regulated community.
- Even for conventional pollutants, there presently is no protocol that enables an engineer to design with certainty a BMP that will produce a desired outflow concentration for a constituent of concern. A possible exception is removal of Total Suspended Solids in extended detention basins, and some types of media filters. The typical approach for evaluating BMP pollutant removal efficiency has been percent removal; but observed removal efficiencies vary greatly from facility to facility and it has been demonstrated that percent removal varies directly with the inflow concentration.
- Few, if any, BMPs are designed using the first principles laws of physics, chemistry and/or biology for pollutant removal and/or flow-duration control. It will take a substantial research effort, including data gathering on well-designed BMPs, to develop design criteria for the removal of pollutants with confidence intervals that enable us to make reliable estimates of the median and variance of the effluent concentrations to be expected from the various types of BMPs. Until this is done, it will be very difficult to assign legally enforceable numerical effluent limitations to any particular BMP.

Preventing the Imposition of Numeric Effluent Limits

Given that numeric effluent limits are not desirable for stormwater, but considering the ongoing pressure from public interest groups to impose limits in order to reach water quality standards, a number of practices can be employed to address the underlying needs and interests in BMP effectiveness: ^{li}

- **Rigorous design of individual BMPs and treatment trains.** Effluent concentration distribution estimates for a number of BMPs are available in the International BMP Database (www.bmpdatabase.org) from more than 250 studies throughout the U.S. BMPs or treatment trains of BMPs that are rigorously designed and constructed with respect to the physical, chemical and/or biological processes that take place within them would provide greater confidence that treatment design targets are reached, if the BMPs are properly maintained. In selecting and designing BMPs:
 - Identify Whether Receiving Water Body is 303(d) listed and if TMDLs have been set
 - Identify Constituents of Concern
 - BMP selection based on removal efficiency
 - Require Technology-Based BMPs
 - Require BMP(s) by BAT for Constituents of Concern
 - Monitor BMP Maintenance for Compliance
- **Require a detailed maintenance plan and schedule** that includes:

1. Actions to be taken and when,
2. Designation of the party legally accountable for the facility maintenance, and
3. A whole-life cost estimate for the facility that include maintenance.

Compliance with the design criteria and the maintenance plan and schedule may be considered to constitute achievement of the design effluent criteria. In the event of failure by the responsible party to perform the required maintenance and/or to perform it to the required level of quality, the whole-life cost schedule could be used to determine the consideration that the defaulting responsible party would pay to the new responsible party that takes over the maintenance.

- **Employ practical and quantifiable enforcement mechanisms, such a checklist** of items to be inspected.
- **Address and minimize impervious surface in a drainage area**, as the latter “have been shown to be quite effective in reducing adverse hydromodifications in the receiving waters.”
- **Set “upset” values or Action Levels** above the normal observed variability, to allow “bad actor” catchments to receive additional attention. While not directly address the issue of establishing numeric effluent criteria and achieving desired effluent quality, this would help address one of the desired ends of ensuring that “bad actor” watersheds received needed attention.

Strategies for Addressing Runoff Volume and Peak Flows

Runoff volume and peak flows have been recognized as two of the most important stormwater factors needing control. Urbanization dramatically changes the hydrologic regime of urban waterways; the number of runoff events per year on developed land increases by a factor of 2 times the number of runoff events that occur in the undeveloped state, and the runoff volume increases by a factor of ten. The peak flows also increase dramatically, but the peak flow frequency curve can be adjusted back to its predevelopment character by the proper application of runoff controls. While these controls restore the peak flow frequency to its natural regime, the duration of flows at the low end (but still channel “working”) of the flow frequency curve is greatly increased, which raises potential for channel scour in stream channels with erosive soils.

Since many of the stormwater pollutants are strongly associated with particulates, stormwater particulate control is also often a component of stormwater control programs. Therefore, an effective stormwater control strategy that could be encouraged is a combination of several practices, listed below in the order of increasing events: ^{lii}

- On-site stormwater reuse, evapotranspiration and infiltration for the smallest storms and up to specific targeted events, depending on site limitations (soil characteristics and groundwater contamination potential) usually by conservation design emphasizing infiltration, disconnecting paved areas, etc.
- Treatment of excess runoff that cannot be infiltrated, again, up to a specific targeted runoff volume (usually by sedimentation or filtration).
- For pollutants of concern, it should be demonstrated that the BMP(s) need to include the physical, biological, and/or chemical treatment processes that address the typical pollutants of concern and/or specific pollutants in the case of 303(d) listed water bodies or those with established TMDLs.
- Control of energy discharges for the channel forming events (such as through storage-release, focusing on flow-duration analyses and peak flow frequency analyses). To be most effective, this should to be completed under a watershed management plan and not site-by-site.
- Provide safe drainage for damaging events (conventional drainage, plus secondary drainage systems)

- In watersheds that are already experiencing damaging flow impacts to streams, it could be in many circumstances much more cost-effective (and effective period) to develop through a watershed plan a natural stream stabilization approach that could address both the existing development and the remaining smaller infill or otherwise smaller new development. In these cases, requiring the remaining new development to implement flow-duration control would not solve the issue in a measurable way and resources would be better spent restoring the functions of the creek with instream enhancements.

Programmatic Approaches to Standards Attainment

MS4/DOT discharges are required to control pollutants to the maximum extent practicable (MEP). In addition, stormwater runoff is required to not cause an exceedance of water quality standards. BMPs can offer a programmatic approach to standards attainment.

Ohio DOT and Ohio EPA

For example, the Ohio DOT and Ohio EPA met to review and improve existing processes a number of times, culminating in:

- OEPA satisfaction with stream protection measures implemented through ODOT's culvert design process and a decision that water quantity treatment requirements are satisfied when ODOT culvert design procedure is followed.
- OEPA agreement that vegetation treats water quality very effectively. Adjustments were made to determine ditch widths to satisfy OEPA concerns about water quality.

Oregon CETAS

Oregon's State Bridge Delivery Program includes more than 300 bridges to be repaired or replaced by 2011. As a result, ODOT decided to address regulatory requirements, as much as feasible, on a programmatic basis. That is, ODOT began working with its regulatory agency partners and consultants to address permitting needs for the bridge program as a whole. The goals were:

- To reduce bridge design and environmental permitting times
- To reduce cost and schedule impacts from re-design
- To maintain ODOT's strong commitment to environmental stewardship

The key elements in this programmatic approach include programmatic permits and approvals, environmental performance standards, and a comprehensive program for mitigating environmental impacts. As a first step, ODOT took a programmatic approach to bridge assessment and permitting. Environmental assessments were done up front, for every bridge in the bridge program, using common data collection methods and a common reporting format. Permitting requirements were established for the entire bridge program. If the design and construction proposed for a particular bridge meets the programmatic requirements, the permits or approvals addressed by those requirements are assured. The approach coordinated the requirements of multiple agencies and put standards in place to ensure comprehensive environmental protection. While each bridge must still be reviewed individually, the programmatic permits are already in place and the requirements to obtain those permits have already been defined. As a result, permitting for individual bridges is cheaper and faster, and design efforts more efficient, than with the traditional approach.

The core of ODOT's programmatic approach is a set of environmental performance standards that define the requirements that project activities must meet. They are goal-oriented; i.e., they define the acceptable level of effect that a project activity may have on the environment, rather than specifying exactly how the activity must be performed. For example, the Habitat Avoidance performance standard

limits stream bank protection activities to those not expected to have long-term adverse effects on aquatic habitats, and lists several protection techniques. Bridge design and construction personnel have the flexibility to choose the most cost-effective method to preserve habitat at a particular site.

Collectively, performance standards address all phases of the program: administration, bridge design, bridge construction, and post-construction mitigation. If a project meets all applicable performance standards, it will be in compliance with the programmatic requirements and will receive the required permits. Although some permits and approvals (e.g., noise variances, land use exceptions) must be addressed site by site, most can be addressed programmatically, resulting in significant time and cost savings and a smoother permitting process. Because performance standards describe desired outcomes, not specific construction techniques, they enable design teams to focus on creative solutions that accommodate the unique conditions at each bridge site.

Streamlined permitting efforts for the Oregon's Statewide OTIA III Bridge Replacement Program have included a wide range of programmatic approaches to achieve environmental compliance. The use of Environmental Baseline Reports (EBRs) is being instituted for Statewide Transportation Improvement Program (STIP) projects. The EBR is a comprehensive environmental scoping mechanism intended to identify resources and constraints prior to the design process. Up through June 2006, progress toward instituting use of the EBR process has included: ^{liii}

- An ODOT policy paper was prepared to outline recommendations on how and where to best use baseline reports in ODOT project development.
- Revisions have been made to ODOT Project Delivery Leadership Team (PDLT) Notice – 02 specifically requiring use of the EBR process, as appropriate, during early project development. The revised Notice also addresses staff roles and responsibilities for EBRs. The revision will become official once approved by the ODOT Project Development Leadership Team, which is expected to be imminent.
- Criteria for determining EBR applicability have been drafted and are going through internal ODOT review.
- Specific guidance (content, format, methods, etc.) for the EBR process is being developed for STIP project development. This guidance is based on experience from the OTIA III Bridge Program EBR process, and is being modified to the context of STIP project development.
- Full implementation of the EBR process at the front end of STIP project development will require establishment of a new, earlier funding mechanism.

Antidegradation

Under the Federal water quality standards regulations, water quality standards include designated uses, criteria to protect those uses, and an antidegradation policy. The purpose of an antidegradation policy is to protect water quality that is higher than necessary to protect the uses. Antidegradation has become an issue for DOTs in states which have made greater use of these policies.

Water quality standards contain criteria that set the maximum allowable level of pollutants that can occur in a water body without causing injury to or loss of beneficial uses. Such beneficial uses include swimming, fishing, boating, aquatic life habitat, and water supplies. The antidegradation process focuses on how a state will determine when an activity will be allowed to degrade higher quality waters down to lower water quality criteria. All states are required to develop rules and programs that will not only protect beneficial uses but that will also “restore and maintain the chemical, physical, and biologic integrity of the nation's waters;” however, such policies largely depend on the approach and utilization of the provision by state regulatory agencies. Primary components of a state antidegradation strategy are: 1) Degradation of water quality must never be so great as to violate minimum state water quality criteria

established to protect designated beneficial uses. 2) High quality waters are not to be degraded unless that degradation is necessary and in the overriding public interest. As cleaner water bodies have a higher capacity to absorb pollutants, such capacity is an important resource in economic development.

Sometimes designated uses seem out of date or unable to be attained in the current context. These issues often emerge around the time of NPDES permitting, at which point a use attainability analysis can be undertaken. Any action taken that might result in lowering water quality is subject to the policy and triggers of an antidegradation review.

When Water Quality Standards Seem Unreachable—Antidegradation Review

In some limited circumstances, water quality standards (objectives) seem unreachable and can be changed based on local conditions. Lowering of water quality may be allowed when it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, and will not unreasonably affect present and anticipated beneficial use of such water (40 Code of Federal Regulations (CFR) parts 131.12(a) (1) and (2)). The regulation requires that an antidegradation policy be established to maintain and protect existing beneficial uses and the water quality necessary to protect these uses. The regulation, however, allows a lowering of water quality if water quality exceeds the level necessary to support propagation of fish, shellfish, and wildlife, and recreation in and on the water; and the lowering is necessary to accommodate important economic or social development in the area of the waters. Lowering of water quality can take place only when existing uses will not be impaired. Intergovernmental coordination and public participation procedures must be followed. In addition, the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable BMPs for nonpoint sources must be achieved. Finally, there must be a reasonable showing of the costs involved and the anticipated economic or social development that will be foregone. Making a determination to allow a lowering of water quality based on these factors is called an antidegradation review.

The adoption of site-specific objectives that are less stringent than existing criteria or objectives may ultimately result in a lowering of water quality. This action, hence, triggers the antidegradation policy. Under these circumstances, the regulator must consider whether an antidegradation review is more appropriately done at the water quality standards-setting phase or the permitting phase. In some cases, the impetus to develop site-specific objectives is driven by the desire to accommodate economic or social development in the affected area. In these circumstances, the regulator may have sufficient information such as economic data to perform an antidegradation review when the site-specific objectives are adopted. The advantage of doing an antidegradation review at this stage is that it obviates the need to do an additional review when NPDES permits are issued implementing the new objectives. However, the necessary information is usually not available at this stage, and thus determinations whether a water quality lowering is justified more often occur at the NPDES permitting stage.

Site Specific Standards

“Site-specific objectives” use local information to adjust water quality objectives to account for their over- and under-protectiveness. Three USEPA-published procedures and a number of other procedures allowed by USEPA can be used. The most common is the *Water-Effect Ratio (WER) Procedure*, which adjusts objectives to account for a site’s water chemistry. The *Recalculation Procedure* adjusts objectives on the basis of the assemblage of species in the water at a particular site, and the *Resident Species Procedure* accounts for site water chemistry plus the assemblage of resident species.

- *Water-effect Ratio Procedure* The water effect ratio is the ratio of the toxicity of a chemical in site water to the chemical’s toxicity in laboratory water. This procedure is commonly used when it is suspected that either chemical or physical aspects of receiving water or effluent (or both) will cause a pollutant to be less bioavailable and, therefore, less toxic. The Water-effect Ratio Procedure results in a multiplier which is applied to an existing water quality objective. If a chemical is less

toxic in a site water, the multiplier is >1 and results in a higher objective; if a chemical is more toxic in a site water, the multiplier is <1 and results in a lower objective.

