SECTION 7 –

DOCUMENTATION

IN SUPPORT OF TEST CLAIMS IN RE SANTA ANA RWQCB

ORDER NO. R8-2009-0030

(NPDES NO. CAS618030)

VOLUME III

MISCELLANEOUS AUTHORITIES

(Exhibits 1 – 12)

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VOLUMES III AND IV – MISCELLANEOUS AUTHORITIES

VOLUME III

DESCRIPTION OF AUTHORITY	EXH. NO.
EPA Guidance Memorandum, Subject: Establishing Total Maximum Daily Load (TMDL) Waste Load Allocations (WLAs) for Stormwater Sources and NPDES Permit Requirements Based On Those WLAs, November 22, 2002	1.
Letter dated August 22, 2003, from EPA Headquarters to the Honorable Bart Doyle	2.
TMDLs Stormwater Handbook, November, 2008	3.
Report issued for Congress by the National Research Council ("NRC") in 2001, entitled "*Assessing the TMDL Approach to Water Quality Management*"	4.
State Board Order No. 91-04	5.
State Board Order No. 96-13	6.
State Board Order No. 98-01	7.
State Board Order No. 2001-11	8.
State Board Order No. 2001-15	9.
State Board Order No. 2006-12	10.
Stormwater Quality Panel Recommendations to the California State Water Resources Control Board – *The Feasibility of Numeric Effluent Limits Applicable to Discharges of Stormwater Association with Municipal Industrial and Construction Activities*, June 19, 2006	11.
April 18, 2008 letter from State Board's Chief Counsel to Commission on State Mandates	12.
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California Toxics Rule ("CTR"), 65 Fed. Reg. 31682, *et seq*	13.
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State Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays and Estuaries in California (State Implementation Plan)	16.
California Regional Water Quality Control Board (Santa Ana Region) Order No. R8-2010-0033 (January 29, 2010)	17.
San Diego Regional Board Staff Report re: *Comparison Between the Requirements of Tentative Order 2001-01, the Federal NPDES Storm Water Regulations, the Existing San Diego Municipal Storm Water Permit (Order 90-42), and Previous Drafts of the San Diego Municipal Storm Water Permit*	18.

EXHIBIT "1"

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOV 22 2002

OFFICE OF WATER

MEMORANDUM

SUBJECT: Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs

FROM: Robert H. Wayland, III, Director
Office of Wetlands, Oceans and Watersheds

James A. Hanlon, Director
Office of Wastewater Management

TO: Water Division Directors
Regions 1 - 10

This memorandum clarifies existing EPA regulatory requirements for, and provides guidance on, establishing wasteload allocations (WLAs) for storm water discharges in total maximum daily loads (TMDLs) approved or established by EPA. It also addresses the establishment of water quality-based effluent limits (WQBELs) and conditions in National Pollutant Discharge Elimination System (NPDES) permits based on the WLAs for storm water discharges in TMDLs. The key points presented in this memorandum are as follows:

- NPDES-regulated storm water discharges must be addressed by the wasteload allocation component of a TMDL. See 40 C.F.R. § 130.2(h).

- NPDES-regulated storm water discharges may not be addressed by the load allocation (LA) component of a TMDL. See 40 C.F.R. § 130.2 (g) & (h).

- Storm water discharges from sources that are not currently subject to NPDES regulation may be addressed by the load allocation component of a TMDL. See 40 C.F.R. § 130.2(g).

- It may be reasonable to express allocations for NPDES-regulated storm water discharges from multiple point sources as a single categorical wasteload allocation when data and information are insufficient to assign each source or outfall individual WLAs. See 40 C.F.R. § 130.2(i). In cases where wasteload allocations

are developed for categories of discharges, these categories should be defined as narrowly as available information allows.

The WLAs and LAs are to be expressed in numeric form in the TMDL. See 40 C.F.R. § 130.2(h) & (i). EPA expects TMDL authorities to make separate allocations to NPDES- regulated storm water discharges (in the form of WLAs) and unregulated storm water (in the form of LAs). EPA recognizes that these allocations might be fairly rudimentary because of data limitations and variability in the system.

NPDES permit conditions must be consistent with the assumptions and requirements of available WLAs. See 40 C.F.R. § 122.44(d)(1)(vii)(B).

WQBELs for NPDES-regulated storm water discharges that implement WLAs in TMDLs may be expressed in the form of best management practices (BMPs) under specified circumstances. See 33 U.S.C. §1342(p)(3)(B)(iii); 40 C.F.R. §122.44(k)(2)&(3). If BMPs alone adequately implement the WLAs, then additional controls are not necessary.

EPA expects that most WQBELs for NPDES-regulated municipal and small construction storm water discharges will be in the form of BMPs, and that numeric limits will be used only in rare instances.

When a non-numeric water quality-based effluent limit is imposed, the permit's administrative record, including the fact sheet when one is required, needs to support that the BMPs are expected to be sufficient to implement the WLA in the TMDL. See 40 C.F.R. §§ 124.8, 124.9 & 124.18.

The NPDES permit must also specify the monitoring necessary to determine compliance with effluent limitations. See 40 C.F.R. § 122.44(i). Where effluent limits are specified as BMPs, the permit should also specify the monitoring necessary to assess if the expected load reductions attributed to BMP implementation are achieved (e.g., BMP performance data).

The permit should also provide a mechanism to make adjustments to the required BMPs as necessary to ensure their adequate performance.

This memorandum is organized as follows:

(I). Regulatory basis for including NPDES-regulated storm water discharges in WLAs in TMDLs;

(II). Options for addressing storm water in TMDLs; and

(III). Determining effluent limits in NPDES permits for storm water discharges consistent with the WLA

(I). Regulatory Basis for Including NPDES-regulated Storm Water Discharges in WLAs in TMDLs

As part of the 1987 amendments to the CWA, Congress added Section 402(p) to the Act to cover discharges composed entirely of storm water. Section 402(p)(2) of the Act requires permit coverage for discharges associated with industrial activity and discharges from large and medium municipal separate storm sewer systems (MS4), i.e., systems serving a population over 250,000 or systems serving a population between 100,000 and 250,000, respectively. These discharges are referred to as Phase I MS4 discharges.

In addition, the Administrator was directed to study and issue regulations that designate additional storm water discharges, other than those regulated under Phase I, to be regulated in order to protect water quality. EPA issued regulations on December 8, 1999 (64 FR 68722), expanding the NPDES storm water program to include discharges from smaller MS4s (including all systems within "urbanized areas" and other systems serving populations less than 100,000) and storm water discharges from construction sites that disturb one to five acres, with opportunities for area-specific exclusions. This program expansion is referred to as Phase II.

Section 402(p) also specifies the levels of control to be incorporated into NPDES storm water permits depending on the source (industrial versus municipal storm water). Permits for storm water discharges associated with industrial activity are to require compliance with all applicable provisions of Sections 301 and 402 of the CWA, i.e., all technology-based and water quality-based requirements. See 33 U.S.C. §1342(p)(3)(A). Permits for discharges from MS4s, however, "shall require controls to reduce the discharge of pollutants to the maximum extent practicable ... and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants." See 33 U.S.C. §1342(p)(3)(B)(iii).

Storm water discharges that are regulated under Phase I or Phase II of the NPDES storm water program are point sources that must be included in the WLA portion of a TMDL. See 40 C.F.R. § 130.2(h). Storm water discharges that are not currently subject to Phase I or Phase II of the NPDES storm water program are not required to obtain NPDES permits. 33 U.S.C. §1342(p)(1) & (p)(6). Therefore, for regulatory purposes, they are analogous to nonpoint sources and may be included in the LA portion of a TMDL. See 40 C.F.R. § 130.2(g).

(II). Options for Addressing Storm Water in TMDLs

Decisions about allocations of pollutant loads within a TMDL are driven by the quantity and quality of existing and readily available water quality data. The amount of storm water data available for a TMDL varies from location to location. Nevertheless, EPA expects TMDL authorities will make separate aggregate allocations to NPDES-regulated storm water discharges

(in the form of WLAs) and unregulated storm water (in the form of LAs). It may be reasonable to quantify the allocations through estimates or extrapolations, based either on knowledge of land use patterns and associated literature values for pollutant loadings or on actual, albeit limited, loading information. EPA recognizes that these allocations might be fairly rudimentary because of data limitations..

EPA also recognizes that the available data and information usually are not detailed enough to determine waste load allocations for NPDES-regulated storm water discharges on an outfall-specific basis. In this situation, EPA recommends expressing the wasteload allocation in the TMDL as either a single number for all NPDES-regulated storm water discharges, or when information allows, as different WLAs for different identifiable categories, e.g., municipal storm water as distinguished from storm water discharges from construction sites or municipal storm water discharges from City A as distinguished from City B. These categories should be defined as narrowly as available information allows (e.g., for municipalities, separate WLAs for each municipality and for industrial sources, separate WLAs for different types of industrial storm water sources or dischargers).

(III). Determining Effluent Limits in NPDES Permits for Storm Water Discharges Consistent with the WLA

Where a TMDL has been approved, NPDES permits must contain effluent limits and conditions consistent with the requirements and assumptions of the wasteload allocations in the TMDL. See 40 CFR § 122.44(d)(1)(vii)(B). Effluent limitations to control the discharge of pollutants generally are expressed in numerical form. However, in light of 33 U.S.C. §1342(p)(3)(B)(iii), EPA recommends that for NPDES-regulated municipal and small construction storm water discharges effluent limits should be expressed as best management practices (BMPs) or other similar requirements, rather than as numeric effluent limits. See *Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits*, 61 FR 43761 (Aug. 26, 1996). The Interim Permitting Approach Policy recognizes the need for an iterative approach to control pollutants in storm water discharges. Specifically, the policy anticipates that a suite of BMPs will be used in the initial rounds of permits and that these BMPs will be tailored in subsequent rounds.

EPA's policy recognizes that because storm water discharges are due to storm events that are highly variable in frequency and duration and are not easily characterized, only in rare cases will it be feasible or appropriate to establish numeric limits for municipal and small construction storm water discharges. The variability in the system and minimal data generally available make it difficult to determine with precision or certainty actual and projected loadings for individual dischargers or groups of dischargers. Therefore, EPA believes that in these situations, permit limits typically can be expressed as BMPs, and that numeric limits will be used only in rare instances.

Under certain circumstances, BMPs are an appropriate form of effluent limits to control pollutants in storm water. See 40 CFR § 122.44(k)(2) & (3). If it is determined that a BMP approach (including an iterative BMP approach) is appropriate to meet the storm water component of the TMDL, EPA recommends that the TMDL reflect this.

EPA expects that the NPDES permitting authority will review the information provided by the TMDL, see 40 C.F.R. § 122.44(d)(1)(vii)(B), and determine whether the effluent limit is appropriately expressed using a BMP approach (including an iterative BMP approach) or a numeric limit. Where BMPs are used, EPA recommends that the permit provide a mechanism to require use of expanded or better-tailored BMPs when monitoring demonstrates they are necessary to implement the WLA and protect water quality.

Where the NPDES permitting authority allows for a choice of BMPs, a discussion of the BMP selection and assumptions needs to be included in the permit's administrative record, including the fact sheet when one is required. 40 C.F.R.§§ 124.8, 124.9 & 124.18. For general permits, this may be included in the storm water pollution prevention plan required by the permit. See 40 C.F.R. § 122.28. Permitting authorities may require the permittee to provide supporting information, such as how the permittee designed its management plan to address the WLA(s). See 40 C.F.R. § 122.28. The NPDES permit must require the monitoring necessary to assure compliance with permit limitations, although the permitting authority has the discretion under EPA's regulations to decide the frequency of such monitoring. See 40 CFR § 122.44(i). EPA recommends that such permits require collecting data on the actual performance of the BMPs. These additional data may provide a basis for revised management measures. The monitoring data are likely to have other uses as well. For example, the monitoring data might indicate if it is necessary to adjust the BMPs. Any monitoring for storm water required as part of the permit should be consistent with the state's overall assessment and monitoring strategy.

The policy outlined in this memorandum affirms the appropriateness of an iterative, adaptive management BMP approach, whereby permits include effluent limits (e.g., a combination of structural and non-structural BMPs) that address storm water discharges, implement mechanisms to evaluate the performance of such controls, and make adjustments (i.e., more stringent controls or specific BMPs) as necessary to protect water quality. This approach is further supported by the recent report from the National Research Council (NRC), *Assessing the TMDL Approach to Water Quality Management* (National Academy Press, 2001). The NRC report recommends an approach that includes "adaptive implementation," i.e., "a cyclical process in which TMDL plans are periodically assessed for their achievement of water quality standards" . . . and adjustments made as necessary. *NRC Report* at ES-5.

This memorandum discusses existing requirements of the Clean Water Act (CWA) and codified in the TMDL and NPDES implementing regulations. Those CWA provisions and regulations contain legally binding requirements. This document describes these requirements; it does not substitute for those provisions or regulations. The recommendations in this memorandum are not binding; indeed, there may be other approaches that would be appropriate

in particular situations. When EPA makes a TMDL or permitting decision, it will make each decision on a case-by-case basis and will be guided by the applicable requirements of the CWA and implementing regulations, taking into account comments and information presented at that time by interested persons regarding the appropriateness of applying these recommendations to the particular situation. EPA may change this guidance in the future.

If you have any questions please feel free to contact us or Linda Boornazian, Director of the Water Permits Division or Charles Sutfin, Director of the Assessment and Watershed Protection Division.

cc:
Water Quality Branch Chiefs
Regions 1 - 10

Permit Branch Chiefs
Regions 1 - 10

EXHIBIT “2”

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 22 2003

OFFICE OF WATER

The Honorable Bart Doyle
CPR Steering Committee
Mayor Pro Tem
City of Sierra Madre
2175 Cherry Avenue
Signal Hill, CA 90755

Dear Mayor Doyle:

Thank you for your letter of March 28, 2003, following up on our March 11, 2003 meeting. Your letter requests the Environmental Protection Agency's (EPA) assistance with several aspects of both the Los Angeles Region Basin Plan Review and the Los Angeles County MS4 NPDES permit.

I want to apologize for not responding sooner to your letter. You have raised many important issues for us to look at in more detail. You have asked EPA to support an accelerated review of the Los Angeles Basin Plan as well as participating and helping build consensus in completing the review. EPA staff are working closely with Regional Board staff to develop basin plan amendments and are actively working with stakeholder groups seeking solutions to ongoing water quality problems in the Los Angeles Region.

In addition, you have expressed concern about the need to complete numerous use attainability analyses (UAAs) in order to designate proper water quality standards for small, minor water bodies. You have asked for information on how various EPA Regions have interpreted the Tributary Rule and request guidance from EPA Headquarters to Region 9 and California on this issue. EPA supports the state's effort to identify and adopt appropriate designated uses for the water bodies of concern. However, EPA and state regulations require any change in designated uses to go through the state's water quality standards revision process, including the public participation process. In addition, any change to a designated use that results in a use that is not specified in Clean Water Act section 101(a), must be accompanied by a UAA. This does not automatically mean that detailed case-by-case analyses would be required for each water body. EPA believes that there are several approaches that may be appropriate for conducting analyses to modify designated uses, such as conducting a batch analysis for multiple waters with similar characteristics or conducting simplified analyses, depending on the water body's characteristics and the type and/or source of pollutants. EPA Region 9 is committed to working with the Los Angeles Regional Water Quality Board on any efforts it may undertake to revise water bodies' designated uses.

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California and EPA Region 9 are not unique in how they interpret the Tributary Rule. Several other states have similar provisions contained in their water quality standards. Individual states and EPA have generally interpreted these provisions as a mechanism to apply water quality standards where an individual water body's standards, including designated uses, are not explicitly identified.

Your letter also raises issues related to the Los Angeles County MS4 permit. You have requested that EPA clarify to the Regional Board the intent of the receiving waters limitations. The Los Angeles Regional Water Quality Control Board developed a Frequently Asked Questions (FAQ) document to help clarify this and other questions that have been raised about this permit. It is available at www.swrcb.ca.gov/rwqcb4. EPA believes this document clarifies the intent of the receiving waters limitations language.

You also ask EPA to provide guidance on the definition of Maximum Extent Practicable (MEP) and to provide examples of its practical application. Congress established MEP but did not provide language defining this standard. EPA envisions MEP as an iterative process that considers such factors as conditions and beneficial uses of receiving waters, MS4 size, climate, implementation schedules, current ability to finance the program, hydrology, geology, and capacity to perform operation and maintenance. EPA understands the importance of providing assistance to help communities implement MEP. We are looking at the information gathered from evaluating many MS4 permits and programs. We hope to use this to provide examples of good storm water programs.

You have raised concerns about implementation of TMDLs through NPDES permits and have asked EPA to provide samples of alternative implementation methods. EPA believes that permits are a critical component of TMDL implementation. In this situation, the LA permit contains a compliance framework that provides flexibility and time for communities to develop cost-effective controls. EPA will continue to work with the Regional Board to make sure that they consider different implementation methods for TMDLs.

Your letter states that the Regional Board is not following EPA's November 2002 memo on establishing TMDL Waste Load Allocations and Stormwater NPDES Permit Requirements. You ask EPA to provide guidance to the Regional Board that supports this memo. EPA worked closely with all ten Regions on this memo and expects that it will be followed by the states. I've asked my staff to follow up with the State and would be happy to discuss this with you further if the Regional Board is not following the memo.

Finally, you request approval of your FY 2003 program funding from this year's appropriation and request additional funding for demonstration projects along the Lower Los Angeles and San Gabriel Rivers. EPA supports the types of demonstration projects that you are proposing, but as you know, we always have requests to fund far more worthy projects than we have funds for. I would be glad to talk with you further about your proposal for additional funding.

Thank you for sharing your concerns on these issues. Please contact me if you wish to discuss any of this further, or have your staff call James A. Hanlon, Director, Office of Wastewater Management, at (202) 564-0748.

Sincerely,

Benjamin H. Grumbles
Deputy Assistant Administrator

EXHIBIT "3"

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF WATER

November 17, 2008

Dear Colleague:

Today we are making available the draft technical document *TMDLs to Stormwater Permits Handbook* for your review and comment. Stormwater runoff is a significant contributor to water quality impairments across the country, particularly runoff from developing and urbanized areas. Currently there are thousands of Clean Water Act section 303(d) waters listed as impaired for stormwater-source pollutants such as pathogens, nutrients, sediments and metals. To effectively address these impairments it is important to strengthen connections between two key federal programs under the Clean Water Act – the TMDL program and the NPDES stormwater permitting program.

This Handbook provides a reference for TMDL practitioners and permit writers on current methods being used to develop more detailed stormwater-source TMDL allocations, TMDL implementation plans including best management practices, and methods for translating TMDL allocations into NPDES stormwater permit requirements. The Handbook assumes that the reader has a working knowledge of both TMDLs and NPDES stormwater permits, and provides background information on the components of these programs. Please note that last month the National Research Council released a lengthy report, *Urban Stormwater Management in the United States* (NRC, the National Academies Press, October 15, 2008). We intend to review the publication for consideration in producing the final version of the Handbook.

Please provide us feedback on the methods and approaches presented in this Draft Handbook, as well as additional TMDL-stormwater case studies, implementation plans, other valuable resources, or permits and/or permit language that would be useful to include. Comments on the document should be sent to Christine Ruf (ruf.christine@epa.gov), Dean Maraldo (maraldo.dean@epa.gov) and Jack Faulk (faulk.jack@epa.gov) by February 27, 2009.

Thanks again for your interest.

John Goodin /s/
Chief, Watershed Branch

Jack Faulk, /s/
Acting Chief, Industrial Permits Branch

Kevin Pierard /s/
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For more information on this technical document, please refer to the TMDL or NPDES contacts, below:

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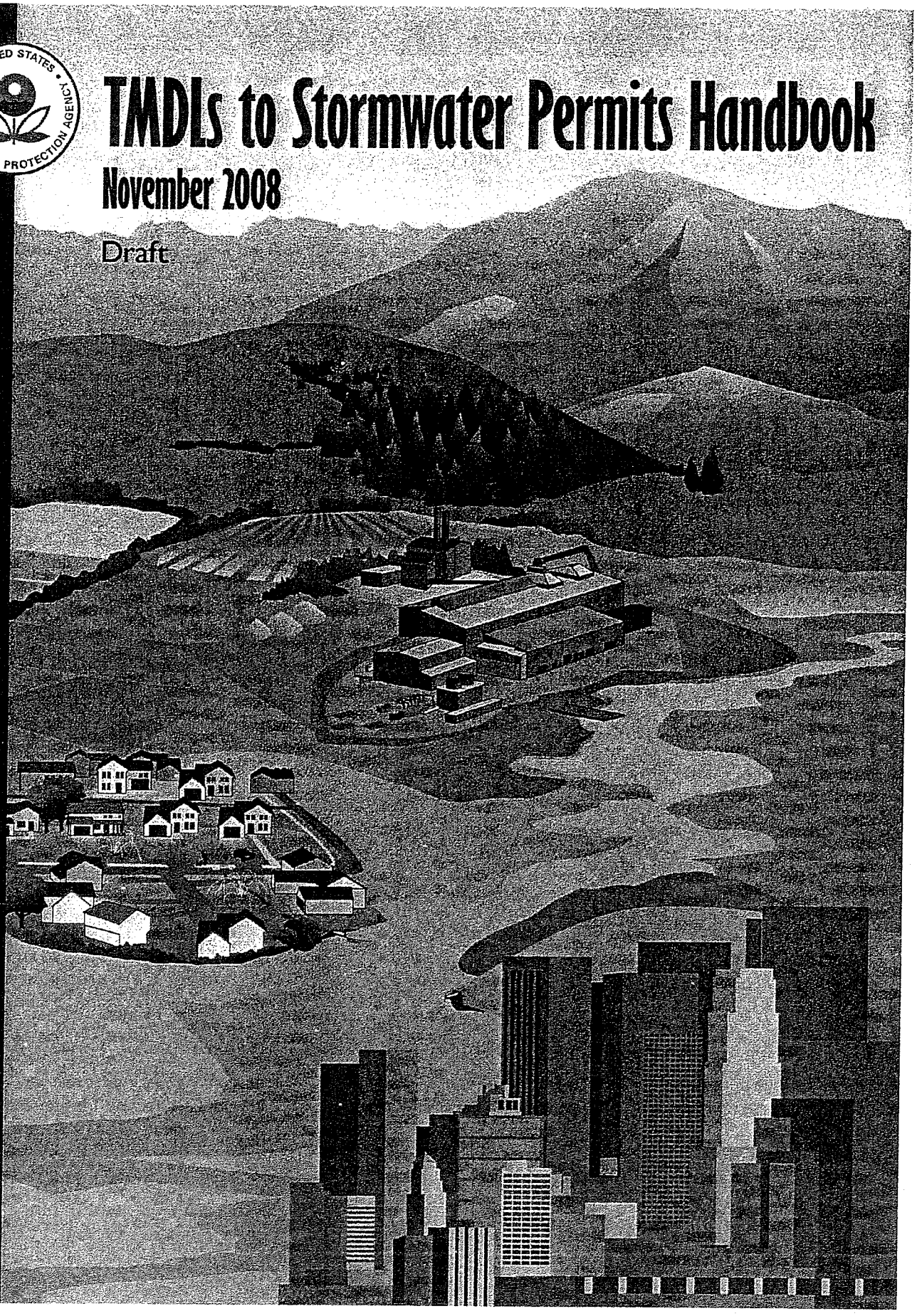
TMDLs to Stormwater Permits Handbook

November 2008

Draft



TMDLs To Stormwater Permits Handbook

DRAFT

November 2008

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DISCLAIMER

This document provides technical information to TMDL and NPDES practitioners who are familiar with the relevant technical approaches and legal requirements pertaining to developing TMDLs and NPDES stormwater permits, and refers to statutory and regulatory provisions that contain legally binding requirements. This document does not substitute for those provisions or regulations, nor is it a regulation itself. Thus, it does not impose legally binding requirements on EPA or States, who retain the discretion to adopt approaches on a case-by-case basis that differ from this information. Interested parties are free to raise questions about the appropriateness of the application of this information to a particular situation, and EPA will consider whether or not the technical approaches are appropriate in that situation.

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Preface

Thousands of impaired waterbodies require total maximum daily loads (TMDLs) for pollutants, such as pathogens, nutrients, sediments, and metals – pollutants commonly associated with urban stormwater discharges. As a result, it is important for the TMDL program and the National Pollutant Discharge Elimination System (NPDES) Stormwater program to identify opportunities and approaches for promoting TMDL implementation through stormwater permits. The U.S. Environmental Protection Agency (EPA) developed this *TMDLs to Stormwater Permits Handbook* (Handbook) to address challenges that are unique to TMDL development and implementation involving permitted stormwater discharges from municipal separate storm sewer systems (MS4s), industrial facilities, and construction activities.

The Handbook is intended for federal and state TMDL writers and NPDES stormwater permit writers responsible for addressing waterbodies impaired by discharges from stormwater sources. The Handbook assumes that the reader has a working knowledge of both the TMDL and the NPDES stormwater programs and provides limited background information on the basic regulatory and programmatic aspects of these programs.

The Handbook contains information to give TMDL and stormwater permit writers a better understanding of (1) cross-program regulatory requirements and programmatic processes; (2) current efforts to establish better cross-program connections; and (3) opportunities to further improve how the TMDL and NPDES Stormwater programs interact to address stormwater-related water quality impairments. Real-world examples are the predominant mechanism to illustrate concepts and approaches for promoting improved implementation of TMDLs through stormwater permits. The information contained in this Handbook represents an initial step in identifying and comprehensively addressing these issues. The issues and challenges surrounding TMDL implementation through stormwater permits will continue to evolve as EPA and state TMDL practitioners and stormwater permit writers consider and test new approaches and strategies.

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Acronyms and Abbreviations

303(d)	Section 303(d) of the Clean Water Act
AnnAGNPS	Annualized Agricultural Non-Point Source model
ASCE	American Society of Civil Engineers
BAT	best available technology economically achievable
BMP	best management practice
BOD5	five-day biochemical oxygen demand
CADDIS	Causal Analysis/Diagnosis Decision Information System
CASQA	California Stormwater Quality Association
CBOD5	five-day carbonaceous biochemical oxygen demand
CFB	commercial fishing ban
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
CGP	Construction General Permit
CWA	Clean Water Act
DA	drainage area
DMR	discharge monitoring report
DO	dissolved oxygen
DRSCW	DuPage River Salt Creek Workgroup
DURMM	Delaware Urban Runoff Management Model
EFDC	Environmental Fluid Dynamics Code
EMAP	Environmental Monitoring and Assessment Program
eNOI	Electronic Notice of Intent
EPA	U.S. Environmental Protection Agency
FCG	fish consumption guidelines
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
GI	green infrastructure
GIS	geographic information system
GWLF	Generalized Watershed Loading Functions
HSPF	Hydrologic Simulation Program in Fortran

IC	impervious cover
ICIS	Integrated Compliance Information System
IDDE	Illicit Discharge Detection & Elimination
IDEAL	Integrated Design and Evaluation Assessment of Loadings
LA	load allocation
LID	low impact development
LSPC	Loading Simulation Program in C++
MASTEP	Massachusetts Stormwater Technology Evaluation Project
MDAS	Mining Data Analysis System
MEP	maximum extent practicable
mg/L	milligram per liter
MOS	margin of safety
MRLC	multi-resolution land characteristics
MS4	municipal separate storm sewer system
MSGP	Multi-Sector General Permit
MUSIC	Model for Urban Stormwater Improvement Conceptualization
NAWQA	National Water-Quality Assessment (Program)
NLCD	National Land Cover Dataset
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NSPS	New Source Performance Standards
NTU	nephelometric turbidity units
NURP	Nationwide Urban Runoff Program
NWIS	National Water Information System
O&M	operation and maintenance
P8-UCM	Program for Predicting Polluting Particle Passage through Pits, Puddles, and Ponds—Urban Catchment Model
PCS	Permit Compliance System
PCB	polychlorinated biphenyl
PG BMP-DSS	Prince George's County Best Management Practice Decision Support System
QAPP	quality assurance project plan

SB	shellfishing ban
SET	Site Evaluation Tool
SI	stressor identification
SIC	standard industrial classification
SLAMM	Source Loading and Management Model
STORET	Storage and Retrieval (database)
SWAT	Soil and Water Assessment Tool
SWMM	Storm Water Management Model
SWMP	stormwater management program
SWPPP	stormwater pollution prevention plan
TARP	Technology Acceptance and Reciprocity Partnership
TMDL	total maximum daily load
TSS	total suspended solids
TWR	trophic weighted residue value of mercury in fish tissue
UNRBA	Upper Neuse River Basin Association
UOD	ultimate oxygen demand
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VAFSWM	Virginia Field Scale Wetland Model
VFSMOD	Vegetative Filter Strip Model
WLA	wasteload allocation
WQBEL	water quality-based effluent limitations
WQ_v	water quality volume

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INTRODUCTION

Across the country, stormwater runoff is a significant contributor to water quality impairments, particularly in developing and urbanized areas. There are thousands of impaired waterbodies requiring total maximum daily loads (TMDLs) for pollutants associated with stormwater sources, such as pathogens, nutrients, sediments, and metals. Developing TMDLs that include stormwater sources can present unique challenges because of the variety and number of sources, the variability of the pollutants discharged by these sources, the limited availability of monitoring data, and the complexity of the mechanisms by which pollutants in stormwater discharges affect ambient water quality criteria. Implementing TMDLs via National Pollutant Discharge Elimination System (NPDES) stormwater permits can also present challenges because of difficulties in translating the numeric, water quality-based TMDL wasteload allocations (WLAs) into permit requirements.

The purpose of this Handbook is to provide information to TMDL practitioners and NPDES stormwater permit writers (referred to as *TMDL writers and permit writers* throughout this Handbook) on the following:

- Current methods and other potential options for developing more precise WLAs for stormwater sources (referred to simply as *sources* throughout this Handbook)
- TMDL implementation plans including best management practice (BMP) and other stormwater management strategy recommendations
- Approaches for translating TMDL WLAs and implementation recommendations into NPDES stormwater permit requirements and implementation strategies

Information contained in this Handbook specifically addresses the following:

- TMDL WLAs for stormwater sources that clearly express and assign the targeted loading reductions necessary to attain and maintain water quality standards
- TMDL implementation plans that connect WLAs and stormwater permits by either (1) including specific recommendations (e.g., performance standards, management measures) for implementing WLAs, or (2) providing technical information for permit writers and permittees on how to analyze, select, and implement provisions to implement the WLAs
- Stormwater permits that are consistent with the WLAs by identifying specific elements, including management measures, that implement the WLA and, if available, TMDL implementation plan recommendations or specifying approaches for demonstrating that specific provisions will implement WLAs

In addition, the goal is to provide TMDL and permit writers a better cross-program understanding of regulatory requirements and programmatic processes and a better understanding of opportunities to further improve how the TMDL and NPDES Stormwater programs should interact to address stormwater-related water quality impairments. The real-world examples provided in this Handbook are intended to provide a range of options for TMDL and permit writers to consider. Where real-world examples do not exist to illustrate a concept, the Handbook provides a hypothetical example for TMDL and permit writers to consider, and the writers hope that it provides insight into future directions to improve this linkage.

This Handbook is organized as follows:

- **Chapter One: Understanding the connections between TMDLs and stormwater permits.** Provides overviews of TMDL and NPDES Stormwater programs and summarizes the challenges of developing TMDLs and implementing WLAs through stormwater permits.
- **Chapter Two: Identifying opportunities to coordinate TMDLs and stormwater permits.** Identifies ideas and opportunities for TMDL and permit writers to coordinate at various points throughout the TMDL and stormwater permitting processes.
- **Chapter Three: Characterizing impairments and stormwater sources.** Provides a detailed discussion of the type of information that TMDL and permit writers can use to generate a detailed stormwater source characterization, including data on water quality and watershed conditions, as well as data generated by stormwater permittees and where to obtain this information.
- **Chapter Four: Developing TMDLs with Stormwater Sources.** Addresses key stormwater-specific issues that TMDL writers can consider when developing TMDLs using a specific technical approach. It also discusses options for categorizing stormwater WLAs to facilitate their implementation in permits.
- **Chapter Five: Promoting effective stormwater management.** Presents an adaptive management framework for selecting, implementing, assessing, and modifying stormwater management strategies using information and tools that predict potential BMP performance
- **Chapter Six: Coordinating TMDLs and stormwater permit requirements.** Provides a variety of options for effectively tying together TMDLs and associated permit requirements through the development of TMDL reports, stormwater permit language, and fact sheets, as well as TMDL implementation planning documents.
- **Appendix.** Provides excerpts of TMDLs, implementation plans, and stormwater permit requirements to illustrate how states connect permitted stormwater source requirements among programmatic documents.
- **Bibliography.** Provides a comprehensive list of documents, Web sites, and databases that are included in the Resources section of each chapter or cited in the Handbook.
- **Glossary.** Defines key terms introduced throughout the Handbook.

1 **Understanding the Connections Between TMDLs and Stormwater Permits**
2 Identifying Opportunities to Coordinate TMDLs and Stormwater Permits
3 Characterizing Impairments and Stormwater Sources
4 Developing TMDLs with Stormwater Sources
5 Promoting Effective Stormwater Management
6 Coordinating TMDLs and Stormwater Permits

Chapter One
Understanding the Connections Between TMDLs and Stormwater Permits

What's included in this chapter

- ✓ Overview of the TMDL and stormwater programs.
- ✓ Discussion of the challenges associated with connecting TMDLs and stormwater permit requirements.

What you should know after reading this chapter

- ✓ Basic components of a TMDL and why stormwater sources receive WLAs.
- ✓ The three categories of permitted stormwater sources, the two types of stormwater permits, and a general understanding of stormwater permit requirements.
- ✓ Why development of this Handbook was necessary to help connect TMDLs and stormwater permits.

Potential roles and responsibilities under this activity

If you are a TMDL writer

1. Develop a basic understanding of who the stormwater program covers, the types of permits and requirements to which stormwater sources are subject, and factors affecting the role of the stormwater permit writer.
2. Understand how TMDL development relates for permit writers.

If you are a stormwater permit writer

1. Develop a basic understanding of when TMDLs are necessary, the TMDL development process, and factors affecting the role of TMDL writers.
2. Understand how stormwater permitting relates to developing and implementing TMDLs.

1. UNDERSTANDING THE CONNECTIONS BETWEEN TMDLS AND STORMWATER PERMITS

Understanding the regulatory, programmatic, and technical issues associated with the TMDL and NPDES Stormwater programs can help TMDL and permit writers improve cross-program connections, leading to better TMDLs and stormwater permits. This chapter briefly summarizes the key statutory and regulatory elements of these two programs.

1.1. What Every Permit Writer Should Know about the TMDL Program

> ***Resources:*** For more information on the TMDL program, refer to the Resources list at the end of this chapter in Section 1.4.1, including EPA's TMDL Web site at www.epa.gov/owow/tmdl/.

A TMDL reflects the total pollutant loading a waterbody can receive and still meet water quality standards. TMDLs are one of the many tools Congress authorized in the Clean Water Act (CWA) to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." (CWA section 101(a)). Section 303(d) of the CWA requires states, territories, and authorized tribes to identify and establish a priority ranking for waters for which technology-based effluent limitations required by section 301 are not stringent enough to implement applicable water quality standards, establish TMDLs for the pollutants causing impairment in those waters, and submit to the U.S. Environmental Protection Agency (EPA), from time to time, the list of waters in which water quality standards are not attained or maintained and for which TMDLs are required, as well as their associated TMDLs. EPA must review and approve or disapprove lists and TMDLs within 30 days. If EPA disapproves a list or a TMDL submitted by states, territories, and authorized tribes, EPA must establish the list or TMDL. In addition, some courts have interpreted the statute as requiring EPA to establish lists and TMDLs when a state fails to do so. EPA's TMDL regulations can be found at Title 40 of the *Code of Federal Regulations* (CFR) sections 130.7 and 130.2.

Listing impaired waters and establishing TMDLs for waters impaired by pollutants from point and nonpoint sources does not, by itself, create any new or additional implementation authorities to control point or nonpoint sources. Permitting authorities implement WLAs included in a TMDL through enforceable water quality-based discharge limits in NPDES permits authorized under section 402 of the CWA (see next section, "What every TMDL Writer Should Know about the NPDES Stormwater Program"). Mechanisms for implementing nonpoint source load allocations (LAs) within TMDLs include state section 319 nonpoint source management programs, coupled with a wide variety of other state, local, tribal, and federal programs—which may be regulatory, nonregulatory, or incentive-based, depending on the program—as well as voluntary action by committed citizens. To date, no tribe has sought or received CWA authority to establish TMDLs.

A brief summary of the key aspects of the TMDL program is provided below.

- **Section 303(d) Lists of Impaired Waterbodies.** Each state is required to identify "water quality limited segments," or impaired waterbodies, for which federal technology-based controls, state, tribal, or local effluent limitations or other pollution control requirements (e.g., BMPs) required by local, state, tribal, or federal authority are not stringent enough to achieve water quality standards, including waters not meeting standards due to thermal discharges (40 CFR 130.7 (b)). The list that

identifies these water quality limited segments is known as the Section 303(d) list. States are required to submit Section 303(d) list updates every 2 years. The information that the Section 303(d) list must contain (40 CFR 130.7) is as follows:

- ✓ The pollutant(s) causing (or expected to cause) the violation of water quality standards for each listed water
- ✓ A priority ranking of all listed waters and waters targeted for TMDL development within the next 2-year listing cycle
- ✓ Documentation to support listing decisions, including a description of the methodology used, data evaluated, rationale for not using any readily available data, and any other reasonable information requested by EPA to evaluate the listing decisions

New Location for 303(d) Lists

States are now integrating Section 303(d) lists of impaired waters and Section 305(b) water quality assessment reports to produce Integrated Reports. The Integrated Report groups a state's waters into five categories, depending on a determination of whether a waterbody is impaired or is in attainment of water quality standards. Category 5 of the Integrated Report contains the list of waterbodies that do not meet water quality standards and require a TMDL. Therefore, Category 5 represents the Section 303(d) list of impaired waters. For more information on Integrated Reports, visit EPA's Web site: www.epa.gov/owow/tmdl/2008_ir_memorandum.html

- **Components of a TMDL.** EPA's regulations at 40 CFR 130.2(i) define a TMDL as the sum of WLAs plus load LAs plus a margin of safety (MOS) to account for uncertainty between pollutant sources and resulting water quality. Allocations to pollutant sources vary on the basis of the type of pollutant sources—WLAs are loads allotted to existing and future point sources, and LAs are loads attributed to existing and future nonpoint sources, plus loads from natural background. Future growth allowances in TMDLs account for increased pollutant loadings and can be included as an allocation of pollutant loads from new sources expected in the future. For instance, in areas where land use changes are anticipated, TMDLs can include a reserve for future growth, which can be a separate component of the TMDL or included in WLAs or LAs.

Characteristics of a TMDL

- Addresses a variety of pollutants
- Contains quantified targets
- Considers all significant sources
- Expresses pollutant loads in relationship to water quality standards
- Provides allocations for known sources
- Considers a MOS and future growth
- Focuses on temporal nature of allocations to achieve standards
- Requires sound data
- Involves stakeholders

- **TMDL implementation plans.** Although not required by federal law or regulation, many states include (and some state regulations do require) TMDL implementation plans, which are typically developed in coordination with relevant stakeholders. A TMDL implementation plan typically identifies recommended management practices that major sources in the watershed are expected to implement, along with a general time frame and strategy for funding and monitoring. Factors such as waterbody ranking, data availability, court-ordered schedules, and anticipated management activities can affect the timing of TMDL development and implementation.

As illustrated in Figure 1, the process for developing a TMDL typically includes the following steps:

- Stakeholder involvement and public participation to engage affected parties and solicit input, feedback and buy-in for a successful TMDL. This process can occur throughout the TMDL development (and implementation) process.
- Watershed characterization to identify the waterbody, watershed, and impairment conditions; TMDL targets; and potential sources.

- Linkage analysis to calculate the loading capacity.
- Allocation analysis to evaluate and assign WLAs to point sources and LAs to nonpoint sources.
- Developing the TMDL report and administrative record for submittal to EPA.
- TMDL implementation to identify management activites to implement WLAs and LAs.

Figure 1 also illustrates where to find a discussion of each activity in the Handbook. At the beginning of each chapter, you will find a modified version of Figure 1 that highlights the TMDL activities discussed in that chapter.

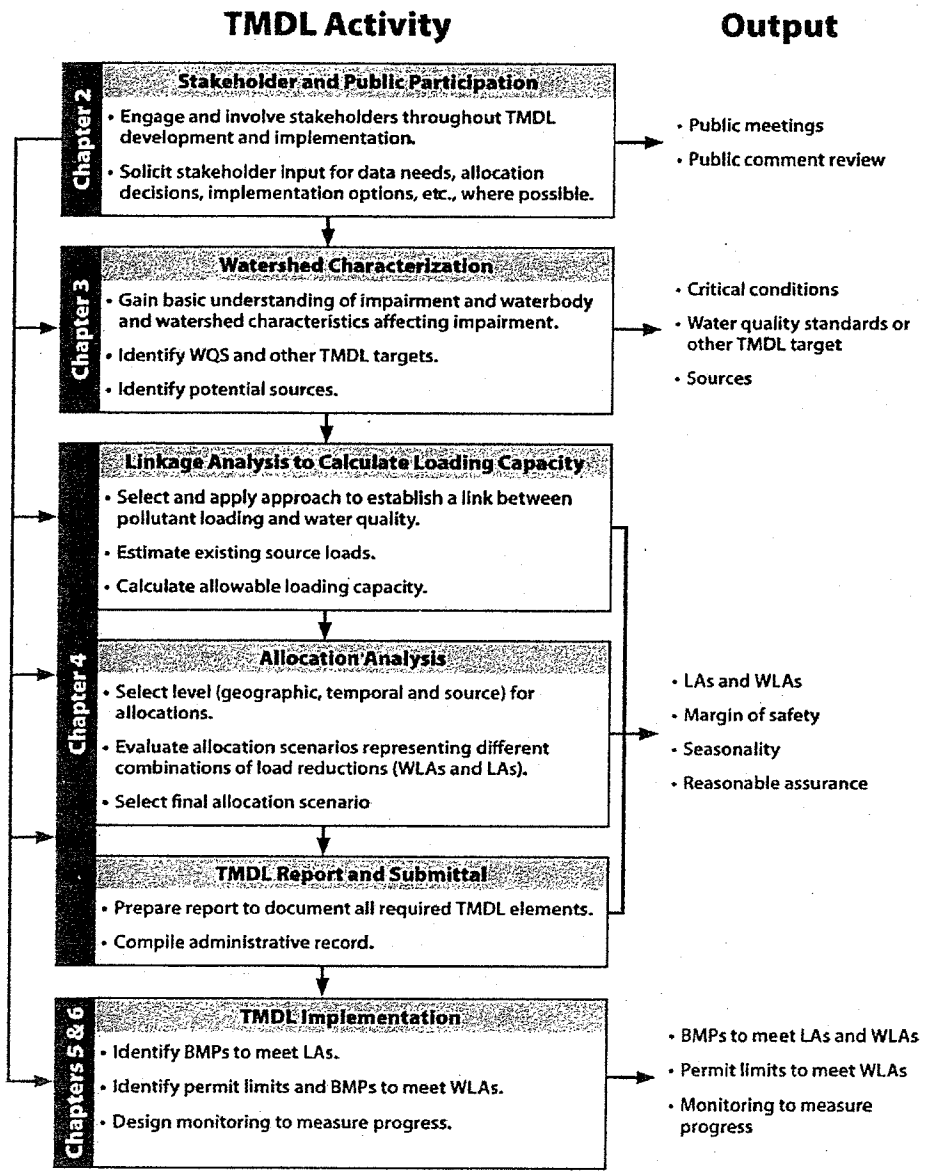

Figure 1. Typical steps in the TMDL development process.

1.2. What Every TMDL Writer Should Know about the NPDES Stormwater Program

To understand the NPDES Stormwater program, it is important to have an understanding of the NPDES program framework. This section provides a brief overview of the NPDES program to introduce basic permitting concepts and then provides details about the NPDES Stormwater program.

1.2.1. NPDES Program Framework

The CWA enacted in 1972 established the NPDES program and provides that either EPA or the state can administer (i.e., issue permits, assess compliance, take enforcement) the program. EPA, however, must first authorize a state to do so. Authorization requires that a state demonstrate to EPA's satisfaction that it has the necessary legal authority, technical skills, and resources to administer the program. Once authorized, a state becomes the *permitting authority*, taking on the responsibility of administering the NPDES program, including issuance of NPDES stormwater permits. As of 2008, 45 states (excluding Alaska, Idaho, Massachusetts, New Hampshire, and New Mexico) and one territory (U.S. Virgin Islands) are authorized to administer the NPDES program.[1] Where a state is not authorized to administer the NPDES program, the EPA Regional office is the permitting authority. For the purpose of this Handbook, the term *permit writer* is intended to convey a state or EPA staff person responsible for acting on behalf of the state agency or EPA regional office serving as the NPDES permitting authority in that area.

The NPDES regulations provide for two basic types of permits: individual and general. Dischargers requesting to be covered under an individual permit are required to submit an individual permit application, which the permit writer uses as the basis for developing site-specific permit requirements. The individual permit is then issued to that discharger for a period not to exceed 5 years, with a requirement to reapply before the expiration date. An individual permit is tailored specifically for an individual facility.

Five Basic Components of General and Individual NPDES Permits

- Cover page
- Effluent limits (numeric or narrative; technology-based or water quality-based)
- Monitoring and reporting requirements
- Standard conditions
- Special conditions

When the permitting authority expects that many dischargers with similar types of activities will require coverage under an NPDES permit, the permitting authority may choose to issue a general permit in lieu of issuing individual permits to each of these dischargers. After a general permit is issued, dischargers wishing to be covered under the general permit submit a Notice of Intent (NOI) to the permitting authority. These dischargers, consistent with procedures specified in the general permit, are then authorized to discharge under the terms of that general permit. The CWA requires that NPDES permits, both individual and general, be made available to the public for at least 30 days for review and comment before final issuance.

NPDES permits, with the exception of municipal separate storm sewer system (MS4) permits, must include technology-based effluent limitations based on best available technology economically achievable (BAT), or New Source Performance Standards (NSPS) for new sources, and any other more

[1] EPA Regions retain permitting authority for most Indian lands, federal facilities in four states (Colorado, Deleware, Vermont, and Washington) certain oil and gas activities (Texas and Oklahoma) and agricultural activities (Oklahoma).

stringent limitations as necessary to ensure that the discharge does not cause or contribute to in-stream exceedances of water quality standards. MS4s defined by the regulations as needing NPDES permit coverage are required to implement stormwater management programs (SWMPs) designed to control pollutants to the maximum extent practicable (MEP) to protect water quality rather than meeting a BAT requirement as for other NPDES permittees. NPDES-authorized states and territories may impose more stringent permit requirements than those set forth in federal regulations.

1.2.2. NPDES Stormwater Program

> ***Resources:*** For more information on the NPDES Stormwater program, refer to the Resources list at the end of this chapter in Section 1.4.3, including EPA's NDPES Web site at www.epa.gov/npdes/stormwater.

In 1987 Congress amended the CWA to require EPA to regulate certain stormwater discharges through the NPDES program. After promulgating stormwater rules in 1990 and 1999 (known as the Phase I and Phase II stormwater rules, respectively), NPDES permitting authorities now issue permits to control stormwater discharges from (1) MS4s, (2) industrial activities, and (3) construction activities as follows:

(1) Medium, large, and regulated small MS4s: MS4s, generally, are public storm sewer systems (including roads with drainage systems and municipal streets) that are owned or operated by a public body and not part of a combined sewer (i.e., storm and sanitary sewers combined). Incorporated places and counties meeting EPA's definitions of medium and large MS4s are identified in the NPDES regulations in 40 CFR Part 122, Appendices F through I. In general, these are separate storm sewer systems that serve populations over 100,000 people. Regulated small MS4s are identified according to the U.S. Census Bureau definition of urbanized area as established every 10 years in its decennial census. Populations served by these regulated small MS4s range from several hundred to tens of thousands of people, but in most instances these systems serve fewer than about 30,000–50,000 people.

> ***Types of MS4 Infrastructure and Permittees***
>
> The NPDES Stormwater program uses the term MS4 to describe the type of stormwater conveyance infrastructure, as well as the permittee required to obtain stormwater permit coverage. As a type of infrastructure, MS4s are not merely a system of pipes. As defined by regulations, an MS4 can also include drainage systems for roadways, gutters, and ditches.
>
> An MS4 permittee does not just include municipally owned storm sewer systems. The term MS4 can also apply to a variety of entities that own and operate MS4 infrastructure, such as departments of transportation, military bases, universities, hospitals, and prisons.

(2) Industrial facilities that fall under 11 categories of industrial activities that discharge to an MS4 or to waters of the United States (construction activity disturbing 5 acres or more is one of these 11 categories, but because of the nature of its operations, it is addressed separately from the other 10 categories.). Industrial facilities (except construction) may certify to a condition of *no exposure* in lieu of obtaining NPDES permit coverage if their industrial materials and operations are not exposed to stormwater.

> ***11 Categories of Industrial Activity***
>
> Category One (i): Facilities subject to national effluent limitations
>
> Category Two (ii): Heavy Manufacturing
>
> Category Three (iii): Mining and Oil and Gas
>
> Category Four (iv): Hazardous Waste Storage, Treatment, or Disposal Facilities
>
> Category Five (v): Landfills
>
> Category Six (vi): Recycling Facilities
>
> Category Seven (vii): Steam Electric Plants
>
> Category Eight (viii): Transportation Facilities
>
> Category Nine (ix): Wastewater Treatment Works
>
> Category Ten (x): Construction Activity disturbing 5 acres or more
>
> Category Eleven (xi): Light Industrial Activity

(3) Construction activity that disturbs one or more acre of land and less than one acre if the activity is part of a larger common plan of development or sale (USEPA 2004). The Phase I stormwater rule regulates construction activities 5 acres and above. The Phase II stormwater rule added sites between one and 5 acres.

Figure 2 illustrates how the regulation of these stormwater sources affected the universe of regulated NPDES dischargers over time. From the beginning of the NPDES program, permit writers across the country developed and issued permits for approximately 60,000 facilities with wastewater discharges. The NPDES Phase I Stormwater program required stormwater discharges from large and medium MS4s, large construction activities, and industrial facilities to obtain NPDES permit coverage; bringing approximately 300,000 stormwater sources into the NPDES program. The NPDES Phase II Final Rule covering regulated small MS4s and construction sites between one and 5 acres added approximately 200,000 additional stormwater sources to the NPDES program universe.

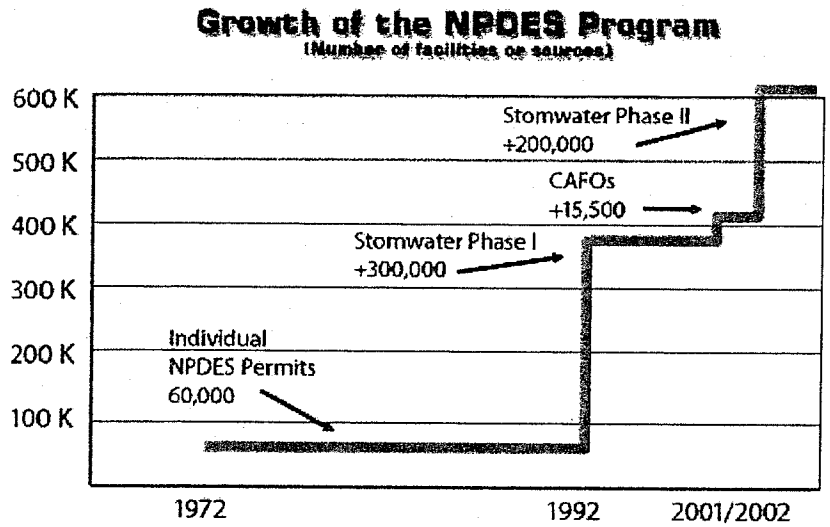

Figure 2. Number of facilities or sources permitted under various programs of the NPDES program over time.

A brief summary of key aspects of the NPDES Stormwater program is provided below.

1.2.2.1. Types of NPDES Stormwater Permits

To regulate the approximately 500,000 stormwater sources, the NPDES Stormwater program uses both individual and general permits.

- **Individual permits**, issued to most medium and large MS4s and small MS4s in a few states, require the initial submission of a comprehensive permit application. However, because most MS4s have already been permitted, the content of future applications is expected to contain less information than the original submission. Applications will contain available data or a summary of that data and the permittee's plans for future activities and controls to address any identified concerns. NPDES permitting authorities use the detailed permit application information to develop site-specific requirements.

- **General permits**, issued for most stormwater discharges associated with industrial and construction activities and small MS4s in most states, contain more widely applicable requirements. Stormwater dischargers submit an NOI to the permitting authority to obtain coverage under a general permit. The information necessary to complete an NOI for coverage under a general permit is usually (depending on state requirements) less burdensome than the information required for an individual permit. Coverage under a general permit is often relatively automatic when the discharger meets the eligibility requirements for coverage. Stormwater permittees that are unable to meet eligibility conditions for general permits must obtain coverage under an individual permit. Table 1 highlights the estimated number of stormwater permittees across the country by type of stormwater discharge and the number of general and individual permits issued to these permittees.

Table 1. Estimated number of stormwater permittees and permits by type of stormwater discharge

Type of stormwater discharge	Permittees	General permits	Individual permits
MS4	7,000	50	500
Industrial	100,000	120	Unknown*
Construction	250,000	60	Unknown*

* These permits are not tracked separately under the stormwater program. EPA estimates that several hundred entities are permitted with individual permits each year.

1.2.2.2. Standards and Limits in Stormwater Permits

The CWA requires, with the exception of MS4s, that NPDES permits contain technology-based effluent limits and water quality-based effluent limits (WQBELs) when the technology-based limits alone do not adequately protect water quality. The CWA standard for MS4s is that the permit must require controls to reduce the discharge of pollutants to the MEP to protect water quality. Stormwater permits use a variety of approaches to incorporate these concepts into NPDES permit conditions. Generally, stormwater permits require implementation of BMPs, identified as narrative effluent limits, deemed by the permitting authority to be appropriate to meet the intent of the CWA. These narrative effluent limits include practices such as source control and pollution prevention BMPs. Stormwater permits typically stipulate general categories of controls, and charge the permittee to articulate the details in a stormwater plan. Occasionally, stormwater permits will establish numeric effluent limits that must be met at the discharge point.

MEP Pollutant Reduction Standard for MS4s

Operators of regulated MS4s must develop and implement SWMPs that reduce the discharge of pollutants to the MEP to protect water quality. While MEP is a pollutant reduction standard that applies to all permitted MS4s, the practical aspects of MEP varies from location to location depending on factors such as pollutant sources and local receiving water conditions and concerns. EPA's *Measureable Goals Guidance for Phase II MS4s* (http://cfpub.epa.gov/npdes/stormwater/measurablegoals/part1.cfm) states the following:

> The definition of "MEP" should adapt continually to both current conditions and BMP effectiveness, but ultimately, successive iterations of the mix of BMPs and measurable goals should be made to achieve the objective of meeting water quality standards. If, after implementing the minimum control measures, there is still water quality impairment associated with discharges from the MS4, you will need to expand or better tailor your BMPs (USEPA 2001).

Stormwater permitting authorities must review MS4 SWMPs to determine if implementation of the plan is likely to reduce the discharge of pollutants to the MEP. Where the permitting authority identifies deficiencies, the MS4 must modify its SWMP.

1.2.2.3. Basic Stormwater Management Program and Pollution Prevention Plan Requirements

The primary requirement of NPDES stormwater permits is the development and implementation of a plan that describes how the permittee will control the discharge of pollutants in stormwater to meet permit requirements. Operators of regulated MS4s develop and implement SWMPs that cover a variety of activities discharging to the MS4, while operators of industrial facilities and construction activities must develop and implement facility-specific stormwater pollution prevention plans (SWPPPs). A brief overview of the type of management activities required in MS4 (Phase I and Phase II), industrial, and construction permits is provided below.

- **Phase I MS4 Permits.** Phase I MS4s, all of which were identified by incorporated place or county names in the 1990 Phase I Rule, were required to apply for permit coverage in the early 1990s with the application including the MS4s proposed SWMP to address programmatic, structural, and source control measures for stormwater discharges from commercial and residential areas, including discharges from areas of new development or redevelopment; illicit discharges; priority industrial facilities; and construction sites. Individual permits issued to Phase I MS4s specified the required SWMP activities and included other provisions to ensure effective implementation, such as monitoring and annual reporting.
- **Phase II MS4 Permits.** Regulated, small MS4s are required to obtain individual or general permit coverage and implement an SWMP that addresses the six minimum control measures: (1) public education and outreach; (2) public participation and involvement; (3) illicit discharge detection and elimination (IDDE); (4) construction site stormwater runoff control; (5) post-construction stormwater management in new and redevelopment; (6) pollution prevention/good housekeeping for municipal operations. In addition, Phase II MS4s must also develop and specify measurable goals for each of the six minimum control measures in the SWMP. The Phase II Final Rule does not require monitoring data as part of the application or as a requirement of the permit, although permitting authorities may decide otherwise. Regulated small MS4s are required to submit periodic reports to the permitting authority ranging from annually to twice every 5-year permit cycle.
- **Construction Stormwater Permits.** NPDES permits for stormwater discharges associated with construction activities require control measures (i.e., BMPs) to address pollutants in stormwater discharges. These requirements, almost always addressed through the issuance of statewide general permits, include erosion and sediment control BMPs to prevent the discharge of sediment and measures to prevent the discharge of non-sediment materials such as construction debris, vehicle fluids, concrete washout, and trash. In addition, some permitting authorities require post-construction stormwater management measures to minimize pollutant discharges after construction is complete. SWPPPs prepared by site operators describe activities to be performed and how the operator intends to comply with permit requirements (e.g., a description of controls to minimize

> ***Tip: Read SWMPs and SWPPPs—not just stormwater permits—to get implementation details.***
>
> TMDL writers often go to NPDES stormwater permits looking for information on stormwater discharges that will assist in the TMDL development process. Reviewing stormwater permits will provide an understanding of what permittees must include in the required SWMPs and SWPPPs, but the permits rarely provide complete details on this information. TMDL writers might need to obtain and review SWMPs and SWPPPs to gather information to support TMDL activitites, such as pollutant source characterization and pollutant load allocation. Chapter 3 of this Handbook provides an in-depth discussion of what information is available through SWMPs and SWPPPs and how TMDL writers can use this information to characterize stormwater sources.

exposure of the materials to stormwater and spill prevention and response practices). NPDES construction permits also typically require the site operator to document in an SWPPP any interim and permanent stabilization practices for the site, including a schedule of when the practices will be implemented.

- **Industrial Stormwater Permits.** Industrial stormwater permits typically focus on the implementation of BMPs to reduce stormwater pollutants. NPDES stormwater permits for industrial facilities typically require SWPPPs to document the facility's pollution prevention team, describe the site, identify the receiving waters, and describe the BMPs that will be implemented to meet permit requirements. An SWPPP should also contain a summary of potential pollutant sources, including spills and leaks, and a summary of existing stormwater discharge sampling data. The focus of the SWPPP is the description of the existing and planned BMPs to reduce stormwater pollutants. BMPs may be procedural such as good housekeeping activities, spill prevention and response planning, preventative maintenance, routine facility inspections, and employee training or structural systems, such as containment systems or sediment basins.

1.3. Key Challenges Associated with Connecting the TMDL and NPDES Stormwater Programs

> ***Resources:*** For more information on research and policy related to TMDLs and stormwater, refer to the Resources list at the end of this chapter in Section 1.4.2.

Improving the ways in which water quality programs work together and relate to one another often presents challenges because of programmatic, regulatory, and technical differences. Improving connections between the TMDL and NPDES Stormwater programs highlights challenges such as conflicting program priorities, and unsynchronized development schedules, lack of sufficient data, inadequate cross-program communication, and lack of adequate staff and resources. EPA and state TMDL and permit writers working to improve connections between the TMDL and NPDES Stormwater programs have identified some key challenges facing each program. EPA's *Total Maximum Daily Loads and National Pollutant Discharge Elimination System Storm Water Permits for Impaired Water Bodies: A Summary of State Practices* (USEPA 2007) provides a detailed discussion of these key challenges and possible solutions. These key challenges are briefly summarized below and discussed in greater detail in subsequent chapters.

1.3.1. Challenge 1: Addressing Differences in Organizational Structure

Strengthening the connections between TMDLs and stormwater permits begins with communication and coordination among internal programmatic staff. Often this is challenging for a variety of reasons. In most instances, TMDL and NPDES permitting staff function not only in different programs, but in different organizational groups. In some states, the separation between programs is more drastic, with TMDL and NPDES staff functioning under different agencies. These organizational differences can create real and perceived obstacles for effective staff coordination. In addition, agency staff can face programmatic pressures (e.g., court ordered deadlines, permit reissuance schedules) that limit timely coordination.

1.3.2. Challenge 2: Developing Consistent Stormwater Allocations in TMDLs

Approaches for developing and expressing TMDLs that include stormwater sources can vary within and among states. For example, some TMDLs assign aggregated stormwater WLAs to all permitted stormwater sources within a watershed or to each type of permitted stormwater source. Collecting additional dataor information on the permitted stormwater sources within a watershed might allow TMDL writers to generate more detailed WLAs that could facilitate the development of permit requirements.

1.3.3. Challenge 3: Translating Numeric TMDL WLAs into Implementation Strategies and Permit Requirements

One way for TMDL and permit writers to facililitate the implementation of TMDLs is to provide permittees with information on specific types of management strategies that could be used to implement the WLAs. In most cases, this means facilitating efforts so that the WLA, the TMDL implementation plan (if applicable), and the stormwater permit requirements are developed to coordinate with each other in a meaningful way, particularly when stormwater sources are covered exclusively by general permits.

1.3.4. Challenge 4: Reconciling Spatial Boundaries of TMDLs with Boundaries of NPDES Stormwater Permits

The TMDL program often provides information on impaired waters by waterbody or watershed. The majority of actions under the NPDES Stormwater program focus on site-specific activities (e.g., construction sites and industrial facilities) and large stormwater conveyances systems (e.g., MS4s). The different spatial scales at which regulatory agencies provide information to, and require information from, permittees can create challenges as permittees attempt to identify applicable requirements and determine the appropriate locations to implement the requirements.

1.3.5. Challenge 5: Incorporating Monitoring, Tracking, and Adaptive Management Elements into TMDL WLAs and Stormwater Permits

Monitoring and evaluation are key components to determining if stormwater management efforts are producing the necessary pollutant load reductions identified in the TMDLs, thereby making progress toward attainment of water quality standards. Because it is not required, most TMDLs do not address monitoring or, if the need is mentioned, the type and frequency of monitoring necessary to demonstrate progress towards attaining and maintaining water quality standards. Stormwater permits require all stormwater permittees to evaluate the efficacy of their SWMP or SWPPP. However, the evaluation process does not usually involve end-of-pipe or in-stream analytical monitoring to directly evaluate stormwater discharge or ambient water quality. To more effectively connect TMDLs and stormwater permits, the TMDL could include recommendations regarding monitoring, tracking, and adaptive management activities, and the relevant stormwater permits could either reference the recommended activities or adopt these recommendations. Permit writers can consider permittees to identify milestones on the basis of criteria (water quality- or technology-based) that use the monitoring and tracking information to drive adaptive management efforts..

1.4. Resources

1.4.1. TMDL Program

1. EPA's TMDL Web site: www.epa.gov/owow/tmdl/

2. USEPA (U.S. Environmental Protection Agency). 2005. *Guidance for 2006 Assessment, Listing, and Reporting Requirements Pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act [2006 Integrated Report Guidance (IRG)]*. U.S. Environmental Protection Agency, Office of Water, Office of Wetland, Oceans and Watersheds, Washington, DC. www.epa.gov/owow/tmdl/2006IRG/#documents

   This document provides a recommended reporting format and suggested content to be used in developing a single document that integrates the reporting requirements of the CWA sections 303(d), 305(b), and Part 314. The report also provides a comprehensive compilation of EPA's previous guidance related to integrated reporting.

3. USEPA (U.S. Environmental Protection Agency). 2006. *Information Concerning 2008 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Listing and Reporting Decisions*. Memorandum from Diane Regas, Director, Office of Wetlands, Oceans and Watersheds to Regions 1-10 Water Division Directors. www.epa.gov/owow/tmdl/2008_ir_memorandum.html

   This EPA memorandum dated October 12, 2006, provides information to assist in the preparation and review of 2008 integrated water quality reports to supplement the information provided in the 2006 Integrated Report Guidance.

4. USEPA (U.S. Environmental Protection Agency). 1991. *Guidance for Water-Quality-based Decisions: The TMDL Process*. EPA 440/4-91-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC. www.epa.gov/OWOW/tmdl/decisions/

   This guidance document explains the programmatic elements and requirements of the TMDL process as established by CWA section 303(d) and by EPA's Water Quality Planning and Management Regulations (40 CFR Part 130). It discusses the process for developing a TMDL, roles of EPA and the states in the process, and supporting or related water programs.

5. Best-Wong, B. 2006. *Clarification Regarding "Phased" Total Maximum Daily Loads*. Memorandum from Benita Best-Wong, Director, Assessment and Watershed Protection Division, to Water Division Directors, Regions 1–10, August 2, 2006. www.epa.gov/owow/tmdl/tmdl_clarification_letter.html

   This memorandum clarifies the *Guidance for Water Quality-Based Decisions: The TMDL Process*, issued in 1991, by explaining EPA's interpretation of the term *phased TMDL* as used in EPA guidance and explaining the distinction between *phased TMDLs*, *staged implementation*, and *adaptive implementation*.

6. EPA's *Guidelines for Reviewing TMDLs Under Existing Regulations Issued in 1992*: www.epa.gov/owow/tmdl/guidance/final52002.html

This Web document provides guidance on the required elements of a TMDL report for use in reviewing and approving TMDLs.

1.4.2. TMDLs and Stormwater

1. EPA's TMDL and Stormwater Resources Web site: www.epa.gov/owow/tmdl/stormwater

2. USEPA (U.S. Environmental Protection Agency). 2007. *Total Maximum Daily Loads with Stormwater Sources: A Summary of 17 TMDLs*. EPA 841-R-07-002. U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, Washington, DC. www.epa.gov/owow/tmdl/17_TMDLs_Stormwater_Sources.pdf

   This document summarizes 17 TMDLs that have been developed for stormwater-source pollutants in 16 states, representing a range of pollutants, models used, and different allocation and implementation methods.

3. USEPA (U.S. Environmental Protection Agency). 2007. *Total Maximum Daily Loads and National Pollutant Discharge Elimination System Storm Water Permits for Impaired Water Bodies: A Summary of State Practices*. U.S. Environmental Protection Agency, Region 5, Chicago, IL. www.epa.gov/region5/water/wshednps/pdf/state_practices_report_final_09_07.pdf

   This report summarizes information on TMDL-stormwater practices in 10 states, provides specific TMDL and permit language, and identifies some specific technical and programmatic challenges.

4. Wayland, R.H., and J.A. Hanlon. 2002. *Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs*. Memorandum from Robert H. Wayland, III, Director, Office of Wetlands, Oceans and Watersheds, and James A. Hanlon, Director, Office of Wastewater Management, U.S. Environmental Protection Agency, Washington, DC. www.epa.gov/npdes/pubs/final-wwtmdl.pdf

   This memo clarifies existing EPA regulatory requirements for, and provides guidance on, establishing WLAs for stormwater discharges in TMDLs approved or established by EPA.

5. NRC (National Research Council). 2008. *Urban Stormwater Management in the United States*. Committee on Reducing Stormwater Discharge Contributions to Water Pollution, Water Science and Technology Board, Division on Earth and Life Studies, National Research Council of the National Academies. National Academies Press, Washington, D.C.

   The report provides a description of the history of stormwater management in the United States; an overview of stormwater regulations and the federal regulatory program; and information on a number of relevant scientific and technological issues such as hydrology, geomorphology, biology, monitoring and modeling. The report also provides a number of significant findings and recommendations on how stormwater management in the United States should be improved to achieve better environmental outcomes

1.4.3. NPDES Stormwater Program

1. EPA's NPDES Stormwater program Web site: http://cfpub.epa.gov/npdes/home.cfm?program_id=6

2. EPA's NPDES Stormwater Program Authorization Status: http://cfpub.epa.gov/npdes/stormwater/authorizationstatus.cfm

3. NRC (National Research Council). 2008. *Urban Stormwater Management in the United States.* Committee on Reducing Stormwater Discharge Contributions to Water Pollution, Water Science and Technology Board, Division on Earth and Life Studies, National Research Council of the National Academies. National Academies Press, Washington, D.C.

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1.4.3.1. MS4s

1. EPA's NPDES Stormwater Discharges from Municipal Separate Storm Sewer Systems Web site: http://cfpub.epa.gov/npdes/stormwater/munic.cfm

2. USEPA (U.S. Environmental Protection Agency). 2007. *Municipal Separate Storm Sewer System (MS4) Program Evaluation Guidance*. EPA-833-R-07-003. U.S. Environmental Protection Ageny, Office of Wastewater Management, Water Permits Division, Washington, DC. www.epa.gov/npdes/pubs/ms4guide_withappendixa.pdf and www.epa.gov/npdes/pubs/ms4guide_appendicesb-d.pdf

   This guide is primarily for use by NPDES authorities to evaluate the quality of Phase I and Phase II MS4 programs for permit compliance, technical assistance, and other purposes. It can be used for comprehensive program evaluations or for certain components. MS4 program managers can also use it to evaluate their own programs.

3. USEPA (U.S. Environmental Protection Agency). 2005. *Stormwater Phase II Final Rule Fact Sheet: Small MS4 Stormwater Program Overview*. EPA 833-F-00-002. U.S. Environmental Protection Agency, Office of Water. www.epa.gov/npdes/pubs/fact2-0.pdf

   This three-page fact sheet provides the definition of regulated small MS4s and associated permit requirements for regulated small MS4s.

1.4.3.2. Industrial Activities

1. EPA's NPDES Stormwater Discharges from Industrial Facilities Web site: http://cfpub.epa.gov/npdes/stormwater/indust.cfm

2. List of sectors of industrial activity that require permit coverage: http://cfpub.epa.gov/npdes/stormwater/swcats.cfm

3. USEPA (U.S. Environmental Protection Agency). 1992. *Stormwater Management for Industrial Activities: Summary Guidance on Developing Pollution Prevention Plans and Best Management*

Practices. EPA 833-R-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC. www.epa.gov/npdes/pubs/owm0236a.pdf

This document provides guidance on the SWPPP requirements and includes a set of worksheets, a checklist, and a sample SWPPP.

1.4.3.3. Construction Activities

1. EPA's NPDES Stormwater Discharges from Construction Activities Web site: http://cfpub.epa.gov/npdes/stormwater/const.cfm

2. USEPA (U.S. Environmental Protection Agency). 2007. *Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites*. EPA 833-R-060-04. U.S. Environmental Protection Agency, Washington, DC. http://cfpub.epa.gov/npdes/stormwater/swppp.cfm

   This guidance document is a reference for construction site operators who must comply with an NPDES stormwater permit. Through its description of the SWPPP development process, this guidance addresses the type of information required in an SWPPP and could help TMDL writers determine if SWPPPs will provide information and data useful to the TMDL development process.

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1. Understanding the Connections Between TMDLs and Stormwater Permits
2. **Identifying Opportunities to Coordinate TMDLs and Stormwater Permits**
3. Characterizing Impairments and Stormwater Sources
4. Developing TMDLs with Stormwater Sources
5. Promoting Effective Stormwater Management
6. Coordinating TMDLs and Stormwater Permits

Chapter Two
Identifying Opportunities to Coordinate TMDLs and Stormwater Permits

What's included in this chapter

- ✓ Overview of activities used by various state agencies to promote better coordination and communication among TMDL and permit writers.
- ✓ Discussion of opportunities to promote better coordination between TMDLs and stormwater permits at different stages of the development process.

What you should know after reading this chapter

- ✓ Internal reorganization efforts can help to promote better coordination between TMDL and stormwater permitting programs.
- ✓ Options exist for coordinating TMDLs and stormwater permits, even if development schedules are not synchronized.
- ✓ Communication between program staff, as well as affected stakeholders, is key to improving connections between TMDLs and stormwater permits.

Potential roles and responsibilities under this activity

If you are a TMDL writer

1. Find out the names of stormwater permit staff and talk to them about the state's stormwater permitting program.
2. Identify TMDLs on the 303(d) list that might have a stormwater component and share the list of watersheds and municipalities with stormwater permitting staff, along with the associated TMDL development schedule.

If you are a stormwater permit writer

1. Find out the names of TMDL program staff and talk to them about the state's TMDL program.
2. Submit list of permits to be issued or reissued categorized by watershed to TMDL staff to determine status on the 303(d) list and TMDL development schedule.

2. IDENTIFYING OPPORTUNITIES TO COORDINATE TMDLS AND STORMWATER PERMITS

Improving the connection between TMDLs and stormwater permits can start with TMDL and permit writers taking steps to improve communication through efforts such as (1) coordinating programmatic schedules and activities and (2) developing institutional and organizational communication mechanisms. Improved communication at the programmatic level can lead to improved coordination of technical activities, such as assessment and monitoring. Improving internal coordination and communication among TMDL and permit writers can foster good communication and information sharing with key stakeholders, including stormwater sources. As shown in Figure 3, stakeholder and public involvement is an important element of the overall TMDL process. Engaging and involving stakeholders is required under both the TMDL and NPDES Stormwater programs and provides stakeholders with the opportunity to share stormwater related data and information to strengthen and focus the overall TMDL analysis and related implementation efforts. This chapter addresses opportunities to improve coordination and communication both internally and with key stakeholders that affect stormwater management decisions and activities.

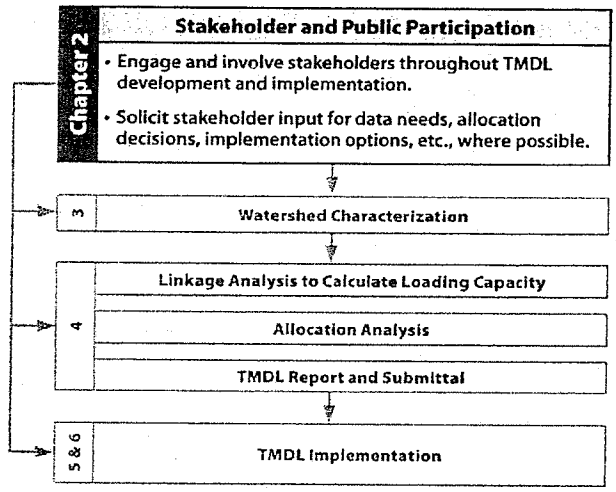


Figure 3. Illustration of the steps in the TMDL process, including the step of stakeholder involvement and public participation.

2.1. Improving Internal Communication and Coordination

Schedules and priorities for the TMDL program are driven by factors such as court-ordered deadlines, waterbody rankings under the section 303(d) list, rotating watershed basin planning approaches, as well as available staff and resources. Factors such as regulatory requirements, permit expiration dates, rotating watershed basin planning and assessment approaches, as well as available staff and resources, affect NPDES stormwater permit development schedules. Regardless of how internal program schedules and priorities are set, it could prove beneficial for TMDL and permit writers to participate in some type of internal planning to determine short-term and long-term schedules for TMDLs and stormwater permit development. Examining internal program schedules is a good starting point for identifying opportunities for coordination and collaboration between the programs.

> ***Resources:*** For more information on approaches states and EPA Regions use to improve coordination between the TMDL and Stormwater programs, refer to the Resources list at the end of this chapter in Section 2.3.

TMDL and permit writers should collectively examine each program's schedule to determine the timing for (1) waterbodies and watersheds with *ongoing* TMDL development activities for impairments with known or suspected stormwater sources; (2) waterbodies and watersheds with *planned* TMDL

development activities for impairments with known or suspected stormwater sources; and (3) general and individual stormwater permits nearing expiration, expired, or administratively continued discharging to impaired waterbodies or within impaired watersheds that have ongoing or planned TMDL development activities. Ultimately, the goal is to identify stormwater source TMDLs and stormwater permits that fall into the following categories: impending, in progress, and developed.

As illustrated in Table 2, there are a variety of ways that TMDL and permit writers can promote better connections between TMDLs and stormwater permits regardless of the development status. Significant opportunities for coordination include activities such as data collection and sharing, stakeholder involvement, permit and TMDL language development, and process administration. It is important to note that coordination opportunities might vary depending on the type of permit used to implement the TMDL. Table 2 highlights where differences in opportunities exist according to permit type.

Planning and scheduling is only one factor affecting internal TMDL and NPDES Stormwater program coordination and collaboration. Organizational structures that affect how easily staff from the two programs can work together also influence TMDL and permit writer coordination and collaboration. Several EPA Regions and state agencies have reorganized to bring the TMDL and NPDES Stormwater programs under a common management unit (e.g., branch, division, group). Some have gone beyond bringing the programs together and have taken steps to ensure further integration either by developing TMDL-stormwater teams or specific positions tasked with promoting stormwater-source TMDL implementation.