- *Recalculation Procedure.* A water quality objective can be derived utilizing data for any North American aquatic species. It is possible that the level of protection provided by the suite of species in the national dataset is inappropriate for the species found at a particular site. The goal of the Recalculation Procedure is to eliminate from the database those taxa that are not resident (and not expected to be present) in the site waters, while keeping in the database resident species and those non-resident species that serve as toxicological surrogates for taxonomically related resident species for which no toxicological data are available. The end result of the Recalculation Procedure is that the remaining data are more representative of the sensitivities of species found at the site. The recalculation procedure consists of a systematic stepwise process which deletes (or adds) species from the dataset following a set of stringent guidelines. A site-specific objective is “recalculated” from the adjusted dataset using the same procedure described in the national aquatic life guidelines.
- *Resident Species Procedure.* The Resident Species Procedure accounts for site-specific conditions by testing the toxicity of the chemical of interest to resident species in site water. A site-specific objective is then calculated using the toxicity values and the procedure described in the national aquatic life guidelines. The over-riding problem with the Resident Species Procedure is that the number of genera in the generated dataset is usually so low (because of the cost of generating a robust dataset) that the statistical computation typically produces a criterion that is below that needed to protect the most sensitive species tested. For this reason, it is the least-used procedure for determining a site-specific objective.
- *Chemical Translator.* Although not a type of site-specific objective, another approach which addresses the issue of the bioavailability of a chemical as do the WER and Resident Species Procedures is the chemical translator. In contrast to the WER and Resident Species Procedures, the chemical translator does not modify the water quality objective directly, but rather it translates the site-specific dissolved form of the objective to the total recoverable form. A chemical translator can be empirically determined by relating the dissolved metal concentration (operationally defined as the metal which passes through a $0.45\ \mu\text{m}$ or a $0.40\ \mu\text{m}$ filter) to the total recoverable concentration. Alternatively, the fraction of dissolved metal is derived using a partition coefficient. In this case, the coefficient is determined as a function of total suspended solids (although some other basis such as humic substances or particulate organic carbon may be used).

Other alternatives for making site-specific modifications include a two-step procedure to evaluate the possibility of changing the number of times a water quality objective can be exceeded over a three-year period by first assessing impairment, followed by an analysis of the historical concentrations of the chemical of interest. Another approach uses natural background concentrations. Where appropriate, USEPA recommends that site-specific objectives for aquatic life protection be derived using natural background concentrations of the toxic chemicals. To ensure compliance with the objectives of the Endangered Species Act special consideration must be given to listed species in the bodies where they are located. Site-specific criteria may be developed for human health impacts as long as the site-specific data, either toxicological or exposure-related, is justifiable. Examples of site-specific factors include site-specific fish consumption rate, bioaccumulation factors, and percent lipid in aquatic organisms. In 2001, USEPA published a recommended fish tissue criterion of $0.3\ \text{mg methylmercury/kg}$ to protect human health (USEPA 2001a). USEPA’s preferred approach for relating a concentration of methylmercury in fish tissue to a concentration of mercury in ambient water is to derive site-specific bioaccumulation factors based on water and fish collected in the water body of concern. Once a site-specific bioaccumulation factor has been determined for methylmercury, a dissolved site-specific objective can be calculated by dividing the tissue-based objective by the bioaccumulation factor.

Before studies to modify water quality standards are initiated, a number of factors need to be considered in order to determine whether a site-specific objective is appropriate. Factors such as site definition and boundaries, the presence of endangered species, water quality characteristics of effluent dominated streams, and multiple site-specific objectives, require a careful evaluation of the anticipated levels of contaminants a site-specific objective may allow.

When undertaking a site-specific objective modification, it is critical that the State identify those interested parties (environmental, industrial, or governmental) that are likely to have an interest in the particular water body for which the site-specific objective is being considered. They are primarily Federal and Regional offices of USEPA and state offices of USFWS (and NOAA Fisheries if appropriate). All parties should be involved early in the process, remain informed of all anticipated economic and environmental impacts, and have access to the study data and discussion of data uncertainties.

Could SWPPPs Have to Be Reviewed By Permitting Authorities, in the Future?

A recent federal appeals court ruling concerning confined animal feeding operations (CAFO) could have an impact on the level at which SWPPPs are reviewed and the way in which stormwater permits are written and reviewed. EPA developed a general permit for CAFO which was appealed by various parties. The recent decision on this permit implies that 1) management plans (such as SWPPPs) must be reviewed by the permitting authority; 2) permits must include the terms of the management plans (these cannot be developed post-permit); 3) public participation must be provided for each permitted facility or operation (i.e., each construction project or industrial site operating under a general permit); and, 4) permits must more definitively identify the specific control standards for pollutant reduction.^{liv} The decision would seem to negate many aspects of generally permits. Nevertheless, permitting agencies have taken heed of the decision and have been taking additional action to ensure that oversight and enforcement are occurring, within current permitting formats. DOTs have been hit with an unusually large number of NOV's and consent decrees in the past two years.

DOT Research Programs on BMP Effectiveness

Some DOTs have active research programs examining the effectiveness of BMPs. Caltrans may have invested more in this area than any other DOT, and their new technology evaluations are available to all on the web. The Minnesota Department of Transportation initiated a study in 2005 (results due in fall 2007) assessing stormwater management practices in relation to the water quality of runoff. The study is intended to help cities, counties and other agencies to make informed decisions regarding the purchase and installation of underground stormwater treatment structures which are required to meet the MS4 NPDES regulations.

FHWA, USEPA, and several professional organizations have formed a coalition of organizations to fund and manage the International Stormwater BMP Database. The work will consist of entering currently available and newly developed data sets, keeping the web site and database up to date, providing data analysis and developing protocols for integrating low impact development techniques into the database. The work is ongoing and the database is currently accessible through the website at <http://www.bmpdatabase.org>.

12.7 TMDL COMPLIANCE AND INTERFACE WITH NPDES

Segments of state waters that do not meet water quality standards are classified as “impaired waters” and must be listed for federal and public review on a state’s 303(d) list, so-named for the CWA section which requires it. States are required to develop models to quantify and allocate loads—also called TMDLs—of pollutants that are causing the impairment to such waters. Section 303(d) of the 1972 Federal Water Pollution Control Act requires priority rankings for water bodies for which the beneficial

uses are listed as impaired by pollution, and also requires the establishment of TMDLs to protect water quality of these impaired water bodies from specific pollutants. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive while still meeting water quality standards; i.e. a “safe” loading of pollutants going into a waterway. The TMDL also includes an allocation of the maximum loading amount to the individual sources of the pollutant (industry, stormwater, etc.). TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a water quality standard. A TMDL is the sum of the following:

- Individual *wasteload allocations* (WLAs) for point sources (e.g. industries, sewage treatment plants, and permitted stormwater dischargers, such as DOT)
- *Load allocations* (LAs) for non-point sources (e.g., most agriculture, non-permitted stormwater runoff, forestry practices) and natural background,
- A *margin of safety* (MOS).

TMDLs are established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards. (See 40 CFR Section 130.7(c)(1).) As a sample application, one can look at the TMDL for the Ochlockonee River, which was listed by Georgia on their 2000 Section 303(d) list because mercury in the tissue of largemouth bass and sunfish exceeded the Fish Consumption Guidelines (FCG) established by the State of Georgia. The State of Georgia’s Rules and Regulations for Water Quality Control do not include a numeric criterion for the protection of human health from methylmercury. Instead, the State’s regulations provide a narrative water quality standard, “free from toxics.” Since mercury may cause toxicity in humans, a numeric “interpretation” of the narrative water quality standard was necessary to assure that a TMDL will protect human health. EPA defers to the State water quality standard or criterion as the applicable water quality standard for development of the TMDL. States may establish (or interpret) their applicable water quality standards for protection of human health at a numeric concentration different from their fish consumption guidelines. The State of Georgia made a numeric interpretation of their narrative water quality standard for toxic substances at a numeric concentration of no more than 0.3 mg/kg methylmercury in fish tissue.^{lv}

Usually, each TMDL takes several years to prepare including public hearings and meetings with stakeholders. The TMDL effort is a major statewide regulatory undertaking which has a significant impact on wastewater dischargers within the state, both in terms of preparation effort as well as the cost of implementing controls to comply with the allocations. Typically, several pollutants or water body segments will be addressed by a single TMDL. A “completed TMDL” means that the TMDL has been prepared and incorporated into a watershed Basin Plan. TMDL implementation may extend for years, or decades. In most cases, TMDLs still need to be developed for 303(d) listed waters.

Response Strategies

Projects discharging to receiving waters with TMDLs often have to comply with additional discharge criteria. This typically requires additional internal coordination with water quality and often fish and wildlife specialists. Sediment is the main pollutant of concern for most DOTs, and in a small number of cases, highways have been identified as the major cause. Often, segments are listed for pollutants of concern without causes unidentified. DOT environmental staff usually help the agency stay aware of listed waters and the additional care and/or more stringent requirements in such areas. Caltrans is unusual among DOTs in that the agency had Cal State University-Sacramento develop a [water quality planning tool](#), including 303(d) list information, to assist project staff in planning for TMDL compliance, in developing SWMPs.

Of uncertain implication due to its impracticality, a recent U.S. Court of Appeals decision for the District of Columbia Circuit reversed a lower court decision and ruled that “daily” means “every day” for TMDLs rather than annually or some other interval (Friends of the Earth Inc. v. EPA, D.C. Cir., No. 05-

5015, 4/25/06). The court pointed out that, “Doctors making daily rounds would be of little use to their patients if they appeared seasonally or annually.” The decision may have national implications if other Courts of Appeal rule in a similar manner or if the U.S. Supreme Court concurs. EPA has indicated that it will attempt to change the TMDL regulations in order to address the ruling; however, an attempt to amend the TMDL provisions in 1999 was so controversial it subsequently failed. Assigning allocations to the

Marina Del Ray TMDL for Copper, Lead, Zinc, PCBs, and Chlordane in Sediments

In Los Angeles, wet-weather runoff from the stormwater conveyance system is assumed to be the major contributor of metals and organic compounds to Marina Del Ray Harbor (MDRH).^{lvi} Stormwater runoff is regulated through eight NPDES permits including the County of Los Angeles, California Department of Transportation (Caltrans), General Construction, and General Industrial. The sediment loadings of legacy pollutants chlordane and PCBs reflect historic uses that are now banned. Major nonpoint sources of contaminants in MDRH include copper and lead leaching from anti-fouling paint on boats, corrosion of zinc from metal boat components, and atmospheric deposition.

The TMDL is based on pollutant loadings to the sediments of MDRH back basins. The Los Angeles Water Board used numeric targets from sediment quality guidelines compiled from the National Oceanic and Atmospheric Administration (NOAA) to calculate the TMDLs for copper, lead, zinc, PCBs, and chlordane impairments in sediments. The sediment quality guidelines were used to translate the Basin Plan narrative objectives into numeric targets for the TMDL. Effects Range-Low (ERL) values were selected as numeric targets for sediment rather than Effects Range-Medium (ERM) values to limit adverse effects to aquatic life. ERLs are lower than ERMs and thus provide an implicit margin of safety.

Numeric targets were established for PCBs in fish tissue, the water column, and sediments. The sediment target for total PCBs is the primary numeric target and is also used to calculate the TMDL and the allocations. Water quality objectives and fish tissue guidelines for total PCBs are secondary targets that will provide additional means of assessing attainment of water quality standards, including the narrative toxicity objective. The final numeric target for total PCBs in the water column is from the CTR Criterion for Protection of Human Health. However, current analytical methods cannot detect concentrations at this low level and, thus, the California Toxics Rule Chronic Criterion for the protection of aquatic life in saltwater was selected as the interim numeric target.

TMDL allocations include a mass-based load allocation for direct atmospheric deposition; a group mass-based wasteload allocation (WLA) for the Municipal Separate Storm Sewer Systems (MS4), Caltrans, General Industrial, and General Construction permittees; and, concentration-based sediment WLAs for other point sources including minor NPDES permittees and general non-stormwater NPDES permittees that discharge to MDRH.

Implementation of the TMDL is based on a combination of non-structural and structural BMPs that address pollution prevention and/or sediment reduction. Compliance with the TMDL will be determined through sediment and water quality-monitoring programs. The proposed implementation schedule for the MS4 and Caltrans permittees consists of a phased approach, with compliance to be achieved in prescribed percentages of the watershed until the entire watershed meets the WLAs within 10–15 years. TMDL implementation provisions require no specific pollutant reductions from stormwater permittees within the first six years, during which period the Los Angeles Water Board will re-assess the MDRH Toxic Pollutants TMDL to consider the results of special studies. Should the Los Angeles Water Board or another responsible jurisdiction or agency determine that toxic pollutants bound in sediments in the harbor are preventing attainment of numeric targets, the Los Angeles Water Board will issue investigatory or cleanup and abatement orders to achieve the numeric targets.^{lvii}

Example 1: Marina Del Ray TMDL

various sources on a daily basis is often not practical so allocations are currently generally assigned for a longer time interval. Daily loading allocations for an intermittent discharge such as stormwater would be very difficult to formulate and implement.^{lviii} More often, TMDL goals are set out over an annual basis, such as annual sediment basin cleanings along a blue ribbon trout stream (Colorado DOT) or, in the case of the Los Angeles River, a numeric goal of zero trash/floatables and an implementation plan requiring a 10 percent reduction in trash loading per year.^{lix}

Atmospheric Deposition

Atmospheric deposition is a largely unmonitored, but potentially a large source of pollutants to aquatic ecosystems and their surrounding watersheds. The problem is further exacerbated in urban environments where the sources of pollutants to the atmosphere are numerous and the washoff of these contaminants once deposited are enhanced due to imperviousness. Atmospheric deposition of pollutants of concern is likely to be a growing issue for DOTs.

In general, aerial deposition of contaminants results in water pollution by direct deposition onto waterways or indirectly via stormwater runoff. In a few cases, the pollutants go the other way; for example, the amount of mercury volatilizing from San Francisco Bay is estimated to about equal the inputs from direct deposition and urban runoff.^{lx} In that region, Caltrans suggested that car emissions testing be expanded to include not only traditional air pollutants but also airborne debris from brake wear, tires, and other automotive sources that may affect water as well as air quality.^{lxi} State level DOT and regulatory staff are meeting to jointly develop an inventory of the original sources of and actions plan to deal with those pollutants at the source.

For two decades, atmospheric deposition of N compounds has been included in estuarine nutrient budgets. Atmospheric deposition of nitrogen contributes to eutrophication in a significant number of our coastal watersheds; roughly 10-40% of the nitrogen that reaches East and Gulf Coast estuaries is transported and deposited via the atmosphere.^{lxii} Now atmospheric deposition of other nutrients and toxics is being explored. For example, research in Delaware's Inland Bays found that Phosphorus deposition is significant, particularly at times when and to regions where P is depleted in surface waters.^{lxiii} In Tampa Bay, researchers found that while direct or "point" discharges of pollution to the bay have declined, stormwater runoff and atmospheric deposition have increased and are expected to grow as more people settle in the region.^{lxiv} The action plan calls for "reduction of future nitrogen loadings to the bay by 11 tons per year, that portion of the future nitrogen load which is attributed largely to atmospheric, industrial and agricultural sources."^{lxv}

The five categories of air pollutants most likely to degrade water quality through atmospheric deposition are nitrogen compounds, mercury, other metals, pesticides, and combustion emissions.^{lxvi}

- **Nitrogen Compounds.** While 78% of the Earth's atmosphere is nitrogen gas (N₂), only certain kinds of microbes have the ability to use this compound. All other organisms depend on ammonia (NH₃), nitrogen oxides (NO_x), and organic nitrogen compounds. Anthropogenic sources of NO_x and NH₃ currently equal natural sources (see Schlesinger, 1997). The largest single source of NO_x to the atmosphere is the combustion of fossil fuels (see Schlesinger, 1997). Bodies of water receiving elevated amounts of nitrogen compounds often show signs of water quality degradation. In some places, nitrogen deposited from the atmosphere is a large percentage of the total nitrogen load. For instance, Albemarle-Pamlico Sound in North Carolina receives 38 percent of its nitrogen from the atmosphere (see [Great Waters 3rd Report to Congress](#), 2000). While NO_x, NH₃, and organic nitrogen compounds are a natural part of the earth's atmosphere, human activities are increasing concentrations to the point that some areas are harmed or degraded. Anthropogenic sources dominate nitrogen emissions to the atmosphere. The largest source of NO_x is the combustion of fossil fuels (such as coal, oil and gas) by automobiles and electric power plants. The largest sources of NH₃ emissions are fertilizers and domesticated animals (such as hogs, chickens,

and cows). Atmospheric deposition of nitrogen compounds can lead to degradation of water quality. Most commonly, nitrogen pollution leads to eutrophication, or harmful increases in the growth of algae. In some cases, however, nitrogen pollution can also contribute to acidification of water bodies.

- **Mercury.** Atmospheric deposition is a major contributor to the overall loading of mercury to U.S. waters and thus the fish consumption advisories in over 40 states. Mercury is a toxic metal released by both natural and man-made processes, which have greatly increased its concentration in the environment. Mercury is able to travel great distances in the atmosphere and give rise to pollution through atmospheric deposition. Biological processes can transform mercury into a very toxic compound known as methyl mercury, which can bioaccumulate in the tissues of fish and shellfish and pose a threat to the health of humans and wildlife.

Human activities have greatly increased the atmospheric concentration of mercury (see Mason et. al. 1994). It is estimated that man-made emissions have tripled mercury concentrations in the air and in the surface of the ocean since 1900. Human activities presently account for about 75 percent of worldwide mercury emissions. Man-made sources include incinerators, coal-burning facilities, certain industrial processes, and household items. A number of consumer products also contain mercury including batteries, fluorescent lights, thermometers, electrical switches, dental fillings, and antibiotic treatments such as Thimerosal and mercurochrome. Burning coal for electric power generation and municipal waste incineration are the largest combustion sources of mercury emission.

Atmospheric deposition plays a major role in delivering mercury to ecosystems. Up to 83 percent of the mercury load to the Great Lakes comes from atmospheric deposition (see Shannon and Voldner, 1995). Approximately half of the mercury in Chesapeake Bay is deposited from the atmosphere directly to the surface of the bay (see Mason et. al., 1997). The National Atmospheric Deposition Program (NADP) estimated that mercury was deposited at the rate of 4-20 micrograms per square meter in the United States in 1998. The unique chemistry of mercury affects its toxicity and how it travels in the atmosphere. Elemental mercury (Hg_0) is able to travel great distances but it is not absorbed readily into biological tissues and is not very toxic. Other forms of mercury that may be emitted are divalent mercury (Hg^{2+}), and mercury that is bound to particles. These forms of mercury do not travel far in the atmosphere and tend to deposit very close to the source of emission. The forms of mercury emitted by different sources are not well characterized. In most cases, a combination of Hg_0 , Hg^{2+} , and particle-bound mercury are emitted from most sources. Hg^{2+} dissolves quickly in water and is often the form of mercury found in bodies of water. When mercury becomes deposited within a waterbody, microorganisms can transform it into a very toxic substance known as methyl mercury. Methyl mercury tends to remain dissolved in water and does not travel very far in the atmosphere; however, it can be converted back into elemental mercury and emitted again to the atmosphere. Mercury emitted from a single source can be deposited and re-emitted many times. The cycles of mercury allow it to travel great distances and make it very difficult to track in the environment, including the atmospheric deposition of mercury into water bodies. This process has been called the “leapfrog effect” and emphasizes the tendency of mercury to become deposited and re-emitted many times. There is some evidence that the process continues until the mercury comes to rest at high latitudes or high altitudes. The primary concern with mercury in water bodies is that it accumulates within the tissues of wildlife and humans. In fact, the concentration of mercury within the tissue of a fish or shellfish may be tens of thousands of times greater than the concentration of mercury in the water. Exposure to high concentrations of mercury most often results from eating contaminated fish. A mercury advisory has been in effect for the entire Gulf Coast from the Florida Keys to Corpus Christi.

- **Other Metals (excluding Mercury)** Industrial processes have led to an increase in the environmental concentration of a number of metals. Currently, **lead, cadmium, nickel, copper,** and

zinc are recognized as potentially polluting metals in the United States. These metals are a natural part of the environment, but elevated concentrations from human activities can have toxic effects on humans and wildlife.

- **Lead** contamination results from incinerating material that contains the metal (such as solder and paint) and from gasoline additives. Lead contamination peaked in the U.S. around 1970 and has been declining steadily since then. In Lake Michigan, for example, atmospheric deposition of lead decreased from over 1.2 million pounds in 1988 to under 200,000 pounds in 1994 (see [Great Waters 2nd Report to Congress](#), 1997). Programs eliminating lead as a gasoline additive as well as a reduction in the extent of solid waste incineration are contributing to declines in the levels of lead in the environment.
- **Cadmium** pollution also arises from incinerating cadmium-containing waste. Cadmium is used in batteries, and in electroplating and in many types of solder. Cadmium is also a significant by-product of zinc purification. Sources of cadmium include incinerators, smelters, and coal-burning facilities. Atmospheric deposition adds about 2,300 pounds of cadmium to the Chesapeake Bay each year.
- Though less of an atmospheric deposition issue, **copper** in roadway runoff is receiving increased attention. The LA River/ Ballona Creek TMDLs proposed reductions in copper loadings of around 80 percent. The TMDLs suggested “The permittees could sponsor legislative actions with state and federal agencies to pursue the development of alternative materials for brake pads. The use of alternative materials for brake pads would help to reduce the discharge of metals in all watersheds. Just as the phase out of leaded gasoline resulted in the gradual decline of lead concentrations in the environment, a phase out of copper brake linings would also be expected to reduce the amount of copper in storm water runoff.” A public-private Brake Pad Partnership has been working for several years to address brakepad and copper issues. They have posted a Draft Work Plan for Watershed Modeling Study. The manufacturers involved with the Partnership have agreed to voluntarily introduce new brake pads if current brake pads are shown to be causing water quality problems.^{lxvii}
- **Pesticides.** There are literally tens of thousands of registered pesticides used in the United States, the vast majority of which are synthetic. Once pesticides are released in the environment, they undergo chemical reactions that break them down into other chemical compounds called byproducts. For instance, the pesticide aldrin degrades into a different pesticide, dieldrin, in the environment. Many pesticides break down very slowly and thus, the pesticide and its byproducts can remain in soil, air, or water for decades. Some byproducts can be toxic whereas others can be relatively non-toxic. Atmospheric deposition of pesticides is recognized as a source of toxic substances to water bodies. The likelihood that a pesticide will become an atmospheric deposition problem depends on its use, its chemical characteristics, how much pesticide already exists in a receiving water body, and how it reaches the water body (direct deposition vs. indirect deposition through agricultural runoff). While the concentrations of pesticides that are deposited in rainwater are usually low, there is a marked seasonality peaking in the summer months. On several occasions, the concentration of the pesticides 2,4-dichlorophenoxy acetic acid and atrazine in rainwater has exceeded levels considered safe by EPA (maximum contaminant levels).^{lxviii} Recent work by the USGS NAWQA group indicates that there is significant atmospheric deposition of atrazine, the most commonly used herbicide in agriculture, golf courses, and urban yards.^{lxix}

Six pesticides that are linked to water quality problems and that are potentially transported through the atmosphere are described below:

Table 22: Common Pesticides

Pesticide	History/Uses	Effects	Water Quality Related Facts
Chlordane	1948 to 1978 widely used pesticide. Phased out 1983 to 1988. Used to termite-proof many homes. Still manufactured and exported to other countries for use as pesticide.	Persistent toxin which remains in food and water supply. Cancer-causing. Harms endocrine system, nervous system, digestive system, and liver.	Chlordane is stable in the environment and can travel extremely long distances. Very low levels of chlordane were detected in rainwater at Enewetak Atoll - a remote area in the North Pacific Ocean.
DDT/DDE	Used as pesticide until banned in 1972. Highly persistent in environment. Fish consumption advisories for DDT still exist in Great Lakes. Still used as pesticide and in disease control programs in other countries.	Can cause liver cancer, damages nervous system, damages reproductive system	DDT levels have fallen from 11 ppm in 1972 to around 2 ppm in 1992 in Trout Lake, a closely monitored water body in Michigan. Advisories for DDT begin at 2 ppm.
Aldrin/ Dieldrin	Popular pesticide 1950-1970. Restricted in 1974, banned in 1987. Dieldrin persists today at very low levels in nearly all environments. Concentrates in shellfish, dairy products, & soil around houses treated for termites before 1987.	May build up in body tissues. Affects central nervous system. Exposure results in headaches, convulsions, suppressed immune system. High doses can cause death.	Lake Michigan received an average of 140 lbs. of dieldrin through atmospheric deposition each year 1991-1993.
Hexachlorobenzene	Popular fungicide until 1965. Extremely stable in the environment and can build up in fish, birds, mammals and lichens. Present as waste product in chlor-alkali plants. Can enter atmosphere through incineration.	Can damage liver, thyroid, nervous system, kidneys, bones, and blood. Can result in abnormal fetal development and is especially toxic to young children.	Studies with lab animals suggest that liver damage can result from chronic exposure to hexachlorobenzene in doses smaller than 1 part per billion
α -Hexachlorocyclohexane (several related compounds including Lindane)	Used as insecticide on fruit and vegetable crops, and forest products. Still used to control lice and scabies. Not produced in U.S. since 1977, but still imported and used here. Extremely volatile, found in rainwater. Broken down by microbes in soils and water. Generally persists < 30 days.	Affects reproductive system and immune system at low levels. May cause seizures, blood disorders and death at high levels.	Lindane is a highly volatile compound. As much as 90% of lindane applied to crops may evaporate and enter the atmosphere.
Toxaphene	Volatile mixture of 670 chemicals. Used heavily as insecticide in Southern U.S. until 1990. Still used on pineapples in Puerto Rico and bananas in Virgin Islands.	Highly persistent in the environment; accumulates in fish or mammals. Liver, kidneys, adrenal gland and immune system affected at low levels. Damages lungs and nervous system or can cause death at higher levels	Trout from Lake Superior contain greater than 5 ppm toxaphene. The state of Michigan has ordered a consumption advisory for lake trout from Lake Superior since 1991.

Besides these pesticides, chlorpyrifos, atrazine and methoxychlor are currently being studied for their adverse effects in the environment. Chlorpyrifos is one of the most commonly used insecticides in the world today. It is the major ingredient in the pesticides Dursban and Lorsban. It is not persistent in the environment, but has been linked to birth defects and a number of neurological effects in humans. Laboratory tests show that chlorpyrifos is extremely toxic to aquatic organisms at concentrations less than 0.1 parts per billion. Atrazine is a widely used pesticide which can persist for up to one year in soils and is often found in streams running through agricultural areas. While atrazine is considered only mildly toxic, it is present in about 1 percent of drinking water wells in the U.S. - sometimes above levels considered safe by the EPA (EXTOXNET, Oregon State Toxicology Site). Methoxychlor is chemically related to DDT and its use has been increasing since the ban on DDT in 1972. Methoxychlor is practically nontoxic to humans and birds. However, it is extremely toxic to fish and many aquatic invertebrates with lethal effects observed at concentrations <100 ppb (see EXTOXNET, Oregon State Toxicology Site).