Table 2. Potential opportunities for coordination based on status of TMDL and stormwater permit development

Status of TMDL	Status of stormwater permit	Potential opportunities for coordination	
		Individual permit	General permit
Impending	Impending (New or Anticipated Reissuance)	▪ Identify available data, data gaps, and develop integrated approach for collecting additional data ▪ Attempt to synchronize schedules for coordinated development ▪ Develop coordinated TMDL and permit stakeholder involvement process ▪ Conduct collaborative kick-off meeting among TMDL and permit writers and permittee(s) that integrates discussion of TMDL development issues and implementation considerations ▪ Determine how the permit can address future TMDLs	▪ Conduct internal collaborative kick-off meeting among TMDL and permit writers ▪ Determine if TMDL will recommend specific stormwater BMPs recommended to implement the WLA ▪ Coordinate development of TMDL and permit language to ensure consistency ▪ Determine how the permit can address future TMDLs
	In Progress	▪ Consider adjusting permit development schedule to track with TMDL development ▪ Share data and information collected through permit application process with TMDL writers to inform TMDL development ▪ Discuss potential TMDL data needs and incorporate permit requirements that focus on monitoring and other types of data collection that will inform TMDL development	▪ Tailor permit language to acknowledge the need for permittees to review and modify SWMP/SWPPP to achieve consistency with WLAs upon approval of the TMDL

Status of TMDL	Status of stormwater permit	Potential opportunities for coordination	
		Individual permit	General permit
	Developed	▪ Discuss options for modifying the permit to be consistent with TMDL WLA assumptions. ▪ Share data and information collected through permit application process with TMDL writers to inform TMDL development	▪ Determine if the permit will be consistent with TMDLs approved at the time of permit issuance or at the time of NOI submission ▪ Evaluate existing permit language regarding consistency with approved WLAs to determine if it is adequate or requires revision during permit reissuance process ▪ Consider developing a technical appendix/amendment to update existing stormwater permit, without triggering permit modification requirements, to compile and present TMDL requirements upon completion
In-Progress	Impending (New or Anticipated Reissuance)	▪ Discuss TMDL development process and options for WLA categorization to enable sources to implement them through planned permit requirements ▪ Develop specific requirements that directly relate to implementation of the proposed WLAs, such as monitoring and SWMP/SWPPP assessment and modification	▪ Consider including any implementation planning information from the TMDL into the permit either directly or by reference ▪ Identify data gaps discovered through the TMDL development process and determine what type of permit requirements are appropriate to include to facilitate filling data gaps for potential future revision of the TMDL or to support adaptive management activities
	In Progress	▪ Compare information collected to date under each program to ensure that each process is working with the same data and information and to determine if one program can fill any data gaps identified by the other program ▪ Attempt to streamline interaction with stakeholders by conducting joint meetings or consolidating data requests ▪ Identify activities under each process to determine if there is any overlap and any opportunity for integrating remaining activities ▪ Ensure that any language used in both the TMDL and the permit are consistent; provide updates on changes to language as necessary	▪ Identify activities under each process to determine if there is any overlap and any opportunity for integrating remaining activities ▪ Ensure that any language used in both the TMDL and the permit are consistent; provide updates on changes to language as necessary
	Developed	▪ Review existing permit requirements and required permit documents (e.g., SWMPs and SWPPPs) to determine if existing permittee-generated data and information can facilitate remaining TMDL development activities ▪ Discuss options for modifying the permit to be consistent with TMDL WLA assumptions and requirements	▪ Determine if the permit will be consistent with TMDLs approved at the time of permit issuance or at the time of NOI submission ▪ Evaluate existing permit language regarding compliance with proposed WLAs to determine if it is adequate or requires revision during permit reissuance process ▪ Consider developing a technical appendix/amendment to update existing stormwater permit, without triggering permit modification requirements, to compile and present TMDL requirements upon completion

Status of TMDL	Status of stormwater permit	Potential opportunities for coordination	
		Individual permit	General permit
Developed	Impending (New or Anticipated Reissuance)	▪ Review the approved WLA to determine how best to reflect the input factors and pollutant loads established in the WLA for implementation into new or reissued permit requirements ▪ Identify any TMDL implementation planning activities or information that the permit could incorporate or reference to help permitted stormwater sources implement the approved WLA	▪ Determine most feasible and appropriate requirements to include in the permit to demonstrate SWMP or SWPPP progress toward implementing the WLA ▪ Consider developing a technical appendix/amendment to compile and present TMDL information
	In Progress	▪ Review draft permit conditions to ensure consistency with the approved WLA and any TMDL implementation plan recommendations ▪ Develop and incorporate tailored monitoring requirements to assess progress toward implementing the WLA	▪ Review draft permit conditions to ensure requirements related to impaired waterbodies with approved TMDLs reflect WLAs and , if applicable TMDL implementation plan recommendations ▪ Ensure that draft permit conditions include meaningful monitoring and assessment requirements that will support adaptive management activities
	Developed	▪ Assess if current permit conditions are consistent with approved WLA ▪ Determine if mechanisms exist to assess progress toward implementing WLAs ▪ Plan potential changes to future versions of the permit	▪ Assess if current permit conditions are consistent with approved WLA ▪ Determine if mechanisms exist to assess progress toward implementing WLAs ▪ Plan potential changes to future versions of permit conditions

In Practice: Efforts to Promote Improved Coordination Between TMDL and Permit Activities

States and EPA are making strides to promote improved coordination between TMDL and permit writers. A few examples of internal efforts are provided below.

Consolidating stormwater-source TMDL development with one group. The Vermont Department of Environmental Conservation has a Stormwater Management Section that focuses on administering the state's stormwater program—both the federal NPDES Stormwater program and the state-authorized SWMP. Although staff in this section address stormwater permitting issues, they also tackle TMDL development if the impairment involves stormwater. TMDL staff hand off stormwater-related TMDL development and implementation to staff in the Stormwater Management Section that have expertise both in permitting issuance and stormwater BMP implementation.

Assigning staff to coordinate and promote implementation. In Minnesota and Tennessee, the state agencies have recently created new positions intended to promote successful stormwater management implementation and connection to the TMDL program, as well as other related requirements. Oregon assigns one person to coordinate TMDL development and permitting within one watershed, although that one person might not necessarily be responsible for actually developing the TMDLs or crafting permit language.

Bringing staff physically and organizationally together. Promoting more effective communication and data sharing often requires reorganizing staff to share physical space or space on an organizational chart. EPA Region 2 reorganized TMDL and permit staff to bring them together under one branch. EPA Region 10 physically moved TMDL and permit staff to share a common area. EPA Region 4 is reorganizing to include TMDL development, permits, and nonpoint sources together in one branch

Facilitating regular communication. EPA headquarters works with EPA Regional Offices to host monthly TMDL and Stormwater Workgroup conference calls. These internal calls provide EPA TMDL and permit staff from every region with the opportunity to exchange information and ideas related to TMDL development and implementation through stormwater permits. The group participates in developing technical resources and

shares information on TMDL and stormwater projects. EPA Region 4 conducts bimonthly conference calls with state TMDL and stormwater permit staff to exchange information and ideas on issues affecting coordination between the two programs.

2.2. Improving Stakeholder Communication and Coordination

Another reason to promote coordination between TMDL and permit writers is to enable key stakeholders, including stormwater sources, to participate in the TMDL development process. Permit writers can help to encourage stormwater sources to participate in the TMDL development process and facilitate information sharing. Although TMDL writers are likely to work with permit writers to obtain permit-related information from stormwater sources, there might be instances when TMDL writers have to go directly to stormwater sources to obtain information and data. Stormwater sources might have an additional level of comfort and willingness to share information knowing their permit writer is involved in the process.

> ***Resources:*** For more ideas and strategies to involve stakeholders, refer to the Resources list at the end of this chapter in Section 2.3.2.

Stakeholder involvement is an essential component of both the TMDL development and NPDES permitting process. Both the TMDL and the NPDES programs contain regulatory requirements for public participation that involve activities such as public review, public notice, public hearings, and public comment periods Ideally, TMDL and permit writers should identify and involve stakeholders early in both the TMDL development and NPDES permitting processes. The primary stakeholders in the TMDL and NPDES processes are parties directly affected by the TMDL allocations or the permit requirements. In the case of stormwater source TMDLs, the primary stakeholders are permitted stormwater sources that will receive a WLA under the TMDL and must implement the WLA through stormwater permits. In addition to permitted stormwater sources, other stakeholders include those affected by the TMDL and permitting decisions or have information to contribute to the process, such as local environmental organizations, homeowner associations, universities, local developers, and city planners.

Providing data and information is one of the most significant contributions that stakeholders can make to the stormwater source TMDL development process. TMDL and permit writers can consider opportunities and approaches to facilitate information exchanges and technical participation in the TMDL development process. These opportunities could include face-to-face information exchange meetings, facility visits, focus group meetings for feedback on technical issues pertaining to stormwater source WLA development and associated permit requirements, or regular group conference calls to discuss ideas and progress. As mentioned in the previous section, permit writers might have access to much of the data and information generated by stakeholders through compliance with existing stormwater permit requirements. (Chapter 3 of this Handbook provides a discussion of the types of information sources generate through stormwater permit requirements and how TMDL writers can use this information in the stormwater source TMDL development process.)

In Practice: Using Stakeholder Data and Information to Identify High-Priority Stormwater Sources

The 2007 Charles River watershed (Massachusetts) pathogen TMDL relies on data from the Charles River Hot Spot monitoring effort to identify and prioritize bacterial sources of pollution. This monitoring effort, crucial to the TMDL development process, is the result of a single watershed stakeholder dedicated to voluntarily kayaking the Lower Charles River shoreline to conduct sampling after rain events. From 2002 through 2005, this dedicated watershed stakeholder followed sampling procedures detailed in the approved Charles River Watershed Association Quality Assurance Project Plan (QAPP) for fecal coliform. He was able to collect samples from several hundred storm drain outfalls during this period. Data from this stakeholder-based monitoring effort allowed the Massachusetts Department of Environmental Protection to identify and prioritize 31 stormwater outfalls along the Lower Charles River as high-priority bacterial sources in the TMDL analysis. Ultimately, the data collected by this dedicated watershed stakeholder will help the Massachusetts Department of Environmental Protection and other key stakeholders target future bacterial source tracking efforts and implementation activities.

In Practice: Locally Led TMDL Implementation

The DuPage River Salt Creek Workgroup (DRSCW) is a collaborative stakeholder effort by sanitary districts, municipalities, counties, forest preserve districts, state and federal agencies, and private environmental organizations to address the water quality impairments identified in chloride and dissolved oxygen TMDLs for branches of the DuPage River and Salt Creek (Illinois). Although Illinois EPA held public meetings during the development of the TMDL reports, a watershed-based stakeholder group did not exist in the area when the TMDL reports were written. Stakeholders affected by the TMDL allocations wanted an opportunity to *substantiate* implementation strategies and determine whether there were other cost-effective options for achieving water quality standards (DRSCW 2004). Representatives from municipalities affected by the TMDL reports discussed forming the workgroup to collect data and carry out other technical activities to move forward with implementing the TMDLs. It was also envisioned that the DRSCW could help stakeholders establish a solid foundation for future TMDLs, contribute to developing nutrient criteria, and address other water quality or regulatory issues in the watersheds. A core group of municipalities generated support for the workgroup concept by emphasizing the importance of locally led decisions on where and how to spend local money to address water quality issues.

2.3. Resources

2.3.1. TMDL and Stormwater Permitting

1. EPA's TMDL and Stormwater Web site: www.epa.gov/owow/tmdl/stormwater/

2. USEPA (U.S. Environmental Protection Agency). 2007. *Total Maximum Daily Loads and National Pollutant Discharge Elimination System Storm Water Permits for Impaired Water Bodies: A Summary of State Practices*. U.S. Environmental Protection Agency, Region 5, Chicago, IL. www.epa.gov/region5/water/wshednps/pdf/state_practices_report_final_09_07.pdf

   This EPA report summarizes information on TMDL-stormwater practices in 10 states, provides specific TMDL and permit language, and identifies some specific technical and programmatic challenges.

2.3.2. Identifying and Involving Stakeholders

1. USEPA (U.S. Environmental Protection Agency). 2008. *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*. EPA 841-B-08-002. U.S. Environmental Protection Agency, Office of Water, Nonpoint Source Control Branch, Washington, DC. www.epa.gov/nps/watershed_handbook/

   Chapter Three: Building Partnerships (www.epa.gov/nps/watershed_handbook/pdf/ch03.pdf): This chapter provides guidance on initial activities to organize and involve interested parties in watershed-based water quality protection activities. Topics include identifying stakeholders, integrating other key programs, and conducting outreach.

2. Conservation Technology and Information Center Web site, *Know Your Watershed: Building Local Partnerships*: www2.ctic.purdue.edu/KYW/Brochures/BuildingLocal.html

1. Understanding the Connections Between TMDLs and Stormwater Permits
2. Identifying Opportunities to Coordinate TMDLs and Stormwater Permits
3. **Characterizing Impairments and Stormwater Sources**
4. Developing TMDLs with Stormwater Sources
5. Promoting Effective Stormwater Management
6. Coordinating TMDLs and Stormwater Permits

Chapter Three
Characterizing Impairments and Stormwater Sources

What's included in this chapter

- ✓ General description of the types of impairments resulting from stormwater.
- ✓ Description of the commonly used types of data analyses to understand the impairment being addressed in a TMDL.
- ✓ Discussion of setting TMDL targets for TMDLs with stormwater sources.
- ✓ Discussion of identifying potential sources to include in the TMDL analysis.
- ✓ Description of the types of data generated by stormwater dischargers that TMDL writers can use to better understand the relative contribution of stormwater sources to a waterbody impairment.

What you should know after reading this chapter

- ✓ What data and information can help to characterize the impairment to support identification of TMDL targets and potential sources.
- ✓ What information is available to accurately and comprehensively include stormwater sources in the watershed characterization for TMDL development.
- ✓ How TMDL writers can work with permit writers to determine the availability and the value of the stormwater discharger information before investing time and energy into data collection.

Potential roles and responsibilities under this activity

If you are a TMDL writer

1. Analyze waterbody and watershed data to characterize the impairment related to the stormwater impacts.
2. Identify whether stormwater sources are contributing to the impairment addressed in your TMDL.
3. Coordinate with stormwater permit staff to obtain existing data and information from stormwater permittees.
4. Use available data to characterize stormwater sources and their potential contribution to water quality impairments.

If you are a stormwater permit writer

1. Share existing stormwater discharger generated data available in-house with TMDL writers.
2. Serve as a liaison between TMDL writers and stormwater permittees to streamline the data sharing process.

3. CHARACTERIZING IMPAIRMENTS AND STORMWATER SOURCES

The general process for developing a TMDL including stormwater sources is much the same as that for developing any TMDL, including the following typical steps:

- Watershed characterization to identify the watershed, waterbody, and impairment conditions; TMDL targets; and potential sources
- Linkage analysis to calculate the loading capacity
- Allocation analysis to evaluate and assign WLAs to point sources and LAs to nonpoint sources
- Development of the TMDL report and administrative record for submittal to EPA

While these steps are common to all TMDL development projects, there are a number of considerations for each step when developing TMDLs that address stormwater sources. As shown in Figure 4, this chapter discusses the step of watershed characterization, and the remaining steps to calculate the loading capacity, establish allocations and document the TMDL report are discussed in Chapter 4.

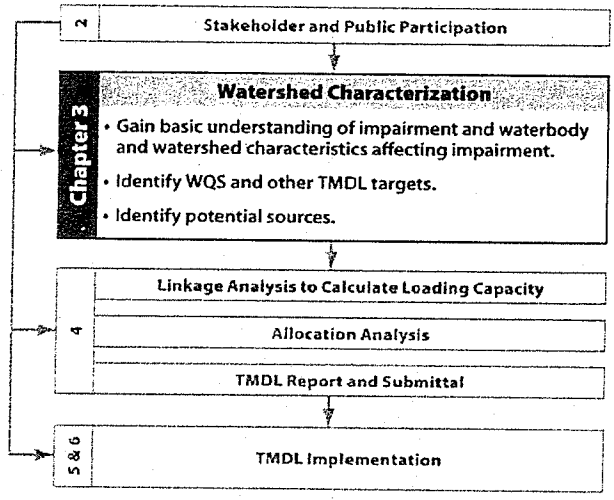


Figure 4. Illustration of the steps in the TMDL process, including the step of watershed characterization discussed in this chapter.

The TMDL process requires a thorough understanding of the waterbody and watershed characteristics, available data, causes of impairment, sources, water quality standards, and potential targets. Some of this information will be available through a state's 303(d) list and waterbody assessment documentation, but much of the information will be gathered and summarized while completing the TMDL. Collectively, this is referred to here as the *watershed characterization* step of the TMDL. Watershed characterization serves as the foundation of the TMDL analysis, providing a basic understanding of the impairments of concern, the desired levels for restoration (e.g., water quality standards and TMDL targets) and the likely sources contributing to the impairment. Characterizing the waterbody and the associated impairments as well as the sources and other watershed characteristics provides the necessary background information to support decisions regarding the approach used for calculating the TMDL, the level of detail or focus of the analysis, and ultimately TMDL implementation. The following sections describe the major elements of the watershed characterization:

- Understanding the impairment
- Identifying TMDL targets
- Identifying and assessing potential sources

At the end of the watershed characterization step for a TMDL addressing stormwater sources, the TMDL writer should understand how stormwater is affecting the impaired waterbody, what stormwater sources exist in the watershed, and what data and information are available to characterize the sources.

3.1. Understanding the Impairment

Understanding the impairment(s) being addressed by a TMDL is critical to establishing appropriate TMDL targets, identifying potential sources and eventually selecting a technical approach for calculating the loading capacity. The main objective of this step is to identify the nature of the impairment(s) being addressed by the TMDL, including location, timing, and magnitude of impairment. A state or tribe's 303(d) list identifies the basic information regarding the impaired waterbody and the observed impairment, usually including the waterbody characteristics (e.g., name, location, size), the water quality standard that was violated, the pollutant of concern (if known), and the suspected causes and sources contributing to the impairment. It is usually necessary to analyze available monitoring data to further characterize and understand the impairments. This section first introduces the commonly observed impairments associated with stormwater and discusses how stormwater can affect waterbody conditions. The section then describes the types of data analyses that are typically used to support characterization of impairments for TMDL development, highlighting the issues unique to developing stormwater TMDLs.

It is important to note that flow is a key component in characterizing, developing and implementing TMDLs for stormwater sources and is discussed throughout this Handbook. Quantity of flow and variation in flow regimes are important factors in transporting stormwater pollutants such as metals, pathogens or sediments that violate water quality standards. Flow is taken into account when developing loading analyses, and flow is specifically considered when calculating seasonal variation and critical conditions in a TMDL. The TMDL regulations specify that TMDLs can be expressed in terms of either mass per time, toxicity or other appropriate measure, and flow has been used as a surrogate for stormwater pollutants, as discussed in Section 3.2. Flow is also a critical component to consider when TMDLs are being implemented. Additonal information on this is presented in Chapter 5 and Chapter 6.

> ***Resources:*** Several EPA documents include discussion of flow in developing TMDLs and are included in the Resource section at the end of this chapter in Section 3.4.2. In addition, Resource sections at the end of other chapters include TMDL documents available for further information.

3.1.1. Stormwater Effects on Receiving Waterbodies

The purpose of this section is to briefly summarize the effects that stormwater has on streams and lakes and other receiving waterbodies. Stormwater can affect waterbodies in a number of ways depending on the type of stormwater source and the waterbody characteristics. While stormwater sources can include illicit discharges and dry-weather flows, most stormwater sources represent precipitation-driven runoff from impervious and pervious surfaces. The effects of stormwater runoff have been well documented in multiple journal aricles, books and other publications. Most recently, the National Research Council has issued a report, *Urban Stormwater Management in the United States* (NRC 2008), that describes in detail the hydrologic, geomorphic, and biological effects of urbanization on watersheds. The conclusions derived from these reports are that increased imperviousness and stormwateer discharges can lead to the following effects:

- Altered stream hydrology, including higher peak flows, higher peak flow duration, lower base flows, and decreased groundwater recharge
- Increased pollutant loadings associated with higher runoff volumes (from increased imperviousness)

These two processes—flow alterations and increased pollutant loading—are the primary causes of stormwater effects on receiving waters. These effects on both water quantity and water quality can in turn cause impairment to a number of designated uses, as shown in Table 3. For example, flow alterations can cause impairments, especially to aquatic life, by altering habitat, increasing channel instability, causing stream incision, increasing bank erosion, causing riparian degradation, and altering sediment supply and transport (Burton and Pitt 2001). Increases in pollutant loading from stormwater sources can create conditions that are harmful to human health, fish, and other aquatic life. Pollutants that are typically associated with stormwater runoff include pathogens, metals, sediment, nutrients, chlorides, pesticides, oil and grease, toxic organics, and polychlorinated biphenyls (PCBs) (Burton and Pitt 2001). The type of pollutant varies for each area depending on the specific sources within a watershed. In addition, permitted stormwater includes unique sources that are not necessarily precipitation-driven such as illicit discharges and dry-weather flows (e.g., from lawn watering or car washing). These types of stormwater sources are typically associated with effects due to water quality rather than water quantity.

> ***Resources:*** For more information on stormwater impacts to receiving waters, refer to the Resources list at the end of this chapter in Section 3.4.1.

Table 3. Examples of the effect of stormwater runoff on common designated uses

Designated use	Water quantity effects	Water quality effects
Aquatic Life	Change in stream hydrology resulting in habitat modification and degradation (e.g., change in riffle/pool ratio, streambed alteration, stream incision and streambank erosion, change in sediment transport)	▪ Degradation of receiving water quality that can be detrimental to aquatic life (e.g., increased turbidity, increased temperature, eutrophic effects from increased nutrients)
Recreation	Alteration of stream channel or lake bathymetry impairing swimming or boating uses	▪ Increased pollutant levels that pose a risk to human health (e.g., bacteria, metals) ▪ Increased pollutants that degrade aesthetics (e.g., nutrients resulting in algal growth, oil and grease and litter causing odors or floatables)
Drinking Water	Less opportunities for infiltration to recharge groundwater supplies that serve as public drinking water	▪ Increased pollutant levels that pose a risk to human health (e.g., bacteria, metals) ▪ Increased pollutants that impede function of drinking water intakes (e.g., nutrients resulting in algal growth, blocked intakes from litter or increased sediment)

3.1.2. Data Analysis to Characterize Impairment

The analysis of waterbody monitoring data (e.g., flow, water quality, biological) supports an understanding of impairments by determining when, where, and under what conditions the problems are evident. These answers help to define many of the

> ***Resources:*** For more information on where to obtain water quality and flow data, refer to the Resources list at the end of this chapter in Section 3.4.3.

technical aspects of the TMDL, including what targets are appropriate, what sources are quantified, what approaches can be used, how allocations are determined, and on what time and spatial scale the analysis is conducted. Important aspects of the data analysis to understand the impairments for a TMDL include the following:

> ***Tip: Using data analysis to support source identification***
>
> Data analysis to understand the impairment is typically conducted in tandem with source identification activities (as discussed in Section 3.3). Analysis of waterbody data along with review of watershed land uses, source locations, and other source information helps to determine what sources exist and whether they are affecting impairment.

- Data analysis to identify pollutant of concern or expected causes of impairment in cases of a listing based on general or biological impairment
- Spatial analysis to identify spatial variations in waterbody and watershed conditions to identify environmental conditions or sources that affect impairment
- Temporal analysis to evaluate the timing of impairment and potential source loading or other conditions contributing to impairment
- Analysis of the relationships among multiple parameters or waterbody measures (e.g., pollutant concentration and flow) to understand impairment conditions and identify potential sources
- Review of results of data analyses to identify critical conditions to support identification of TMDL targets and select appropriate TMDL development approach

The following sections provide more detail on these common types of data analyses to support the characterization of impairments. These analyses also help to identify potential sources and evaluate their effect on impairment. Section 3.3 will discuss other activities and information that can help to identify sources and can be evaluated concurrently with the waterbody data to assess sources.

3.1.2.1. Identifying Pollutants or Other Causes of Impairment

Impaired waterbodies affected by stormwater sources are often listed as impaired due to such things as *biological impairment* or *habitat alteration* rather than for specific pollutants (e.g., metals, sediment). These listings are typically based on biological assessments or violations of biocriteria. Biological communities can show a response from multiple stressors or from a series of combined stressors such as water column pollutants, flow alterations, channel alterations, and other habitat alterations. Therefore, it might be difficult to identify the pollutant or suite of pollutants affecting the biological community.

EPA developed the *Stressor Identification Guidance Document* (USEPA 2000c) to help practitioners determine which pollutants might be affecting biological communities. The stressor identification (SI) document covers the organization and analysis of available evidence to determine the cause of biological impairment. The general SI process entails critically reviewing available information, forming possible stressor scenarios that might explain the impairment, analyzing those scenarios, and producing conclusions about which stressor(s) are causing the impairment. The SI process is iterative, usually beginning with a retrospective analysis of available data, and the accuracy of the identification depends on the quality of data and other information used in the process. If the SI process identifies specific pollutant parameters (e.g., sediment, nutrients, temperature) that are causing the biological impairment, TMDL writers can establish targets for the pollutant(s) and use additional waterbody

> ***Resources:*** For more information on conducting biomonitoring, bioassessment, biocriteria or where to obtain biological data, refer to the Resources list at the end of this chapter in Section 3.4.4.

and watershed information (e.g., analysis of ambient in-stream data, field reconnaissance) to identify potential sources.

However, because biological impairments often represent the cumulative effects of a number of stressors, it might not be possible to isolate a pollutant or even multiple pollutants as the primary cause of impairment. The impairment might be the result of hydrological and physical changes from the change in flow patterns often associated with impervious areas as well as the increase in pollutant loading. In these instances, the TMDL might be developed for a surrogate target that represents the combined effects from stormwater. Identifying TMDL targets, including the use of surrogates, is discussed in Section 3.2.

3.1.2.2. Identifying Spatial Patterns

Analyzing waterbody data to identify spatial variations in waterbody conditions and impairment can help to identify sources or waterbody or environmental conditions that are contributing to impairment. For instance, evaluating the data to identify spatial variations in water quality can identify *hot spots* where sources are affecting a greater impact on water quality. A hot spot downstream of an urban area might indicate that stormwater is a potentially significant source. Spatial evaluation can also be useful in evaluating the effects of different land uses or stormwater source types. For example, comparing monitoring data from sites representative of heavily developed commercial or industrial areas to data representative of residential or undeveloped areas can help to evaluate the relative significance of the different land use types discharging to an MS4.

> ***Tip: Use data analysis to support approach selection***
>
> The conclustions drawn during data analyses will help to define the technical needs of the TMDL development approach. Chapter 4 discusses selecting a TMDL approach.

Although the data might not always be available to support it, evaluation of conditions upstream and downstream of a suspected source can help to determine whether it has an effect on water quality. Figure 5 presents paired (i.e., collected at the same time) total suspended solids (TSS) readings from stations upstream and downstream of a landfill that discharges runoff into a small stream. It was expected that the landfill might be a source of nutrients and sediment to the stream. Data were plotted together to evaluate the corresponding conditions upstream and downstream. Also plotted in Figure 6 is a line representing a 1:1 linear relationship, where the values upstream would be equal to those downstream. As shown in the figure, the downstream measurements are typically higher than those upstream of the landfill, suggesting that the landfill could be a significant source of TSS to the stream.

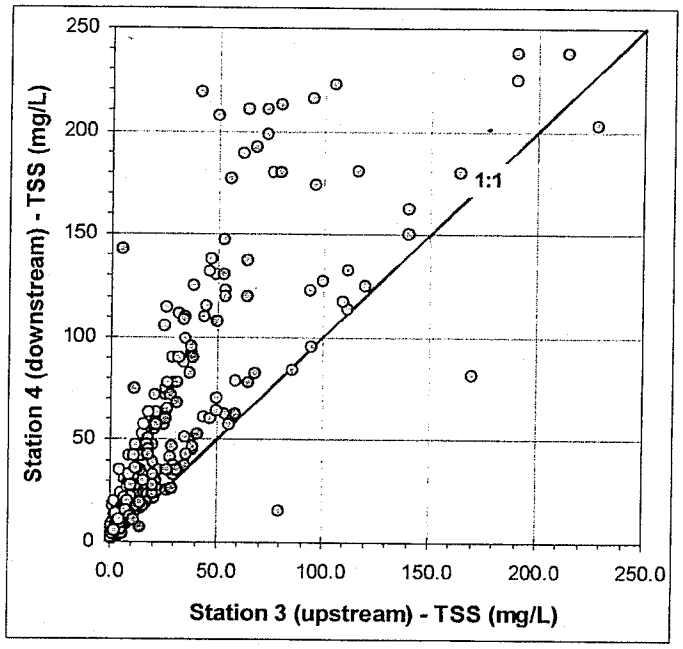


Figure 5. Analysis of upstream and downstream data to evaluate potential impact of an expected source.

3.1.2.3. Identifying Temporal Trends

TMDL writers can also assess data for temporal trends to better understand the impairment and identify potential sources. Temporal variations in water quality, whether from month to month or year to year, can be the result of trends in environmental conditions, such as weather and resulting runoff and flows, or from variations in loading because of schedules or variations in source activities. For example, open areas or parks that drain to MS4s can experience increased wildlife activity or dog walking during summer months, potentially increasing pathogen loads. Similarly, increased loads of sediment or chlorides can occur during winter months from use of sand and deicers on roadways during winter weather.

Longer-term, temporal variations such as trends over a decade rather than across seasons can also provide clues about watershed sources. Figure 6 illustrates a data analysis that evaluates both spatial and temporal variations using data from two stations on the same stream and collected over a 4-year period. The graph of time-series turbidity data shows that a significant increase in turbidity occurred in 2001 at the downstream station; since then, the levels have been consistently higher than upstream. Because upstream levels were measured at comparable levels before and after 2001, the data at the downstream station might suggest the introduction of a new source discharging between the two stations and contributing to the turbidity levels in the stream.

While source activity can affect temporal variations in water quality, they are more often related to environmental conditions such as flow. Evaluating the relationship among water quality, flow, and seasonality can be done using a variety of techniques including simple visual comparison of graphed time-series data, regression analyses, or the use of flow duration curves. Figure 7 includes examples of

each of these types of data representation using the same data set. As shown in the figure, all the figures can be used to show the relationship between bacteria and flow. While the regression plot does not show a strong correlation between flow and bacteria, the chronological and flow duration graphs show that they do tend to follow similar patterns, with elevated bacteria typically occurring during higher flows.

Because discharges from certain types of stormwater sources are typically observed during particular flow conditions, evaluations of flow and corresponding water quality can be a helpful tool in identifying potential sources of impairment. Many stormwater sources are related to increased runoff that can carry pollutants from impervious surfaces, such as parking lots and rooftops, and also lead to streambank or surface erosion, especially in areas of land-disturbing activities such as construction. Therefore, a waterbody influenced by stormwater would likely have observed water quality problems occurring at higher flows. However, waterbodies exhibiting the inverse relationship, with higher pollutant concentrations at lower flows, can also indicate MS4 sources such as illicit discharges to the storm sewer. Figure 8 depicts an example of pollutant loadings observed during low-flow conditions, possibly indicating illicit discharges entering the MS4 through either direct connections (e.g., sanitary sewer piping connected to storm drains, failing septic drain fields connected to ditches that are part of an MS4 conveyance system) or indirect connections (e.g., infiltration into the MS4 pipes from cracked sanitary systems).

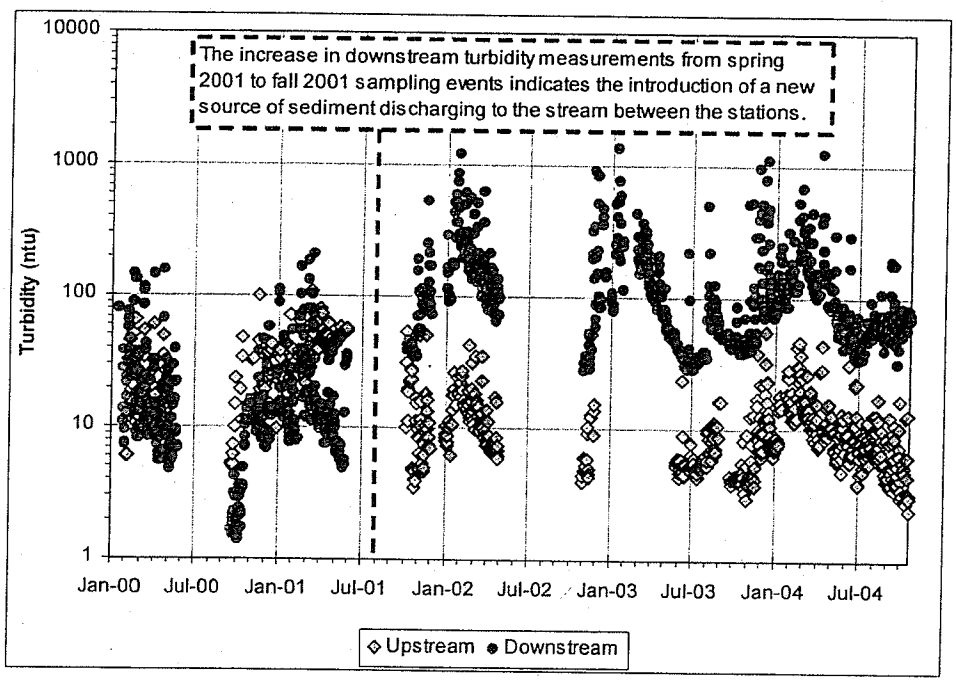
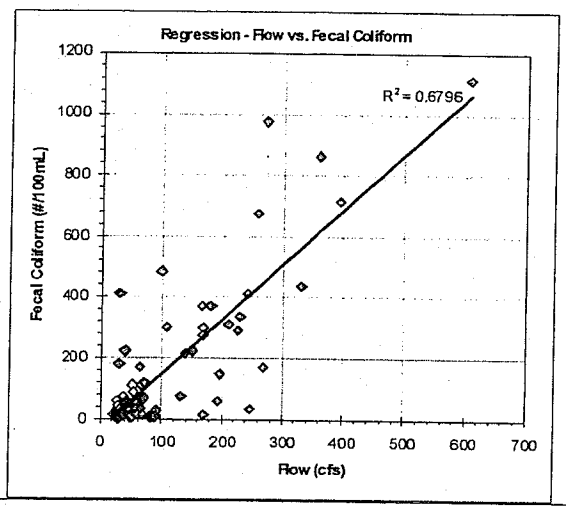
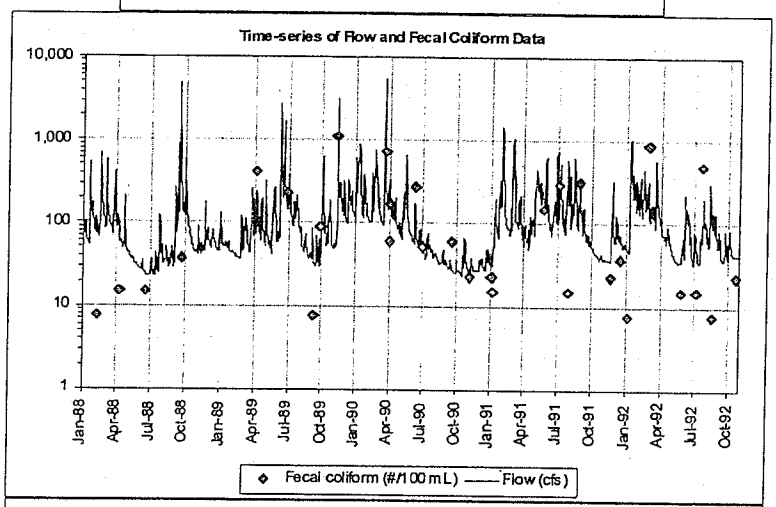


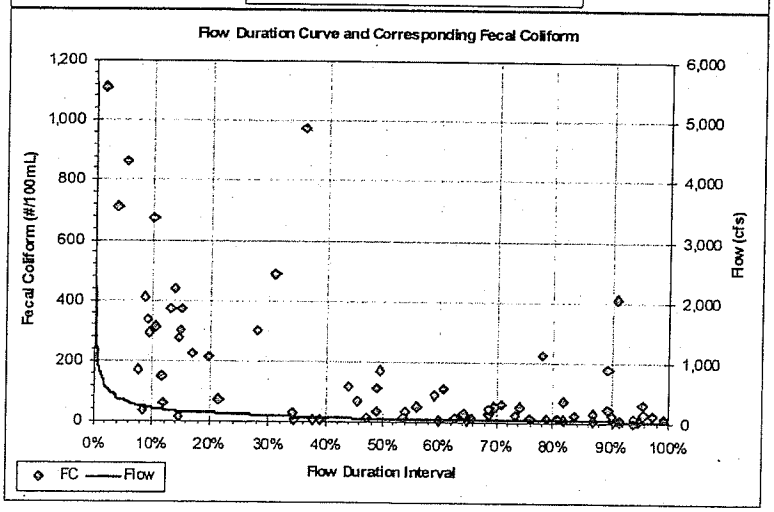
Figure 6. Evaluation of spatial variations in turbidity data to identify locations of potential sources.



Regression of matching measurements of fecal coliform and flow. R^2 of 0.7 might not indicate a strong correlation, but plot does show that the highest fecal coliform measurements occurred during high flows.

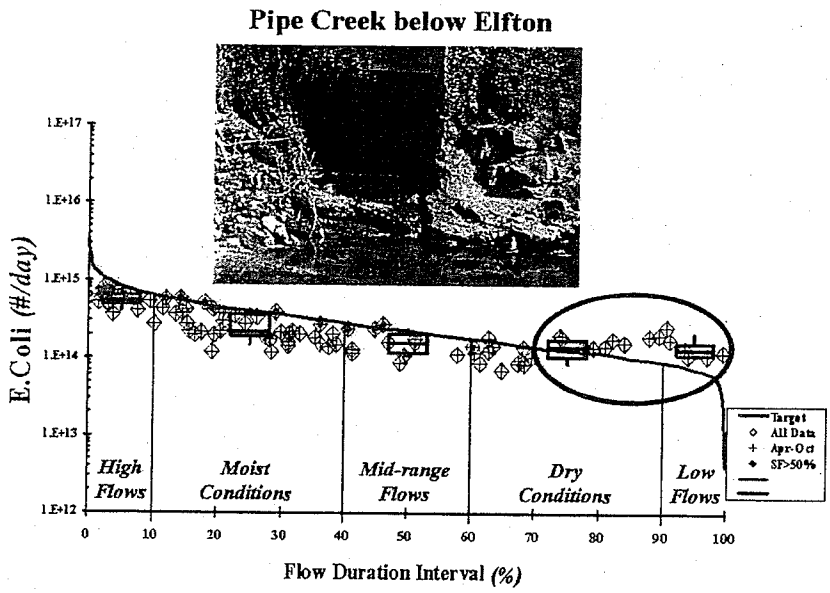


Chronological graph showing continuous flow data and instantaneous fecal coliform measurements. Plot indicates that higher measurements of fecal coliform generally correspond to times of higher flows.



Flow duration curve for continuous flow dataset shown above. Instantaneous fecal coliform measurements are plotted based on the corresponding flow duration interval of the flow measured on the sample date. Plot indicates that higher measurements of fecal coliform generally correspond to higher flows.

Figure 7. Examples of different data representations to evaluate the relationship between flow and fecal coliform.



Stormwater Source: *Illicit Discharges*

Figure 8. Duration curve analysis indicating illicit discharges as stormwater source. Circled data points represent those exceeding the target for *Escherichia coli.*

3.1.2.4. Evaluating Relationships among Parameters

Evaluating the relationship among pollutants can also help TMDL writers to understand observed impairments and identify the types of sources in the watershed. Many pollutants causing impairments can originate from common watershed sources. If a waterbody is impaired by multiple pollutants, evaluating trends or patterns in all pollutants can investigate the potential of common sources among pollutants. For example, sediment, chlorides, and litter are often associated with road maintenance for snow and ice removal. Observed impairments by these parameters in the same waterbody segment might indicate snow removal activities as a source. Similarly, pathogens and nutrients often share common sources that could be contributing to stormwater loads, such as landfills, sanitary sewer breaks, and wildlife or domestic pet waste.

In addition, some pollutants might be associated with other pollutants. For example, some pollutants (e.g., nutrients, metals) can be delivered to receiving waters adsorbed to sediment particles. Fertilizer or pesticide application in residential, commercial, or industrial areas can experience an accumulation of contaminants (e.g., nutrients, pesticides) that have adsorbed to sediment. Soil erosion and washoff in these areas can result in the delivery of loads of sediment and associated contaminants. Identifying a relationship between increased sediment concentrations and other pollutants can help to identify these situations to understand the nature of the impairment and identify potential sources.

3.1.2.5. Identifying Critical Conditions

EPA regulations require that the TMDL writer consider critical conditions while developing a TMDL. Evaluating the critical conditions builds on the previous analyses of spatial and temporal trends and

relationships among pollutants and processes and identifies the combination of environmental conditions (physical, chemical, and biological) under which impairment occurs. When addressing stormwater sources, understanding the critical conditions can be crucial when identifying a TMDL target. Especially without an applicable numeric water quality criterion or when dealing with a biological impairment, evaluation of the critical conditions will help determine the causes and conditions associated with the impairment, such as times of elevated pollutant concentrations or high flows. As with all the other analyses discussed, understanding critical conditions can provide clues about the location, timing, and type of sources affecting impairment and guides selection of an appropriate TMDL development approach (as discussed in Section 4.2.3).

3.2. Identifying TMDL Targets

Impaired waterbodies requiring TMDLs are included on state 303(d) lists because of violations of water quality standards. Water quality standards include the designated use of a waterbody, the water quality criteria established to protect that use, and an antidegradation policy. Water quality criteria can be expressed as numeric or narrative criteria, affecting both the nature of the listing and developing the resulting TMDL. All TMDLs must have a numeric target for which to calculate a loading capacity. Figure 9 illustrates the potential steps or options for developing targets for TMDLs that include stormwater sources. When developing a TMDL for a waterbody listed for a specific pollutant that has an associated numeric criterion, the criterion serves as the target for the TMDL. However, many impaired waterbodies affected by stormwater sources are listed as impaired by pollutants with narrative criteria (e.g., sediment, nutrients) or due to biological impairments (e.g., biological assessments indicate poor benthic communities, increase in *tolerant* species, or decrease in fish populations). In such cases, it is necessary for the TMDL writer to identify a numeric TMDL target that can be used for calculating the loading capacity. When waters are listed for biological impairments, sometimes a TMDL writer will use data analysis and SI to identify a specific pollutant(s) (e.g., sediment) contributing to the impairment (as discussed in Section 3.1). If a specific pollutant is identified relating to a biological impairment, the TMDL writer can identify a numeric target based on data analysis (e.g., reference conditions, historical conditions) or appropriate site-specific or regional literature values. Similarly, a numeric target can be identified for a pollutant that does not have associated numeric criteria.

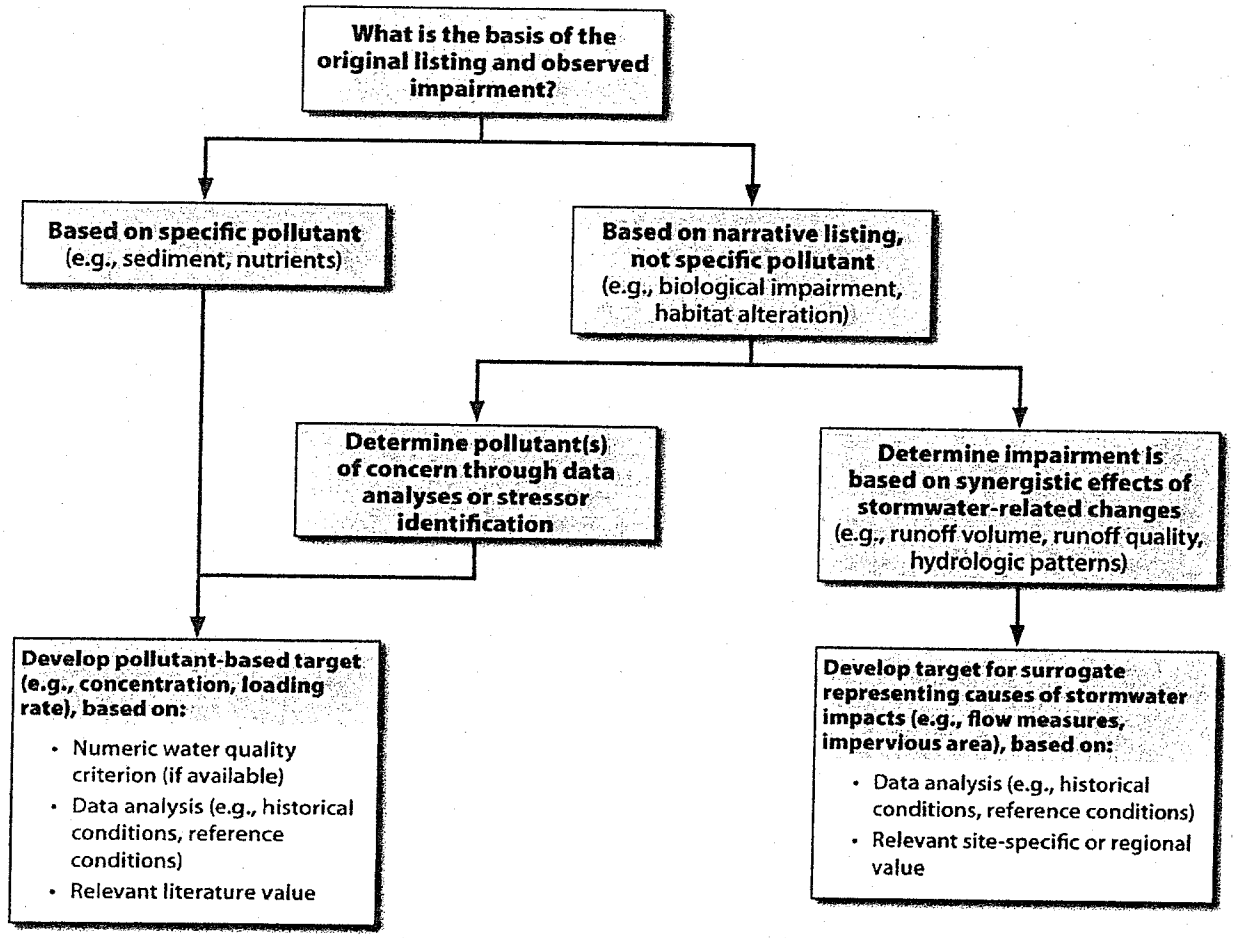


Figure 9. Options for identifying targets for TMDLs that include stormwater sources.

However, when dealing with stormwater effects on an impaired waterbody, it might be difficult to identify all the specific pollutants that are related to the impairment. The underlying problem might be due to hydrologic changes such as quantity of flow and variation in flow regimes that are important factors in transporting pollutants (e.g., metals, pathogens, sediment) that can violate water quality standards. For instance, the impairment might be the result of pollutant loads from flow-related in-stream scouring and and also increased pollutant loads being transported from specific activities within the stormwater source's drainage area (e.g., road sanding, pesticide treatments to lawns) or more generally because of the increased runoff from impervious surfaces. Therefore, when developing a stormwater TMDL, a TMDL writer might use a surrogate measure (e.g., flow) to represent the impairment and establish a numeric target for the surrogate to represent attainment of water quality standards. (The TMDL regulations specify that TMDLs can be expressed in terms of mass per time, toxicity or other appropriate measure). Rather than representing a specific pollutant, the surrogate would represent the suite of pollutants contributing to the impairment. Examples of surrogates for use in stormwater TMDLs based on biological listings include the percent of impervious cover (IC) in the watershed of the impaired water and the flow volume in the impaired stream. The TMDL developed for Eagleville Brook, Connecticut, provides an example of a TMDL using IC as a surrogate and provides

information on how the target represents the impairment and how an appropriate target was established. The TMDL developed for Potash Brook, Vermont, illustrates the use of flow volume as a surrogate for stormwater-related impairments. The TMDL establishes a target for high flow in the brook on the basis of hydrologic conditions of two reference streams where aquatic life criteria are met.

In Practice: Using Impervious Cover as a Surrogate for Water Quality Standards in Eagleville Brook, Connecticut

Eagleville Brook does not meet water quality criteria and designated uses for aquatic life. The relevant criteria are based on distribution and abundance metrics for benthic invertebrates that inhabit lotic waters and are described in the state's narrative water quality standards. An SI analysis concluded that the biological impairments are most likely due to a combination of pollutants related to stormwater runoff from developed areas and other related stressors (such as the physical impacts of stormwater flows). Because the major source of stormwater is runoff from the impervious surfaces in the watershed, the Connecticut Department of Environmental Protection selected iIC as a surrogate to represent attainment of aquatic life criteria and to establish the loading capacity. The IC target is set at 12 percent IC. This threshold is based on Rapid Bioassessment Protocol data from 125 small (< 50 square mile) watersheds indicating that no stream monitoring location with more than 12 percent IC in its watershed met criteria for full support of aquatic life use.

The TMDL loading capacity of 12 percent was reduced 1 percent to provide for an MOS, yielding an overall allocation target of 11 percent. The TMDL applies the 11 percent IC target to all stormwater drainage areas and affects all sources subject to LAs and WLAs in the watershed. The percent IC TMDL and WLA/LA targets apply at all times (instantaneously, daily, monthly, seasonal, and annual). The final TMDL (2007) is at: www.ct.gov/dep/lib/dep/water/tmdl/tmdl_final/eaglevillefinal.pdf.

3.3. Identifying and Assessing Potential Sources

The step of identifying sources for TMDL development should be an extension of the data analyses conducted to understand the impairment and serves to further characterize the important sources and better define their location, behavior, magnitude, and influence. The source assessment should result in an understanding of what major sources are contributing to impairment and how (e.g., pollutants, delivery pathways). This can affect what approach is selected and how it is applied for TMDL development and helps to focus the allocation analysis as well as future implementation.

While the pollutant loads originating with each source are typically quantified during the linkage analysis (Chapter 4), the information necessary to understand their location and discharge behavior and characteristics is compiled and reviewed during this step. In general, the methods that are used to complete a source assessment do not differ between a TMDL addressing stormwater sources and any other TMDLs, and they involve identification and characterization of point sources (e.g., stormwater, wastewater treatment plants, industrial facilities) and nonpoint sources (e.g., grazing, timber harvest, septic systems). The methods for completing a source assessment vary with the type of watershed, pollutants, and sources but typically rely on information from state or national databases, literature reviews, and local knowledge from state or local contacts. It is important to correlate the assessment of both point and nonpoint sources with the data analysis to characterize source impacts and behavior. For example, land use, locations of stormwater outfalls or facility discharges, and other source information should be evaluated along with water quality data analyses (e.g., spatial analysis) to understand potential effects from the various sources or explore unknown sources. The following are examples of information typically reviewed to identify sources for TMDL development:

- Query EPA's NPDES databases to identify permitted facilities or sources discharging to the impaired water or its tributaries
- Coordinating with state permitting staff to identify the number, type, and location of NPDES permitted point sources in a watershed (including stormwater sources)
- Review geographic information system (GIS) coverages (e.g., land use, soils), satellite images, and aerial photos to identify potential nonpoint sources (e.g., agriculture, silviculture)
- Conduct field or *windshield* surveys of the watershed to identify potential nonpoint sources (e.g., livestock operations, illegal dumping, failing septic systems)
- Review previous watershed, local, or regional studies or reports to identify potential nonpoint sources

Identifying and understanding the effect of stormwater sources might require additional investigation or information to support TMDL development. This section discusses the information available to support the following activities to further define and characterize stormwater sources:

- Identify type and general location of stormwater sources
- Delineate drainage area for stormwater sources
- Characterize discharge from stormwater sources

Tip: Maximize resources when characterizing stormwater sources

A thorough characterization of stormwater sources can require a significant amount of time and resources. Therefore, it is important for TMDL and permit writers to work together to determine the significance of stormwater sources to the TMDL and, if it is determined that further characterization of stormwater sources is necessary, what type and amount of data are necessary to complete the characterization.

3.3.1. Identifying the Type and Location of Stormwater Sources

Stormwater sources will fall within one of three categories—MS4, construction or industrial—but there can be a number of sources or activities within those permitted areas that might contribute to an impairment. Common stormwater-related pollutants of concern that cause water quality impairment include pathogens, metals (other than mercury), sediment, nutrients, and chlorides. Table 4 illustrates the range of permitted stormwater sources and related activities typically associated with certain pollutants or impairments.

Table 4. Examples of sources within regulated stormwater areas associated with common pollutants and impairments

Pollutant/stressor of concern	Potential source(s) within permitted area		
	MS4	Construction	Industrial
Pathogens	▪ Sanitary sewer breaks and cross-connections ▪ Restaurant trash areas and mat washing ▪ Landfills and transfer stations ▪ Pet and wildlife waste		▪ Sanitary sewer breaks and cross-connections ▪ Food trash areas ▪ Landfills and transfer stations ▪ Improper disposal of sanitary waste (e.g., dumping from boats at marinas) ▪ Wildlife waste (sea gulls)
Metals	Vehicular emissions build up on impervious surfaces ▪ Roadways ▪ Driveways ▪ Parking lots	▪ Vehicle and equipment use on-site ▪ Materials storage/handling	Varies with industry type* ▪ Materials storage and handling ▪ Outdoor processing ▪ Legacy pollutants in soil

Pollutant/stressor of concern	Potential source(s) within permitted area		
	MS4	Construction	Industrial
	Industrial activities and materials storage ▪ NPDES permitted industrial facilities ▪ Corporation yards (i.e., municipal) ▪ Unpermitted industrial facilities		
	Commercial activities and materials storage ▪ Automotive repair facilities ▪ Gas stations ▪ Car washes ▪ Auto dealerships		
Sediment	▪ Active construction ▪ NPDES permitted active construction ▪ Non-permitted active construction (<1 acre) ▪ Hillside development ▪ Roads and highways ▪ Snow/ice management	▪ Erosion on-site causing off-site discharge ▪ Road tracking	▪ Debris from materials storage ▪ Runoff from parking lots ▪ Snow/ice management
Nutrients	▪ Residential fertilizer application ▪ Industrial/commercial fertilizer application ▪ Municipal fertilizer application ▪ Pet and wildlife waste		▪ Fertilizer application
Chlorides	▪ Snow/ice removal activities and storage		▪ Snow/ice management
Habitat Alteration	▪ New development in greenspaces ▪ Building roads and highways ▪ Development in sensitive areas (i.e., near waterways, on hillsides)	▪ Sediment discharge from site	
Flow Alteration	▪ Increased, unmitigated imperviousness due to new development or redevelopment ▪ Increased, unmitigated imperviousness due to new roads and highways ▪ Increased connection of existing imperviousness	▪ Change in drainage patterns due to removal of vegetation and changing grade	
Pesticides	▪ Residential pesticide application ▪ Industrial/commercial pesticide application ▪ Municipal pesticide application ▪ Fuel stations		
Oil and grease	▪ Vehicle leaks on parking lots and roadways ▪ Spills ▪ Illegal dumping	▪ Spills ▪ Equipment maintenance and fueling	Varies with industry type* ▪ Materials storage and handling ▪ Outdoor processing ▪ Legacy pollutants in soil
Toxic Organics			Varies with industry type* ▪ Materials storage and handling ▪ Outdoor processing ▪ Legacy pollutants in soil
PCBs	▪ Landfills		Varies with industry type* ▪ Materials storage and handling ▪ Outdoor processing ▪ Legacy pollutants in soil

* The federal Multi-Sector General Permit for Industrial Activities (MSGP 2000) covers 30 industrial sectors that fall into one or more of the 10 categories of stormwater discharges associated with industrial activity (and construction activities) described in 40 CFR 122.26(b)(14)(i)-(xi). The 30 sectors are defined by either the facility's Standard Industrial Classification (SIC) code or a general description of the facility's industrial activities. MSGP 2000 expired at midnight on October 30, 2005. A new permit has not been issued.

Compiling a list of all stormwater sources in the watershed of an impaired water should be, in theory, relatively easy because stormwater sources are covered under NPDES general and individual stormwater permits, and coverage under these permits is tracked by state and EPA NPDES permitting authorities.

Each state has a stormwater permit program coordinator or multiple coordinators that TMDL writers can contact for information. NPDES-authorized states issue NPDES permits for MS4s and stormwater discharges associated with construction and industrial activities. The amount of information available online varies from state to state, but generally, it is a good idea to speak with the permitting authority directly to assess the adequacy of online resources. TMDL writers should be aware that in many states stormwater permittees are tracked in different data systems than other NPDES permittees. For example, EPA's Permit Compliance System (PCS) and Integrated Compliance Information System (ICIS) data systems include permit information for a very small percentage of stormwater permittees regulated under the NPDES program.

> ***Resources:*** For links to online resources for identifying permitted stormwater sources in your watershed, refer to the Resources list at the end of this chapter in Section 3.4.5. Resources include links to state and regional stormwater contacts and EPA's PCS/ICIS and eNOI systems.

In nonauthorized states, TMDL writers should contact the individual EPA Regional office for information about dischargers within a watershed boundary and use the Electronic Notice of Intent (eNOI) system EPA has developed to track construction sites and industrial facilities that need to apply for coverage under EPA's Construction General Permit (CGP) or Multi-Sector General Permit (MSGP). This system can be used to search, sort, and view NOIs and can be searched by city, county, or ZIP Code. The NOIs include location and receiving water name and for construction sites, the size of the disturbed area.

It is important to work with the permitting authority to identify stormwater sources in the watershed of an impaired water. Regulatory definitions of permitted stormwater sources can result in challenges in identifying the boundaries of regulated (i.e., permitted) stormwater sources versus and unregulated stormwater sources. This is particularly true for MS4s. Figure 10 illustrates the complexities of identifying regulated versus unregulated MS4s within a watershed boundary. As Figure 10 shows, it is possible to have both regulated and unregulated MS4s within the watershed boundary of an impaired waterbody. Phase I MS4s are defined as large and medium MS4s on the basis of population served, while Phase II regulated small MS4s are defined as small MS4s (i.e., any MS4 not regulated under Phase I) within an urbanized area. Any portion of a small MS4 within the urbanized area is considered a Phase II regulated small MS4 and is subject to Phase II MS4 permit requirements. Small MS4s outside the urbanized area are not subject to Phase II MS4 permit requirements; however, TMDL writers should take into account pollutant contributions from these stormwater discharges in a manner similar to regulated, small MS4s.

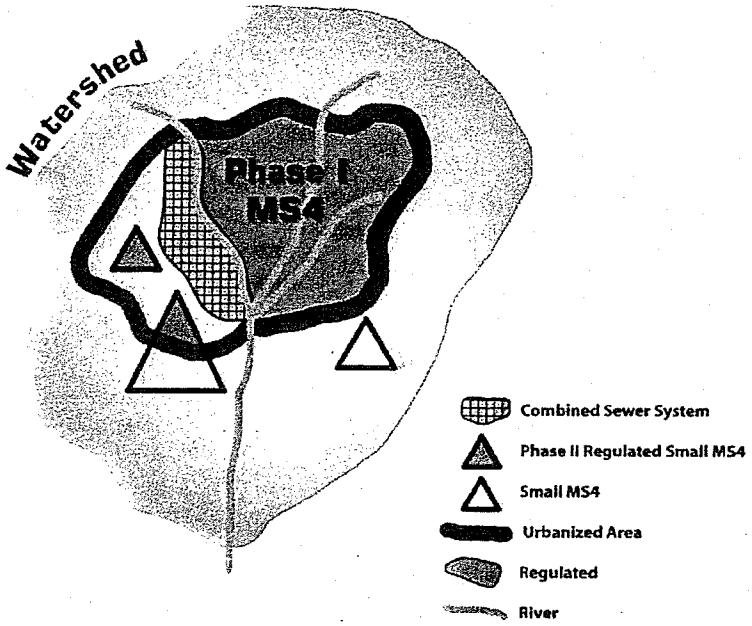


Figure 10. Potential spatial complexities of regulated and unregulated stormwater sources.

While land use is often an indicator for the existence of MS4s within the watershed of an impaired waterbody, it is important to remember that not all MS4s are municipal entities (e.g., cities, counties, or towns). Other entities such as departments of transportation, irrigation districts, sanitary districts, universities, hospitals, federal facilities and other entities that own and operate separate storm sewer systems can also fall into the category of regulated MS4s. These *nontraditional* MS4s have the potential to add another layer of MS4 boundaries for TMDL writers to consider. In addition, TMDL writers might focus on MS4s as the primary stormwater sources, but it is important to remember that regulated construction activities and industrial facilities both inside and outside the boundaries of regulated MS4s can also contribute stormwater discharges. Permit information on all types of regulated stormwater sources should be readily available in PCS. Identifying unregulated stormwater sources, such as other small MS4s, will require an understanding of local land uses and communication with the entities that own and operate these systems.

> ***Resources:*** For more information on obtaining land use and coverage information and conducting field reconnaissance and visual surveys, refer to the Resources list at the end of this chapter in Sections 3.4.6 and 3.4.7.

Field reconnaissance can also be used to identify any potential unknown stormwater sources as well as nonpoint sources. Field reconnaissance involves visiting the watershed and can range from a *windshield* survey while driving to a more comprehensive survey such as *walking the stream* to identify and geo-locate potential sources or identify potential monitoring sites to fill information gaps. Field reconnaissance is also useful to ground-truth available information used in characterizing the waterbody and its surrounding watershed, including areas within an MS4 boundary. For example, land use and land cover data are sometimes out of date and might include open space areas that have since been converted to residential, commercial, or industrial uses. Field reconnaissance is also helpful in identifying or better characterizing certain types of sources that might not be identifiable in the typical watershed coverages or information; for example,

field investigations are an essential tool for MS4 communities to detect illicit discharges and connections, which can be significant sources of contaminants. Field reconnaissance can also help identify areas where stormwater volumes and velocities are affecting stream morphology and contributing to impairment by noting streambank, channel and habitat conditions (e.g., embeddedness, number of pools and riffles).

3.3.2. Delineating the Drainage Areas of Stormwater Sources

To include a stormwater source in the TMDL analysis, it is necessary to identify its regulated area and if possible isolate the specific area drained by its sewer system and discharged to the receiving waterbody. Differences in spatial scale between the geographic focus of a TMDL (e.g., waterbody or watershed) and stormwater sources (e.g., regulated MS4s, construction sites, and industrial facilities) can create unexpected challenges for TMDL writers at this stage of TMDL development. To identify stormwater source areas, it is important that the TMDL writers fully understand the types of sources and how they are regulated. For example, it might be assumed that identifying jurisdictional boundaries is a straightforward way to identify regulated MS4s. However, the jurisdictional boundary is not necessarily the same as the regulated MS4 boundary. For example, combined sewer system portions of storm sewer infrastructure are not regulated by the NPDES MS4 program. As another example, regulated small MS4s typically are only the portion of the MS4 system that is actually within the urbanized area boundary (Figure 10). These distinctions can affect how the stormwater sources are included in the analysis and how their respective WLAs are subsequently developed and assigned.

It is also important to understand the stormwater conveyance methods for each stormwater source in a watershed to determine whether the source is discharging to or affecting the impaired waterbody and to delineate the boundary and drainage area. Stormwater can be conveyed to a waterbody through direct surface flow or through a pipe, ditch, or other conveyance. In addition, stormwater might be recharged to groundwater, which might or might not affect a stream. The type and location of these conveyance methods will help a TMDL writer to assess the potential effects that a stormwater source is having on a stream. For example, a concrete-lined channel that discharges stormwater directly to a receiving stream will likely have a greater effect than a discharge from a well-maintained wet pond designed to capture and treat 80 percent of the received water quality volume. Because of these issues, the outfall location and conveyance method for each stormwater source should be documented and summarized before completing a TMDL. This could be as simple as plotting the outfall locations in a GIS and comparing those locations to observed in-stream impacts, or it might require a more comprehensive analysis.

TMDL writers should work with the permitting authority to identify the information available to delineate the areas and drainage boundaries for stormwater sources. Individual NPDES permit application requirements for Phase I MS4s [40 CFR 122.26(d)(1)(iii)(B)] include the submittal of a map showing the service boundaries of the MS4 covered by the application as well as the location of all outfalls that discharge into a water of the United States. Phase II MS4s applying for individual permit coverage are required to submit the same information. Phase II MS4s regulated under general permits submit NOIs that might have a map, a description of the regulated MS4 boundary, or both and should be available from the permitting authority. However, those MS4s are required to develop such maps as part as permit implementation, not at the time of application. Industrial and construction SWPPPs should include site descriptions or maps to identify the facility or site location and locations of outfalls or surface water discharges.

If this information is not readily available or not sufficient to determine the area draining a stormwater source, a TMDL writer should work with the permitting authority to determine if additional information is necessary to locate and delineate all the stormwater sources in the watershed of the impaired waterbody. City and county planning departments often have information on the location and extent of stormwater infrastructure and controls, and in some cases, detailed sewer and boundary maps or stormwater facility plans might be available. This information should be obtained, where available, because it is often the most detailed and accurate information about stormwater sources. Similarly, industrial facilities and construction sites will have, and might submit to the city, county, or permitting authority, plans that document stormwater sources and management practices. Stormwater facilities are often required to submit a facility plan that documents the characteristics of the facility. However, additional investigations might still be needed to locate all potential stormwater sources.

3.3.3. Characterizing Discharges from Stormwater Sources

To better understand the quality and quantity of discharge being delivered to an impaired waterbody from a stormwater source, it is useful to evaluate data and information generated by the source to satisfy permit requirements. Table 5 outlines the types of data and information generated by the three types of stormwater sources—MS4s, industrial facilities, and construction activities—and the following sections briefly describe the information.

Table 5. Data and information generated by stormwater sources through the permitting process

Stormwater permit document or activity	Specific type of data generated by permittee
MS4 discharger generated data	
Phase I MS4 permit application	▪ Description of land use and 10-year growth projections ▪ Outfall characterization sampling data ▪ Receiving waters
Phase II MS4 general permit NOI	▪ MS4 location and boundaries ▪ Receiving waters
Industrial facility inventory and inspections (Phase I MS4s)	▪ Location of industrial facility to determine the watershed ▪ Activities, materials, and physical features of the industrial facility that might be sources of pollutants of concern during dry or wet weather ▪ Prioritization based on location, pollutants of concern, etc. ▪ Compliance history of industrial facility ▪ Location and pollutants of concern from nonregulated industrial (and perhaps commercial) facilities
Construction activities inventory and inspections	▪ Location of construction activity ▪ Size of disturbed area ▪ Receiving water/watershed ▪ Prioritization based on size, location, compliance history, etc. ▪ Compliance history of project ▪ Number and location of nonregulated (less than one acre) construction projects
IDDE and tracking	▪ Outfall map with receiving waters ▪ Dry weather screening ▪ Tracking of citizen complaints, dumping, spills, restaurant inspections, etc.
Post-construction BMP implementation and tracking	▪ Types of BMPs required ▪ Locations of BMPs ▪ Operation and maintenance (O&M) records/agreements ▪ Inspection results

Stormwater permit document or activity	Specific type of data generated by permittee
Outfall and ambient water quality monitoring data	▪ Characterization of discharges from particular land use types, subwatersheds, etc. ▪ Ambient data could provide baseline information before installing BMPs ▪ Habitat assessments might be part of monitoring program
Annual reports	▪ Location and type of identified illicit discharges ▪ Location of approved erosion and sediment control plans ▪ Compiled post-construction BMP inspection results ▪ Compiled monitoring results ▪ Planned SWMP changes
Industrial discharger generated data	
Industrial individual permit application	▪ Location of outfalls ▪ Site drainage map ▪ Impervious area calculation ▪ Description of proposed activities, spills and leaks, on-site materials ▪ Sampling data (if available)
Industrial general permit NOI	▪ Location of facility ▪ Receiving water/MS4 ▪ Applicable industrial sector
Industrial SWPPP	▪ Location of industrial facility to determine the receiving water(s) and if the facility is within an MS4 boundary ▪ Activities, materials, and physical features of the industrial facility that might be sources of pollutants of concern during dry or wet weather ▪ Map that shows outfalls into receiving waters
Monitoring data	▪ Loading from facility for benchmark discharge monitoring parameters
Industrial compliance evaluations and inspections	▪ Assess any compliance or BMP implementation issues on-site which may contribute to loading
Industrial sampling data	▪ Loading from particular facilities ▪ Assess general loading from types of industrial facilities ▪ Assess industrial loading from an MS4
Construction project generated data	
Construction individual permit application	▪ Location of construction activity ▪ Total area and total disturbed area ▪ Proposed BMPs ▪ Runoff coefficient ▪ Imperviousness created ▪ Receiving water
CGP NOI	▪ Location of construction activity ▪ Start/end dates ▪ Total disturbed area ▪ Receiving water
Construction activity SWPPP	▪ Location and size of disturbance as well as a location with associated surface water discharges. ▪ A description of any discharge associated with industrial activity other than construction and the location of that activity on the construction site. ▪ Type and location of any post-construction BMPs to be implemented on-site
Monitoring data	▪ Loading from project

The list of data types in Table 5 is based on the minimum federal permit requirements and assumed implementation strategies. Permitting authorities can choose to develop more stringent permit requirements; therefore, TMDL writers might want to take some time to carefully review individual and general permits issued by state permitting authorities to identify state or regional specific data and

information requirements. If a TMDL writer identifies potentially useful data generated by stormwater sources, the TMDL writer can work through the permitting authority to obtain this information. The permitting authority will have some information readily available on file (e.g., applications, NOIs, annual reports) or can make official requests to permittees for other types of information that the permitting authority might not have on file. It is important for TMDL writers to coordinate with permitting authorities to obtain this information, rather than directly contacting stormwater sources without the permitting authority's knowledge. This will ensure efficient use of time and resources and maintain clear communication with stormwater sources.

3.3.3.1. MS4-Generated Data

Both individual and general MS4 permits require Phase I and Phase II MS4s to develop specific types of documents that contain information and data potentially useful to the TMDL development process. Figure 11 illustrates the type of documents that MS4s must develop to comply with either individual permit requirements or general permit requirements. Under individual permits, Phase I MS4s must complete a two-part application, develop an SWPPP, conduct monitoring, and generate an annual report that compiles information and data on from SWPPP implementation from the previous year. As shown in Figure 11, Phase II MS4s have the option of obtaining permit coverage under either an individual permit or a general permit, depending on which type of permit the permitting authority makes available. Under an individual permit, a Phase II MS4 would likely have the same requirements to generate an SWPPP and prepare annual reports as a Phase I MS4. Although Phase II MS4s covered under a general permit must prepare the same type of documents, the information required in each document might vary. For example, the permit application for a general permit, the NOI, does not have the same extensive information requirements as the two-part application for an individual permit. In addition, not all general permits require monitoring. The Phase II MS4 general permit does require development of an SWPPP and annual reports, although the content might vary from those developed under an individual permit.

> ***Tip: Understanding the potential types of data not required by permits***
>
> Municipal MS4s might have data valuable to the TMDL development process that is not required by NPDES permits. For example, comprehensive planning or zoning documents could provide information regarding land use distribution. In addition, municipalities might coordinate or support volunteering monitoring or *watch* groups that could provide valuable input (e.g., stream monitoring, cleanups).

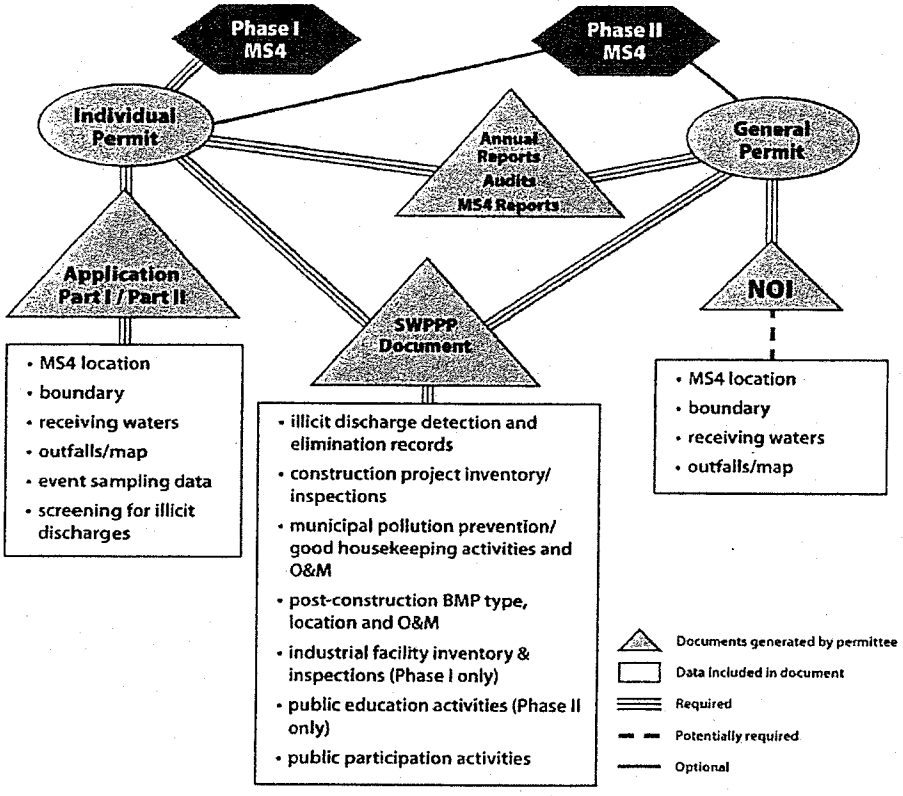


Figure 11. Required MS4 permit documents and associated information and data.

3.3.3.2. Industrial Discharger Generated Data

Most stormwater discharges associated with industrial activity have permit coverage under an NPDES general permit rather than an individual permit. However, significant industrial dischargers might have stormwater discharges covered under the facility's overall NPDES permit, which covers process wastewater, non-process wastewater, and stormwater. Figure 12 shows the type of documents required under both individual and general permits for industrial facilities.

Where an EPA Region is the permitting authority, rather than the state, regulated industrial facilities obtain permit coverage under EPA's MSGP. State permitting authorities often use EPA's MSGP as a template for developing and issuing their state-specific industrial stormwater general permit, with modifications necessary to address state-specific issues. All industrial stormwater general permits require industrial facilities to submit NOIs, and most require these permittees to develop and implement SWPPPs and conduct comprehensive site compliance evaluations and periodic inspections. Also, most of these industrial stormwater general permits require at least some sectors to conduct analytical monitoring of stormwater runoff. Figure 12 illustrates the types of data and information generated by an industrial discharger as a result of complying with permit requirements. This information can assist TMDL writers in characterizing stormwater discharges from industrial stormwater sources during the TMDL development process. .

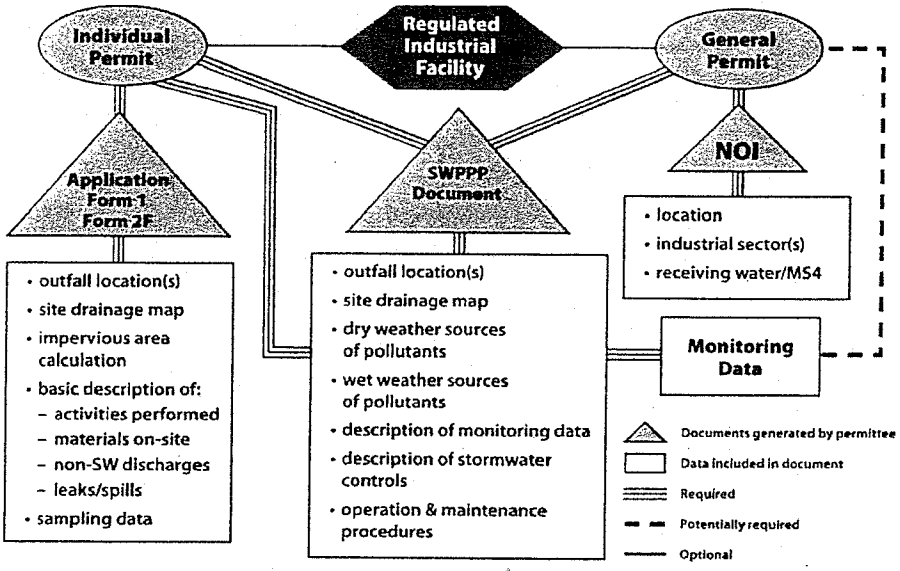


Figure 12. Required industrial stormwater permit documents and associated information and data.

3.3.3.3. Construction Project Generated Data

Construction projects disturbing one acre or more are required to obtain NPDES permit coverage for stormwater discharges. Figure 13 illustrates the data generated by construction stormwater sources as a result of complying with individual and general construction permit requirements. Construction stormwater discharges are most often permitted under an NPDES CGP, issued either by the state permitting authority or by an EPA Regional office. To obtain general permit coverage, the construction site operator must complete the required NOI and provide information such as project location and receiving waters. Construction stormwater general permits require operators of construction projects to develop and implement SWPPPs and conduct routine self-inspections. SWPPPs contain the majority of site-specific documentation of stormwater management activities performed. In limited instances, the state or EPA permitting authority may require certain construction projects (e.g., due to impaired receiving waters or to protect high-quality streams) to obtain coverage under an individual permit. When required, individual permits for construction activity typically contain requirements similar to those found in general permits; however, it is likely that the permittee will have specific monitoring requirements. Some construction stormwater permits (i.e., both individual and general) include effluent limits or *action levels* and associated effluent or receiving stream monitoring.

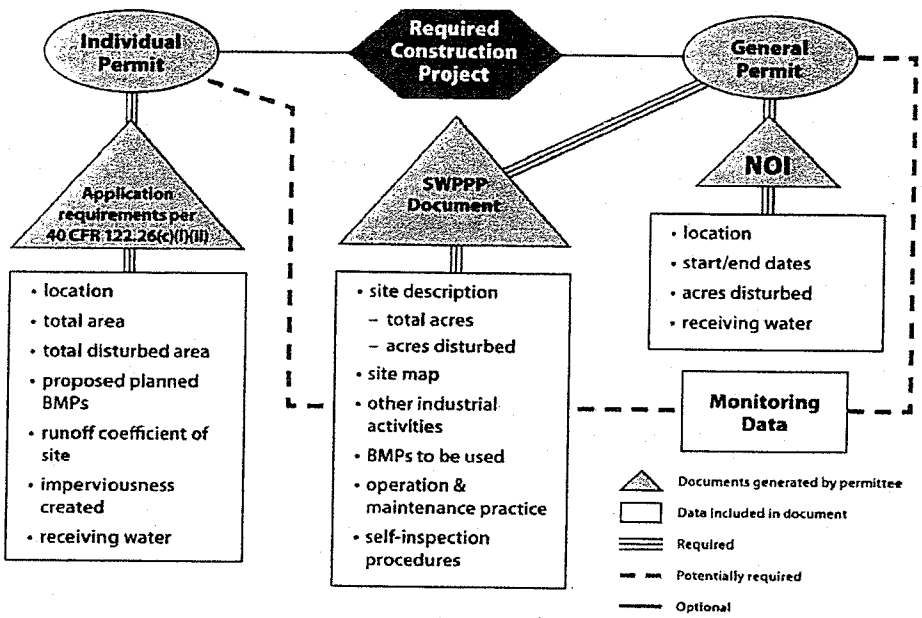


Figure 13. Required construction stormwater permit documents and associated information and data.