- **Combustion Emissions (excluding Nitrogen Compounds).** Pollutants that are released by incineration of waste are known as combustion emissions. While many compounds are released during the incineration of solid waste, several classes of compounds pose a significant threat to water quality and human health. **Dioxins, furans, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs)** are pollutants that degrade very slowly in the environment, can build up in the tissues of humans and wildlife, and have adverse effects on human and ecosystem health. Both dioxins and furans are families of chemicals that are formed completely as byproducts of industrial processes and have no use as products. Both families of chemicals enter the atmosphere predominantly during incineration and may become a deposition problem for some bodies of water. Dioxins are very stable and may travel great distances in the atmosphere. It has been estimated that 60 percent of all dioxins deposited in the Great Lakes arise from only 10 sources.^{lxx}

Polycyclic aromatic hydrocarbons (PAHs) are a family of over 100 compounds that arise from the incomplete combustion of fuel, garbage, coal, and other materials. They usually occur in complex mixtures such as soot. Most PAHs can be broken down by soil microorganisms over a period of weeks or months. Exposure generally occurs by breathing smoke or exhaust from automobiles or other combustion processes. Typically concentrations of 2-6 nanograms per liter of individual PAHs are found in rainwater throughout the Great Lakes and Chesapeake Bay region. **Polychlorinated biphenyls (PCBs)** are a class of chemicals that were manufactured for industrial purposes as coolants and lubricants for electrical equipment until they were phased out in 1977. These highly persistent chemicals can still be found in older electrical equipment and in industrial waste sites. The primary means of introduction to the environment today, however, is through incineration of material that contains PCBs.

One of the difficulties with developing pollutant loading models from atmospheric deposition is the lack of data. EPA has posted a paper that provides a simple method for estimating the annual rate of direct deposition of pollutants to an estuary when little to no local monitoring data is available. This approach can be a useful starting point for understanding the sources of pollutants entering water bodies that cannot be accounted for through run-off or point source discharges.^{lxxi}

Atmospheric Deposition of Pollutants of Concern Can Exceed that Initially Attributed to MS4s

Atmospheric deposition of pollutants of concern can exceed that initially attributed to surface runoff from MS4s, with significant cost implications for DOTs.

TMDL for Sediment and Nutrients in Lake Tahoe

Fine inorganic particles are the major pollutants affecting the clarity of Lake Tahoe. Atmospheric deposition of nitrogen represents 40-50 percent of total nitrogen loading. Streams and direct runoff are also significant pollutant contributors.^{lxxii} The Lake Tahoe TMDL for sediment and nutrients uses very detailed source modeling to identify targets for reductions from groundwater, stream channel erosion, shoreline erosion, atmospheric deposition and upland (general watershed contributions). While the upland category contributes the majority of the phosphorous and fines (fines are small particles that cause most of the reduction in clarity) and the DOT has played a significant role in reducing total suspended solids (TSS), contributions from atmospheric deposition are significant: 51 percent of nitrogen, 16 percent of phosphorous and 9 percent of total fines.^{lxxiii} The majority of deposited air pollutants are assumed to be generated in the Tahoe basin. Air deposition appears to be a major pollutant source because the lake itself occupies such a large surface area (500 km²) relative to its drainage basin (800 km²).

Initially, while acknowledging the limited amount of field data, the Lake Tahoe Watershed Assessment (Reuter and Miller, 2000) hypothesized that atmospheric nitrogen was largely associated with automobiles while phosphorus is most likely associated with wood smoke from various sources and with road dust. Thus, air pollution was viewed as among the most critical, if also challenging, pollutant sources to characterize and to control. The potential importance of air deposition prompted a \$2 million study of air quality and deposition in the Lake Tahoe Basin, entitled “Lake Tahoe Atmospheric Deposition Study,” or LTADS, to contribute to the TMDL research program. This study aimed to better characterize atmospheric deposition of nitrogen, phosphorus, and particulate matter, emission sources in the Tahoe Basin, and transport of pollutants from outside the Tahoe Basin. The complex meteorology of the Tahoe Basin often traps smoke and other pollution in layers above the Lake.

TMDL for Chromium, Copper, Lead, Nickel and Zinc in Santa Monica

Trace metals are responsible for numerous impaired water bodies throughout the southern California region. Since atmospheric deposition represented a potentially important load, a study was undertaken to account for this source in TMDL development. Trace metal loads from atmospheric deposition were estimated using a combination of aerosol sampling, water sampling and atmospheric transport and fate modeling. The annual atmospheric deposition of chromium, copper, lead, nickel and zinc exceeded the estimated annual loads from industrial and power generating station effluents to Santa Monica Bay. Atmospheric deposition rivaled and, at times, exceeded the trace metal loads from municipal wastewaters to the Bay. In the Santa Monica Bay region, the majority of the atmospheric deposition loading occurred during dry weather. The estimates of annual stormwater emissions from the Santa Monica Bay watershed was similar to the estimated annual dry deposition loading to the watershed. Steep gradients in deposition were observed, peaking near the downtown industrial and commerce center, decreasing towards the coast and further declining as one moved offshore. These gradients are consistent with the atmospheric flow patterns in the airshed. Based on modeling scenarios, it appears that sources of trace metals responsible for most atmospheric deposition in Santa Monica Bay from within the Santa Monica Bay watershed.^{lxxiv}

Several EPA Strategies for Atmospheric Deposition Relate to Transportation Planning

EPA’s general strategy for dealing with atmospheric deposition in the context of TMDLs is to:

- Continue to reduce the national loadings of pollutants of concern through implementation of existing CAA rules and promulgation of additional regulations on emissions sources.
- Work with States to support the development and implementation of atmospheric deposition focused TMDLs.

- Improve and expand the monitoring network for pollutants, emissions inventories and our modeling abilities.
- Communicate about air deposition issues with a variety of audiences.

Nitrogen Compounds are being addressed through:

1. Title IV Acid Rain Program NOX reductions
2. NOX SIP Call, Section 126 Petitions, and Federal Implementation Plans
3. New Source Performance Standards
4. New Source Review and RACT
5. Regional Haze Rule
6. Mobile Source Control
7. Total Maximum Daily Load Program (TMDL)
8. Water Quality Criteria for Nutrients
9. Concentrated Animal Feeding Operations (CAFOs)
10. Measuring economic and environmental benefits pilot
11. Consolidated Emission Reporting Rule (CERR)

A primary challenge is to understand both national deposition trends, while being able to characterize the air deposition problem at the regional, state, local and watershed levels. To address these, EPA is performing:

1. Monitoring - National Atmospheric Deposition Network (NADP), Clean Air Status and Trends Network (CASTNet).
2. Assessment activities - In the context of various policy analysis activities, EPA is using models to estimate nitrogen deposition in local/regional areas and to relate nitrogen deposition information to specific watersheds. Specific assessment activities planned are: NAPAP Report to Congress and Nitrogen deposition assessment.

EPA Strategies Related to Air Toxics

With regard to air toxics, EPA still lacks good source-receptor relationships and there is a need for more refined emissions inventories, more and better monitoring, and national scale and local scale modeling to better identify the relative contribution of sources which emit pollutants, how much of each pollutant gets deposited, and how much of what is deposited creates water quality problems. To address these challenges, EPA is working on:

- National Toxics Inventory (NTI) - guidance to and working closely with State, local and Tribal agencies on how to develop an emission inventory for HAPs.
- National Air Toxics Deposition Assessment Activities - modeling and support activities, and evaluation of results (monitoring).

EPA is also addressing air toxics through:

1. Total Maximum Daily Loads (TMDLs)
2. National Technology-Based Standards - Section 112 (d) of the CAA
3. Solid Waste Combustion Standards - Section 129 of the CAA
4. Residual Risk Standards - Section 112(f) of the CAA
5. Area Source Standards - Section 112 (k) of the CAA
6. Seven Specific Pollutants - Section 112(c)(6) of the CAA
7. Utility Determination and Actions - December 15th determination.
8. Mobile Source Standards - Section 202(l)
9. Water Quality Criteria Standards - Under the CWA, review and revise reference dose for mercury, new water quality human health criterion for methylmercury.

10. Persistent Bioaccumulative Toxics Initiative (PBTI)
11. Toxic Air Deposition Monitoring - MDN (NADP), NEP and, IADN
12. Air Toxics Ambient Monitoring - Air Toxics Monitoring Strategy, NDAMN
13. Consolidated Emission Reporting Rule (CERR) - proposed on May 23, 2000
14. Tool Development - inventories and models (TRIMfate, Models3 and etc)

Pathogens

Pathogens are agents that cause disease. Pathogenic microbes of concern in recreational waters include: 1) bacteria that cause gastrointestinal and other diseases (e.g., *Salmonella*, pathogenic *Escherichia coli*), 2) viruses causing such diseases such as hepatitis and diarrhea, and 3) protozoa that can also cause gastrointestinal problems (e.g., *Giardia*, *Cryptosporidium*).

Since testing directly for all these pathogens would be prohibitively expensive, water quality control programs rely on *indicator* bacteria: total coliform, fecal coliform (including *E. coli*), and enterococci. The indicators belong to the natural microbial population that inhabit mammals, including humans, their pets, livestock, and wildlife. They are generally not pathogens but instead represent recent fecal pollution. However, evidence has been mounting that the indicator principle does not hold for recreational waters, because indicators may survive for extended periods and possibly increase in numbers along beaches and in sediments. Work at UC Davis has shown that there is no correlation between the incidence of coliforms and human viruses in storm water.

Caltrans is helping to support research into new DNA-based technologies that can be used to detect specific pathogens in water and also to determine the exact sources of microbial indicators (e.g., humans, dogs, birds, cows). The goal is to better target specific inputs and to further develop monitoring capabilities to more precisely determine the chance that microbes in runoff include pathogens capable of causing human infection. This may make it possible to better target sources presenting the greatest risk of causing disease. The research is ongoing and will be used to assess DOT sites with discharges to waterways that have bacteria TMDLs underway.

A recent research project at the University of New Hampshire Stormwater Center showed that riprap (rock) swales, retention basins, and other BMPs may increase concentrations of bacteria (enterococci in this case) used as indicators of possible contamination with disease-causing organisms. This was generally the case when the influent loadings of the bacteria were relatively low. The BMPs may serve as incubators or other sources of bacteria may be present, such as animals. The bacteria concentrations were often above standards for recreational waters.^{lxxv}

Caltrans *BMP Retrofit Pilot Program Final Report* similarly found that some BMPs, including unlined extended detention basins and biofiltration swales, appeared to increase the concentrations of fecal coliform, another indicator bacterium. On the other hand, ponds were once used to treat sewage (and still are in some cases) and an extensive literature documents bacteria die-off in these facilities. Also, in some situations, storm water ponds show better reductions in bacteria than other conventional stormwater BMPs. Currently, there are no commonly-used BMPs that reliably attain water quality standards for storm water runoff.^{lxxvi}

The proposed Napa River Pathogen TMDL sets a “density-based” wasteload allocation for municipal runoff of 126 CFU/100 ml (geometric mean) for *E. coli*. River sampling showed that about 20% of samples exceeded targets for both wet and dry seasons with exceedances most common in urbanized tributaries. For comparison, Caltrans’ *Discharge Characterization Study Report* in statewide sampling found a median value in highway runoff for fecal coliform of 362 MPN/100ml (the fecal coliform group consists mostly of *E. coli*). Caltrans is completing research on pathogen detection techniques in this area, which may yield information that will aid in monitoring and adaptive implementation of the TMDLs.

12.8 WATERSHED APPROACHES TO WATER QUANTITY ISSUES, TREATMENT LOCATION, AND DOT STEWARDSHIP COMMITMENTS

In EPA's Phase II rule, the agency allowed that watershed planning could lead to reduced emphasis on DOT stormwater management in some basins, where gains in water quality could be achieved more cheaply and expeditiously by other nonpoint sources. "EPA proposes flexible requirements for permittees in allowing consideration of BMPs tailored to the needs of the watershed." (FR 1547, I.H.) At that time, for example, in Washington state watershed stormwater management plans were identifying and prioritizing sites for improvement and cost-sharing opportunities. WSDOT developed a prioritization method and model that helps direct mitigation dollars towards watershed restoration and enhancement projects having the highest priority and likelihood for success in the basin.

Applying stormwater management techniques to address water quality and water quantity concerns is now common practice in highway projects. In order to protect water resources from increased runoff after construction is complete, quantity management techniques such as stormwater ponds are constructed to control runoff and release stormwater according to design goals. Along the same lines, the stormwater is treated in water quality BMPs, such as wet ponds, wetlands and filters. Groundwater recharge is typically accomplished through infiltration BMPs.

Conventional BMPs are typically designed to meet certain regulatory requirements, and are typically focused on treating and managing runoff within the rights-of-way of highways. Since stormwater regulations and guidance tend to be broad, the specific needs of watersheds are less frequently addressed in SWPPPs. How to identify and implement the most needed and cost-effective watershed improvement opportunities is another question.