3.4. Resources

3.4.1. Stormwater Effects on Receiving Waters

1. USEPA (U.S. Environmental Protection Agency). 1983. *Results of the Nationwide Urban Runoff Program – Volume I Final Report.* U.S. Environmental Protection Agency, Water Planning Division, Washington, DC. www.epa.gov/npdes/pubs/sw_nurp_vol_1_finalreport.pdf

   The 5-year Nationwide Urban Runoff Program (NURP) was designed to examine the quality of urban runoff at different urban locations; whether urban runoff is a significant contributor to water quality problems in the United States; and the performance, effectiveness, and utility of management practices for controlling pollutant loads from urban runoff. This report presents the findings of the program.

2. USEPA. Undated. *Urbanization and Streams: Studies of Hydrologic Impacts.* U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, Washington, DC. http://epa.gov/owow/nps/urbanize/report.html. Accessed July 2008.

   This Web-based report summarizes the findings of a literature search to document physical impacts and indications of water quality problems associated with stormwater runoff. The report summarizes the review documents, articles and reports, and provides citations for further information.

3. Burton, Allen, and Robert Pitt. 2001. *Stormwater Effects Handbook: A Toolbox for Watershed Managers, Scientists, and Engineers*. Lewis Publishers, Boca Raton, Florida. www.epa.gov/ednnrmrl/publications/books/handbook/index.htm

This handbook is intended to be a working document that assists scientists, engineers, consultants, regulators, citizen groups, and environmental managers in determining if stormwater runoff is causing adverse effects and beneficial use impairments in local receiving waters. The handbook provides an extensive discussion of the effects of stormwater (based on information documented in a number of other studies and documents) and focuses on providing information to support the design of a sampling program to assess stormwater impacts.

4. Center for Watershed Protection. 2003. *Impacts of Impervious Cover on Aquatic Systems*. Center for Watershed Protection, Ellicott City, MD. www.cwp.org/Store/guidance.htm

This report examines more than 225 multidisciplinary studies documenting the hydrological, physical, water quality, and biological effects of urbanization and its accompanying IC.

5. Center for Watershed Protection's Stormwater Manager's Resource Center Web site: www.stormwatercenter.net/

3.4.2. Understanding Flow in TMDL Development

1. USEPA (U.S. Environmental Protection Agency). 2007. *An Approach for Using Load Duration Curves in the Development of TMDLs*. EPA 841-B-07-006. U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans, and Watersheds, Washington, DC. www.epa.gov/OWOW/tmdl/duration_curve_guide_aug2007.pdf

This document provides an overview on the use of duration curves for TMDLs, describing the basic steps needed to develop duration curves and subsequently identify loading capacities, LAs, WLAs, MOS, and seasonal variations. The guide also discusses some considerations and limitations in using the approach and includes several case examples.

2. USEPA (U.S. Environmental Protection Agency). 1999. *Protocol for Developing Sediment TMDLs*. EPA 841-B-99-004. U.S. Environmental Protection Agency, Office of Water, Washington, DC. www.epa.gov/owow/tmdl/sediment/pdf/sediment.pdf

This technical guidance document provides information to support TMDL writers in developing TMDLs for sediment. The document includes information on how to complete each step of the TMDL process, including problem identification, source assessment, linkage of water quality targets and sources, allocation analysis, and monitoring.

3. USEPA. 2005. *TMDL Model Evaluation and Research Needs*. EPA/600/R-05/149. U.S. Environmental Protection Agency, Office of Research and Development, National Risk Management Research Laboratory, Cincinnati, OH. www.epa.gov/nrmrl/pubs/600r05149/600r05149.htm

This report documents the review of more than 60 available watershed and receiving water models for their applicability to TMDL development and implementation. It discusses model selection on the basis of model capabilities and provides a series of tables rating the capabilities

or applicability the models using the categories of TMDL endpoints, general land and water features, special land processes, special water processes, and application considerations. The document also provides individual fact sheets for each reviewed model.

4. USEPA (U.S. Environmental Protection Agency). 2008. *Incorporating Green Infrastructure Concepts into Total Maximum Daily Loads.* U.S. Environmental Protection Agency, Washington, DC. www.epa.gov/owow/tmdl/stormwater/

   This 11 page fact sheet provides recommendations for incorporating GI and LID concepts into various elements of a TMDL and provides two TMDL case studies.

3.4.3. Chemical, Physical and Biological Data

1. EPA's Storage and Retrieval Database (STORET): www.epa.gov/storet/
2. USGS's National Water Information System Web site (NWISWeb): http://waterdata.usgs.gov/nwis
3. EPA's Environmental Monitoring and Assessment Program (EMAP) database: www.epa.gov/emap/index.html
4. USGS's National Water-Quality Assessment (NAWQA) Program: http://water.usgs.gov/nawqa/
5. USDA's PACFISH/INFISH Biological Opinion Program: http://fsgeodata.fs.fed.us/pibo/

3.4.4. Biological Assessment and Guidance

1. EPA's Biocriteria Web site: www.epa.gov/waterscience/biocriteria/
2. USEPA (U.S. Environmental Protection Agency). 2000. *Stressor Identification Guidance Document.* EPA 822-B-00-025. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC. www.epa.gov/waterscience/biocriteria/stressors/

   This document describes EPA's process for identifying any type of stressor or combination of stressors that cause biological impairment. The SI Guidance is intended to lead water resource managers through a formal and rigorous process that identifies stressors causing biological impairment in aquatic ecosystems and provides a structure for organizing the scientific evidence supporting the conclusions.

3. EPA's CADDIS Web site: http://cfpub.epa.gov/caddis/

   The Causal Analysis/Diagnosis Decision Information System (CADDIS) is an online application based on the process developed in EPA's SI Guidance Document. It uses a step-by-step guide, worksheets, and examples to help scientists and engineers find, access, organize, share, and use environmental information to evaluate causes of biological effects observed in aquatic systems such as streams, lakes, and estuaries.

4. EPA's list of bioassessment publications from EPA and other federal agencies (e.g., U.S. Geological Survey [USGS], U.S. Department of Agriculture [USDA]): www.epa.gov/bioindicators/html/publications.html

3.4.5. Permitted Stormwater Sources in a Watershed

1. EPA's list of state stormwater contacts: http://cfpub.epa.gov/npdes/contacts.cfm?program_id=6&type=STATE
2. EPA's list of Regional stormwater contacts: http://cfpub.epa.gov/npdes/contacts.cfm?program_id=6&type=REGION
3. EPA's PCS: www.epa.gov/enviro/html/pcs/index.html
4. EPA's eNOI system: http://cfpub.epa.gov/npdes/stormwater/enoi.cfm
5. Authorization Status for EPA's Stormwater Construction and Industrial Programs by State: http://cfpub.epa.gov/npdes/stormwater/authorizationstatus.cfm
6. USEPA (U.S. Environmental Protection Ageny). 2007. *MS4 Program Evaluation Guidance*. EPA-833-R-07-003. U.S. Environmental Protection Ageny, Office of Wastewater Management, Water Permits Division, Washington, DC. http://cfpub.epa.gov/npdes/docs.cfm?program_id=6&view=allprog&sort=name#ms4_guidance

   The MS4 Evaluation Guide is primarily for use by NPDES authorities to evaluate the quality of Phase I and Phase II MS4 programs, for permit compliance, technical assistance, and other purposes. It can be used for comprehensive program evaluations or for certain components. MS4 program managers can also use it to evaluate their own programs.

3.4.6. Land Use and Impervious Surface Coverages

1. Multi-Resolution Land Characteristics (MRLC) Consortium's National Land Cover Database (NLCD): www.epa.gov/mrlc/
2. National Agriculture Imagery Program (NAIP) Aerial Photos: http://165.221.201.14/NAIP.html
3. USGS's Earth Explorer: http://edcsns17.cr.usgs.gov/EarthExplorer/
4. USGS's Land Cover Institute: http://landcover.usgs.gov/
5. Google Earth: http://earth.google.com/

3.4.7. Field Reconnaisance and Illicit Discharge Detection

1. Kitchell, A., and T. Schueler. 2005. *Unified Stream Assessment: A User's Manual*. Version 2.0. Center for Watershed Protection, Ellicott City, MD. www.cwp.org/Store/usrm.htm#10

   This document outlines how to perform a Unified Stream Assessment, a rapid technique to locate and evaluate problems and restoration opportunities within the urban stream corridor. It also describes how to interpret the data collected to determine the stream corridor restoration potential.

2. Wright, T., C. Swann, K. Cappiella, and T. Schueler. 2005. *Unified Subwatershed and Site Reconnaissance: A User's Manual*. Version 2.0. Ellicott City, MD. www.cwp.org/Store/usrm.htm#11

The manual provides detailed guidance on how to perform each of its four components: the Neighborhood Source Assessment, Hotspot Site Investigation, Pervious Area Assessment, and the analysis of Streets and Storm Drains. Together, these rapid surveys help identify upland restoration projects and source control to consider when devising subwatershed restoration plans.

3. Brown, E., D. Caraco, and R. Pitt. 2004. *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments*. Prepared for the U.S. Environmental Protection Agency, Office of Water and Wastewater, Water Permits Division, Washington, DC, by Center for Watershed Protection and the University of Alabama. www.epa.gov/npdes/pubs/idde_manualwithappendices.pdf

Chapter 7 of this document describes the use of watershed reconnaissance to search for illicit discharge problems in the field, with the process consisting of rapid screening of priority outfalls in priority subwatersheds followed by indicator monitoring at suspect outfalls to characterize flow types and trace sources.

❶ Understanding the Connections Between TMDLs and Stormwater Permits
❷ Identifying Opportunities to Coordinate TMDLs and Stormwater Permits
❸ Characterizing Impairments and Stormwater Sources
❹ **Developing TMDLs with Stormwater Sources**
❺ Promoting Effective Stormwater Management
❻ Coordinating TMDLs and Stormwater Permits

Chapter Four
Developing TMDLs with Stormwater Sources

What's included in this chapter

- ✓ Discussion of considerations for selecting an approach for developing TMDLs with stormwater sources.
- ✓ Description of common analytical approaches that can be used for developing stormwater source TMDLs.
- ✓ Identification of factors that affect how stormwater sources are addressed in the TMDL analysis.
- ✓ Discussion of and examples illustrating options for calculating and expressing stormwater WLAs.

What you should know after reading this chapter

- ✓ The unique considerations for incorporating stormwater sources and calculating associated WLAs in a variety of commonly used TMDL development approaches.
- ✓ The advantages and disadvantages of different methods for developing stormwater-source TMDLs.
- ✓ Options for developing stormwater WLAs.

Potential roles and responsibilities under this activity

If you are a TMDL writer

1. Evaluate the potential approaches for developing your stormwater-source TMDL based on your technical and programmatic needs.
2. Select an approach for developing your stormwater-source TMDL.
3. Decide how to represent and include stormwater sources in your TMDL analysis.
4. Calculate WLAs for stormwater sources that will facilitate effective permit development.

If you are a stormwater permit writer

1. Coordinate with TMDL writer to support accurate and appropriate representation of stormwater sources in the TMDL analysis.
2. Provide input on WLA analysis to support development of equitable and feasible WLAs.

4. DEVELOPING TMDLS WITH STORMWATER SOURCES

The TMDL analysis establishes a quantitative link between pollutant sources and receiving water response to identify the loading capacity of an impaired waterbody that will result in meeting water quality standards. There are a number of approaches to support this analysis and selecting which to use for any given TMDL is often guided by a number of technical and practical factors. Developing stormwater-source TMDLs can present some unique technical considerations that affect what approaches can be used and how they are applied. As shown in Figure 4, this chapter discusses the activities related to calculating the TMDL and its associated allocations. To address these activities as related to stormwater-source TMDLs, the chapter first introduces a number of approaches for developing stormwater-source TMDLs and then discusses the following:

- Selecting an approach for developing the stormwater-source TMDL
- Applying that approach to develop the TMDL
- Expressing stormwater WLAs

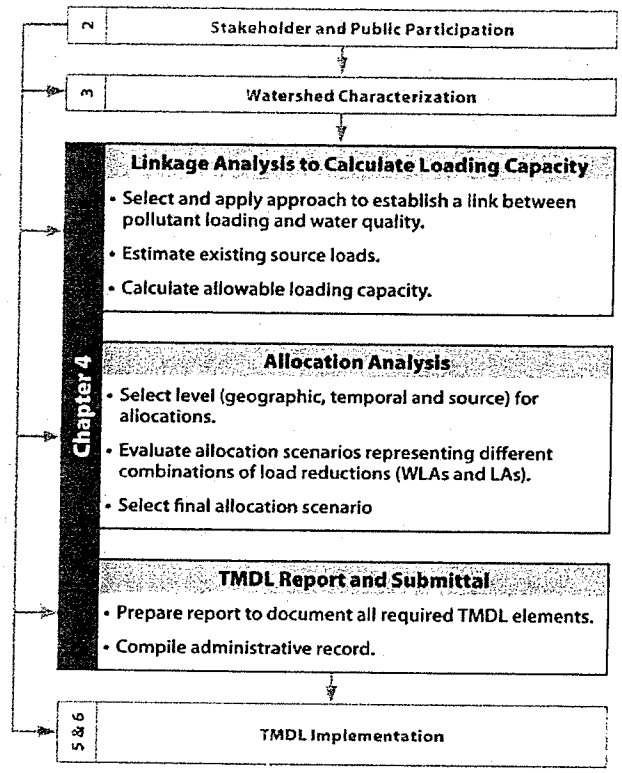


Figure 14. Illustration of the steps in the TMDL process, including activities related to calculation and documentation of the TMDL and its allocations.

4.1. Overview of Approaches for Developing TMDLs

There are a handful of approaches that are commonly used for developing TMDLs. This section briefly introduces these approaches, and Sections 4.2 and 4.3 describe the considerations for their selection and application when dealing with stormwater sources.

The types of TMDL approaches discussed fall into to two major categories—modeling approaches and non-modeling approaches. The term *model* describes the set of equations or algorithms that are used to simulate a physical system. In this report, model refers to the available software tools that automate the calculation of equations or groups of equations representing the system. These can include watershed models that simulate the processes related to surface runoff and receiving water models that simulate a range of waterbody conditions and processes. *Non-modeling* approaches include those approaches that are not based on a standardized, automated software that simulates watershed or waterbody processes. They

> ***Resources:*** For more information the general approach for calculating TMDLs, refer to the Resources list at the end of this chapter in Section 4.5.1.

include those approaches that are based on monitoring data, empirical equations or other statistical or site-specific calculations. Examples include load duration curves developed using observed flow and water quality data and simple mass-balance calculations.

Within those categories, there are various types of approaches, all of which can be further characterized according to the type of simulation or calculation they perform. The approaches either calculate land-based loads or the resulting waterbody loads. Table 6 presents the types of approaches discussed in this section and their respective categories of modeling vs. non-modeling and land-based vs. waterbody-based. The *land-based* approaches calculate loading from land-based runoff processes assuming some measure of precipitation and characteristics representative of the watershed (e.g., soils, imperviousness). The *waterbody-based* approaches calculate the *delivered* load in the waterbody on the basis of in-stream conditions, either using observed monitoring data (i.e., concentration and flow) or assuming some user-defined load inputs and outputs. Many of these approaches are applied in combination to represent both source loading and waterbody response to establish a loading capacity and associated WLAs and LAs to meet water quality standards.

Table 6. Commonly used TMDL approaches

Calculation process	Type of TMDL approach	
	Modeling	Non-modeling
Land-based	▪ Watershed models (simple to complex)	▪ Export coefficients ▪ IC method ▪ Simple Method
Waterbody-based	▪ Receiving water models (simple to complex, hydrodynamic and water quality)	▪ Load duration method ▪ Percent reduction method ▪ Mass balance or steady-state analysis

The following discussion provides a brief description of these common TMDL approaches. More detail on their application in stormwater-source TMDLs is then provided, with examples, in Section 4.3.

4.1.1. Land-based Approaches

The following are brief descriptions of several land-based approaches used for TMDL development:

- **Watershed Model.** Many TMDLs use watershed models to evaluate existing and allowable pollutant loads to identify allocations, load reductions, and management scenarios. This group of models emphasizes description of watershed hydrology and water quality, including runoff, erosion, and washoff of sediment and pollutants. Some models simulate only the land-based processes, while some can also include linked river segments and simulate in-stream transport and water quality processes. Watershed models vary in the level of detail, including what processes they simulate and the simulation timestep (e.g., daily vs. monthly). The complexity of watershed models can range from the use of loading functions—empirically based estimates of load based on generalized meteorologic factors (e.g., precipitation, temperature)—to physically based simulations—scientifically based equations to represent the physical, chemical, and biological processes associated with runoff, pollutant accumulation and washoff, and sediment detachment and transport. An example of a loading function model is Generalized Watershed Loading Functions (GWLF), which simulates basic watershed processes related to weather, erosion, and runoff and pollutant washoff and does not include waterbody response or in-stream fate and transport. GWLF provides watershed load and flow estimates on a monthly basis. Alternatively, Hydrologic Simulation

Program – Fortran (HSPF) combines watershed processes with in-stream fate and transport to simulate watershed hydrology, land and soil contaminant runoff, and sediment-chemical interactions. HSPF can generate time series results of any of the simulated processes on a daily or even sub-daily timestep.

- **Export Coefficients/Pollutant Budgets.** This category encompasses a number of approaches built on empirical relationships among watershed processes and pollutant loading as well as the use of literature values of typical watershed loading rates. Examples include using monthly load rates from various land uses to calculate allowable loading from an impaired watershed. Another example is using an empirical relationship that allows a user to calculate an allowable load depending on desirable conditions (e.g., target runoff/waterbody concentration or indicator levels). This approach would typically be used to calculate existing loads and would often be combined with a supplementary approach that calculates an allowable load on the basis of in-stream targets (e.g., percent reduction). Another approach that could fall within this category is a Vollenweider type approach where an empirical equation relating reservoir tropic status to allowable phosphorus loading is used to identify an allowable load corresponding to the desired reservoir condition.
- **IC Method.** This emerging method calculates a target of percent IC in a watershed to represent attainment of water quality standards. Available data are used to relate the percent IC with the resulting runoff, pollutant loading, and waterbody response to calculate the loading capacpity.
- **Simple Method.** The Simple Method is an empirical equation used to calculate pollutant loading on the basis of drainage area, pollutant concentrations, a runoff coefficient, and precipitation. In the Simple Method, the amount of rainfall runoff is assumed to be a function of the imperviousness of the contributing drainage area. When using the Simple Method, the TMDL loading capacity would typically be calculated using a combination approach with a waterbody-based approach such as the percent reduction method.

4.1.2. Waterbody-based Approaches

The following are brief descriptions of several waterbody-based approaches used for TMDL development:

- **Receiving Water Model.** Receiving water models simulate conditions within a receiving waterbody (e.g., lake, stream, estuary) on the basis of a representation of physical, chemical and biological processes. Inputs to the waterbody are often defined as user-defined boundary conditions or using linked dynamic output from a watershed model. Receiving water models are typically either steady-state or dynamic models. Steady-state models operate under a single, nonvariable flow condition with constant inputs, typically used to evaluate conditions for a design or critical flow. Dynamic models allow for variations in both flow and meteorologic conditions on a small timestep, typically shorter than daily. Level of complexity in receiving water models is also determined by spatial detail described as one, two, or three dimensions.
- **Load Duration.** The load duration methodology relies on using observed flows and water quality criteria to establish a curve of loading capacities for various flow conditions. This builds on using flow duration curves, which use hydrologic data from stream gages to evaluate the cumulative frequency of historic flow data over a specified period. A water quality criterion or other target concentration can then be multiplied by the observed flows to create a curve representing the distribution of allowable loads as a function of daily flow, representing the loading capacity of the stream. The entire curve can be used to represent flow-variable loading capacities, or allowable loads

can be identified for specified flow intervals, which can be used as a general indicator of hydrologic condition (e.g., wet versus dry).

- **Percent Reduction.** This method assumes a 1:1 relationship between surface water concentrations and pollutant loading. The existing pollutant concentrations are compared to applicable water quality criteria to calculate a necessary reduction. This reduction is then applied to an estimate of *existing* loading to calculate the loading capacity to meet water quality standards. Existing loads are often calculated using ambient monitoring data (e.g., concentration and flow) or some estimation of land-based loading (e.g., export coefficients).
- **Mass Balance or Steady-State.** These approaches rely on the assumption of conservation of mass into a waterbody. The analysis might calculate loads entering a waterbody using export coefficients or observed data and calculate the resulting waterbody concentrations on the basis of estimated losses (e.g., settling, decay) and inputs. The approach relies on identifying the necessary loads entering a waterbody that will meet the desired waterbody target after considering all inputs and losses. These approaches can be applied for a steady-state critical condition or longer time periods, such as average monthly loading rates.

4.2. Selecting an Approach for Developing Stormwater-Source TMDLs

TMDL writers often consider a number of factors when deciding which approach to use to calculate the loading capacity and associated LAs and WLAs for TMDLs. As shown in Figure 15, these can include user needs or requirements, programmatic considerations, and technical needs. While user needs and programmatic considerations often guide the general type of approach (e.g., simple vs. complex, modeling vs. non-modeling), the technical considerations often guide the selection of a specific approach or methodology. The technical considerations define the following needs for the TMDL analysis:

- Spatial scale/resolution
- Temporal resolution/time scale
- Processes or features that need to be included (e.g., pollutant type, surface runoff, in-stream transport)

The watershed characterization step of TMDL development (Chapter 3) should generate the necessary information to define these needs by providing an understanding of the impaired waterbodies, the surrounding watershed and the associated impairments. Specifically, the major considerations or questions that were addressed during the watershed characterization that can support selection of an appropriate approach for TMDL development include the following:

- What are the applicable water quality criteria?
- What are the sources?

Tip: Evaluating Stormwater Issues when Selecting a TMDL Approach

Stormwater-source TMDLs can present unique considerations affecting selection and application of a TMDL approach. TMDL writers should evaluate stormwater-specific considerations within the context of *all* the issues and characteristics of the TMDL, waterbody, and associated watershed. If stormwater is a significant source affecting water quality, these considerations might carry more weight in the decision-making process; however, they should be evaluated with all watershed-specific issues when selecting the most appropriate approach.

- What are the impairments and associated critical conditions?

Table 7 summarizes the considerations related to each of the three technical needs for these defining topics of water quality standards, impairment, and sources. The answers to the questions outlined in Figure 15 and more specifically in Table 7 will guide approach selection for TMDL development. While these questions and considerations will not be much different for a stormwater-source TMDL than for any other TMDL, there might be some unique issues related to stormwater that will affect the selection of an appropriate approach for TMDL development. The following section discusses these stormwater-specific issues to be considered when selecting an approach for TMDL development.

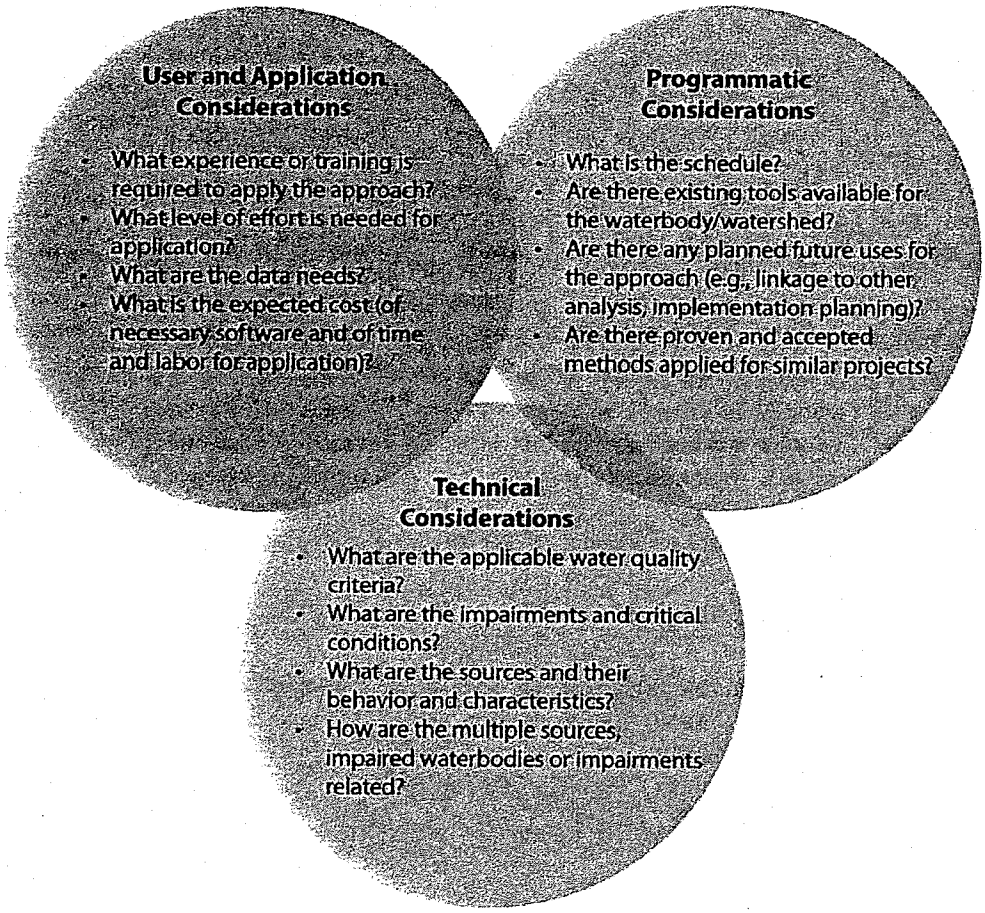


Figure 15. Considerations for selecting a TMDL development approach.

Table 7. Summary of technical considerations for selecting a TMDL development approach

Technical needs of approach	Technical considerations for approach selection		
	Water quality criteria and TMDL targets	Impairments and critical conditions	Sources
Spatial Needs	▪ Are different criteria or TMDL targets applicable in different locations within the watershed?	▪ How many impaired segments are being addressed? ▪ What are the location and distribution of impaired segments?	▪ What type of sources/land uses exist in the watershed? ▪ What are the location and distribution of sources? ▪ At what level do the sources need to be isolated (e.g., gross loading vs. land use specific loading)?
Time-scale Needs	▪ What are the duration and frequency of applicable criteria or targets?	▪ What is the timing associated with impairment (e.g., instantaneous vs. chronic or cumulative effects)? ▪ Are there any temporal trends to capture (e.g., seasonality in waterbody conditions)?	▪ Are the effects due to cumulative or acute loading conditions? ▪ Are there temporal variations in source loading (e.g., due to weather patterns, seasonal activities)? ▪ At what temporal scale do the sources need to be estimated?
Processes to Include	▪ Is criterion based on pollutant level (e.g., concentration) or a measure of response or condition (e.g., flow, habitat quality, eutrophication)? ▪ What are the pollutants?	▪ Is impairment based on a specific pollutant (e.g., sediment, metals) or based on cumulative effects of stressors (e.g., flow, habitat quality, pollutants)? ▪ Is meeting the target dependent on or affected by multiple waterbody measures (e.g., nutrient levels, temperature, pH)? ▪ What are the waterbody critical conditions for loading response (e.g., dynamic, flow variable vs. steady-state)? ▪ If dealing with multiple pollutants, how are they related?	▪ What is the source loading behavior (e.g., precipitation-driven, direct discharge)? ▪ Do sources impact multiple impaired segments (i.e., need for in-stream routing and transport)? ▪ Does the analysis need to evaluate individual and/or cumulative impact of sources?

4.2.1. How Are Water Quality Criteria or TMDL Targets Expressed?

The ultimate goal for any TMDL is to restore the impaired waterbody to meet water quality standards. As discussed in Section 3.2, identifying a TMDL target is typically based on using a numeric water quality criterion or interpreting narrative criteria. The expression of the resulting TMDL target can influence what types of TMDL development approaches are appropriate and how a TMDL analysis considers and represents water quality standards attainment. In many respects, considering the TMDL target for selecting an approach for a stormwater-source TMDL is no different than for any other TMDL. For example, numeric water quality criteria (or a numeric target representing narrative criteria) have an associated magnitude, duration, and frequency. The applicability of an approach can be affected by its ability to simulate at a time-scale necessary for comparison to the water quality target's magnitude, duration and frequency. Targets designed to address acute (short-term) impairments are typically based on instantaneous maximums or daily averages while chronic (long-term) problems (e.g., eutrophication, sediment loading and deposition) can be represented by targets with longer durations (e.g., monthly average concentration, annual loading).

As discussed in Section 3.2, an issue unique to stormwater-source TMDLs is the use of surrogate targets (e.g., flow volume, percent IC) to represent the combined effects of stormwater quantity and quality on maintenance of water quality standards. In these situations, the use of a surrogate target will have a direct bearing on the choice of the technical approach. For example, if using an IC target, the approach chosen must be able to calculate flows from varying levels of imperviousness. Similarly, an analysis that uses peak flow as a target and identification of TMDL allocations and subsequent controls will depend on controlling flow volumes and peak flows, it will be necessary to use an approach that can either simulate the hydrology and hydraulics of a system in response to watershed characteristics or one that can otherwise relate in-stream flow conditions to watershed characteristics (e.g., imperviousness).

> ***Tip: Select an approach consistent with water quality standards***
>
> Regardless of the significant pollutant sources, the TMDL writer should select a technical approach that is suitable for the pollutant of concern. For example, some models do not simulate certain pollutants and, therefore, are not appropriate for certain types of TMDLs. The approach should also provide the necessary output to allow for a direct comparison to the temporal duration specified in water quality criteria.

In Practice: Integrating Stormwater Runoff Volume as a Surrogate for Water Quality Standards into a TMDL Approach in Potash Brook, Vermont

Vermont's water quality standards provide for the use of numeric biological indices to determine the condition of fish and aquatic life based on reference conditions for different waterbody types. Potash Brook, near Burlington, is on Vermont's section 303(d) list as a result of biological impairments, including loss of sensitive taxa, and a compositional shift toward more tolerant species in macroinvertebrate communities. Data suggests that degraded habitat and increased sedimentation are the highest concerns, most likely caused by changes in water flow and increases in sediment erosion and deposition. To effectively address biological impairments in Potash Brook, the Vermont Department of Environmental Conservation selected stormwater runoff volume as a surrogate TMDL measure to represent issues associated with the following:

- Sediment delivered through erosion processes
- Physical effects on the stream channel such as sediment release from channel erosion and scour from increased flows
- Diminished base flow (e.g., decreased groundwater recharge)
- Amount of other potential pollutants (e.g., nutrients, toxics) delivered to Potash Brook is a function of the amount of storm water runoff generated within the watershed.

A high-flow reduction target was established on the basis of the hydrologic conditions of two reference watersheds where aquatic life criteria are attained. Flow duration curves were used to evaluate existing and target conditions for the stream and establish the TMDL. Flow duration curves were developed for both Potash Brook and the reference watersheds, and the difference between the 0.3 percent duration point on the curves was used to derive the reduction target. The 0.3-percentile flow represents the flow that is exceeded by only 0.3 percent of the measured flows and was selected because it approximately equals the one-year flow and the channel forming flow for this stream. The vast majority of reductions are assigned to the WLA, which applies to runoff from urban and developed portions of the watershed, and includes an allocation for future growth. The LA applies to the limited agricultural and open space portions of the watershed.

More information on the Potash Brook TMDL (2006), as well as other hydrology-based TMDLs approved in Vermont, is available at www.anr.state.vt.us/dec//waterq/stormwater/htm/sw_impairedwaters.htm. Other examples of hydrology-based TMDLs include Maine's Barberry Creek (2007) available at www.maine.gov/dep/blwq/docmonitoring/impairedwaters/TMDL/2007/barberry_ck_rep.pdf and Connecticut's Eagleville Brook (2007) available at www.ct.gov/dep/lib/dep/water/tmdl/tmdl_final/eaglevillefinal.pdf.

4.2.2. What Are the Stormwater Sources Affecting Impairment?

Analysis during the previous activity of characterizing the impairment and pollutant sources (Chapter 3) identified the regulated stormwater sources in the watershed that contribute to the impairment of concern. The TMDL writer should also have a general understanding of the relative importance of each source, which can guide decisions regarding technical approaches for TMDL development. It is important that a TMDL approach be able to represent important sources in a way that captures the sources' effect on water quality to calculate appropriate allocations. This is no different for stormwater sources than for other types of point or nonpoint sources. Therefore, when stormwater is a major source affecting impairment, it is important to consider its characteristics when selecting an approach. As discussed in the followings sections, which type of approach is selected for stormwater-source TMDLs will be influenced by the type of sources, size of the source area, and how the source generates and delivers pollutants of concern.

Characteristics of Stormwater Sources that Can Affect Approach Selection

- Type and distribution of sources
  - Pollutant generating activities
  - Spatial coverage
- Pollutant Delivery
  - Timing of loading
  - Delivery mechanism

4.2.2.1. Type and Distribution of Sources

If regulated stormwater sources are within the watershed of the impaired waterbody and discharge the pollutant of concern, they will be included in the TMDL analysis. However, there are varying levels of detail at which the sources can be characterized and quantified in the analysis, affecting both the selection and application of a TMDL approach. Decisions regarding the level of detail for including stormwater sources can include not only the spatial resolution at which sources are represented within the analysis, but also the types of spatial units (e.g., subwatershed, land use types) that can be included and how they are spatially related and represented in the analysis. These decisions will depend primarily on the significance of each source in their effect on the impairment of concern. For example, perhaps an MS4 in an impaired watershed is expected to be a minimal source of the pollutant of concern, whether because it covers a small portion of the watershed, it has already installed a number of effective controls minimizing its effect, or other active sources in the watershed (e.g., agriculture, mining, forestry) contribute significantly more pollutant load. In such a case, it might be appropriate to choose an approach that does not specifically include or calculate loads originating with individual stormwater sources but rather evaluates a cumulative load from all sources (e.g., load duration) and then distributes the total load among sources. Alternatively, if there are multiple regulated stormwater sources in the watershed, including MS4, construction, and industrial, that all represent major contributions of pollutant loading to the system, it will likely be necessary to choose an approach (e.g., watershed model) that can evaluate the watershed at a finer scale, both temporally and spatially, to isolate the source-specific loadings and evaluate their effect on water quality.

One of the first considerations regarding sources is how well they are understood. The analysis of impairment conditions and sources discussed in Chapter 3 helps the TMDL writer understand what and how sources are affecting impairment. This can help to identify the type of information that the technical approach will need to include and also produce, thereby narrowing the range of approach options. If sources and their impacts are well understood based on available data and local knowledge, it might not be necessary to use an approach that evaluates individual sources or provides the ability to predict effects from existing and future source inputs. Some approaches, such as receiving water modeling, can

potentially provide a great deal of information on how known sources will affect receiving water quality but will not provide much information on unknown sources. Land-based watershed modeling, on the other hand, can help to quantify the relative significance of various sources such as urban runoff compared to point source discharges. Data-driven approaches, such as load duration curves, that rely on evaluation of in-stream loads based on monitoring data are very useful when significant observed data are available and the impairments predominantly occur during certain flow conditions. However, they do not typically support direct calculation of loads originating from individual sources and require a supplementary analysis to do so.

Also affecting approach selection is the decision of the spatial resolution for representing the individual stormwater sources in the approach. Stormwater sources can have a variety of activities within their boundaries that contribute to pollutant loads. For example, within an MS4 different land uses (e.g., residential vs. commercial) and areas can contribute varying magnitudes of loads. It might be important to capture those variations in pollutant loading and evaluate subareas within the MS4 boundary, such as areas that drain to certain outfalls or different land uses, to more effectively target BMP implementation. Therefore, it would be appropriate to use an approach that can isolate and calculate pollutant loading from specified *sub-sources*. For example, using a watershed model allows for the inclusion of multiple types of land areas that are represented by characteristics (e.g., soils, pollutant accumulation, imperviousness) that can vary by land use or type, allowing a TMDL writer to not only isolate loads generated within a stormwater source boundary but also by other characteristics such as land use. However, approaches that do not specifically calculate loads from individual sub-sources can still accommodate and capture these variations depending on how they are applied. For example, while a load duration approach calculates a total allowable in-stream load without direct calculation of source-based loads, it can be applied at multiple strategic locations to capture the variability in loading from different sources.

Alternatively, an area within a source's boundary might be small or fairly homogenous, without much variation in pollutant generation. For example, regulated construction sites are relatively small in area and would not likely require further division within their boundaries. As another example, depending on the overlap of an MS4 and the watershed of an impaired water, the portion of the MS4 within the watershed might represent similar land uses and activities (e.g., all residential areas). In these cases, it is likely appropriate to use an approach that evaluates loading on a coarser level, possibly evaluating the cumulative load to an impaired waterbody rather than area-specific inputs.

If regulated construction stormwater sources are important in your watershed, they might present a different set of considerations and challenges for the TMDL analysis than MS4s or industrial sites. Again, there is the question of spatial coverage but also one of temporal effects. MS4s and industrial are static with a definable boundary, while regulated construction sites represent a *moving target* in that they have definable boundaries, but their existence and effects are more intermittent. The temporal aspect of the locations, magnitudes, and activities related to stormwater from construction sites makes it difficult to include in a TMDL analysis. Through the stormwater source characterization and the impairment analysis, the TMDL writer should determine whether construction is an important potential source given the characteristics of the watershed and the impairment. For example, if the watershed is experiencing rapid growth and expansion, construction could be a significant current or future source and might require specific representation in the TMDL analysis. Or perhaps the watershed had a number of construction sites that were active during the time the waterbody was identified as impaired, but the sites are no longer active or contributing to the impairment. In such cases, it might be necessary to select an

approach that can evaluate the temporal variations in waterbody conditions on the basis of time-variable source inputs and other watershed factors (e.g., weather). This type of evaluation is most directly accomplished using a time-variable watershed model. However, other non-modeling approaches can be applied to represent different time frames and source inputs to more generally evaluate the variable effects over time. This can allow the TMDL writer to evaluate past, current, and future conditions related to construction impacts.

Another level of detail in spatial resolution when representing stormwater sources is the potential for including loadings from individual outfalls. While the location of outfalls should be known, it is not always feasible to include or analyze loadings from individual outfalls in a TMDL analysis. To evaluate outfall-specific loads and effects, it is necessary to have data to characterize the outfall discharge (e.g., flow, pollutant concentrations) for at least the critical conditions (e.g., high flows) but preferably under a range of conditions. Data to support this level of detail are often not available. However, if sufficient data are available, it is important to consider the added benefit as well as the added effort in conducting the analysis. The TMDL writer along with the permit writer should identify the benefits of evaluating loading at the outfall level and whether those same benefits could be achieved by conducting the analysis at a broader scale (e.g., subwatershed level) and likely with less expended effort and resources.

4.2.2.2. Pollutant Delivery

How and when a pollutant is delivered to a receiving waterbody is an important consideration in selecting an appropriate TMDL approach. For stormwater-related sources, the typical pathway for pollutants is accumulation and washoff, where overland runoff transports pollutants deposited on land surfaces to stormwater conveyances and eventually receiving waterbodies. However, depending on the type of pollutant, the timing of delivery or mode of transport can present unique needs for a TMDL development approach. For example, many pollutants are delivered in dissolved form in stormwater runoff, while others can be transported adsorbed to sediment particles. Waterbodies that are impaired by sediment-associated pollutants such as phosphorus or organics can therefore require an approach that simulates the processes of sediment erosion and transport to fully evaluate the pollutant loading and impacts.

In addition to the delivery pathway, the timing of pollutant loading is another consideration for the evaluation of stormwater. Stormwater is typically driven by precipitation events and subsequent runoff and discharge. However, dry-weather flows delivered through MS4 infrastructure caused by such things as automobile washing and lawn watering also might be a source of loading to a waterbody, especially in arid regions. This situation might require a TMDL approach that can evaluate both precipitation-driven sources during wet weather and also direct inputs occurring during dry weather. For example, load duration curves and watershed models can be applied to evaluate loads for different flow conditions.

Regardless of the conditions of delivery, stormwater source activity can also occur during different times of year. For example, pollutants associated with deicing and winter road maintenance are more likely to be deposited and delivered during winter months while pollutant runoff from residential car washing might be more frequent during warmer summer months. These situations might warrant a TMDL approach that can evaluate and capture the variations in pollutant loading across months and seasons. For example, many watershed models can produce either daily continous loads or monthly loads that would capture the variations in loading during different seasons.

4.2.3. What Are the Critical Conditions?

As discussed in Chapter 3, the critical conditions for a TMDL represents the combination of environmental conditions (physical, chemical and biological) under which impairment occurs. This can include such things as the environmental processes that affect impairment (e.g., nutrient dynamics affecting dissolved oxygen levels, flow modification due to increased development affecting in-stream habitat) and the timing of impairment (e.g., certain months or times of day). From the characterization step discussed in Chapter 3, the TMDL writer should understand the impairment and the effect of stormwater sources on receiving water quality and can now evaluate how to capture that in the selected approach.

For example, some stormwater-related impairments are not associated with specific pollutants and therefore require the analysis of a variety of pollutants and processes to capture the impairment conditions. Evaluating the effects of stormwater and identifying necessary allocations might require the evaluation of such things as sediment delivery and deposition, peak flows, and nutrient loading and resulting eutrophication dynamics. Another example is critical conditions related to low dissolved oxygen that can be affected by the timing and availability of nutrient loads and also on seasonal factors such as temperature, resulting algal growth, and flow. The TMDL writer should evaluate the processes that need to be included to sufficiently represent the critical conditions when selecting an approach for developing the TMDL.

In Practice: Selecting a TMDL Approach to Capture Critical Conditions in Ballona Creek, California (2005)

Segments of Ballona Creek and Sepulveda Canyon Channel were included on 1996, 1998, and 2002 303(d) lists for cadmium, copper, lead, selenium, silver, zinc and toxicity. Data analysis indicates differences in waterbody conditions (e.g., water quality, flow) and sources between dry and wet weather. To capture the varying critical conditions and source loading, two distinct approaches were used to develop the TMDL.

Because the metals criteria are based on hardness, separate wet- and dry-weather targets were developed to reflect the different hardness values and flow conditions in the creek and its tributaries. For the purpose of this TMDL, wet weather is defined in terms of flow rather than rainfall. Wet weather is defined as any day in which the maximum daily flow is equal to or greater than 40 cubic feet per second (cfs) based on the 90th percentile of flows measured over a 10-year period.

The dry-weather loading capacity for each metal was derived by multiplying the hardness-adjusted, dry-weather numeric targets by the critical flow assigned to these two waterbodies. The wet-weather TMDL calculation was based on the simulation of the hydrologic processes and watershed metals loading using a watershed model (HSPF). Using simulated flows and metals concentrations, a load duration curve approach was used to establish the wet-weather loading capacity. Loading capacities were calculated by multiplying the daily storm volume by the appropriate numeric water quality target.

A grouped mass-based WLA was developed for stormwater permittees (Los Angeles County MS4, Caltrans, General Industrial and General Construction) for both dry weather and wet weather. Because there are no identified areas in the watershed that discharge directly to Ballona Creek or a tributary rather than through the storm drain system, the WLA was equal to the calculated loading capacity minus the estimated loads from atmospheric deposition. The grouped stormwater WLA was partitioned among the MS4 permittees (77,546 acres) and Caltrans (1,080 acres) using an estimate of the percentage of land area covered under each permit.

The Ballona Creek metals TMDL report is at www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/2005-007/05_0831/StaffReport.pdf.

4.3. Applying Approaches for Stormwater-Source TMDLs

Once an approach is selected for TMDL development, the TMDL writer will apply the approach to calculate the loading capacity and associated allocation for sources. While all sources present challenges in deciding how to accurately represent their inputs and effects, stormwater sources can require some unique considerations when applying a TMDL approach. The two key issues to address when developing TMDLs with stormwater sources are

1. How to represent stormwater source characteristics (e.g., discharge flows and concentrations)
2. How to isolate and estimate the loads transported and discharged through the stormwater system

Several commonly used TMDL approaches were introduced previously in Section 4.1. This section discusses the considerations for developing TMDLs with stormwater sources using these different methods and is organized according to whether the approach is land-based or waterbody-based, as identified in Table 6. Table 8 summarizes the advantages and disadvantages of each method, and the following sections provide more detail on their application for stormwater-source TMDLs.

Table 8. Summary of commonly used TMDL development approaches

Approach	Can be combined with...	Advantages	Disadvantages
Land-based Approaches			
Watershed Models	▪ Receiving Water Model ▪ Load Duration Curves	▪ Can directly simulate regulated stormwater sources as distinct hydrologic units to facilitate better representation of source inputs. ▪ Enables source-level allocations ▪ Provides flexibility in expression of allocations, from gross to detailed, site-level (if detailed model is used). ▪ Provides time-variable simulation and results to better represent varying conditions for regulated stormwater source inputs and impacts (if dynamic model is used). ▪ Flexibility in how model is set up to represent land units allows for simulation of subareas or land uses within regulated stormwater source boundaries to define spatial inputs and impacts for targeting implementation. ▪ Allows users to simulate potential changes in water quality conditions that might result from implementation activities.	▪ Requires significant data and analysis if outlet-level allocation is necessary. ▪ Direct simulation of stormwater sources is dependent on accurate information on drainage areas and runoff. ▪ Moderate or general watershed models (e.g., those with monthly time-steps) have limited capabilities for temporal evaluation or highly variable stormwater sources. ▪ Model accuracy dependent on having sufficient water quality data for calibration. ▪ Requires trained or experienced staff to run the model and understand model assumptions and limitations.
IC Method	▪ Watershed Models ▪ Load Duration Curves	▪ Because area of impervious surfaces is easily explained and tangible, can be more understandable to the public. ▪ Is translated more easily into management actions.	▪ Requires supplemental analysis and data to support linkage to a load . ▪ Requires sufficient data to support the link between IC and water quality standards. ▪ Is not appropriate for waterbodies affected by a mix of sources other than urban runoff.

Approach	Can be combined with...	Advantages	Disadvantages
Export Coefficients	▪ Percent Reduction ▪ Load Duration Curves	▪ Is simple to apply.	▪ Is usually based on regional or national literature values that might not be representative of local conditions. ▪ Does not provide a direct link to waterbody conditions and use support.
Simple Method	▪ Percent Reduction ▪ Load Duration Curves	▪ Is useful in watersheds lacking flow data. ▪ Is specifically designed to evaluate stormwater pollutant loads from impervious areas.	▪ Assumes all loading originates on impervious surface during storm events, not accounting for runoff from impervious areas or subsurface inputs and baseflow loading. ▪ Because it uses a static runoff concentration, does not account for variability in loading or in-stream levels. ▪ Not appropriate for large watersheds (>1 mi^2) or non-urban areas.
Waterbody-based Approaches			
Receiving Water Models	▪ Watershed Model ▪ Mass Balance	▪ Represents a high level of spatial variability within a waterbody, allowing for detailed outfall-based allocations ▪ Provides time-variable simulation and results to better represent varying conditions for regulated stormwater source inputs and impacts (if dynamic model is used).	▪ When applied independently, is limited to allocations set for specific input points; requires combination with a watershed model for land-based allocation analysis. ▪ Provides limited allocation opportunities when source is not discharging directly to the receiving water (e.g., for construction sites in upland locations). ▪ Provides limited allocation options when applied as a steady-state (non-dynamic) modeling application.
Load Duration	▪ Watershed Models ▪ Simple Method	▪ Is based on observed monitoring data, providing a data-based representation of existing conditions. ▪ Identifies the allowable and existing loads for all flow conditions, providing insight into the critical conditions and accounting for the natural variations in loading and in-stream conditions. ▪ Because it is based on observed in-stream conditions, can capture the effects of unknown sources (e.g., failing septic systems, illicit connections).	▪ Provides limited information regarding the relative magnitude of source loads. ▪ Requires supplemental analysis to distribute loading capacity into source-based allocations. ▪ Requires robust and consistent records of flow and in-stream water quality data. ▪ Is applicable only to non-tidal streams or rivers.
Percent Reduction Method	▪ Simple Method ▪ Export Coefficients	▪ Is simply and quickly applied. ▪ Easy for the public to understand.	▪ Assumes a 1:1 relationship between reductions in pollutant loading and resulting reductions in concentration. ▪ Does not calculate source-based loads, requiring supplementary analysis to identify stormwater WLAs.

Approach	Can be combined with...	Advantages	Disadvantages
Mass Balance or Steady-state Analysis	▪ Receiving Water Models	▪ Relatively simple to apply. ▪ Is based on observed monitoring data, providing a data-based representation of existing conditions.	▪ Typically focuses on a single critical condition (e.g., critical flow) or long-term average conditions (e.g., monthly loading and concentration), not allowing for evaluation of variability in pollutant loading or waterbody conditions. ▪ Simple representative of pollutant fate and transport.

4.3.1. Land-based Approaches

This section discusses the modeling and non-modeling TMDL approaches that evaluate land-based loading or conditions and issues related to their use in stormwater TMDLs.

4.3.1.1. Watershed Models

Watershed models are commonly applied to provide a quantitative linkage between source contributions and waterbody response for TMDL development. This category of models loosely refers to numerical frameworks that address a combination of land-based rainfall/runoff and contaminant loading processes and conveyance of flow and contaminants within a stream, impoundment, or some other type of receiving waterbody. Commonly available data used to drive watershed models and accurately simulate conditions within receiving waters include land cover, soil type, meteorological characteristics, and stream/impoundment dimensions. The level of complexity associated with each of these models varies widely from annual flow and contaminant load delivered from a watershed to sub-hourly prediction of detailed hydrologic processes at the land use or site level.

While structure and simulated processes vary from one model to the next, watershed models provide a useful basis for allocation to watershed sources contributing to waterbody impairment, including permitted stormwater sources. Most watershed models perform calculations on a land unit basis. That is, the modeler divides a drainage area into smaller land units to enhance representation of heterogeneities. These land units can represent variable soil characteristics, political boundaries, or more commonly, land use or cover. Many models take this land cover breakdown one step further and represent impervious and pervious land cover types using different mathematical formulations. Impervious land, for example, is not subject to infiltration and associated subsurface processes. Figure 16 illustrates how a typical watershed model categorizes each area of land by land use type (e.g., residential, forest, agriculture) and then routes flow and loads delivered from those within each watershed to the receiving waterbody. Watershed models typically have the capability to separate the watershed into a number of smaller subwatersheds. Some then have the added capability to route the flow and load contributed from each subwatershed to the corresponding stream reach to the downstream reach, creating a system of connected waterbody segments. Dividing a watershed into land cover-based units typically provides a logical basis for developing source-based allocations in a TMDL. For example, specific allocations (in terms of time-variable flow and contaminant loads) can be made to each land cover category represented in a watershed model. A watershed model might, for example, represent the following five land cover categories: forest, pasture, crop, residential–pervious, residential–impervious. In this situation each

category might receive independent allocations, which collectively result in the receiving water for the drainage area to attain and maintain water quality criteria.

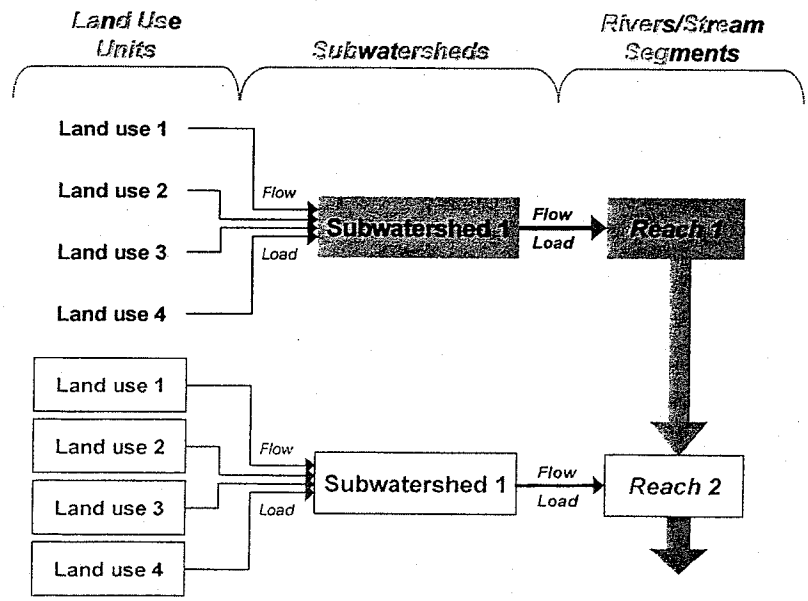


Figure 16. Typical watershed model elements for simulating runoff and pollutant loading from watershed land uses to receiving waterbodies.

Of the approaches presented in this section, watershed models can have the greatest variation in the type and method of application of the approach. Watershed models can vary widely in their capabilities, influencing their applicability for a particular TMDL application. The applicability of a model for simulating stormwater sources in a TMDL analysis can be affected by the model's capabilities, including the following:

- Timestep (temporal resolution)
- Ability to represent spatial variations (spatial resolution)
- Processes that are simulated

The temporal resolution can affect the model's ability to capture the variations in stormwater loading and the waterbody response. Its spatial scale can determine how watersheds are divided and represented, including how stormwater sources are isolated. The processes simulated by a model will often be a primary determining factor in model selection for TMDL development. A model's ability to simulate certain land-based processes (e.g., pollutant accumulation, runoff, erosion), waterbody processes (e.g., in-stream transport, nutrient dynamics, die-off), and management processes (e.g., stormwater detention) can determine whether it is appropriate for use in a certain TMDL project and also how the model will be applied. Table 9 identifies several model capabilities that can affect how it can be used to evaluate and estimate stormwater source loads. For each capability, the table rates a number of watershed models used for TMDL development, including:

> ***Resources:*** For more information on selecting watershed models based on needs for a given TMDL, refer to the Resources list at the end of this chapter in Section 4.5.2.

- Annualized Agricultural Non-Point Source (AnnAGNPS)
- GWLF
- HSPF
- Loading Simulation Program in C++ (LSPC)
- Program for Predicting Polluting Particle Passage through Pits, Puddles, and Ponds—Urban Catchment Model (P8-UCM)
- Source Loading and Management Model (SLAMM)
- Soil and Water Assessment Tool (SWAT)
- Storm Water Management Model (SWMM)

Table 9. Commonly used watershed models and select capabilities for evaluating stormwater sources in TMDLs

Simulation capability	AnnAGNPS	GWLF	HSPF	LSPC	P8-UCM	SLAMM	SWAT	SWMM
Simulates land-based pollutant accumulation and runoff	●	⊙	●	●	⊙	●	●	●
Simulates dynamic daily conditions (variable precipitation/flow)	⊙	○	●	●	⊙	●	⊙	●
Simulates conveyance systems	○	○	⊙	⊙	○	⊙	○	●
Simulates sediment erosion and transport	●	⊙	●	●	⊙	●	⊙	⊙
Simulates in-stream fate and transport	○	○	●	●	○	○	⊙	⊙
Simulates BMPs	●	○	⊙	⊙	●	●	●	⊙
Is appropriate for urban watersheds	○	○	⊙	⊙	●	●	○	●
Is appropriate for mixed land uses	⊙	⊙	●	●	○	⊙	⊙	⊙

○ = Low
⊙ = Medium
● = High

Other modeling references (USEPA 1997, 2005c) include summaries of model applicability for more general considerations, such as land uses simulated, pollutants simulated, and waterbody types simulated as well as for considerations related to their application. For example, *TMDL Model Evaluation and Research Needs* (USEPA 2005c) provides a series of tables rating the capabilities or applicability of more than 60 available watershed and receiving water models in the following categories:

- **TMDL Endpoints.** Considers the model's ability to simulate typical TMDL target pollutants (e.g., nutrients, toxics, bacteria) and expressions (e.g., load vs. concentration). Characterizes the models depending on the timestep of the simulation for the target (e.g., steady state, annual, daily, hourly).
- **General Land and Water Features.** Rates models according to their ability to simulate general land uses (e.g., urban, agricultural) and waterbody types (e.g., river, lake, estuary).
- **Special Land Processes.** Rates models on their ability to simulate more than 15 special land processes such as wetlands, hydrologic modification, urban BMPs (e.g., street sweeping, detention ponds), and rural BMPs (e.g., nutrient control practices, irrigation practices).

- **Special Water Processes.** Rates models on their ability to simulate special processes occurring in receiving waterbodies such as air deposition, stream bank erosion, algae, and fish.
- **Application Considerations.** Rates models on the following practical considerations affecting their application—experience required, time needed for application, data needs, support available, software tools, and cost.

Regardless of what type of watershed model is used, TMDL writers can calculate WLAs for permitted stormwater sources (e.g., MS4s, industrial facilities, and construction sites) in a number of ways using watershed models. The primary issues with modeling approaches that include stormwater sources are similar to those for other approaches, i.e., how to most accurately represent the sources and how to isolate and calculate their pollutant load contributions. Because models typically provide continuous simulation of multiple land- and waterbody-based processes, they can provide more flexibility than non-modeling approaches in representing stormwater sources.

An essential part of defining the contributions from permitted stormwater sources depends on isolating the *regulated boundary* of the source, or the drainage area that delivers stormwater runoff to the source's system. (See Chapter 3 about delineating the regulated area of a stormwater source.) Stormwater permits require all permittees to have documentation of the system configuration, its outfalls and boundaries. The level of detail of this information, however, will vary by permittee. Some might have detailed GIS-based coverages of storm sewer outlets and the areas they drain. Others might have coarse, hand-drawn maps roughly identifying their outlet locations and property boundaries. Once the TMDL writer delineates source areas, the issue becomes how to account for the delineated source area in the modeling analysis. The selection of an approach to include permitted stormwater sources in a modeling analysis for load calculation and allocation primarily depends on the available data and the importance or magnitude of the types of permitted stormwater sources. The two primary approaches include the following:

1. Including the permitted stormwater sources as discrete land units within the model—units that produce flows and loads separate from other watershed land areas and are hydrologically connected to the stream system
2. Calculating the load from the regulated stormwater source in a supplementary analysis using the model results of loads generated by watershed land uses

Which approach is used might depend on the significance of permitted stormwater sources to the impairment and the level of detail needed to characterize each source (e.g., evaluate as a whole vs. evaluate subareas within the regulated boundary). The first approach is most suitable for watersheds where stormwater sources are considered significant sources of impairment and sufficient data exist to define and isolate their regulated boundary, as well as discharge quality and quantity. The second approach can be used when regulated boundaries are not easily defined or because it is more important to evaluate the land use-specific effects on water quality rather than the effect of the cumulative contributions from a stormwater source (e.g., a regulated MS4) as a whole. For example, the regulated boundary of an MS4 might cover the majority of the watershed of the impaired waterbody. In such a case, it might be more efficient to set up the watershed model to evaluate the entire watershed area and the specific land uses or activities and then estimate and subtract the small portion that is delivered to the waterbody through nonpoint source runoff rather than the MS4. Both approaches are discussed in greater detail in the following sections.

4.3.1.1.1 Including Stormwater Sources as a Modeled Land Unit

The most direct approach for calculating stormwater source allocations is to develop a watershed model including the regulated boundary. This means that the TMDL writer can isolate and represent the regulated area in the watershed model as a separate land unit—representing the area that produces stormwater runoff that is delivered to the receiving waterbody through the permittee's stormwater conveyance system. Using this approach, the model would internally calculate flow and pollutant loading separately for each stormwater source's area. For example, the TMDL writer could separate land covering each permitted industrial facility into individual land units to independently determine flow and contaminant contributions from each permitted industrial facility. The TMDL writer can use the same approach for construction sites (or areas expected to undergo construction) and areas covered by an MS4 permit.

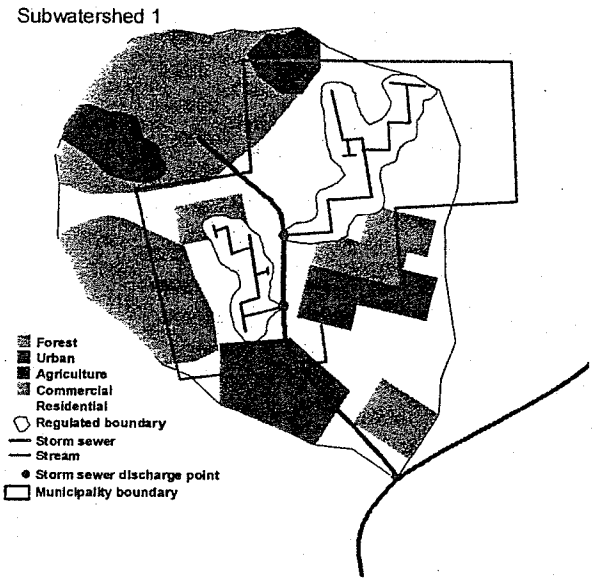
> ***Tip: Modeling surface runoff vs. baseflow loads in MS4s***
>
> The use of watershed models allows a TMDL writer to estimate both surface runoff and baseflow loads from all sources, including MS4s. A strict reading of the MS4 definition would suggest that only groundwater that enters the stream by reemerging or infiltrating into the conveyance system should be covered by the MS4 permit, while groundwater that discharged directly to the stream would not be covered. However, in some situations groundwater discharge can be included within the WLAs because the entire watershed is within the MS4 boundary and much of the groundwater load (e.g., for bacteria) was assumed to derive from leaky sewer systems which are also covered by NPDES permit. In the case of fecal coliform and a watershed entirely within MS4 boundaries it is probably safe (and easier) to include all the load within the WLAs. For other parameters, however, it might not be so clear. For example, for TDS the natural geologic background in groundwater would be inappropriate to lump into the MS4 WLA.

Figure 17 illustrates this process for calculating the WLA for an MS4. The example assumes that the overlay of the storm sewer system is available, along with the corresponding areas that drain to that system for delivery to watershed streams (i.e., the regulated boundary), as shown in the *Subwatershed Characteristics* panel of the figure. Therefore, the TMDL writer can isolate areas drained by the system and include these areas in the model as discrete units. As shown in the *Model Setup* panel, the model then simulates flow and loads contributed by the discrete MS4 units within each subwatershed to the respective stream segment. Because of this setup, the TMDL writer can directly calculate WLAs within the model, similar to the approach for other simulated land units (e.g., urban, agriculture), as shown in the *Allocations based on Model Output* panel.

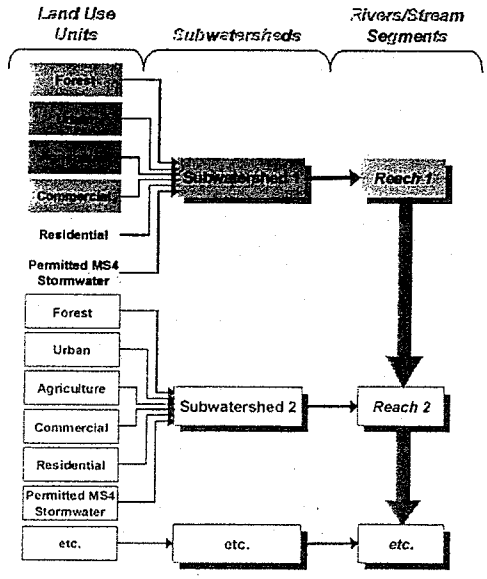
If the individual stormwater resources are represented in the model by their regulated boundaries, it will be necessary to characterize their land areas for simulation of runoff and loading. For example, when a watershed model is set up, the individual land use or other source areas are characterized by things such as soil type and characteristics (e.g., erodibility), perviousness, and measures of pollutant accumulation and generation. If available, monitoring data from the stormwater source should be used to characterize the source area and their associated runoff. If such data are not available, the areas included within the stormwater boundaries can be characterized in the same manner as other land uses. This is typically done by using GIS coverages such as land use, soil type, and topography to characterize the physical conditions of the land areas and site-specifc calculations or default values to represent pollutant accumulation for certain land use types.

The extent to which TMDL writers can use this approach of including stormwater sources as modeled land units depends primarily on the level of detail available geographically for each stormwater source, the data available to characterize pollutant generation and washoff from the source area and, in some cases, the capabilities of the watershed model.

Subwatershed Characteristics



Model Setup



Allocations based on Model Output

Sub.	Land Use	Allocated Load (kg/yr)
1	Forest	3.87
1	Urban	15.37
1	Agriculture	15.43
1	Commercial	3.6
1	Residential	29.16
1	MS4	29.57
1	Total	97
etc.	etc.	x

Figure 17. Process for calculating MS4 allocation when the MS4 drainage area is included in the model as a discrete land unit.

In Practice: Modeling Sediment Loads from Permitted Construction in the Potomac Direct Drains, West Virginia, TMDL (2008)

West Virginia's 2006 section 303(d) list includes 29 impaired streams in the 927-square-mile Potomac Direct Drains watershed in Berkeley and Jefferson counties. Many of the listed waters are biologically impaired on the basis of a narrative water quality criterion that prohibits the presence of wastes in state waters that cause or contribute to significant adverse effects on the chemical, physical, hydrologic, and biological components of aquatic ecosystems. SI analyses indicated sedimentation as a causative stressor in many of the streams, and sediment TMDLs were developed.

In recent years, the eastern panhandle of West Virginia has undergone significant development, with agricultural land and open space being converted to roads and housing subdivisions. The increased

construction activity is a potential source of sediment to the impaired waterbodies. At the time the TMDLs were developed, 297 construction sites encompassing 8,470 acres were registered, or had registrations pending, under the general permit.

The Mining Data Analysis System (MDAS) was used to represent the source-response linkage for sediment. Sediment TMDLs were developed using a reference watershed approach where MDAS was used to model sediment loading from a reference watershed. The reference loading rate was normalized for the Potomac Direct Drains watershed to establish the numeric TMDL target for sediment.

Sites subject to the Construction Stormwater General Permit were represented in the model using precipitation and runoff from the registered disturbed area and an assumption that proper installation and maintenance of required management practices would achieve an approximate 60 percent reduction of the sediment loading contributed by barren land. All registered sites and sites with registrations pending as of October 2006 were incorporated. All active registered sites and pending site registrations as of October 2006 were provided individual WLAs in the TMDL.

The Potomac Direct Drains TMDL reports are at www.wvdep.org/alt.cfm?asid=140.

4.3.1.1.2 Calculating Stormwater Source Loads Outside of the Model

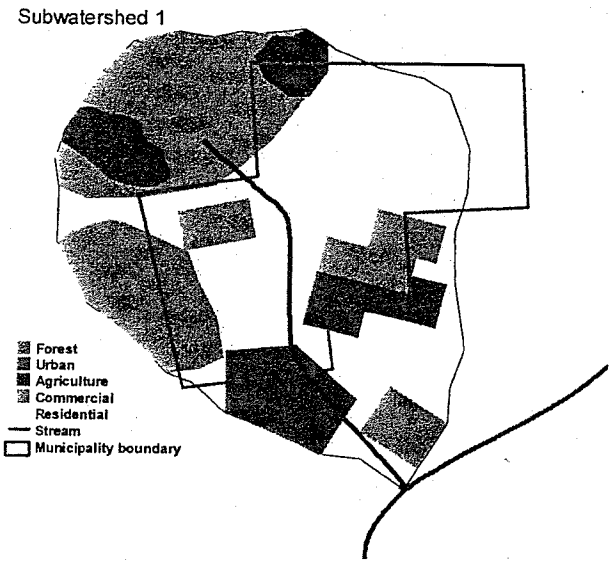
More commonly, the TMDL writer develops the watershed model based on typical land cover categories, without specifically including the regulated boundaries of stormwater sources. This is typically done because the boundaries of the area draining to the source's MS4 are not yet available or it is decided to focus on the land-use specific effects in more detail. In such situations, the TMDL writer will develop, calibrate, and apply the watershed model to TMDL development first, and then subsequently make allocations to permitted stormwater sources on the basis of their respective boundaries, whether represented by the regulated boundary or some alternative boundary (e.g, jurisdictional area) in the absence of the regulated boundary. The TMDL writer makes this allocation by overlaying the land cover represented in the model with applicable stormwater source area boundaries, such as the areas of an industrial facility exposed to stormwater runoff or the regulated MS4 boundary. The TMDL writer then determines the flow and pollutant load contribution associated with the various land cover categories that fall within the permitted stormwater source area boundary. This is often done by determining the unit area flow and pollutant loading for each land cover category on the basis of model results. The TMDL writer can then multiply the unit area rates by the corresponding area of the stormwater source that falls within that land cover category to calculate the portion of the land-use load that originates within the stormwater source boundary. To find the total load for the permitted stormwater source, the TMDL writer can then sum the land use-specific loads.

Figure 18 illustrates this type of process for calculating the WLA for an MS4 when the regulated boundary for the stormwater source is not included as a discrete area in the model. Unlike the example in Figure 17, the exact coverage of the storm system and the regulated boundary draining to the system has not yet been delineated by the permittee. Therefore, the model is set up to include only watershed land uses (see *Model Setup* panel in the figure), regardless of the MS4's boundary. The land-use loads are then used as the basis for calculating the load allocated to the MS4. This is done using an alternate boundary representing

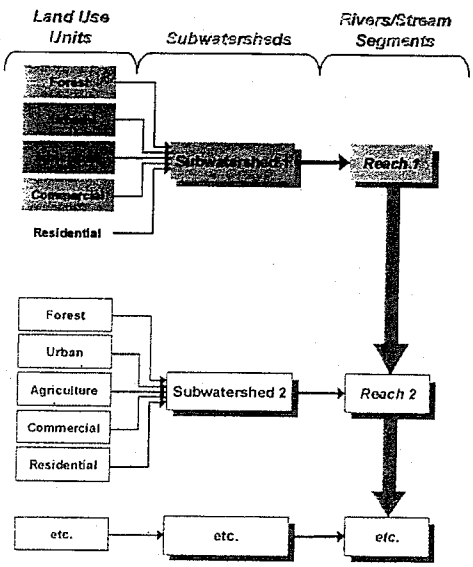
> ***Tip: Regulated Boundary vs. Jurisdictional Boundary***
>
> The most accurate way to represent a stormwater source's runoff and pollutant load contributions in a watershed model is to use the *regulated boundary*—the area actually generating and delivering runoff to the storm sewer system. However, many TMDLs represent the regulated stormwater source simply using the jurisdictional boundary (e.g., the municipal boundary for a small MS4) rather than the regulated boundary. As discussed in Chapter 3, the TMDL writer should work with the permitting authority to identify and obtain the regulated boundary to include in the modeling analysis or identify an appropriate alternative boundary if it does not exist.

the MS4 (e.g., jurisdictional boundary) rather than the actual area draining to the system. As shown in the *Allocations based on Model Output* panel of the figure, the areas of each land use that fall within the regulated MS4 boundary is calculated and multiplied by the loading rate for that land use. These loads are then totaled to calculate the total load attributed to the MS4.

Subwatershed Characteristics



Model Setup



Allocations based on Model Output

Sub.	Land Use	Modeled Load (kg/yr)	Area (acre)	Unit Area Loading (kg/acre/yr	MS4 Area in Land Use (acres)	MS4 Load (kg/yr)	Allocated Load (kg/yr)*
1	Forest	5	110	0.045	25	1.13	3.87
1	[illegible]	25	65	0.385	25	9.63	15.37
1	[illegible]	20	35	0.571	8	4.57	15.43
1	Commercial	12	40	0.300	28	8.40	3.6
1	Residential	35	120	0.292	20	5.84	29.16
1	MS4	-	106	-	-	-	29.57
1	Total	97	476	-	106	29.57	97
etc.	etc.	x	x	x	x	x	x

* Allocated load = modeled load – MS4 load

Figure 18. Process for calculating MS4 allocation when the specific stormwater drainage boundary is not included in the model and MS4 load is calculated based on percent of area within each modeled land use.

In Practice: Using watershed model-based approach for MS4 WLAs in the Christina River Basin

The Christina River Basin High-Flow Nutrient TMDL (www.epa.gov/reg3wapd/tmdl/pa_tmdl/ChristinaMeetingTMDL/index.htm), established by EPA in conjunction with Pennsylvania, Delaware, and Maryland, demonstrates the approach of calculating MS4 WLAs on the basis of watershed model output and jurisdictional boundary. TMDLs were determined for the Christina River and its tributaries using a watershed model (HSPF) combined with a receiving water model (Environmental Fluid Dynamics Code [EFDC]). The HSPF model represented contributions from 10 land cover categories: residential-septic, residential-sewer, agricultural-livestock, agricultural-rowcrop, agricultural-mushroom, open land, forested, wetlands/water, undesignated, and urban.

After determining the allowable nutrient load contributions from each land cover category for each subwatershed, the allowable loading was summarized for each township/municipality covered under the MS4 permit. To do this, the municipality boundary GIS layer was overlaid with the land use coverage. Nutrient loadings were then estimated for each land cover category within each municipality boundary within each of the modeled subwatersheds.

Because data were not readily available to determine stormwater outfall locations or to distinguish between areas within the municipalities that collected/conveyed stormwater and those that are truly nonpoint sources, the WLAs were based on jurisdictional boundaries. It was assumed that as part of the Phase II process more detailed stormwater information would be collected. This would enable the LA portion (i.e., that representing the truly nonpoint sources not delivered to receiving waters through stormwater collection/conveyance) to be extracted from the initial MS4 WLA allocations.

4.3.1.1.3 Modeling Specific Stormwater Conveyances and Discharges

Detailed stormwater conveyance models might be available in urbanized areas to support identification of allocations to regulated stormwater sources, particularly MS4 infrastructure. Stormwater models, often developed using the SWMM modeling framework, are implemented to support engineering design. They are generally capable of representing the effects of different storm events on flow throughout surface and subsurface components of a stormwater network. Thus, they are able to predict flow at individual stormwater discharge points to a receiving water.

It is possible to modify these models so that they also represent long-term conditions and contaminant loading. Employing this approach would provide the greatest level of detail for stormwater allocation in TMDLs (particularly for regulated MS4s and permitted industrial facilities and construction sites within regulated MS4 boundaries); however, it can be cost-prohibitive for TMDL development because of the time and effort needed to set up and calibrate a model at that level of detail. The number of outfalls to include could require the model be set up at a spatial level that is not supported by available data. For example, to include inputs from individual outfalls, it is necessary to have monitoring data to characterize the discharge from each outfall.

4.3.1.2. Impervious Cover Method

The IC method for stormwater TMDL development involves setting a target of percent IC for the watershed of the impaired waterbody to represent attainment of water quality standards. As discussed in Chapter 3, many areas affected by stormwater sources experience impairments due to the increase in the frequency and volume of surface runoff from impervious surfaces as well as the degraded quality of surface runoff. Therefore, the use of a target based on IC relates the amount of impervious surface to the resulting runoff volume and pollutant loading. This approach has been used in areas where waters are listed on the basis of biological impairment, and stormwater runoff has been determined to be the .

primary cause of impairment. The approach should focus on effective imperviousness (i.e., a calculation of imperviousness that reflects the extent to which water falling on impervious areas is infiltrated, evapotranspired or reused) rather than total imperviousness. The target can represent the cumulative effects of both flow quantity and flow quality or the runoff and loading of a particular pollutant (e.g., metals, sediment, nutrients). The target should be used with available data to establish a link between IC, associated pollutant loading, and resulting waterbody conditions to calculate the loading capacity for the TMDL. Because the approach relies on a linkage between IC and the resulting runoff and waterbody effects, the approach is not be appropriate in areas where multiple sources other than urban runoff (e.g., wastewater treatment plant discharging nutrients) are affecting biological impairment.

In Practice: Using the Impervious Cover Method to Develop TMDLs in the State of Connecticut

To support TMDL development for waters impaired by stormwater, the state of Connecticut evaluated the relationship among IC and stream biological health to establish a statewide target using the surrogate measure of IC to represent attainment of water quality standards and support for aquatic life uses. The evaluation of statewide GIS-derived estimates of IC and macroinvertebrate data to identify a relationship among the parameters showed that measures of biological community (e.g., taxa richness) decreased with increasing IC. Using this analysis Connecticut Department of Environmental Protection established a target of 12 percent IC as representing maintenance of the state's aquatic life criteria.

4.3.1.3. Export Coefficients

Export coefficients are measures of typical loading rates from certain land uses or sources. In TMDLs they would typically be used to calculate existing loads on the basis of the land use distribution in a watershed and would often be combined with a supplementary approach that calculates an allowable load on the basis of in-stream targets (e.g., percent reduction). Export coefficients can be obtained from literature values from regional or national studies (e.g., EPA's NURP study [USEPA 1983]) or based on site-specific sampling of stormwater from individual land uses. The TMDL writer should evaluate the applicability of the coefficients to the watershed of the impaired waterbody and decide whether they are representative and appropriate. In addition, it is important to use the export coefficients in conjunction with some type of analysis of in-stream conditions to support calculation of a loading capacity.

4.3.1.4. Simple Method

The Simple Method calculates pollutant loading on the basis of stormwater runoff and typically is used in combination with another waterbody-based approach to support TMDL calculations to meet a waterbody target. For example, the Simple Method can be used to calculate the existing loading and then the percent reduction method would be applied to calculate the corresponding loading capacity. In other instances, the Simple Method equation can be applied to represent conditions assumed to meet water quality standards, such as using the applicable criteria as the allowable runoff pollutant concentration or using impervious targets to calculate the runoff and resulting loads. Regardless of how it is applied, the Simple Method will likely result in a gross pollutant load for the drainage area of an impaired waterbody. It would be necessary to distribute that load among the sources to set WLAs and LAs using such characteristics as land use areas

> ***Resources:*** For more information on the Simple Method, refer to the Resources list at the end of this chapter in Section 4.5.3.

or jurisdictional areas. Alternatively, the Simple Method can be applied for delineated source areas to calculate loads from the different sources in the watershed.

In Practice: Using the Simple Method to Support Development of the Swamp Creek Fecal Coliform TMDL (2006)

Washington's Swamp Creek, north of Seattle, does not meet state water quality criteria for primary contact recreation due to high levels of fecal coliform bacteria. Data analysis using ambient monitoring and source inventories identified urban stormwater and nonpoint sources as the primary problem. The Washington State Department of Ecology developed a TMDL for Swamp Creek, including separate loading capacities for the wet season (October–April) and the dry season (May–September) to capture significant variations in in-stream concentrations and expected source loading. Daily dry-season and wet-season loading capacities were calculated at three points in the watershed by multiplying the average seasonal flows by the water quality criteria of 100 cfu/100 mL, representing the allowable 90th percentile concentration. To compare with the loading capacities and identify necessary load reductions, existing loads were estimated by multiplying the same season average flows by the observed 90th percentile bacteria concentration based on data collected at the respective station. The Simple Method was used to estimate the relative stormwater loading from each MS4 to assign WLAs to the multiple MS4s in the watershed. WLAs were then assigned on the basis of the total loading capacity and each MS4's proportional loading contribution at that station. Washington's Swamp Creek TMDL is at www.ecy.wa.gov/biblio/0610021.html.

4.3.2. Waterbody-based Approaches

Waterbody-based approaches rely on calculating an overall in-stream load, sometimes reflecting drainage areas with multiple sources. Therefore, it is necessary to use some supplementary analysis to distribute the calculated loading capacity among the identified sources, including permitted stormwater sources. To divide a cumulative load among watershed sources, it is necessary to gain a general understanding of the relative magnitude of the sources. The source characterization discussed in Chapter 3 should provide a TMDL writer with enough information to identify the sources of concern and at least generally delineate their location. The TMDL writer should be able to list the sources requiring LAs and WLAs and should know what data or information is available to characterize that source. For example, are there outfall or stormwater monitoring data for any of the stormwater sources? If so, such data (e.g., flow and concentration) can be evaluated and used to calculate a representative load attributed to the source. Or can the approach (e.g., load duration) be applied at a location that represents a drainage area from only one source? If so, the calculations at this point can be allocated to that individual source.

With any of the waterbody-based approaches, if stormwater source monitoring data are available, the TMDL writer should try to incorporate the data to most accurately represent the source inputs and calculate existing loads and subsequently distribute allowable loads. For example, storm event sampling can be used to estimate source loads, either through collecting data at major stormwater outfalls or through ambient monitoring at key locations representative of certain land use categories. However, monitoring data are not always available to characterize the discharge characteristics of individual sources. In such cases, common methods used to divide the total load into WLAs for stormwater include consideration of a stormwater source regulated area, jurisdictional area, land use, or IC:

- *Stormwater regulated boundary:* loading capacity is allocated to permitted stormwater sources (and other land-based sources) based on the proportion of the total drainage area they represent. For

example, if the loading capacity is 100 lbs/day and an MS4 conveyance system drains and transports runoff from 20 percent of the area draining to the assessment location, the MS4 WLA is specified as 20 lbs/day. To use this approach, it is necessary to be able to delineate the area draining to the source's stormwater conveyance system. Otherwise, an alternate estimate of the stormwater source's *drainage* area can be used, such as jurisdictional area. (For information on delineating the area of a stormwater source, see Chapter 3.)

- *Jurisdictional area:* loading capacity is allocated to permitted stormwater sources (and other land-based sources) on the basis of the portion of the drainage area included within their physical boundary. Without knowing the specific area draining to a stormwater conveyance system, the stormwater source area can be represented by the jurisdictional or operational area of the source (e.g., urbanized area for an MS4). For example, if the loading capacity is 100 lbs/day and the *urbanized area* of an MS4 represents 30 percent of the area draining to the assessment location, the MS4 WLA is specified as 30 lbs/day.
- *Land use:* loading capacity is allocated to permitted stormwater sources on the basis of expected land use unit area loads derived from literature values. For example, if the loading capacity is 100 lbs/day and an MS4 is estimated to contribute 25 percent of the load on the basis of the land uses within its boundary, the MS4 WLA is specified as 25 lbs/day.

> ***Resources:*** For more information on obtaining land use and coverage information, refer to the Resources list at the end of Chapter 3 in Sections 3.4.6 and 3.4.7.

- *IC:* loading capacity is allocated to permitted stormwater sources on the basis of the proportion of the drainage area they represent modified to reflect the amount of IC.

While the issue of how to distribute the cumulative loading capacity among sources is relevant to all the waterbody-based approaches, the following discussion identifies some issues and considerations specific to each approach.

4.3.2.1. Receiving Water Models

In some situations, the TMDL writer might use receiving water models alone to support TMDL development. Receiving water models differ from watershed models in that they only represent conditions within a receiving water, such as a stream or reservoir. Land-based contributions are typically addressed through designation of boundary conditions (which are often based on monitoring data) or through development of a separate watershed model. While these models provide many benefits for water column analysis, they pose limitations for stormwater allocation when applied independently from a land-based loading or watershed model. The inherent limitation is that they do not explicitly represent land-based sources (i.e., land units). This limitation is most pronounced when only limited geographical data are available for regulated MS4s, industrial facilities, and construction sites.

> ***Resources:*** For more information on selecting receiving water models based on needs for a given TMDL, refer to the Resources list at the end of this chapter in Section 4.5.4.

In situations where detailed geographic data are available, they can potentially provide a level of stormwater allocation commensurate with that of a watershed model application. Receiving water models are robust in their ability to provide a high level of detail laterally, vertically, and longitudinally. They can represent a stream, lake, or estuary using numerous analytical elements—in some cases tens of thousands. Thus, model predictions can be very accurate at many locations along the length of a receiving water. With this capability, receiving water models can be used to most accurately determine

the specific amount of a pollutant that can enter a receiving water at different locations while still attaining and maintaining water quality criteria throughout. Thus, allocations can potentially be made at the very detailed stormwater discharge level. This assumes that very detailed stormwater discharge location (i.e., outfall) and contribution (flow and contaminant levels) are available to support the receiving water analysis. Without this level of detail, a receiving water model is limited.

In practice, TMDLs employing receiving water models often also employ a watershed model to support source-based allocations, including those to regulated stormwater sources.

4.3.2.2. Load Duration Approach

> ***Resources:*** For more information on the load duration approach, refer to the Resources list at the end of this chapter in Section 4.5.5.

TMDLs developed using the load duration approach most often identify the portion of the loading capacity for the stormwater WLA(s) on the basis of jurisdictional area. However, because the duration curve framework establishes a series of individual flow-variable loading capacities, the portion of each loading capacity attributed to individual sources typically will also vary by flow. Figure 19 illustrates a TMDL that was developed using a duration curve framework. WLAs are specified for municipal treatment plants that reflect NPDES permit limits. In the case of Figure 19, these WLAs are based on technology-based effluent limits at facility design flows. The treatment plant WLAs are constant across all flow conditions and ensure that water quality standards will be attained. WLAs are also identified for MS4s, which reflect increased loads under higher flow conditions. In the Figure 19 example, stormwater WLAs for MS4 communities are based on the percent jurisdictional area approach. In this case, 3 percent of the watershed falls within the jurisdiction of MS4 communities. Thus, the MS4 WLA is 3 percent of the available allocation for each flow zone. The remaining 97 percent is designated for nonpoint sources and natural background as the LA for each zone.

Because a load duration curve establishes a flow-variable loading capacity, the framework allows for source-specific allocations to be adjusted by flow zone. To target loading controls and put the load duration results in a more *digestible* format, the load duration curve is usually divided into different flow zones representing different conditions (e.g., low flow, high flow). Representative existing loads and allowable loads can then be identified for each of those intervals. Because some sources tend to produce pollutant loads and affect the stream under certain flow conditions, this can help to distribute the allowable load among expected sources specific to a flow zone. This can account for different source areas and delivery mechanisms that might dominate under different flow conditions. For example, some TMDLs developed using the load duration approach allocate WLAs to stormwater sources for only certain flow zones (e.g., a WLA of zero is specified for the low-flow zone under the assumption that no load is generated from this source during those periods; see Table 10 for example). During the characterization activity discussed in Chapter 3, the TMDL writer should have an understanding of the types of stormwater sources and under what conditions they are affecting the stream. Within the load duration framework, allocations within the TMDL can be set in a way that reflects dominant concerns associated with appropriate hydrologic conditions.

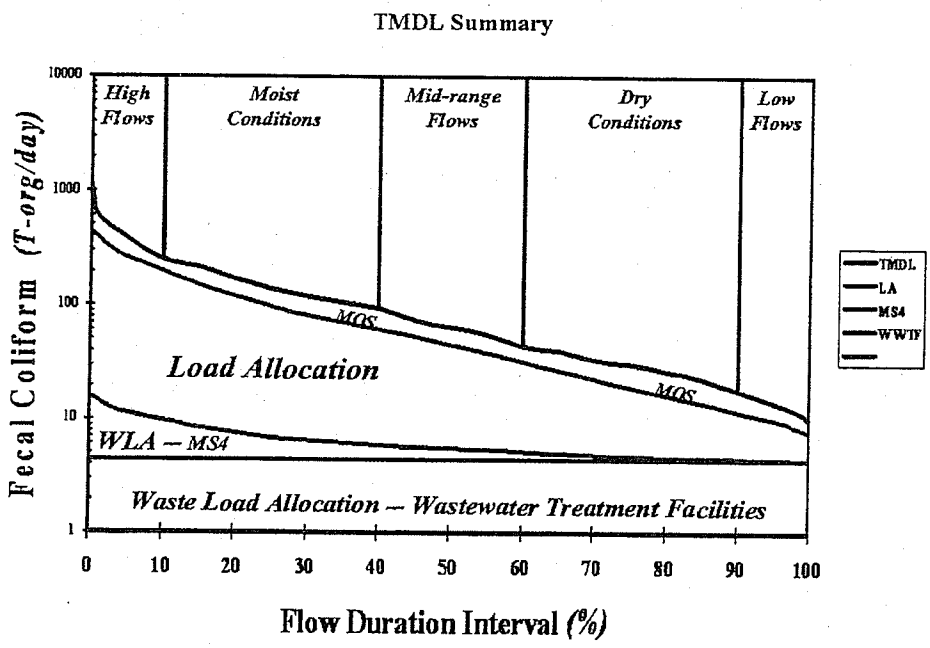


Figure 19. Example TMDL using duration curve framework

Table 10. Example summary of allocations calculated for a TMDL using the load duration framework

Name	TMDL Component	Duration Curve Zone (Phosphorus expressed as pounds/day)				
Redrock River—Phosphorus		High	Moist	Mid	Dry	Low
	TMDL	19.93	10.84	8.53	6.53	3.44
	MOS	5.63	1.47	0.72	0.57	0.43
	LA	11.79	7.62	6.28	4.72	2.59
Douglton (WWTP)	WLA	0.38	0.38	0.38	0.38	0.38
Guilaine (Industrial)	WLA	0.04	0.04	0.04	0.04	0.04
Douglton (MS4 / Phase 1)	WLA	1.39	0.89	0.74	0.55	0.00
Westerbridge (MS4 / Phase 2)	WLA	0.49	0.31	0.26	0.19	0.00
Thompath (MS4 / Phase 2)	WLA	0.21	0.13	0.11	0.08	0.00
Stormwater Source Areas of Concern		CSOs				
		Riparian Areas				
		Impervious Surfaces				
				Illicit Discharges		

4.3.2.3. Percent Reduction Method

The Percent Reduction method typically involves comparing ambient water quality data to applicable water quality criteria to identify a necessary percent reduction in observed concentrations to meet WQS. That percent reduction is then applied to an *existing* load to calculate the loading capacity. Depending on how the existing loads were calculated, that analysis can help to support distributing the loading capacity among the sources and identifying any stormwater WLAs. For example, if the existing load is based on export coefficients or literature values for watershed land uses or sources, the TMDL writer will already

have calculated the source-specific existing loads and can target percent reductions to individual sources to meet the overall loading capacity goal. If the existing load did not include specific calculation for stormwater sources, it will be necessary to use one of the approaches discussed previously to distribute the loading capacity (e.g., source drainage area, jurisdictional area) into LAs and WLAs.

4.3.2.4. Mass Balance or Steady-State Analysis

Like the Percent Reduction method, applying a mass balance or steady-state analysis to calculate a loading capacity relies on some calculation of the incoming existing pollutant load. This might be done by *back-calculating* an existing load on the basis of observed concentrations and stream flow (or volume for lakes and reservoirs) and accounting for any expected losses (e.g., die-off, settling). If this is the case, the existing load represents a cumulative load from all the sources contributing to the pollutant of concern. If there are no data available to directly calculate loads from individual sources, the most likely approach for distributing the loading capacity and identifying stormwater WLAs will be to use some measure of source area (e.g., jurisdiction, drainage area) as discussed previously. Another option for calculating the existing load for a mass-balance analysis is the use of export coefficients. Similar to the Percent Reduction method, this would produce source-specific existing loads that could be multiplied by an estimated load reduction to calculate LAs and WLAs that meet the overall loading capacity.

4.4. Categorizing WLAs for Stormwater Sources

This section provides a description of the various ways that TMDL writers can categorize and assign WLAs to permitted stormwater sources. The manner in which TMDL writers choose to calculate the WLAs for permitted stormwater sources can vary depending on data availability and quality, stormwater source characteristics, and permit implementation considerations. Four basic options for categorizing stormwater source WLAs include the following:

1. Aggregated for all stormwater sources (i.e., one overall WLA that represents total allocation to all MS4s, construction activities, and industrial facilities)
2. Aggregated by each type of stormwater source (i.e., one WLA for all permitted MS4s; one WLA for all permitted construction activities; one WLA for all permitted industrial facilities)
3. Individual by each stormwater source
4. Individual by each outfall

It is important to note that the four categories listed above are just basic options for presenting allocations within the TMDL. They do not represent all possibilities. TMDL writers can consider using one or more of these options in concert within a TMDL for various types of stormwater sources. In addition, TMDL writers can further refine these basic options using spatial and temporal considerations to make the allocations more meaningful to stormwater sources. For example, a TMDL writer could present individual or aggregated WLAs for sources by subwatershed or by land cover category. If the WLA has temporal variations, a TMDL writer could further refine the WLAs by flow conditions (i.e., wet versus dry), months, or seasons.

> ***Tip: Refining allocations using spatial and temporal considerations***
>
> TMDL writers can consider further refining any of the four basic categories of stormwater source WLAs using spatial and temporal considerations. Spatial considerations can include jurisdictional boundary, subwatershed boundary, or land cover. Temporal considerations can include wet seasons versus dry condition (based on flow), seasonally, or monthly.

WLAs that reflect the way that stormwater sources implement their respective SWMPs and SWPPPs are likely to be more *user-friendly* than WLAs that do not closely align with how stormwater sources manage their programs and plans. The more detailed and refined the allocation, the easier it will be for permit writers to translate through the permit and for stormwater sources to implement through by complying with permit requirements. The goal is to ultimately develop WLAs that are accurate, equitable, and implementable.

The details of each basic categorization option are discussed below. Table 11 summarizes advantages and disadvantages associated with the four basic options for categorizing and assigning WLAs to stormwater sources. Where available, examples illustrate how states and EPA have used each categorization approach. The Appendix of this Handbook contains additional examples of categorization approaches for WLAs.

Table 11. Options for assigning WLAs to stormwater sources

Option	Advantages	Disadvantages
Single Aggregated WLA for All Permitted Stormwater Sources *Example: Lake Champlain (Vermont) Phosphorus TMDL (2002)*	▪ Requires fewer permitted stormwater source characterization data to calculate ▪ Requires fewer resources to calculate ▪ Allows use of less complex WLA development approaches ▪ Allows permitted stormwater sources to determine at the local level how to further subdivide the overall allocation without specific commitments that could translate into permit requirements ▪	▪ More difficult to implement in permits ▪ Requires permit writers or sources to conduct further analyses to disaggregate the overall WLA to individual sources ▪ Potentially overlooks pollutant load contributions from all types of permitted stormwater sources throughout the watershed ▪ Does not promote individual permitted stormwater source accountability for pollutant load reductions to implement the WLA ▪ More potential to capture unpermitted stormwater sources (i.e., urban nonpoint source runoff) in the aggregated WLA
Separate Aggregated WLA for Types of Permitted Stormwater Sources *Examples:* ▪ *Potomac Direct Drain (West Virginia) Sediment TMDL* ▪ *Charles River (Massachusetts) Pathogen TMDL* ▪ *Shingle Creek (Minnesota) Chloride TMDL* ▪ *Columbia Slough (Oregon) TMDLs*	▪ Requires less permitted stormwater source characterization data to calculate but allows for specificity within each category of permitted stormwater sources ▪ Requires fewer resources to calculate ▪ Allows use of less complex WLA development approaches ▪ Allows permitted stormwater sources within a specific category to determine at the local level how to further subdivide the overall allocation without specific commitments that could translate into stormwater permit requirements ▪	▪ Does not result in equitable and easy-to-understand (i.e., implementable) WLAs for permit writers or stormwater sources ▪ Requires permit writers or stormwater sources to conduct further analyses to identify sources that will implement the WLA ▪ Does not promote individual permitted stormwater source accountability for pollutant load reductions to implement the overall WLA ▪ Potential for double-counting pollutant load reductions where categories of stormwater sources might overlap (e.g., MS4s with permitted construction activities that a TMDL writer could assign under the aggregated MS4 WLA or under the aggregated construction WLA

Option	Advantages	Disadvantages
WLAs to Each Individual Stormwater Source *Examples:* ▪ *Columbia Slough (Oregon) Lead TMDLs* ▪ *Wissahickon Creek (Pennsylvania) Siltation TMDL* ▪ *Swamp Creek (Washington) Pathogen TMDL* ▪ *Potomac Direct Drain (West Virginia) Sediment TMDL*	▪ Promotes transparency and accountability in TMDL implementation ▪ Provides permit writers enough information to include reasonable provisions in relevant permit(s) ▪ Allows permitted stormwater source to understand specific pollutant load reduction responsibility and take steps to analyze overall SWMP or SWPPP to achieve reduction ▪ Promotes following regulatory boundaries (e.g., regulated MS4 boundary) that are familiar to permitted stormwater sources and used to develop and implement SWMPs and SWPPPs	▪ Has the potential to add time to the overall TMDL development process if each permitted stormwater source has concerns related to the separate WLA assigned to its respective regulated MS4, industrial facility, or construction site ▪ Requires data and information specific to each permitted stormwater source, depending on the WLA development approach selected by TMDL writers (e.g., specific regulatory boundaries for each permitted stormwater source)
Individual WLAs on an Outfall Basis *Example: Middle Rio Grande (New Mexico) Fecal Coliform TMDL (2002)*	▪ Provides permit writers with detailed information to develop tailored permit provisions, particularly for individual permits ▪ Allows stormwater sources to target implementation efforts to address a specific area represented by a stormwater discharge from a specific outfall	▪ Requires data and information pertinent to each outfall addressed by the TMDL analysis ▪ Requires comprehensive spatial understanding of a permitted stormwater source area, including a detailed system map with location of all outfalls, and surrounding land uses ▪ Might not be feasible in watersheds with a large number of permitted stormwater sources, particularly permitted MS4s that might have a large number of outfalls draining the system ▪ Does not align with how many permitted stormwater sources approach SWMP and SWPPP implementation (i.e., focus on systemwide approach as opposed to an outfall-by-outfall approach)

4.4.1. Single Aggregated WLA for All Stormwater Sources

When data and resources to develop a refined characterization of sources are extremely limited, the ability of TMDL writers to analyze and identify the pollutant load contributions from each type of source is also limited. As a result, the TMDL writer might opt to group all stormwater sources into one category and assign one all allocation to all stormwater sources in this generalized category.

Although this approach alleviates some technical complexities for TMDL writers, the lack of specificity associated with this approach can result in a lack of transparency and accountability that can create implementation challenges for permit writers and sources. TMDL writers can mitigate some of the challenges by considering and addressing them at the outset of WLA development. To ensure that the single aggregated WLA promotes transparency and accountability, it is essential to generate a comprehensive inventory of all permitted stormwater sources represented under the single WLA as a means to help (1) stakeholders and EPA reviewers ensure that the WLA considers all relevant stormwater sources in the watershed boundary (2) permit writers to incorporate reasonable and clear provisons into the relevant permit(s), and (3) stormwater sources understand who has a responsibility to help conduct implementation activities to implement the WLA. As discussed in Chapter 3, Characterizing Impairments and Stormwater Sources, it is important that the TMDL writer has a comprehensive understanding of the type, number, and location of stormwater sources within the watershed boundary. The TMDL document should clearly identify all stormwater sources addressed by

the single aggregated WLA. As with all WLAs, the TMDL writer should also document other assumptions used to generate the single aggregated WLA. Assumptions might include the following:

- The analysis used municipal jurisdictional boundary versus the actual MS4 boundary that defines the permitted area
- The analysis assumes that all construction sites within the boundary selected to represent the MS4 (i.e., jurisdictional boundary or actual MS4 boundary) are the responsibility of regulated MS4s and fall under the MS4 allocation, not a separate construction allocation

Under this approach, permit writers or stormwater sources captured in the single aggregated WLA likely will need to conduct further analyses to make sub-allocations to each source; therefore, it is important that the TMDL document clearly identifies which stormwater sources are included in the single aggregated WLA. While it is possible to use single aggregated WLAs for stormwater sources in TMDLs, this approach is not preferred because of the associated implementation challenges. To avoid using this approach, TMDL writers can work with permit writers and stormwater sources to collect the additional data necessary to disaggregate allocations and assign to specific types of stormwater sources or, ideally, individual sources.

Tips for Using a Single Aggregated WLA for All Permitted Stormwater Sources

- Create a comprehensive inventory of all permitted stormwater sources within the watershed boundary and document this inventory in the WLA assumptions
- Indicate which permitted stormwater sources are part of the single aggregated WLA and provide rationale
- Consider providing guidance to permitted stormwater sources on ways to further sub-allocate the single aggregated WLA to promote equity and accountability in implementation strategies and approaches
- Provide rationale for using this approach versus other approaches that assign WLAs to more narrowly defined categories (e.g., limited available data, limited TMDL development resources, desire to promote flexibility)
- Highlight any plans to revisit and revise the single aggregated WLA based on future data availability

4.4.2. Separate Aggregated WLA for Each Type of Permitted Stormwater Source

This approach is an option for the TMDL writer to consider when the data are available to identify and separate the general pollutant load contributions from each type of permitted stormwater source, but source-specific information is not available to support accurate individual source allocations. For example, the TMDL writer might have a complete inventory of industrial facilities within the watershed boundary compiled from data obtained from a Phase I MS4 required to maintain an inventory of regulated industrial facilities (for permitted industrial facilities within the regulated MS4 boundary) and from a state or EPA Regional Office database of industrial facilities covered by individual or general industrial stormwater permits (for permitted industrial facilities outside the regulated MS4 boundary but within the watershed boundary). Although the TMDL writer has compiled a comprehensive inventory of the location and number of permitted industrial facilities, more information would be necessary on facility-specific processes and practices to estimate the pollutant load contribution from each facility. In such a case, the TMDL writer can use a general set of assumptions about the inventory of industrial facilities, such as the aggregate land area occupied by all industrial facilities and the location of these facilities within the watershed boundary (to determine soil type, perviousness, proximity to receiving waterbody) to calculate an aggregated.

Tips for Using Separate Aggregated WLA for Each Type of Permitted Stormwater Source

- Create a comprehensive inventory of all permitted stormwater sources within the watershed boundary under each category of stormwater sources and document this inventory by category in the WLA assumptions
- Indicate which permitted stormwater sources are included under each permitted stormwater source category of the separate aggregated WLA for each category and provide decision criteria to ensure consistency and clarity (e.g., all separately permitted construction sites in and outside regulated MS4 boundaries should be represented in the aggregated construction WLA; all separately permitted industrial facilities in and outside of regulated MS4 boundaries should be represented in the aggregated industrial WLA; only stormwater discharges from within the regulated MS4 boundary should be represented in the aggregated MS4 WLA)
- Provide guidance to permitted stormwater sources on ways to further sub-allocate the separate aggregated WLA for each stormwater source category to promote equity and accountability in implementation strategies and approaches
- Provide rationale for using this approach versus other approaches that assign WLAs to more narrowly defined categories (e.g., limited available data, limited TMDL development resources, desire to promote flexibility for purposes of implementation)
- Highlight any plans to revisit and revise the separate aggregated WLAs for each stormwater source category and under what circumstances (e.g., availability of better data or additional resources)

In Practice: Approaches and Rationale for Developing and Assigning Separate Aggregated WLAs for Specific Types of Stormwater Sources in West Virginia, Massachusetts, Minnesota, and Oregon

TMDL writers might decide to develop and assign separate aggregated WLAs for specific categories of stormwater sources based on a variety of factors, such as data availability, links to other TMDLs, or implementation considerations. Three TMDLs that assign separate aggregated WLAs for categories of stormwater sources include the Potomac Direct Drain (West Virginia) Sediment TMDL, the Charles River (Massachusetts) Pathogen TMDL, and Shingle Creek (Minnesota) Chloride TMDL. A brief description of the approach and rationale for developing and assigning stormwater source WLAs under each TMDL is provided below.

Potomac Direct Drain (West Virginia) Sediment TMDL (www.wvdep.org/alt.cfm?asid=140)

This TMDL addresses construction activities in tributaries of the Potomac River in Berkeley and Jefferson counties, West Virginia. The TMDL provides allocations for 297 active and pending construction sites registered under the West Virginia CGP. The main TMDL report provides an aggregated WLA for construction activities by subwatershed. In addition, the TMDL's appendices provide individual WLAs for each impending and active construction site.

Charles River (Massachusetts) Pathogen TMDL (www.mass.gov/dep/water/resources/tmdls.htm#charles)

According to the final TMDL, all 35 communities in the Charles River watershed have stormwater permit coverage under the Phase I and Phase II MS4 Stormwater program (34 are covered under Phase II, and one is covered under Phase I). The TMDL addresses stormwater runoff from Phase I and Phase II as a pathogen source and assigns two WLAs toall MS4s—one for each type of surface water classification—as daily concentration targets. In addition, the TMDL expresses WLAs for stormwater as a daily load (i.e., colonies/day) using flow data from the fraction of the watershed that has IC; areas with pervious cover are considered nonpoint source runoff and accounted for under the LA. WLAs expressed as daily loads for stormwater runoff from Phase I and Phase II also includes contributions from combined sewer overflows and are presented on a segment-by-segment basis.

Shingle Creek (Minnesota) Chloride TMDL (www.pca.state.mn.us/water/tmdl/project-shinglecreek-chloride.html)

The Shingle Creek Chloride TMDL addresses chloride contributions from road deicing activities by nine municipalities, one county, and the Minnesota Department of Transportation that have road maintenance

responsibilities within the Shingle Creek watershed. All these entities are MS4s. Under this TMDL, the MS4s received one aggregated WLA in the form of a percent reduction. (It is important to note that the WLA also addressed road salt storage facilities, private application, and residential chloride sources.) These permitted stormwater sources worked together through the Shingle Creek Watershed Commission to develop an implementation plan to meet the overall percent reduction target. The approach of assigning a single aggregated WLA for permitted stormwater sources in the regulated MS4 category allowed for a more flexible approach to implementation. Per the Shingle Creek Chloride Implementation Plan, working collectively to achieve the overall percent chloride load reduction allowed the entities with permitted MS4s to allocate load reductions to meet the percent reduction target on the basis of unique factors such as financial constraints, feasibility limitations, and public concerns and perceptions.

Columbia Slough (Oregon) TMDLs
(www.deq.state.or.us/wq/TMDLs/docs/willamettebasin/columbiaslough/tmdl.pdf)

The TMDLs developed for the Columbia Slough include WLAs for industrial facilities and MS4s to address numerous parameters including dissolved oxygen, phosphorus, bacteria, and lead. To address the pollutant load reductions needed from stormwater sources, the TMDLs for 5-day biochemical oxygen demand (BOD_5) and lead group together the two MS4s in the Columbia Slough basin into an MS4 category and the industrial facilities with permitted stormwater discharges into an industrial category.

4.4.3. Individual WLAs for Each Permitted Stormwater Source

TMDL writers can develop and assign WLAs for each stormwater source within the impaired waterbody's watershed boundary. Although this approach might require additional data, it can facilitiate the implementation of permits and is ideal for permitted stormwater sources that want to know their specific pollutant load reduction responsibility without the need for negotiating with other permitted stormwater sources to further allocate pollutant load reductions. In some instances, depending on data availability, TMDL writers might have the ability to assign individual WLAs to specific permitted stormwater sources under a category of permitted stormwater sources (e.g., each MS4, each industrial facility), but might find that data limitations require the use of aggregated WLAs for other permitted stormwater sources (e.g., all active construction sites). This approach has the potential to allow each permitted stormwater source, and other interested stakeholders, to more closely review and analyze the technical approach for WLA development, including the specific assumptions used to generate the individual WLA. It also provides more of a direct nexus between the WLA and stormwater permit requirements that must contain conditions consistent with the requirements and assumptions of the WLA, thus promoting more accountability and a more clearly defined expectation with regards to implementation. Individual WLAs also provide a foundation for transparent and accountable watershed-based trading because each permittee has its own WLA (which is enforceable through a permit), and the WLAs are available to all potential trading partners to review.

Tips for Using WLAs Assigned to Each Permitted Stormwater Source

- Provide clear description of assumptions and information used to calculate the WLA for each permitted stormwater source
- Ensure that permitted stormwater sources listed in the TMDL source characterization links to the list of permitted stormwater sources assigned a WLA to ensure transparency and equity
- Provide information on estimated baseline pollutant load contributions from each permitted stormwater source to help sources understand the required pollutant load reduction
- Consider additional methods for presenting the WLA that will support implementation based on understanding of existing SWMP and SWPPP approaches (e.g., breaking down total WLA for each permitted stormwater source on a subwatershed basis)

In Practice: Approaches and Rationale for Developing and Assigning Separate WLAs for Individual Stormwater Sources in Oregon, Pennsylvania, Washington, and West Virginia

Columbia Slough (Oregon) TMDLs
(www.deq.state.or.us/wq/TMDLs/docs/willamettebasin/columbiaslough/tmdl.pdf)

The lead TMDL developed for the Columbia Slough includes an aggregated WLA for the industrial permitted area and provides an approach for these industrial facilities to calculate their individual allocation. The approach involves calculating individual industrial facility allocations on a unit-area basis for each flow condition. While the TMDL does not contain specific individual WLAs for each industrial facility, the TMDL provides the equation necessary for each facility to calculate the load specific to its site.

Wissahickon Creek (Pennsylvania) Siltation TMDL
(www.epa.gov/reg3wapd/tmdl/pa_tmdl/wissahickon/index.htm)

This TMDL calculated WLAs for 16 permitted MS4s (defined by municipal boundaries, as opposed to regulated MS4 boundaries, for purposes of this TMDL) using land-use-specific, unit-area loads determined in modeling analysis for specific regions of the Wissahickon Creek basin, as well as the streambank erosion within each municipality. TMDL writers divided the Wissahickon Creek watershed into five main subwatersheds to match the impaired watershed with the smaller reference watershed used in the analysis. Sediment loads were estimated for each of the five subwatersheds and then distributed among municipalities as MS4 stormwater WLAs for each individual 303(d)-listed watershed. The WLA assigned to each of the 16 permitted MS4s accounted for both overland flow and streambank erosion. The final TMDL report presented a summary table that presented the existing load, the WLA, and the associated percent reduction to implement the WLA for both overland flow and streambank erosion, as well as the total WLA, for each permitted MS4. Appendix G of the final TMDL report also presents this information for each permitted MS4 on a subwatershed basis, allowing permitted MS4s to see and understand WLA information in both formats.

Swamp Creek (Washington) Pathogen TMDL (www.ecy.wa.gov/biblio/0610021.html)

This TMDL estimated the relative bacteria loading from each MS4 permit holder (i.e., the permit holder's jurisdictional boundary, not necessarily the loading from the actual MS4 boundary) using the Simple Method and assigned WLAs to MS4s at each water quality monitoring station on the basis of their proportional contribution at that station and the bacteria criterion needing the greatest reduction. Each MS4 is required to achieve a percent reduction of the loading capacity at each TMDL compliance point according to the estimated contribution from the MS4 permit holder.

Potomac Direct Drain (West Virginia) Sediment TMDL (www.wvdep.org/alt.cfm?asid=140)

Although the main body of the TMDL report provides an aggregated WLA for construction sites, the TMDL's appendices provide individual WLAs for each impending and active construction site. The individual WLAs are provided on a subwatershed basis. This TMDL covers approximately 297 active and pending construction sites registered under the West Virginia CGP in tributaries of the Potomac River within Berkeley and Jefferson counties, West Virginia.

4.4.4. Individual WLAs on an Outfall Basis

Stormwater permits require permitted stormwater sources to develop maps of regulated MS4s, industrial facilities, and construction sites that include locations of stormwater outfalls. Permitted stormwater sources are required to map the location of stormwater outfalls, and with increasing frequency, this information is available. It is still possible that some stormwater sources might not have the information necessary to develop and assign WLAs on an outfall-by-outfall basis. However, for those stormwater sources that do have adequate data, TMDL writers can consider the feasibility and benefits of assigning individual WLAs to specific outfalls. For example, if a TMDL addresses pathogens during dry-weather flow from a high-priority area within the boundary of a regulated MS4 (i.e., the system boundary), an individual WLA for specific outfalls within the high-priority area could be more useful in terms of supporting implementation than a WLA assigned to the entire MS4.

Tips for Using Individual WLAs on an Outfall Basis

- Use where information about the permitted stormwater source and watershed conditions indicate that an outfall approach is not only feasible, but would be supported through SWMP and SWPPP implementation (e.g., few known outfalls that allow permitted stormwater sources to isolate and track implementation activities associated with changes in discharge pollutant loads at each outfall)
- Ensure that permitted stormwater source has up-to-date information about outfall locations
- Ensure that an outfall-by-outfall approach is feasible for the TMDL development process
- Ensure that effectiveness monitoring is required in relevant permits, as appropriate, on an outfall-by-outfall basis

In Practice: Developing and Assigning WLAs to Individual Outfalls Under the Middle Rio Grande, New Mexico, Fecal Coliform TMDL (2002)

The Middle Rio Grande fecal coliform TMDL established that stormwater conveyances are the primary sources of fecal coliform loading to the Middle Rio Grande. Specifically, the TMDL report identifies four discrete concrete transports of stormwater contributing to fecal coliform loads and assigns a WLA to these four conveyances. The city of Albuquerque is responsible for implementing the WLAs assigned to these four stormwater conveyances through its MS4 SWMP. The TMDL is at www.nmenv.state.nm.us/SWQB/Middle_Rio_Grande-Fecal_Coliform_TMDL-May2002.pdf

In Practice: Using Multiple Approaches to Categorize Stormwater Source WLAs in the Los Angeles River Metals TMDL (2007)

The Los Angeles River Metals TMDL categorizes stormwater source WLAs using a variety of options to help permitted stormwater sources meet both dry-weather and wet-weather targets for cadmium, copper, lead, zinc, and selenium in impaired reaches of and tributaries to the Los Angeles River.

For dry weather, the TMDL provides single aggregated WLAs for all permitted stormwater sources on a subwatershed basis for three pollutants—copper, lead, and zinc. The permitted stormwater sources included in the single aggregated dry-weather WLAs include Los Angeles County MS4, Long Beach MS4, Caltrans, industrial facilities subject to the general industrial stormwater permit, and construction activities subject to the CGP. However, per the TMDL, industrial facilities and construction activities received a WLA of zero for dry weather, so only those entities subject to MS4 permit requirements share the single aggregated dry-weather WLAs for copper, lead, and zinc in the six reaches of the Los Angeles River and the seven tributaries.

For wet weather, the TMDL presents single aggregated WLAs for cadmium, copper, lead, and zinc that apply to all reaches and tributaries. In addition to providing single aggregated WLAs for each of these pollutants, the TMDL breaks down the overall WLAs into different stormwater source categories "by their percent area of the portion of the watershed served by storm drains." Under this approach, the TMDL assigns separate aggregated WLAs to MS4s (i.e., Los Angeles County and Long Beach MS4s), Caltrans, industrial facilities covered by the industrial general permit, and construction sites covered by the CGP. In addition to separate aggregated WLAs, the TMDL states that each permitted industrial facility and construction site will receive individual WLAs per acre on the basis of the total acres of their facility.

The TMDL is available at www.swrcb.ca.gov/rwqcb4/water_issues/programs/tmdl/tmdl_list.shtml.

4.4.5. Other Elements in a TMDL

Regulation and guidance require that all TMDLs include minimum elements. In addition to the elements already discussed in previous chapters (water quality standards, loading capacity, WLAs, LAs), a TMDL must also include a MOS, seasonal variation, and daily loads, In addition EPA recommends that TMDLs include allocations for future growth and reasonable assurance. The process or decisions related to including these elements in a TMDL might not vary when stormwater sources are involved. However, TMDL writers should consider how these other minimum elements might change when addressing stormwater sources in the analysis. Summarized below is each additional minimum element and, where appropriate, the stormwater-specific considerations related to the minimum element.

> ***Resources:*** For more information on the required elements of a TMDL, refer to the Resources list at the end of this chapter in Section 4.5.7.

- **MOS.** MOS must be included in a TMDL to account for any lack of knowledge concerning the relationship between allocations and water quality. The MOS may be implicit, incorporated into the TMDL through conservative assumptions in the analysis, or explicit, expressed in the TMDL as loadings set aside for the MOS.
- **Seasonal Variation.** TMDLs must be developed with a consideration of seasonal variation in the analysis. As discussed in Section 4.3, TMDLs addressing stormwater sources are likely to have seasonal variations related to wet and dry seasons included in the analysis.
- **Reasonable Assurance.** For TMDLs developed for waters affected by a mix of point sources and nonpoint sources, the TMDL should include reasonable assurance that nonpoint source control measures can achieve expected load reductions. TMDLs addressing stormwater sources often use this element to describe the NPDES permit requirements that apply to MS4s, industrial facilities, and construction activities included in the analysis.
- **Future Growth.** TMDLs can also include allocations for future nonpoint and point sources, acting as a reserve for future sources. This minimum element is particularly important to stormwater sources that are intermittent. For example, construction activities might obtain permit coverage and commence after developing a TMDL or an industrial facility might no longer certify to a condition of no exposure and require permit coverage. These types of stormwater sources would need to implement WLAs from the future growth allocation.
- **Daily Load.** TMDLs should include allocations expressed in terms of daily time increments. In addition, TMDL submissions can include alternative, non-daily pollutant load expressions (e.g., monthly, annual) to facilitate implementation of the applicable water quality standards.

TMDL writers should consider how to include these minimum elements early in the TMDL development process and evaluate them in context of the major sources, critical conditions, and the chosen TMDL development approach.

4.5. Resources

4.5.1. General TMDL Development

1. USEPA (U.S. Environmental Protection Agency). 1991. *Guidance for Water-Quality-based Decisions: The TMDL Process*. EPA 440/4-91-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC. www.epa.gov/OWOW/tmdl/decisions/

   This guidance document explains the programmatic elements and requirements of the TMDL process as established by CWA section 303(d) and by EPA's Water Quality Planning and Management Regulations (40 CFR Part 130). It discusses the process for developing a TMDL, roles of EPA and the states in the process, and supporting or related water programs.

2. USEPA (U.S. Environmental Protection Agency). 1999. *Protocol for Developing Sediment TMDLs*. EPA 841-B-99-004. U.S. Environmental Protection Agency, Office of Water, Washington, DC. www.epa.gov/owow/tmdl/sediment/pdf/sediment.pdf

   This technical guidance document provides information to support TMDL writers in developing TMDLs for sediment. The document includes information on how to complete each step of the TMDL process, including problem identification, source assessment, linkage of water quality targets and sources, allocation analysis, and monitoring.

3. USEPA (U.S. Environmental Protection Agency). 2000. *Protocol for Developing Pathogen TMDLs*. EPA 841-R-00-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC. www.epa.gov/owow/tmdl/pathogen_all.pdf

   This technical guidance document provides information to support TMDL writers in developing TMDLs for pathogens. The document includes information on how to complete each step of the TMDL process, including problem identification, source assessment, linkage of water quality targets and sources, allocation analysis, and monitoring.

4. USEPA (U.S. Environmental Protection Agency). 2000. *Protocol for Developing Nutrient TMDLs*. EPA 841-B-99-007. U.S. Environmental Protection Agency, Office of Water, Washington, DC. www.epa.gov/owow/tmdl/nutrient/pdf/nutrient.pdf

   This technical guidance document provides information to support TMDL writers in developing TMDLs for nutrients. The document includes information on how to complete each step of the TMDL process, including problem identification, source assessment, linkage of water quality targets and sources, allocation analysis, and monitoring.

4.5.2. Watershed Models

1. USEPA. 2005. *TMDL Model Evaluation and Research Needs*. EPA/600/R-05/149. U.S. Environmental Protection Agency, Office of Research and Development, National Risk

Management Research Laboratory, Cincinnati, OH. www.epa.gov/nrmrl/pubs/600r05149/600r05149.htm

This report documents the review of more than 60 available watershed and receiving water models for their applicability to TMDL development and implementation. It discusses model selection on the basis of model capabilities and provides a series of tables rating the capabilities or applicability the models using the categories of TMDL endpoints, general land and water features, special land processes, special water processes, and application considerations. The document also provides individual fact sheets for each reviewed model.

2. USEPA. 1997. *Compendium of Tools for Watershed Assessment and TMDL Development*. EPA 841-B-97-006. U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans, and Watersheds, Washington, DC. www.epa.gov/owow/tmdl/comptool.html

This document reviews more than 50 watershed, receiving water and ecological assessment models. The document provides factsheets for each model that describes model components, methods, applications, pollutants addressed, limitations, input data requirements, and type of output. The document also contains information on model selection for specific applications, model calibration, and model verification.

4.5.3. Simple Method

1. Center for Watershed Protection's Web site on the Simple Method: www.stormwatercenter.net. Click "By Category." Information on the Simple Method is included in the *Impacts of Urbanization* category.

4.5.4. Receiving Water Models

1. USEPA. 2005. *TMDL Model Evaluation and Research Needs*. EPA/600/R-05/149. U.S. Environmental Protection Agency, Office of Research and Development, National Risk Management Research Laboratory, Cincinnati, OH. www.epa.gov/nrmrl/pubs/600r05149/600r05149.htm

This report documents the review of more than 60 available watershed and receiving water models for their applicability to TMDL development and implementation. It discusses model selection on the basis of model capabilities and provides a series of tables rating the capabilities or applicability the models using the categories of TMDL endpoints, general land and water features, special land processes, special water processes, and application considerations. The document also provides individual fact sheets for each reviewed model.

2. USEPA. 1997. *Compendium of Tools for Watershed Assessment and TMDL Development*. EPA 841-B-97-006. U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans, and Watersheds, Washington, DC. www.epa.gov/owow/tmdl/comptool.html

This document reviews more than 50 watershed, receiving water and ecological assessment models. The document provides factsheets for each model that describes model components, methods, applications, pollutants addressed, limitations, input data requirements, and type of

output. The document also contains information on model selection for specific applications, model calibration, and model verification.

4.5.5. Load Duration Curves

1. USEPA (U.S. Environmental Protection Agency). 2007. *An Approach for Using Load Duration Curves in the Development of TMDLs*. EPA 841-B-07-006. U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans, and Watersheds, Washington, DC. www.epa.gov/OWOW/tmdl/duration_curve_guide_aug2007.pdf

   This document provides an overview on the use of duration curves for TMDLs, describing the basic steps needed to develop duration curves and subsequently identify loading capacities, LAs, WLAs, MOS, and seasonal variations. The guide also discusses some considerations and limitations in using the approach and includes several case examples.

4.5.6. WLA Expression Options

1. Wayland, R.H., and J.A. Hanlon. 2002. *Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs*. Memorandum from Robert H. Wayland, III, Director, Office of Wetlands, Oceans and Watersheds, and James A. Hanlon, Director, Office of Wastewater Management, U.S. Environmental Protection Agency, Washington, DC. www.epa.gov/npdes/pubs/final-wwtmdl.pdf

   This memo clarifies existing EPA regulatory requirements for, and provides guidance on, establishing WLAs for stormwater discharges in TMDLs approved or established by EPA.

4.5.7. Required Elements of a TMDL

1. USEPA (U.S. Environmental Protection Agency). 1991. *Guidance for Water-Quality-based Decisions: The TMDL Process*. EPA 440/4-91-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC. www.epa.gov/OWOW/tmdl/decisions/

   This guidance document explains the programmatic elements and requirements of the TMDL process as established by CWA section 303(d) and by EPA's Water Quality Planning and Management Regulations (40 CFR Part 130).

2. Grumbles, B.H. 2006. *Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No. 05-5015, (April 25, 2006) and Implications for NPDES Permits*. Memorandum from Benjamin H. Grumbles, Assistant Administrator. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. www.epa.gov/owow/tmdl/dailyloadsguidance.html

   This memo clarifies EPA's expectations concerning the appropriate time increment used to express TMDLs in light of the recent decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No. 05-5015 (D.C. Cir. 2006), which held that two TMDLs for the Anacostia River did not comply with the CWA because they were not expressed as *daily* loads.

3. USEPA (U.S. Environmental Protection Agency). 2007. *Options for Expressing Daily Loads in TMDLs (Draft)*. U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, Washington, D.C. www.epa.gov/owow/tmdl/draft_daily_loads_tech.pdf

   This document provides technically sound options for developing daily load expressions for TMDLs calculated using allocation time frames greater than daily (e.g., annual, monthly, seasonal).

4. Perciasepe, R. 1997. *New Policies for Establishing and Implementing Total Maximum Daily Loads (TMDLs)*. Memorandum from Robert Perciasepe, Assistant Administrator, to Regional Administrators Regional Water Division Directors. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

   The memo supplements existing regulations and guidance by documenting two policies to establish a nationally consistent approach for establishing and implementing TMDLs. These policies, and will remain in effect unless they are specifically changed by the Office of Water.

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1. Understanding the Connections Between TMDLs and Stormwater Permits
2. Identifying Opportunities to Coordinate TMDLs and Stormwater Permits
3. Characterizing Impairments and Stormwater Sources
4. Developing TMDLs with Stormwater Sources
5. **Promoting Effective Stormwater Management**
6. Coordinating TMDLs and Stormwater Permits

Chapter Five
Promoting Effective Stormwater Management

What's included in this chapter

- ✓ Description of possible stormwater management strategies and techniques for evaluating and selecting appropriate strategies for implementing WLAs.

What you should know after reading this chapter

- ✓ Potential criteria for evaluating and selecting stormwater BMPs most suitable for implementing WLAs.
- ✓ Types of resources, tools, and models available to assist in the selection of appropriate BMPs.

Potential roles and responsibilities under this activity

If you are a TMDL writer

1. Determine if the TMDL can include BMP recommendations for implementing stormwater WLAs.
2. Work with stormwater permit staff and others involved with implementation activities to identify BMPs and associated pollutant load reduction estimates to recommend through the TMDL.
3. Provide technical assistance to stormwater staff in reviewing stormwater management plans and pollution prevention plans that contain BMPs selected to implement WLAs.

If you are a stormwater permit writer

1. Determine if the stormwater permit will include prescriptive BMP implementation requirements in permit(s) based on recommendations in TMDL and work with TMDL staff to develop those BMP recommendations.
2. Determine if the stormwater permit will require stormwater dischargers to identify and implement BMPs necessary to achieve WLAs, but will provide assistance by recommending BMPs to consider or a process for quantifying potential pollutant load reductions.
3. Review stormwater management plans and pollution prevention programs to ensure selected BMPs and associated rationale are technically appropriate for achieving pollutant load reductions.

5. PROMOTING EFFECTIVE STORMWATER MANAGEMENT

TMDLs identify and quantify the loading reductions needed to meet water quality standards and, to the extent possible, facilitate implementation of management measures to implement targeted loading reductions. For stormwater discharges, permittees will reduce loadings in most cases by implementing a suite of structural and nonstructural stormwater BMPs over a certain period of time. Permittees then need to evaluate the effectiveness of BMPs implemented to implement loading reductions, make adjustments where performance was less than expected, and incorporate lessons learned in future BMP implementation activities. In many cases TMDL writers can anticipate an iterative process for making progress toward implementing WLAs and reflect this type of process in the TMDL report. This type of iterative, information-based approach to continuous improvement is often referred to as adaptive management. Through TMDL recommendations and permit requirements, TMDL and permit writers can direct permittees to create SWMPs and SWPPPs that achieve progress toward implementing WLAs over time and demonstrating such progress.

As shown in Figure 20, the step of TMDL implementation involves identifying management options to implement LAs and WLAs. This chapter discusses the activities related to TMDL implementation for stormwater sources. The goal of this chapter is to provide TMDL and permit writers with an understanding of (1) their potential role in developing implementation and adaptive management recommendations and requirements; (2) technical considerations for analyzing and selecting structural and nonstructural BMPs that are suitable for making progress toward implementing a WLA; and (3) technical considerations for monitoring and assessing implementation strategies to implement the WLA.

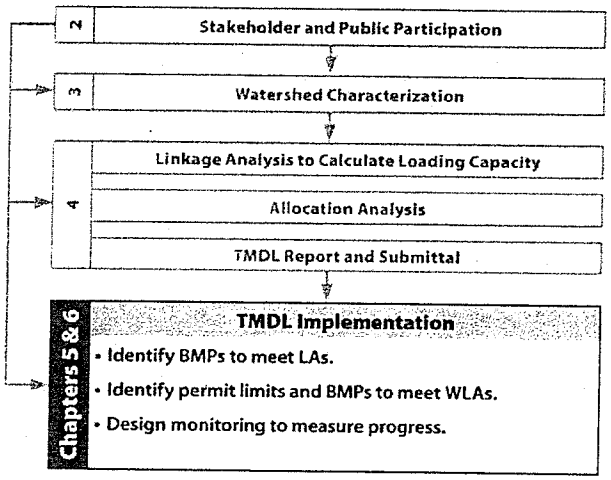

Figure 20. Illustration of the steps in the TMDL process, including activities related to TMDL implementation.

5.1. Implementation Roles and Responsibilities

Implementing TMDLs through stormwater permits will involve planning and coordination. Implementation planning activities might involve TMDL and permit writers or draw on the skills of other agency staff dedicated to implementation related activities. In some instances, implementation planning activities might only involve permittees. As a result, this chapter refers to those engaged in implementation planning activities as *stormwater planners*.

The role of stormwater planners in implementation planning will vary. Potential roles and activities for stormwater planners can include the following:

- **Evaluating and interpreting the WLAs assigned to stormwater sources.** As discussed in Chapter 4, TMDL writers can use a variety of approaches for categorizing and calculating stormwater WLAs in TMDLs. Individual WLAs assigned to each stormwater source or a specific source's stormwater outfall(s) are the most straightforward type of WLAs to interpret and implement. Permit writers can

most directly use individual WLAs and translate them into permit requirements. Stormwater planners should have the ability to conduct implementation planning activities using these refined WLAs. Where TMDL writers use aggregated approaches to categorize WLAs, stormwater sources might need to implement disaggregated WLAs for the purpose of SWMP or SWPPP implementation. Who disaggregates an aggregated WLA might vary—in some instances, it could be the TMDL writer, the permit writer, or even the actual stormwater sources. Stormwater planners can play a role in conducting the activities necessary to refine aggregated WLAs.

- **Developing a recommended list of structural and nonstructural BMPs to include in TMDLs or permits.** If the approach entails providing sources with a narrow suite of BMPs to promote implementation, TMDL and permit writers can play the role of stormwater planners and have the responsibility for analyzing and identifying a suite of BMPs that is most appropriate for addressing the impairment(s) for use by one or more types of sources. Under this option, TMDL and permit writers acting as stormwater planners can coordinate to determine where to list the suite of BMPs—either in the TMDL as recommended BMPs or in the permit as part of the permit requirements. Chapter 6 of this Handbook provides a detailed discussion on options for language to connect BMP implementation recommendations and requirements through TMDLs and permits.
- **Identifying specific structural and nonstructural BMPs when no BMP recommendations or requirements are provided in the TMDL or permits.** If the approach requires sources to analyze and select BMPs on their own, permittees can then act as the primary stormwater planners. Under this option, TMDL and permit writers might focus on providing permittees with technical assistance to assist in BMP selection. As mentioned throughout this Handbook, federal law does not require the development of TMDL implementation plans. Where state regulations require the development of TMDL implementation plans, or states voluntarily attempt to develop these plans as part of the TMDL development process, TMDL writers might consider providing technical assistance type information in the implementation plan. TMDL writers can also consider incorporating recommendations on BMPs to implement the load reductions as part of the TMDL report. Permit writers can consider providing TMDL implementation technical assistance to permittees through the permit fact sheet or compliance assistance documents.
- **Developing BMP performance standards to include in the TMDL or permit.** In some instances, the TMDL or permit might focus on BMP performance standards, rather than actual BMP recommendations or requirements. TMDL and permit writers in the role of stormwater planners can develop BMP performance standards to implement WLAs. Performance standards provide sources with the flexibility to select structural and nonstructural BMPs that are locally suitable while achieving the required or recommended performance standard. For example, New Jersey's Stormwater Management Rules (N.J.A.C. 7:8) requires *major development* projects that create at least 0.25 acres of new or additional impervious surface to include stormwater management measures that reduce the average annual TSS load in the development site's post-construction runoff by 80 percent. This type of performance standard allows sources in the role of stormwater planners to identify, select, and implement the most effective structural and nonstructural BMPs for a site or facility.

Regardless of who plays the role of stormwater planner and to what degree, it is important for TMDL and permit writers to understand the range of potential BMPs, technical information related to BMP performance, processes for BMP selection, and adaptive management techniques to ensure that implementation recommendations and requirements translate into effective, on-the-ground implementation actions by sources. It is also important that permit writers and other agency staff

involved in permitting activities (e.g., enforcement and compliance staff) have an understanding of BMP implementation and adaptive management for purposes of reviewing and approving (where applicable) permit information and documentation (e.g., SWMPs, annual reports, monitoring data).

The focus of this chapter is on the technical considerations necessary for selecting appropriate BMPs, evaluating BMP effectiveness over time, and making modifications to BMP implementation to ensure continuous water quality improvements. The goal of this chapter is to present these technical considerations to help stormwater planners as they develop implementation recommendations and requirements for use in TMDLs and permits to form the basis for demonstrating that TMDLs are adequately addressed in permits and associated SWPPPs and SWMPs. Although the focus of this chapter is on TMDL and permit writers serving as stormwater planners, the information presented in this chapter might also benefit permittees playing the role of stormwater planners.

5.2. Key Questions for Promoting Effective BMP Implementation

Stormwater planners can ask a series of six key questions to promote effective BMP implementation through an adaptive management framework. The adaptive management framework consists of planning, implementing, evaluating and learning, and adjusting. The six key questions are as follows:

1. What is the current pollutant loading from the stormwater source's discharge to the impaired waterbody accounting for existing BMPs?
2. What additional loading reduction is necessary to implement the WLA?
3. What additional BMPs might provide the remaining pollutant load reductions necessary to implement the assigned WLA on the basis of the expected performance of these BMPs?
4. How should permittees measure BMP performance as implementation proceeds?
5. Are measured pollutant load reductions adequate to make progress toward the assigned WLA over time?
6. What modifications to the overall implementation strategy are necessary to make further progress toward implementing the WLA?

Stormwater planners can use these key questions to guide implementation and adaptive management activities to achieve progress toward implementing WLAs. Although the discussion of the key questions highlights potential roles for TMDL and permit writers, sources might find these key questions helpful in conducting their implementation planning activities to comply with permit requirements.

5.2.1. Establishing the Baseline Load and Accounting for Existing Load Reductions (Key Questions 1 and 2)

The planning phase of adaptive management focuses on selecting BMPs to achieve the WLA and associated performance indicators to aid in tracking progress. Because the goal is to make iterative progress toward implementing a WLA, it is first necessary to quantify the starting point from which a source should measure progress. This is often referred to as the baseline. The baseline for a source might vary, depending on the context of the TMDL analysis. Sometimes the baseline pollutant loads for a

source's discharge might take into account existing BMPs, and sometimes it might not. Stormwater planners involved in implementation planning should address the issue of a source's baseline by asking the first two key questions as follows:

1. What is the current pollutant loading from the stormwater source's discharge to the impaired waterbody accounting for existing BMPs?
2. What additional load reduction is necessary to implement the WLA?

5.2.1.1. Answering Key Question 1: Determining Current Pollutant Loading from Stormwater Source Discharge

Stormwater planners can first review the TMDL to determine how the analysis defined a source's pollutant baseline load. During the development of the TMDL, the TMDL writer characterizes the pollutant loads from existing stormwater discharges. It is important for stormwater planners to review the TMDL analysis to determine the approach used to characterize pollutant loads from stormwater discharges. For example, the TMDL report should indicate if the TMDL writer made this determination on the basis of modeling using literature values for land use types and other generalized assumptions related to the stormwater source or if the analysis included real-world data and information, such as monitoring data to calibrate the model to actual conditions.

After identifying the stormwater discharge pollutant loading used in the TMDL analysis, stormwater planners can then determine if the analysis accounted for any existing BMPs and, if so, the assumed or measured pollutant load reductions from those BMPs. If the TMDL analysis does account for existing BMPs, stormwater planners can use the pollutant loading information contained in the TMDL analysis as the starting point for gauging progress toward the WLA. Stormwater planners should attempt to verify that the existing BMPs used in the TMDL analysis represent a comprehensive and accurate listing.

It is important for TMDL writers to remember that the information provided in the TMDL, as well as the assumptions used in the analysis, can influence the BMP selection process. The information contained in the TMDL serves as the basis for identifying the pollutants of concern and their source, which broadly indicates the type(s) and locations of BMPs needed to implement the pollutant load reductions from the sources with assigned WLAs. Greater specificity in the characterization of existing stormwater loads can likely promote more effective implementation.

If the TMDL analysis does not provide comprehensive information on existing BMPs, answering key question 1 requires conducting two activities: (a) accounting for existing BMPs and (b) quantifying the associated pollutant load reductions. The first activity involves developing an inventory of existing BMPs that would affect loads of the pollutant of concern. The second activity involves measuring or estimating the pollutant load reductions from the BMPs identified in the inventory.

5.2.1.1.1 Key Question 1, Activity A: Inventorying Existing BMPs

A BMP inventory is a comprehensive listing or database of existing structural and, if applicable, nonstructural BMPs that directly or indirectly address the impairment(s). For structural BMPs, the inventory should include information on the type of BMP, location, date of installation, area treated by the BMP, and design and maintenance issues. For nonstructural BMPs, the inventory should include information on type of activity, implementation schedule, area addressed, and performance related data.

Stormwater planners involved in implementation activities for sources covered by individual stormwater permits might feasibly engage in developing BMP inventories by working with sources. For sources covered by general permits, it is unlikely that stormwater planners will conduct this activity. Instead, permit writers might opt to include in general permits a requirement for developing a BMP inventory. Through this option, stormwater planners could provide criteria to assist sources in the development of a BMP inventory, such as defining the type or location of BMPs that are most appropriate to address the impairment(s). The TMDL writer could include these BMP inventory criteria in the TMDL or the permit writer could include the criteria in the permit with the BMP inventorying requirement.

Sources can also develop an accurate and comprehensive BMP inventory without the aid of criteria in the TMDL or permit. Permit writers can include BMP inventory requirements in permits that instruct sources to review existing SWPPPs or SWMPs—depending on the type of permittee—and identify BMPs that are likely to address the impairment(s). Sources would develop BMP inventories in compliance with this requirement through inspections or *desktop auditing*, depending on the type and number of BMPs in place.

> ***Resources:*** For more information on compiling a BMP inventory, refer to the Resources list at the end of this chapter in Section 5.3.1.

Technical issues related to compiling a BMP inventory can vary depending on the type of stormwater source—industrial facility, construction site, or MS4. Therefore, stormwater planners—particularly permit writers—should keep these technical issues in mind when developing permit requirements related to compiling BMP inventories. For industrial facilities and construction sites, compiling a BMP inventory might involve a review of SWPPPs or a thorough facility inspection or monitoring of influent and effluent of BMP structures. This approach would obviously be very complex within some MS4s, however, because of the sheer numbers of BMPs and the difficulty in locating and characterizing them. The level of detail, therefore, for the BMP audit at an MS4 might be less, and many assumptions might need to be made. For example, an MS4 responsible for conducting a BMP inventory as part of the implementation process to implement a TSS WLA might determine that it is necessary to include all erosion and sediment control BMPs on active construction projects. Because of the large number and dynamic nature of construction projects, however, the MS4 might determine that it is not feasible to do an actual count of the numbers of various types of BMPs. Therefore, the MS4 uses the assumption that all active construction sites implement certain standard BMPs (i.e., silt fence, construction entrances, sediment traps) due to local ordinance and state permit requirements. The MS4 could then assume a certain *noncompliance factor* after reviewing enforcement actions against existing sites to attempt to correct for improper implementation of BMPs in the field when modeling actual contribution. Using municipal planning tools, municipalities with permitted MS4s can also project the number and location of future construction sites on the basis of growth projections, comprehensive planning, and land use zoning.

In Practice: Promoting the Development of an Existing BMP Inventory in Washington

The draft Phase II MS4 General Permit for Western Washington (Appendix 2) contains the list of all TMDLs in western Washington that include specific implementation activities that go beyond the general permit requirements. The general permit requires permittees with WLAs under these TMDLs to implement the activities specified in Appendix 2. Some of these additional requirements include developing an inventory of existing BMPs. For example, the Snohomish River Tributaries fecal coliform TMDL (2001) in Washington requires (via the permit) permittees to implement *baseline* source control BMPs for (1) commercial animal handling areas and (2) commercial composting facilities. The TMDL requires (via the permit) that the permittees compile a list of the existing facilities and conduct inspections of them to ensure implementation of

source control BMPs. After meeting these baseline conditions, permittees must develop and implement a Bacterial Pollution Control Plan.

In addition to the type of stormwater source, the effort of compiling a BMP inventory can have an additional set of technical issues if the inventory is to include nonstructural BMPs. Nonstructural BMPs are typically programmatic in nature, such as good housekeeping practices at a transportation facility. While it might prove easy to account for these activities, it is not always easy to determine the pollutant load reduction associated with these activities. In the case of programmatic BMPs, stormwater planners should consider the need to make assumptions about defining what it means to implement nonstructural BMPs according to plan and justifying associated assumptions.

5.2.1.1.2 Key Question 1, Activity B: Quantifying Load Reductions from Existing BMPs

After the BMP inventory is complete, stormwater planners can either undertake the second activity of key question 2 or develop recommendations or requirements for sources related to this activity. The second component of key question 2 focuses on measuring or estimating the pollutant load reductions associated with the existing BMPs. Quantifying existing pollutant load reductions can help to determine if sources have made any progress toward implementing the WLA if the TMDL had assumed no BMP implementation.

It is important that planners consider how best to evaluate and quantify the effectiveness of BMPs and provide guidance to sources either through the TMDL or the permitting process. Evaluation techniques might vary by the type of BMP, pollutant type, and other factors. It is particularly important to provide this type of guidance in instances where multiple sources addressed under the same TMDL will participate in BMP evaluations to determine progress toward the same or related WLAs. Ensuring that sources are using similar evaluation techniques for similar BMPs can not only provide a more defensible pool of BMP performance data, but also provide a level of equity among sources as they determine progress toward implementing WLAs.

Quantifying pollutant load reductions associated with existing BMPs can vary in complexity for sources, depending on the size of the source's permitted boundary, the number and types of BMPs, and whether they are structural versus nonstructural. For example, it might be relatively easy to determine the effectiveness of BMPs at an industrial facility with a single defined outfall and four oil/water separators which treat the runoff from the processing facility and parking lots than it would be to quantify the effects of multiple, individual BMPs or an entire MS4 SWMP.

For a source with many BMPs, such as a large MS4 or a large construction site, the most viable option might be a suite of evaluation techniques that include monitoring, researching applicable literature values, and modeling using justifiable assumptions. For example, a large construction site with several types of erosion and sediment control BMPs could choose to either monitor representative BMPs or use existing literature to determine optimum sediment removal efficiency. Using the values for representative pollutant removal, the source could then estimate erosion and sediment control BMPs throughout the entire construction site.

The complexities only increase when trying to quantify the effects of more programmatic BMPs, including employee training on good housekeeping techniques, public outreach, and inspections of industrial/commercial facilities. Many of these activities focus on source reduction and pollution prevention or behavioral changes that are difficult to translate into pollutant load reductions.

BMPs are likely to vary among the types of sources; therefore, appropriate evaluation techniques and approaches are likely to also vary. Evaluation techniques might also vary depending on the specific pollutant of concern or impairment that a source is trying to address through BMP implementation.

The evaluation of stormwater management BMPs and plans can be very complex because many of these BMPs and plans focus on nonstructural, source reduction activities that prevent pollutants from entering the storm sewer system to begin with. As a result, there might not be any easy means to quantify the associated pollutant load reductions. Stormwater planners attempting to quantify pollutant load reductions from BMPs can likely have to generate estimates using a wide range of information sources ranging from state and local studies, national BMP performance data, monitoring data, modeling, and assumptions based on best professional judgment. It is critical that TMDL and permit writers keep these challenges in mind when developing WLAs and recommendations or requirements for assessing progress toward WLAs. The TMDL itself needs to account for the complexities of quantifying the effects of BMPs on stormwater runoff and the permit writer needs to allow for flexibility in the development of assessment strategies.

Regardless of the difficulty level, it is in the source's best interest that stormwater planners conduct the inventory of existing BMPs thoroughly and justifiably. If the source is the primary stormwater planner and is conducting the BMP inventory, the permit writer might want to review the BMP inventory procedure before initiation to confirm that the pollutant load reductions attributed to existing BMPs are appropriate. If a review of the BMP inventory procedure is a permit requirement, the permit writer should consider explicitly stating what the source must submit for review and approval. Information in the final inventory can assist sources with future implementation efforts, including scheduling and tracking maintenance activities and compiling records and reports.

In Practice: Conducting a BMP Effectiveness Evaluation in Portland, Oregon

Portland conducted an evaluation to determine the effectiveness of existing stormwater BMPs. According to the summary document, *Effectiveness Evaluation of Best Management Practices for Stormwater Management in Portland, Oregon* (www.portlandonline.com/shared/cfm/image.cfm?id=133994), the purpose of the effectiveness evaluation was to "develop and document the effectiveness ranges and preferred values for all BMPs either currently in use or anticipated for use in the management of stormwater quality and quantity in the City of Portland." The evaluation methodology focused on analyzing a list of BMPs that met specific criteria, including BMPs required to implement TMDLs. The methodology also focused on surrogate pollutants selected to represent whole classes of pollutants. Surrogates included TSS, dissolved zinc, *E. coli*, and total phosphorus. In addition to water quality parameters, the evaluation addressed flow rates and volume, temperature, and habitat issues. Through the evaluation, Portland derived values for BMP performance using a wide variety of information sources as well as best professional judgment. The evaluation provides a range of effectiveness values for each BMP to account for uncertainty and location-specific or application-specific conditions that result in various points in the range of values. The evaluation serves as the necessary documentation of methods and assumptions to facilitate future review of BMP effectiveness and to evaluate the applicability of a particular value to a specific BMP.

5.2.1.2. Answering Key Question 2: Determining Additional Load Reductions Necessary to Implement the WLA

After quantifying the measured or estimated pollutant load reductions associated with existing BMPs, stormwater planners can calculate the remaining pollutant load reductions necessary to implement the WLA. This value can serve as the driver for addressing key question 3: selection of additional BMPs.

By comparing the information generated to answer key question with the overall pollutant load reduction necessary to implement the WLA, stormwater planners can estimate the magnitude of the pollutant load not addressed by BMPs. The difference between the source's actual contribution (defined as the baseline pollutant load minus the pollutant load reductions addressed through existing BMPs) and the assigned WLA is the additional amount of pollutant removal that the source can implement through additional BMPs.

5.2.2. Selection of Additional BMPs to Implement WLAs (Key Question 3)

The information generated under key question 2 can serve as a starting point for stormwater planners to answer key question 3:

What additional BMPs might provide the remaining pollutant load reductions necessary to implement the assigned WLA on the basis of the expected performance of these BMPs?

> ***Tip: Ensure proper O&M to maximize BMP performance and resource investment***
>
> State planners can remind sources that O&M are extremely important factors in maximizing BMP effectiveness. Sources might maximize pollutant load reductions by improving the O&M of existing BMPs rather than investing in additional BMPs. TMDL and permit writers can develop recommendations and requirements that ensure sources focus on proper O&M of BMPs intended to achieve progress toward WLAs.

Answering key question 3 also entails two activities: (a) identifying the list of possible BMPs to address the pollutant of concern or impairment and (b) quantifing the expected performance of each BMP under consideration. The role of stormwater planners in the BMP identification and selection process can vary depending on the approaches discussed at the beginning of this chapter. In addition, factors such as the type of source and the type of permit under which the source has coverage can also affect the role of stormwater planners at this phase of implementation planning. For example, TMDL and permit writers playing the role of stormwater planners can work closely with sources covered under an individual permit (e.g., large and medium MS4s) to conduct an analysis of possible BMPs and select a final suite of prescribed BMPs to include in the permit. Where general permits are available to sources, TMDL and permit writers playing the role of stormwater planners might rely on the use of performance standards in TMDLs and permits, while providing broad technical assistance through guidance documents. For example, TMDL and permit writers could research a range of possible BMPs and provide some of the information (e.g., expected performance information, cost, maintenance requirements) that sources would need to evaluate and identify the most suitable additional BMPs to address the remaining pollutant load reductions necessary to implement the WLA. Stormwater planners should keep in mind the range of other factors that can ultimately influence a source's decision to implement a BMP, such as location, cost, and maintenance.

The topics of identifying possible management strategies and selecting final management strategies to implement pollutant load reduction targets are discussed extensively in Chapters 10 and 11 of EPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (USEPA 2008a). While

the information provided in this extensive EPA resource is geared toward sources with implementation responsibilities, the process for screening and selecting BMPs described in these chapters have applicability to planners involved in TMDL implementation planning activities considering developing a suite of recommended or required BMPs to include in the TMDL or the permit. This section provides an overview of BMP identification and selection information that would benefit stormwater planners playing a more active role in this step of the process.

5.2.2.1. Key Question 3, Activity A: Identifying List of Possible BMPs

Identifying and selecting BMPs to implement the remaining pollutant load reductions involves compiling a list of candidate BMPs appropriate for the pollutant of concern or the impairment and determining a BMP performance rating (i.e., expected pollutant load removal or flow rate and volume reduction). It is possible that much of this work might already be done by addressing key question 1 focused on inventorying and estimating the pollutant load reductions from existing BMPs. However, the suite of BMPs available to implement a WLA might encompass BMPs beyond those already implemented by a source. Therefore, the list of candidate BMPs is likely to include both existing and new practices for consideration.

> ***Resources:*** For more information on BMP selection, refer to the Resources list at the end of this chapter in Section 5.3.2.

Stormwater planners should consider providing a suite of BMPs that encompasses every possible category of controls: source controls, treatment controls, structural controls, and nonstructural controls. Source controls are BMPs that seek to reduce the presence, use, or exposure of pollutants to the weather; volume controls promote infiltration, evapotranspiration and reuse of water, detention, or retention of stormwater and its constituents. Treatment controls are BMPs that attempt to remove or inactivate pollutants through physical, chemical, or biological processes. Structural controls are built structures or facilities that capture runoff, treat it through chemical, physical, or biological means, and discharge the treated effluent to the soil, the stormwater conveyance system, or directly to surface waters. Nonstructural controls usually involve management practices that focus on changes in activities or behaviors, as well as focus on controlling pollutants at their source. Examples include developing and implementing erosion and sediment control plans, organizing public education campaigns, and practicing good housekeeping at municipal, commercial, and industrial facilities. Regulatory and policy tools, such as ordinances, operating procedures, and maintenance schedules, are also examples of nonstructural controls.

> ***Tip: Addressing peak flows to reduce channel impacts***
>
> To prevent downstream degradation and maintain stream channel stability, planners should promote maintenance of predevelopment runoff volumes and rates for new development and redevelopment. Recent research shows that simply requiring site designs not to exceed pre-development runoff rates for a specified storm size (e.g., a detention basin designed to limit release rates) will not adequately protect the hydrology and habitat of the receiving water. Management practices that slow, detain or infiltrate the runoff and release it slowly via baseflow to the receiving stream systems can replicate predevelopment site conditions and ensure both adequate aquifer recharge and stream base flow.

It is important to note that for certain types of impairments in certain areas nonstructural controls and source reduction practices might be less expensive and more effective than structural controls. For example, implementing new policies for sweeping streets and addressing illicit discharges is often less costly and more protective of water quality than constructing ponds or other stormwater treatment facilities at down-gradient locations. For example, stormwater planners addressing areas with seasonal chloride impairments associated with deicing activities can consider nonstructural practices

such as alternatives to salt or salt reduction management activities (e.g., calibrating salt trucks) rather than structural BMPs.

Many BMPs do and should target volume reductions (i.e., flow) to reduce total pollutant load. In addition to pollutant load reductions, BMPs that provide volume reductions also reduce channel erosion, alleviating impacts related to increased runoff. Streambank erosion, channel deformation and down-cutting, and loss of natural habitat are among the more common effects of increased runoff from impervious surfaces. Stormwater planners can promote BMPs that reduce volumes through infiltration and evapotranspiration to ensure that BMPs are most effective in protecting or restoring impaired waterbodies. Volume reduction can also play a significant role in overall pollutant load reduction, which might not be immediately apparent if a BMPs ability to reduce incoming effluent concentrations is the primary metric by which it is measured. When a BMP, such as a rain garden or bioretention practice, captures a portion of incoming runoff and infiltrates it into the soil, the pollutants in that portion are prevented from entering a nearby river, lake, wetland, or coastal water. Simply comparing the concentration in and the concentration out of a BMP does not account for this pollutant load reduction due to infiltration.

Because flow is a critical factor to consider during BMP selection and implementation, stormwater planners can promote that sources first consider source controls and volume reduction controls before considering more traditional treatment controls. One option for doing so is to include only these types of BMPs on a list of prescribed BMPs (e.g., sources must implement all BMPs on the list) or on a required menu of options (e.g., sources must select one or more BMPs from the list). Another option could involve stormwater planners developing recommendations or requirements that indicate that sources must first examine source and volume reduction controls to implement remaining pollutant load reductions and provide associated assumptions that indicate treatment controls are more appropriate or effective at reducing remaining loads.

> ***Resources:*** For more information on volume control, refer to the Resources list at the end of this chapter in Section 5.3.3.

In Practice: Promoting Maintenance of Predevelopment Runoff Volumes and Rate in New Jersey

New Jersey's Stormwater Management Rules (N.J.A.C. 7:8) recognize that predevelopment site hydrology is essential to maintain to protect downstream hydrology. The New Jersey Model Stormwater Control Ordinance for Municipalities, included in the *New Jersey Stormwater Best Management Practices Manual* (www.state.nj.us/dep/stormwater/tier_A/bmp_manual.htm) as Appendix D, contains requirements pertaining to controlling stormwater runoff quantity impacts. The ordinance requires developers to select and comply with one of the requirements. Two requirements focus on conducting a hydrologic and hydraulic analysis that compares pre-construction runoff volume and rates with post-construction conditions. A third requirement focuses on performance standards for stormwater management measure design to control post-construction peak runoff rates.

In Practice: Promoting Consideration of Nonstructural Controls First in New Jersey

The New Jersey Model Stormwater Control Ordinance for Municipalities (referenced above) encourages MS4s to require developers to first consider nonstructural controls into new development designs. The model ordinance provides a list of nonstructural controls that includes protecting natural vegetation and drainage; protecting areas susceptible to erosion; minimizing impervious surfaces and breaking up or disconnecting flow over impervious surfaces; providing low maintenance landscaping; and incorporating source controls to minimize use and exposure of pollutants into site designs. The ordinance language states that if the developer contends it is not feasible to include these nonstructural controls into a project, the developer must provide the engineering, environmental, or safety reasons that render use of the nonstructural controls unfeasible.

In many cases, functions of the various BMPs can overlap and can reduce a pollutant in more than one way. For example, green infrastructure (GI) and low impact development (LID) practices control the volume of stormwater being delivered downstream, which can help reduce streambank erosion and sediment loading, while also retaining sediment. GI and LID are stormwater management approaches and practices intended to eliminate or reduce urban runoff and pollutant loadings by managing the runoff as close to its sources as possible. As a collection of small-scale practices, linked together on a site, GI/LID have the potential to reduce the effects of development and redevelopment activities on water resources by maintaining or replicating the predevelopment hydrology of the site. Through practices such as rain gardens, vegetated swales, pervious pavements, and green roofs, GI/LID promote on-site infiltration, evapotranspiration, or reuse of rainwater.

Resources: For more information on GI and LID, refer to the Resources list at the end of this chapter in Section 5.3.4.

The final mix of structural and nonstructural management practices selected can, most importantly, be determined by which pollutants each BMP can effectively address and, more importantly, what specific level of performance each can provide. This can depend upon several highly variable factors, including the concentration and total load of the pollutant in the runoff, the volume and various rates of the runoff, antecedent rainfall and runoff conditions, and even the season or time of year. The variability of both applicable pollutants and levels of treatment can be seen by reviewing the sampling results of actual structural facilities taken over a number of storm events. Depending on the pollutant, the reduction in pollutant load or mean concentration achieved by selected structural facilities can vary considerably from event to event, with even negative reductions achieved at times, particularly for nutrients. Such variability makes it extremely difficult to determine a structural facility's exact pollutant removal rate and illustrates why pollutant removal criteria are typically based on average annual conditions.

Tip: Calculating the savings associated with GI

The Green Values® Stormwater Calculator (http://greenvalues.cnt.org/calculator), developed by the Center for Neighborhood Technology, helps users see how GI can help save money and increase hydrologic benefits. It can be used to estimate the benefits of LID and conservation practices and allows users to input site development characteristics and green practices and returns financial and hydrologic outcomes for different scenarios.

5.2.2.2. Key Question 3, Activity B: Determining Expected BMP Performance

Evaluating the potential performance of a BMP is a potentially challenging activity, but the information generated through this activity is essential to selecting BMPs with the most potential for making progress toward WLAs and attainment of water quality standards. Although this activity is discussed as

a separate activity after compiling the list of possible BMPs, planners can make assumptions and determinations about BMP performance *while* generating the list.

There are three important factors to consider when evaluating the potential performance of BMPs: concentration, volume, and total load. Estimating the total pollutant load reduction associated with a BMP is probably the best way to evaluate overall BMP performance. To calculate the total load, multiply the volume of water discharged by the BMP over a given period by the mean or average concentration of the pollutant. EPA's Urban BMP Performance Tool Web site, at http://cfpub.epa.gov/npdes/stormwater/urbanbmp/bmptopic.cfm, provides an in-depth discussion of these factors and other considerations for evaluating potential BMP performance.

Stormwater planners can estimate load reductions from BMPs in a number of ways. The most desirable method would be to monitor a BMP for every rain event over the course of several years to determine the volume of water coming into and leaving the BMP and the associated changes in pollutant concentrations. Rarely, however, is this level of monitoring possible because of resource constraints or because the type of BMP does not lend itself to this kind of *water in—water out* type of monitoring. This is important for planners to keep in mind when considering options related to monitoring and assessing implementation progress as part of the overall adaptive management framework.