Under Maryland's leadership, the multi-state, Green Highways group is outlining a watershed approach to stormwater management, a collaborative approach that provides an opportunity for highway agencies to plan and deliver the most cost-effective protection and enhancement of watersheds.^{lxxvii} They define a watershed approach as "a strategy that promotes the integration of both public and private stakeholder interests in working toward a common goal – to support the sustainable use of natural resources...recogniz(ing) that cost effective approaches to stormwater management can yield watershed protection, even improvement, if we integrate the planning, maintain flexibility, and focus on outcomes."^{lxxviii} The group outlined the following:

Principles:

- Delivering transportation programs including effective stormwater management in ways that address resource protection issues in the most effective ways in addressing watershed-wide needs.
- This should be done for the benefit of multiple stakeholders such as highway agencies and environmental protection agencies to achieve "better than before"
- Flexible approaches to implement and meet the desired goals of regulatory programs to protect natural resources.
- Cost effective approaches to derive watershed benefits will be identified and promoted
- Promote integrated water and habitat resource protection (i.e. Stormwater and Watershed plans) into highway project development and project features
- Use collaboration and partnerships to deliver watershed improvements

Partnerships:

- In an effort to combine resources to improve watersheds where a DOT has planned major projects, the DOT should form partnerships with others, such as local governments, resource agencies and private groups.

- A watershed improvement plan that reflects a consensus between resource agencies and local governments is necessary. In developing such a document, other data/efforts such as watershed management plans, tributary strategies, watershed restoration action strategies, 303(d) lists, TMDLs, and Maryland Biological Stream Surveys could be utilized.
- Watershed improvement plans should develop a menu of environmental enhancement projects along with their cost estimates, environmental benefits, restoration goals, constraints/feasibility, and relative priority. Ideally this is done as a partnership led by the local government, with cooperation of the DOT and resource agencies. In Maryland, DOT has also taken the lead in developing such partnered watershed improvement plans.
- Partnership will also entail coordinating local government and private funding for mitigation and watershed improvement purposes to achieve a cumulative and coordinated benefit. There are several examples of this in Maryland.
- A process for developing and utilizing such partnerships should be developed.

DOT Project Development:

- Stormwater management plans should be integral part of project development and NEPA studies.
- Watershed needs should be the focus of stormwater management plans, not just on-site regulatory compliance.
- Project's minimum responsibilities should be established based on regulatory compliance, and a plan should consist of a combination of on-site and watershed-wide stormwater management opportunities, including banking and trading.
- Both in-kind and out of kind BMPs should be in the plan, to obtain the best environmental result in a cost-effective manner.
- Coordination with other projects – DOT or other – is important to get a coordinated mitigation/enhancement strategy.

Technology:

- Use a combination of conventional and new BMPs to fit the watershed needs, sustainability goals, and the context of their surroundings.
- Need a set of context-sensitive and sustainable BMPs that can work along rural and urban highways.
- Need to develop a set of sustainable BMPs to retrofit existing highways in rural and urban areas.
- Need to understand long-term performance of BMPs, and plan watershed improvement and stormwater management measures based on sustainable performance.
- Need new and adaptation of existing methods to establish equivalency for out-of-kind stormwater management.
- Develop a process to measure effectiveness of watershed approach to stormwater management using existing technology, and identify technology gaps.

EPA Called to Further Integration of a Watershed Approach into NPDES, TMDLs

In 2005, EPA's Office of Inspector General recommended that the Agency do a better job of integrating the "watershed approach" into its core water quality programs.^{ixxix} The premise of the watershed approach is that many water quality problems are best solved at the watershed level rather than

the individual water body or discharger level. The OIG's report notes that the approach has only gained "limited acceptance as a means to implement water programs." Permits are generally still issued on an individual basis.^{lxxx}

Likewise most TMDLs currently tend to focus on one or a few pollutants and on a water body segment. A watershed TMDL would address a larger geographical scale and possibly more or all the pollutants causing impairment. This could require longer and more complicated TMDL development; however, a watershed TMDL might avoid problems where controls implemented for initial TMDLs may not be compatible with controls needed for later TMDLs in the same basin or in the same segment, but for different pollutants of concern.

Increasing Attention to Watershed Needs and Managing Water Quantity As It Relates to Quality

After development in an area, less rainwater typically infiltrates into the ground. Instead it runs off immediately from roof downspouts, curbs, and streets directly into storm drains, which subsequently discharge to streams. This increase in flows in developed areas can cause serious scouring of the streams. Streambeds become deeper and wider. This sediment may be deposited in lower reaches, along with other pollutants sorbed to those sediments. Stream biota can also be "washed out" by the increased volume and velocity of the runoff. Habitat degradation and property damage can result.

In addition, the lack of infiltration decreases groundwater recharge and the groundwater is consequently less able to contribute to stream flows during dry periods. The overall result is increased flows during wet weather and decreased flows during dry weather. On a watershed basis, this disruption of the natural hydrologic cycle and the scouring/sedimentation can have a greater environmental impact than the pollutants contributed by the runoff.^{lxxxi}

Rising Interest in Hydromodification and Inclusion of Hydromodification Management in Stormwater Management Plans

Increases in flow volume, peak rates, and duration from impervious surfaces and the potential for harm can trigger requirements for flow controls. These adverse effects downstream on watercourses, such as increased erosion and sedimentation, are collectively referred to as "hydromodification."

Hydromodification requirements are beginning to be seen in municipal stormwater permits. Usually, Phase II MS4 permits require stormwater programs to control post-development peak runoff rates where the increased peak discharge rate will result in increased potential for downstream erosion. However, these requirements have tended to be very general and have not mandated the development of a specific control plan.

Recently the San Francisco Regional Water Quality Control Board (SFRWQCB) initiated an effort to collect data on the changes in the amount of impervious surface from all new and redevelopment projects within the jurisdiction of the Santa Clara Valley Urban Runoff Pollution Prevention Program (15+ jurisdictions). The goal is to collect information irrespective of whether the impervious surface area change is subject to the Program's internal permit requirements. The Board wants to quantify the "total impervious surface created or replaced that is exempted from current stormwater treatment or flow controls, and to provide a potential measurement of all stormwater programs' effectiveness in creek protection and compliance with wasteload allocations established by TMDLs." The information will be used in the development of a future Municipal Regional Permit (MRP) for the Bay area. The Board staff views the proposed new data on changes in impervious surface as a major tool for prioritizing stormwater control efforts and for measuring progress.^{lxxxii}

The Santa Clara Valley Urban Runoff Pollution Prevention Program's most recent permit amendment from the SFRWQCB required that additional runoff resulting from increases in impervious

surfaces (roofs, pavement, etc.) not adversely affect watercourses downstream from a project. In a divergence from previous permits issued in the state, adverse effects were required to be controlled through implementation of a detailed Hydromodification Management Plan (HMP). The HMP must be developed by the Program and approved by the Board. It describes the methods that will be implemented by the permittees to ensure that projects do not result in increased flows which could damage waterways. Similar requirements have now been added to other San Francisco Bay Area municipal stormwater permits.^{lxxxiii}

LID/Bioretenction

Low Impact Development or Bioretention BMPs are generally used for smaller volumes of runoff such as from parking lots or small sections of roadway. Typically, the runoff is directed to a vegetated area and forms a shallow (e.g., 6") temporary pond.

Although widely used in the eastern U.S., bioretention BMPs are much less common in the western states. For this reason, testing is underway. Caltrans, for example, is testing several designs. For the Route 73 BMP, a 30" layer of planting soil is overlain by mulch, and underlain by a 1 ft. gravel layer separated by a geotextile. The gravel layer includes underdrains to remove runoff that has filtered through the planting soil. The design is intended to remove standing water within 72 hours to prevent mosquito breeding. In addition, a pretreatment unit removes litter and settleable solids. The vegetation in the Route 73 BMP have had 1 ½ years to become established and water quality monitoring will start this fall. Caltrans will start construction soon on additional bioretention areas as part of the San Francisco-Oakland Bay Bridge project. Two bioretention areas will be divided into 3 cells each—a total of 6 cells—with the goal of investigating different soil and ponding depths, as well as different vegetation within the cells.^{lxxxiv}

The City of Los Angeles has created an artificial wetland for purposes of runoff treatment along the LA River, which is subject to a TMDL. Located in an industrial corridor, the Augustus F. Hawkins Nature Park is 8 ½ acres and includes a wetland that receives runoff from city streets. The wetland was designed to provide multiple benefits, including treatment of dry and wet weather runoff, wildlife habitat, recreation, and education. During wet weather the wetlands increase in size allowing detention and treatment of the storm flows before they discharge to the Los Angeles River. By discharging after peak flows, the wetland also provides a flood control benefit. The City is planning several more wetlands and will collect performance data.^{lxxxv}

Urban Runoff Can Affect Water Supply

California's 2005 statewide water plan (primarily water supply oriented) discussed problems and opportunities associated with runoff for the first time. It identified several objectives, including the following:

- Maintenance of the predevelopment hydrologic conditions (i.e., preventing increases in flow peaks or volume)
- Protection and augmentation of groundwater supplies
- Management of aquatic and riparian resources for active and passive pollution control

The plan states that the traditional approach to runoff management – generally flood channels –has been successful at preventing flood damage, but has not addressed loss of habitat or infiltration to groundwater. The plan notes that the Fresno-Clovis area manages to recharge more than 70 percent of its stormwater runoff using retention basins. It also cites Santa Monica's goal of treating and reusing all urban runoff. The plan identifies funding and lack of coordination as impediments to its stormwater goals.^{lxxxvi}

Pollutant Trading

Pollutant trading may be considered a particular type of watershed approach. It is considered an innovative approach to achieve water quality goals more efficiently, based on the fact that sources in a watershed can face very different abilities and costs to control the same pollutant. Trading programs allow facilities facing higher pollution control costs to meet their regulatory obligations by purchasing environmentally equivalent (or superior) pollution reductions from another source at a lower cost, thus achieving the same water quality improvement at a lower overall cost. In the case of a DOT, a highway expansion through an urban area may have little area to work with to install water quality control/filtration devices, which may also require dramatic maintenance costs. Incentives for trading may exist where:

- There is a “driver” that motivates facilities to seek pollutant reductions, usually a TMDL or a more stringent water quality-based requirement in an NPDES permit.
- Sources within the watershed have significantly different costs to control the pollutant of concern.
- The necessary levels of pollutant reduction are not so large that all sources in the watershed must reduce as much as possible to achieve the total reduction needed – in this case there may not be enough surplus reductions to sell or purchase.
- Watershed stakeholders and the state regulatory agency are willing to try an innovative approach and engage in trading design and implementation issues.

Regulatory agencies and permittees have or are exploring the option of trading pollutant allocations as a cost-effective method of meeting TMDL loadings in some states, especially for when they are unable to meet the required reductions in the area available. At a recently concluded Water Quality Trading Conference, U.S. EPA announced their goal to increase the number NPDES permits that have trading provisions by 33 percent. Currently 93 permits, mostly in the Northeastern U.S., include trading provisions. EPA also plans to issue guidance on trading for the agriculture community and a trading toolkit for permit writers.^{lxxxvii}

California

In northern California, Bay area MS4s have had difficulty demonstrating the needed 50 percent reduction in mercury loading which has been assigned to urban runoff by the proposed San Francisco Bay Mercury TMDL. These agencies, however, may be able to “trade” or buy their assigned loading reductions by contributing to mercury reductions elsewhere such as mine cleanup projects. When the State Board remanded this TMDL back to the Regional Board, they also instructed State Board staff to develop an “offset” or trading policy to provide an alternative method for dischargers to meet mercury allocations other than eliminating more mercury from their own discharges. This policy has not yet been developed so the San Francisco Board is proposing to include a re-opener provision in the revised TMDL so that permits can be revised at a later date to incorporate offset provisions.^{lxxxviii}

North Carolina

In North Carolina, trading has been in place and very successful in two of the large basins in the state. Now North Carolina has plans for trading in three others.^{lxxxix} North Carolina implemented a system of in-lieu fees to achieve nutrient reductions, to cost-effectively achieve reduction objectives. Sources have allocations and achieve partial reductions in discharges on their own, then pay a pre-set \$/lb. for remaining discharges. This approach has helped direct resources to more cost-effective source controls, even if other sources are not regulated or under the same regulation. Point source effluent trading occurs within the Neuse River Compliance Association. Point to Nonpoint in-lieu Fees are used to implement water quality improvements in the Tar-Pamlico Basin Association, the Neuse Compliance Association, the North Carolina Agriculture Cost Share Program, and the NCDOT funded North Carolina Ecosystem Enhancement Program – Watershed/Wetland Restoration Fund (NC EEP WRF). Nonpoint to

nonpoint source in-lieu fees are used for new and existing development in several watersheds with nutrient sensitive waters, and in the NC EEP WRF for stormwater BMP retrofits. In the Final Phase I agreement (1990-94), there were 14 associations of dischargers, an annual step-down cap for pollutants, and a charge for agricultural BMPs that exceeded the cap. The program funded an estuary model and optimized facilities for nutrients. Signatories to the agreement included environmental groups. Phase II aimed for a 30 percent reduction in Nitrogen and holding Phosphorus discharges at 1991 levels. 16 associations participated, there were no individual limits and the agricultural limits were adjusted downwards. Non-Association dischargers were governed under a separate rule requiring technology limits plus an offset for any new loading. Environmental groups did not sign the agreement. The EEP offset rate to provide for stormwater BMP retrofits has been revised to address the lifespan of the BMP and maintenance, the cost of developed land BMP/drainage, an area ratio, and an administrative cost factor. Offset BMPs are located no further from the estuary than the load being offset.

North Carolina compared the cost-effectiveness of different measures, per pound of Nitrogen reduced:

- Wet Detention/Bioretenion: \$57-\$86
- Riparian Wetland Restoration: \$11-\$20
- Conservation Tillage: \$20-\$80
- Vegetated Filter Strip: \$7- \$8
- Nutrient Management: \$7- \$9
- Water Control Structure: \$1.20

Reductions were achieved by optimizing existing operations for N and P removal. Two major facilities implemented nutrient removal, together putting their Associations below the caps and providing time for others to install nutrient removal very cost-effectively, as operations were otherwise occurring, expanding or renovating.