Other options for evaluating potential BMP performance include using existing information from past BMP studies and evaluations or computer-based predictive tools. Stormwater planners can consider the strengths and challenges associated with each option for evaluating potential BMP performance to determine which approach to use for supporting internal implementation planning activities, or to promote through recommendations and requirements for sources. Planners should consider several factors when examining each potential approach, including water quality parameters, source types, local conditions, available data, and user experience. Approaches range from simple to complex. Simple approaches include the use of published literature values for typical BMP performance or simple, spreadsheet-based models that calculate loads delivered to and removed by management measures. Complexity increases with the use of watershed models, which require substantial data inputs on multiple management techniques and can evaluate the optimum placement of BMPs as well as their performance. Simpler models are often sufficient to meet the needs of an analysis and are advantageous when time and budget resources are limited. Considerations for the use of literature values versus computer-based predictive tools are provided below.

> ***Tip: Understanding "Percent Removal"***
>
> Percent removal is a common metric for gauging BMP effectiveness. The pollutant concentration of stormwater flowing into a BMP is compared to the pollutant concentration of stormwater discharged after treatment by the BMP. Stormwater planners should understand the advantages and challenges associated with using percent removal as a way to determine BMP performance. One advantage of using percent removal is that it is a relatively available estimation of BMP performance. The challenge, however, is that percent removal can be a misleading statistic. For example, percent removal depends primarily on the influent quality. A BMP treating very *dirty* runoff will have a higher percent removal than the same BMP treating *cleaner* runoff. Also does not take into account volume reductions achieved through the BMP. For more detail describing why percent removal is a poor measure of BMP performance, see the fact sheet developed for the international stormwater BMP database at www.bmpdatabase.org/Docs/FAQPercentRemoval.pdf.

5.2.2.2.1 BMP Literature Values

One method used for predicting load reductions from BMPs is to use literature values of performance typically associated with type

> ***Resources:*** For more information on BMP performance literature values, refer to the Resources list at the end of this chapter in Section 5.3.5.

of management practice and pollutant (e.g., detention pond, sediment). The percent reductions commonly documented in the literature are normally estimated from one or more monitoring studies where performance of BMPs was measured using flow and chemical monitoring. For example, the effectiveness of management practice systems could be calculated using the relative effectiveness of individual practices. Stormwater planners using this approach should verify that the study carefully estimated inflow pollutant concentrations and should also take volume reductions into consideration. This approach can help with initial BMP scoping and screening. However, planners using this approach to estimate pollutant load removals should be aware that this approach might oversimplify and overestimate cumulative removal rates for BMP treatment trains.

5.2.2.2.2 Modeling Tools

Stormwater planners can select or refine a list of potential BMPs using computer-based predictive tools, or modeling. Modeling stormwater pollutant load reductions from BMPs commonly involves three primary measures—pollutant concentrations in the stormwater at some point in time, the total pollutant load conveyed over a time period, and the event mean concentration. Stormwater planners can refer to the TMDL analysis to determine what modeling approach the TMDL writer used and if it is possible to use the same model to narrow the range of BMP options and aid in siting and sizing them. Performance standards for management practices often include controls on the stormwater peak discharge rate, the total runoff volume, and the total pollution load, which often is the focus of the WLA. Load reductions for individual and multiple BMPs—functioning as groups of practices or consecutive facilities arranged in a treatment train—can be modeled in some cases by using BMP calculators built into watershed models. For example, planners can use SWMM to evaluate urban area management practices and has the capabilities to emulate the major management practice processes (i.e., storage, infiltration, first-order decay, and sediment settling). The recently added overland flow rerouting (land-to-land routing) options block can be used to mimic the parcel (individual lot) level sites.

> ***Resources:*** For more information on model applicability, refer to the Resources list at the end of this chapter in Section 5.3.6.

A variety of more BMP-specific modeling options exist to simulate specific BMPs or unique situations. In some cases, specialized watershed models and management practice models are used to perform small-scale analysis of BMPs. Table 12 provides a brief description of several specialized models that can aid planners in selecting and siting BMPs to implement progress toward WLAs.

Those selecting BMPs can take into account the unique set of conditions associated with each stormwater source. In addition to performance, sources will undoubtedly need to consider other selection factors that have little to do with water quality improvement. If the planning is being conducted by someone other than the permittee, consultations with industrial, construction site, and MS4 permittees during this process can help to create a bridge for discussions regarding BMPs selected, sites, designs, size, and cost.

> ***Tip: Determining if models used in TMDL development are appropriate for implementation planning.***
>
> If the TMDL development process involved watershed modeling, planners might have an opportunity to use this type of model for selecting and siting BMPs. Planners can work with TMDL writers to determine if the watershed model contains the necessary data for BMP implementation analysis. TMDL writers can also keep in mind the potential a watershed model might have for implementation planning purposes early in the TMDL development process.

Table 12. Description of modeling tools available for BMP selection, sizing, and siting decision making

Model/tool	Description
The Site Evaluation Tool (SET)	The model was developed to assess the effects of development, including sediment and nutrient loading, on a site scale. The tool allows definition of pre- and post-treated land use, allowing for multiple drainage areas and various combinations of practices. Structural and nonstructural practices can be represented, giving the user a suite of options for evaluation. www.unrba.org/set/index.shtml
Prince George's County BMP-Decision Support System (PG BMP-DSS)	The PG BMP-DSS evaluates the effect of management practices or combinations of management practices on flow and pollutant loading. This module uses simplified process-based algorithms to simulate management practice control of modeled flow and water-quality time series generated from runoff models such as HSPF. These simple algorithms include weir and orifice control structures; storm swale characteristics; flow and pollutant transport; flow routing and networking; infiltration and saturation; and a general loss/decay representation for a pollutant. The module offers the user the flexibility to design retention-style or open-channel management practices; define flow routing through a management practice or management practice network; simulate Integrated Management Practices such as reduced or discontinued imperviousness through flow networking; and compare management practice controls against a defined benchmark such as a simulated predevelopment condition.
Model for Urban Stormwater Improvement Conceptualization (MUSIC)	MUSIC was developed to evaluate small and large-scale (100 square kilometer) urban stormwater systems using modeling time steps that range from 6 minutes to 24 hours. MUSIC provides an interface to help set up complex stormwater management scenarios. The stormwater control devices evaluated by MUSIC include ponds, bioretention, infiltration buffer strips, sedimentation basins, pollutant traps, wetlands, and swales. Major techniques used to evaluate management practices including settling in ponds and decay of pollutants. www.toolkit.net.au/cgi-bin/WebObjects/toolkit.woa/wa/productDetails?productID=1000000
Integrated Design and Evaluation Assessment of Loadings (IDEAL)	IDEAL provides a spreadsheet-based technique for assessing the benefits of urban management practices on flow, sediment, nutrients and bacteria. The model predicts watershed runoff, concentrations, and loads, using the user's selection of vegetative filter strips, dry detention ponds, and wet detention ponds. Urban areas are defined as pervious, impervious connected, and impervious unconnected areas. Flow and loads can be directed to a pond that can be either dry (no permanent pool) or wet (permanent pool). The model then calculates the pollutant removal efficiencies of the practices using empirical equations. The model predicts single storm values and converts them to average annual storm values using a statistical process. The IDEAL model is designed to help managers estimate long-term management practice pollutant removal efficiencies and is not designed for looking at individual storms. www.greenvillecounty.org/land_development/Planning.asp
Soil and Water Assessment Tool (SWAT)	SWAT is a river basin-scale model developed to quantify the effect of land management practices in large, complex (primarily agricultural) watersheds. SWAT was developed to predict the effect of land management practices on water, sediment, and agricultural chemical yields in watersheds with varying soils, land use, and management conditions over long periods of time. www.brc.tamus.edu/swat/
Storm Water Management Model (SWMM)	SWMM is a dynamic rainfall-runoff simulation model applied primarily to urban areas and for single-event or long-term (continuous) simulation using various time steps. It was developed for analyzing surface runoff and flow routing through complex urban sewer systems. In SWMM, flow routing is performed for surface and subsurface conveyance and groundwater systems, including the options of nonlinear reservoir channel routing and fully dynamic hydraulic flow routing. SWMM has a variety of options for quality simulation, including traditional buildup and washoff formulation as well as rating curves and regression techniques. SWMM can simulate storage, treatment, and other BMPs. www.epa.gov/ednnrmrl/models/swmm/index.htm
Vegetative Filter Strip Model (VFSMOD)	VFSMOD provides specialized modeling of field-scale processes associated with filter trips or buffers. This model provides routing of storms runoff from an adjacent field through a vegetative filter strip and calculates outflow, infiltration, and sediment trapping efficiency. The model is sensitive to characteristics of the filter including: vegetation roughness or density, slope, infiltration characteristics, and the incoming runoff volume and sediment particle sizes. http://carpena.ifas.ufl.edu/vfsmod/

Model/tool	Description
Wetland water balance and nutrient dynamics model (WETLAND)	WETLAND is a dynamic compartmental model to simulate hydrologic, water quality and biological processes and to assist the design and evaluation of wetlands. The model can simulate both free-water surface and subsurface flow wetlands. WETLAND is modular and includes hydrologic, nitrogen, carbon, dissolved oxygen, bacteria, sediment, vegetation, and phosphorous submodels.
Virginia Field Scale Wetland Model (VAFSWM)	VAFSWM is a field-scale model for quantifying the pollutant removal in a wetland system. It includes a hydrologic subroutine to route flow through the treatment system; precipitation, evapotranspiration, and exchange with subsurface groundwater.
Delaware Urban Runoff Management Model (DURMM)	The Delaware Department of Natural Resources (DNREC) created DURMM to provide a more rigorous hydrological design tool for Green Technology BMPs. Green Technology BMPs are designed to "intercept runoff from rooftops, parking lots and roads as close as possible to its source, and direct it into vegetative recharge/filtration facilities incorporated into the overall site design and runoff conveyance system." They include conservation site design, impervious area disconnection, conveyance of runoff through swales and biofiltration swales, filtration through filter strips, terraces, bioretention facilities, and recharge through infiltration facilities. www.swc.dnrec.delaware.gov/Pages/SedimentStormwater.aspx
Basin Sizer	The Basin Sizer program allows users to find information useful for sizing stormwater basins in California. It is built from the STORM model and performs continuous simulation. Elements sized include infiltration basins, detention basins, and flow-based BMPs. http://stormwater.water-programs.com/BasinSizer/Basinsizer.htm
City of Emeryville Stormwater Sizing Worksheet	This spreadsheet allows the user to size metered detention, bioretention, planter strip, flow-through planter box, and biofiltration BMPs. www.ci.emeryville.ca.us/planning/stormwater.html

In Practice: Predicting BMP performance using a BMP Decision Support System in Vermont

The Vermont Department of Environmental Conservation has developed a BMP Decision Support System (BMP-DSS) to facilitate stormwater permit issuance and compliance under the state's stormwater regulation. The BMP-DSS is an innovative decision-making tool for evaluating placement and selection of BMPs and LID techniques at strategic locations in urban watersheds. It uses GIS technology, integrates BMP process simulation models, and applies system optimization techniques for BMP placement and selection to address the cost/benefit issues associated with stormwater management. The model provides the continuous simulation of hydrographs and pollutant loads and concentrations so that the effectiveness of LID approaches can be simulated within large-scale watersheds models such as HSPF and SWMM. It offers the user the flexibility to design stormwater structural practices such as bioretention cells, rain barrels, roof gardens, vegetated swales, infiltration chambers, wetlands and off-line regional stormwater retention and detention ponds. It also includes the simulation of site design characteristics such as storm drains, building density, road and sidewalk dimensions, disconnection of impervious surfaces, and compares BMP controls against some defined benchmark such as a simulated predevelopment condition.

In Practice: Predicting BMP performance using a Site Evaluation Tool in the Upper Neuse River Basin, North Carolina

The Upper Neuse River Basin Association (UNRBA), made up of 13 city and county governments in the Triangle region of North Carolina, works to protect water resources within the 770-square-mile watershed above Falls Lake dam. Critical issues in the watershed are risk of nutrient enrichment in water supply reservoirs and effects on stream aquatic life from sediment loading and stream channel erosion. The Upper Neuse Site Evaluation Tool (SET) was developed under the guidance of many of the participating governments that were interested in a tool that could be used for both UNRBA goals and for local stormwater programs. This version of the SET included the ability to predict storm event peak flows and hydrographs, with scoping-level assessment of BMP influence on the storm event hydrographs. Model output was also tailored to assess site performance against variable nutrient loading rate goals on the basis of the user's selection of the whether the site was residential or nonresidential and whether it was in a predefined urban versus rural zone.

5.2.2.2.3 Additional Screening Criteria

After researching candidate BMPs with regard to the effect on the pollutant of concern, planners should have enough information to analyze each management opportunity using appropriate and locally applicable screening criteria (see example in Table 13). Screening criteria are typically based on pollutant type, source area(s), performance/effectiveness, capital and O&M costs, and so on.

Table 13. Example of screening criteria for stormwater management practices

Screening criteria	Description
Volume reduction/source controls	Consider the role volume plays in contributing to elevated pollutant loads. Determine the extent to which rate and volume of flow can be retained or reduced on-site.
Location of the management practice within the critical area/watershed landscape	Check to see if the candidate management practice can help implement the load reductions that were identified in one of the critical areas of the watershed.
Estimated load reductions	Using the information you collected during desktop and field scoping, document whether the anticipated load reduction is low, medium, or high.
Legal and regulatory requirements	Identify legal or regulatory requirements for projects, and determine whether any pose significant constraints.
Property ownership	Determine the numbers of property owners that need to agree to installation or implementation of the management practice(s). It is often easier to obtain easements on lands in public ownership.
Site access	Consider whether you will be able to physically access the site and identify a contact to obtain permission if private property must be traversed to access the site. Consider whether maintenance equipment (e.g., front-end loaders, vacuum trucks) will be able to reach the site safely. Designs and cost estimates might require adjustment if a structural control requires hand-cleaning because of maintenance access constraints.
Added benefits	In addition to their intended design, management practices can also provide secondary benefits by controlling other pollutants, depending on how the pollutants are generated or transported. For example, practices that reduce erosion and sediment delivery often reduce phosphorus losses because phosphorus is strongly adsorbed to silt and clay particles.
Unintended effects	In some cases, management practices that are used to control one pollutant could inadvertently increase the generation, transport, or delivery of another pollutant.

Screening criteria	Description
Physical factors	There are many physical factors that can determine whether you will be able to install management practices. Look for constraints such as steep slopes, wetlands, high water tables, and poorly drained areas. Also look for opportunities such as open space, existing management practices that can be upgraded, outfalls where management practices could be added, and well-drained areas.
Infrastructure	Look for sites that have few utilities, road crossings, buried cables, pipelines, parking areas, or other significant physical constraints that could preclude installation or cause safety hazards.
Costs	The appropriateness of a management practice for a site can be affected by economic feasibility considerations that encompass short- and long-term costs. Short-term costs include installation costs, while long-term costs include continued O&M.
Social acceptance	Consider how nearby landowners will perceive the management practice. Will it cause nuisances such as localized ponding of water or vector control problems? Can these issues be addressed in the siting and design of the practice? How can nearby residents be involved in selecting and designing the practice to address their concerns? The optimal method for evaluating site feasibility for both riparian and upland management practices is through a site visit.

5.2.2.2.4 BMP Site Selection

In most instances, it is likely that sources acting as stormwater planners, rather than TMDL and permit writers or other entities at the state or EPA Regional level, will focus on identifying the most appropriate geographic location for siting and installing structural BMPs or conducting nonstructural BMPs. Factors affecting BMP siting decisions might include local conditions such as slopes, soils, and critical areas; historical, current, and future land uses; property ownership; cost; site access; infrastructure considerations; and social acceptance. Therefore, state or EPA Regional stormwater planners should either work closely with sources if the strategy includes making siting recommendations or consider leaving siting decisions to sources altogether.

Stormwater planners can use, recommend, or require desktop and field reconnaissance to scope the possible additional BMPs appropriate for addressing the pollutants of concern and the potential geographic locations for implementing these additional BMPs. This information can be gathered during the initial phase of determining the location of existing BMPs. The reconnaissance usually involves locating and mapping the likely source areas for the TMDL listed pollutants, identifying candidate BMPs that might be used to address them, and screening possible BMP installation sites—or, in the case of nonstructural BMPs (e.g., erosion control, pavement sweeping, IDDE, materials management)—scoping potential policy practices to address the problems identified.

After identifying pollutant sources cited in the TMDL, stormwater planners might consider recommending areas where appropriate management measures can likely implement the greatest pollutant load reductions, or requiring sources to identify these areas. These so-called *critical areas* are at or near pollutant source areas, and could include places with severe upland or channel erosion, sites generating oil and grease or other toxics, extensively paved subwatersheds or small catchments requiring runoff volume controls, areas with a high density of illicit connections, parks that generate significant bacteria loads from pets, industrial facilities generating high pollutant loads, and similar locations.

Stormwater treatment via multiple, consecutive BMPs can significantly improve the quality of water discharged to urban rivers, lakes, streams, wetlands, and coastal waters. In general, stormwater treatment

trains should seek to address source controls and infiltration, evapotranspiration and reuse first, then large particles, and, finally, small particles. The specific pollutant removal role of the second or third facility in a treatment train often assumes that significant settling or removal of solids has already occurred. For example, phosphorus removal using a two-facility treatment sequence relies on the second facility (e.g., sand filter) to remove a finer fraction of solids than those removed by the first facility. Oil control facilities must be upstream of treatment facilities and as close to the source of oil-generating activities as possible. They should also be upstream of detention facilities, if possible.

5.2.3. Monitoring and Assessing Implementation Progress (Key Questions 4-5)

After identifying the suite of BMPs appropriate for addressing the remaining pollutant load reduction to implement the WLA, stormwater planners will need to rely on the sources to undertake the necessary steps to implement the final set of BMPs. At this point, stormwater planners can provide recommendations and requirements that focus on assessing BMP performance to determine if the additional controls are producing the expected pollutant load reductions. To accomplish this, stormwater planners should consider what recommendations and requirements can promote iterative improvements using an adaptive management framework. The key questions that planners should help sources answer include the following:

4. How should permittees measure BMP performance as implementation proceeds?
5. Are measured pollutant load reductions adequate to make progress toward the assigned WLA?

5.2.3.1. Answering Key Question 4: Monitoring and Assessing Implementation of Additional BMPs

This set of questions summarizes the basic activities related to conducting an adaptive management approach. It is important to remember that the ultimate goal of stormwater management driven by implementing a WLA is to meet the water quality criteria associated with the designated use(s) of the relevant waterbody. The iterative approach of stormwater management implementation allows for sources to make progress toward that goal over time. Therefore, it is imperative that stormwater planners provide sources with recommendations and requirements related to assessing the performance of BMPs and overall SWMPs and SWPPPs and how to use assessment information to make meaningful changes to management strategies that can ensure further progress.

Stormwater planners can generate monitoring and assessment recommendations and requirements that can encourage sources to periodically evaluate BMP implementation and review monitoring and assessment information to track progress toward implementing WLAs. To comprehensively evaluate implementation activities, stormwater planners need to consider a combination of both process and

> ***Tip: Consider best placement of treatment trains***
>
> There is some uncertainty regarding whether treatment facilities should be placed upstream or downstream of detention facilities that are needed for flow control purposes. In general, all treatment facilities can be installed upstream of detention facilities, although presettling basins are needed for sand filters and infiltration basins. However, not all treatment facilities can function effectively if located downstream of detention facilities. Those facilities that treat unconcentrated sheet flows, such as filter strips and narrow biofilters, are usually not practical downstream of detention facilities because of a variety of factors, including the sheer volume that must be treated.

summative analyses. A process analysis is one that tracks progress, assesses the quality of data relative to measurement quality objectives (i.e., whether the data are of sufficient quality to answer the monitoring question), and provides early feedback on trends, changes, and problems in the watershed. The summative analysis is more intensive and determines the status, changes, trends, or other issues that measure the environmental response to BMP implementation, as well as overall SWMP and SWPPP implementation.

The California Stormwater Quality Association (CASQA) developed the *Municipal Stormwater Program Effectiveness Assessment Guidance* (CASQA 2007) to assist municipal stormwater program managers in designing and conducting program effectiveness assessments using a range of assessment methods. The document also describes how to use these methods on the basis of program-specific desired outcomes and goals. Figure 21 (labeled Figure 2 in the CASQA guidance document) shows the outcome levels described with associated effectiveness assessments. Levels 1 to 4 are evaluated through *Implementation Assessments* and Levels 5 to 6 are evaluated through *Water Quality Assessments*. An MS4 would typically use Levels 1-4 to determine if programmatic targets or goals are being met.

Evaluations like the ones described in the CASQA document or those typically conducted by permitting authorities to determine an MS4's compliance with permit requirements and SWMP obligations typically do not *quantify* the level of effectiveness. They typically assess whether the MS4 is meeting the goals of the permit to the MEP. (For a discussion of MEP, see Chapter 2) This quantification or characterization in a manner that can be compared to the goals in a TMDL is the greatest challenge when trying to determine if an MS4 program is making progress toward a WLA. The best, most appropriate method to accomplish this can vary greatly among MS4s according to the types of BMPs and pollutant being limited by the TMDL.

> ***Resources:*** For more information on stormwater program evaluation, refer to the Resources list at the end of this chapter in Section 5.3.7.

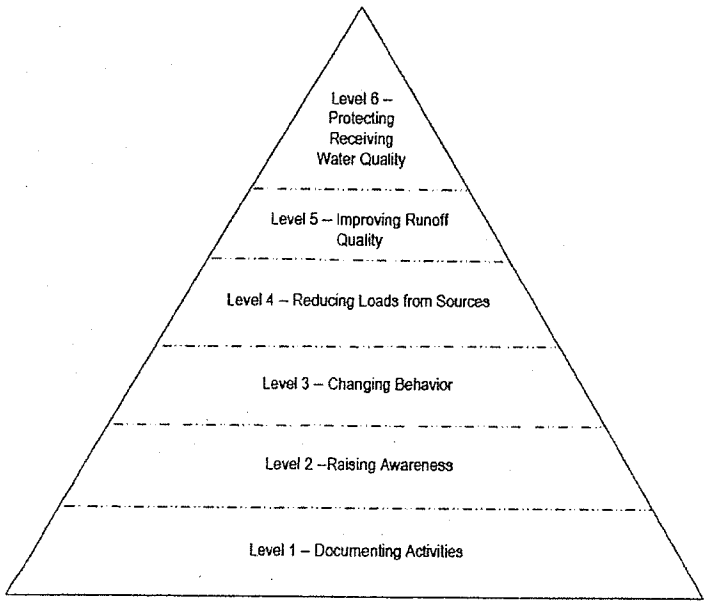

Figure 21. Approaches to evaluating storm water program effectiveness. (Source: CASQA 2007)

In Practice: Developing a Monitoring Program to Assess BMP Effectiveness in Addressing Pathogens in the Middle Rio Grande, New Mexico (2002)

Middle Rio Grande TMDL for fecal coliform recommends that MS4s, "[d]evelop and implement a monitoring program to assess BMP effectiveness and to compare loadings to the targets." The Albuquerque MS4 permit, based on this recommendation in the TMDL, requires the city to develop a monitoring program to track trends in fecal coliform and BMP effectiveness to track compliance with the TMDL WLA; to use an adaptive management approach by implementing revisions to the required programs if deemed necessary on the basis of monitoring data; and to develop and submit BMP evaluations and assessments, as well as an Annual TMDL Progress Report that summarizes monitoring results and includes computations of annual percent reduction achieved from the baseline loads and comparisons with the target loads.

In Practice: Working with Stakeholders on Adaptive Management for Swamp Creek, Washington

The Swamp Creek TMDL (2006) includes language that requires the Washington Department of Ecology to annually meet with municipal stakeholders to, "share information on the state of water quality in the watershed and status of implementation activities. Water quality data, trends (where applicable), regulatory changes, new and innovative concepts, and funding sources will be discussed to evaluate the overall status of the TMDL. Ecology will solicit input from the workgroup at this time to help direct the adaptive management of this TMDL. Ecology will track implementation no less than annually using the tracking table in Appendix E and through municipal stormwater permit program audits."

In Practice: Permit Requirements for Establishing Pollutant Load Reduction Benchmarks for Columbia Slough, Oregon

The Columbia Slough TMDL (1998) states that monitoring and implementation of BMPs will be done by MS4s to comply with the BOD_5 WLA. The Phase I MS4 permit for the city of Gresham, city of Fairview, and Multnomah County specifies BMP requirements to implement the WLA to the MEP. The Oregon Department of Environmental Quality created an MS4 permit benchmarking approach that applies to all TMDL parameters for which stormwater WLAs were established. Benchmarks are estimates of future pollutant load reductions. The permit requires that the benchmarks and necessary BMPs be included in the MS4 SMWP. The permit defines a benchmark as follows:

> A benchmark is a total pollutant load reduction estimate for each parameter or surrogate, where applicable, for which a WLA is established at the time of permit issuance. A benchmark is used to measure the overall effectiveness of the stormwater management plan in making progress toward the WLA (this estimate will be related to the statistical variability of the underlying data and may be stated as a range), and is intended to be a tool for guiding adaptive management activities. A benchmark is not a numeric effluent limit; rather it is a goal that is subject to the maximum extent practicable standard. The co-permittee must provide the rationale for the proposed benchmark, which includes an explanation of the relationship between the benchmarks and the TMDL wasteload allocations. Any limiting factors related to the development of a benchmark, such as data availability and data quality, must also be included in this rationale.

The Phase I permit requires that a monitoring plan be designed to track the long-term progress of the SWMP toward achieving improvements in receiving water quality, including progress toward implementing pollutant load reduction benchmarks associated with TMDL constituents. This requirement is addressed with the ambient and outfall monitoring that is conducted, and assessed as part of the data evaluation and reporting components of the program that occur during each permit renewal application. The permit also requires that results of the monitoring be used to support the adaptive management process and lead to refinements of the SWMP.

To ensure a successful adaptive management process, both water quality and BMP performance monitoring data should be assessed fairly frequently (e.g., as part of the SWPPP/SWMP evaluation process). Progress reports and regular team meetings are two effective ways to accomplish this. Even though frequent evaluations of BMP performance and water quality data might seem demanding, early indications of trends or problems can prevent major future problems.

The best use of monitoring data can depend on a variety of factors, including the type of permittee, geographic size of the permittee and the impairment(s). However, there are three basic types of monitoring that could be used—BMP monitoring, outfall monitoring, and receiving water monitoring.

- **BMP Monitoring.** There are several options for assessing BMP performance, including BMP monitoring. The University of Minnesota's *Assessment of Stormwater Best Management Practices* provides a process for developing and implementing a BMP assessment program that includes four levels of assessment: (1) visual inspections, (2) capacity testing, (3) synthetic runoff testing, and (4) monitoring. Monitoring is considered the most accurate method for assessing BMP volume reduction, peak flow reduction, and pollutant removal efficiency. Procedures for each level of BMP assessment can vary by the type of BMP. As previously stated, certain types of structural BMPs lend themselves well to direct monitoring (e.g., discharge from a stormwater pond). Data from these types of BMPs should be collected to the extent possible and used to determine if the BMPs are performing as expected and if this is adequate. If there is a large number of BMPs, it will likely be more appropriate to sample a representative number and extrapolate the results to the rest.

> ***Resources:*** For more information on BMP monitoring, refer to the Resources list at the end of this chapter in Section 5.3.8.

- **Outfall Monitoring.** Permittees of small geographic size (i.e., construction project or industrial facility) with few outfalls might be able to monitor the effluent and directly measure whether the facilities' contribution has been reduced adequately to implement the applicable WLA. Monitoring outfalls of large permittees (i.e., MS4s) might not provide any useful data for adaptive management of specific BMPs but could help to determine geographic areas or isolated land use types that might need further attention if the monitoring reveals inadequate progress toward TMDL goals. Data from outfall monitoring can also serve as an indicator to determine if more structural or nonstructural BMPs are needed in the area contributing flow to the outfall (e.g., data from one outfall demonstrates inferior BMP performance versus other outfalls).

> ***Resources:*** For more information on stormwater outfall monitoring, refer to the Resources list at the end of this chapter in Section 5.3.9.

- **Receiving Water Monitoring.** Because the ultimate purpose of the TMDL and subsequent implementation efforts is to improve receiving water quality, it might be in the best interests of permittees to conduct their own ambient monitoring. For example, larger permittees with adequate resources could regularly monitor receiving water to evaluate trends, confirm significant sources, and potentially update and improve existing models. As previously described, the CASQA *Municipal Stormwater Program Effectiveness Assessment Guidance* provides information on water quality assessments to help determine what effect BMPs are having on receiving water quality. A list of other monitoring-related resources is also provided at the end of this section.

> ***Resources:*** For more information on receiving water monitoring, refer to the Resources list at the end of this chapter in Section 5.3.10.

In Practice: Using Receiving Water Monitoring to Demonstrate Progress in the Los Angeles River, California

Receiving water monitoring is required to demonstrate a permittee is implementing the WLAs in the Los Angeles River and Tributaries Metals TMDL. This TMDL includes an implementation plan which states the following:

> Each municipality and permittee will be required to meet the storm water waste load allocations shared by the two MS4s and Caltrans permittees at the designated TMDL effectiveness monitoring points. [...] The MS4 and Caltrans stormwater NPDES permittees will be found to be effectively meeting dry-weather waste load allocations if the in-stream pollutant concentration or load at the first downstream monitoring location is equal to or less than the corresponding concentration- or load-based waste load allocation. Alternatively, effectiveness of the TMDL may be assessed at the storm drain outlet based on the waste load allocation for the receiving water. For storm drains that discharge to other storm drains, the waste load allocation will be based on the waste load allocation for the ultimate receiving water for that storm drain system. The MS4 and Caltrans stormwater NPDES permittees will be found to be effectively meeting wet-weather waste load allocations if the loading at the downstream monitoring location is equal to or less than the wet-weather waste load allocation.

5.2.3.2. Answering Key Question 5: Determining Whether Implementation Progress is Adequate

After quantifying the pollutant load reduction gains made through implementing existing and additional BMPs, stormwater planners should assist sources in determining if the current SWMP and SWPPP are adequate to implement the WLA over time. To answer this question, however, both stormwater planners and sources need guidance or criteria for judging progress, information that ideally should be first presented in the TMDL and permit. Therefore, TMDL and permit writers should consider how to define progress, which is likely to vary by pollutant, permittee type, and other potential factors such as compliance determination methods by the permitting authority.

Options for defining progress toward implementing the WLA are as follows:

- Demonstrating pollutant load reductions by an agreed on date
- Demonstrating pollutant concentration reductions by a particular date
- Implementing a set of prescribed BMPs with specific performance standards by a particular date
- Complying with the permit SWMP or SWPPP requirements during the permit term

Stormwater planners should be aware that current TMDLs and permits use a variety of these approaches to define progress, while still other TMDLs and permits remain silent on the issue of progress. If the TMDL and the permit do not provide a definition of how to determine progress, stormwater planners can consider developing recommendations and requirements to help sources create and justify their own progress milestones or benchmarks. Stormwater planners can specify the nature of the benchmarks (e.g., quantifiable) and determine supporting information sources should submit to justify and verify the validity and accuracy of the selected benchmarks. Most importantly, TMDL and permit writers need to remember the iterative, dynamic nature of SWMP and SWPPP implementation when crafting TMDL and permit requirements. Where possible, defining a framework approach, including goals, for assessing progress and allowing the sources to determine the details (with adequate evaluation through the SWMP and SWPPP) is going to be more useful than trying to identify a detailed approach at the state level.

(Chapter 6 provides a brief discussion on compliance schedules—an important factor to consider when evaluating overall progress.)

In Practice: Including Specific Criteria for Assessing Progress in the Los Angeles MS4 Permit

The Santa Monica Bay Beaches dry weather bacteria TMDL is expressed in terms that are directly applicable to MS4s and the associated WLA is included in the Los Angeles MS4 permit. This provides the permittees a clear understanding of what must be accomplished to implement the WLA. The permit language (Provision 29 of Order 01-182) is as follows:

> The Waste Load Allocations (WLAs) in the Dry Weather Bacteria TMDL are expressed as the number of allowable days that the Santa Monica Bay beaches may exceed the Basin Plan water quality objectives for protection of Water Contact Recreation (REC-1) in marine waters, specifically the water quality objectives for bacteria.... Tables 7-4.1, 7-4.2a, and 7-4.3 of the [Los Angeles River] Basin Plan set forth the pertinent provisions of the Dry Weather Bacteria TMDL. They require that during Summer Dry Weather there shall be no exceedances in the Wave Wash of the single sample or the geometric mean bacteria objectives set to protect the Water Contact Recreation (REC-1) beneficial use in marine waters. Accordingly, a prohibition is included in this Order barring discharges from a MS4 to Santa Monica Bay that result in exceedance of these objectives. Since the TMDL and the WLAs contained therein are expressed as receiving water conditions, Receiving Water Limitations have been included in this Order that are consistent with and implement the zero exceedance day WLAs.
>
> [Provision 32] These Receiving Water Limitations apply at the compliance monitoring sites identified in the Santa Monica Bay Beaches Bacterial TMDLs Coordinated Shoreline Monitoring Plan dated April 7, 2004.1 Compliance with the Receiving Water Limitations shall be determined using shoreline monitoring data obtained in conformance with the Santa Monica Bay Beaches Bacterial TMDLs Coordinated Shoreline Monitoring Plan dated April 7, 2004.

In Practice: Allowing Sources to Establish Benchmark Values for Pollutants in the City of Gresham, Oregon

The MS4 permit for the City of Gresham requires that the permittees develop benchmark values for applicable TMDLs. The permit language is as follows:

> Schedule D.2.(d)
>
> i) Progress toward reducing TMDL pollutant loads must be evaluated by the co-permittee through the use of performance measures and pollutant load reduction benchmarks developed and listed in the SWMP.
>
> (1) ...
>
> (2) A benchmark is a total pollutant load reduction estimate for each parameter or surrogate, where applicable, for which a [Waste Load Allocation] WLA is established at the time of permit issuance. A benchmark is used to measure the overall effectiveness of the storm water management plan in making progress toward the wasteload allocation (this estimate will be related to the statistical variability of the underlying data and may be stated as a range), and is intended to be a tool for guiding adaptive management activities. A benchmark is not a numeric effluent limit; rather it is a goal that is subject to the maximum extent practicable standard. The co-permittee must provide the rationale for the proposed benchmark, which includes an explanation of the relationship between the benchmarks and the TMDL wasteload allocations. Any limiting factors related to the development of a benchmark, such as data availability and data quality, must also be included in this rationale. The Interim Evaluation Report City of Gresham & Co-permittees (May 1, 2006, 4.0 Benchmark Evaluation for Gresham) summarizes the benchmarking process developed by the City of Gresham for TMDLs within the Columbia Slough.

In Practice: Specifying Pollutant Concentrations and BMPs Necessary to Make Adequate Progress in Oregon

The state of Oregon includes two options in the general permit for construction activities (www.deq.state.or.us/wq/stormwater/constappl.htm) that must be implemented to meet the goals of any turbidity or sediment TMDL—either meeting a benchmark concentration in the runoff established by the permitting authority or implementing a set of BMPs specific to the pollutant of concern. The exact permit language follows:

> 2. Water Quality Requirements for TMDL and 303(d) Listed Waterbodies
>
> In addition to other applicable requirements of this permit, if sediment or turbid water from a permit registrant's construction project has the potential to discharge into waterbodies that are listed for turbidity or sedimentation on the most recently EPA-approved Oregon 303(d) list or that have an established Total Maximum Daily Load (TMDL) for sedimentation or turbidity, the permit registrant must implement one of the two following sets of actions, in accordance with Schedule C.
>
> a. Option #1: Collect and analyze samples for turbidity in stormwater runoff from the construction site as required by Condition B.2. (p. 12) and compare the results to the benchmark value of 160 Nephelometric Turbidity Units (NTUs). The benchmark is used to determine if best management practices are effective; it is not an effluent limit. If any stormwater sample exceeds the benchmark, then the permit registrant must evaluate the best management practices (BMPs) and the adequacy of the ESCP and take corrective actions. If after such actions have been implemented and sample results still exceed the 160 NTU benchmark, the requirements of Option #2 below must be followed, and the permit registrant must submit an Action Plan to the department identifying the selected BMP(s) that will be implemented and the rationale for choosing the selected BMP(s).
>
> b. Option #2: In addition to the applicable BMPs required by Condition A.7., implement one or more of the following BMPs to control and treat sediment and turbidity:
>
> i. Compost berms, compost blankets, or compost socks;
>
> ii. Erosion control mats (rolled or blown);
>
> iii. Tackifiers used in combination with perimeter sediment control BMPs;
>
> iv. Established vegetated buffers sized at 50 feet plus 25 feet per 5 degrees of slope;
>
> v. Water treatment by electro-coagulation, chemical flocculation, or filtration; or
>
> vi. Other substantially equivalent sediment or turbidity BMP approved by the department.
>
> The selected BMP(s) must be specifically identified in the ESCP [erosion and sediment control plan] as addressing this condition of the permit, and the rationale for choosing the selected BMP(s) must also be provided.

In this example, the permittee has two choices for demonstrating that the construction project is implementing the goals of the TMDL. The permittee would either need to apply Option A and monitor the effluent per the requirements of the permit to show that the benchmark turbidity value is being met at the construction project. Or the permittee would need to demonstrate through inspection reports, that the BMPs required in a basic SWPPP as well as the additional BMPs defined by Option B are implemented and operating as designed on the site.

5.2.4. Adjusting Implementation for Continuous Improvements (Key Question 6)

Adaptive management focuses on learning from the information gathered through monitoring and assessment and making changes to implementation strategies on the basis of the information collected. Sources can continue to implement BMPs, as well as overall SWMPs and SWPPPs, if the information gathered through the process and summative analyses show the necessary progress toward implementing the WLA. If progress is not adequate, planners should develop recommendations and requirements that will allow sources to answer key question 6:

5.2.4.1. Answer Key Question 6: Identifying Modifications to Implementation Strategy

Because the adaptive management approach is not linear but iterative, TMDL and permit writers can develop recommendations and requirements for sources that focus on taking the information from key questions 4 and 5 to adjust the current implementation strategy. This could entail conducting an efficiency audit of existing BMPs to determine if they are properly installed, operated, and maintained, or recommend that sources identify the most effective BMPs after a set number of years of operation (so that these most effective BMPs are used in the future). In addition, modifications could involve revisiting key question 3 to determine if additional BMPs are necessary to make continuous improvements. Adaptive management actions might include retrofitting or adjusting previously installed BMPs that are not performing as expected or compiling lessons learned from implementation activities to help in future implementation planning.

It is important to note that permit writers include requirements that can facilitate adaptive management activities in existing individual and general stormwater permits, such as recording keeping and reporting requirements associated with inspections and, where applicable, monitoring activities. For example, construction stormwater permits might include requirements to conduct weekly stormwater monitoring and visual BMP inspections; where information from these activities show BMPs are not performing adequately, stormwater sources must modify the SWPPP accordingly. MS4 stormwater permits contain requirements for developing annual SWMP reports that assess the performance of BMPs and include detailed information on planned modifications. While these permit requirements might not have an explicit link to WLAs, sources should already have experience in collecting and analyzing performance information and applying that information to improve the effectiveness of SWPPPs and SWMPs.

5.3. Resources

5.3.1. BMP Inventory

1. USEPA (U.S. Environmental Protection Agency). 2007. *Municipal Separate Storm Sewer System (MS4) Program Evaluation Guidance*. U.S. Environmental Protection Agency, Office of Wastewater Management. EPA-833-R-07-003 (field test version) www.epa.gov/npdes/pubs/ms4guide_withappendixa.pdf and www.epa.gov/npdes/pubs/ms4guide_appendicesb-d.pdf

This document is available to assist in assessing the compliance and effectiveness of Phase I and Phase II MS4 stormwater programs, including compiling a comprehensive BMP inventory. Sources can also use this document to conduct self-audits of SWMPs.

5.3.2. BMP Selection

1. ASCE (American Society of Civil Engineers). 2001. *Guide for Best Management Practice Selection in Urban Developed Areas*. American Society of Civil Engineers, Reston, VA. www.asce.org/bookstore/book.cfm?book=4058

   This guide examines permanent structural techniques which can be used for retrofitting the stormwater management systems in existing developed areas.

2. Washington Department of Ecology. 2005. *Stormwater Management Manual for Western Washington.* Washington Department of Ecology, Olympia, WA. www.ecy.wa.gov/programs/wq/stormwater/manual.html

   This manual focuses on the applicability, technical design, construction, and maintenance of a range of stormwater management practices for use in western Washington to achieve water quantity and water quality control.

3. Maryland Department of the Environment. 2000. *Maryland Stormwater Design Manual*. Maryland Department of the Environment, Baltimore, MD. www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp

   This manual focuses on the applicability, technical design, construction, and maintenance of a range of stormwater management practices for use in Maryland to achieve water quantity and water quality control.

4. New Jersey Department of Environmental Protection. 2004. *New Jersey Stormwater Best Management Practices Manual*. New Jersey Department of Environmental Protection, Trenton, NJ. www.njstormwater.org/bmp_manual2.htm

   This manual focuses on the applicability, technical design, construction, and maintenance of a range of stormwater management practices for use in New Jersey to achieve water quantity and water quality control.

5. University of Wisconsin – Extension. 2000. *Wisconsin Stormwater Manual: Technical Design Guidelines for Stormwater Management Practices*. University of Wisconsin Extension, Madison, WI. http://learningstore.uwex.edu/Wisconsin-Storm-Water-Manual-P603C123.aspx.

   This manual focuses on the applicability, technical design, construction, and maintenance of a range of stormwater management practices for use in Wisconsin to achieve water quantity and water quality control.

6. Center for Watershed Protection. 2003-2008. Urban Subwatershed Restoration Manual Series. Center for Watershed Protection, Ellicott City, MD. www.cwp.org/Store/usrm.htm.

This 11 manual series covers the seven major practices used to restore urban watersheds: stormwater retrofits, stream repair, riparian management, discharge prevention, pollution source controls, watershed forestry and municipal operations. In addition, the series outlines new methods for desktop and field assessment and stakeholder management to develop effective small watershed restoration plans, and presents an integrated framework for urban watershed restoration.

5.3.3. Volume Control

1. Zomodi, K. 2007. *Effectiveness of Time of Concentration Elongation on Peak Flow Reduction.* 2nd National Low Impact Development Conference, March 12–14, 2007. www.bae.ncsu.edu/topic/lidconference07/A6/A6.4.Effectiveness%20of%20Time%20of%20Concentration%20Elongationon%20on%20Peak%20Flow%20Reduction.pdf

   This presentation discusses the findings of a study intended to theoretically evaluate the relative impact of time of concentration elongation on peak flow reduction under typical conditions of LID use.

2. Stein, Eric D. 2005. *Effect of Increases in Peak Flows and Imperviousness on Stream Morphology of Ephemeral Streams in Southern California.* Technical Report 450. Southern California Coastal Water Research Project, Westminster, CA. www.environmental-expert.com/files/19961/articles/4562/4562.pdf.

   This technical report investigates the effects of urbanization on ephemeral or intermittent streams in Southern California. The study seeks to (from the document) establish a stream channel classification system for Southern California streams, assess stream channel response to watershed change, develop deterministic/predictive relationship between changes in IC and stream channel enlargement and provide a conceptual model of stream channel behavior that may be used as the basis for a future numeric model. Eight watersheds and eleven sites were selected for study.

5.3.4. Green Infrastructure and Low Impact Development

1. Horner, R., C. May, E. Livingston, D. Blaha, M. Scoggins, and J. Tims. (n.d.). *Structural and Non-Structural BMPs for Protecting Streams.* Watershed Management Institute, Crawfordsville, FL. www.chesterfield.gov/CommunityDevelopment/Engineering/LIDGrant/Studies/HornerMay2001Paper.pdf

   This paper presents findings from a study of the effects of non-structural BMPs, including riparian buffers and retention of natural wetlands, on three stream ecosystems to help guide application of these practices in low-impact urban design.

2. Kloss, C, and C. Calarusse. 2006. *Rooftops to Rivers: Green Strategies for Controlling Stormwater and Combined Sewer Overflows.* Natural Resources Defense Council, New York City, NY. www.nrdc.org/water/pollution/rooftops/contents.asp

This policy guide provides decisionmakers with ideas on how to incorporate green strategies into urban landscapes to address the effects of wet weather on water quality. Includes nine case studies.

3. USEPA (U.S. Environmental Protection Agency). 2008. *Incorporating Green Infrastructure Concepts into Total Maximum Daily Loads.* U.S. Environmental Protection Agency, Washington, DC. www.epa.gov/owow/tmdl/stormwater/

   This 11 page fact sheet provides recommendations for incorporating GI and LID concepts into various elements of a TMDL and provides two TMDL case studies.

5.3.5. BMP Performance Literature Values

1. American Society of Civil Engineers' (ASCE) and EPA's International Stormwater BMP Database: www.bmpdatabase.org/

   The database contains more than 300 BMP studies, performance analysis results, tools for use in BMP performance studies, monitoring guidance and other study-related publications. The overall purpose of the project is to provide scientifically sound information to improve the design, selection, and performance of BMPs. Continued population of the database and assessment of its data will ultimately lead to a better understanding of factors influencing BMP performance and help to promote improvements in BMP design, selection and implementation.

2. FHWA (Federal Highway Administration). 2002. *Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring.* Federal Highway Administration, Landover, MD. www.fhwa.dot.gov/environment/ultraurb/

   The purpose of this document is to provide a planning-level review of the applicability and use of new and more traditional BMPs in ultra-urban areas. The document presents data, design criteria, and monitoring study results on BMPs implemented in ultra-urban areas

3. Pitt, R.E., A. Maestre, and R. Morquecho. 2004. The National Stormwater Quality Database (NSQD, version 1.1). University of Alabama, Tuscaloosa, AL. http://unix.eng.ua.edu/~rpitt/Research/ms4/mainms4.shtml and http://unix.eng.ua.edu/~rpitt/Research/ms4/Paper/recentpaper.htm

   These stormwater quality data and site descriptions are to describe the characteristics of national stormwater quality, provide guidance for future sampling needs, and enhance local stormwater management activities in areas having limited data. The monitoring data was collected over nearly a 10-year period from more than 200 municipalities throughout the country. This project is creating a national database of stormwater monitoring data collected as part of the existing stormwater permit program, providing a scientific analysis of the data, and providing recommendations for improving the quality and management value of future NPDES monitoring efforts.

4. University of Massachusetts Amherst's Massachusetts Stormwater Technology Evaluation Project (MASTEP), Stormwater Technologies Clearinghouse: www.mastep.net/

   This searchable database contains validated performance data and technical information on innovative stormwater treatment technologies. The Technology Acceptance and Reciprocity

Partnership (TARP) protocol is the basis for evaluating treatment efficiencies for various pollutants and the Web site is designed to help stakeholders interpret information such as site and environmental considerations as well as whether performance studies meet the minimum TARP requirements. It also serves as a repository for test reports and performance data from a variety of sources.

5. Fraley-McNeal, F., T. Schueler, and R. Winer. 2008. National Pollutant Removal Performance Database Technical Brief (Version 3.0). Center for Watershed Protection, Ellicott City, MD. www.cwp.org/Resource_Library/Center_Docs/SW/bmpwriteup_092007_v3.pdf

   The updated database was statistically analyzed to derive the median and quartile removal values for each major group of stormwater BMPs. The data are presented as box and whisker plots for the various pollutants found in stormwater runoff.

6. EPA's Urban BMP Performance Tool: http://cfpub.epa.gov/npdes/stormwater/urbanbmp/bmpeffectiveness.cfm

   Based largely on data from the International Stormwater BMP Database, this tool allows users to search BMP study summaries based on the pollutants measured, BMPs examined, or total volume of stormwater runoff reduced. Search results are displayed in a tabular format sorted by effluent concentration, and additional details on each study can be accessed by clicking on the study title. The Urban BMP Performance Tool also includes background information about BMP performance, including basic information on understanding how BMP affect concentration, volume and total load.

7. University of New Hampshire Stormwater Center, Nonpoint Education for Municipal Officials (NEMO), Innovative Stormwater Management Inventory Database: www.erg.unh.edu/stormwater/index.asp

   This searchable and amendable database highlights innovative stormwater management techniques such as low impact design, used in New England. The database contains information on bioretention areas, green roofs, rain gardens, detention pond retrofits, tree filters, and constructed wetlands.

5.3.6. Model Applicability

1. USEPA. 2005. *TMDL Model Evaluation and Research Needs*. EPA/600/R-05/149. U.S. Environmental Protection Agency, Office of Research and Development, National Risk Management Research Laboratory, Cincinnati, OH. www.epa.gov/nrmrl/pubs/600r05149/600r05149.htm

   This report documents the review of more than 60 available watershed and receiving water models for their applicability to TMDL development and implementation. It discusses model selection on the basis of model capabilities and provides a series of tables rating the capabilities or applicability the models using the categories of TMDL endpoints, general land and water features, special land processes, special water processes, and application considerations. The document also provides individual fact sheets for each reviewed model.

2. USEPA. 1997. *Compendium of Tools for Watershed Assessment and TMDL Development*. EPA 841-

B-97-006. U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans, and Watersheds, Washington, DC. www.epa.gov/owow/tmdl/comptool.html

This document reviews more than 50 watershed, receiving water and ecological assessment models. The document provides factsheets for each model that describes model components, methods, applications, pollutants addressed, limitations, input data requirements, and type of output. The document also contains information on model selection for specific applications, model calibration, and model verification.

3. USEPA (U.S. Environmental Protection Agency).2008. *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*. U.S. Environmental Protection Agency, Washington, DC. www.epa.gov/nps/watershed_handbook/

   Chapter 8 of this document focuses on methods for estimating pollutant loads, including the use of watershed models. This chapter provides assistance in selecting and applying watershed models to estimate pollutant loads from existing conditions.

5.3.7. Stormwater Program Evaluation

1. CASQA (California Stormwater Quality Association). 2007. *Municipal Stormwater Program Effectiveness Assessment Guidance*. California Stormwater Quality Association, Menlo Park, CA. www.casqa.org

   This document provides stormwater managers with a variety of stormwater program assessment strategies and methods appropriate for different stormwater program elements and outcome levels.

2. USEPA (U.S. Environmental Protection Agency). 2007. *Municipal Separate Storm Sewer System (MS4) Program Evaluation Guidance*. U.S. Environmental Protection Agency, Office of Wastewater Management. EPA-833-R-07-003 (field test version) www.epa.gov/npdes/pubs/ms4guide_withappendixa.pdf and www.epa.gov/npdes/pubs/ms4guide_appendicesb-d.pdf

   This document is available to assist in assessing the compliance and effectiveness of Phase I and Phase II MS4 stormwater programs, including compiling a comprehensive BMP inventory. Sources can also use this document to conduct self-audits of SWMPs.

5.3.8. BMP Monitoring

1. Washington Department of Ecology. 2008. *Guidance for Evaluating Emerging Stormwater Treatment Technologies, Technology Assessment Protocol* (revised). Publication # 02-10-037. Washington Department of Ecology, Olympia, WA. www.ecy.wa.gov/biblio/0210037.html

   This document's primary purpose is to establish a testing protocol and process for evaluating and reporting on the performance and appropriate uses of emerging stormwater treatment technologies. This document is also intended for use in evaluating public domain practices possibly resulting in changes to the design standards for these practices in the state's *Stormwater Management Manual*.

2. University of Minnesota. 2008. *Assessment of Stormwater Best Management Practices*. University of Minnesota, St. Paul, MN. http://wrc.umn.edu/outreach/stormwater/bmpassessment/assessmentmanual/

This manual provides information on four levels of a BMP assessment program and provides assessment procedures for source reduction BMPs, filtration practices, infiltration practices, sedimentation practices, and biologically enhanced practices.

3. TARP (Technology Acceptance and Reciprocity Partnership). 2003. *TARP Protocol for Stormwater Best Management Practice Demonstrations*. Final August 2001. Updated July 2003. www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/pdffiles/Tier2protocol.pdf

This protocol describes a set of uniform criteria on evaluating stormwater BMP performance that is acceptable to the endorsing states (California, Massachusetts, Maryland, New Jersey, Pennsylvania, Virginia). The protocol primarily deals with the demonstration of BMPs that are designed for one or more of the following: (1) directing and distributing flows; (2) reducing erosive velocities; and (3) removing contaminants such as suspended or dissolved pollutants from collected stormwater through physical and chemical processes such as settling, media-filtering, ion-exchange, carbon adsorption, and precipitation.

4. Stricker, E., and M. Quigley (URS Greiner Woodward Clyde), ASCE (American Society of Civil Engineers), and USEPA (U.S. Environmental Protection Agency). 1999. *Determining Urban Stormwater Best Management Practice (BMP) Removal Efficiencies*. American Society of Civil Engineers, Urban Water Resources Research Council, City, ST, and U.S. Environmental Protection Agency, Office of Water, Washington, DC. www.bmpdatabase.org/docs/task3_1.pdf

This technical memorandum provides an overview of methods for evaluating the efficiency, performance, and effectiveness of BMPs through analysis of water quality, flow, and precipitation data for monitored storm events as well as BMP design attributes collected and stored in the National Stormwater Best Management Practices Database.

5.3.9. Outfall Monitoring

1. USEPA (U.S. Environmental Protection Agency). 1992. *NPDES Stormwater Sampling Guidance Document*. EPA 833-B-92-001. U.S. Environmental Protection Agency, Washington, DC. www.epa.gov/npdes/pubs/owm0093.pdf

5.3.10. Receiving Water Monitoring

1. Stormwater Monitoring Coalition's Model Monitoring Technical Committee. 2004. *Model Monitoring Program for Municipal Separate Storm Sewer Systems in Southern California. August 2004*. Technical Report #419. ftp://ftp.sccwrp.org/pub/download/PDFs/419_smc_mm.pdf

This report describes a model monitoring program for receiving waters affected by urban runoff in both wet and dry weather.

2. USGS (U.S. Geological Survey). Variously dated. *National Field Manual for the Collection of Water-Quality Data*. U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9. U.S. Geological Survey, Reston, VA. http://pubs.water.usgs.gov/twri9A

This manual includes information and detailed descriptions of water quality sampling methods.

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1. Understanding the Connections Between TMDLs and Stormwater Permits
2. Identifying Opportunities to Coordinate TMDLs and Stormwater Permits
3. Characterizing Impairments and Stormwater Sources
4. Developing TMDLs with Stormwater Sources
5. Promoting Effective Stormwater Management
6. **Coordinating TMDLs and Stormwater Permits**

Chapter Six
Coordinating TMDLs and Stormwater Permits

What's included in this chapter

- ✓ Discussion of the type of permit requirements (e.g., water quality controls and effluent limitations, monitoring and adaptive management, reporting) that permit writers can develop with input from TMDL writers.
- ✓ Options for connecting TMDLs and stormwater permit language.

What you should know after reading this chapter

- ✓ Possible approaches for conveying TMDL-specific recommendations through a general permit without reopening the permit.
- ✓ Options for incorporating TMDL recommendations by reference into stormwater permits to create enforceable permit requirements.

Potential roles and responsibilities under this activity

If you are a TMDL writer

1. Work with permit writers to determine if stormwater permits will reference recommendations in TMDL reports and, where applicable, implementation plans.
2. Develop recommendations and other language for TMDL reports and, where applicable, implementation plans that stormwater permits can incorporate by reference.

If you are a stormwater permit writer

1. Work with TMDL writers to determine what recommendations TMDL reports and, where applicable, implementation plans will contain that stormwater permits can incorporate by reference.
2. Develop appropriate stormwater permit language that implements approved WLAs and are consistent with WLA assumptions.

6. COORDINATING TMDLS AND STORMWATER PERMITS

Improving the communication between TMDLs and permit writers can result in more effective implementation of TMDLs into stormwater permits. Considerations for developing a connection between the TMDL and the stormwater permit can include the following:

- What type of permit requirements (e.g., water quality controls and effluent limitations, monitoring, reporting) can permit writers consider to facilitate implementation of stormwater WLAs?
- How can permit writers, with information provided by TMDL writers, describe these elements?
- What can each programmatic document (e.g., TMDL reports or stormwater permits) say in relation to the other to facilitiate TMDL implementation?

As discussed in Chapter 1 of this Handbook, TMDLs include technical analyses that are not self-implementing. For point sources, permit limits that are consistent with the WLA are enforceable through NPDES permits. It is the permit writer's responsibility to interpret and incorporate information from the TMDL into permits, thereby turning them into enforceable requirements. Stormwater permit writers therefore can incorporate data and information provided in the TMDL directly into the permit, or can include information indirectly (e.g., reference sections of the TMDL. As a result, TMDLs and permitscan work in tandem to identify effective implementation methods and make progress toward restoring impaired waters.

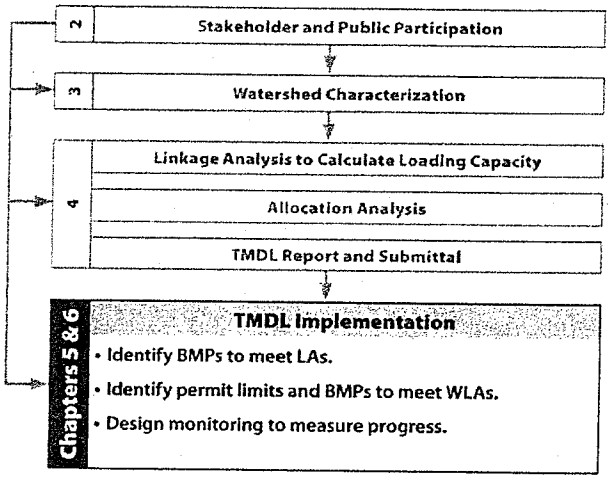

Figure 22. Illustration of the steps in the TMDL process, including activities related to TMDL implementation.

As shown in Figure 22, the step of TMDL implementation involves identifying and implementing management options to implement the LAs and WLAs. This chapter discusses ways to coordinate development of permit language with the information and data provided in the TMDL report to promote effective implementation of TMDLs through permits.

6.1. Options for Implementing TMDLs in Permits

Stormwater permit writers often consider TMDL-related information as they develop permit requirements such as applicability, implementing water quality controls through SWMPs and SWPPPs, developing a monitoring plan, reporting, and assessing progress. Under each of these permit elements, permit writers can consider a variety of options for expressing requirements related to TMDL implementation. The two primary types of stormwater permits—individual and general permits—can affect options and approaches for coordinating TMDL language with the permit.

Regulatory Requirements and EPA Guidance on Establishing Stormwater Permit Requirements to Implement WLAs

In the 2002 memorandum, *Establishing TMDL WLAs for Stormwater Sources and NPDES Permit Requirements Based on Those WLAs*, EPA provides regulatory requirements and guidance on how stormwater permit requirements should link to stormwater source WLAs under approved TMDLs. With regard to stormwater permit requirements, such as effluent limitations and monitoring, the 2002 memorandum states the following:

- NPDES permit conditions must be consistent with the assumptions and requirements of available WLAs. See 40 CFR 122.44(d)(1)(vii)(B).
- WQBELs for NPDES-regulated storm water discharges that implement WLAs in TMDLs may be expressed in the form of BMPs under specified circumstances. See 33 U.S.C. 1342(p)(3)(B)(iii); 40 CFR 122.44(k)(2)&(3). If BMPs alone adequately implement the WLAs, then additional controls are not necessary.
- EPA expects that most WQBELs for NPDES-regulated municipal and small construction storm water discharges will be in the form of BMPs, and that numeric limits will be used only in rare instances.
- When a non-numeric WQBEL is imposed, the permit's administrative record, including the fact sheet when one is required, needs to support that the BMPs are expected to be sufficient to implement the WLA in the TMDL. See 40 CFR 124.8, 124.9, and 124.18.
- The NPDES permit must also specify the monitoring necessary to determine compliance with effluent limitations. See 40 CFR 122.44(i). Where effluent limits are specified as BMPs, the permit should also specify the monitoring necessary to assess if the expected load reductions attributed to BMP implementation are achieved (e.g., BMP performance data).
- The permit should also provide a mechanism to make adjustments to the required BMPs as necessary to ensure their adequate performance.

Individual permits provide the permit writer with an opportunity to develop specific permit requirements because the permit focuses on one source, or a primary source and its co-permittees. As a result, permit writers can feasibly work with the TMDL writer in developing a permit that directly reflect elements of the TMDL analyses and, where available, implementation plans. This could include incorporating information provided in the TMDL directly into the permit. General permits apply to a broad category of sources in a geographic area. In most cases, general permits are statewide, but in some cases, permit writers can develop and issue general permits on a watershed-scale. While general permits provide permit writers with a degree of permitting efficiency, this type of permit may not provide the same opportunities for tailoring requirements and adding a level of specificity. To implement TMDLs through statewide general stormwater permits, permit writers can use broad requirements that direct sources to identify applicable TMDLs and modify their SWMPs or SWPPPs accordingly. Implementing TMDLs through watershed-scale general permits can provide permit writers with more flexibility to incorporate specific elements, such as BMP performance standards, that broadly apply to a group of sources. Permit writers could also add specificity into general permits to promote TMDL implementation, such as developing technical appendices that include TMDL-specific elements applicable to stormwater sources.

Categories of permits elements discussed in this section include determining applicability, water quality controls, and monitoring. These categories apply to both individual and general permits, although the approaches used in each category will vary depending on the type of permit. Each category contains a description of options based on real-world examples, and are available in the Appendix.

6.1.1. Requirements Related to Determining Applicability

Stormwater permits often require permittees to first determine if an existing TMDL is applicable to its discharge. The key questions for making this determination are:

1. Is there a discharge to an impaired waterbody with an approved TMDL?
2. Does the discharge include the pollutant of concern addressed in the approved TMDL?

One option for determining applicability requirements could be for a state that the source should make a determination on the basis of the knowledge of their location and discharges, and provide infomration on how to determine if a discharge goes to an impaired waterbody, such as a link to a Web site that provides lists of impaired waterbodies. Another option could be to provide more detailed information to sources to help them determine if they contribute to one or more impairments, where to go for more information on a specific TMDL, or to even include the applicable TMDL data and information in an appendix to the permit.

Applicability can go beyond whether the source is discharging to an impaired waterbody to determine if the discharge contributes to the impairment(s). A source might have a discharge to an impaired waterbody, but if the discharge does not contribute to the impairment(s) (e.g., does not contain the pollutant of concern) the additional controls related to the impaired waterbody might not apply. If permit writers want to use pollutant-specific considerations as a factor in determining applicability, there are various options to consider. One option could be for permit writers to limit permit coverage for sources that discharge to impaired waterbodies with impairments caused by pollutants commonly associated with that source. For example, permit writers could state that industrial facilities are not eligible for coverage under an industrial general permit if the facility discharges to an impaired waterbody with an approved TMDL for metals. Another option for permit writers could be to require sources to conduct discharge monitoring for a pollutant of concern or flow monitoring (or both) over a specified period of time to determine applicability. If the source can demonstrate that the discharge does not contribute to the impairment(s), the permit could then exempt the source from some or all additional TMDL implementation requirements.

In Practice: Requiring Sources to Determine Applicability in Tennessee

Tennessee's Phase II MS4 General Permit simply states that a permitted stormwater source must determine if any discharges go to an impaired waterbody. The permit states the following:

> Determine whether stormwater discharge from any part of the MS4 significantly contributes directly or indirectly to a 303(d) listed (i.e., impaired) waterbody. Water quality impaired waters means any segment of surface waters that has been identified by the division as failing to support classified uses.... If you have 303(d) discharges described above, you must also determine whether a Total Maximum Daily Load (TMDL) has been developed by the division and approved by EPA for the listed waterbody.

In Practice: Providing Applicable TMDL Requirements as a Permit Appendix in Washington

The state of Washington's final Phase II MS4 general permits for regulated small MS4s in eastern and western portions of the state compile the information permitted stormwater sources need to determine TMDL requirement applicability. Each permit contains a separate appendix that lists all the applicable TMDLs, the specific requirements, and a list of the potential permittees to which each of the TMDLs applies.

In Practice: Using Geographic Location to Determine Applicability for Georgia's Industrial General Permit

Georgia's Industrial General Permit contains applicability requirements that are based on a permitted stormwater source's geographic location, relative to an impaired stream segment. Permit language follows:

Any operator who intends to obtain coverage under this permit for storm water discharges associated with industrial activity into an Impaired Stream Segment, or within one (1) linear mile upstream of and within the same watershed as, any portion of an Impaired Stream Segment, identified as partially supporting or not supporting designated uses on Georgia's most current 303(d) list, must satisfy the requirements of Part III.C of this permit if the pollutant(s) of concern for which the Impaired Stream Segment has been listed may be exposed to storm water as a result of current or previous industrial activity at the facility. Those discharges that are within one (1) linear mile of an Impaired Stream Segment, but are not within the watershed of any portion of that stream segment are excluded from this requirement.

Georgia's 303(d) list is at www.gaepd.org.

In Practice: Identifying Pollutants of Concern in Permit Eligibility Requirements

Minnesota's CGP lays out what are the pollutants of concern for construction sites that discharge to impaired waterbodies. Construction site operators that want coverage under Minnesota's CGP must implement the applicable BMPs listed in the permit and any other specific implementation measures specified in the approved TMDL to which they are subject. The draft Minnesota CGP states the following:

> Discharges to waters identified as impaired pursuant to section 303 (d) of the federal Clean Water Act (33 U.S.C. § 303(d)) where the identified pollutant(s) or stressor(s) are phosphorus (nutrient eutrophication biological indicators), turbidity, dissolved oxygen, or biotic impairment (fish bioassessment, aquatic plant bioassessment and aquatic macroinvertebrate bioassessment), and with or without a U.S. Environmental Protection Agency (USEPA) approved Total Maximum Daily Load (TMDL) for any of these identified pollutant(s) or stressor(s)" must meet the applicable requirements of Part III.A.9, which include specific BMPs to limit these stressors.

6.1.2. Requirements Related to Identifying and Implementing Water Quality Controls

After EPA has approved a TMDL, permit writers must develop effluent limitations and permit conditions that are consistent with the assumptions and requirements of the approved WLA. In the context of stormwater permits, effluent limitations are most often expressed as BMPs, but permit writers can also use numeric limits (e.g., loads, concentrations, or performance standards). Effective TMDL implementation often relies on selecting the right mix of control measures to achieve progress toward addressing the WLA. Chapter 5 of this Handbook focuses on the technical resources and approaches for evaluating and selecting BMPs to implement the WLA.

Permit writers, in conjunction with information provided by TMDL writers, can consider a variety of approaches that involve either recommending BMPs or relying on sources to do the evaluation and selection on their own. Approaches for permit writers to consider are described below.

- **Requiring implementation of specific BMPs in the permit.** Under this option, permit writers could develop a proposed list of BMPs that a source could implement to reduce pollutant loadings to

implement the WLA. Permit writers could consider this approach when stormwater planners have conducted an internal analysis of possible BMPs. Given the resource-intensive nature of this option, this approach might be suitable for geographic areas that need certain types of BMPs (e.g., developing areas versus built-out areas of an MS4), or discreet sources (e.g., the only MS4 or construction site discharging to the impaired waterbody).

- **Providing a recommended menu of potential BMPs in the TMDL, implementation plan, or the permit for sources to evaluate and select.** This option is similar to the option described above in that TMDL and permit writers could develop a recommended list of BMPs. The difference between these options, however, is that this BMP list serves more as a menu of potential BMPs. Under this option, permit writers could provide some technical information related to each BMP to help sources evaluate and select appropriate BMPs. Sources would need to conduct a thorough analysis to select the appropriate suite of BMPs from the list to achieve progress toward implementing the WLA.
- **Referencing BMP performance standards in the TMDL, implementation plan, or the permit.** Under this option, TMDL and permit writers could recommend or reference performance standards for specific pollutants and allow sources to determine which BMPs will best meet the performance standard. One example might be a construction site must achieve a specific percent reduction in TSS, giving the source flexibility in the types of BMPs used to meet the standard. The TMDL and permit writer could provide recommendations on how sources could demonstrate that the selected BMPs can meet the required performance standards (e.g., using a combination of modeling and monitoring).
- **Recommending the selection of BMPs and developing benchmark values or performance measures.** This option has similarities to the option described above in that it focuses on the use of performance standards. However, under this option, permit writers could develop permit requirements that give sources the responsibility for developing the performance standards, often referred to in this context as benchmark values or performance measures. Permit requirements can focus on selecting BMPs to achieve progress toward implementing the WLA and developing performance measures that indicate the expected level of BMP performance. Beyond BMP performance, requirements can focus on developing quantifiable benchmarks that track the overall success of SWMPs and SWPPPs in reducing pollutant loads. If permit writers choose this option, it is important to note that sources might have concerns about compliance implications associated with benchmark values and performance measures. As a result, permit writers might want to consider developing permit language that specifies the intended use of performance measures and benchmark values—not as numeric effluent limits but as guideline values to facilitate adaptive management.
- **Requiring the review of existing BMPs and selecting additional BMPs to achieve progress toward addressing the WLA.** Under this option, permit writers could require sources to conduct an analysis of existing BMPs to determine the need for additional pollutant load reductions through improved BMP implementation or additional BMPs. Sources receive little technical guidance through the requirements, allowing them flexibility in conducting the analysis and justifying the selection of specific BMPs. Permit writers could consider including in the requirements a list of supporting documentation (e.g., calculations, assumptions, studies) that would provide the rationale for the proposed strategy to achieve progress toward addressing the WLA. This option is particularly effective when the the TMDL writer develops a WLA that permit writers can use as the basis for developing a performance standard. This approach provides permittees with flexibility in finding the optimal combination of existing and new BMPs to implement the WLA.

- **Consider numeric effluent limitations.** Permit writers might determine that BMPs are not an appropriate way to express effluent limitations and might choose to develop numeric effluent limitations as a feasible and appropriate way to incorporate the TMDL provisions into the permit.

There are no guidelines for determining which approach is most appropriate to use. It is likely that a variety of factors, including type of source, type of permit, and availability of resources, will influence which approach makes the most sense.

In Practice: Options for Water Quality Control Requirements

Existing stormwater permits use different types of requirements to ensure SWMPs and SWPPPs integrate effective BMPs for addressing stormwater source WLAs under approved TMDLs and, in some cases, impaired waterbodies without approved TMDLs. Provided below are examples of differing SWMP and SWPPP requirements for developing and implementing BMPs to addressWLAs under various types of stormwater permits.

Broad Requirements for Permitted Stormwater Sources to Develop SWMPs and SWPPPs to Address Impairments and Stormwater Source WLAs

Tennessee Phase II MS4 General Permit
The general permit developed for use by regulated small MS4s in Tennessee contains a broad set of requirements for developing and implementing SWMPs. The requirements focus on evaluating whether the implementation of existing stormwater control measures is meeting the TMDL provisions, or if additional control measures are necessary. Permittees must document all control measures being implemented or planned to be implemented and provide a schedule of implementation for all planned controls. To demonstrate that control measures will meet TMDL requirements and assumptions, permittees must also provide associated calculations, assessments, reports, and other evidence that provided the rationale for selecting specific control measures.

Wisconsin Phase II MS4 General Permit
Under Wisconsin's Phase II MS4 general permit, permittees that discharge to an impaired waterbody must take steps to develop and implement an SWMP to reduce—and potentially eliminate—the pollutant of concern contributing to a waterbody impairment. Because the permit is a general permit and the requirements could apply to a wide range of pollutants, the permit uses broadly defined requirements to ensure permittees discharging to impaired waterbodies develop and implement SWMPs that will reduce the pollutant of concern. Specifically, the general permit language requires permittees to, "include a written section in its storm water management program that discusses the management practices and control measures it will implement as part of its program to reduce, with the goal of eliminating, the discharge of pollutant(s) of concern that contribute to the impairment of the waterbody. This section of the permittee's program shall specifically identify control measures and practices that will collectively be used to try to eliminate the MS4's discharge of pollutant(s) of concern that contribute to the impairment of the waterbody and explain why these control measures and practices were chosen as opposed to other alternatives."

Watershed-specific BMP and Performance Standard Requirements

Big Darby Creek Watershed (Ohio) Construction General Permit
To implement the Big Darby Creek Watershed TMDL, Ohio EPA developed and issued the Big Darby Creek Watershed CGP. The overall permit is intended to implement the pollutant load reduction targets established under the TMDL; therefore, the permit states that the "general permit requires control measures/BMPs for construction sites that reflect recommendations set forth in the U.S. EPA approved Big Darby Creek TMDL." The water quality control measures specified under the SWPPP requirements include a combination of management practices, effluent targets, and infiltration requirements necessary to support stream base flows and stream setbacks necessary to protect the stream channel. The permit also states that "the erosion, sediment, and stormwater management practices used to satisfy the conditions of this permit, should meet the standards and specifications in the most current edition of Ohio's Rainwater and Land Development manual or other standards acceptable to Ohio EPA unless otherwise specified as a condition of this permit."

Specific BMP Requirements for SWMPs and SWPPPs to Address Impaired Waterbodies and Implement Stormwater Source WLAs

Oregon Construction General Permit (1200-C)
If a permitted construction site has the potential to discharge sediment or turbid water to a waterbody with an approved TMDL for sedimentation or turbidity, or is listed on the state's 303(d) for impairment due to sedimentation or turbidity, Oregon's CGP requires the permittee to implement one of two sets of options. Under Option 2, the CGP requires permittees to implement one or more of six BMPs identified to control and treat sedimentation and turbidity, in addition to implementing the standard set of BMPs required of all erosion and sediment control plans (ESCP). The BMPs identified in the permit are as follows:

- Compost berms, compost blankets, or compost socks;
- Erosion control mats (rolled or blown);
- Tackifiers used in combination with perimeter sediment control BMPs;
- Established vegetated buffers sized at 50 feet plus 25 feet per 5 degrees of slope;
- Water treatment by electro-coagulation, chemical flocculation, or filtration; or
- Other substantially equivalent sediment or turbidity BMP approved by the department.

Permittees selecting Option 2 must indicate in the ESCP which of the six supplemental BMPs have been selected to address discharges to waterbodies impaired for sedimentation and turbidity.

Georgia Industrial Stormwater Permit (GAR000000)
Georgia's industrial stormwater permit contains requirements related to discharges into, or within 1 linear mile upstream of and within the same watershed as, any portion of an Impaired Stream Segment impaired for fecal coliform, as well as substances other than fecal coliform. Under the requirements for facilities discharging fecal coliform, the permit references an appendix that contains a list of BMPs specifically for animal processing plants that might be potential sources of fecal coliform. Permittees that do not meet the TSS benchmark value (used as a surrogate indicator for fecal coliform under this permit) in the first 12-month sampling period have one year to select, design, and implement supplemental BMPs from the list of BMPs provided in the appendix, or other appropriate BMPs.

Quantifiable Performance Targets to Determine the Need for Additional BMPs

City of Portland, Multnomah County, and Port of Portland (Oregon) Phase I MS4 Individual Permit No. 101314
Portland and its co-permittees are subject to an individual Phase I MS4 permit that contains a variety of requirements for developing and implementing an effective SWMP to address approved WLAs for the permitted MS4s. Permit conditions do not include recommended or required BMPs; instead, the permit requires co-permittees to select BMPs to implement the approved WLAs and develop quantifiable performance measures for assessing BMP effectiveness. Performance measures are pollutant load reduction estimates to facilitate an adaptive management approach to SWMP implementation—the quantifiable performance measures for BMPs are not numeric effluent limitations.

Washington Construction General Permit
The Washington Department of Ecology issued a CGP that contains requirements for three categories of permitted construction sites: (1) less than 1 acre; (2) between 1 and 5 acres; and (3) greater than 5 acres. Under this permit, permittees that discharge turbidity, fine sediment, high pH, or phosphorus to impaired waterbodies listed for one of these parameters is required to conduct regular sampling. If discharge sampling indicates that the permittee's discharge exceeds the water quality standard for turbidity, all future discharges are subject to a numeric effluent limitation equal to the water quality standard for turbidity. Exceedances of the numeric effluent limitation then triggers requirements for evaluating and modifying the SWPPP to include BMPs that will allow the permittee to meet the numeric effluent limitation for turbidity.

Numeric Effluent Limitations

Draft Ventura County Phase I MS4 Individual Permit No. CAS004002
The draft version (dated 08/28/07) of the Ventura County Phase I MS4 Individual permit addresses requirements under multiple TMDLs for multiple watersheds for a variety of pollutants of concern, including nitrogen compounds, bacteria, sediments, and toxicity. Rather than express effluent limitations in the form of BMPs, this version of the Ventura County Phase I MS4 individual permit addresses the TMDL WLAs as numeric WQBELs for dry weather and wet weather.

6.1.3. Monitoring Requirements

As discussed in Chapter 5, monitoring and assessment are essential to help sources to make progress toward implementing WLAs. Information generated through monitoring and assessment activities are also key to promoting adaptive management and continuous improvement in implementation activities. In addition, monitoring and assessment activities are key to quantifying pollutant load reductions achieved through SWMP and SWPPP implementation—first to establish a baseline of pollutant load reductions expected or achieved through BMPs implemented under existing SWMPs and SWPPPs and then to determine pollutant load reductions from any additional BMPs deemed necessary to address WLAs. Requirements related to quantifying pollutant load reductions focus on developing and implementing monitoring plans.

Many SWMP and SWPPP requirements related to meeting stormwater source WLAs include some type of monitoring requirements to gauge BMP effectiveness, overall SWMP and SWPPP effectiveness, and to facilitate adaptive management activities. Options for monitoring requirements include BMP performance monitoring, stormwater discharge outfall monitoring, and ambient in-stream water quality monitoring. Per EPA's 2002 memorandum, where stormwater permits contain effluent limitations expressed as BMPs, these permits should specify the monitoring necessary to determine if BMPs are achieving the expected pollutant load reductions. Therefore, stormwater permits that implement TMDLs often contain monitoring requirements that focus on BMP performance, such as benchmark monitoring to determine progress toward a pollutant reduction goal, and support adaptive management activities related to modifying SWMPs and SWPPPs to improve overall effectiveness. Where stormwater permits do contain numeric effluent limitations, monitoring requirements are likely to focus on determining compliance with applicable numeric effluent limitations.

It is important to note that many existing permits do not specifically require monitoring; however, monitoring might be warranted for these permits to assess TMDL implementation. Chapter 5 of this Handbook discusses monitoring and assessment issues and provides resources that can aid in the development of monitoring and assessment requirements.

In Practice: Options for Monitoring Requirements

General Monitoring Plan Development

Tennessee Phase II MS4 General Permit
Under the general permit, regulated small MS4s must describe a method for evaluating whether stormwater controls are adequate for meeting the requirements of the TMDL.

Performance and Benchmark Monitoring

City of Portland, Multnomah County, and Port of Portland (Oregon) Phase I MS4 Individual Permit No. 101314
To gauge the effectiveness of the SWMP in reducing TMDL pollutant loads to the MEP, the Portland and its co-permittees must include a specific strategy for implementing monitoring in the SWMP. Under this permit, co-permittees measure effectiveness according to the quantifiable performance measures and benchmarks that the permit requires them to establish to support SWMP adaptive management. According to the permit, performance measures are estimates of the effectiveness of BMPs expressed as pollutant load reduction estimates and benchmarks are total pollutant load reduction estimates for each parameter or surrogate, where applicable, for which a WLA is established at the time of permit issuance. Neither performance measures nor benchmarks are numeric effluent limits, but rather tools for guiding adaptive management activities.

Oregon Construction General Permit (1200-C)

If a permitted construction site has the potential to discharge sediment or turbid water to a waterbody with an approved TMDL for sedimentation or turbidity, or is listed on the state's 303(d) for impairment due to sedimentation or turbidity, Oregon's CGP requires the permittee to implement one of two sets of options. Under Option 1, the permittee must conduct stormwater monitoring to determine if discharges meet or exceed a benchmark value for turbidity (i.e., 160 NTUs) that indicates the effectiveness of BMPs. If any samples exceed the benchmark value, the permittee must evaluate existing BMPs and take corrective action. If stormwater discharge samples continue to exceed the benchmark value, the permittee must implement Option 2 (see description of Option 2 under the In Practice discussion related to water quality controls above) and submit an Action Plan that identifies additional BMPs to be implemented and the rationale for selecting the identified BMPs.

Washington Construction General Permit
Permittees covered under Washington's CGP must conduct turbidity sampling to determine compliance with the water quality standard for turbidity. The permit requires permittees to measure background turbidity in the 303(d)-listed receiving water immediately upstream (upgradient) or outside the area of influence of the discharge. For monitoring discharge turbidity, the permit requires permittees to measure at the point of discharge into the 303(d) listed receiving waterbody, inside the area of influence of the discharge or at the point where the discharge leaves the construction site, rather than in the receiving waterbody. Although the permit states that monitoring is used to determine compliance with the turbidity water quality standard, it appears that it functions more as a performance benchmark. If discharge turbidity exceeds the water quality standard for turbidity, all future discharges must comply with a numeric effluent limitation (equal to the water quality standard for turbidity). Future discharges exceeding the numeric effluent limitation triggers SWPPP modification requirements.

Compliance Monitoring

Draft Ventura County Phase I MS4 Individual Permit No. CAS004002
Compliance with the dry-weather and wet-weather numeric WQBELs under the draft version of the Ventura County Phase I MS4 Individual permit is determined through end-of-pipe monitoring at major outfalls. The draft version of the permit requires co-permittees to develop a wet-weather and dry-weather monitoring workplan for review and approval by the Regional Water Board.

6.1.4. Compliance Considerations

[This section still under internal review – do not quote or cite]

When developing permit requirements, permit writers will likely face issues and questions related to determining compliance. One key issue relates to establishing an appropriate compliance schedule for sources to implement a WLA (e.g., within a 5-year permit term or beyond). Permit writers can consider using interim limits or a phased implementation approach. Interim limits are a way for permit writers to schedule incremental progress toward implementing the WLA over time. One option is for the TMDL to reference, or for the permit to specify, the interim limits by providing a schedule with the required interim numeric targets in a specific timeframe. Another option to consider relates to the benchmarking approach (discussed earlier in this chapter) in which a source determines how much progress is feasible, over a specified time frame, to implement the WLA. The source could then submit the proposed benchmarks and associated schedule to the permit writer for review and approval.

Resources: The Appendix of this Handbook contains the actual stormwater permit language referenced in this section, as well as relevant requirements from other stormwater permits, for TMDL and permit writers to review and consider when discussing and developing requirements to implement TMDLs.

In Practice: Incorporating Interim TMDL Numeric Targets into Permits in San Diego, California

The San Diego Phase I MS4 permit (Order No. R9-2007-0001/NPDES No. CAS0108758) contains requirements to implement the Chollas Creek Diazinon TMDL. The permit includes a table that presents the WLA, interim TMDL numeric target, and percent reduction required over the permit duration. Permit language reads as follows:

a. The Copermittees in the Chollas Creek watershed shall implement BMPs capable of achieving the interim and final diazinon Waste Load Allocation (WLA) concentration in the storm water discharge in Chollas Creek listed in Table 5.

b. The Copermittees in the Chollas Creek watershed shall not cause or contribute to the violation of the Interim TMDL Numeric Targets in Chollas Creek as listed in Table 5. If the Interim TMDL Numeric Target is violated in Chollas Creek in more than one sample in any three consecutive years, the Copermittees shall submit a report that either 1) documents compliance with the WLA through additional sampling of the urban runoff discharge or 2) demonstrates, using modeling or other technical or scientific basis, the effectiveness of additional BMPs that will be implemented to achieve the WLA. The report may be incorporated into the Watershed Urban Runoff Management Program Annual Report unless the Regional Board directs an earlier submittal. The report shall include an implementation schedule.

6.2. Options for Connecting Programmatic Documents

TMDL and permit writers can not only work together to consider the appropriate types of conditions that could be developed to implement stormwater source TMDLs, but also can collaborate to decide how the associated programmatic documents, such as the TMDL report and the stormwater permit, can help articulate this information. The goal is to help ensure that no matter what document a permitted stormwater source refers to—the TMDL or the stormwater permit—each document has a clear and consistent connection to the information contained in the other. This section discusses options for TMDL and permit writers to consider when deciding how to develop a connection between the TMDL report and stormwater permits, as well as other related programmatic documents including implementation plans.

Within the TMDL report and stormwater permit, TMDL and permit writers have several possible options for developing a connection between the information contained in the document. In the TMDL report, the TMDL writer might develop a connection to the permit through the WLA or the implementation plan (if included as part of the TMDL report) or other components that could be included in the TMDL report or implementation plan (e.g. optional monitoring section). In stormwater permits, the connection to TMDLs can also vary. Permit requirements might appear as a comprehensive set of detailed special conditions related to stormwater discharges to impaired waterbodies with approved TMDLs (or listed waterbodies without an approved TMDL), or the requirements ccould appear throughout the permit under existing permit conditions related to SWMP and SWPPPs, monitoring, reporting, and other categories of requirements.

TMDL and permit writers can work together to develop the most appropriate section of each programmatic document to place stormwater-source-TMDL-related information. From there, TMDL and permit writers can decide the best approach for developing the connection, such as referencing elements contained in one programmatic document or directly including and referenceing them in each. A brief discussion these approaches related to each type of programmatic document and its associated components is provided below.

6.2.1. Using the WLA to Connect to Permits

Per EPA's 2002 memorandum, regulations state that when a TMDL has been approved, NPDES permits should contain effluent limits and conditions consistent with the requirements and the assumptions of the WLA. One option is to describe and reference all relevant permit requirements for implementing the WLA within the the TMDL report. Under this approach, stormwater permits could state that sources should comply with the numeric WLA and the associated elements included in the TMDL document. This approach basically incorporates the WLA and associated implementation information into the permit by reference. It is important to note, that although this type of approach could facilitate connections between WLAs and general permits, it may result in permits that are more challenging to tailor with specific permit requirements.

Another option is to have stormwater permits directly incorporate the TMDL WLA information so that each programmatic document contains the same element using identical language, as opposed to just referencing the other document as is suggested above. While this more specific approach could be easier to apply when using individual or watershed-based stormwater permits, permit writers could also use this type of approach with general permits in conjunction with a regularly updated TMDL appendix that contains specific information for permittees.

In Practice: Referencing and Integrating TMDL Provisions in Permits in Washington

The Western Washington Phase II MS4 General Permit contains broad language to convey the requirements related to MS4s addressed by an approved TMDL. The body of the permit requires MS4s to comply with the specific actions described in applicable TMDLs. To aid permittees, the Washington Department of Ecology compiled all relevant, existing implementation actions from applicable TMDLs into a comprehensive appendix to the permit. By referencing the appendix in the permit, permit writers were able to ensure that the compilation of TMDL-specific activities would become enforceable permit requirements. The general permit language states the following:

> The following requirements apply if an applicable Total Maximum Daily Load (TMDL) is approved for stormwater discharges from MS4s owned or operated by the Permittee. Applicable TMDLs are TMDLs which have been approved by EPA on or before the date permit coverage is granted. All Permittees shall be in compliance with the requirements of applicable TMDLs.
>
> A. For applicable TMDLs listed in Appendix 2, affected permittees shall comply with the specific requirements identified in Appendix 2. Each Permittee shall keep records of all actions required by this Permit that are relevant to applicable TMDLs within their jurisdiction. The status of the TMDL implementation shall be included as part of the annual report submitted to Ecology.
>
> Where monitoring is required in Appendix 2, the Permittee shall conduct the monitoring according to a Quality Assurance Project Plan (QAPP) approved by Ecology.
>
> B. For applicable TMDLs not listed in Appendix 2, compliance with this Permit shall constitute compliance with those TMDLs.
>
> C. For TMDLs that are approved by EPA after this Permit is issued, Ecology may establish TMDL related permit requirements through future permit modification if Ecology determines implementation of actions, monitoring or reporting necessary to demonstrate reasonable further progress toward achieving TMDL waste load allocations, and other targets, are not occurring and shall be implemented during the term of this Permit or when this Permit is reissued. Permittees are encouraged to participate in development of TMDLs within their jurisdiction and to begin implementation.

6.2.2. Using Implementation Plans to Connect to WLAs and Permits

While implementation plans are not a required component of a TMDL, many states do develop and include some form of an implementation plan in their TMDL document either to satisfy state regulatory requirements or to facilitiate TMDL implementation. If TMDL and permit writers intend to engage in implementation planning activities and develop an implementation plan for stormwater source TMDLs, there are a few ways to consider developing a stronger connection between WLAs and permits through the use of implementation plans. One option for using implementation plans to connect stormwater source WLAs with stormwater permits is to have the implementation plan serve as the primary vehicle for referencing and conveying information relating to implementation of the stormwater source WLAs (e.g., supplemental BMPs, SWMP and SWPPP assessment and modification, monitoring plan development and implementation, adaptive management measures). The TMDL could include these elements by reference and the associated stormwater permits could then incorporate the implementation plan information by reference.

In Practice: Using Implementation Plans to Connect WLAs and Stormwater Permits

Implementation plans with recommendations to guide stormwater permit requirements:

Swamp Creek Fecal Coliform Bacteria TMDL (Washington) Water Quality Improvement Report and Implementation Plan
The Water Quality Improvement Report and Implementation Plan includes recommendations for each MS4 as well as "anticipated actions" or requirements that the permitting authority intends to include in associated NPDES permits (Appendix D). The recommendations are those measures and practices that are intended to reduce bacterial pollution to Swamp Creek.

Big Darby Creek (Ohio) Watershed TMDLs
The implementation portion of the TMDL develops a tiered approach to monitoring progress and validating the TMDL:

1. Confirmation of completion of implementation plan activities
2. Evaluation of attainment of chemical water quality criteria
3. Evaluation of biological attainment.

A TMDL revision will be triggered if any one of the validation steps is not being completed or if the water quality standards are not being attained after an appropriate time interval. Once the majority of or the major implementation plan items have been carried out or the water quality monitoring shows consistent and stable improvements then a watershed assessment would be completed to evaluate attainment of the use designations. If water quality monitoring does not show improvement or waterbodies are still not attaining water quality standards after the implementation plan has been carried out, a TMDL revision would be initiated.

Implementation plans with specific BMPs using adaptive management and phased implementation:

Chloride TMDL Report: Shingle Creek, Minnesota
The implementation portion of the TMDL report calls for the use of adaptive management principles. According to the report, adaptive management is appropriate because it is difficult to predict the chloride reduction that will occur from implementing strategies with limited amount of data available to predict expected reductions. The report requires continued monitoring and *course corrections* based on monitoring results.

Another possible option is for the stormwater permit, not the implementation plan, to include all additional requirements developed to implement the stormwater source WLAs. Under this approach, the implementation plan serves as a mechanism to link the TMDL and the stormwater permit without providing a significant amount of detail in the TMDL. This approach could be ideal for situations in which TMDL writers do not have the time or resources to engage in detailed implementation planning.

Resources: The Appendix of this Handbook contains excerpts of TMDLs, implementation plans, and stormwater permit requirements from the real-world examples provided in this section, as well as other TMDLs and stormwater permits that illustrate how states connect permitted stormwater source requirements among programmatic documents.

6.3. Other Information to Consider

Permit writers, watershed organizations, or municipalities could encounter situations where previously developed TMDLs and implementation plans are more difficult to implement in permits, including the following situations.

6.3.1. No separate WLA for NDPES Stormwater source

Permit writers might be working with older TMDLs that were approved prior to EPA's guidance, *Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs* (Wayland, R.H., and J.A. Hanlon, 2002), or that include allocations for stormwater discharges that were considered to be nopoint sources at the time the TMDL was approved, but that currently are subject to NPDES permitting. For example, an older TMDL could group both urban nonpoint source and point source runoff into one overall category under an aggregated load allocation, or the older TMDL could include runoff from MS4's under the load allocation that are now covered under the Phase II NDPES requirments. Because permit effluent limits have to meet water quality standards under 122.44(d)(1)(vii)(A), the permit writer will need to account for the current regulated stormwater discharges identified in the TMDL regarldless of how they were labeled in the older TMDL document, and should explain how they are being accounted for in the permit. The permit writer might be able to get additional information from TMDL writers to help implement these wasteload allocations into permits.

6.3.2. Impaired Waterbody with No Approved TMDL

Another scenario that TMDL and permit writers might encounter is an impaired waterbody that does not yet have an approved TMDL. Clearly, it is important to ensure that stormwater discharges do not further cause or contribute to exceedances of water quality standards. However, without a specific WLA, TMDL and permit writers might have questions about the appropriate implementation activities to recommend or, in the case of a permit, require until a TMDL is developed and approved. To provide some level of control on pollutants of concern associated with the impairment, TMDL and permit writers could work together to identify interim early action BMPs or performance standards that sources could implement until an approved TMDL becomes available. In such cases, it might be valuable to identify monitoring programs to evaluate contributions from stormwater sources to the impairment for use in future TMDL development.

In Practice: Addressing Impaired Waterbodies with No Approved TMDL in Permits in Wisconsin

The Wisconsin Phase II MS4 General Permit contains requirements that address MS4 discharges to impaired waterbodies with no approved TMDL. The permit requires permittees to address the pollutant of concern contributing to the impairment in the SWMP and limits permittees' ability to have a new or increased discharge of a pollutant of concern unless there is an approved TMDL. The general permit language states the following:

> 1.5.2 If the permittee's MS4 discharges to an impaired waterbody, the permittee shall include a written section in its storm water management program that discusses the management practices and control measures it will implement as part of its program to reduce, with the goal of eliminating, the discharge of pollutant(s) of concern that contribute to the impairment of the water body. This section of the permittee's program shall specifically identify control measures and practices that will collectively be used to try to eliminate the MS4's discharge of pollutant(s) of concern that contribute to the impairment of the waterbody and explain why these control measures and practices were chosen as opposed to other alternatives. Pollutant(s) of concern means a pollutant that is causing impairment of a waterbody.
>
> 1.5.3 After the permittee's start date of coverage under this permit, the permittee may not establish a new MS4 discharge of a pollutant of concern to an impaired waterbody or increase the discharge of a pollutant of concern to an impaired waterbody unless the new or increased discharge causes the receiving water to meet applicable water quality standards, or the Department has approved a total maximum daily load (TMDL) for the impaired waterbody.

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Appendix: TMDL and NPDES Stormwater Permit Language Excerpts

California

Los Angeles County MS4 NPDES Permit

10. On May 18, 2000, the USEPA established numeric criteria for priority toxic pollutants for the State of California (California Toxics Rule (CTR)) 65 Fed. Reg. *31682 (40 CFR 131.38), for the protection of human health and aquatic life. These apply as ambient water quality criteria for inland surface waters, enclosed bays, and estuaries. The State Board adopted the* Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP) – 2000, *on March 2, 2000, for implementation of the CTR (State Board Resolution No. 2000-15 as amended by Board Resolution No. 2000-030). This policy requires that discharges comply with TMDL-derived load allocations as soon as possible but no later than 20 years from the effective date of the policy.*

28. The Regional Board adopted the Santa Monica Bay Beaches Dry Weather TMDL for Bacteria (hereinafter "Dry Weather Bacteria TMDL") on January 24, 2002. The TMDL was subsequently approved by the State Board, the Office of Administrative Law (OAL), and the USEPA and became effective on July 15, 2003.

29. The Waste Load Allocations (WLAs) in the Dry Weather Bacteria TMDL are expressed as the number of allowable days that the Santa Monica Bay beaches may exceed the Basin Plan water quality objectives for protection of Water Contact Recreation (REC-1) in marine waters, specifically the water quality objectives for bacteria. Appropriate modifications to this order are therefore included in Parts 1 (Discharge Prohibitions) and 2 (Receiving Water Limitations), pursuant to 40 CFR 122.41(f) and 122.62, and Part 6.I.1 of this Order. Additionally, 40 CFR 122.44(d)(1)(vii)(B) requires that NPDES permits be consistent with the assumptions and requirements of any available waste load allocation. Tables 7-4.1, 7-4.2a, and 7-4.3 of the Basin Plan set forth the pertinent provisions of the Dry Weather Bacteria TMDL. They require that during Summer Dry Weather there shall be no exceedances in the Wave Wash of the single sample or the geometric mean bacteria objectives set to protect the Water Contact Recreation (REC-1) beneficial use in marine waters. Accordingly, a prohibition is included in this Order barring discharges from a MS4 to Santa Monica Bay that result in exceedance of these objectives. Since the TMDL and the WLAs contained therein are expressed as receiving water conditions, Receiving Water Limitations have been included in this Order that are consistent with and implement the zero exceedance day WLAs.

30. Pursuant to federal regulations at 40 CFR 124.8, and 125.56, a Fact Sheet was prepared to provide the basis for incorporating the Dry Weather Bacteria TMDL into this Order. The Fact Sheet is hereby incorporated by reference into these findings.

31. The iterative approach to regulating municipal stormwater is not an appropriate means of implementing the Santa Monica Bay beaches Summer Dry Weather WLAs for any and all of the following reasons: (a) The WLAs do not regulate the discharge of stormwater; (b) The harm to

the public from violating the WLAs is dramatic both in terms of health impacts to exposed beachgoers, and the economic cost to the region associated with related illnesses; (c) Despite the fact that more than a decade and a half has passed since MS4 permittees were required to eliminate illicit connections/discharges (IC/ID) into their MS4s, their programs have not eliminated standards violations at the beaches; and (d) Few permittees have ever documented revisions to their SQMP to address chronic exceedances of water quality standards.

Georgia

Phase II MS4 General Permit

D. Stormwater Management Modifications

1. The SWMP may be modified by the permittee at any time. Written notification of substantial SWMP modifications must be submitted 30 days prior to implementation of the SWMP modification.

2. EPD may require the permittee to modify the SWMP as needed to:

a. Include more stringent requirements as necessary to comply with new State or Federal statutory or regulatory requirements;

b. Include other conditions deemed necessary by the Director to comply with the goals and requirements of the CWA and the State Act. The Director's request for modifications shall be made in writing and set forth a time schedule for the permittee to develop the modification(s), and offer the permittee the opportunity to propose alternative SWMP modifications to meet the objective of the requested modification.

General Permit for Stormwater Discharges Associated with Industrial Activity

C. Discharges Into, Or Within One Mile Upstream Of And Within The Same Watershed As, Any Portion Of An Impaired Stream Segment.

An operator is not eligible for coverage under this permit for discharges of stormwater associated with industrial activity to waters of the State for which a Total Maximum Daily Load (TMDL) is approved prior to or during the term of this permit, unless the facility develops, implements, and maintains a SWP3 that is consistent with the TMDL. The SWP3 must specifically address any conditions or requirements included in the TMDL that are applicable to the operator's discharge within the timeframe specified in the TMDL. If the TMDL establishes a specific numeric wasteload allocation that applies to an operator's discharge, or to stormwater discharges associated with industrial activity in general, then the operator must incorporate that allocation into the facility's SWP3 and implement all necessary measures to meet that allocation.

Any operator who intends to obtain coverage under this permit for stormwater discharges associated with industrial activity into an Impaired Stream Segment, or within one (1) linear mile upstream of and within the same watershed as, any portion of an Impaired Stream Segment, identified as "partially supporting" or "not supporting" designated uses on Georgia's most current 303(d) list, must satisfy the requirements of Part III.C of this permit if the pollutant(s) of concern for which the Impaired Stream Segment has been listed may be exposed to stormwater

as a result of current or previous industrial activity at the facility. Those discharges that are within one (1) linear mile of an Impaired Stream Segment, but are not located within the watershed of any portion of that stream segment are excluded from this requirement. Georgia's 303(d) list can be viewed on EPD's website at www.gaepd.org.

1. Discharges into, or within one (1) linear mile upstream of and within the same watershed as, any portion of an Impaired Stream Segment Impaired by substances other than fecal coliform.

a. Sampling schedule.

Regulated industrial facilities that are subject to the requirements in Part III.C.1. of this permit must conduct stormwater discharge sampling for the pollutant(s) of concern two times per quarter for a period of twelve (12) months. The pollutant(s) of concern for each impaired stream segment are identified on Georgia's 303(d) list. The sampling will only be required for those outfalls at the facility that have the potential to discharge the pollutant(s) of concern. The sampling must be conducted in accordance with Parts VI.A.3, 4, and 5 of this permit, except that composite samples may be collected in lieu of grab samples at the permittee's discretion. The Director may require composite or grab sampling where deemed appropriate in order to ensure that representative samples are collected.

Except as provided below, the sampling must begin no later than ninety (90) days after the later of the effective date of the permit or the date the facility becomes subject to the sampling requirements in Part III.C. However, if a facility with an existing stormwater discharge associated with industrial activity determines that additional time is needed to design and implement new or improved BMPs specifically for the pollutant(s) of concern, then that facility may delay commencement of the sampling program under this section of the permit for no more than twelve (12) months after the effective date of the permit in order to design and implement those BMPs. Facilities choosing this option must, no later than the date on which the Part III.C sampling would otherwise begin, provide a written notification, signed in accordance with Part VII.G of this permit, to EPD that they have elected to delay sampling and provide a schedule for BMP implementation. The Part III.C sampling program must begin immediately after the BMPs are required to have been implemented according to the schedule provided to EPD.

A summary of the sampling results must be submitted to EPD's Watershed Protection Branch with the Annual Report (see Appendix B of this permit). The report must also identify the applicable benchmark value(s) and state whether the facility has passed or failed the benchmark requirement for the twelve (12) month sampling period.

If a facility is unable to conduct one or both of the Part III.C sampling event(s) during a certain quarter due to adverse climatic conditions (i.e. no qualifying rainfall event occurs), then the facility shall include a written explanation for the absence of the sampling event in the next Annual Report submitted to EPD.

b. Applicable Benchmark Values.

The applicable benchmark values for discharges into, or within one (1) linear mile upstream of and within the same watershed as, any portion of an Impaired Stream Segment shall be the same numeric value as the Instream Water Quality Criterion for the pollutant(s) of concern as specified in Georgia's Rules and Regulations for Water Quality Control (Georgia Rule 39136.

03) unless otherwise established in Part III.C of this permit. The benchmark values are designed to assist permittees in determining if the BMPs established in a facility's SWP3 are effective in minimizing the concentration of the pollutant(s) of concern in stormwater discharge(s) from their facility. These benchmark values are intended to be guideline concentrations rather than numeric effluent limitations or permit conditions. The exceedance of a benchmark value established in Part III.C of this permit is not a permit violation and does not of itself indicate a violation of instream water quality standards. However, an exceedance of a benchmark value may be used in conjunction with other information to demonstrate a violation of this permit or a violation of water quality standards.

(1). Specific requirements for discharges into, or within one (1) linear mile upstream of and within the same watershed as, any portion of an Impaired Stream Segment impaired for DO (Dissolved Oxygen).

Facilities discharging into, or within one (1) linear mile upstream of and within the same watershed as, any portion of an Impaired Stream Segment for which the listing criterion is identified as DO (Dissolved Oxygen) will only be required to conduct sampling under Part III.C if industrial materials that may contribute Five Day Carbonaceous Biochemical Oxygen Demand (CBOD5) or ammonia (NH3) may be exposed to stormwater as a result of current or previous industrial activity at the facility. These facilities must sample for Five Day Carbonaceous Biochemical Oxygen Demand (CBOD5) and NH3. The applicable benchmark value for these discharges shall be an Ultimate Oxygen Demand (UOD) of 125 mg/l. The UOD shall be calculated as [(CBOD5 x 1.5) + (NH3 x 4.57)].

(2). Specific requirements for discharges into, or within one (1) linear mile upstream of and within the same watershed as, any portion of an Impaired Stream Segment impaired by nonpollutant specific criteria.

(i). Facilities discharging into, or within one (1) linear mile upstream of and within the same watershed as, any portion of an Impaired Stream Segment for which the listing criterion is identified as "Biota or Sediment" are required to conduct sampling for Total Suspended Solids (TSS) unless a TMDL has identified a different pollutant from nonpoint sources as causing the impairment, in which case sampling should be conducted for the pollutant(s) identified in the TMDL. The applicable TSS benchmark value for these discharges shall be 100 mg/l.

(ii). Facilities discharging into, or within one (1) linear mile upstream of and within the same watershed as, any portion of an Impaired Stream Segment for which the listing criterion is toxicity, FCG (fish consumption guidelines), SB (shellfishing ban), CFB (commercial fishing ban) or TWR (trophic weighted residue value of mercury in fish tissue)" will only be required to conduct sampling under Part III.C if a TMDL identifying a specific water quality parameter has been approved for the stream segment.

c. Evaluation of Part III.C sampling data

The Part III.C stormwater discharge sampling is intended to measure the effectiveness of the Best Management Practices (BMPs) implemented at those facilities. If benchmark values are exceeded using the pass/fail determination provided below, then improved or additional BMPs are required at the facility.

The sampling data for the twelve (12) month period must be evaluated using one of the following criteria. This shall constitute the pass/fail determination for evaluating BMP effectiveness:

(1). At least seventy-five (75) percent of the samples collected during the twelve (12) month period do not exceed the applicable benchmark value(s); or

(2). The average of the samples collected during the twelve (12) month period does not exceed the applicable benchmark value(s).

If a facility meets at least one of the above criteria then that facility has passed the benchmark requirement and may discontinue the Part III.C sampling but must thereafter properly maintain all of the BMPs that enabled the facility to meet the benchmark requirement.

If a facility does not meet at least one of the above criteria, then that facility has failed the benchmark requirement. Those facilities that do not pass the benchmark requirement for the first twelve (12) month sampling period may take up to one year to budget, select, design and construct/implement additional supplemental BMPs at the facility. Once the supplemental BMPs have been implemented, an additional twelve (12) month (two samples per quarter) period of sampling must be conducted as described in Part III.C.1.a above. Those facilities that pass the benchmark requirement, using the above pass/fail determination, after implementing supplemental BMPs may discontinue the Part III.C sampling but must thereafter properly maintain all of the BMPs that enabled the facility to meet the benchmark requirement.

Facilities that are not able to pass the benchmark requirement, using the above pass/fail determination, after implementing supplemental BMPs must continue the process of implementing additional supplemental BMPs at the facility and conducting a subsequent twelve month (two samples per quarter) period of sampling until the facility meets the benchmark requirement using the pass/fail determination provided above. If a facility is unable to pass the benchmark requirement after the twelve (12) month sampling period following a second round of implementing supplemental BMPs, then EPD will determine what further action is required, which may include, but is not limited to, applying for an individual NPDES permit.

d. Written justification to cease Part III.C sampling.

If a facility provides a written justification after the first twelve (12) month period of sampling (or after any subsequent twelve (12) month period of sampling) and EPD concurs that the facility's stormwater discharges associated with industrial activity do not have a reasonable potential to cause or contribute to a violation of an instream water quality standard, then EPD may conclude that additional sampling under Part III.C is not required. Facilities that have passed the benchmark requirement are not required to submit a written justification in order to cease Part III.C sampling.

2. Discharges into, or within one (1) linear mile upstream of and within the same watershed as, any portion of an Impaired Stream Segment impaired for fecal coliform.

Facilities discharging into, or within one (1) linear mile upstream of and within the same watershed as, any portion of an Impaired Stream Segment for which the listing criterion is identified as fecal coliform must adhere to the following conditions if industrial materials or

activities that are potential sources of fecal coliform (as defined in Part IV.D.9 of this permit) are, or may be, exposed to stormwater at the facility during the term of this permit.

a. List of BMPs for animal processing plants that may be potential sources of fecal coliform.

A list of BMPs designed to reduce fecal coliform levels in stormwater runoff has been developed for animal processing plants that may be potential sources of fecal coliform. Other facilities may find this list to be useful as well. The list is provided in Appendix C of this permit.

b. Sampling schedule.

Regulated industrial facilities that are subject to the requirements in Part III.C.2 of this permit must conduct stormwater discharge sampling for TSS two times per quarter for a period of twelve (12) months. Two of the sampling events must include simultaneous testing of TSS and fecal coliform. The sampling will only be required for those outfalls at the facility that have the potential to discharge stormwater associated with industrial activity where industrial materials or activities that are potential sources of fecal coliform (as defined in Part IV.D.9 of this permit) are, or may be, exposed to stormwater at the facility during the term of this permit. The sampling must be conducted in accordance with Parts VI.A.3, 4, and 5 of this permit.

Except as provided below, the sampling must begin no later than ninety (90) days after the later of the effective date of the permit or the date the facility becomes subject to the sampling requirements in Part III.C. However, if a facility with an existing stormwater discharge associated with industrial activity determines that additional time is needed to design and implement new or improved BMPs specifically for the pollutant(s) of concern, then that facility may delay commencement of the sampling program under this section of the permit for no more than twelve (12) months after the effective date of the permit in order to design and implement those BMPs. Facilities choosing this option must, no later than the date on which the Part III.C sampling would otherwise begin, provide a written notification, signed in accordance with Part VII.G of this permit, to EPD that they have elected to delay sampling and provide a schedule for BMP implementation. The Part III.C sampling program must begin immediately after the BMPs are required to have been implemented according to the schedule provided to EPD.

A summary of the sampling results for TSS and fecal coliform must be submitted to EPD's Watershed Protection Branch with the Annual Report (see Appendix B of this permit). The report must also identify the applicable benchmark value(s) and state whether the facility has passed or failed the benchmark requirement for the twelve (12) month sampling period.

If a facility is unable to conduct one or both of the Part III.C sampling event(s) during a certain quarter due to adverse climatic conditions (i.e. no qualifying rainfall event occurs), then the facility shall include a written explanation for the absence of the sampling event in the next Annual Report submitted to EPD.

c. Applicable Benchmark Value

A Total Suspended Solids (TSS) benchmark value of 100 mg/l will be used as a surrogate for evaluating fecal coliform levels in stormwater discharges associated with industrial activity. Fecal coliform sampling data collected simultaneously with TSS sampling data (as required in

Part III.C.2.b) is not subject to the pass/fail determination for benchmark sampling as established in Part III.C.2.d below.

The TSS benchmark value is designed to assist permittees in determining if the implementation of the BMPs (as established in a facility's SWP3) is minimizing the concentration of the pollutant(s) of concern in stormwater discharge(s) from their facility. These benchmark values are intended to be guideline concentrations rather than numeric effluent limitations or permit conditions. The exceedance of a benchmark value established in Part III.C of this permit is not a permit violation and does not of itself indicate a violation of instream water quality standards. However, an exceedance of a benchmark value may be used in conjunction with other information to demonstrate a violation of this permit or a violation of water quality standards.

d. Evaluation of Part III.C sampling data.

The Part III.C stormwater discharge sampling is intended to measure the effectiveness of the Best Management Practices (BMPs) implemented at those facilities. If benchmark values are exceeded using the pass/fail determination provided below, then improved or additional BMPs are required at the facility.

The TSS sampling data for the twelve (12) month period must be evaluated using one of the following criteria. This shall constitute the pass/fail determination for evaluating BMP effectiveness.

(1). At least seventy-five (75) percent of the samples collected during the twelve (12) month period do not exceed the TSS benchmark value; or

(2). The average of the samples collected during the twelve (12) month period does not exceed the TSS benchmark value.

If a facility meets at least one of the above criteria then that facility has passed the TSS benchmark requirement and may discontinue the Part III.C sampling but must thereafter properly maintain all of the BMPs that enabled the facility to pass the TSS benchmark requirement.

If a facility does not meet at least one of the above criteria, then that facility has failed the TSS benchmark requirement. If a facility does not pass the TSS benchmark requirement for the first twelve (12) month sampling period then the facility may take up to one year to budget, select, design and construct/implement additional supplemental BMPs from the list provided in Appendix C, or other appropriate BMPs. Once the supplemental BMPs have been implemented at the facility, an additional twelve (12) month (two samples per quarter) period of sampling must be conducted as described in Part III.C.2.b above. Those facilities that pass the benchmark requirement, using the above pass/fail determination, after implementing supplemental BMPs may discontinue the Part III.C sampling but must thereafter properly maintain all of the BMPs that enabled the facility to pass the TSS benchmark requirement.

Facilities that are not able to pass the TSS benchmark requirement after implementing supplemental BMPs must continue the process of implementing additional supplemental BMPs from the Appendix C list, or other appropriate BMPs, (within twelve (12) months after the end of the previous twelve (12) month sampling period) and conducting a subsequent twelve month (two

samples per quarter) period of sampling until the facility passes the benchmark requirement using the pass/fail criteria provided above.

e. Written justification to cease Part III.C monitoring.

If a facility provides a written justification, after the first twelve (12) month period of sampling (or after any subsequent twelve (12) month period of sampling), and EPD concurs that the facility's stormwater discharges associated with industrial activity do not have a reasonable potential to cause or contribute to a violation of an instream water quality standard, then EPD may conclude that additional sampling under Part III.C is not required. Facilities that have passed the benchmark requirement are not required to submit a written justification in order to cease Part III.C sampling.

f. Demonstration of appropriate BMPs.

If a facility with a stormwater discharge associated with industrial activity that may be a potential source of fecal coliform has implemented all technologically and economically feasible BMPs in the Appendix C list (for animal processing facilities), or other appropriate BMPs (for other facilities), and is still unable to pass the TSS benchmark requirement, the owner or operator of that facility may submit a demonstration to EPD that the facility has properly designed, installed and maintained all of the BMPs that are technologically and economically feasible for the facility and still cannot meet the benchmark. If, after reviewing the demonstration and conducting a site inspection, EPD concurs with the facility's determination, then the facility will not be required to implement additional supplemental BMPs in order to comply with the permit. However, if new BMPs become technologically and economically feasible for the facility at a later date, then EPD may require the implementation of such BMPs at that time. EPD may also require an individual NPDES permit for a facility if that facility does not properly design, install and maintain technologically and economically feasible BMPs in a timely manner.

New Mexico

Phase I MS4 Permit for the City of Albuquerque

B. Area-specific Stormwater Management Program Requirements. Permittees are required to develop and implement measures necessary to bring the discharge into compliance with the Middle Rio Grande Total Maximum Daily Load (TMDL) for Fecal Coliform. Specific permit requirements to implement the TMDL are included in Part III, Table III.B. [Note: Table III.B. includes the implementation activities required, the co-permittees responsible and the schedule of compliance. The implementation activities in the table have been incorporated as text as follows:]

1.0 Source Categories. Develop and submit a list of potential categories of fecal coliform sources by watershed and watershed density (undeveloped, low, moderate, high), covering the entire permit area.

1.1 Legal Authority Evaluate adequacy of existing legal authority to implement the conditions included in this Table. Where existing ordinances are lacking, provide a schedule for obtaining the necessary legal authority. Ordinances shall be in place prior to the implementation of the programs.

2.0 Dry Weather Investigation. Develop and submit a dry weather field investigation program, by watershed, to identify and isolate fecal coliform sources that occur during dry weather so that they can be reduced/eliminated. The program shall address the sources identified in item 1.0 above. The program shall address the suitability of each of the following measures and shall include detailed description of activities and frequencies.

2.1 Low Density Watersheds:

2.1.1 Conduct dry weather channel survey
2.1.2 Conduct survey of septic systems (e.g. aerial, ground, etc.)
2.1.3 Conduct visual or tracer tests on suspected failing systems
2.1.4 Investigate recreational and seasonal sewage dischargers
2.1.5 Conduct ARA and study to determine whether fecal coliform s are of human or nonhuman origin
2.1.6 Test ditch or channel sediments to see if they are a bacteria source or reservoir

2.2 Moderate/High Density Watersheds:

2.2.1 Conduct dry weather channel survey
2.2.2 Test for Illicit connections
2.2.3 Check integrity of major trunk lines for cracks and leaks
2.2.4 Check for historic and unconnected septic systems
2.2.5 Conduct ARA and study to determine whether fecal coliform s are of human or nonhuman origin
2.2.6 Check ponds, lakes and impoundments for waterfowl concentrations

3.0 Wet Weather Investigation Develop and submit a wet weather field investigation program, by watershed, to identify and isolate fecal coliform sources that occur during wet weather so that they can be reduced/eliminated. The program shall address the sources identified in item 1.0 above. The program shall address the suitability of each of the following measures and shall include detailed description of activities and frequencies.

3.1 Low Density Watersheds

3.1.1 Inspect septic systems for wet-weather failure
3.1.2 Conduct comprehensive wet weather monitoring to isolate subwatershed hot spots
3.1.3 Submit results of the Antibiotic Resistance Analysis and the study to determine whether fecal coliforms are of human or nonhuman origin
3.1.4 Sample runoff from suspected source areas (e.g. hobby farms and livestock areas)
3.1.5 Test storm drain or channel sediments to see if they are a bacteria sink or source

3.2 Moderate/High Density Watersheds:

3.2.1 Check for chronic sanitary sewer overflows at specific manholes and /or pumping stations
3.2.2 Submit results of the Antibiotic Resistance Analysis and the study to determine whether fecal coliforms are of human or nonhuman origin
3.2.3 Conduct comprehensive wet weather monitoring to identify key source areas or subwatersheds

4.0 Submit certification of the full implementation of the dry and wet weather field investigation programs.

5. 0 Fecal Coliform Reduction and Treatment Develop and submit a program for reducing or treating existing fecal coliform sources, by watershed and watershed density. The program shall address the sources identified in items 3.0 and 4.0 above. The program shall address the suitability of each of the following measures and shall include detailed description of activities and frequencies. Where activities are to be performed by entities other than the permittee, describe enforcement mechanism to be used to ensure compliance.

5.1 Low Density Watersheds

5.1.2 Rehabilitate failing septic systems
5.1.3 Connect failing septic systems to sewer
5.1.4 Increase sep tic system clean outs
5.1.5 Retrofit stormwater ponds
5.1.6 Retrofit ditches as dry swales
5.1.7 Waterfowl management
5.1.8 Install recreational vehicle sewage pumpouts
5.1.9 Implement conservation plans at hobby farms

5.2 Moderate/High Density Watersheds:

5.2.2 Eliminate illicit connections to storm sewer
5.2.2 Rehabilitate existing sewer system to eliminate sanitary sewer overflows
5.2.3 Relocate storm outfalls
5.2.4 Disinfect at the end of pipe
5.2.5 Retrofit stormwater ponds
5.2.6 Retrofit ditches as dry swales
5.2.7 Waterfowl harassment
5.2.8 Enforce pet waste disposal
5.2.9 Implement conservation plans at hobby farms

6.0 Submit certification of the full implementation of fecal coliform reduction and treatment program.

7.0. Prevention of Future Fecal Discharges Develop and submit a program for preventing future fecal coliform discharges, by watershed. The program shall address at a minimum, the measures included below, with detailed description of activities and frequencies. Where activities are to be performed by entities other than the permittee, describe enforcement mechanism to be used to ensure compliance.

7.1 Low Density Watersheds

7.1.1 Land use management
7.1.2 Stringent septic system requirements:
7.1.2.1 Feasibility criteria
7.1.2.2 Setbacks
7.1.2.3 Reserve field requirements
7.1.2.4 Minimum lot size
7.1.2.5 Technology criteria
7.1.2.6 Inspections
7.1.2.7 Maintenance requirements
7.1.3 Stream/ ditches buffers and access restrictions
7.1.4 Livestock fencing
7.1.5 Wildlife control
7.1.6 Land application criteria for biosolids

7.1.7 Stormwater treatment for new development
7.1.8 Public education
7.1.9 Recreational vehicle and park sewage pump-out facilities
7.2 Moderate/High Density Watersheds:
7.2.1 New Sewer Testing
7.2.2 Inspection of new sewer hookups
7.2.3 SSO monitoring and prevention
7.2.4 Stormwater treatment for new development
7.2.5 Optimal stormwater outfall location
7.2.6 Engineered stream buffers
7.2.7 Pet Exclusion
7.2.8 Waterfowl control /management
7.2.9 Public education on pet waste
7.2.10 Transient sewage disposal
7.2.11 Septic system rehabilitation

8.0 Submit certification of the implementation of the program to prevent future fecal coliform sources.

9.0 Monitoring Program Develop a monitoring program, in consultation with the State of New Mexico, to assess BMP effectiveness and compliance with Fecal Coliform TMDL at North Diversion Floodway Channel, San Jose Drain, South Diversion Channel and Tijeras Arroyo. Target values and equation for comparison of loadings are included in Table III.B.2 below. While developing this monitoring program, the permittees should take into account the frequency of storm events, and the variation in Fecal Coliform levels, within individual storm event. Collection and analysis of samples shall be conducted in accordance with Part V requirements. Results shall be submitted in Discharge Monitoring Report (DMR) forms.

10.0 Submit certification of the full implementation of the monitoring program to assess BMP effectiveness.

11.0 BMP Assessment Submit BMP evaluations and assessment, and revisions to the programs above if deemed necessary, based on monitoring data obtained.

12. 0 Annual TMDL Progress Reports The permittees shall submit annual reports describing progress on the activities required in Table III.B. to comply with the Fecal Coliform TMDL. The reports shall follow the requirements included in Part V.C, items 1, 4, 6 and 7, but shall be submitted separately from the Annual Report covering all other items of the permit. Results of the monitoring program shall be summarized in the Annual TMDL Progress Report and shall include graphic representation of fecal coliform trends. The Annual TMDL Progress Report shall also include computations of annual percent reduction achieved from the baseline loads and comparisons with the target loads.

Ohio

Big Darby Creek Watershed Construction General Permit

F. Total Maximum Daily Load (TMDL) allocations

This general permit requires control measures/BMPs for construction sites that reflect recommendations set forth in the U.S. EPA approved Big Darby Creek TMDL.

G. SWP3 Requirements

G2. Controls.

2b. ***Riparian Setback Requirements****. The SWP3 shall clearly delineate the boundary of required stream setback distances. No construction activity shall occur within the delineated setback boundary except activities associated with restoration or recovery of natural floodplain and channel form characteristics as described in Attachment B and storm water conveyances from permanent treatment practices. Such conveyances must be designed to minimize the width of disturbance. If intrusion within the delineated setback boundary is necessary to accomplish the purposes of a project then mitigation shall be required in accordance with Part III.G.2.c of this permit. Streams requiring protection under this section are defined as perennial, ephemeral or intermittent streams with a defined bed, bank or channel. National Resources Conservation Service (NRCS) soil survey maps should be used as one reference and the presence of a stream requiring protection should also be confirmed in the field. Any required setback distances shall be clearly displayed in the field prior to any construction related activity.*

Riparian setbacks shall be delineated based upon one of the following three methods:

i. The setback distance from the centerline of the stream shall be sized as the greater of the following:

1. The regulatory 100 year floodplain based on FEMA mapping;

2. A minimum of 100 feet on each side; or

3. Distance calculated using the following equation:

$W = 133DA^{0.43}$
where:
DA = drainage area (mi^2)
W = total width of riparian setback (ft)

W should be divided by two (2) in order to calculate the setback for one side of the stream. If the DA remains relatively constant throughout the stretch of interest, then the DA of the downstream edge of the stretch should be used. Where there is a significant increase in the DA from the upstream edge to the downstream edge of the area of interest, the setback width shall increase accordingly.

ii. Site Specific Riparian Setback Delineation. The total setback width shall be the streamway width centered over the meander pattern of the stream plus an additional 100 feet from the edge of the streamway per side.

The streamway width shall be calculated as described in Part III.G.2.b.i.3 or as ten times the bankfull width determined from sufficient site specific information adequate to characterize the channel through the site by a professional experienced in stream morphology. The average site specific bankfull width may be used if the bankfull width does not vary significantly throughout the reach of interest. Otherwise the streamway width should vary with bankfull width. Centering about the meander pattern can be thought of as determining where a line representing the streamway width would evenly intersect equal elevation lines on either side of the stream.

iii. Stream Restoration with 100 feet (each side) Riparian Setback. Each stream segment within the proposed site boundaries can be assessed in accordance with Attachment B. In the event the stream segment is classified as a "Previously Modified Low Gradient Headwater Stream", the permittee has the option to restore the stream segment in accordance with Attachment B and include a 100 feet water quality setback distance from the centerline of the stream on each side. In the event the stream segment exceeds the minimum criteria in Attachment B to be classified as a "Previously Modified Low Gradient Headwater Stream", Part III.G.2.b.iii may be considered on a case-by-case basis. No structural sediment controls (e.g., the installation of silt fence or a sediment settling pond) or structural post-construction controls shall be used in a stream or the delineated setback.

2i. ***Post-Construction Storm Water Management Requirements****. So that receiving stream's physical, chemical, and biological characteristics are protected and stream functions are maintained, post-construction storm water practices shall provide perpetual management of runoff quality and quantity. To meet the post-construction requirements of this permit, the SWP3 must contain a description of the post-construction BMPs that will be installed during construction for the site and the rationale for their selection. The rationale must address the anticipated impacts on the channel and floodplain morphology, hydrology, and water quality.*

Detail drawings and maintenance plans shall be provided for all postconstruction BMPs. Maintenance plans shall be provided by the permittee to the post-construction operator of the site (including homeowner associations) upon completion of construction activities (prior to termination of permit coverage). A description of maintenance operations must be included in the maintenance agreement to ensure all Post Construction BMP's will be maintained in perpetuity. For sites located within a community with a regulated municipal separate storm sewer system (MS4), the permittee, land owner, or other entity with legal control of the property may be required to develop and implement a maintenance plan to comply with the requirements of the MS4. Maintenance plans must ensure that pollutants collected within structural post-construction practices, be disposed of in accordance with local, state, and federal regulations. Permittees, except for those regulated under the small MS4 program, are not responsible under this permit for operation and maintenance of post-construction practices once coverage under this permit is terminated.

This permit does not preclude the use of innovation or experimental postconstruction storm water management technologies. However, the director may require discharges from such structures to be monitored to ensure compliance with Part III.G.2.i of this permit. The installation of structural controls in certain scenarios may also require a separate permit under section 404 of the CWA. Permittees are only responsible for the installation and maintenance of storm water management measures prior to final stabilization of the site and are not responsible for maintenance after storm water discharges associated with construction activity have been

eliminated from the site. However, post-construction storm water BMPs that discharge pollutants from point sources once construction is completed, may in themselves, need authorization under a separate NPDES permit.

Linear construction projects, (e.g., pipeline or utility line installation), which do not result in the installation of impervious surface, are not required to comply with the conditions of Part III.G.2.i of this permit. However, linear construction projects must be designed to minimize the number of stream crossings and the width of disturbance.

Large Construction Activities. For all large construction activities (involving the disturbance of five or more acres of land or will disturb less than five acres, but is a part of a larger common plan of development or sale which will disturb five or more acres of land), the post construction BMP(s) chosen must be able to detain storm water runoff for protection of the stream channels, stream erosion control, and improved water quality. Structural (designed) post-construction storm water treatment practices shall be incorporated into the permanent drainage system for the site. The BMP(s) chosen must be sized to treat the water quality volume (WQ_v) and ensure compliance with Ohio's Water Quality Standards in OAC Chapter 3745-1. The WQ_v shall be equivalent to the volume of runoff from a 0.75-inch rainfall and shall be determined according to one of the two following methods:

i. Through a site hydrologic study approved by the local municipal permitting authority that uses continuous hydrologic simulation and local long-term hourly precipitation records or ii. Using the following equation:

$WQv = C * P * A / 12$
where:
WQ_v = *water quality volume in acre-feet*
C = *runoff coefficient appropriate for storms less than 1 inch (see Table 5)*
P = *0.75 inch precipitation depth*
A = *area draining into the BMP in acres*

An additional volume equal to 20 percent of the WQ_v shall be incorporated into the BMP for sediment storage and/or reduced infiltration capacity. Ohio EPA recommends that BMPs be designed according to the methodology included in the most current edition of the Rainwater and Land Development manual or in another design manual acceptable for use by Ohio EPA.

BMPs shall be designed such that the drain time is long enough to provide treatment, but short enough to provide storage available for successive rainfall events as described in Table 6 below.

The permittee may request approval from Ohio EPA to use alternative structural post-construction BMPs if the permittee can demonstrate that the alternative BMPs are equivalent in effectiveness to those listed in Table 6 above. Construction activities shall be exempt from this condition if it can be demonstrated that the WQ_v is provided within an existing structural post-construction BMP that is part of a larger common plan of development or if structural post-construction BMPs are addressed in a regional or local storm water management plan.

For redevelopment projects (i.e., developments on previously developed property), post-construction practices shall either ensure a 20 percent net reduction of the site impervious area, provide for treatment of at least 20 percent of the WQ_v, or a combination of the two.

Small Construction Activities. For all small land disturbance activities (which disturb one or more, but less than five acres of land and is not a part of a larger common plan of development or sale which will disturb five or more acres of land), a description of measures that will be installed during the construction process to control pollutants in storm water discharges that will occur after construction operations have been completed must be included in the SWP3. Structural measures should be placed on upland soils to the degree attainable.

i. Such practices may include, but are not limited to: storm water detention structures (including wet basins); storm water retention structures; flow attenuation by use of open vegetated swales and natural depressions; infiltration of runoff onsite; and sequential systems (which combine several practices). The SWP3 shall include an explanation of the technical basis used to select the practices to control pollution where flows exceed pre-development levels.

ii. Velocity dissipation devices shall be placed at discharge locations and along the length of any outfall channel to provide non-erosive flow velocity from the structure to a water course so that the natural physical and biological characteristics and functions are maintained and protected (e.g., no significant changes in the hydrological regime of the receiving water).

Big Darby Creek Watershed TMDL

5.0 Implementation of the Big Darby Creek TMDL

A key objective for preserving or restoring the high quality aquatic communities in the Big Darby Creek watershed is to determine ways for human activities to proceed without disrupting the existing natural system. Human intervention usually happens on a local scale. A small swale or ditch is often viewed locally as a conduit for exporting water so that the products of human pursuits can be maximized. But the system as a whole has a finite capacity. The cumulative impact of local interventions in the system has grown to the point that the system can no longer assimilate the changes, particularly in the upper Big Darby Creek watershed, Treacle Creek, Robinson Run and Hellbranch Run. These local interventions are happening from all aspects of our society, as such, solutions will need to come from all aspects of our society. This chapter of the TMDL report outlines the ways to implement the guidelines and loading reductions provided in Chapter 4. Achievement of these are necessary to maintain the Big Darby Creek watershed as a high quality aquatic system.

5.1 Implementation Mechanisms

Stream integrity concepts are discussed in Chapters 3 and 4, as well as the establishment of allowable loads for pollutants, and effluent limitations for point source dischargers. A variety of mechanisms will be evaluated and used to achieve these loading reductions. These mechanisms are discussed in more detail below.

5.1.1 Storm Water Control

Storm water control is largely achieved through the issuance of general permits under the NPDES program. These permits are issued for construction activities, and for industrial activities, and are issued to control storm water that is discharged from a discrete conveyance, such as pipes or confined conduits. NPDES individual and general permits are issued to

individuals, private entities, and local government entities. These permits function together to form a web of state and local authority under which storm water is controlled.

General Permits For Construction Storm Water

Ohio EPA has issued a draft general permit for runoff associated with construction activity that is specific to the Big Darby Creek watershed. Ohio EPA has used existing permit terms and conditions and has included new types of permit terms and conditions to ensure, to the extent authorized by law, that loading targets developed in Chapters 3 and 4 are achieved for storm water. These permit terms and conditions include management practices, effluent targets, infiltration requirements necessary to support stream base flows and stream setbacks necessary to protect the stream channel. The goal is to issue a permit that is protective of the aquatic life uses in the Big Darby Creek watershed.

As is the case with the existing construction storm water general permit, construction companies will be expected to be co-permittees along with developers. This condition of the permit will be an area of emphasis by Ohio EPA in evaluating compliance with the general permit for storm water from construction activity.

Phase I and Phase II MS4 Permits For Local Jurisdictions

Federal storm water regulations call for the issuance of Phase I NPDES storm water permits to large municipalities, and the issuance of Phase II NPDES storm water permits to smaller municipalities. As with the general permits for construction storm water, Ohio EPA intends to revise the MS4 permits, to the extent authorized by law, so as to achieve the loading limitations established in Chapter 4 of this TMDL for storm water. Ohio EPA expects to exercise its authority to designate additional Phase II communities within the Big Darby Creek watershed and to ensure that the permits issued to those jurisdictions are protective of the aquatic life uses.

Oregon

Columbia Slough TMDL

The DMAs will conduct monitoring of stormwater BOD5 loads and the instream response to those loads. Previous monitoring under the MS4 permits has measured BOD5 levels from urban runoff that do not correlate with the few instream BOD5 samples taken during storm events. The discrepancy between loads and instream concentration is likely due to processes such as deposition and decay during the transport to the receiving water. The monitoring data will be used to calibrate a dynamic water quality model to simulate the Slough's response to stormwater and deicing fluid. The DMA WLA will not be included as an effluent limit. Achievement of the WLA will be through implementation of BMPs. Municipal discharges will be required to implement BMPs and demonstrate that the BMPs achieve the WLAs established. The DMAs will be required, through MOAs, to:

1. Provide DEQ with a description of the program designed to reduce BOD5 loads to the Slough.

2. Implement a program of BMPs that will reduce overall BOD5 load to achieve the DMA WLAs.

3. Implement coordinated monitoring to define stormwater loads to the Slough and the influence of stormwater BOD5 on receiving water quality.

4. Implement monitoring to demonstrate compliance with BOD5 WLA targets. Instream monitoring will include grab samples of BOD5 and DO and continuous hydrolab monitoring.

5. Implement water quality management plans as developed as part of the Lower Willamette Subbasin plan (projected completion spring 1999).

Phase I MS4 Permit for City of Gresham, City of Fairview, and Multnomah County

The requirements of this section [p. 17] apply to co-permittee's MS4 discharges to receiving waters with established TMDLs and associated allocations as noted on page 1 of this permit. It is the intent of this section to ensure that pollutant discharges for those parameters listed in the TMDL are reduced to the maximum extent practicable. Adequate progress toward achieving assigned wasteload allocations (WLAs) will be demonstrated through the implementation of best management practices that are targeted at TMDL related pollutants.

i) Progress towards reducing TMDL pollutant loads must be evaluated by the co-permittee through the use of performance measures and pollutant load reduction benchmarks developed and listed in the SWMP.

(1) Performance measures are estimates of the effectiveness of various best management practices (BMPs) implemented by the co-permittees as per the SWMP; and they are not numeric effluent limits. Performance measures must, where appropriate, be pollutant reduction estimates. The performance measures for the BMPs addressing TMDL pollutants may be based on the same metrics developed in accordance with the program effectiveness monitoring requirements in Schedule B(1)(c)(i).

(2) A benchmark is a total pollutant load reduction estimate for each parameter or surrogate, where applicable, for which a WLA is established at the time of permit issuance. A benchmark is used to measure the overall effectiveness of the stormwater management plan in making progress toward the wasteload allocation (this estimate will be related to the statistical variability of the underlying data and may be stated as a range), and is intended to be a tool for guiding adaptive management activities. A benchmark is not a numeric effluent limit; rather it is a goal that is subject to the maximum extent practicable standard. The co-permittee must provide the rationale for the proposed benchmark, which includes an explanation of the relationship between the benchmarks and the TMDL wasteload allocations. Any limiting factors related to the development of a benchmark, such as data availability and data quality, must also be included in this rationale.

ii) The SWMP must describe a program that includes BMPs, monitoring triggers, narrative conditions, or other elements, designed to achieve reductions in the TMDL pollutants. The SWMP must include a specific strategy for implementing monitoring designed to enable the co-permittee to gauge the effectiveness of the SWMP in reducing TMDL pollutant loads to the maximum extent practicable.

iii) When the co-permittee applies for permit renewal, the co-permittee must include an evaluation of the effectiveness of the stormwater management plan with respect to all pollutant

parameters addressed in an applicable TMDL. This evaluation must assess progress towards meeting the pollutant load reductions (benchmarks) using the reporting and monitoring programs and other methods described in Schedules B(1), B(2) and D(2)(d)(v) of this permit. If the co-permittee has failed to meet the estimated pollutant load reductions during the permit term, they must use the adaptive management process described in Schedule D(2)(a)of this permit to reassess the SWMP and determine what additional or alternative BMPs are practicable. The co-permittee must update the SWMP to include these BMPs. The co-permittee must submit the evaluation and any SWMP revisions to the Department as specified in Schedule D(2)(d)(v).

iv) If within three (3) years following permit issuance a TMDL is approved by the Environmental Protection Agency (EPA) and the TMDL has wasteload allocations assigned to stormwater within the geographic area covered by this permit, the co-permittee must, at the time of the next permit renewal application, complete a review and strategy development, and propose changes, if appropriate, to the SWMP to address the urban stormwater discharges.

v) If, at the time of permit issuance, TMDL wasteload allocations have been established for pollutant parameters associated with the MS4's discharges, each co-permittee must, as appropriate, review their SWMP to determine its adequacy in reducing TMDL pollutant discharges to the maximum extent practicable and develop pollutant load reduction benchmark(s) and performance measures in the SWMP as defined in Schedule D(2)(d)(i)(1) and (2). As part of the SWMP review and benchmark and performance measure development process, the co-permittee must document, and subsequently report in accordance with Schedule B(2)(b), the following information:

(1) A description of the methodology and rationale used to develop and select pollutant reduction benchmarks and performance measures. The methodology must address current estimated discharge loadings and TMDL wasteload allocations.

(2) Any proposed modifications to the SWMP resulting from the adaptive management process [Schedule D(2)(a)] necessary to give reasonable assurance that the SWMP is designed to reduce TMDL pollutants to the maximum extent practicable. This must include selection of BMPs and any assumptions related to the proposed BMPs.

(3) Any proposed modifications to the monitoring component of the SWMP that are necessary to ensure adequate data and information are collected to assess SWMP implementation, BMP effectiveness, progress towards the pollutant load reduction (4) A description of the public participation process, including a summary of material public comments and the responses to those comments.

The requirements of this section apply to receiving waters without established TMDL wasteload allocations. The co-permittee must qualitatively review the pollutants that are on the 2002 303(d) list that are relevant to the co-permittee's MS4 discharges. This review and corresponding summary of proposed actions must be incorporated into the interim evaluation report. The review and summary must accomplish the following:

i) Determine whether there is a reasonable likelihood for stormwater from the MS4 to cause or contribute to water quality degradation of receiving waters through the discharge of pollutants

on the 2002 303(d) list. Provide the rationale for the conclusion, including the results of an evaluation.

ii) If the discharges from the MS4 is a contributor to specific listed pollutants, determine and describe the relationship between the 303(d) listed pollutant and the MS4 discharges.

iii) Determine whether the BMPs in the existing SWMP are effective to address the 303(d) pollutants. If not, describe how the plan could be adapted to more appropriately address these pollutants. A summary of the rationale for this determination must also be included in the report. If sufficient information is not available to make the determinations required above, the co-permittee must compile pertinent information necessary to adequately complete these determinations.

The Interim Evaluation Report is to include: i) An evaluation of, and proposed revisions to, the SWMP that addresses the requirements of Schedules D(2)(b) and B(1)(b), including the rationale supporting the proposed revisions. ii) A description of the current source identification components of the SWMP and the rationale regarding the adequacy of these components. iii) For each of the listed non-stormwater discharges [Schedule A(3)] expected to occur in a copermittee's area, the co-permittee must identify the appropriate control measures and the rationale for the selection of these BMPs (or the rationale for why BMPs are deemed not necessary). iv) The required information regarding TMDL pollutants as described in Schedule D(2)(d)(v) and the corresponding proposed revisions to the SWMP, and/or the required information regarding 303(d) listed pollutants as described in Schedule D(2)(e) and the corresponding proposed revisions to the SWMP. v) An executive summary of the SWMP, no more than 15 pages in length, that describes the main elements of the SWMP. vi) Maps providing updated information as described in 40 CFR §122.26(d)(1)(iii)(B), where applicable.

Draft Phase II MS4 Permit

The requirements of this section apply to MS4 discharges to receiving waters with established TMDLs and associated wasteload allocations as noted on page 1 of this permit or if the permittee becomes subject to an approved TMDL, and following notice of such by the Department. If the permittee reduces applicable pollutant discharges for the parameters listed in the TMDL to the maximum extent practicable, this reduction is deemed to be adequate progress toward achieving assigned TMDL wasteload allocations (WLAs).

a) Progress towards reducing TMDL pollutant loads will be evaluated, in subsequent permit terms, by the permittee through the use of performance measures and pollutant load reduction benchmarks developed and listed in the SWMP.

(1) Performance measures are estimates of the effectiveness of various best management practices (BMPs) implemented by the permittee as per the SWMP; and are not numeric effluent limits. Performance measures must, where appropriate, be pollutant reduction estimates. If appropriate, the performance measures for the BMPs addressing TMDL pollutants may be based on the same metrics developed to determine progress towards measurable goals, as described in the SWMP.

(2) A pollutant load reduction benchmark is an estimate for each parameter or surrogate, where applicable, for which a WLA is established. A benchmark is used to measure the overall

effectiveness of the stormwater management program in making progress toward the WLA (this estimate will be related to the statistical variability of the underlying data and may be stated as a range), and is intended to be a tool for guiding adaptive management activities. A benchmark is not a numeric effluent limit; rather it is a goal. The permittee must provide the rationale for the proposed benchmark, which includes an explanation of the relationship between the benchmarks and the TMDL wasteload allocations. Any limiting factors related to the development of a benchmark, such as data availability and data quality, must also be included in this rationale.

b) The permittee must use adaptive management, as described in Schedule A(3), to focus and refine SWMP elements to address TMDL wasteload allocation(s) over the course of this permit cycle.

c) If, at the time of permit issuance or within three (3) years of permit issuance, a TMDL establishes municipal stormwater wasteload allocations for pollutant parameters associated with the MS4's discharges, the permittee must develop and propose to the Department specific performance measures and pollutant load reduction benchmarks, as described in Schedule D(2)(a). Performance measures and pollutant load reduction benchmarks must be submitted to the Department as part of the permit renewal package described in Schedule B(3).

Pennsylvania

Wissahickon Creek TMDL

The reference watershed approach is based on determining the current loading rates for the pollutants of interest from a selected unimpaired watershed that has similar physical characteristics (i.e., landuse, soils, size, geology) to those of the impaired watershed. The objective of this process is to reduce the loading rate of sediment (or other pollutant) in the impaired stream segment to a level equivalent to or slightly lower than the loading rate in the unimpaired reference stream segment.

Tennessee

Harpeth River E. coli TMDL

SWMPs must include a section describing how discharges of pollutants of concern will be controlled to ensure that they do not cause or contribute to instream exceedances of water quality standards. Specific measures and BMPs to control pollutants of concern must also be identified. In addition, MS4s must implement the WLA provisions of an applicable TMDL and describe methods to evaluate whether stormwater controls are adequate to meet the WLA. In order to evaluate SWMP effectiveness and demonstrate compliance with specified WLAs, MS4s must develop and implement appropriate monitoring programs. Instream monitoring, at locations selected to best represent the effectiveness of BMPs, must include analytical monitoring of pollutants of concern. A detailed plan describing the monitoring program must be submitted to the Division of Water Pollution Control Nashville Field Office within 12 months of the approval date of this TMDL. Implementation of the monitoring program must commence within 6 months of plan approval by the Field Office. The monitoring program shall comply with

the monitoring, recordkeeping, and reporting requirements of NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems.

Phase II MS4 General Permit

1. *Determine whether stormwater discharge from any part of the MS4 significantly contributes directly or indirectly to a 303(d) listed (i.e., impaired) waterbody. Water quality impaired waters means any segment of surface waters that has been identified by the division as failing to support classified uses. If you have discharges meeting these criteria, you must comply with Part 3.1.1.2 and 3.1.2; if you do not, the remainder of this Part 3.1 does not apply to you.*

2. *If you have "303(d)" discharges described above, you must also determine whether a Total Maximum Daily Load (TMDL) has been developed by the division and approved by EPA for the listed waterbody. If there is a TMDL, you must comply with both Parts 3.1.2 and 3.1.3; if no TMDL has been approved, Part 3.1.3 does not apply until a TMDL has been approved.*

3. *Water Quality Controls for Discharges to Impaired Waterbodies. The stormwater management program review submitted to the division must include a section describing how your program will control the discharge of the pollutants of concern. This section must identify the measures and BMPs that will collectively control the discharge of the pollutants of concern. The measures should be presented in order of priority with respect to controlling the pollutants of concern.*

4. *Consistency with Total Maximum Daily Load (TMDL). If a TMDL has been approved for any waterbody into which you discharge, you must follow the procedure below and report on these activities in annual reports to the division:*

5. *Determine whether the approved TMDL is for a pollutant likely to be found in stormwater discharges from your MS4.*

6. *Determine whether the TMDL includes a pollutant wasteload allocation (WLA), implementation recommendations, or other performance requirements specifically for stormwater discharges from your MS4.*

7. *Determine whether the TMDL addresses a flow regime likely to occur during periods of stormwater discharge.*

8. *After the determinations above have been made and if it is found that your MS4 must implement specific provisions of the TMDL, evaluate whether the implementation of existing stormwater control measures is meeting the TMDL provisions, or if additional control measures are necessary.*

9. *Document all control measures currently being implemented or planned to be implemented. Include a schedule of implementation for all planned controls. Provide your rationale (e.g., calculations, assessments, reports and/or other evidence) that shows that you will comply with the TMDL provisions. For control measures that are expected to be implemented and evaluated beyond the term of this permit, you should also include longer schedule of implementation as necessary to describe the control measure.*

10. Describe a method to evaluate whether the stormwater controls are adequate to meet the requirements of the TMDL.

11. If the evaluation shows that additional or modified controls are necessary, describe the type and schedule for the control additions/revisions.

Vermont

Phase II General MS4 Permit

Your SWMP, including your operation and maintenance program for preventing or reducing pollutant runoff from municipal operations prepared pursuant to section 4.2.6, must include a section describing how your program will control to the maximum extent practicable the discharge of the pollutants of concern. This discussion must specifically identify measures and BMPs that will collectively control the discharge of the pollutants of concern. Pollutant(s) of concern refer to the pollutant identified as causing the impairment.

As set forth in 1.3.7 in implementing the six minimum control measures set forth in 4.2 you must be consistent with recommendations applicable to your MS4 in the implementation section of the Lake Champlain TMDL and any future TMDLs for impaired waters affected by your MS4 established or approved by EPA pursuant to section 303(d) of the federal Clean Water Act. The Lake Champlain Phosphorus TMDL recommendations for municipalities include: adoption of erosion controls (page 65), improved construction and maintenance practices for gravel backroads (page 69), promotion of riparian buffers and setbacks (page 76) and impervious surface minimization (page 76). 3.1.4. Determination of Consistency. The assessment of whether your Stormwater Management Program is consistent with TMDL recommendations will be based on your implementation and maintenance of best management practices not on estimates or measurements of pollutant loading does not authorize a direct discharge that is inconsistent with any EPA approved TMDL waste load allocation and any implementation plan for the waterbody to which the direct discharge drains. This general permit does not authorize a discharge to an impaired waterbody for which the Department has issued a watershed-specific general permit.

Washington

Draft Phase II MS4 General Permit (Western Washington)

An example of TMDL specific requirements is as follows:

Name of TMDL: *Snohomish River Tributaries*
Location of Original 303 (d) Listings – WA-07-1012, WA-07-015, WA-07-1052, WA-07-1163WA-07-1163, WA-07-1030 and WA-07-040
Area where TMDL Requirements Apply:
For each waterbody listed, TMDL coverage includes areas draining to the WASWIS segment number, and all the upstream tributaries contributing to it: Allen Creek, YT94RF: Quilceda Creek, TH58TS: French Creek, XZ24XU: Woods Creek, FZ74HO:

Pilchuck River, NF79WA: Marshland Watershed, XW79FQ
TMDL coverage includes the areas indicated in the Lower Snohomish River Tributaries Fecal Coliform Bacteria TMDL Detailed Implementation Plan dated June 2003, Figure 3, page 7. This TMDL can be found at http://www.ecy.wa.gov/programs/wq/tmdl/watershed/tmdl_info-nwro.html
***Parameter** – Fecal Coliform*
***Approval Date** – 9 – Aug. 2001*
***Potential MS4 Permittees** – Phase I permit: Snohomish County*
***Phase II permit**: Granite Falls, Lake Stevens, Monroe, Snohomish, Marysville, Arlington, Everett*
***WSDOT permit**: WSDOT.*
***Action Required** –*
Baseline Requirements: Within 12 months after the effective date of this permit, all municipal stormwater permittees must adopt and enforce an ordinance or ordinances requiring the application of source control BMPs for the following existing land uses if they occur within their jurisdiction: 1) commercial animal handling areas, and 2) commercial composting facilities.

Where these activities are not occurring, no action is required. BMPs shall be equivalent to those found in Volume IV of the 2001 Ecology Stormwater Management Manual for Western Washington. Ordinances shall also address illicit connections to storm drains.

Where potential sources of bacterial pollution exist, operational source control BMPs shall be required for all pollutant generating sources. Only in those cases where a facility is demonstrated to be causing a violation of surface or ground water standards, or is discharging illegally, shall structural source control BMPs shall be required as related to this TMDL. The provision for structural source control BMPs is not intended to apply to individual municipal stormwater outfalls.

No later than 12 months after the effective date of this permit, affected municipal permittees shall compile a list of the existing composting and animal waste handling facilities. This list shall be updated no later than 180 days prior to the expiration of the permit and submitted with the permit renewal application. Starting no later than 24 months after the effective date of this permit, conduct an inspection program for all the listed sites, with adequate enforcement capability to ensure implementation of source control BMPs. All facilities must be inspected with 40 months of the effective date of this permit.

***Monitoring and Implementation Requirements:** Permittees shall choose one or both of the following monitoring strategies. Strategy A is the default implementation strategy unless the permittee chooses to implement Strategy B in all or part of the area subject to the TMDL:*

Strategy A, Targeted Implementation Approach

- *Within 90 days of permit issuance, prepare and submit to Ecology for review, a Quality Assurance Project Plan (QAPP) for the sampling of streams and/or discharges from stormwater conveyances within the jurisdictions boundaries in order to determine areas with highest bacteria concentrations (high priority areas). Provisions for additional monitoring in high priority areas shall be included in order to locate pollution sources were they are not obvious.*

- *The QAPP shall be prepared following Ecology's "Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies, Feb. 2001, Ecology Publication No. 01-03-003. Ecology will review and provide comments within 30 days the plan is received. The sampling plan shall include an adequate number of sampling points and adequate sampling frequency to reasonably characterize the receiving water or waste stream. Monitoring shall begin no later than 270 days after permit issuance.*

- *No later than 365 days prior to permit renewal application, a Bacterial Pollution Control Plan shall be developed. The Bacterial Pollution Control Plan shall, at a minimum, consider the use of the following approaches:*

  1) pet waste ordinance, 2) evaluation of water pollution control enforcement capabilities, 3) evaluation of CAO in relation to TMDL goals, 4) educational program directed at reducing bacterial pollution, 5) investigation and implementation of methods that prevent additional stormwater bacterial pollution through stormwater treatment, reducing stormwater volumes, and preventing additional sources of stormwater in association with new development, 6) implementation of activities in the Quilceda/Allen or French Creek Watershed Management Plans (as applicable), 7) ambient water quality and stormwater quality sampling to specifically identify bacterial pollution sources, and 8) livestock ordinance and compost ordinance (Phase I Permittees only.)

- *No later than 270 days prior to permit renewal application, conduct public review of the Bacterial Pollution Control Plan.*

- *Submit the final Bacterial Pollution Control Plan to Ecology at the time of permit renewal application.*

Strategy B: Early Action Approach.

- *Prepare Early Action BMP plan within 180 days of permit effective date. The Early Action Plan shall contain those BMPs that the permittee believes will be effective in reducing bacteria levels within the MS4 (or otherwise in local waters). The Early Action Plan must include implementation of the required baseline requirement for all municipal stormwater permittees including adoption and enforcement of ordinance(s) requiring the application of source control BMPs related to bacterial pollutants (equivalent to Volume IV of the 2001 Ecology Stormwater Management Manual for Western Washington).*

- *The Early Action BMP Plan shall, at a minimum, consider the use of the following approaches: 1) pet waste ordinance, 2) evaluation of water pollution control enforcement capabilities, 3) evaluation of CAO in relation to TMDL goals, 4) educational program directed at reducing bacterial pollution, 5) investigation and implementation of methods that prevent additional stormwater bacterial pollution through stormwater treatment, reducing stormwater volumes, and preventing additional sources of stormwater in association with new development, 6) implementation of activities in Quilceda/Allen or French Creek Watershed Management Plans (as applicable) Watershed Management Plan, 7) ambient water quality and stormwater quality sampling to specifically identify bacterial pollution sources, and 8) livestock and compost ordinances (Phase I permittees only)*

- *Conduct and complete public review of the Early Action BMP plan within 270 days of permit effective date.*

- *Begin implementation of Early Action BMPs as specified in the plan within 360 days of permit issuance. BMPs shall be place within 36 months of permit issuance unless otherwise approved by Ecology.*
- *Within 30 months of permit issuance, prepare and submit to Ecology for review, a Quality Assurance Project Plan (QAPP) for the sampling of streams and/or discharges from stormwater conveyances within the jurisdictions boundaries in order to assess whether or not affected water bodies and/or stormwater discharges, are meeting state water quality standards.*
- *The QAPP shall be prepared following Ecology's "Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies, Feb. 2001, Ecology Publication No. 01-03-003. Ecology will review and provide comments within 30 days the plan is received. The sampling plan shall include an adequate number of sampling points and adequate sampling frequency to reasonably characterize the receiving water or waste stream. Monitoring shall begin no later than 36 months after permit issuance.*
- *No later than 270 days prior to permit renewal, a Bacterial Pollution Control Plan shall be developed. The Plan shall consider all available monitoring data and the approaches noted for the Early Action BMP Plan above.*
- *No later than 270 days prior to permit renewal application, conduct public review of the Bacterial Pollution Control Plan.*
- *Submit the Bacterial Pollution Control Plan to Ecology at the time of permit renewal application for review.*

Construction General Permit (state-wide)

S8. DISCHARGES TO 303(D) OR TMDL WATERBODIES

A. Sampling and Numeric Effluent Limitations For Discharges to 303(d)-listed Waterbodies

1. Permittees that discharge to water bodies listed as impaired by the State of Washington under Section 303(d) of the Clean Water Act for turbidity, fine sediment, high pH, or phosphorus, shall conduct water quality sampling according to the requirements of this section.

2. All references and requirements associated with Section 303(d) of the Clean Water Act mean the most current listing by Ecology of impaired waters that exists on November 16, 2005, or the date when the operator's complete permit application is received by Ecology, whichever is later.

B. Discharges to 303(d)-Listed Waterbodies (Turbidity, Fine Sediment, or Phosphorus)

1. Permittees which discharge to waterbodies on the 303(d) list for turbidity, fine sediment, or phosphorus shall conduct turbidity sampling at the following locations to evaluate compliance with the water quality standard for turbidity: a. Background turbidity shall be measured in the 303(d)-listed receiving water immediately upstream (upgradient) or outside the area of influence of the discharge; and b. Discharge turbidity shall be measured at the point of discharge into the 303(d) listed receiving waterbody, inside the area of influence of the discharge; or Alternatively, discharge turbidity may be measured at the point where the discharge leaves the construction site, rather than in the receiving waterbody.

2. Based on sampling, if the discharge turbidity exceeds the water quality standard for turbidity (more than 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or more than a 10% increase in turbidity when the background turbidity is more than 50 NTU), all future discharges shall comply with a numeric effluent limit which is equal to the water quality standard for turbidity.

3. If a future discharge exceeds the water quality standard for turbidity, the Permittee shall:

a. Review the SWPPP for compliance with Condition S9 and make appropriate revisions within 7 days of the discharge that exceeded the standard;

b. Fully implement and maintain appropriate source control and/or treatment BMPs as soon as possible, but within 10 days of the discharge that exceeded the standard;

c. Document BMP implementation and maintenance in the site log book; d. Notify the appropriate Ecology Regional Office by phone within 24 hours of analysis;

e. Continue to sample daily until discharge turbidity meets the water quality standard for turbidity.

C. Discharges to waterbodies on the 303(d) list for High pH

1. Permittees which discharge to waterbodies on the 303(d) list for high pH shall conduct sampling at one of the following locations to evaluate compliance with the water quality standard for pH (in the range of 6.5 – 8.5): a. pH shall be measured at the point of discharge into the 303(d) listed waterbody, inside the area of influence of the discharge; or b. Alternatively, pH may be measured at the point where the discharge leaves the construction site, rather than in the receiving water.

2. Based on the sampling set forth above, if the pH exceeds the water quality standard for pH (in the range of 6.5 – 8.5), all future discharges shall comply with a numeric effluent limit which is equal to the water quality standard for pH.