MS4s achieved their share of reductions through fertilizer management, developing and implementing training and plans for applicators, participating in an education program for homeowners, implementing riparian buffer protection, and through additional BMP retrofits. Stormwater export was calculated, considering the total acreage of the catchment, transportation of impervious surface and other categories of impervious surface, the removal rate of each BMP in a treatment train, and the total Nitrogen removal rate.

Phase III, which started in 2005 plans to reach the estuary clean-up deadline of 2013. An upper bound will be incorporated for uncertainty estimates and delivery differences may be spatially weighted. Plans are in the works to establish a Phosphorus offset rate. Environmental groups are supporting the plan.

Climate Change Implications for Stormwater Control

Climate change also has implications for stormwater control. In 2004, a conference addressed the impact of global warming on California. The climate models predicted temperature increases throughout California but much greater inland and especially at higher elevations. Precipitation generally decreased in the projections and snowpack reductions were forecasted at up to 60 percent. Increased coastal winds were expected and days with the temperature above 95 degrees Fahrenheit are projected to double in Los Angeles and quadruple in San Francisco.^{xc}

Figure 4: North Carolina Stormwater Export Calculation (Estimation of Exported Nitrogen via Impervious Surface Estimation and BMP Effectiveness)

Catchment 1:			Stormwater Export Calculation				
Total acreage of catchment 1 =		ac					
First BMP's TN removal rate =		%		First BMP's TP removal rate =		%	
Second BMP's TN removal rate =		%		Second BMP's TP removal rate =		%	
Third BMP's TN removal rate =		%		Third BMP's TP removal rate =		%	
TOTAL TN REMOVAL RATE =	0	%		TOTAL TP REMOVAL RATE =	0	%	
(1) Type of Land Cover	(2) Catchment Acreage	(3) S.M. Formula (0.46 + 8.3I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6)	
Transportation impervious			2.60		0.19		
Roof impervious			1.95		0.11		
Managed pervious			1.42		0.28		
Wooded pervious			0.94		0.14		
Area taken up by BMP			1.95		0.11		
Fraction Impervious (I) =			Pre-BMP TN Load (lb/yr) =		Pre-BMP TP Load (lb/yr) =		
Total Area of Development =			Pre-BMP TN Export (lb/ac/yr) =		Pre-BMP TP Export (lb/ac/yr) =		
			Post-BMP TN Load (lb/yr) =		Post-BMP TP Load (lb/yr) =		
			Post-BMP TN Export (lb/ac/yr) =		Post-BMP TP Export (lb/ac/yr) =		

Identified implications for stormwater were as follows:^{xci}

- Decreased water availability may put pressure on stormwater agencies to conserve runoff through infiltration rather than discharging it.
- Aquatic biota will be stressed as waterways increase in temperature making pollutant control even more critical.
- The increase in prolonged hot events (i.e., extreme temperature events for 7-days or more) may make it more difficult to establish vegetation on construction sites.

Watershed Approaches to MS4 Compliance and TMDLs – Rising Staffing Requirements?

Alabama, Delaware, and Maryland DOTs have begun to use stormwater trading, crediting, or banking in deciding the best locations for permanent BMPs while addressing watershed needs. California, Hawaii, Idaho, New York and Oregon estimate they will have such a system in place in the next two years.

While there are numerous program elements common to all NPDES programs, the needs of specific watersheds and the expectations of the local regulators demand locally focused efforts in some states and regions, which also have implications for organization and staffing. Transportation agencies have been leading watershed assessment efforts in some states, or spending significant time serving on watershed committees. DOTs first leadership efforts in this area were documented a decade ago.^{xcii}

A few states have spent significant resources responding to NPDES requirements on a programmatic level. Caltrans, for example, has already spent more than \$250 million over a 5 year period, with estimated increases to project delivery costs in the range of 2 to 10 percent), and have yet to respond to the local watershed specific needs, which are increasing.^{xciii}

DOTs are working to mitigate some of these impacts by tracking trends and developing water quality and water quantity tools to facilitate this on a watershed basis, with GIS. Decision support tools are helping to support impervious area management and are regional efforts and solutions to address the issue. Impervious cover is being analyzed in relation to the quantity of runoff in a given area.

For example, Minnesota is attempting to build on a tool for the design of effective sediment control strategies for construction sites by expanding upon current modeling efforts to include off-site sediment control practices and to incorporate processes at a watershed scale by linking together the responses of different land uses. The University of Minnesota is assisting Mn/DOT in the effort and will be developing user friendly interface routines that allow spatial data sets to be integrated into the model.^{xciv}

12.9 GUIDANCE FOR WORK NEAR STREAMS

In October 1998, FHWA, AASHTO, and TRB sponsored a scanning review of European practice for bridge scour and stream instability countermeasures.^{xcv} Since that time, state DOTs have undertaken a number of research efforts to establish regionally appropriate guidelines. NYSDOT and NCDOT are among other DOTs that include recommendations for appropriate practices when working near streams in maintenance or construction manuals.

- NCDOT has developed [Guidelines for Relocations of Mountain Streams in North Carolina](#) and jointly funded the [Stream Restoration and Natural Channel Design Guidebook](#).
- Mn/DOT has developed [Guidance for Stream or Water Body Modification](#).
- KYTC has put together a manual of BMPs for streamside areas.

- [WSDOT Roadside Manual Chapter 740 - Soil Bioengineering](#) addresses definitions, planning, design, implementation, site evaluation, and eleven upland soil bioengineering techniques.
- The Nebraska Cooperative Extension Service has published [Bioengineering Techniques for Hillslope, Streambank, and Erosion Control](#).
- The [Stream Restoration: A Natural Channel Design Handbook](#) prepared for the North Carolina Department of Transportation by the NCSU Stream Restoration Institute, is available on-line and contains [River Cross Section Survey](#), [Fact Sheets on River Courses](#), and [Structure Details for Vanes and Rootwads](#) in addition to:

1. Introduction to Fluvial Processes
2. Existing Condition Survey
3. Gage Station Analyses and Bankfull Verification
4. Restoration Priority Options for Incised Streams
5. Reference Reach Survey
6. Design Procedures
7. Structures
8. Vegetation Stabilization and Riparian Buffer Re-establishment
9. Erosion and Sediment Control Plan
10. Flood Studies
11. Evaluation
12. References

Materials for an accompanying four-day workshop held for 35 NCDOT staff are available from the NCSU Stream Restoration Institute, NCDOT, or CTE.

- [Maryland's Waterway Construction Guidelines](#) recommends that the planning and design of any stabilization, restoration, or in-stream construction project should include a set of clearly defined restoration objectives, a comprehensive monitoring strategy, and an adaptive management plan. Objectives vary from aesthetic improvements to habitat enhancement to safety and installation of hydraulic structures and roadways. Identifying the objective of the project must be accomplished before the design process can begin. Regardless of the nature of the objective, it should include measurable performance criteria. Performance criteria are quantitative measurements that are made in the stream corridor, compare to the project's objectives and can include parameters such as suspended sediment load and rate of lateral channel migration. A comprehensive monitoring strategy including appropriate baseline studies and timing, frequency, and location of field measurements, is necessary to assess the degree of project success or failure and to determine an adaptive management plan. Options for an adaptive management plan include adjustment or maintenance of individual measures, modification of project goals and objectives, and project redesign.
- WSDOT's [Integrated Streambank Protection Guidelines \(ISPG\)](#) Manual resulted from the 2002 finalization of an effort by WSDOT, the Washington State Department of Fish and Wildlife, the Washington State Department of Ecology, the U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service. The ISPG contains chapters on the mechanisms and causes of streambank failure, the best method for selecting appropriate solutions, examples of appropriate solutions, and technical background material. WSDOT has worked with regulatory agencies and other stakeholder to make

the ISPG an agreed-upon multi-agency standard, improving bank stabilization efforts while expediting project delivery. The ISPG is part of a series of manuals designed to protect and restore fully functioning marine, freshwater, and riparian habitat in the state and to encourage permit streamlining through the provision of proven, detailed, and well-illustrated technical solutions. Written by professional resource engineers and managers, these manuals – including the ISPG – are geared toward local, state, and federal agencies, elected officials, engineering design consultants, volunteer restoration groups, and riparian landowners. In 2003, WSDOT conducted training based on the ISPG statewide and throughout WSDOT.

- In September 2004, Washington State completed [Stream Habitat Restoration Guidelines](#) including chapters on [Stream Processes and Habitat](#), [Stream Habitat Assessment](#), [Developing A Restoration Strategy](#), [Designing and Implementing Stream Habitat Restoration Techniques](#), and a variety of [Techniques](#) including:
 - [Channel Modification](#)
 - [Levee Removal and Modification](#)
 - [Side Channel/off-Channel Habitat Restoration](#)
 - [Riparian Restoration and Management](#)
 - [Fish Passage Restoration](#)
 - [Nutrient Supplementation](#)
 - [Beaver Re-Introduction](#)
 - [Salmonid Spawning Gravel Cleaning and Placement](#)
 - [General Design and Selection Considerations for Instream Structures](#)
 - [Boulder Clusters](#)
 - [Large Wood and Log Jams](#)
 - [Drop Structures](#)
 - [Porous Weirs](#)
 - [Bank Protection Construction, Modification, and Removal](#)
 - [Instream Sediment Detention Basins](#)

In addition to a [Glossary](#), overviews of [Hydrology](#), [Hydraulics](#), and [Fluvial Geomorphology](#), [Construction Considerations](#), [Placement and Anchoring of Large Wood](#), [Typical Permits Required for Work in and Around Water](#), and [Monitoring Considerations](#) are also included.

Federal efforts have included the following:

- EPA's [Principles for the Ecological Restoration of Aquatic Resources](#)^{xvii}
- [Stream Corridor Restoration: Principles, Processes, and Practices](#).

The latter incorporates and reflects the experiences of the fifteen collaborating agencies and has received the endorsement of and awards from the American Society of Landscape Architects. It is more general than some of the other guidebooks available and is easily applicable nationwide in both urban and rural settings, to a range of stream types. The guide is divided into three principal parts. Part I provides back-ground on the fundamental concepts of stream corridor structure, processes, functions, and the effects of disturbance. Part II focuses on a general restoration plan

development process comprised of several fundamental steps. For example, in analyzing stream restoration alternatives, a management summary of proposed activities should be prepared, including an overview of the following elements:

- Analysis of the various causes of impairment and the effect of management activities on these impaired conditions and causes in the past.
- Statement of specific restoration objectives expressed in terms of measurable stream corridor conditions and ranked in priority order.
- Preliminary design alternatives and feasibility analysis.
- Cost-effectiveness analysis for each treatment or alternative.
- Assessment of project risks.
- Appropriate cultural and environmental reviews and their results
- Monitoring plan linked to stream corridor conditions.
- Anticipated maintenance needs and schedule.
- Alternative schedule and budget.

Part III briefly covers [Restoration, Installation, Monitoring, and Management](#). The information lacks detailed design guidance for various stream restoration techniques, but state environmental agencies and DOTs have begun to fill that gap, as will NCHRP 24-19 results, published as [NCHRP Report 554](#).

- EPA's [Decision-Making Guide for Restoration](#) and a [Stream Restoration Glossary](#)
- [Stream Corridor Inventory and Assessment Techniques](#)
- [Assessing Conditions of Stream Corridors at the Areawide Level -- Using Proper Functioning Condition \(PFC\) Methodology Technical Report](#)
- [TR 1737-12](#), Using Aerial Photographs to Assess Proper Functioning Condition of Riparian-Wetland Areas
- [TR 1737-15](#), Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas

The following new state DOT research is in progress:

- **Mn/DOT** is undertaking a "Scoping Study for the Development of Design Guidelines for Bioengineering in the Upper Midwest," with research results due in 2006.^{xcvii} The project will assess current design methods, clarify current practices, propose areas where better design guidance is needed and outline further research requirements.
- **Georgia DOT** is investigating the feasibility of using recently developed stream restoration techniques, specifically in-stream structures, to restore the previous channel geometry and habitat continuity in the vicinity of bridges.^{xcviii} The project will develop a database of the effectiveness of three different materials (rock, wood, and salvaged concrete slabs) for the restoration structures and restoration failures in the region. Results are due in 2006.
- **Florida DOT**, in conjunction with USFWS, is also collecting regional data; in particular the agencies are developing regional curves to characterize and stream channel hydraulic geometry (i.e., width, depth, and cross-sectional area) in relationship to bankfull discharge and watershed area and assist in natural channel design for FDOT projects. This study is expected to provide a model for future efforts to analyze streams statewide and result in improved guidelines for designing

culverts and bridges to preserve natural bankfull channel dimensions and their associated floodplains and wetlands. Study results are expected in 2006.^{xcix}

- **Nebraska DOR** is establishing guidelines about when and where to use vegetation to control erosion on streambanks, how to establish the vegetation, and what types of vegetation are most practical in any given situation. The research team also investigated combined erosion control methods to see if bioengineering can improve the stability and appearance of non-biological erosion control techniques in locations where vegetation by itself provides insufficient protection against erosion. MDT and FHWA are also undertaking research in alternative strategies in stream restoration.^c

Bioengineering Technique Selection

Selection of the appropriate technique, or techniques, is critical to successful restoration. [NCHRP Report 554](#) on Environmentally-Sensitive Channel and Bank Protection Measures provides guidelines for 44 bioengineering techniques, accompanied by 19 Special Topic guidance documents, and a total of 55 typical drawings in both AutoCAD and MicroStation formats. For each of the 44 different bioengineering techniques, the following information is provided:

- Description
- Purpose
- Planning
 - Useful For Erosion Processes
 - Spatial Application
 - Hydrologic / Geomorphic Setting
 - Conditions Where Practice Applies
 - Complexity
 - Design Guidelines / Typical Drawings
- Environmental Considerations / Benefits
- Hydraulic Loading
- Combination Opportunities
- Advantages
- Limitations
- Materials And Equipment
- Construction / Installation
- Cost
- Maintenance / Monitoring
- Common Reasons / Circumstances For Failure
- Case Studies And Examples
- Research Opportunities
- References

Bioengineering techniques are grouped into four major categories, viz., 1) River Training Techniques, 2) Bank Armor and Protection, 3) Riparian Buffer and River Corridor Treatments, and 4)

Slope Stabilization. The CD includes a rule-based selection system that relates the hydraulic, geotechnical, and environmental constraints of each technique to site conditions and project constraints to aide the user in selecting an applicable measure. Also included are reference materials “hot-linked” within the various design criteria provided. The practices shown in Example 2 are included^{ci}

Sharing DOT Stormwater Management Plans and Reports

At the time of the survey, nearly a quarter responding state DOTs (i.e. 22 percent of respondents; 10 DOTs) either did not have a stormwater management plans or were still in the process of developing one. Sixty-one percent of respondents (27 DOTs) had a stormwater management plan already in place.