3. If a future discharge exceeds the water quality standard for pH, the Permittee shall:

a. Review the SWPPP for compliance with Condition S9 and make appropriate revisions within 7 days of the discharge that exceeded the water quality standard;

b. Fully implement and maintain appropriate source control and/or treatment BMPs as soon as possible, but within 10 days of the discharge that exceeded the standards;

c. Document BMP implementation and maintenance in the site log book; d. Notify the appropriate Ecology Regional Office by phone within 24 hours of analysis; and

e. Continue to sample daily until discharge meets the water quality standard for pH (in the range of 6.5 – 8.5) or the discharge stops or is eliminated.

Parameter identified in 303(d) listing	Parameter/Units		Analytical Method	Sampling Frequency
Turbidity Fine Sediment	Phosphorus	Turbidity/NTU	SM2130 or EPA180.1	Weekly, if discharging If background is 50 NTU or less: 5 NTU over background; or If background is more than 50 NTU: 10% over background
High pH	pH/Standard Units		pH meter	Weekly, if discharging

D. Sampling and Limitations For Sites Discharging to Applicable TMDLs

1. Discharges to a waterbodies subject to an applicable Total Maximum Daily Load (TMDL) for turbidity, fine sediment, high pH, or phosphorus, shall be consistent with the assumptions and requirements of the TMDL.

a. Where an applicable TMDL sets specific waste load allocations or requirements for discharges covered by this permit, discharges shall be consistent with any specific waste load allocations or requirements established by the applicable TMDL. ii. The Permittee shall sample discharges weekly, or as otherwise specified by the TMDL, to evaluate compliance with the specific waste load allocations or requirements. iii. Analytical methods used to meet the monitoring requirements shall conform to the latest revision of the Guidelines Establishing Test Procedures for the Analysis of Pollutants contained in 40 CFR Part 136. Turbidity and pH methods need not be accredited or registered unless conducted at a laboratory which must otherwise be accredited or registered.

b. Where an applicable TMDL has established a general waste load allocation for construction stormwater discharges, but no specific requirements have been identified, compliance with Conditions S4 (Monitoring) and S9 (SWPPPs) will be assumed to be consistent with the approved TMDL.

c. Where an applicable TMDL has not specified a waste load allocation for construction stormwater discharges, but has not excluded these discharges, compliance with Conditions S4 (Monitoring) and S9 (SWPPPs) will be assumed to be consistent with the approved TMDL.

d. Where an applicable TMDL specifically precludes or prohibits discharges from construction activity, the operator is not eligible for coverage under this permit.

2. Applicable TMDL means a TMDL for turbidity, fine sediment, high pH, or phosphorus, which has been completed and approved by EPA prior to November 16, 2005, or prior to the date the operator's complete permit application is received by Ecology, whichever is later. TMDLs completed after the operator's complete permit application is received by Ecology become applicable to the Permittee only if they are imposed through an administrative order by Ecology, or through a modification of permit coverage.

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Facilities that discharge to a waterbody with a control plan unless this general permit is adequate to provide the level of protection required by the control plan. Excluded facilities need to obtain coverage under another NPDES permit for stormwater discharges associated with industrial activity. Control plans may be total maximum daily load (TMDL) determinations, restrictions for the protection of endangered species, ground water management plans, or other limitations that regulate or set limits on discharges to a specific waterbody or groundwater recharge area.

E. Stormwater Discharges to Impaired Waterbodies Except 303(d) Listings for Sediment and Tissue

The Permittee's discharge must not cause or contribute to an excursion of the State's water quality standards, including the State's narrative criteria for water quality. For 303(d) listings based on numeric water quality criteria, Permittees must comply with the State's water quality standard for each pollutant named as a pollutant causing a violation of water quality standards at the location named on the State's 303(d) list except for temperature which is not required and fecal coliform which is only required if there is a potential source from the industrial activity. Ecology will not require monitoring for fecal coliform if the Permittee can document that there is no potential source of fecal coliform from any of their industrial activities. A permittee's requirements to comply with this condition will be listed on the cover sheet. Ecology will maintain an electronic list of permittees subject to this permit condition. This list, titled Appendix 4, is available on Ecology's web site.

For waterbody segments listed as impaired by the State under Section 303(d) of the Clean Water Act, the applicable 303(d) list is the list which is in effect August 21, 2002, or the 303(d) list which is in effect at the date the first application for coverage is received by Ecology, whichever is later.

Permittees must be in compliance with applicable Total Maximum Daily Load (TMDL) determinations. Applicable TMDLs or TMDL determinations are TMDLs which have been completed by the issuance date of this permit, or which have been completed prior to the date that the permittees application is received by Ecology, which ever is later. A permittee's requirements to comply with this condition will be listed on their cover sheet. Ecology will maintain an electronic list of permittees subject to this permit condition. This list, titled Appendix 5, is available on Ecology's web site. Unless the first application for coverage is received after any updated 303(d) list is effective, changes associated with revised 303(d) lists completed after September 20, 2002 will only become effective if they are imposed through an administrative order issued by Ecology.

Unless the first application for coverage is received after the TMDL is completed TMDL requirements associated with TMDLs completed after the issuance date of this permit will only become effective if they are imposed through an administrative order issued by Ecology.

1. New Facilities and Significant Process Change New facilities that discharge either directly or indirectly via a stormwater conveyance system to waterbody segments listed as impaired by the State under Section 303(d) of the Clean Water Act must comply with the State's water quality standards for the named pollutant(s) at the point of discharge. Facilities with coverage under

this permit, that implement a significant process change (see S1.D.1.) must either comply with the State's water quality standards for the named pollutant(s) at the point of discharge or demonstrate no increase in loading from the entire facility as a result of the process change. All new discharges including new discharges associated with significant process changes must be in compliance with any applicable TMDL determination.

PARAMETER	***EFFLUENT LIMITATIONS: NEW FACILITIES TO IMPAIRED WATERS OR WATERS COVERED BY A TMDL***
Parameter(s) as identified for the 303(d) listed segment or if applicable, TMDL determination	*As listed on the coversheet, based on Chapter 173-201A or as identified in the TMDL or listing documentation*

2. Existing Facilities discharging to water bodies for which an applicable TMDL has been completed:

PARAMETER	***EFFLUENT LIMITATIONS: EXISTING FACILITIES TO WATERS COVERED BY A TMDL***
Parameter(s) as identified in the applicable TMDL	*As listed on the cover sheet to comply with the applicable TMDL*

Note: A current listing of permittees subject to this permit condition and the specific effluent limitations and monitoring requirements, Appendix 5, is available on Ecology's web site.

3. Existing facilities which discharge either directly or indirectly via a stormwater conveyance system to waterbody segments listed as impaired by the State under Section 303(d) of the Clean Water Act are subject to the general compliance with standards provisions in S7. Additional monitoring and benchmarks apply as described in S.4.G Note: A current listing of permittees subject to this permit condition, and the associated benchmarks and monitoring requirements, Appendix 4, is available on Ecology's web site.

G. Monitoring Requirements for Facilities Discharging to 303(d) Listed Waters or Subject to TMDL Determination Except 303(d) Listings for Sediment and Tissue

In addition to the requirements in S4.C. above, beginning January, 2005, all facilities that discharge to waterbody segments listed as impaired by the State under Section 303(d) of the Clean Water Act must conduct quarterly monitoring of authorized discharges of stormwater to surface water. Samples must be analyzed for the parameters named on the 303(d) as causing impairment of the listed waters except for temperature which is not required and fecal coliform which is only required if there is a potential source from the industrial activity. Note: A current Appendix 4 with a list of permittees subject to the monitoring requirements of this condition is available on Ecology's web site.

Discharges to a waterbody for which a TMDL has been completed must be consistent with the TMDL determination. Where the TMDL determination sets load allocations for new discharges or limits pollutant concentrations in the discharge, the Permittee must conduct quarterly monitoring for the named pollutant(s) and the monitoring must be consistent with TMDL

requirements, if any. Reporting as required by this permit begins with the first quarter of the year 2005. Note: A current Appendix 5 with a list of permittees subject to the monitoring requirements of this condition is available on Ecology's web site.

1. Permittees may suspend monitoring for a listed parameter if:

a. Eight consecutive samples fail to detect the presence of the listed parameter. Fail to detect does not apply to pH. For pH it is eight consecutive samples where the values are not outside of the water quality-based range of 6.5 to 8.5 (freshwater) or 7.0 to 8.5 (marine).

b. The Permittee can demonstrate to Ecology's satisfaction after eight or more consecutive quarterly samples that there is no reasonable potential to violate water quality standards. For the purposes of suspending monitoring required under S4.G only, no reasonable potential to violate water quality is defined as a single sample exceeding eighty percent of the benchmark, and the average of the last eight consecutive quarterly samples is less than sixty percent of the benchmark.

2. For existing permittees discharging to water bodies for which an applicable TMDL has been completed:

Parameter	***Units***	***Analytical Method***	***Minimum Sampling Frequency***
Parameter(s) as identified in the applicable TMDL. (See cover sheet)	*As Applicable (see cover sheet)*	*Appropriate EPA or Equivalent Method*	*Quarterly (See cover sheet for specifics)*

Note: A current Appendix 5 with a list of permittees subject to the monitoring requirements of this condition is available on Ecology's web site.

3. Existing permittees discharging to water bodies that discharge to waterbody segments listed as impaired by the State under Section 303(d) of the Clean Water Act:

Parameter	***Units***	***Analytical Method***	***303(d) Benchmark Value***	***Minimum Sampling Frequency***
Parameter(s) as identified for the 303(d) listed segment (See cover sheet)	*As Applicable (See cover sheet)*	*Appropriate EPA or Equivalent Method*	*Based on Chapter 173-201A (See cover sheet)*	*Quarterly (See cover sheet for specifics)*

Note: A current Appendix 4 with a list of permittees subject to the monitoring requirements of this condition is available on Ecology's web site.

H. Monitoring Requirements for Facilities Discharging to 303(d) Waterbody segments listed for Sediment

All facilities that discharge to waterbody segments listed for sediment must notify Ecology of any sediment data they may have collected. Upon request from Ecology they will submit the data.

In addition to the requirements in S4.A. above, beginning with the first quarter of the year 2005, all facilities that discharge to waterbody segments listed by the State for violations of sediment standards under Section 303(d) of the Clean Water Act must conduct quarterly monitoring of authorized discharges of stormwater to surface water for total suspended solids (TSS). Discharges that demonstrate TSS levels consistent with secondary treatment standards (30 mg/L monthly average not to exceed 45 mg/L) are considered unlikely to violate sediment quality standards. Permittees that can demonstrate consistent attainment TSS levels of secondary treatment standards may suspend monitoring for the duration of the permit term. Consistent attainment is defined as 8 consecutive quarterly samples (omitting any quarter where there is no discharge) with an average TSS of 30 mg/L and no sample exceeding 45 mg/L.

Wisconsin

Phase II MS4 general permit

1.5 Impaired Water Bodies and Total Maximum Daily Load Requirements

1.5.1 The permittee shall determine whether any part of its MS4 discharges to an impaired water body listed in accordance with section 303(d)(1) of the federal Clean Water Act, 33 USC §1313(d)(1)(C), and the implementing regulation of the US Environmental Protection Agency, 40 CFR §130.7(c)(1). Impaired waters are those that are not meeting applicable water quality standards. A list of Wisconsin impaired water bodies may be found on the Department's Internet site at: http://dnr.wi.gov/org/water/wm/wqs/303d/303d.html.

1.5.2 If the permittee's MS4 discharges to an impaired water body, the permittee shall include a written section in its storm water management program that discusses the management practices and control measures it will implement as part of its program to reduce, with the goal of eliminating, the discharge of pollutant(s) of concern that contribute to the impairment of the water body. This section of the permittee's program shall specifically identify control measures and practices that will collectively be used to try to eliminate the MS4's discharge of pollutant(s) of concern that contribute to the impairment of the water body and explain why these control measures and practices were chosen as opposed to other alternatives. Pollutant(s) of concern means a pollutant that is causing impairment of a water body.

1.5.3 After the permittee's start date of coverage under this permit, the permittee may not establish a new MS4 discharge of a pollutant of concern to an impaired water body or increase the discharge of a pollutant of concern to an impaired water body unless the new or increased discharge causes the receiving water to meet applicable water quality standards, or the Department has approved a total maximum daily load (TMDL) for the impaired water body.

1.5.4 The permittee shall determine whether its MS4 discharges to an impaired water body for which the Department has approved a TMDL. If so, the permittee shall assess whether the TMDL wasteload allocation for the MS4 is being met through the existing storm water management controls or whether additional control measures are necessary. The permittee's assessment of whether the TMDL wasteload allocation is being met shall focus on the adequacy of the permittee's storm water controls (implementation and maintenance). Approved TMDLs

are listed on the Department Internet site at: http://dnr.wi.gov/org/water/wm/wqs/303d/index.html.

1.5.5 The storm water management program developed under section 2 of this permit shall be revised as necessary to achieve and maintain compliance with any Department approved-TMDL wasteload allocation for an impaired water to which the MS4 discharges. The redesigned storm water management programs shall be implemented as soon as possible.

Federal Construction General Permit

Part 1.3.C.: Eligibility, Limitations on Coverage

5. Discharging into Receiving Waters With an Approved Total Maximum Daily Load Analysis

a. You are not eligible for coverage under this permit for discharges of pollutants of concern to waters for which there is a total maximum daily load (TMDL) established or approved by EPA unless you incorporate into your SWPPP measures or controls that are consistent with the assumptions and requirements of such TMDL. To be eligible for coverage under this general permit, you must incorporate into your SWPPP any conditions applicable to your discharges necessary for consistency with the assumptions and requirements of such TMDL. If a specific wasteload allocation has been established that would apply to your discharge, you must incorporate that allocation into your SWPPP and implement necessary steps to meet that allocation.

b. In a situation where an EPA-approved or established TMDL has specified a general wasteload allocation applicable to construction storm water discharges, but no specific requirements for construction sites have been identified in the TMDL, you should consult with the State or Federal TMDL authority to confirm that adherence to a SWPPP that meets the requirements of the CGP will be consistent with the approved TMDL. Where an EPA-approved or established TMDL has not specified a wasteload allocation applicable to construction storm water discharges, but has not specifically excluded these discharges, adherence to a SWPPP that meets the requirements of the CGP will generally be assumed to be consistent with the approved TMDL. If the EPA-approved or established TMDL specifically precludes such discharges, the operator is not eligible for coverage under the CGP.

3.14 Documentation of Permit Eligibility Related to Total Maximum Daily Loads

The SWPPP must include documentation supporting a determination of permit eligibility with regard to waters that have an EPA-established or approved TMDL, including:

A. Identification of whether your discharge is identified, either specifically or generally, in an EPA-established or approved TMDL and any associated allocations, requirements, and assumptions identified for your discharge;

B. Summaries of consultation with State or Federal TMDL authorities on consistency of SWPPP conditions with the approved TMDL, and

C. Measures taken by you to ensure that your discharge of pollutants from the site is consistent with the assumptions and requirements of the EPA-established or approved TMDL, including any specific wasteload allocation that has been established that would apply to your discharge.

See section 1.3.C.5 for further information on determining permit eligibility related to TMDLs.

Federal Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity

Impaired waters include both those with established TMDLs, and those for which TMDL development has been identified as necessary, but for which one has not yet been established. For a more detailed definition see Appendix A.

1.4.4.1 Discharge to an Impaired Water with an Established TMDL. If a wasteload allocation (WLA) has been established that applies to your discharge, you must develop the SWPPP accordingly (Part 2.1.3.2), and implement all necessary controls to meet that allocation. You must verify that your discharge complies with the WLA through the appropriate discharge monitoring (Part 3.2.4.2). Failure to comply with a relevant WLA is a violation of this permit.

If you have properly complied with the requirements of Part 2.1.3.2 and find that the applicable TMDL does not specify a wasteload allocation or other requirements either individually or categorically for your discharge (including disallowing such discharge), compliance with this permit will be deemed adequate to meet the requirements of the TMDL.

1.4.4.2 Discharge to an Impaired Water without an Established TMDL. If a TMDL has not been established that applies to your discharge you must comply with the requirements of this permit and any additional conditions stipulated by the Secretary (Part 2.1.3.2). If you have properly complied with all such requirements then compliance with this permit will be deemed adequate to meet the requirements for discharging to an impaired water. You are also subject to the monitoring requirement of Part 3.2.4.1. Failure to comply with applicable conditions is a violation of this permit.

3.2.4.1 Discharges to impaired waters with no applicable wasteload allocation. For discharges that are conveyed directly or indirectly to impaired waters, monitoring for the pollutant of concern must be conducted at a minimum of once each permit year throughout the term of the permit unless this permit already assigns your discharge an effluent limitation or a benchmark for the pollutant of concern. Your monitoring year begins on the day that your discharge is authorized.

This monitoring requirement is waived after one year if the pollutant of concern is not detected in an amount expected to cause and contribute to a violation of Vermont Water Quality Standards in your stormwater discharge, and you document in your SWPPP that there is no exposure of the pollutant of concern to stormwater at your site.

3.2.4.2 Discharges to impaired waters with an applicable wasteload allocation. For discharges that are conveyed directly or indirectly to waters for which a TMDL has been established with a wasteload allocation applicable to your discharge (either specifically or categorically), monitoring for the wasteload allocation pollutant of concern must be conducted, consistent with

any instructions in TMDL documentation. If the TMDL documentation does not specify specific monitoring requirements, monitoring for the pollutant of concern must be conducted at a minimum of once each permit year throughout the term of the permit, unless this permit already assigns your discharge an effluent limitation or a benchmark for the pollutant of concern, in which case you must follow the effluent limitation or benchmark monitoring schedule. Your monitoring year begins on the day your discharge is authorized. This monitoring must be conducted in addition to all other monitoring requirements prescribed in this permit. Monitoring of a pollutant of concern for which your discharge has been assigned a wasteload allocation cannot be waived unless the WLA is specified only in terms of BMPs, in which case the monitoring requirement is waived after one year if the pollutant of concern is not detected in your stormwater discharge and you document in your SWPPP that you have adopted the required BMPs.

If at any time your monitoring data exceed a relevant waste load allocation you are subject to the Corrective Action requirements of Part 3.3 and the Follow-up Monitoring and Reporting requirements of Part 3.4.

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Web Sites and Databases

American Society of Civil Engineers' (ASCE) and EPA's International Stormwater BMP Database: www.bmpdatabase.org/

Authorization Status for EPA's Stormwater Construction and Industrial Programs by State: http://cfpub.epa.gov/npdes/stormwater/authorizationstatus.cfm

Center for Watershed Protection's Stormwater Manager's Resource Center Web site: www.stormwatercenter.net/

Center for Watershed Protection's Web site on the Simple Method: www.stormwatercenter.net. Click "By Category." Information on the Simple Method is included in the *Impacts of Urbanization* category.

Conservation Technology and Information Center Web site, *Know Your Watershed: Building Local Partnerships*: www2.ctic.purdue.edu/KYW/Brochures/BuildingLocal.html

EPA's Biocriteria Web site: www.epa.gov/waterscience/biocriteria/

EPA's CADDIS Web site: http://cfpub.epa.gov/caddis/

EPA's eNOI system: http://cfpub.epa.gov/npdes/stormwater/enoi.cfm

EPA's Environmental Monitoring and Assessment Program (EMAP) database: www.epa.gov/emap/index.html

EPA's *Guidelines for Reviewing TMDLs Under Existing Regulations Issued in 1992*: www.epa.gov/owow/tmdl/guidance/final52002.html

EPA's list of bioassessment publications from EPA and other federal agencies (e.g., U.S. Geological Survey [USGS], U.S. Department of Agriculture [USDA]): www.epa.gov/bioindicators/html/publications.html

EPA's list of Regional stormwater contacts: http://cfpub.epa.gov/npdes/contacts.cfm?program_id=6&type=REGION

EPA's list of sectors of industrial activity that require permit coverage: http://cfpub.epa.gov/npdes/stormwater/swcats.cfm

EPA's list of state stormwater contacts: http://cfpub.epa.gov/npdes/contacts.cfm?program_id=6&type=STATE

EPA's NPDES Stormwater Discharges from Industrial Facilities Web site: http://cfpub.epa.gov/npdes/stormwater/indust.cfm

EPA's NPDES Stormwater Discharges from Municipal Separate Storm Sewer Systems Web site: http://cfpub.epa.gov/npdes/stormwater/munic.cfm

EPA's NPDES Stormwater Program Authorization Status: http://cfpub.epa.gov/npdes/stormwater/authorizationstatus.cfm

EPA's NPDES Stormwater program Web site: http://cfpub.epa.gov/npdes/home.cfm?program_id=6

EPA's NPDES Stormwater Discharges from Construction Activities Web site: http://cfpub.epa.gov/npdes/stormwater/const.cfm

EPA's PCS: www.epa.gov/enviro/html/pcs/index.html

EPA's Storage and Retrieval Database (STORET): www.epa.gov/storet/

EPA's TMDL and Stormwater Resources Web site: www.epa.gov/owow/tmdl/stormwater

EPA's TMDL Web site: www.epa.gov/owow/tmdl/

EPA's Urban BMP Performance Tool: http://cfpub.epa.gov/npdes/stormwater/urbanbmp/bmpeffectiveness.cfm

Google Earth: http://earth.google.com/

Multi-Resolution Land Characteristics (MRLC) Consortium's National Land Cover Database (NLCD): www.epa.gov/mrlc/

National Agriculture Imagery Program (NAIP) Aerial Photos: http://165.221.201.14/NAIP.html

University of Alabama's (Pitt, R.E., A. Maestre, and R. Morquecho) The National Stormwater Quality Database (NSQD, version 1.1): http://unix.eng.ua.edu/~rpitt/Research/ms4/mainms4.shtml

University of Massachusetts Amherst's Massachusetts Stormwater Technology Evaluation Project (MASTEP), Stormwater Technologies Clearinghouse: www.mastep.net/

University of New Hampshire Stormwater Center, Nonpoint Education for Municipal Officials (NEMO), Innovative Stormwater Management Inventory Database: www.erg.unh.edu/stormwater/index.asp

USDA's PACFISH/INFISH Biological Opinion Program: http://fsgeodata.fs.fed.us/pibo/

USGS's Earth Explorer: http://edcsns17.cr.usgs.gov/EarthExplorer/

USGS's National Water Information System Web site (NWISWeb): http://waterdata.usgs.gov/nwis

USGS's National Water-Quality Assessment (NAWQA) Program: http://water.usgs.gov/nawqa/

USGS's Land Cover Institute: http://landcover.usgs.gov/

Glossary

Benchmark monitoring: The results of MSGP 2000 benchmark monitoring are primarily for the permittee's use to determine the overall effectiveness of an SWPPP in controlling the discharge of pollutants to receiving waters. Benchmark values are not viewed as effluent limitations. An exceedance of a benchmark value does not, in and of itself, constitute a violation of the MSGP. According to EPA, while exceedance of a benchmark value does not automatically indicate that violation of a water quality standard has occurred, it does signal that modifications to the SWPPP may be necessary. In addition, permitting authorities may use the exceedance of benchmark values to identify facilities that would be more appropriately covered under an individual, or alternative general permit where more specific pollution prevention controls could be required.

Best management practice (BMP): Policies or practices that prevent, reduce, or mitigate the effects of stormwater runoff. These methods can be structural (e.g., devices, ponds) or nonstructural (e.g., policies to reduce imperviousness). BMPs classified as *nonstructural* are those that rely predominantly on behavioral changes rather than construction to be effective. *Structural* BMPs are engineered or constructed to prevent or manage stormwater. BMPs are often further classified into (1) source-control BMPs to prevent pollution, (2) water quality BMPs to reduce or prevent pollutants in runoff, (3) flow-control BMPs to reduce the volume of stormwater and (4) infiltration BMPs to increase infiltration.

Combined sewer system: Combined sewer systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all their wastewater to a sewage treatment plant, where it is treated and then discharged to a waterbody. During periods of heavy rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other waterbodies.

Effluent limitation: Any restriction imposed on quantities, discharge rates, and concentrations of pollutants that are discharged from point sources into waters of the United States, the waters of the contiguous zone, or the ocean (40 CFR 122.2).

Flow duration curves: Calculations of limits that analyze the cumulative frequency of historic flow data over a specified period. Flow duration curve development typically uses daily average discharge rates, which are sorted from the highest value to the lowest. Using this convention, flow duration intervals are expressed as a percentage, with zero corresponding to the highest stream discharge in the record (i.e., flood conditions) and 100 to the lowest (i.e., drought conditions). Duration curve analysis identifies intervals that can be used as a general indicator of hydrologic condition (i.e., wet versus dry and to what degree). Flow duration curve intervals can be grouped into several broad categories or zones. For example, many duration curves categorize the flow intervals into the following five zones: high flows, moist conditions, mid-range flows, dry conditions, and low flows. When water quality concentrations or loads are plotted on the basis of these flow zones, the resulting graphs can provide additional insight about conditions, patterns associated with the impairment, and potential sources contributing to the problem. Duration curves add value to the TMDL process by characterizing water quality concerns in terms of flow conditions, linking these concerns to key watershed processes, prioritizing source assessment efforts, and identifying potential solutions.

General permit: An NPDES permit issued under 40 CFR 122.28 that authorizes a category of discharges under the CWA within a geographical area. A general permit is not specifically tailored for an individual discharger.

Illicit discharge: Any discharge to a municipal separate storm sewer that is not composed entirely of stormwater, except discharges pursuant to an NPDES permit and discharges resulting from fire fighting activities.

Individual permit: An NPDES permit specifically tailored for an individual discharger.

Integrated Design and Evaluation Assessment of Loadings (IDEAL; Barfield 2002) provides a spreadsheet-based technique for assessing the benefits of urban management practices on flow, sediment, nutrients, and bacteria. The model predicts watershed runoff, concentrations, and loads on the basis of the user's selection of vegetative filter strips, dry-detention ponds and wet-detention ponds. Urban areas are defined as pervious, impervious connected, and impervious unconnected areas. Flow and loads can be directed to a pond that can be either dry (no permanent pool) or wet (permanent pool). The model then calculates the pollutant removal efficiencies of the practices using empirical equations. The model predicts single storm values and converts them to average annual storm values using a statistical process. The IDEAL model is designed to help managers estimate long-term management practice pollutant removal efficiencies, and is not designed for looking at individual storms.

Load allocation (LA): The portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources. LAs are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and nonpoint source loads should be distinguished [40 CFR 130.2(g)].

Loading capacity: The greatest amount of loading that a waterbody can receive without violating water quality standards. Loading capacity is equal to the TMDL. Loading capacities calculated using data-driven approaches are typically based on *in-stream* or *delivered loads* (i.e., in-stream flow multiplied by target and conversion factor at a location in the waterbody). Loading capacities developed using land-based modeling approaches can also be based on *source loads* (i.e., land-based loads before they are delivered to the stream).

Margin of safety (MOS): The component of a TMDL that accounts for any lack of knowledge concerning the relationship between LAs, WLAs, and water quality [CWA section 303(d)(1)(C), 40 CFR 130.7(c)(1)]. EPA's *Guidance for Water Quality-based Decisions: The TMDL Process* (1991) explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS). If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading set aside for the MOS must be identified.

Maximum extent practicable (MEP): The pollutant reduction standard applied to stormwater management programs developed to address stormwater discharges from regulated MS4s.

Measurable goals: Quantifiable objectives for assessing program and best management practice effectiveness that regulated small municipal separate storm sewer systems must develop for the six minimum control measures to comply with Phase II MS4 permit requirements.

Model for Urban Stormwater Improvement Conceptualization (MUSIC; Wong et al. 2001): Software developed by the Cooperative Research Center (CRC) for Catchment Hydrology in Australia to evaluate small- and large-scale (100-square-mile) urban stormwater systems using modeling time steps that range from 6 minutes to 24 hours. MUSIC provides an interface to help set up complex stormwater management scenarios. It allows users to view results using a range of graphical and tabular formats. The stormwater control devices evaluated by MUSIC include ponds, bioretention, infiltration buffer strips, sedimentation basins, pollutant traps, wetlands, and swales. Major techniques used to evaluate management practices including settling in ponds and decay of pollutants (first order; see www.toolkit.net.au/music).

Multi-Sector General Permit (MSGP): Authorizes the discharge of stormwater from industrial facilities, consistent with the terms of the permit, in areas of the United States where EPA manages the NPDES permit program.

Municipal separate storm sewer system (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) Owned or operated by a state, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to state law)...including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the CWA that discharges into waters of the United States. (ii) Designed or used for collecting or conveying stormwater; (iii) Which is not a combined sewer; and (iv) Which is not part of a publicly owned treatment works (POTW) as defined at 40 CFR 122.2.

Notice of Intent (NOI): Submitting a completed NOI constitutes notice that the entity intends to be authorized to discharge pollutants to waters of the United States from the facility or site identified in the form under a state or EPA general permit such as the Phase II MS4 General Permit, the Multi-Sector General Permit (MSGP) for industrial stormwater, or the Construction General Permit (CGP).

Permitting authority: The U.S. Environmental Protection Agency (EPA), a Regional Administrator of EPA, or an authorized representative.

PGBMP-DSS: Evaluates the effect of management practices or combinations of management practices on flow and pollutant loading. This module uses simplified, process-based algorithms to simulate management practice control of modeled flow and water-quality time series generated from runoff models such as HSPF. These simple algorithms include weir and orifice control structures; storm swale characteristics; flow and pollutant transport; flow routing and networking; infiltration and saturation; and a general loss/decay representation for a pollutant. Users have the flexibility to design retention-style or open-channel management practices; can define flow routing through a management practice or management practice network; can simulate Integrated Management Practices (IMPs) such as reduced or discontinued imperviousness through flow networking; and can compare management practice controls against a defined benchmark such as a simulated predevelopment condition. Because the underlying algorithms are based on physical processes, management practice effectiveness can be evaluated and estimated over a wide range of storm conditions, management practice designs, and flow routing configurations.

Six minimum control measures: Categories of best management practices that regulated small MS4s must address under Phase II MS4 stormwater management programs.

Storm sewershed: Land area in which all stormwater flows are conveyed to a single point, or outlet.

Stormwater management program (SWMP): The program developed and implemented by EPA to minimize the discharge of pollutants from regulated MS4s to the maximum extent practicable using BMPs.

Stormwater pollution prevention plan (SWPPP): A plan developed to minimize the discharge of pollutants from an industrial site (including construction activities) using BMPs.

Subwatershed: Smaller division of a watershed, defined by the area draining to a tributary of the main waterbody.

The Site Evaluation Tool (SET): Software developed to assess the effects of development, including sediment and nutrient loading, on a site scale. The SET provides a more robust environment for testing multiple management practices and site configurations than do simple export calculations. The tool allows definition of pre- and post-treated land use/land cover, allowing for multiple drainage areas and various combinations of practices. An important benefit of the SET is testing management practices in combination with each other, in the context of a site or small catchment. Structural and nonstructural practices can be represented, giving the user a suite of options for evaluation.

Total Maximum Daily Load (TMDL): A calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. A TMDL is the sum of individual wasteload allocations for point sources (WLA), load allocations for nonpoint sources and natural background (LA), and must consider seasonal variation and include a margin of safety. The TMDL comes in the form of a technical document or plan. (40 CFR 130.2 and 130.7)

Urbanized area (UA): A land area comprising one or more places—central place(s)—and the adjacent densely settled surrounding area—urban fringe—that together have a residential population of at least 50,000 and an overall population density of at least 1,000 people per square mile used to identify regulated small MS4s under the Phase II MS4 Stormwater program.

Vegetative Filter Strip Model (VFSMOD; Muñoz-Carpena et al. 2003): A model that provides specialized modeling of field-scale processes associated with filter trips or buffers. It provides routing of storm runoff from an adjacent field through a vegetative filter strip and calculates outflow, infiltration, and sediment trapping efficiency. It is sensitive to characteristics of the filter including vegetation roughness or density, slope, infiltration characteristics, and the incoming runoff volume and sediment particle sizes. VFSMOD includes a series of modules Green-Ampt infiltration, kinematic wave overland flow, and sediment filtration. The model can also be used to describe transport at the edge of the field when flow and transport are mainly in the form of sheet flow and the path represents average conditions across the vegetative filter strip. VFSMOD uses a variable time step that helps to more accurately solve the overland water flow equation. The model inputs are specified on a storm basis, and the model summarizes all the information after each event to generate storm outputs.

Virginia Field Scale Wetland Model (VAFSWM; Yu, et al. 1998): A field-scale model for quantifying the pollutant removal in a wetland system. It includes a hydrologic subroutine to route flow through the treatment system; precipitation, evapotranspiration, and exchange with subsurface groundwater. The model adopted a Continuous Stirred Tank Reactor (CSTR) in series schema. VAFSWM models mechanisms of settling, diffusion, adsorption to plants and substrate, and vegetative uptake for a pollutant in dissolved and particulate forms in a two-segment (water column and substrate), two-state

(completely mixed and quiescent) reactor system by employing first-order kinetics. The governing equations for quiescent condition are identical to that of turbulent condition; however, far lower settling velocities are assumed to account for the greater percentage of finer particles during the quiescent state. VAFSWM is a relatively simple model that includes the most dominant processes in the wetland system. However, the users need to provide and calibrate the requisite kinetics parameters.

Wasteload allocation (WLA): The portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation (40 CFR 130.2(h)).

Water Quality Based-Effluent Limitation (WQBEL): An effluent limitation determined by selecting the most stringent of the effluent limits calculated using all applicable water quality criteria (e.g., aquatic life, human health, wildlife, translation of narrative criteria) for a specific point source to a specific receiving water for a given pollutant or on the basis of the facility's WLA from a TMDL.

Watershed: A land area that drains to a common waterway, such as a stream, lake, estuary, wetland or ultimately the ocean.

WETLAND (Lee 1999; 2002): A dynamic, compartmental model to simulate hydrologic, water quality, and biological processes and help design and evaluate wetlands. WETLAND uses the continuously stirred tank reactor prototype, and it is assumed that all incoming nutrients are completely mixed throughout the entire volume. The model can simulate both free-water surface and subsurface flow wetlands. WETLAND is modular and includes hydrologic, nitrogen, carbon, dissolved oxygen, bacteria, sediment, vegetation, and phosphorous submodels. The strength of WETLAND lies on the linked kinetics for the water quality variables and considers seasonal variation (variable user-defined parameter by season/time period). The weaknesses of this model include the completely mixed assumption, which overlooks the effect of the system shape, and the needs for extensive kinetic parameters.

EXHIBIT "4"

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Water Science and Technology Board

Division on Earth and Life Studies

National Research Council

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COMMITTEE TO ASSESS THE SCIENTIFIC BASIS OF THE TOTAL MAXIMUM DAILY LOAD APPROACH TO WATER POLLUTION REDUCTION

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Preface

The Total Maximum Daily Load (TMDL) program, initiated in the 1972 Clean Water Act, recently emerged as a foundation for the nation's efforts to meet state water quality standards. A "TMDL" refers to the "total maximum daily load" of a pollutant that achieves compliance with a water quality standard; the "TMDL process" refers to the plan to develop and implement the TMDL. Failure to meet water quality standards is a major concern nationwide; it is estimated that about 21,000 river segments, lakes, and estuaries have been identified by states as being in violation of one or more standards. To address this problem, the U. S. Environmental Protection Agency (EPA) proposed an ambitious timetable for states to develop TMDL plans that will result in attainment of water quality standards. Given the reduction in pollutant loading from point sources such as sewage treatment plants over the last 30 years, the successful implementation of most TMDLs will require controlling nonpoint source pollution.

These two features, the ambitious timetable and nonpoint source controls, are probably the two most controversial of many issues that have been raised by those who have questioned the TMDL program. Behind and intertwined with these basic policy issues are important questions concerning the adequacy of the science in support of TMDLs.

In the last year, the TMDL program has become one of the most discussed and debated environmental programs in the nation, primarily because of the drafting of final rules for the program. These rules follow several years of intense activity, including the formation of a Federal Advisory Committee devoted to this topic. In October 2000, Congress suspended EPA's implementation of these rules until further information could be gathered on several aspects of the program. In particular, Congress requested that the National Research Council (NRC) examine the

scientific basis of the TMDL program. In recognition of the urgent need to address water quality standard violations, Congress established an aggressive schedule for completion of the study that allowed only four months from start to finish—unprecedented for most NRC studies. The eight-member committee, constituted in January 2001, immediately conducted its first meeting. This three-day meeting included two days devoted to public comments and a third day focused on internal committee discussions. The ensuing three months was a period of intense activity filled with correspondence, writing, and two additional committee meetings.

The difficult challenges facing EPA and the states in the implementation of the TMDL program were immediately apparent to the committee. Because the committee faced a congressionally mandated deadline, a number of issues important to some stakeholders were not addressed comprehensively. These include bed sediment issues, atmospheric deposition, translating narrative standards into numeric criteria, and a full review of existing water quality models. Nonetheless, the committee found that substantial improvements can be made in a number of areas to strengthen the scientific basis of the TMDL program. Also of importance, the committee identified several policy issues that are restricting the use of the best science in the TMDL program. We urge Congress, EPA, and the states to give thoughtful attention to the recommendations made throughout this report so that resources can be more efficiently used to improve water quality.

We greatly appreciate the assistance of Don Brady and Françoise Brasier of the EPA Office of Water for their assistance in initiating the study and organizing the first committee meeting. We are also grateful to those who spoke with and educated our committee, including congressional staff, EPA scientists, state representatives, and the many individuals and organizations that submitted comments to the committee.

The committee recognizes the vital role of Water Science and Technology Board (WSTB) director Stephen Parker in making this study possible. The extremely short time period for this study created an enormous challenge for NRC study director Laura Ehlers, who was able to juggle her many responsibilities to keep us focused and provide invaluable assistance in crafting the text. Finally, it is fair to say that this study owes most thanks to Leonard Shabman (Virginia Polytechnic Institute and State University) who was working in the WSTB office as a visiting scholar during the study. Dr. Shabman's insight was invaluable; he added immensely to committee discussion and correspondence, and he

played a key role in drafting the text and developing the recommendations.

More formally, the report has been reviewed by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the authors and the NRC in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The reviews and draft manuscripts remain confidential to protect the integrity of the deliberative process. We thank the following individuals for their participation in the review of this report: Richard Conway, consultant; Paul L. Freedman, Limno-Tech, Inc.; Donald R. F. Harleman, Massachusetts Institute of Technology (retired); Robert M. Hirsch, U.S. Geological Survey; Judith L. Meyer, University of Georgia; Larry A. Roesner, Colorado State University; Robert V. Thomann, Manhattan University (retired); and Robert C. Ward, Colorado State University.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Frank H. Stillinger, Princeton University, and D. Peter Loucks, Cornell University. Appointed by the NRC, they were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the NRC.

KENNETH H. RECKHOW
Chair

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Executive Summary

Over the last 30 years, water quality management in the United States has been driven by the control of point sources of pollution and the use of effluent-based water quality standards. Under this paradigm, the quality of the nation's lakes, rivers, reservoirs, groundwater, and coastal waters has generally improved as wastewater treatment plants and industrial dischargers (point sources) have responded to regulations promulgated under authority of the 1972 Clean Water Act. These regulations have required dischargers to comply with effluent-based standards for criteria pollutants, as specified in National Pollutant Discharge Elimination System (NPDES) permits issued by the states and approved by the U.S. Environmental Protection Agency (EPA). Although successful, the NPDES program has not achieved the nation's water quality goals of "fishable and swimmable" waters largely because discharges from other unregulated nonpoint sources of pollution have not been as successfully controlled. Today, pollutants such as nutrients and sediment, which are often associated with nonpoint sources and were not considered criteria pollutants in the Clean Water Act, are jeopardizing water quality, as are habitat destruction, changes in flow regimes, and introduction of exotic species. This array of challenges has shifted the focus of water quality management from effluent-based to ambient-based water quality standards.

This is the context in which EPA is obligated to implement the Total Maximum Daily Load (TMDL) program, the objective of which is attainment of ambient water quality standards through the control of both point and nonpoint sources of pollution. Although the TMDL program originated from Section 303d of the Clean Water Act, it was largely overlooked during the 1970s and 1980s as states focused on bringing point sources of pollution into compliance with NPDES permits. Citizen lawsuits during the 1980s forced EPA to develop guidance for the TMDL program, which is now considered to be pivotal in securing the

nation's water quality goals. Under TMDL regulations promulgated in 1992, EPA requires states to list waters that are not meeting water quality criteria set for specific designated uses. For each impaired water, the state must identify the amount by which point and nonpoint sources of pollution must be reduced in order for the waterbody to meet its stated water quality standards. Meeting these requirements, many of which have been imposed by court order or consent decree, has become the most pressing and significant regulatory water quality challenge for the states since passage of the Clean Water Act.

Given the most recent lists of impaired waters submitted to EPA, there are about 21,000 polluted river segments, lakes, and estuaries making up over 300,000 river and shore miles and 5 million lake acres. The number of TMDLs required for these impaired waters is greater than 40,000. Under the 1992 EPA guidance or the terms of lawsuit settlements, most states are required to meet an 8- to 13-year deadline for completion of TMDLs. Budget requirements for the program are staggering as well, with most states claiming that they do not have the personnel and financial resources necessary to assess the condition of their waters, to list waters on 303d, and to develop TMDLs. A March 2000 report of the General Accounting Office (GAO) highlighted the pervasive lack of data at the state level available to set water quality standards, to determine what waters are impaired, and to develop TMDLs.

Subsequent to the GAO report and following issuance by EPA of updated TMDL regulations, Congress requested that the National Research Council (NRC) assess the *scientific basis* of the TMDL program, including:

- the information required to identify sources of pollutant loadings and their respective contributions to water quality impairment,
- the information required to allocate reductions in pollutant loadings among sources,
- whether such information is available for use by the states and whether such information, if available, is reliable, and
- if such information is not available or is not reliable, what methodologies should be used to obtain such information.

Of concern to the nation's lawmakers was the paucity of data and information available to the states to comply with program requirements and meet water quality standards. Indeed, as the TMDL program proceeds, the best available science, especially with regard to nonpoint sources of

pollution, will be needed for regulatory and nonregulatory actions to be equitable and effective. Report recommendations are targeted (1) at those issues where science can and should make a significant contribution and (2) at barriers (regulatory and otherwise) to the use of science in the TMDL program. Chapters 2, 3, and 4 discuss the information required to set water quality standards, to list waters as impaired, and to develop TMDLs (including the identification of pollution sources), while Chapter 5 discusses the role of science in allocating pollutant loading among sources. Chapters 3 and 4 go into considerable detail about the monitoring, modeling, and statistical analysis methods needed to collect data and convert it to information, and to assess and reduce uncertainty.

This report represents the consensus opinion of the eight-memb NRC committee assembled to complete this task. The committee met three times during a three-month period and heard the testimony of over 40 interested organizations and stakeholder groups. The NRC committee feels that the data and science have progressed sufficiently over the past 35 years to support the nation's return to ambient-based water quality management. Given reasonable expectations for data availability and the inevitable limits on our conceptual understanding of complex systems, statements about the science behind water quality management must be made with acknowledgment of uncertainties. The committee has concluded that there are creative ways to accommodate this uncertainty while moving forward in addressing the nation's water quality challenges. These broad conclusions are elaborated upon below.

TMDL PROGRAM GOALS

The TMDL program should focus first and foremost on improving the condition of waterbodies as measured by attainment of designated uses. Work on meeting the strict time demands within the budget constraints cited by most states has focused on administrative outcomes as measures of success for the TMDL program. However, the success of the nation's premier water quality program should not be measured by the number of TMDL plans completed and approved, nor by the number of NPDES permits issued or cost share dollars spent. Success is achieved when the condition of a waterbody supports its designated use. Adequate monitoring and assessment must be used to improve the listing of impaired waterbodies and to characterize the effectiveness of the actions taken to meet the designated use.

The program should encompass all stressors, both pollutants and pollution, that determine the condition of the waterbody[1]. Proposed regulations may limit the applicability of the program to only those water quality problems caused by chemical and physical pollutants. Given their demonstrated effectiveness, activities that can overcome the effects of "pollution" and bring about waterbody restoration—such as habitat restoration and channel modification—should not be excluded from consideration during TMDL plan implementation.

Scientific uncertainty is a reality within all water quality programs, including the TMDL program, that cannot be entirely eliminated. The states and EPA should move forward with decision-making and implementation of the TMDL program in the face of this uncertainty while making substantial efforts to reduce uncertainty. Securing designated uses is limited not only by a focus on administrative rather than water quality outcomes in the TMDL process, but also by unreasonable expectations for predictive certainty among regulators, affected sources, and stakeholders.

CHANGES TO THE TMDL PROCESS

This report focuses on how scientific data and information should be used within the TMDL program. Science plays a crucial role in the standards-setting process, in the decision to add waters to the 303d list, in the development of the TMDL plan, and in the allocation of pollutant loads among various sources (although its importance relative to the role of policy decisions varies). The committee finds that although the state of the science is sufficient to develop TMDLs to meet ambient water quality goals in many situations, programmatic issues substantially hinder the use of the best available science. Thus, the following changes in the TMDL process are recommended, with an understanding that without such changes, the TMDL program will be unable to incorporate and improve upon the best available scientific information.

States should develop appropriate use designations for waterbodies in advance of assessment and refine these use designations prior to TMDL development. Clean Water Act goals of fishable and swimmable waters are too broad to be operational as statements of designated uses. Thus, there should be greater stratification of designated

[1] This refers to the legal definitions of "pollutant" and "pollution," which are given in Box 1-1 of Chapter 1.

uses at the state level (such as primary and secondary contact recreation). The appropriate designated use may not be the use that would be realized in the water's predisturbance condition. Sufficient science and examples exist for all states to inject this level of detail into their water quality standards. To ensure that designated uses are appropriate, use attainability analysis should be considered for all waterbodies before a TMDL is developed.

EPA should approve the use of both a preliminary list and an action list instead of one 303d list. Many waters now on state 303d lists were placed there without the benefit of adequate water quality standards, data, or waterbody assessment. These potentially erroneous listings contribute to a very large backlog of TMDL segments and foster the perception of a problem that is larger than it may actually be. States should be allowed to move those waters for which there is a lack of adequate water quality standards or data and analysis from the 303d list back to a preliminary list, as shown in Figure ES-1. This would provide the assurance that listed waters are indeed legitimate and merit the resources required to complete a TMDL. If no legal mechanism exists to bring this about, one should be created by Congress. The data requirements and other criteria that should be used to differentiate the preliminary list from the action list are discussed in the report. No waterbody should remain on the preliminary list for more than one rotating basin cycle.

TMDL plans should employ adaptive implementation. As shown in Figure ES-2, adaptive implementation is a cyclical process in which TMDL plans are periodically assessed for their achievement of water quality standards including designated uses. If the implementation of the TMDL plan is not achieving attainment of the designated use, scientific data and information should be used to revise the plan. Adaptive implementation is needed to ensure that the TMDL program is not halted because of a lack of data and information, but rather progresses while better data are collected and analyzed with the intent of improving upon initial TMDL plans. Congress and EPA need to address the policy barriers that inhibit adoption of an adaptive implementation approach to the TMDL program, including the issues of future growth, the equitable distribution of cost and responsibility among sources of pollution, and EPA oversight.

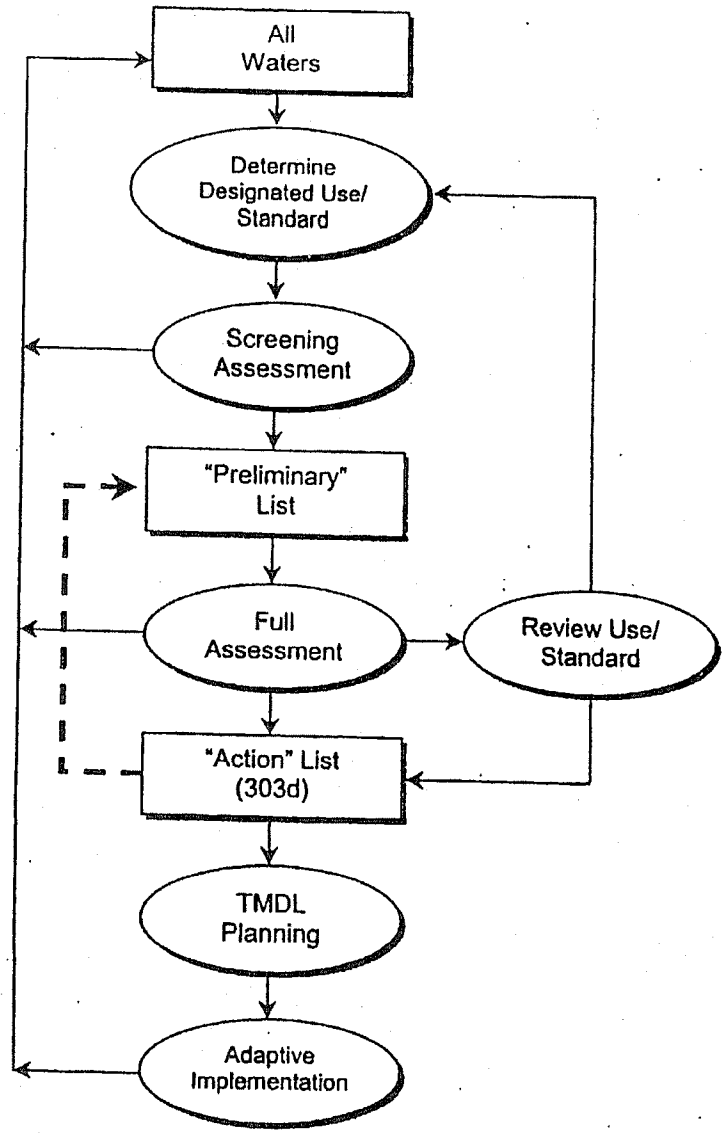

FIGURE ES-1 Framework for water quality management.

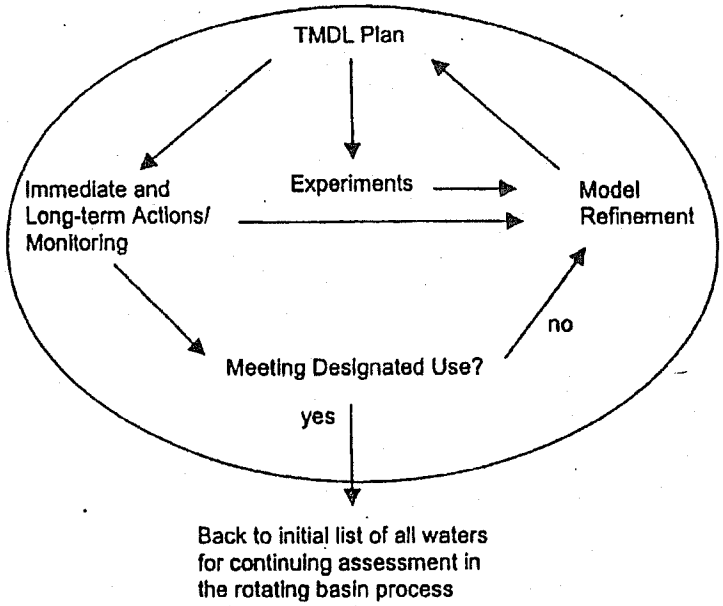

FIGURE ES-2 Adaptive implementation flowchart.

USE OF SCIENCE IN THE TMDL PROGRAM

This report suggests changes in the data used and analytical method. employed that will support the revisions to the TMDL process recommended above. The following sections highlight the use of science in the TMDL program steps as illustrated in Figure ES-1. Additional recommendations about the scientific basis of the program not included in this executive summary are found throughout the report.

Water Quality Standards

The TMDL process is primarily a measurement process and as such is significantly impacted by the setting of water quality standards. Water quality standards consist of two parts: a specific desired use appropriate

to the waterbody, termed a *designated use*, and a *criterion* that can be measured to establish whether the designated use is being achieved.

The criterion used to measure whether the condition of a waterbody supports its designated use can be positioned at different points along the causal chain connecting stressors (such as land use activities) to biological responses in a waterbody. Positioning the criterion involves a trade-off between forecast error for the stressor–criterion relationship and the adequacy of the criterion as a measure (surrogate) for the designated use. Model results that forecast the impact of the stressor on the criterion are likely to be more uncertain as the criterion is positioned farther from the stressor and closer to the designated use. On the other hand, positioning the criterion closer to the stressor and farther from the designated use is likely to mean that the criterion is a poorer measure or surrogate for the designated use.

Biological criteria should be used in conjunction with physical and chemical criteria to determine whether a waterbody is meeting its designated use. In general, biological criteria are more closely related to the designated uses of waterbodies than are physical or chemical measurements. However, guiding management actions to achieve water quality goals based on biological criteria also depends on appropriate modeling efforts.

All chemical criteria and some biological criteria should be defined in terms of magnitude, frequency, and duration. The frequency component should be expressed in terms of a number of allowed excursions in a specified period. Establishing these three dimensions of the criterion is crucial for successfully developing water quality standards and subsequently TMDLs.

Water quality standards must be measurable by reasonably obtainable monitoring data. In many states, there is a fundamental discrepancy between the criteria that have been chosen to determine whether a waterbody is achieving its designated use and the frequency with which water quality data are collected. This report gives examples of this phenomenon and makes suggestions for improvement.

Waterbody Assessment and Listing

Ambient monitoring and assessment programs should form the basis for determining whether waters are placed on the preliminary list or the action list.

EPA needs to develop a uniform, consistent approach to ambient monitoring and data collection across the states. The rotating basin approach used by several states is an excellent example of a framework than can be used to conduct waterbody assessments of varying levels of complexity, for example to support 305b reports, to place impaired waters on a preliminary list or action list, and to develop TMDLs. **In that regard, EPA should set the TMDL calendar in concert with each state's rotating basin program.**

Evidence suggests that limited budgets are preventing the states from monitoring for a full suite of indicators to assess the condition of their waters and from embracing a rotating basin approach to water quality management. Currently, EPA is assessing the suff ciency of state resources to develop and implement TMDLs. Depending on the results of that assessment, Congress might consider aiding the states, for example through matching grants to improve data collection and analysis.

Evaluated data and evidence of violation of narrative standards should not be exclusively used for placement of a waterbody on the action list, but is useful for placement on the preliminary list. EPA should develop guidance to help states translate narrative standards to numeric criteria for the purposes of 303d listing and TMDL calculation and implementation.

EPA should endorse statistical approaches to defining all waters, proper monitoring design, data analysis, and impairment assessment. For chemical parameters, these statistical approaches might include the binomial hypothesis test or other methods that can be more effective than the raw score approach in making use of the data collected to determine water quality impairment. For biological parameters, the might focus on improvement of sampling designs, more careful identification of the components of biology used as indicators, and analytical procedures that explore biological data as well as integrate biological information with other relevant data.

TMDL Development

The scientific basis of the latter half of the TMDL process revolves around a wide variety of models of varying complexity that are used to relate waterbody conditions to different land uses and other factors. Models are a required element of developing TMDLs because water quality standards are probabilistic in nature. However, although models

can aid in the decision-making process, they do not eliminate the need for informed decision-making.

Uncertainty must be explicitly acknowledged both in the models selected to develop TMDLs and in the results generated by those models. Prediction uncertainty must be estimated in a rigorous way, models must be selected and rejected on the basis of a prediction error criterion, and guidance/software needs to be developed to support uncertainty analysis.

The TMDL program currently accounts for the uncertainty embedded in the modeling exercise by applying a margin of safety (MOS); EPA should end the practice of arbitrary selection of the MOS and instead require uncertainty analysis as the basis for MOS determination. Because reduction of the MOS can potentially lead to a significant reduction in TMDL implementation cost, EPA should place a high priority on selecting and developing TMDL models with minimal forecast error.

EPA should selectively target some postimplementation TMDL compliance monitoring for verification data collection so that model prediction error can be assessed. TMDL model choice is currently hampered by the fact that relatively few models have undergone thorough uncertainty analysis. Postimplementation monitoring at selected sites can yield valuable data sets to assess the ability of models to reliably forecast response.

EPA should promote the development of models that can more effectively link environmental stressors (and control actions) to biological responses. A first step will be the development of conceptual models that account for known system dynamics. Eventually, these should be strengthened with both mechanistic and empirical models, although empirical models are more likely to fill short-term needs. Such models are needed to promote the wider use of biocriteria.

Monitoring and data collection programs need to be coordinated with anticipated water quality and TMDL modeling requirements. For many parameters, there are insufficient data to have confidence in the results generated by some of the complex models used in practice today. Thus, EPA should not advocate detailed mechanistic models for TMDL development in data-poor situations. Either simpler, possibly judgmental, models should be used or, preferably, data needs should be anticipated so that these situations are avoided.

In order to carry out adaptive implementation, EPA needs to foster the use of strategies that combine monitoring and modeling and expedite TMDL development. This should involve the use of Bayesian

techniques that can combine different types of information. Although the modeling framework proposed in this report calls for improvements in models, there are existing models that can be applied rapidly and effectively within an adaptive implementation framework.

FINAL THOUGHTS

Through the adoption and use of the preliminary list/action list approach, adequate monitoring and assessment approaches, sound selection of appropriate models, and adaptive implementation described in this report, the TMDL program will be capable of utilizing the best available scientific information. It is worth noting that the success of these approaches is directly related to the provision of adequate personnel and financial resources for data collection, management, and interpretation and for the development of sufficiently detailed and stratified water quality standards.

1
Introduction

THE RETURN TO AMBIENT-BASED WATER QUALITY MANAGEMENT

The Federal Water Pollution Control Act Amendments of 1972 (PL 92-500), as supplemented by the Clean Water Act (CWA) of 1977 and the Water Quality Act of 1987, are the foundation for protecting the nation's water resources. Precursors to the Water Quality Act go back to the Rivers and Harbors Appropriations Act of 1899, often referred to as the Refuse Act, and the Water Pollution Control Acts of 1948 and 1965 (Rodgers, 1994). An important impetus for earlier water quality legislation was protection of public health. Over time, this purpose was supplemented by aesthetic and recreational purposes (fishable and swimmable) and then by the goal of restoring and maintaining the "chemical, physical, and biological integrity of the Nation's waters" (Section 101a of PL 92-500).

In practice, each of these general purposes must be restated in operational and measurable terms as *ambient* water quality standards, which are established by the states and are subject to federal approval. Section 303d of the CWA makes it a responsibility of the states to assess whether ambient standards are being achieved for individual waterbodies. If ambient standards are not being met, a water quality management program to achieve those standards is anticipated.

The data and analytical requirements for determining both the causes of a failure to meet ambient standards and the solutions to such problems have challenged water quality analysts for over half a century. Prior to the 1972 Water Pollution Control Act Amendments, states were expected to identify pollutant sources that were resulting in violations of ambient water quality standards. Once the sources of the problem were carefully identified, controls on polluting activities would be put in place. How-

ever, in even modestly complex watersheds, multiple sources of pollutants made it difficult to unambiguously determine which sources were responsible for the standard violation. One source might insist that the cause of the problem was the discharge from others, or at least that its own contribution to the problem was not as significant as the contributions of others. Neither the available monitoring data nor the analytical methods available at the time allowed the states to defensibly mandate differential load reduction requirements (Houck, 1999).

The 1972 amendments recognized this analytical dilemma and shifted the focus of water quality management away from ambient standards. Instead, all dischargers of certain pollutants were expected to limit their discharges by meeting nationally established *effluent standards*. Effluent standards are specified in National Pollution Discharge Elimination System (NPDES) permits, issued by the states to certain pollutant sources and approved by the U.S. Environmental Protection Agency (EPA). Effluent standards were set at a national level based on available technologies for wastewater treatment appropriate to different industry groups (although in certain waterbodies effluent standards more stringent than the technology-based requirement have been required to meet local water quality goals). The shift to effluent standards eliminated the need to link required reductions at particular sources with the ambient condition of a waterbody. Instead, each regulated source was simply required to meet the effluent standard in its wastewater. In the intervening period since passage of PL 92-500, pollutants discharged by industry and municipal treatment plants have declined, and the ambient quality of many of the nation's lakes, rivers, reservoirs, groundwater, and coastal waters has improved.

There were consequences that followed the embracing of effluen based standards instead of ambient-based standards. First, efforts to measure and communicate water quality accomplishments were often described in terms of compliance with wastewater permit conditions rather than the condition of the waters. Second, effluent standards could only apply to so-called point sources rather than to all sources of a pollutant or other forms of pollution (Box 1-1). Pollutants from nonpoint sources (derived from diffuse and hard-to-monitor origins such as land-disturbing agricultural, silvicultural, and construction activities) largely escaped oversight. Third, attention to chemical pollutants measured in discharge water came to dominate water quality policy, and the physical and biological determinants of the ambient condition of a waterbody were less frequently considered. A *pollutant* is defined as a substance added by humans or human activities. In many cases, the condition of a

The 303d focus on ambient water quality standards has returned the nation to a water quality program that was not considered implementable 35 years ago when there was a paucity of data and analytical tools for determining causes of impairment and assigning responsibility to various sources. Determining the pollutant load from a regulated point source is a relatively straightforward task, although isolating its effect in a complex waterbody remains a technical challenge. Such technical uncertainties in relating stresses on the waterbody to impairment are compounded when nonpoint sources of pollutants and other forms of pollution are considered. Having returned the focus to ambient water quality conditions, are we better positioned today than we were years ago? Do we have more and better data and analytical methods? Do we have a better understanding of watershed events and processes responsible for water quality violations? These are the science questions facing the nation as we implement Section 303d of the Clean Water Act.

NATIONAL RESEARCH COUNCIL STUDY

Despite recent progress, the demands of the TMDL program weigh heavily on the limited resources of EPA and the states. The TMDL process requires high-quality data and sophisticated tools to analyze those data. States have reported having insufficient funds, inadequate monitoring programs, and limited staff to collect and analyze such data (GAO, 2000). According to the General Accounting Office (GAO), only six states have enough data to fully assess the condition of their waterbodies, while only 18 have enough data to place their waterbodies on the list of impaired waters (303d list). Forty states had sufficient high-quality data to determine TMDLs for waterbodies impaired primarily by point sources such as municipal sewage treatment plants, and 29 had sufficient high-quality data to implement these TMDLs. When states were asked about waterbodies impaired primarily by nonpoint sources, however, only three claimed to have sufficient data.

The GAO report outlined several critical issues for consideration by the states and EPA. Beyond questions of additional funding for data collection and staff, the states need assistance using watershed models; many reported being unclear where to go for such assistance. There appears to be no formalized process to capitalize on lessons learned, to transfer technology, and to share knowledge. Aside from the reported lack of data to comply with the TMDL regulations, when data are available, they are often not the type needed for source identification and

TMDL analyses.

Subsequent to the GAO report, Congress requested that the National Research Council (NRC) analyze on a broad scale *the scientific basis of the TMDL program*. The NRC was asked to evaluate:

- the information required to identify sources of pollutant loadings and their respective contributions to water quality impairment,
- the information required to allocate reductions in pollutant loadings among sources,
- whether such information is available for use by the states and whether such information, if available, is reliable, and
- if such information is not available or is not reliable, what methodologies should be used to obtain such information.

While the GAO report was about data, the NRC was charged to focus on *reliable information* for making decisions. In presentations made to the NRC committee, the terms "data" and "information" often were used as synonyms, but data are not the same as information. Unanalyzed data do not constitute information. Data must be interpreted for their meaning through the filter of analytical techniques, and the result of such data analysis is information that can support decision-making. Knowing what data are needed and turning those data into information constitutes, in large part, the science behind a water quality management program. The techniques for transforming data into information include statistical inference methods, simulation modeling of complex systems, and, at times, simply the application of the best professional judgment of the analyst. In all these processes there will always be some uncertainty (and thus some "unreliability") about whether the resulting information accurately characterizes the water quality problem and the effectiveness of the solutions. Because uncertainty cannot be eliminated, determining whether the information generated from data analysis is reliable is a value judgment. Individuals and groups will have different opinions about whether and how to proceed with water quality management given a certain level of uncertainty.

To organize its deliberations, the committee considered the role of science at each step of the TMDL process, from the initial defining of all waters to the implementation of actions to control pollution; the report is structured around this organization. Report recommendations are targeted (1) at those issues where science can and should make a significant contribution and (2) at barriers (regulatory and otherwise) to the use of

science in the TMDL program. Because of this broad scope, the content of the report extends beyond the confines of the charge in the bulleted items above. Chapters 2, 3, and 4 discuss the information (as defined above) required to set water quality standards, to list waters as impaired, and to develop TMDLs (including the identification of pollution sources); Chapter 5 comments on the role of science in allocating pollutant loading among sources. Because GAO (2000) already documents a widespread lack of data and information at the state level and because availability of information varies significantly from state to state, the committee did not devote substantial time to determining availability. As mentioned above, whether the information is reliable depends on the degree of uncertainty decision-makers are willing to accept when making regulatory or spending choices—a decidedly nonscientific matter. Chapters 3 and 4 describe in detail the monitoring, modeling, and statistical analysis methods needed to collect data and convert it to information, and to assess and reduce uncertainty. Chapter 5 describes an approach for making decisions in the face of uncertainty.

This report represents the culmination of three meetings over three months, including a two-day public session in which 30 presentations from a wide variety of stakeholders were made (see Appendix B). Given the information gathered during the study period and the collective experience of its members, the committee feels that the data and science have progressed sufficiently over the past 35 years to support the nation's return to ambient-based water quality management. In addition, the need for this approach is made apparent by the inability of a large percentage of the nation's water to meet water quality standards using point source controls alone. Given reasonable expectations for data availability and inevitable limits on our conceptual understanding of complex systems, statements about the science behind water quality management must be made with acknowledgment of uncertainties. Finally, the committee has concluded that there are creative ways to accommodate this uncertainty while moving forward in addressing the nation's water quality challenges. These broad conclusions are elaborated upon throughout this report.

CURRENT TMDL PROCESS AND REPORT ORGANIZATION

Section 303d requires that states identify waters that are not attaining ambient water quality standards (i.e., are impaired). (Although new rules are pending, at the request of Congress, this report focuses on the 1992

regulations that govern the current program.) States must then establish a priority ranking for such waters, taking into account the severity of the impairment and the uses to be made of such waters. For impaired waters, the states must establish TMDLs for pollutants necessary to secure applicable water quality standards. The CWA further requires that once water quality standards are attained they must be maintained.

Figure 1-1 depicts the basic steps in the TMDL process. These steps are described briefly below and are considered in greater detail throughout the report. At the beginning of the process are all waterbodies for the state and the development of water quality standards for each waterbody. Water quality standards are established outside the TMDL process and include designated uses for a waterbody and measurable water qualit

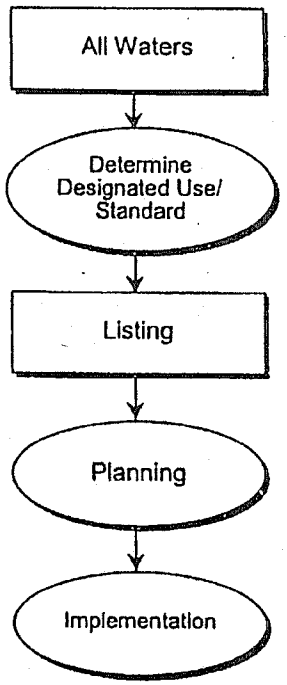

FIGURE 1-1 Conceptualized steps of the TMDL process.

criteria designed to assure that each designated use is being achieved. Because water quality standards are the foundation on which the entire TMDL program rests, more detailed discussion of standard setting is provided in Chapters 2 and 3.

The next step in the process is the listing of *impaired* waterbodies if evaluation of available data suggests that certain waterbodies are not meeting standards. According to Section 303d, all impaired waterbodies must be listed by the states or responsible agencies and submitted to EPA every two years. In addition, the states should provide priority ranking for the waterbodies on the 303d list. Following its submission, EPA must either approve or disapprove the list. Listing of a waterbody initiates a costly planning process and may lead to added costs to implement pollutant controls by point and nonpoint sources. The NRC committee heard testimony that many waterbodies have been listed based on limited or completely absent data and poorly conceived analytical techniques for data evaluation. Chapter 3 reviews the listing process and makes recommendations that will improve the reliability of the listing decision.

Once an impaired waterbody is listed, a planning step ensues. Section 303d specifies that those waters impaired by pollutants should undergo calculation of a TMDL. The term TMDL has essentially two meanings (EPA, 1991):

- The TMDL process is used for implementing state water quality standards—that is, it is a planning process that will lead to the goal of meeting the water quality standards.
- The TMDL is a numerical quantity determining the present and near future maximum load of pollutants from point and nonpoint sources as well as from background sources, to receiving waterbodies that will not violate the state water quality standards with an adequate margin of safety. The permissible load is then allocated by the state agency among point and nonpoint sources.

The calculation described above requires data collection and various forms of modeling in order to identify sources of pollution and background conditions, calculate the maximum load that will meet water quality standards with a margin of safety, and make allocations of responsibility for load reduction to point and nonpoint sources. Chapter 4 reviews modeling capability, data needs for model implementation, and the appropriate role of modeling in the TMDL planning process.

The last step in the process is implementation of the TMDL and the delisting of the waterbody. Implementation is the process of putting the

actions envisioned in the TMDL plan in place. Such actions could include limitations on point sources beyond technology-based effluent standards. Also, using best management practices for nonpoint sources, as well as addressing pollution problems, might be part of implementation, although these actions are not required by Section 303d.[1] The results of implementation actions need to be assessed before a waterbody can be removed from the list. Monitoring in this phase is necessary to measure the success (or failure) of the plan. Chapter 5 discusses postimplementation monitoring and a strategy for assuring that the best available science is used in the TMDL implementation phase. When the monitoring proves that the implementation is successful (i.e., the water quality standards are met), the waterbody can be delisted.

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[1] Whether nonpoint source controls are required as part of the TMDL program is the source of much of the debate, especially with regard to the 2000 regulations that are now on hold. Under the current (1992) regulations, 303d is a planning exercise only. Implementation must be by some other provisions of the CWA or other programs. Also, states differ in their ability to enforce use of certain best management practices.

2
Conceptual Foundations for Water Quality Management

This chapter describes the analytical and related policy challenges of implementing an ambient-focused water quality management program, of which the Total Maximum Daily Load (TMDL) program is an example[1]. The goal of an ambient water quality management program is to measure the condition of a waterbody and then determine whether that waterbody is meeting water quality standards. By definition, this process is dependent on the setting of appropriate water quality standards. Although realistic standard setting must account for watershed (hydrologic, ecological, and land use) conditions, the corresponding need to make policy decisions in setting standards must also be recognized. In addition, ambient-based water quality management requires decision-making under uncertainty because the possibility for making assessment errors is always present. Properly executed statistical procedures can identify the magnitude and direction of the possible errors so that knowledge can be incorporated into the decisions made. In addition to uncertainties inherent in measuring the attainment of water quality standards, there are uncertainties in results from models used to determine sources of pollution, to allocate pollutant loads, and to predict the effectiveness of implementation actions on attainment of a standard. As part of the information needed in the TMDL program, this uncertainty must be understood and addressed as implementation decisions are made.

AMBIENT WATER QUALITY STANDARDS

Unlike an effluent standard, an ambient water quality standard ap-

[1] Although this discussion refers to the TMDL program, it is not meant to be a description of that program.

plies to a specific spatial area—a defined waterbody—and is expected to be met over all areas of that waterbody. Thus, identifying the waterbody of interest, whether a lake, a stream segment, or areas of an estuary, is a first step in setting water quality standards. Waterbodies vary greatly in size—for example, from a small area such as a mixing zone below a point source discharge on a river to an estuary formed by a major river discharge.

Water quality standards themselves consist of two parts: a specific desired use appropriate to the waterbody, termed a *designated use*, and a *criterion* that can be measured to establish whether the designated use is being achieved. Barriers to achieving the designated use are the presence of pollutants and hydrologic and geomorphic alterations to the waterbody or watershed.

Appropriate Designated Uses

A designated use describes the goal of the water quality standard. For example, a designated use of human contact recreation should protect humans from exposure to microbial pathogens while swimming, wading, or boating. Other uses include those designed to protect humans and wildlife from consuming harmful substances in water, fish, and shellfish. Aquatic life uses are intended to promote the protection and propagation of fish, shellfish, and wildlife resources.

A designated use is stated in a written, qualitative form, but the description should be as specific as possible. Thus, more detail than "recreational support" or "aquatic life support" is needed. The general "fishable" and "swimmable" goals of the Clean Water Act constitute the beginning, rather than the end, of appropriate use designation. For example, a sufficiently detailed designated use might distinguish between beach use, primary water contact recreation, and secondary water contact recreation[2]. Similarly, rather than stating that the waterbody needs to be "fishable," the designated use would ideally describe whether the water-

[2] These uses are defined differently from state to state. In Ohio, primary contact recreation includes full body immersion activities such as swimming, canoeing, and boating. Such streams or rivers must have a depth of at least 1 meter. Secondary contact recreation includes activities such as wading, but where full body immersion is not practical because of depth limitations. The fecal bacteria criteria are less stringent for secondary contact recreation than for primary contact recreation.

body is expected to support a desired fish population (e.g., salmon, trout, or bass) and the relative invertebrate or other biological communities necessary to support that population. Although small headwater streams may have aesthetic values, they may not have the ability to support extensive recreational uses themselves (i. e., be "fishable" or "swimmable"). However, their condition may have an influence on the ability of a downstream area to achieve a particular designated use. In this case, the designated use for the smaller waterbody may be defined in terms of the achievement of the designated use of the larger downstream waterbody (as illustrated in the discussion of criteria below).

In many areas of the United States, human activities have radically altered the landscape and aquatic ecosystems, such that an appropriate designated use may not necessarily be the aquatic life condition that was present in a watershed's predisturbance condition, which may be unattainable. For example, a reproducing trout fishery in downtown Washington, D.C., may be desired, but may not be attainable because of the development history of the area or the altered hydrologic regime of the waterbody. Similarly, designating an area near the outfall of a sewage treatment plant for shellfish harvesting may be desired, but health considerations would designate it as a restricted shellfish harvest water. Furthermore, there may be a conscious decision to establish a designated use that would *not* have existed in the predisturbance condition. For example, construction of a lake for a warm water fishery is a use possible only as a result of human intervention.

Appropriate use designation for a state's waterbodies is a policy decision that can be informed by technical analysis. However, a final selection will reflect a social consensus made in consideration of the current condition of the watershed, its predisturbance condition, the advantages derived from a certain designated use, and the costs of achieving the designated use. Ideally, a statewide water quality management program should establish a detailed gradient of use designations for waterbodies. Box 2-1 describes the multiple tiers of designated uses developed for waters in Ohio.

Defining a Criterion

A water quality standard includes a criterion representing the condition of the waterbody that supports the designated use. Thus, the designated use is a description of a desired endpoint for the waterbody, and the criterion is a measurable indicator that is a surrogate for use attainment.

BOX 2-1

Appropriate Designated Uses: The Ohio Example

An approach to setting appropriately stratified or tiered designated uses for a state's waterbodies has been developed in Ohio. The state recognized early on that a stratified set of use designations for aquatic life, recreation, and water supply was needed to accurately reflect the potential quality for various waterbodies and to guide cost-effective expenditures for pollution controls and other restoration activities. In lieu of general use, more detailed designated uses were developed that reflect the potential of the aquatic ecosystem and account for the historical influence of broad-scale socioeconomic activities. Individual waterbodies are assigned the appropriate designated use based on a use attainability analysis (UAA) process that relies heavily on site-specific information about the waterbody. The information used in this process results from the systematic monitoring of waters via a rotating basin approach in which biological, chemical, and physical data are collected and analyzed. Aquatic life uses are based primarily on the biological criteria and physical habitat assessments that are calibrated with regard to the important regional and watershed-specific variables that determine the potentially sustainable aquatic assemblage. Recreational uses are designated based on the size of the waterbody, reflecting the ability of humans to use the water for swimming, boating, fishing, or wading.

The system of tiered aquatic life and recreational uses in the Ohio water quality standards was established in 1978, well before biological criteria were adopted for use (May 1990). Two newly proposed uses are now under study: one for urban streams, which would require a site-specific UAA, and one for primary headwater streams (<1 sq. mi. drainage area), which are outside of the practical resolution of the present biological criteria. A readily accessible and detailed example of such designated uses for Ohio can be found at http://www.epa.state.oh.us/dsw/rules/3745-1.html.

The criterion may be positioned at *any* point in the causal chain of squares shown in Figure 2-1. Criteria in squares 2 and 3 are possible measures of ambient water quality condition. Square 2 includes measures of a water quality parameter such as dissolved oxygen (DO), pH, nitrogen concentration, suspended sediment, or temperature. Criteria closer to the designated use (e.g., square 3) include measures such as the condition of the algal community (chlorophyll *a*), a comprehensive index

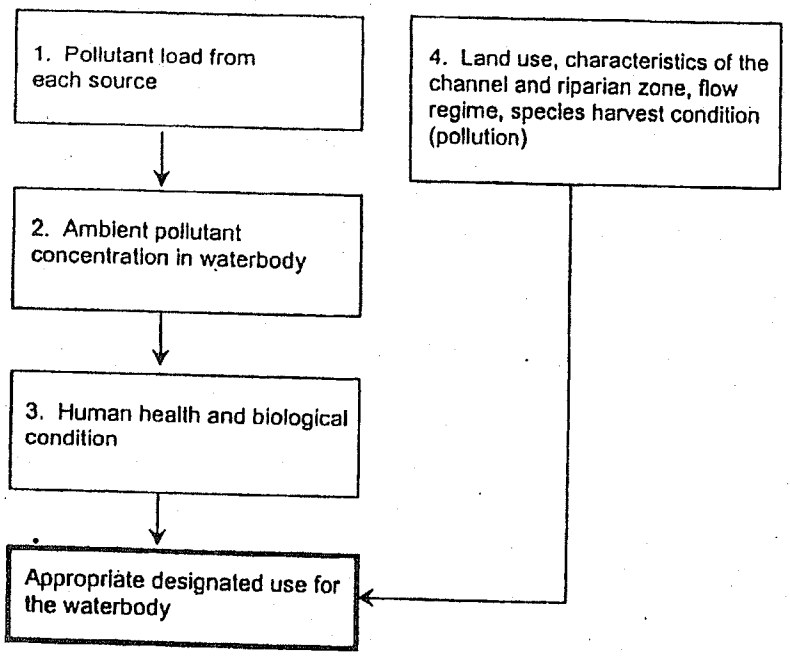

FIGURE 2-1 Types of water quality criteria and their position relative to designated uses.

measure of the biological community as a whole, or a measure of contaminant concentration in fish tissue. In square 1, where the criterion is farther from the designated use, are measures of the pollutant discharge from a treatment plant (e.g., biological oxygen demand, NH_3, pathogens, suspended sediments) or the amount of a pollutant entering the edge of a stream from runoff. A criterion at this position is referred to as an effluent standard. Finally, square 4 represents criteria that are associated with sources of pollution other than pollutants. These criteria might include measures such as flow timing and pattern (a hydrologic criterion), abundance of nonindigenous taxa, some quantification of channel modification (e.g., decrease in sinuosity), etc.