Several states have on-line copies of their stormwater management plans, which may be shared, in the interests of strategic and organizational streamlining and cost-savings in program development, across DOTs. These are listed in Table24.

Likewise, some DOTs have made their annual reports on their statewide and/or MS4 stormwater management plans available on-line. (see Table 25)

Example 2: Environmentally Sensitive Channel & Bank-Protection Measures Included in NCHRP Rpt 554

River Training

1. Spur dikes
2. Vanes
3. Bendway weirs
4. Large woody debris structures
5. Stone weirs
6. Longitudinal stone toe with spurs
7. Longitudinal stone toe
8. Coconut Fiber Rolls
9. Vegetated gabion basket
10. Live cribwalls
11. Vegetated Mechanically Stabilized Earth
12. Live siltation
13. Live brushlayering
14. Willow posts and poles
15. Trench fill revetment
16. Vegetated floodways
17. Meander restoration

Bank Armor and Protection

18. Vegetation alone
19. Live staking
20. Live fascines
21. Turf reinforcement mats
22. Erosion control blankets
23. Geocellular Containment Systems
24. Rootwad revetments

Bank Armor and Protection, cont.

25. Live brush mattresses
26. Vegetated articulated concrete blocks
27. Vegetated riprap
28. Soil & grass covered riprap
29. Vegetated gabion mattress
30. Cobble or gravel armor

Riparian Buffer and Stream Corridor Opportunities

31. Live gully repair

Vanes with J hooks

32. Cross Vanes
33. Boulder clusters

Slope Stabilization

34. Diversion dike
35. Slope drain
36. Live pole drain
37. Chimney drain

38. Trench drain
39. Drop inlet
40. Fascines with Subsurface Drain
41. Flattening
42. Stone - Fill Trenches

Special Topics

1. Bankfull Discharge
2. Bio-Adaptive Plant Response
3. Checklist/Guidelines for Effective Design
4. Combining Techniques
5. Designing Stone Structures
6. Ecological Aspects of Bridge Design
7. Geotextiles and Root Penetration
8. Harvesting/Handling of Woody Cuttings
9. Management of Conveyance
10. Optimal Compaction and Other Strategies
11. Physical Aquatic Habitat
12. Proper Functioning Condition
13. Resistive (Continuous) vs. Redirective (Discontinuous)
14. Revetments to Resist Wave Wash
15. Self-Launching Stone / Well Graded Stone
16. Sources, Species, and Durability of Large Wood
17. The Key to Stability is the Key
18. The Role of Geotextiles and Natural Fabrics

Table 23: State DOT Stormwater Management Plans Available on the Web

State DOT	Website with Stormwater Management Plan
AZ	http://adotnet/consent_decree/environmental/PDF/SSWMP_020105.pdf
CA	www.dot.ca.gov/hq/env/stormwater/special/newsetup/_pdfs/management_ar_rwp/CTSW-RT-02-008.pdf
KY	http://transportation.ky.gov/EnvAnalysis/stormwaterquality/Default.htm
MA	http://www.mhd.state.ma.us//default.asp?pgid=content/envpublications02&sid=about
MI	http://www.michigan.gov/mdot/0,1607,7-205-30101-93181--,00.html
MN	http://www.dot.state.mn.us/metro/waterresources/pdf/METRO%202006%20SWPPP.pdf http://www.dot.state.mn.us/environment/pdf_files/SWPPPBMP.pdf
MS	http://www.gomdot.com/business/pdf/SWMPFinal_AF.pdf
NC	http://www.ncdot.org/environment/stormwater/
ND	http://www.state.nd.us/dot/docs/design/nddotswppplan.pdf
OH	www.dot.state.oh.us/stormwater http://www.dot.state.oh.us/stormwater/Final_ODOT_SWMP.pdf
RI	http://www.dot.state.ri.us/programs/enviro/stormwater/index.html
SD	http://www.sddot.com/pe/projdev/docs/stormwater/SDDOTSWMP.doc http://www.sddot.com/pe/projdev/environment_stormwater_2.asp
VT	http://www.aot.state.vt.us/TechServices/EnvPermit/Stormwater04.htm

Table 24: MS4 SWM Plans available on-line

CA	www2.dot.ca.gov/hq/env/stormwater/annual_report/2005/_regional_workplans/region_1.pdf
CO	www.dot.state.co.us/environmental/envWaterQual/docs/AnnualReport/AnnualReportFY2002.pdf
OH	http://www.dot.state.oh.us/stormwater/FinalAnnualReport-Yr1.pdf , 2005: http://www.dot.state.oh.us/stormwater/Year3AnnualReport/ENTIREY3AnnRpt.pdf

13 CONCLUSION

State DOTs have much to gain by sharing tools they have developed and the products of their NPDES Phase II MS4 compliance work. A DOT's work is similar across states, especially in construction and maintenance. The six minimum measures required by EPA are applied in all 50 states.

States have developed a wide range of sample approaches for meeting these requirements and for efficiently using existing resources within and outside the agency. This research examined how states are meeting the requirements of the Phase II program, to determine and document how state transportation agencies have ensured compliance with National Pollutant Discharge Elimination System (NPDES) Phase II requirements, what approaches were used in this effort, and how the six minimum measures are being met. DOTs may expand their repertoire through consideration of the range and distribution of strategies presented in this report, leading practices in meeting some of the most pressing challenges faced by DOTs in the water quality arena.

-
- ¹ LA Dept. of Public Works, <http://ladpw.org/wmd/> (go to Harbor Survey).
- ² US EPA. "Public Education and Outreach on Stormwater Impacts." Updated May 22, 2006.
<http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=1>
- ³ US EPA. "Illicit Discharge Detection and Elimination." Updated May 22, 2006.
<http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=3>
- ⁴ Chaney, Jerry. UDOT. "UDOT environmental training for contractors." March 3, 2004.
- ⁵ Indiana DOT. "Research project 2378, Implementation of Erosion Control Warranty Specification, SPR-II." \$43,797 Approved/Funded Bob McCullough, Scott Newbolds, Ed Ratulowski, Merrill Dougherty, and Richard Phillabaum, anticipated completion date November 30, 2009.
- ⁶ Douglas L. Hicks. Ecological Research Associates (N.Z.) for the Ministry for the Environment and Regional Councils' Land Monitoring Group. "A summary of techniques for measuring soil erosion,"
- ⁷ WSDOT. AASHTO Environmental Excellence Award Application. "Erosion and Sedimentation Control Program." 2003.
- ⁸ Sherrod, T., personal communication, February 9, 2006.
- ⁹ WSDOT. AASHTO Environmental Excellence Award Application, "Erosion and Sedimentation Control Program." 2003.
- ¹⁰ Venner, M. "Quality Research Needs: Survey." NCHRP Project 25-20 (02). 2002.
- ¹¹ US EPA. "Construction Site Stormwater Runoff Control." Updated May 22, 2006
<http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=4>
- ¹² California State Water Resources Control Board, <http://www.waterboards.ca.gov/plnspols/oplans/asbs.html>
- ¹³ Maryland State Highway Administration (MSHA) NPDES Procedure Manual (January, 2001).
- ¹⁴ AASHTO Best Practices in Context-Sensitive Solutions, 2005 competition, p. 22.
- ¹⁵ US EPA. "Post-Construction Stormwater Management in New Development and Redevelopment." Updated May 22, 2006.
<http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=5>
- ¹⁶ Arizona DOT. "Statewide Storm Water Management Plan." February 2005. p. 25
- ¹⁷ Pennsylvania Department of Transportation, Center for Performance Excellence, Transportation University.
<<http://www.dot.state.pa.us/internet/secinet.nsf>>
- ¹⁸ Williams, Dan., Montana Department of Transportation. Personal communication. August, 2004.
- ¹⁹ Lorentson, John. Maintenance Manager, Alabama DOT. Personal communication. March, 2005.
- ²⁰ Caltrans. College Training Related to Stormwater Pollution Prevention,
<http://www.dot.ca.gov/hq/construc/stormwater/swppp_cctraining.htm>
- ²¹ Edson, J. Presentation at the 2003 AASHTO-TRB Maintenance Meeting. Duluth, MN. July 2003.
- ²² Narowski, John. Environmental Manager, Vermont Agency of Transportation. Personal communication. March, 2005.
- ²³ McConnell, Mark. Maintenance Director, Mississippi DOT. Personal communication. March, 2005.
- ²⁴ Ohio DOT. "Storm Water Management Program, Annual Report-Year 3 (2005)." March 17, 2006, p. 3.
- ^{xxv} Venner, M. "SCOE Briefing to AASHTO Chief Administrative Officers on NPDES Phase II." 1999.
- ^{xxvi} Ohio DOT. "Storm Water Management Program, Annual Report-Year 3 (2005)." March 17, 2006, p. 3.
- ^{xxvii} Arizona DOT. "Statewide Storm Water Management Plan." February 2005. p. 12.
- ^{xxviii} South Dakota DOT. "Stormwater Management Program." March 2003.
<<http://www.sddot.com/pe/projdev/docs/stormwater/SDDOTSWMP.doc>>
- ^{xxix} Office of Water Programs, California State University, Sacramento. "NPDES Stormwater Cost Survey." January 2005.
<<http://www.owp.csus.edu/research/npdes/costsurvey.pdf>>
- ^{xxx} 2002 USC rpt.
<http://www.citiessavejobs.com/dynamic/downloads/individual_download_file_link_english_175.pdf>
- ^{xxxi} Office of Water Programs, California State University, Sacramento. "NPDES Stormwater Cost Survey." January 2005.
<<http://www.owp.csus.edu/research/npdes/costsurvey.pdf>>
- ^{xxxii} Office of Water Programs, California State University, Sacramento. "NPDES Stormwater Cost Survey." January 2005.
<<http://www.owp.csus.edu/research/npdes/costsurvey.pdf>>

^{xxxiii} Office of Water Programs, California State University, Sacramento. “NPDES Stormwater Cost Survey.” January 2005.
 <<http://www.owp.csus.edu/research/npdes/costsurvey.pdf>>

^{xxxiv} Office of Water Programs, California State University, Sacramento. “NPDES Stormwater Cost Survey.” January 2005.
 <<http://www.owp.csus.edu/research/npdes/costsurvey.pdf>>

^{xxxv} US EPA. “EPA’s Response to the National Association of Home Builders’ Request for Correction of the May 12, 2004 Fact Sheet.” December 28, 2004.
 <<http://www.epa.gov/compliance/resources/cases/civil/cwa/walmart2-fs.pdf>>

^{xxxvi} TenBruggencate, J. “State to pay \$52M for polluting waters, Honolulu Advertiser.” October 7, 2005.
 <<http://www.honoluluadvertiser.com/apps/pbcs.dll/article?AID=/20051007/NEWS11/510070352>>

^{xxxvii} US Environmental Protection Agency Press Releases. “Idaho Transportation Department and Contractor to Pay Total of \$895,000 to Settle Federal Storm Water Discharge Claims.” May 3, 2006.

^{xxxviii} Texas DOT–USEPA. “Consent Decree, Erosion and Sedimentation Control Violations at Construction Sites.” 2004.

^{xxxix} Sonal Sanghavi. “EMS Presentation.” May 2006.

^{xl} Texas DOT. “Gap Analysis General Execution Plan, Support Activities for the Development and Implementation of a Pilot Environmental Management System.” September 2005.

^{xli} Office of Water Programs, U.S. Environmental Protection Agency. “Clinton’s Clean Water Initiative. EPA 800-R-94-001.” Washington, D.C. 1994.

^{xlii} USEPA, “Draft Phase II Implementing Regulation,” 1999.

^{xliii} California State Water Resources Control Board. “Phase II Small MS4 General Permit Questions and Answer Document.” Updated August 5, 2004.
 <<http://www.swrcb.ca.gov/stormwtr/smallms4faq.html>>

^{xliv} Krieger, F. News Flash, 02-06, reporting this from Caltrans submitted comments during hearing on the Surface Water Ambient Monitoring Program (SWAMP).

^{xlvi} Natural Resources Defense Council v. U.S. EPA, C.D. Cal. No. CV-04-8307-GHK (RCx). June 28, 2006.

^{xlvii} Storm Water Panel Recommendations to the California State Water Resources Control Board. “The Feasibility of Numeric Effluent Limits Applicable to Discharges of Storm Water Associated with Municipal, Industrial and Construction Activities.” June 19, 2006.
 <http://www.waterboards.ca.gov/stormwtr/docs/numeric/swpanel_final_report.pdf>

^{xlviii} Storm Water Panel Recommendations to the California State Water Resources Control Board. “The Feasibility of Numeric Effluent Limits Applicable to Discharges of Storm Water Associated with Municipal, Industrial and Construction Activities.” June 19, 2006.
 <http://www.waterboards.ca.gov/stormwtr/docs/numeric/swpanel_final_report.pdf>

^{xlviii} Storm Water Panel on Numeric Limits. “Findings on Feasibility of Numeric Effluent Limits Applicable to Municipal Activities: Municipal Observations.” June 19, 2006. pp. 6-7.

^{xlix} Storm Water Panel on Numeric Limits. “Findings on Feasibility of Numeric Effluent Limits Applicable to Municipal Activities: Municipal Observations.” June 19, 2006. p. 5.

ⁱ Storm Water Panel on Numeric Limits. “Findings on Feasibility of Numeric Effluent Limits Applicable to Municipal Activities: Municipal Observations.” June 19, 2006. pp. 7-8.

ⁱⁱ Storm Water Panel on Numeric Limits. “Findings on Feasibility of Numeric Effluent Limits Applicable to Municipal Activities: Municipal Observations.” June 19, 2006. pp. 14-15.

ⁱⁱⁱ Storm Water Panel on Numeric Limits. “Findings on Feasibility of Numeric Effluent Limits Applicable to Municipal Activities: Municipal Observations.” June 19, 2006. pp. 14-15.

^{liii} Oregon DOT Bridge Delivery Program, CETAS Annual Report and Recommended Work Plan, June 16, 2005
 <http://www.oregon.gov/ODOT/HWY/GEOENVIRONMENTAL/docs/cetas_pr-wp6-05.pdf#search=%22Oregon%20CETAS%20water%20quality%20programmatic%20compliance%22>

^{liv} WaterKeeper Alliance, Inc., American Farm Bureau Federation, National Chicken 9 Council, National Pork Producers Council, American Littoral Society, Sierra Club, 10 Inc., Natural Resources Defense Council, Inc., v. US EPA, Michael O. Leavitt, Administrator. Docket Nos. 03-4470 (L), 03-4621 (C), 03-4631 (C), 03-4641 (C), 03-4849 (C), 6 04-40199 (C), 03-40229 (C). (2nd Circuit, August 2004).
 <<http://caselaw.lp.findlaw.com/data2/circs/2nd/034470p.pdf>>

-
- ^{lv} US EPA, Region 4. "Total Maximum Daily Load (TMDL) Development for total Mercury in the Ocklockonee Watershed Including Listed Segments in the Ocklockonee River." February 28, 2002.
<www.epa.gov/Region4/water/tmdl/georgia/ochlockonee/final_tmdls/OchlockoneeHgFinalTMDL.pdf>
- ^{lvi} California State Water Resources Control Board. "Board Meeting Session - Division of Water Quality, Resolution Approving An Amendment To The Water Quality Control Plan For The Los Angeles Region Incorporating A Total Maximum Daily Load (TMDL) for Toxic Pollutants In Marina Del Rey Harbor." January 13, 2006
<www.swrcb.ca.gov/agendas/2006/january/0113-03.pdf>
- ^{lvii} California State Water Resources Control Board. "Board Meeting Session – Division of Water Quality, Consideration of a Resolution Approving an Amendment to the Water Quality Control Plan for the Los Angeles Region Incorporating a Total Daily Maximum Load (TMDL) for Toxic Pollutants in the Marina Del Rey Harbor." January 13, 2006. pg.2.
<www.swrcb.ca.gov/agendas/2006/january/0113-03.pdf>
- ^{lviii} Friends of the Earth, Inc. v. Environmental Protection Agency Et Al., No. 05-5015 (D.C. 2006)
<<http://pacer.cadc.uscourts.gov/docs/common/opinions/200604/05-5015a.pdf>>
- ^{lix} Los Angeles Regional Water Quality Control Board. "Attachment A to Resolution No. 06-0XX". Amendments to the Water Quality Control Plan – Los Angeles Region for the Los Angeles River Trash TMDL. July 7, 2006. pp.3-4,7.
<http://www.waterboards.ca.gov/losangeles/html/bpaRes/bpa_td/50_New/Proposed%20Basin%20Plan%20Amendment_Los%20Angeles%20River%20Trash%20TMDL.pdf>
- ^{lx} California State Water Resources Control Board. "Historic Joint Meeting of Two Cal / EPA Boards Focuses on Air Pollutants that are Transferred to Water." February 10, 2006.
<http://www.swrcb.ca.gov/press/docs/2006/06_004.pdf>
- ^{lxi} California State Water Resources Control Board. "Historic Joint Meeting of Two Cal / EPA Boards Focuses on Air Pollutants that are Transferred to Water." February 10, 2006.
<http://www.swrcb.ca.gov/press/docs/2006/06_004.pdf>
- ^{lxii} US EPA. "Frequently Asked Questions about Atmospheric Deposition: A Handbook for Watershed Managers" (EPA-453/R-01-009). September 2001.
<<http://www.epa.gov/owow/oceans/airdep/air7.html>>
- ^{lxiii} Ullman, W. J., et al. "SPS-03 - Atmospheric Inputs of Nutrients and Contaminants to Estuaries."
<http://erf.org/cgi-bin/conference05_abstract.pl?conference=erf2005&id=1103>
- ^{lxiv} Tampa Bay Environmental Program. "Charting the Course for Tampa Bay: Sediment and Water Quality"
<<http://www.tbep.org/pdfs/ctc/WaterActions.pdf>>
- ^{lxv} Tampa Bay Environmental Program. "Charting the Course for Tampa Bay: Sediment and Water Quality"
<<http://www.tbep.org/pdfs/ctc/WaterActions.pdf>>
- ^{lxvi} US EPA. "Which Atmospheric Deposition Pollutants Pose the Greatest Problems for Water Quality?"
<<http://www.epa.gov/owow/oceans/airdep/air2.html>>
- ^{lxvii} Brake Pad Partnership, <http://www.suscon.org/brakepad/documents.asp>.
- ^{lxviii} USGS National Water Quality Assessment Program. "Pesticides in the Nation's Streams and Groundwater, 1992 – 2001." Revised March 15, 2006.
<<http://pubs.usgs.gov/circ/2005/1291/>>
- ^{lxix} Rocky Bay National Estuarine Research Reserve, Florida Department of Environmental Protection. "Region Science Plan: Big Cypress Basin - Estero Bay, Southwest Florida." September 2002.
<http://ocean.floridamarine.org/bcb/docs/Science_Plan.pdf#search=%22%22atmospheric%20deposition%22%20Florida%20MPO%20transportation%20planning%22>
- ^{lxx} Center for the Biology of Natural Systems (CBNS). "Dioxin Fallout in the Great Lakes." June 1996.
<<http://www.qc.edu/CBNS/dxnsun.html#fallout>>
- ^{lxxi} Casco Bay Air Deposition Team. "Estimating Estuarine Pollutant Loading From Atmospheric Deposition Using Casco Bay, Maine as a Case Study." May 2003.
<<http://www.epa.gov/owow/oceans/airdep/cascobay.pdf>>
- ^{lxxii} Reuter, J., E. Strecker and D. Roberts. "BMPs and TMDL Implementation Plans: Lake Tahoe." 2005.
<http://www.waterboards.ca.gov/nps/docs/conference2005/presentations/m330a3_reuter.pdf>
- ^{lxxiii} Pathway 2007. "Lake Tahoe Sediments and Nutrients Total Maximum Daily Load." April 27, 2006.
<http://www.pathway2007.org/assets/APRIL_MAY_06/TMDL.pdf>

- ^{lxxiv} K. Schiff and K. Stolzenbach. "Contributions of Trace Metals Via Atmospheric Deposition to Santa Monica Bay and the Santa Monica Bay Watershed." Total Maximum Daily Load (TMDL) Environmental Regulations—II Proceedings of the 8-12 November 2003 Conference (Albuquerque, New Mexico USA), Publication Date 8 November 2003. pp. 222. Published by the American Society of Agricultural and Biological Engineers, St. Joseph, Michigan
<<http://www.asabe.org/http://asae.frymulti.com/abstract.asp?aid=15562&t=1>>
- ^{lxxv} University of New Hampshire Stormwater Center
http://www.unh.edu/erg/cstev/Presentations/Willey_R70_files/frame.htm
- ^{lxxvi} Caltrans BMP Retrofit Report:
http://www.dot.ca.gov/hq/env/stormwater/special/newsetup/pdfs/new_technology/CTSW-RT-01-050.pdf
- ^{lxxvii} Veeramacheneni, R., "A Green Highways Approach to Stormwater Management," March 2006 draft.
- ^{lxxviii} Veeramacheneni, R., "A Green Highways Approach to Stormwater Management," March 2006 draft.
- ^{lxxix} Krieger, F., "Watershed Approach - EPA Inspector General Calls for greater use." Water Quality News Flash, Number 05-45. November 7, 2005.
- ^{lxxx} Office of Inspector General, US EPA. "Evaluation Report: Sustained Commitment Needed to Further Advance Watershed Approach." Resolution No. 2005-P-00025. September 21, 2005.
<<http://www.epa.gov/oig/reports/2005/20050921-2005-P-00025.pdf>>
- ^{lxxxi} California Regional Water Quality Control Board, San Francisco Bay Region. "Santa Clara Valley Urban Runoff Pollution Prevention Program, HMP Report, Appendix B." June 29, 2004.
<http://www.scvurppp-w2k.com/hmp_web_110404/hmp_appendices/Appendix_B_HMP_lit_review.pdf>
- ^{lxxxii} Krieger, F. "Water Quality News Flash." February 20, 2006.
- ^{lxxxiii} http://www.scvurppp-w2k.com/hmp_web_110404/HMP_report.htm
- ^{lxxxiv} Alderete, D. and M. Scharf. Office of Water Programs, University of California, Sacramento. "Case Study: The Design of a Bioretention area to Treat Highway Runoff and Control Sediment." Presented at International Erosion Control Association, Conference 36, Dallas, TX. February 20-24, 2005.
<<http://www.owp.csus.edu/research/papers/papers/PP061.pdf>>
- ^{lxxxv} LA Times, <http://www.latimes.com/news/local/la-me-wetlands5feb05,0,31080.story?coll=la-headlines-california>. Also, <http://www.lastormwater.org/WPD/program/science/augustus.htm>.
- ^{lxxxvi} California Water Plan Update 2005. Volume 2, Chapter 21. "Urban Runoff Management." 2005.
<<http://www.waterplan.water.ca.gov/docs/cwpu2005/vol2/v2ch21.pdf>>
- ^{lxxxvii} US EPA. "Water Quality Trading." Updated July 26, 2006.
<<http://www.epa.gov/owow/watershed/trading.htm>> Presentations from the conference posted at:
<<http://www.envtn.org/>>
- ^{lxxxviii} Krieger, F. "Trading Pollutant Allocations – Option for storm water." EPA website, Stormwater News Flash. Number 06-24. June 12, 2006.
- ^{lxxxix} Gannon, R., NC DWQ. "Pollutant Trading in North Carolina's River Basins." August 31, 2005.
<<http://www.deq.state.va.us/vpdes/pdf/tarpamlicoriverpresentaug31tac.pdf>>
- ^{xc} Bell, J., L. Sloan and M. Snyder. Dept. of Earth Sciences, University of California, Santa Cruz. "Regional Changes in Extreme Climatic Events: A Future Climate Scenario." February 11, 2003.
<http://www.es.ucsc.edu/~jbell/Belletal2004_JCL.pdf>
- ^{xci} Bell, J., L. Sloan and M. Snyder. Dept. of Earth Sciences, University of California, Santa Cruz. "Regional Changes in Extreme Climatic Events: A Future Climate Scenario." February 11, 2003.
<http://www.es.ucsc.edu/~jbell/Belletal2004_JCL.pdf>
- ^{xcii} Venner, M. "Integrating Planning for DOT Mitigation and Watershed Restoration." 2006. Presented at TRB in January 2008.
- ^{xciii} Borroum, S. Personal communication, March 2005.
- ^{xciv} Minnesota DOT. "Research Project: Design Tool for Controlling Runoff and Sediment from Highway Construction, 2006-2007." Contract/Grant Number: 81655-174, 2005-029R, University of Minnesota.
- ^{xcv} Bryson, D.W., Ghore, D.G., Hulbert, W.H., "European Practice for Bridge Scour and Stream Instability Countermeasures." Transportation Research Record No. 169, Transportation Research Board. Washington, DC. (2000) pp. 236-243.
- ^{xcvi} US EPA, Office of Water (4501F). "Principles for the Ecological Restoration of Aquatic Resources." (EPA841-F-00-003). Washington, DC. (2000) p.4.
- ^{xcvii} . Research underway and due in 2005. Mn/DOT contact is Nambisan, Shashi S. Phone: (702) 895-1338.

^{xcviii}. Research underway and due in mid 2006. Georgia DOT contact is Jared, David, Phone: (404) 363-7569
Email: david.jared@dot.state.ga.us.

^{xcix}. Unpublished research. "Regional Channel Characteristics for Maintaining Natural Fluvial Geomorphology in Florida Streams." Report due in 2005. Personal communication, Josh Boan, FDOT, Phone: (850) 922-7208, May 17, 2004.

^c Garrett, Paul. Personal communication. May 18, 2004.

^{ci} Hess, Tim. Personal communication. NCHRP 24-19 and Salix Applied Earthcare. May, 2004.