Because the designated use is stated in written and qualitative terms, the challenge is to logically relate the criterion to the designated use. Establishing this relationship is easier as the criterion moves closer to the designated use (Figure 2-1). In addition, the more precise the statement of the designated use, the more accurate the criterion will be as an indicator of that use. For example, the criterion of fecal coliform count may be used for determining if the use of water contact recreation is achieved, and the fecal count criterion may differ among waterbodies that have primary versus secondary water contact as their designated use.

Surrogate variables often are selected for use as criteria because they are easy to measure. Although the surrogate may have this appealing attribute, its usefulness can be limited if it cannot be logically related to a designated use. For example, chlorophyll *a* has been chosen as a biocriterion in some states because it is a surrogate for aesthetic conditions or the status of the larger aquatic ecosystem. In North Carolina, the ambient water quality standard of 40 μg/l for chlorophyll *a* was proposed for lakes, reservoirs, sounds, estuaries, and other slow-moving waters not designated as trout waters. However, a discussion of the appropriate designated uses for the waters of the state and how this criterion is logically related to those uses did not accompany the adoption of this criterion.

As with setting designated uses, the relationship among waterbodies and segments must be considered when determining criteria. For example, where a segment of a waterbody is designated as a mixing zone for a discharge, the criterion adopted should assure that the mixing zone use will not affect the attainment of the uses designated for the surrounding waterbody. In a similar vein, the desired condition of a small headwater stream may need to be chosen as it relates to other waterbodies in the watershed. Thus, an ambient nutrient criterion may be set in a small headwater stream to secure a designated use in a downstream estuary, even if there are no localized effects of the nutrients in the small headwater stream. Conversely, a higher fecal coliform criterion that supports only secondary contact recreation may be warranted for a waterbody with little likelihood of being a recreational resource—if the fecal load dissipates before the flow reaches an area designated for primary contact recreation.

DECISION UNCERTAINTY

Ambient-focused water quality management requires one to ask whether the designated use is being attained and, if not, the reasons for nonattainment and how the situation can be remedied. Neither of these questions, which make reference to the chosen criteria, can be answered with complete certainty. Determining use attainment requires making criterion measurements at different locations in the waterbody and at different times and comparing the measurements to the standard. Individual measurements of a single criterion constitute a sample, and statistical inference procedures use the sample data to test hypotheses about whether the actual condition in the water meets the criterion. Errors of inference are always possible in statistically valid hypothesis testing. It is possible to falsely conclude that a criterion is not being met when it is. It is also possible to conclude that a criterion is being met when in fact it is being violated. Chapter 3 includes recommendations for controlling and managing such uncertainty.

Water quality management also requires models to relate the criterion to activities that might control pollution. For example, a criterion requiring a certain DO level may be chosen to help meet the designated use of a trout fishery. Models will be required to relate a management practice, such as fertilizer control, to the DO criterion. These types of models can be broadly labeled as models that relate stressors (sources of pollutants and pollution) to responses—similar to models used in hazardous waste risk assessment and many other fields. Stressors include human activities likely to cause impairment, such as the presence of impervious surfaces in a watershed, cultivation of fields too close to the stream, over-irrigation of crops with resulting polluted return flows, the discharge of domestic and industrial effluent into waterbodies, dams and other channelization, introduction of nonindigenous taxa, and overharvesting of fishes. Indirect effects of humans include the clearing of natural vegetation in uplands that alters the rates of delivery of water and sediment to stream channels.

A careful review of direct and indirect effects of human activities suggests five major classes of environmental stressors: alterations in physical habitat, modifications in the seasonal flow of water, changes in the food base of the system, changes in interactions within the stream biota, and release of contaminants (conventional pollutants) (Karr, 1990; NRC, 1992). The presence of one of more of these in a landscape may be responsible for changes in a waterbody that result in failure to attain a designated use. Ideally, models designed to protect or restore water

quality to ensure attainment of designated uses should include all five classes of pollution. The broad-based approach implicit in these five features is more likely to solve water resource problems because it requires a more integrative diagnosis of the cause of degradation (NRC, 1992).

Models that relate stressors to responses can be of varying levels of complexity (Chapter 4). Sometimes, models are simple conceptual depictions of the relationships among important variables and indicators of those variables, such as the statement "human activities in a watershed affect water quality including the condition of the river biota." More complicated models can be used to make predictions about the assimilative capacity of a waterbody, the movement of a pollutant from various point and nonpoint sources through a watershed, or the effectiveness of certain best management practices.

There are two significant sources of uncertainty in any water quality management program: epistemic and aleatory uncertainty (Stewart, 2000). Epistemic uncertainty—incomplete knowledge or lack of sufficient data to estimate probabilities—is a by-product of our reliance on models that relate sources of pollution to human health and biological responses. We are limited by incomplete conceptual understanding of the systems under study, by models that are necessarily simplified representations of the complexity of the natural and socioeconomic systems, as well as by limited data for testing hypotheses and/or simulating the systems. Limited conceptual understanding leads to parameter uncertainty. For example, at present there is scientific uncertainty about the parameters that can represent the fate and transfer of pollutants through watersheds and waterbodies. It is plausible to argue that more complete data and more work on model development can reduce epistemic uncertainty. Thus, a goal of water quality management should be to increase the availability of data, improve its reliability, and advance our modeling capabilities. Indeed, Chapter 4 describes ways in which improved data and modeling can narrow the band of uncertainty and ways to characterize the remaining uncertainty.

However, complete certainty in support of water quality management decisions cannot be achieved because of aleatory uncertainty—the inherent variability of natural processes. Aleatory uncertainty arises in systems characterized by randomness. For example, if a pair of dice is thrown, the outcome can be predicted to be between 2 and 12, although the exact outcome cannot be predicted. The example of the dice toss represents the best-case scenario of a system characterized by random-

ness, because it is a closed system in which we have complete confidence that the result will be between 2 and 12. Not only are waterbodies, watersheds, and their inhabitants characterized by randomness, but they are also open systems in which we cannot know in advance what the boundaries of possible biological outcomes will be.

Thus, uncertainty is a reality that water quality management must recognize and strive to assess and reduce when possible. It derives from the need to use models that relate actions taken to alter the stressors so that the desired criterion and designated use of a waterbody will be secured. Although the purpose of water quality modeling will change depending on how close to the designated use the criterion is positioned, the importance of modeling and the inevitable uncertainties of model results remain.

CONCLUSIONS AND RECOMMENDATIONS

The two major themes of this chapter represent areas in water quality management where science and public policy intersect. First, with respect to the setting of water quality standards, in order for designated uses to reflect the range of scientific information and social desires for water quality, there must be substantial stratification and refinement of designated uses. Information from science can and must be part of this process; however, there are unavoidable social and economic decisions to be made about the desired state for each waterbody. Second, although science should be one cornerstone of the program, an unwarranted search for scientific certainty is detrimental to the water quality management needs of the nation. Recognition of uncertainty and creative ways to make decisions under such uncertainty should be built into water quality management policy, as discussed in the remaining chapters.

1. Assigning tiered designated uses is an essential step in setting water quality standards. Clean Water Act goals (e.g., "fishable," "swimmable") are too broad to be operational as statements of designated use. However, designated uses will still remain narrative statements.

2. Once designated uses are defined, the criterion chosen to measure use attainment should be logically linked to the designated use. The criterion can be positioned anywhere along the causal chain connecting stressors (sources of pollution) to biological response. As the designated uses are expressed with more detail and are appropriately tiered, the criterion can be more readily related to the use. However, criteria should not be adopted based solely on the ease of measurement in making this link.

3. Expectations for the contribution of "science" to water quality management need to be tempered by an understanding that uncertainty cannot be eliminated. In both the assessment and planning processes, even the best available tools cannot banish uncertainty stemming from the variability of natural systems.

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3
Waterbody Assessment: Listing and Delisting

On July 27, 2000, the Assistant Administrator for Water at the U. S. Environmental Protection Agency (EPA) testified before a U.S. House committee that over 20,000 waterbodies across the United States were not meeting water quality standards according to Section 303d lists. Because of legal, time, and resource pressures placed upon the states and EPA, there is considerable uncertainty about whether many of the waters on the 1998 303d lists are truly impaired. In many instances, waters previously presented in a state's 305b report[1] or evaluated under the 319 Program[2] were carried over to the state's 303d list without *any* supporting water quality data [e.g., see Iowa Senate File 2371, Sections 7–12 (Credible Data Legislation)]. Meanwhile, some waters that may be impaired have yet to be identified and listed.

The creation of an accurate and workable list of impaired waters is dependent on the first three steps of the Total Maximum Daily Load (TMDL) process, as depicted in Figure 1-1. States need to decide what waters should be assessed in the first place, how to create water quality standards for those waters, and then how to determine exceedance of

[1] The Clean Water Act Section 305b report—the National Water Quality Inventory Report—is the primary vehicle for informing Congress and the public about general water quality conditions in the United States. This document characterizes water quality, identifies widespread water quality problems of national significance, and describes various programs implemented to restore and protect our waters (http://www.epa.gov/305b/).

[2] Under the Clean Water Act Section 319 Nonpoint Source Management Program, States, Territories, and Indian Tribes receive grant money to support a wide variety of activities, including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects (http://www.epa.gov/owow/nps/cwact.html).

those standards. Ideally, all these activities are encompassed and coordinated under the umbrella of a holistic ambient water quality monitoring program, described in the next section. However, given resource constraints, the approaches currently used in most states to list impaired waters fall short of this ideal. In recognition of these constraints, the committee recommends changes to the TMDL program that would make the lists more accurate over the short and long terms. In addition, this chapter includes discussion on identifying waters to be assessed, defining measurable criteria for water quality standards, and interpreting monitoring results for making the listing (and delisting) decision.

ADEQUATE AMBIENT MONITORING AND ASSESSMENT

The demands of an ambient-focused water quality management program, such as the TMDL program, require changing current approaches toward monitoring and assessment and subsequent decision-making. In many states, administrative performance measures (e.g., number of TMDLs developed, number of permits issued, and timeliness of actions) have been the principal measure of program effectiveness (Box 3-1). Such administrative measures are important, but reliance on such measures diverts attention and resources away from environmental indicators of waterbody condition—the principal measures of effectiveness and success. Rather, information for decision-making should be based on carefully collected and interpreted monitoring data (Karr and Dudley, 1981; Yoder, 1997; Yoder and Rankin, 1998). The committee recognizes that state ambient monitoring programs have multiple objectives beyond the TMDL program (e.g., 305b reports, trends and loads assessmen' and other legal requirements), which are not addressed in this report. .. is suggested that to make efficient use of resources, states evaluate the extent to which their present ambient monitoring programs are coordinated and collectively satisfy their objectives.

Ambient monitoring and assessment begins with the assignment of appropriate designated uses for waterbodies and measurable water quality criteria that can be used to determine use attainment (EPA, 1995a). The criteria, which may include biological, chemical, and physical measures, define the types of data to be collected and assessed. In response to the Government Performance and Results Act, the EPA Office of Water has developed national indicators for surface waters (EPA, 1995a) and a conceptual framework for using environmental information in decision-making (EPA, 1995b). EPA's Office of Research and Development

BOX 3-1

Ohio's Experience with TMDLs

In 1998, Ohio EPA's Division of Surface Water (DSW) made recommendations for a process to develop TMDLs (Ohio EPA, 1999). The impetus for developing a comprehensive TMDL strategy was: (1) the national attention brought about by lawsuits filed by environmental organizations and (2) the potential for the TMDL process to address all relevant sources of pollution to a waterbody. Prior to realizing the importance of this issue, state water quality management efforts were focusing on point sources and National Pollution Discharge Elimination System (NPDES) permitting, although since 1996, the leading cause of waterbody impairment has been shown to be nonpoint pollution and habitat degradation (Ohio EPA 2000, Section 305b report).

An agreement was reached between Ohio EPA and U.S. EPA Region V on a 15-year schedule for TMDL development. Ohio's 1998 303d list shows 7881 of 5,000 waterbody segments as being impaired or threatened in 276 of the 826 watershed areas. Thus, completing TMDLs for all the currently listed segments by 2013 (in keeping with the 15-year schedule) will require an average of 18 watershed TMDLs per year, assuming that no new watersheds are added to future revisions of the 303d lists. It is understood that this latter assumption is unrealistic because a good portion of the state's 5,000 waterbody segments has yet to be assessed, and it is a near certainty that additional waterbodies and watersheds will be listed. Ohio recognizes that the technical and management processes required to implement TMDLs will need to go beyond the purview of the past emphasis on NPDES permits and point sources.

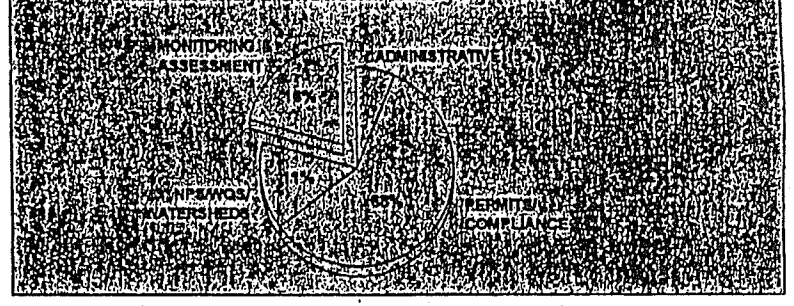
At present, Ohio estimates it has sufficient resources available to develop only half of the TMDLs needed each year to produce the quality of product needed to meet various program expectations and expectations of stakeholders. Using 1998 as a baseline, approximately 16 percent of the DSW's resources were dedicated to efforts that directly support TMDL development (see pie chart below). Without increases in funding, the resources will need to be diverted from other programs, or the pace of TMDL development will slow to the point where the 15-year schedule will need to be significantly extended. Diverting resources from other programs is highly unlikely in that each program faces unique challenges, including reduction and elimination of NPDES permit backlogs,

(continues)

BOX 3-1 Continued

and the growing need for new source permits, both of which place new burdens on the largest share of DSW resources. Devoting additional resources to TMDL development and implementation would require significant changes in water quality management emphasis on the national level, which seems unlikely given historical inertia and the emphasis placed on permitting programs by EPA and the states. Better coordination between competing programs, as well as additional resources, are needed to resolve the present TMDL resource shortfall dilemma. Focusing water quality management more on environmental results (as opposed to administrative accomplishments alone) should provide a framework to better unify the emphasis and direction of competing programs.

Ohio EPA Surface Water Program Resources Allocation by Functional Category (1998)



recently published technical guidelines for the evaluation of ecological indicators (Jackson et al., 2000). One set of measurable parameters, termed indicators in Table 3-1, is offered for illustration. The core indicators include baseline biological, chemical, and physical parameters that comprise the basic attributes of aquatic ecosystems supplemented by specific chemical, physical, and bacteriological parameters from water, sediment, and tissue media, depending on the applicable designated use(s) and watershed-specific issues. Additional indicators not listed (e.g., biochemical markers and whole toxicity testing) may be appropriate as the situation dictates.

TABLE 3-1. Core and Supplemental Indicators and Parameters that Comprise the Elements of an Adequate State Monitoring and Assessment Framework (after ITFM, 1992, and Yoder, 1997).

Core Indicators					
Fish	Macroinvertebrates	Periphyton	Physical habitat	Chemical quality	
• Use at least two assemblages			• Channel morphology • Flow regime • Substrate quality • Riparian condition	• pH • Temperature • Conductivity • DO	
For Specific Designated Uses, add the following:					
	Aquatic Life	*Recreation*	*Water Supply*	*Human/Wildlife Consumption*	
Base list	• Ionic strength • Nutrients, sediment	• Fecal bacteria • Ionic strength	• Fecal bacteria • Ionic strength • Nutrients, sediment	• Metals (in tissues) • Organics (in tissues)	
Supplemental list	• Metals • Organics • Toxics	• Other pathogens • Organics	• Metals • Organics • Other pathogens		

More than one criterion may be necessary to determine attainment of a designated use, and each criterion will have strengths and limitations. In many instances of impairment—for example when riparian and aquatic habitats have been modified or flow regimes altered—biological parameters are better than chemical parameters at reflecting the condition of the aquatic ecosystem (Box 3-2). This is because biological assemblages respond to and integrate all relevant chemical, physical, and biological factors in the environment whether of natural or anthropogenic origin. On the other hand, relying only on biological assessments would not allow precise enough determination of associated causes and sources of impairments to satisfy water quality management needs including TMDL development. Over the long term, a full complement of measured parameters must be the goal for water quality monitoring, assessing

BOX 3-2
The Information Value of Monitoring Multiple Criteria

The tendency for misdiagnosis of impairment by relying on only one type of criterion was illustrated in a study of more than 2,500 paired stream and river sampling sites in Ohio (Ohio EPA, 1990; Rankin and Yoder, 1990). In 51.5 percent of the samples the results from biomonitoring and chemical monitoring agreed—that is, they both detected either impairment or attainment of the water quality standard. This was particularly true for certain classes of chemicals (e.g., toxicants) where an exceedance, as measured by the chemical parameter, was always associated with a biocriteria impairment. However, in 41.1 percent of the samples, impairment was revealed by exceedance of the biocriteria but not by exceedance of the chemical criteria. These results suggest that impairment may go unreported in areas where only chemical measurements are made. Interestingly, in 6.7 percent of the samples, chemical assessment revealed impairment that was not detected by bioassessment (especially for parameters such as ammonia-N, dissolved oxygen (DO), and occasionally copper). This latter occurrence is likely related to the fact that biocriteria have been stratified to reflect regional or ecotype peculiarities, and the more generically derived chemical criteria have not. Both the under- and overprotective tendencies of a chemical criteria-only approach to water quality management can be ameliorated by joint use of chemical criteria and biocriteria, each used within their most appropriate indicator roles and within an adequate monitoring and assessment framework.

chemistry and biology in a complementary manner and in their most appropriate indicator role (Karr, 1991; ITFM 1992, 1993, 1995; Yoder, 1997; Yoder and Rankin, 1998).

At present, monitoring resources available to some states often do not allow for collecting and interpreting data for such a comprehensive suite of parameters. Indeed, ITFM (1995) reported that of the funding allocated by state and federal agencies to water quality management activities, only 0.2 percent was devoted to ambient monitoring. GAO (2000) has also noted the lack of adequate state budgets for the collection of meaningful data and for data interpretation. In response to these resource shortfalls, the tendency has been to use only a single indicator of ambient conditions and often just a limited number of observations. Although some parameters can be monitored at lower costs than others, all monitoring can be costly (Yoder and Rankin, 1995).

After standards development, a second requirement is adoption of a strategic and consistent approach to sampling and assessment given limited data collection resources. Currently, the states use vastly different frameworks for monitoring and assessment, the net result of which is widely divergent estimates of the extent of impaired waters and of the proportion of waters that are fully assessed. This casts a great deal of uncertainty not only about what water quality problems are the most important, but also about the accuracy and completeness of their delineation. Errors in these estimates often become evident in the poor credibility of 303d listings.

A monitoring strategy that has promise in this limited-resource environment is the rotating basin approach, commonly referred to as a five-year basin approach (ITFM, 1995). As discussed in Box 3-3 for Florida, this approach is already followed by a number of states, at least in how ambient monitoring is accomplished[3]. As part of a rotating basin approach, individual waters are assessed at differing levels of complexity each year, allowing for localized problems to be identified and solutions to be developed. For example, whether an individual assessment consists of an initial screening to identify gross impairment or a full assessment with more serious consequences will depend on how the information is to be used (for 305b reports, 303d listing, or other water quality programs). Over time, different waterbodies are intensively studied as part of the rotation. Data collected can be used to support a number of differ-

[3] In some states, the rotating basin approach is considered to be part of the ambient monitoring program, while in others, it is a separate program. This report assumes the former throughout.

BOX 3-3

The Rotating Basin Program in Florida

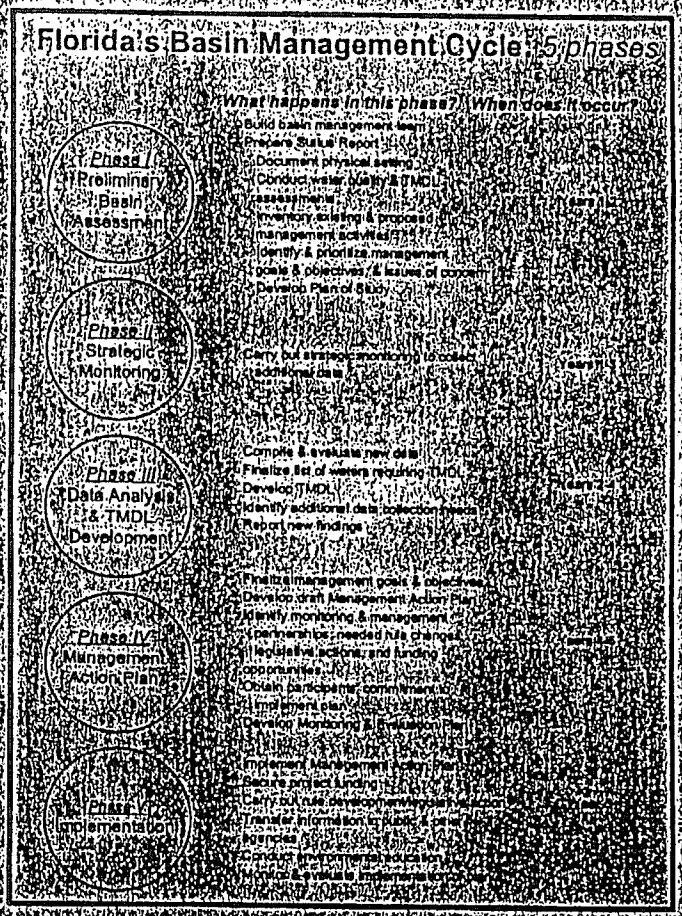
Settlement of a lawsuit brought by Earthjustice against EPA for its failure to enforce timely actions to accomplish TMDL-related activities in Florida occurred in June 1999. Under the consent decree's (CD) Terms of the Agreement, nearly 2,000 TMDLs in 711 waterbody segments are to be completed by the year 2011. Florida Department of Environmental Protection (FDEP) has been named the lead agency to produce and adopt TMDLs, but its efforts must be coordinated with numerous other state and local agencies. In addition, the state has created opportunities for public participation throughout the TMDL generation and adoption process.

To address the challenge of conducting the TMDL program and to better allocate its available resources, on July 1, 2000, Florida moved to the rotating basin approach for watershed management. Florida's rotating basin approach has five phases (see below), with each phase taking about one year to complete. Further, FDEP has divided the state into 30 areas based on 8-digit hydrologic unit codes (HUCs), such that six areas representing approximately one-fifth of Florida will be in the TMDL adoption phase in any one year, to meet the timelines ordered in the CD for Florida. FDEP must limit the time, effort, and resources it can commit in any one phase or waterbody.

Because EPA has largely focused on addressing point source discharges through the NPDES permitting program, state and local governments have in many cases taken the lead in dealing with nonpoint source issues, usually outside of the TMDL program. These programs often provide a flexible option to the time and budget constraints mentioned above. Florida believes that if local stakeholders are willing to initiate substantive programs that can fully or even partially accomplish the goals of the TMDL program at an expedited pace, then state and federal agencies should be able to support these actions rather than delay or resist them. For example, in southwest Florida, a group of concerned stakeholders combined to form a "Nitrogen Consortium" (NC) to reduce inputs of nitrogen from all sources to the waters of Tampa Bay. Working together with the Tampa Bay Estuary Program and the FDEP, the NC developed a plan designed to "hold the line" against future increases of nitrogen (Tampa Bay National Estuary Program, 1996). Specific load reduction efforts have been identified within the basin that allow for anticipated growth to occur without resulting in a net increase in nitrogen loads to Tampa Bay. As would be anticipated under the conditions of a more formal TMDL, periodic reviews are made of the underlying assumptions and models used to further refine the nitrogen loads and associated goals. Although FDEP has not formally adopted a TMDL for Tampa Bay, EPA has approved these "holding line" limits as a TMDL for Tampa Bay.

continues

BOX 3-3 Continued



ent reporting and planning requirements, including a finding of attainment of water quality standards, a determination of impairment, or possible delisting if the waterbody is found not to be impaired. Initial assessments that identify a waterbody as *potentially* impaired could be followed up by more thorough assessment. The rotating basin approach is an iterative process where the end result is both continual improvement of water quality management tools and policies and the ability to respond to emerging issues.

Conclusions and Recommendations

1. To achieve the goal of ambient-based water quality management, monitoring and reporting must mature to focus on the condition of the environment as the principal measure of success rather than on administrative measures.

2. Biological parameters should be used in conjunction with physical and chemical parameters to assess the condition of waterbodies. The use of both biological and chemical parameters is needed because they provide different and complementary types of information about the source and extent of impairment.

3. Evidence suggests that limited budgets are preventing the states from monitoring for a full suite of indicators to assess the condition of their waters and from embracing a rotating basin approach to water quality management. Currently, EPA is assessing the sufficiency of state resources to develop and implement TMDLs. Depending on the results of that assessment, Congress might consider aiding the states, for example through matching grants to improve data collection and analysis. EPA would be instructed to develop guidelines for such a program, if needed, making eligibility contingent on an approved statewide monitoring and assessment strategy.

4. To allow states to better target limited monitoring budgets, EPA should set the TMDL calendar in concert with each state's rotating basin program. The rotating basin approach used by several states is an excellent example of a rigorous approach to ambient monitoring and data collection that can be used to conduct waterbody assessments of varying levels of complexity. For example, this approach can be used to create 305b reports, to list impaired waters, and to develop

TMDLs. Once TMDLs are developed, the rotating basin approach could allow state and local governments to issue permits and implement management programs based on the TMDLs in a coordinated manner.

DEFINING ALL WATERS

As shown in Figure 1-1, the TMDL process begins with identification of all waters for which achievement of water quality standards is to be assessed. The proposed regulations for the TMDL program (EPA, 1999a) define a waterbody as "a geographically defined portion of navigable waters, waters of the contiguous zone, and ocean waters under the jurisdiction of the United States, including segments of rivers, streams, lakes, wetlands, coastal waters and ocean waters." The proposed regulations also require that states identify the geographic location of listed waterbodies using a "nationally recognized georeferencing system as agreed to by [the state] and the EPA." States identify listed waterbodies using a variety of georeferencing systems, including stream segments in the EPA's reach file system and watersheds in the U. S. Geological Survey (USGS) system of hydrologic drainage basins. The use of such systems for documenting the location of listed waters is convenient and provides a degree of national standardization to the TMDL process. However, the selection of a georeferencing system and a spatial scale for defining the totality of state waters is a more complicated issue (aside from the policy issue of national standardization).

The EPA's definition of waterbody implies that all state waters should be considered in the search for impaired waters and provides no guidance on a practical upstream limit or spatial scale to observe in that search. In theory, the hierarchy of tributaries in a watershed extends upstream indefinitely. In practice, however, the choice of a lower limit on spatial scale or stream size has a very large influence on the total number of stream miles and small lakes that are included in the definition of state waters and thus require some form of assessment. For example, RF1, the original version of the EPA's national reach file system (DeWald et al., 1985) contained approximately 65,000 stream reaches totaling approximately 1 million km of stream channels. Now considered by EPA to be inadequate for describing the nation's river and stream system, RF1 has been replaced by the National Hydrography Dataset (NHD) containing more than 3 million reaches totaling nearly 10 million km of channels. Moreover, a number of states have petitioned the EPA to add still lower-

order reaches (i.e., smaller streams) to the NHD in order to document the location of waters assessed by local interest groups. Because of local pressure and the lack of a regulatory lower limit on the size of streams and lakes to be considered, and because Geographic Information Systems (GIS) can document the existence and location of very small streams and lakes, the task of accurately and comprehensively assessing state waters has become formidable. At the current NHD scale, states contain an average of about 70,000 stream reaches (>100,000 km), and given recent trends, that average is rising.

This raises the question of how large the region of validity (the spatial area over which the data apply) is for data gathered at a single monitoring station. The question is conceptually troubling to begin with because the variability of water quality is large and continuous in both space and time. In practice, moreover, the de facto valid region for monitoring stations is extremely large. Given the spatially detailed treatment of rivers and streams in the NHD, however, most states would need to gather data from more than a thousand stations per year to maintain an average "monitoring ratio" of 100 km per station (assuming the NHD approximately describes state waters). This distance is clearly greater than the valid region for monitoring stations on most surface waters, especially because most of the channel length in state waters is contributed by relatively small streams (e.g., drainage areas less than 100 km^2) where water quality conditions may vary greatly over short distances. Thus, a substantial portion of state waters would appear to be located outside of the valid monitoring region for a state monitoring program of 1,000 stations. These waters are either left out of the decision process and are deemed not impaired by default, or they are included in the decision process with higher error rates.

One solution to this problem is to avoid the concept of a valid region for individual monitoring stations entirely and replace it with an approach in which monitoring data are used to develop statistical models of water quality in state waters. Water quality conditions at monitoring sites can be statistically related to known factors that cause impairment in watersheds (the size and location of stressors, for example), thus enabling estimates of water quality conditions at other unmonitored locations. As discussed later, this approach may also benefit the listing process.

Conclusions and Recommendations

1. Each state should develop a catalogue of waterbodies based on the National Hydrography Dataset for the purposes of defining state waters and designing sampling and assessment programs.

2. States should attempt to move away from the concept of a region of validity of individual monitoring stations and instead consider a statistical modeling approach to assessing the condition of waters. This approach would combine monitoring data with estimates of water quality based on statistical models.

DESIRABLE CRITERIA

This section considers the desired features of chemical and biological criteria as surrogates for designated use. For listing and delisting purposes, numeric and measurable criteria should be logically derived from the designated use statement. Ideally, appropriate designated uses and associated criteria are assigned to each waterbody prior to an assessment. Realistically, the cost and effort involved in categorizing every waterbody in advance of an assessment may be prohibitive, and many states' programs for setting appropriate use designation are continuing efforts. As is noted in Chapter 5, it is advisable to conduct a site-specific review to refine the standard once a waterbody is listed and before a TMDL is initiated.

One desired feature of a criterion is that it must be measurable with available monitoring methods. Unfortunately, federal guidelines for water quality assessment (EPA, 1994) do not assure this feature. In many cases there may be a discrepancy between the formulation of water quality criteria and the frequency with which water quality data are gathered.

A criterion may not be a single number, but instead may be represented as a frequency, duration, and magnitude. In the context of a pollutant, the *magnitude* refers to how much of the pollutant can be allowed in the water while still achieving the designated use. The magnitude can be chosen to protect against either acute or chronic effects of a pollutant. *Duration* refers to the period of time over which measurements of the pollutant are considered. Pollutant levels may be averaged over some number of hours or days to determine that amount of the pollutant that can be present without a loss of the designated use. The allowable *frequency* at which the criterion can be violated (called an excursion) without a loss of the designated use also must be considered. Thus, in the case of a trout fishery, the criterion might specify a minimum DO (or maximum chlorophyll *a*) that can be realized for a period of time and the number of times this number can be violated before there is demonstrable harm to the designated use. It should be noted that these numbers are pollutant-specific, and they might vary with season depending on, for example, fish life-stage.

Establishing these three dimensions of the criterion is crucial for successfully developing water quality standards[4]. Currently, there are many cases where there are insufficient data collected in one or more of these three dimensions to evaluate attainment of water quality criteria. In addition, some standards are virtually impossible to comply with, especially when the frequency of allowable excursions is zero (called "no-exceedance" standards). Box 3-4 provides three examples of criteria that are either unmeasurable given current monitoring protocols or are exceedingly difficult to meet and thus constitute an intractable problem for the TMDL program. Careful consideration of the three dimensions of the criterion is also critical to the development of appropriate TMDLs. In the law, the letter "d" in TMDL refers to a *daily* load, which has been interpreted literally in some legal cases. However, for many pollutants, the load determined over a longer time period (e.g., a season or year) is more relevant to securing the designated use. Examples of this are nutrient and sediment criteria, where the duration component of the criterion is generally not stated as "daily."

A second desirable feature is that the measured criterion must be logically derived from the qualitative statement of the designated use. The closer the criterion is in the causal chain (Figure 2-1), the easier it is make that connection. This has led to increased interest in biocriteria, particularly numeric measures of fish, benthic invertebrate, algal, and diatom assemblages. Recommendations to adopt biocriteria are often made because biocriteria integrate the effects of multiple stressors over time and space, thus minimizing the need for a large number of samples (Karr, 2000). A second advantage of using biocriteria is that, unlike chemical criteria, they are designed to be specific to certain regions and

[4] Specifying the magnitude, frequency, and duration is critical for chemical criteria, but may not be necessary for certain biological criteria. For example, the fecal coliform standard is best defined with all three components. On the other hand, many biocriteria such as IBI are well defined by a single number because they integrate biological, chemical, and physical effects over time.

BOX 3-4

Problems Associated with Standards

Unmeasurable Standards

By definition, the TMDL program requires that waterbodies meet water quality criteria daily. Interpreted by some as meaning that the sampling frequency must be daily. This requires that a complete time series of grab or composite samples be taken daily without an interruption over a period of a minimum of three years. As one might expect, such time series of water quality data are almost never available for waterbody assessment (with the exception of the continuous monitoring for a few parameters such as DO or temperature). Samples are generally taken monthly for common parameters and annually or less often for some toxic chemicals that require expensive laboratory analytical methodology. Sediment sampling is done infrequently, perhaps once in a period of several years.

Similarly, the frequency/duration components of water quality criteria for contact recreation are generally infeasible to measure. Many states use fecal coliform count as an indicator for the contact recreation. The standards are usually compared to the geometric mean of at least five samples taken over 30 days. This standard is not defined in terms of allowable excursions, thus, there is no frequency component. With the exception of waterbodies used for water supply, monitoring data are rarely collected often enough to comply with such a standard.

No-Exceedance Standard

Many states require that a numeric standard be maintained at all times, which implies that all monitored values of a parameter should be below the criterion. Such a limitation is a statistical impossibility because there is always a chance—albeit remote—that a water parameter may reach a high but statistically possible value exceeding an established standard. In addition, this requirement would seem to provide an incentive to sample as little as possible in order to reduce the chance of collecting a sample that is in exceedance. For example, it is possible that if nine samples are taken over a period of three years, none of the samples would, by chance, result in an excursion. If 100 samples are taken in the same period, a few (e.g., five or less) may exceed the standard. The former sampling scheme would indicate that the waterbody is in compliance while the other would not. Stream concentrations represent statistical time series for which only infinitesimally large values of a standard would have a 100 percent statistical probability of not ever being exceeded.

Flow Restriction Standards

To make "no-exceedance" standards easier to comply with, EPA (1992) and many states incorporated a flow restriction into the standards. Thus, the standards must be maintained at all times except at flows that are less than some specified low flow value (one example is given below). Unfortunately, except for the "harmonic mean flow" (Singh and Ramamurthy, 1991), none of the critical low flows specified by EPA allow consideration of wet weather discharges (Novotny, 1999). Thus, under wet weather flows, the "no-exceedance" criterion is in effect. This ignores the fact that measured water quality parameters are naturally variable.

One type of flow restriction standard is based on hydrologically based design flows. To protect against acute effects, such water quality criteria must be met at all times except during the lowest daily flow occurring once every 10 years (referred to as 1Q10). To protect against chronic effects, water quality criteria must be met at all times except during the lowest flow occurring once every 10 years averaged over a 7-consecutive-day period (7Q10). This approach assumes that concentrations of pollutants of concern are decreasing as flows increase—likely to be true for the case of a continuous year-round discharge from a point source but not for nonpoint sources. It should be noted that these design flows have interim status and were not recommended for general application with water quality standards. In addition, hydrologically based design flows vary from state to state.

conditions. For example, a swamp forest will typically violate DO criteria, and waterbodies in mountain areas with heavy metal-bearing rocks may violate heavy metal criteria. Biocriteria that are regionally relevant would not show those conditions as violations.

Fecal coliform counts and algal community parameters such as chlorophyll *a* are a type of biocriteria, but they are not comprehensive measures of waterbody condition. To make bioassessment more comprehensive, index systems have been developed that focus on characteristics of the biota expected in the particular region where the waterbody is located, including desired fish species and other associated organisms (Box 3-5).

The scientific community measures integrity by describing the biological condition of waterbodies that, as much as possible, have not been altered by human activity. When "pristine" or "minimally disturbed"

BOX 3-5

Index Systems for Bioassessment

During the past two decades, biological assessment—evaluating human-caused biotic changes apart from those occurring naturally—has become a part of water managers' tool kits. Two major approaches to ambient biological monitoring are used—the river invertebrate prediction and classification system (RIVPACS) and the multimetric index of biological integrity (IBI). Although their conceptual and analytical details differ, both RIVPACS and IBI (1) focus on biological endpoints to define waterbody condition, (2) use a concept of a regionally relevant reference condition as a benchmark, (3) organize sites into classes with similar environmental characteristics, (4) assess change and degradation caused by human effects, (5) require standardized sampling, laboratory, and analytical methods, (6) score sites numerically to reflect site condition, (7) define "bands" or condition classes representing waterbody condition, and (8) furnish needed information for diverse management decisions (Karr and Chu, 2000).

RIVPACS was developed in England (Wright et al., 1989, 1997) with clones available for use in Australia (Norris et al., 1995) and Maine (Davies and Tsomides, 1997). IBI was developed in the United States (Karr, 1981; Karr et al., 1986; Karr and Chu, 1999) with clones applied by state and federal agencies (Ohio EPA, 1988; Davis et al., 1996; Barbour et al., 1999) and abroad (Hughes and Oberdorff, 1999). Although applications of RIVPACS are historically limited to invertebrates in rivers, IBI applications have been developed for diverse taxonomic groups and waterbody types. For example, a multimetric index (RFAI, reservoir fish assessment index) has been developed as a component of Tennessee Valley Authority's (TVA) "vital signs" monitoring program to assess fishery management success in reservoirs (Jennings et al., 1995; McDonough and Hickman, 1999).

As a general example, consider a minimally disturbed Pacific Northwest stream supporting self-sustaining populations of salmon and associated assemblages of invertebrates. With urban development, salmon decline and cutthroat trout become relatively more abundant and certain invertebrate taxa (e.g., stoneflies) are reduced or eliminated. Tiered beneficial uses could in this case differentiate between streams supporting salmon vs. cutthroat trout using an index based on the invertebrate assemblages as the biocriterion. Recent work in these streams suggests that a benthic index of biological integrity (B-IBI) of about 35 is a minimum required to maintain a healthy salmon population (Karr, 1998). If the IBI drops below 20 because of continued development, even the cutthroat trout will eventually disappear.

sites are used to define integrity, any site that has been altered by human actions must, by definition, lack integrity because its biota have changed in response to the actions of humans. For obvious reasons, reservoirs, farm ponds, and other waterbodies "created" by human actions cannot be assessed using this standard.

However, it does *not* follow that a waterbody lacking integrity is impaired or that restoring biological integrity is either possible or desirable. A waterbody that is described as lacking "biological integrity" should not be assumed to be in a less-than-desirable state. Rather, when a bioassessment finds that a waterbody diverges from integrity, there must be a social decision about whether that divergence is acceptable. In short,

> "The biota of minimally disturbed sites—those with integrity—provides a benchmark, a standard by which others are measured. The protection of that standard, or something very close to it, is likely to be the goal—the end toward which effort is directed—in relatively few places (e.g., national parks). The modern reality is that we are not able to preserve all areas in this benchmark condition. For example, restoring salmon to every Pacific Northwest stream is not realistic, yet a restoration goal that includes viable populations of cutthroat trout may be reasonable even in many urban or suburban streams. (Karr, 2000)

Measures of biological condition (e.g., IBI) inform society of the status of a water resource. But society must decide the desired designated use and then determine what level on the index numeric scale is, with reasonable certainty, likely to protect that designated use.

Recently, the EPA Office of Water has convened a working group of states and other supporting institutions to better define the gradient o biological condition from pristine to highly degraded and link this with operational measures such as numeric biocriteria in a manner that will ensure consistency across state programs. This is referred to as tiered aquatic life uses and is expressed as a biocondition axis. Examples of this framework already exist in Maine, Ohio, and Vermont. The expectation is that as states develop a more detailed system of tiered designated uses, they will also develop measurable biocriteria logically tied to those uses.

Conclusions and Recommendations

1. **All chemical criteria and some biological criteria should be defined in terms of magnitude, frequency, and duration.** Each of these three components is pollutant-specific and may vary with season. The frequency component should be expressed in terms of a number of allowed excursions in a specified period (return period) and not in terms of the low flow or an absolute "never to be exceeded" limit. The requirement of "no exceedances" for many water quality criteria is not achievable given natural variability alone, much less with the variability associated with discharges from point and nonpoint sources.

2. **Water quality standards must be measurable by reasonably obtainable monitoring data.** In many states, there is a fundamental discrepancy between the criteria that have been chosen to determine whether a waterbody is achieving its designated use and the frequency with which water quality data are collected.

3. **Biological criteria should be used in conjunction with physical and chemical criteria to determine whether a waterbody is meeting its designated use.** Biocriteria are more closely related to designated uses, they can be defined and measured, and they integrate the effects of multiple stressors over time and space.

LISTING AND DELISTING IN A DATA-LIMITED ENVIRONMENT

As discussed at the beginning of this chapter, states are confronted with lengthy lists of impaired waters requiring TMDLs, many of which were judged against inadequate standards or were not fully assessed as part of a comprehensive ambient monitoring program. This section proposes a mechanism for managing the large number of waters requiring attention by dividing the listing process into multiple smaller steps, as shown in Figure 3-1.

Figure 3-1 illustrates a framework for water quality management that is more detailed than the conceptualized steps of the TMDL process shown in Figure 1-1. Figure 3-1 begins with the identification of all waters to be assessed and the determination of appropriate water quality standards as in the current TMDL program. Following this, however,

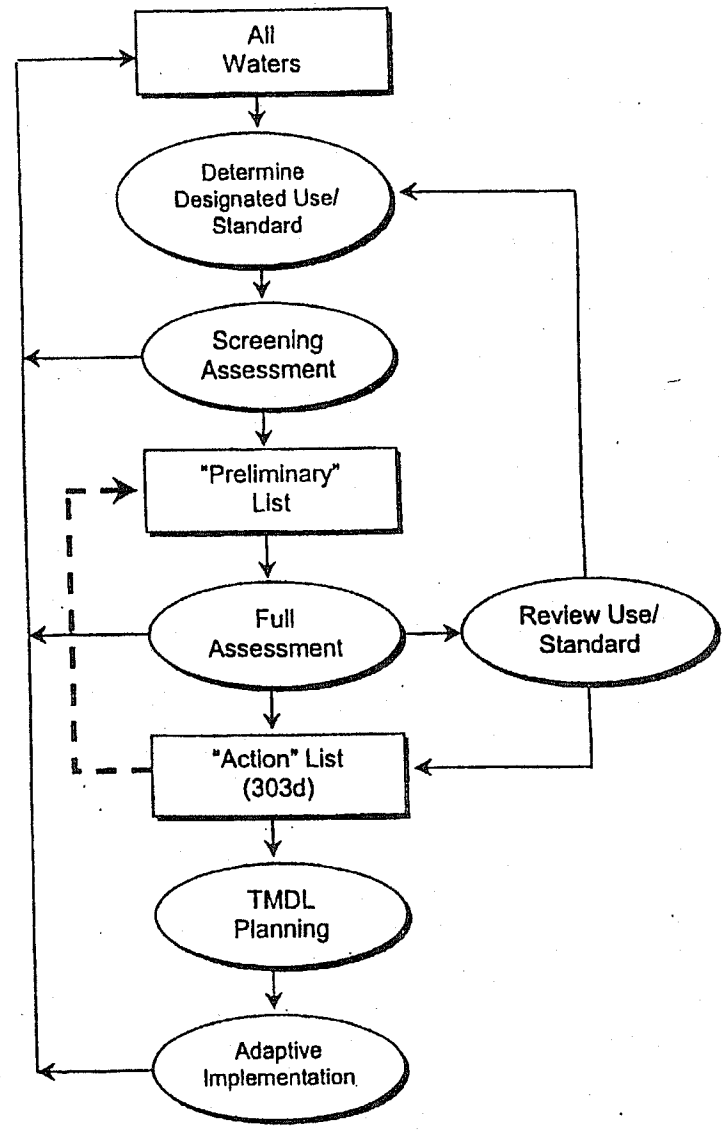


FIGURE 3-1 Framework for water quality management.

waters to be assessed would next go through an initial screening assessment. This involves comparing available, and often limited, data on water quality conditions with the existing applicable water quality criterion. If based on this initial screening assessment the waterbody is considered a candidate for impairment, it is advanced to the "preliminary" list for further consideration. It should be relatively easy to get on the preliminary list, the consequences of which include additional and immediate investigation to determine the nature and reality of a suspected problem. The term "preliminary" indicates that waterbodies on this list may later be placed on an action list, but they may also be declared unimpaired. Such a preliminary list has been suggested or employed in some states (e.g., Florida).

Those waterbodies placed on the preliminary list are the object of a more complete assessment that would involve additional monitoring and appropriate analysis of new data to reduce the uncertainty about their condition. If the decision from the full assessment is that the waterbody is impaired, then it moves to an "action list." One might think of the action list as the state's impaired waters (303d) list. The word "impaired" is a term of art. Impaired waters under Section 303d are analogous to "water quality limited segment(s)," as defined in the federal regulations (40 CFR Section 130.2(j)). The consequence of advancing to the action list is that additional resources are needed to either review and update the existing standard or complete a TMDL. (For those cases in which the existing criteria are not appropriate to a waterbody, Figure 3-1 allows for review of the water quality standard for that waterbody. The process for completing that review—use attainability analysis—is discussed in Chapter 5.)

The organizing concept in this idealized process is continuous and concurrent progress toward improved monitoring and listing decisions. The process moves forward from a position of limited information to more information; from uncertainty to more certainty; and from inaction to progressively larger and possibly more costly actions. Were EPA to endorse the idealized process represented in Figure 3-1, the listing process would be improved. For example, at the current time, there are thousands of waters on state 303d lists that were not placed there using adequate data or information. Waters in this category should be moved back to the preliminary list, represented by the dashed return arrow in Figure 3-1, to allow a more complete evaluation to be made.

Creating the Preliminary List

Determining whether there should be some minimum threshold of data available when evaluating waterbodies for attainment of water quality standards is an issue of great concern to states. On the one hand, many call for using only the "best science" in making listing decisions, while others fear many impaired waters will not be identified in the wait for additional data. The existence of a preliminary list addresses these concerns by focusing attention on waters suspected to be impaired without imposing on stakeholders and the agencies the consequences of TMDL development, until additional information is developed and evaluated.

In many cases, biological and limited water quality surveys along with an inventory of existing sources of pollution may provide adequate information for a screening assessment of the waterbody. Evaluated data are also an important source of information for determining if a waterbody should be placed on the preliminary list. Evaluated data may take many forms (e.g., data older than a certain age, beach closures based on fixed rainfall thresholds, visual observations, and statistical inferences from small data sets) and have been described differently from state to state[5]. In contrast, monitored data are viewed as being more comprehensive, typically using data less than five years old, and may include a wide array of direct measurements of water quality, including physical, chemical, or biological measures. Use of evaluated data has been controversial in water quality assessments under the Clean Water Act. The controversy would be lessened if the use of evaluated data were limited to placing waters on the preliminary list.

The quality of the data used to list waterbodies as impaired is frequently a concern. Beyond the normal data entry, sampling, and laboratory errors, states must determine the reliability of the data coming from a wide range of sources (especially for evaluated data). Some states have responded to this uncertainty by strictly limiting the data used in making assessments to those collected by the state's lead environmental agency or some other select group of data providers (such as USGS). To over-

[5] Evaluated data and/or information provides an indirect appraisal of water quality through such sources as information on historical adjacent land uses, aquatic and riparian health and habitat, location of sources, results from predictive modeling using input variables, and some surveys of fish and wildlife. Monitored data refers to direct measurements of water quality, including sediment measurements, bioassessments, and some fish tissue analyses (EPA, 1998, 2000).

this test are beyond the scope of this document, but can be found in Smith et al. (2001) and the proposed Chapter 62-303 of the Florida Administrative Code[9].

Whether the binomial or the raw score approach is used, there must be a decision on an acceptable frequency of violation for the numeric criterion, which can range from 0 percent of the time to some positive number. Under the current EPA approach, 10 percent of the sample measurements of a given pollutant made at a station may exceed the applicable criterion without having to list the surrounding waterbody. The choice of 10 percent is meant to allow for uncertainty in the decision process. Unfortunately, simply setting an upper bound on the percentage of measurements at a station that may violate a standard provides insufficient information to properly deal with the uncertainty concerning impairment.

The choice of acceptable frequency of violation is also supposed to be related to whether the designated use will be compromised, which is clearly dependent on the pollutant and on waterbody characteristics such as flow rate. A determination of 10 percent cannot be expected to apply to all water quality situations. In fact, it is inconsistent with federal water quality criteria for toxics that specify allowable violation frequencies of either one day in three years, four consecutive days in three years, or 30 consecutive days in three years (which are all less than 10 percent). Embedded in the EPA raw score approach is an implication that 10 percent is an acceptable violation rate, which it may not be in certain circumstances.

Both the raw score and binomial approaches require the analyst to "throw away" some of the information found in collected data. For example, if the criterion is 1.0, measurements of 1.1 and 10 are given equal importance, and both are treated simply as exceeding the standard. Thus, a potentially large amount of information about the likelihood of impairment is simply discarded. (The standard deviation can be used to set priorities for TMDL development or other restoration activities.) There are other approaches that are more effective at extracting information from a single monitoring sample, thereby reducing the number of samples needed to make a decision with the same level of statistical confidence. For example, Gibbons (in press) suggests testing the data for normality or log normality and then examining the confidence intervals surrounding the estimated 90th percentile of the chosen distribution. When the data are neither normal nor lognormal, or when more than 50 percent of the observations are censored (below the detection limit), Gibbons suggests constructing a nonparametric confidence limit based on the binomial distribution of ranked data. Another approach that uses all the data to make a decision is "acceptance sampling by variables" (Duncan, 1974). In general, alternative statistical approaches transform questions about the proportion of samples that exceed a standard into questions about the center (or another parameter) of a continuous distribution. It should be noted that new approaches will bring new analytica requirements that must be taken into consideration. For example, if there is a requirement to specify a distribution, sufficient data must be available. In some cases, data from other similar sites may be needed to give an overall assessment of distribution type. Finally, as more powerful statistical procedures are used, water quality assessors will need to understand how to run the tests and also how to state hypotheses that clearly relate to the water quality criterion.

[9] This proposed rule chapter was approved for adoption by the Florida Department of Environmental Protection's Environmental Regulation Commission on April 26, 2001, but has not been officially filed for adoption by the Department because of a pending rule challenge before the Division of Administrative Hearings.

Statistical Approaches for Biological Parameters

Error bands exist with any sampled data, including bioassessment results. Thus, bioassessment procedures must also be designed to be statistically sound. The utility of any measure of stream condition depends on how accurately the original sample represents the condition in the stream—that is, how successful it is in avoiding statistical "bias." Protocols to for making such measurements are established in the technical literature (Karr and Chu, 1999) as well as in guidance manuals produced by EPA (Barbour et al., 1996, 1999; EPA, 1998a; Gibson et al., 2000).

There are three principal ways variability is dealt with in the process of deriving and using biocriteria (Yoder and Rankin, 1995). First, variability is compressed through the use of multimetric evaluation mechanisms such as IBI. Reference data for each metric are compressed into discrete scoring ranges (i.e., 5, 3, and 1). Second, variability is stratified via tiered uses, ecoregions, stream size categories (headwaters, wadable, boatable), and method of calibrating each metric (i.e., vectoring expectations by stream size). Third, variability is controlled through standardized operating procedures, data quality objectives (i.e., level of taxonomy), index sampling periods (to control for seasonal effects), replication

of sampling, and training (Yoder and Rankin, 1995). One can, for example, avoid seasonal variation by carefully defining index sampling periods or variation among microhabitats by sampling the most representative microhabitat (Karr and Chu, 1999). Box 3-6 presents results of several studies in which the error around biological parameters was assessed.

BOX 3-6

Understanding Sources of Variability in Bioassessment

Sources of error evaluated in one study of biological monitoring data from New England lakes (Karr and Chu, 1999) included three types of variance: interlake variability (differences among lakes), intralake variability (variability associated with sampling different sites within a lake as decided by the field crew), and lab error (error related to subsample work in the lab). The interlake variability was the effect of interest, and the goal was to determine if that source of variability was dominant. Distribution of variance varied as a function of biological metric selected. Those measures with reduced variance except for the context of interest (e.g., interlake variability) were selected for inclusion in IBI to increase the probability of detecting and understanding the pattern of interest.

Two other studies involved an examination not of the individual metrics, but of the overall IBI (i.e., after individual metrics were tested and integrated into an IBI). For Puget Sound streams, 9 percent of variation came from differences within streams and 91 percent was variability across streams (reported in Karr and Chu, 1999, Fig.35). For a study in Grand Teton National Park, streams were grouped in classes reflecting different amounts of human activity in their watersheds. In this case, 89 percent of the variance came from differences among the groups, and 11 percent came from differences among members of the same group (reported in Karr and Chu, 1999).

In all these cases, the goal was to find ways of measuring that emphasize differences among watersheds with differing human influences while keeping other sources of variation small. Success in these examples was based on the development of an earlier understanding of sources of variation and then establishing sampling protocols that avoid other irrelevant sources of variation (such as variation stemming from the differing abilities of personnel to select and use methods). If these sources of variation are controlled for, then the study can emphasize the kind of variation that is of primary interest (e.g., human influence gradients).

Conclusions and Recommendations

1. EPA should endorse statistical approaches to proper monitoring design, data analysis, and impairment assessment. For chemical parameters, these might include the binomial hypothesis test or other statistical approaches that can more effectively make use of the data collected to determine water quality impairment than does the raw score approach. For biological parameters, these might focus on improvement of sampling designs, more careful identification of the components of biology used as indicators, and analytical procedures that explore biological data as well as integrate biological information with other relevant data.

2. States should be required to report the statistical properties of the sample data analyses used to make listing determinations. Error rates, confidence limits, or other means of conveying uncertainty should be presented along with the rationale for a decision to list or delist a waterbody.

USE OF MODELS IN THE LISTING PROCESS

As stated in EPA guidance documents as well as the Federal Advisory Committee Act (FACA) report (EPA, 1998b), monitoring data are the preferred form of information for identifying impaired waters. Model predictions might be used in addition to or instead of monitoring data for two reasons: (1) modeling could be feasible in some situations where monitoring is not, and (2) integrated monitoring and modelir systems could provide better information than monitoring alone for the same total cost. EPA guidance and the FACA report explicitly recognize the obvious practicality of the first reason, but largely ignore the potential importance of the second. This section considers some of the ways in which modeling might be used as a complement to monitoring and points out some limitations of modeling in informing the listing process.

Often, in attempting to estimate the frequency of violation of a standard, the number of pollutant concentration measurements made in a waterbody is so small that it is difficult to avoid false negative error with the desired level of confidence. One way in which a simple statistical model may assist in interpreting monitoring data in such cases is by introducing a variable to the analysis that is correlated with pollutant concentration. One common correlate of many water quality time series is

stream flow, which is measured continuously at many monitoring stations, including nearly all USGS stations. The statistical methods for taking advantage of correlated stream flow data are called record extension techniques, several of which have been described and compared by Hirsch (1982). By modeling pollutant concentration as a function of streamflow and using the resulting model to estimate a denser concentration time series, a better estimate of the frequency distribution of pollutant concentration may be obtained. The predicted concentration time series then may be tested for violation frequency using either the binomial approach (see above) or the quantile approach. The value of this modeling approach over using pollutant data alone is directly dependent on the level of correlation that exists between the pollutant concentration and stream flow. Further discussion of the specific extension technique called MOVE (Maintenance of Variance–Extension) appears in Helsel and Hirsch (1991).

The EPA guidance on 303d listing suggests that a simple, but useful, modeling approach that may be used in the absence of monitoring data is "dilution calculations," in which the rate of pollutant loading from point sources in a waterbody (recorded as kg per day in NPDES permits, for example) is divided by the stream flow distribution to give a set of estimated pollutant concentrations that may be compared to the state standard. Simple dilution calculations assume conservative movement of pollutants through a watershed and ignore the fact that for most pollutants some loss of mass occurs during transport due to a variety of processes including evaporation, settling, or biochemical transformation (see, for example, Novotny and Olem, 1994). Thus, the use of dilution calculations will tend to bias the decision process toward false positive conclusions. Lacking a clear rationale for such a bias, a better approach would be to include a best estimate of the effects of loss processes in the dilution model.

Section 303d and related guidance from EPA emphasize the importance of searching for information on waterbodies that are suspected of violating water quality standards, which is understandable given the desire to limit the number of sites sampled and hence the cost of monitoring. Targeted monitoring will often increase the efficiency of the assessment process (i.e., reduce the total number of decision errors), but may have somewhat hidden effects on the balance of false positive and false negative errors. Targeted monitoring represents the informal use of a prior *probability distribution on impairment* to guide monitoring toward sites located in a particular region of the distribution. One of the

most potentially valuable uses of modeling in relation to 303d listing would be to formalize the use of prior information on impairment probability in order to better organize the decision process. That is, modeling techniques such as SPARROW (Smith et al., 1997) could be used to estimate preliminary impairment distributions for all waterbodies in the state. These distributions would then be used to guide monitoring and control the rates of false positive and false negative error either through Bayesian or other methods of interpreting monitoring data. Limited monitoring resources generally could be focused on the sites where impairment was most *un*certain (i.e., where the estimated probability of impairment was neither very high nor very low), potentially improving the efficiency of monitoring. Sites at the extremes of the impairment distributions (i.e., extremely likely or unlikely to be impaired) would be less frequently monitored. Decisions for placing waters on a preliminary list might be made primarily on the basis of such modeling. (Formal placement of a waterbody on the 303d list would require additional monitoring.)

Conclusions and Recommendations

1. Models that can fill gaps in data have the potential to generate information that will increase the efficiency of monitoring and thus increase the accuracy of the preliminary listing process. For example, regression analyses that correlate pollutant concentration with some more easily measurable factor could be used to extend monitoring data for preliminary listing purposes. Models can also be used in a Bayesian framework to determine preliminary probability distributions of impairment that can help direct monitoring efforts and reduce the quantity of monitoring data needed for making listing decisions at a given level of reliability.

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4
Modeling to Support the TMDL Process

This chapter addresses the planning step (Figure 1-1) that occurs once a waterbody is formally listed as impaired. The main activity required during the planning step is an assessment of the relative contribution of different stressors (sources of pollution) to the impairment. For example, during this step Total Maximum Daily Loads (TMDLs) are calculated for the chemical pollutant (if there is one) causing the impairment, and the maximum pollutant loads consistent with achieving the water quality standard are estimated. Pollutant load limits alone may not secure the designated use, however, if other sources of pollution are present. Changes in the hydrologic regime (such as in the pattern and timing of flow) or changes in the biological community (such as in the control of alien taxa or riparian zone condition) may be needed to attain the designated use, as discussed in Chapter 2. As hydrologic, biological, chemical, or physical conditions change, the estimation of the TMDL can change.

Because they represent our scientific understanding of how stressors relate to appropriate designated uses, models play a central role in the TMDL program. Models are the means of making predictions—not only about the TMDL required to achieve water quality standards, but also about the effectiveness of different actions to limit pollutant sources and modify other stressors to reach attainment of a designated use. This chapter discusses the necessity for, and limitations of, models and other predictive approaches in the TMDL process. Thus, it directly addresses the committee's charge of evaluating the TMDL program's information needs and the methods used to obtain information.

MODEL SELECTION CRITERIA

Mathematical models can be characterized as empirical (also known as statistical) or mechanistic (process-oriented), but most useful models have elements of both types. An empirical model is based on a statistical fit to data as a way to statistically identify relationships between stressor and response variables. A mechanistic model is a mathematical characterization of the scientific understanding of the critical biogeochemical processes in the natural system; the only data input is in the selection of model parameters and initial and boundary conditions. Box 4-1 presents a simple explanation of the difference between the two types of models.

Water quality models for TMDL development are typically classifi as either watershed (pollutant load) models or as waterbody (pollutant response) models. A watershed model is used to predict the pollutant load to a waterbody as a function of land use and pollutant discharge; a waterbody model is used to predict pollutant concentrations and other responses in the waterbody as a function of the pollutant load. Thus, the waterbody model is necessary for determining the TMDL that meets the water quality standard, and a watershed model is necessary for allocating the TMDL among sources. Some comprehensive modeling frameworks [e.g., BASINS (EPA, 2001) and Eutromod (Reckhow et al., 1992)] include both, but most water quality models are of one or the other type. Except where noted, the comments in this chapter reflect both watershed and waterbody models; examples presented may address one or the other model type as needed to illustrate concepts.

Although prediction typically is made with a mathematical model, there are certainly situations in which expert judgment can and should be employed. Furthermore, although in many cases a complex mathema cal model can be developed, the model best suited for the situation may be relatively simple, as noted in examples described later in the chapter. Indeed, reliance on professional judgment and simpler modeling will be acceptable in many cases, and is compatible with the adaptive approach to TMDLs described in Chapter 5.

Highly detailed models are expensive to develop and apply and may be time consuming to execute. Much of the concern over costs of TMDLs appears to be based on the assumption that detailed modeling techniques will be required for most TMDLs. In the quest to efficiently allocate TMDL resources, states should recognize that simpler analyses can often support informed decision-making and that complex modeling studies should be pursued only if warranted by the complexity of the

BOX 4-1

Mechanistic vs. Statistical Models

Suppose a teacher is conducting a lesson on measurements and sets out to measure and record the height and weight of each student. Unfortunately, the scale breaks after the first several children have been weighed. In order to proceed with the lesson (though on a somewhat different tack), a *mechanistically* inclined teacher might decide to use textbook data on the density of the human body together with a variety of length measurements of each child (e.g., waist, leg, and arm dimensions) to estimate body volumes as the sum of the volumes of body parts. The teacher may then obtain the weights of the students as the product of density and volume. A *statistically* inclined teacher, on the other hand, might simply use the data obtained for the first several children in a regression model of weight on height that could then be used to predict the weights of the other students based on their height.

The accuracy and utility of each of these two approaches depend on both the details of the input data and the calculation procedures. If the mechanistic teacher has good information on tissue densities, for example, and has the time to make many length measurements, the results may be quite good. Conversely, the statistical approach may yield quite acceptable results at a fraction of the mechanistic effort, if enough children had been weighed before the scale broke and if those children were approximately representative of the whole class in terms of body build. Moreover, the regression model comes with error statistics for its predictions and parameters. Although the same statistical approach would work with other groups of students, additional weight measurements would be required for model calibration. Thus, the benefits of the statistical approach are that it is less costly and its reliability is known, but its use is dependent on data collected for the variable of interest (weight, in this case) under the circumstances of interest. The mechanistic approach has wider application and a clearer rationality (the total equals the sum of the parts), but it requires more time and effort and unless some data are collected for the variable of interest under similar circumstances, its error characteristics are unknown.

Of course, in practice, mechanistic and statistical models are often make considerable use of each other's techniques. In the classroom analogy, for example, it would make sense for the statistically inclined teacher to make more detailed measurements of the weighed students' dimensions and develop a multivariate regression model of weight as a function of torso volume, leg volume, etc., rather than height alone. The more complex model could be applied to a wider range of body builds. Moreover, the regression coefficients would represent the estimated densities of different parts of the body. These could be compared with the textbook values of body density as a test of the rationality of the model. Conversely, the mechanistic teacher might use body density data from the textbook to adjust the height–weight regression equations for use with different age and ethnic groups. This would eliminate the need for collecting additional weight data for these groups.

It is also worth distinguishing a third type of model termed *stochastic* that is widely used in engineering applications and that may have a useful role in TMDL modeling. The objective of stochastic modeling is to simulate the statistical behavior of a system by imposing random variability on one or more terms in the model. Such models are usually fundamentally mechanistic, but avoid mechanistic description of complex processes by using simpler, randomized terms. Stochastic models generally require a large number of measurements of certain variables (e.g., inputs, state variables) in order to correctly characterize their random behavior. As an example, consider a mechanistic model of river water quality that includes randomly generated streamflow and pollutant loads. If the randomly generated inputs are realistic (both individually and in relation to each other), then the output may provide a very useful description of the variability to expect in the water quality of the river.

analytical problem. More complex modeling will not necessarily assure that uncertainty is reduced, and in fact can compound problems of uncertain predictions. As discussed below, accounting for uncertainty and representing watershed processes are two of the possible criteria that need to be considered when selecting an analytical model for TMDL development.

TMDLs, which are typically evaluated through predictive modeling, lead to decisions concerning controls on pollutant sources or other stressors. Thus, models used in TMDL analysis provide "decision support."

Box 4-2 lists *desirable* model selection/evaluation criteria in consideration of the decision support role of models in the TMDL process. The list is intended to characterize an ideal model. Given the limitations of existing models, it should not be viewed as a required checklist for attributes that all present-day TMDL models must have.

EPA has supported water quality model development for many years and, along with the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers, and the U.S. Department of Agriculture, is responsi-

BOX 4-2

Model Selection Criteria

A predictive model should be broadly defined to include both mathematical expressions and expert scientific judgment. A predictive model useful for TMDL decision support ideally should have the following characteristics:

1. *The model focuses on the water quality standard.* The model is designed to quantitatively link management options to meaningful response variables. This means that it is desirable to define the TMDL endpoints (e.g., pollutant sources and standard violation parameter) and incorporate the entire chain from stressors to response into the modeling analysis. This also means that the spatial/temporal scales of the problem and the model should be compatible.

2. *The model is consistent with scientific theory.* The model does not ignore process characterization. Note that this is different from the often-stated goal that the model correctly represents processes which, for terrestrial and aquatic ecosystems, cannot be achieved.

3. *Model prediction uncertainty is reported.* Given the reality of prediction errors, it makes sense to explicitly acknowledge the prediction uncertainty for various management options. This provides decision-makers with an understanding of the risks of options, and allows them to factor this understanding into their decisions. To do this, prediction error estimates are required.

4. *The model is appropriate to the complexity of the situation.* Simple water quality problems can be addressed with simple models. Complex water quality problems may or may not require the use of complex models (as discussed later in this chapter and in Chapter 5).

5. *The model is consistent with the amount of data available.* Models requiring large amounts of monitoring data should not be used in situations where such data are unavailable.

6. *The model results are credible to stakeholders.* Given the increasing role of stakeholders in the TMDL process, it may be necessary for modelers to provide more than a cursory explanation of the predictive model.

7. *Cost for annual model support is an acceptable long-term expense.* Given growth and change, water quality management will not end with the initial TMDL determination. The cost of maintaining and updating the model must be tolerable over the long term.

8. *The model is flexible enough to allow updates and improvements.* Research can be expected to improve scientific understanding leading to refinements in models.

ble for most models currently being applied for TMDL development. Agency-wide, EPA has funded model development and technology transfer activities for a wide range of models. The greatest concentration of this effort has been at the Center for Exposure Assessment Modeling (CEAM). In contrast to the broad perspective found within EPA as a whole, CEAM has demonstrated a clear preference for mechanistic models, as evidenced by their adoption of the BASINS modeling system (EPA, 2001) as the primary TMDL modeling framework.

Models developed at the CEAM and incorporated into BASINS place high priority on correctly describing key processes, which is related to but different from model selection criterion #2 (see Box 4-2). It is important to recognize that placing priority on ultimate process description often will come at the expense of the other model selection criteria. For one thing, an emphasis on process description tends to favor complex mechanistic models over simpler mechanistic or empirical models and may result in analyses that are more costly than is necessary for effective decision-making. In addition, physical, chemical, and biological processes in terrestrial and aquatic environments are far too complex to be conceptually understood or fully represented in even the most complicated models. For the purposes of the TMDL program, the primary purpose of modeling should be to support decision-making. Our inability to completely describe all relevant processes can be accounted for by quantifying the uncertainty in the model predictions.

UNCERTAINTY ANALYSIS IN WATER QUALITY MODELS

The TMDL program currently accounts for the uncertainty embedded in the modeling exercise by applying a margin of safety (MOS). As discussed in Chapter 1, the TMDL can be represented by the following equation:

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

This states that the TMDL is the sum of the present and near future load of pollutants from point sources and nonpoint and background sources to receiving waterbodies plus an adequate margin of safety (MOS) needed to attain water quality standards.

One possible metric for the point source waste load allocation (ΣWLA) and the nonpoint source load allocation (ΣLA) is mass per unit time, where time is expressed in days. However, other units of time may

actually be more appropriate. For example, it may be better to use a season as the time unit when the TMDL is calculated for lakes and reservoirs, or a year when contaminated sediments are the main stressor.

EPA (1999) gives additional ways in which a TMDL can be expressed:

- the required reduction in percentage of the current pollution load to attain and maintain water quality standards,
- the required reduction of pollutant load to attain and maintain riparian, biological, channel, or morphological measures so that water quality standards are attained and maintained, or
- the pollutant load or reduction of pollutant load that results from modifying a characteristic of a waterbody (e.g., riparian, biological, channel, geomorphologic, or chemical characteristics) so that water quality standards are attained and maintained.

The MOS is sometimes a controversial component of the TMDL equation because it is meant to protect against potential water quality standard violations, but does so at the expense of possibly unnecessary pollution controls. Because of the natural variability in water quality parameters and the limits of predictability, a small MOS may result in nonattainment of the water quality goal; however, a large MOS may be inefficient and costly. The MOS *should* account for uncertainties in the data that were used for water quality assessment and for the variability of background (natural) water quality contributions. It should also reflect the reliability of the models used for estimating load capacity.

Under current practice, the MOS is typically an arbitrarily selected numeric safety factor. In other cases, a numeric value is not stated, and rather conservative choices are made about the models used and the effectiveness of best management practices. Consistent with our concerns, NRC (2000) notes that since parameters involved in the TMDL determination are probabilistic and the MOS is a measure of uncertainty, the MOS should be determined through a formal uncertainty and error propagation analysis. There is also a compelling practical reason for explicit and thorough quantification of uncertainty in the TMDL via the MOS—reduction of the MOS can potentially lead to a significant reduction in TMDL implementation cost. On this basis alone, EPA should place a high priority on estimating TMDL forecast uncertainty and on selecting and developing TMDL models with minimal forecast error.

Model prediction error can be assessed in two ways. First, Monte Carlo simulation can be used to estimate the effect of model parameter error, model equation error, and initial/boundary condition error on prediction error. This process is data-intensive and may be computationally unwieldy for large models. A second and simpler alternative is to compare predictions with observations, although the correct interpretation of this analysis is not as straightforward as it may seem. If a model is "overfitted" to calibration data and the test or "verification" data are not substantially different from the calibration data, the prediction–observation comparison will underestimate the prediction error. The best way to avoid this is to obtain independent verification data substantiated with statistical comparison between calibration data and verification data.

To date, we are aware of no thorough error propagation studies with the mechanistic models favored by EPA (by thorough, we mean that all errors and error covariance terms are estimated and are plausible for the application). Further, the track record associated with even limited uncertainty analyses is not encouraging for water quality models in general. Among empirical models, only the relatively simple steady-state nutrient input–output models have undergone reasonably thorough error analyses. For example, Reckhow and Chapra (1979) and Reckhow et al. (1992) report prediction error of approximately 30 percent to 40 percent for cross-system models that predict average growing season total phosphorus or total nitrogen concentration based on measured annual loading. Prediction errors are likely to be higher for applications based on estimated or predicted loading. Prediction error will be higher still when these simple models are linked to statistical models to predict chlorophyll *a*, Secchi disk transparency, or an integrative measure of biological endpoints.

Most error analyses conducted on mechanistic water quality models have also focused on eutrophication, so relatively little is known of prediction error for toxic pollutants, microorganisms, or other important stressors. In one of the few relatively thorough error propagation studies, Di Toro and van Straten (1979) and van Straten (1983) used maximum likelihood to determine point estimates and covariances for parameters in a seasonal phytoplankton model for Lake Ontario. Of particular note, they found that prediction error decreased substantially when parameter covariances were included in error propagation, underscoring the importance of including covariance terms in error analyses. This result occurred because, while individual parameters might be highly uncertain, specific *pairs* of parameters (e.g., the half saturation constant and the maximum growth rate in the Michaelis–Menten model) may vary in a

predictable way (expressed through covariance) and thus may be *collectively* less uncertain. Di Toro and van Straten found the prediction coefficient of variation to range from 8 percent (for nitrate-N) to 390 percent (for ammonia-N), with half of the values falling between 44 percent and 91 percent. Zooplankton prediction errors tended to be much higher. Beck (1987) found that the error levels cited in these studies are typical of those reported elsewhere. There is evidence to suggest that the current models of water quality, in particular, the larger models, are capable of generating predictions to which little confidence can be attached (Beck, 1987).

The need for understanding the prediction uncertainty of chosen models is not new. Indeed, recent TMDL modeling and assessment guidance from EPA often mentions the importance of formal uncertainty analysis in determining the MOS (EPA, 1999). However, EPA has consistently failed to either recommend predictive models that are amenable to thorough uncertainty analysis or provide adequate technical guidance for reliable estimation of prediction error.

Conclusions and Recommendations

1. EPA needs to provide guidance on model application so that thorough uncertainty analyses will become a standard component of TMDL studies. Prediction uncertainty should be estimated in a rigorous way, and models should be evaluated and selected considering the prediction error need. The limited error analysis conducted within the QUAL2E-UNCAS model (Brown and Barnwell, 1987) was a start, but there has been little progress at EPA in the intervening 14 years.

2. The TMDL program currently accounts for the uncertainty embedded in the modeling exercise by applying a margin of safety (MOS); EPA should end the practice of arbitrary selection of the MOS and instead require uncertainty analysis as the basis for MOS determination. Because reduction of the MOS can potentially lead to a significant reduction in TMDL implementation cost, EPA should place a high priority on selecting and developing TMDL models with minimal forecast error.

3. Given the computational difficulties with error propagation for large models, EPA should selectively target some postimplementation TMDL compliance monitoring for verification data collection to assess model prediction error. TMDL model choice is currently hampered by the fact that relatively few models have undergone thorough uncertainty analysis. Postimplementation monitoring at selected sites can yield valuable data sets to assess the ability of models to reliably forecast response. Large or complex models that pose an overwhelming computational burden for Monte Carlo simulation are particularly good candidates for this assessment.

MODELS FOR BIOTIC RESPONSE: A CRITICAL GAP

The development of models that link stressors (such as chemical pollutants, changes in land use, or hydrologic alterations) to biological responses is a significant challenge to the use of biocriteria and for the TMDL program. There are currently no protocols for identifying stressor reductions necessary to achieve certain biocriteria. A December 2000 EPA document (EPA, 2000) on relating stressors to biological condition suggests how to use professional judgment to determine these relationships, but it offers no other approaches. As discussed below, informed judgment can be effectively used in simple TMDL circumstances, but in more complex systems, empirical or mechanistic models may be required.

There have been some developments in modeling biological responses as a function of chemical water quality. One approach attempts to describe the aquatic ecosystem as a mechanistic model that includes the full sequence of processes linking biological conditions to pollutant sources; this typically results in a relatively complex model and depends heavily on scientific knowledge of the processes. The alternative is t build a simpler empirical model of a single biological criterion as a function of biological, chemical, and physical stressors. Both approaches have been pursued in research dating back at least 30 years, and there has been some progress on both fronts. One promising recent approach is to combine elements of each of these methods. For example, Box 4-3 describes a probability network model that has both mechanistic and empirical elements with meaningful biological endpoints.

Advances in mechanistic modeling of aquatic ecosystems have occurred primarily in the form of greater process (especially trophic) detail and complexity, as well as in dynamic simulation of the system (Chapra, 1996). Still, mechanistic ecosystem models have not advanced to the point of being able to predict community structure or biotic integrity. Moreover, the high level of complexity that has been achieved with this

BOX 4-3

Neuse Estuary TMDL Modeling

The Neuse Estuary is listed for chlorophyll *a* violations (exceedances of 40 μg/l), and nitrogen is the pollutant for which a TMDL is developed. Two distinct estuarine models have been developed to guide the TMDL process: one is a two-dimensional process model (CE-Qual-W2), and the other is a probability (Bayes) network model (Borsuk, 2001) depicted in Figure 1.

This probability network model has several appealing features that are compatible with the modeling framework proposed here:

- The probabilities in the model are an expression of uncertainty.
- The conditional probabilities characterizing the relationships described in Figure 1 reflect a combination of simple mechanisms, statistical (regression) fitting, and expert judgment.
- Some of the model endpoints—estimated using judgmental probability elicitation, which is a rigorous, established process for quantifying scientific knowledge (Morgan and Henrion, 1990)—such as "shellfish survival" and "number of fishkills," characterize biological responses that are more directly meaningful to stakeholders and can easily be related to designated use.

The Neuse Bayes network is a waterbody model. It is being linked to the USGS SPARROW watershed model for allocation of the TMDL.

approach has made it difficult to use statistically rigorous calibration methods and to conduct comprehensive error analyses (Di Toro and van Straten, 1983; Beck, 1987).

The empirical approach depends on a statistical equation in which the biocriterion is estimated as a function of a stressor variable. Success with this empirical approach has been primarily limited to models of relatively simple biological metrics such as chlorophyll *a* (Peters, 1991; Reckhow et al., 1992). For reasons that are not entirely clear, empirical models of higher-level biological variables, such as indices of biotic integrity, have not been widely used. Regressions of biotic condition on chemical water quality measures are potentially of great value in TMDL development because of their simplicity and transparent error characteristics. Two accuracy issues, however, need to be considered. First is the obvious question of whether the level of statistical correlation between biotic metrics and pollutant concentrations is strong enough that prediction errors will be acceptable to regulators and stakeholders. A second

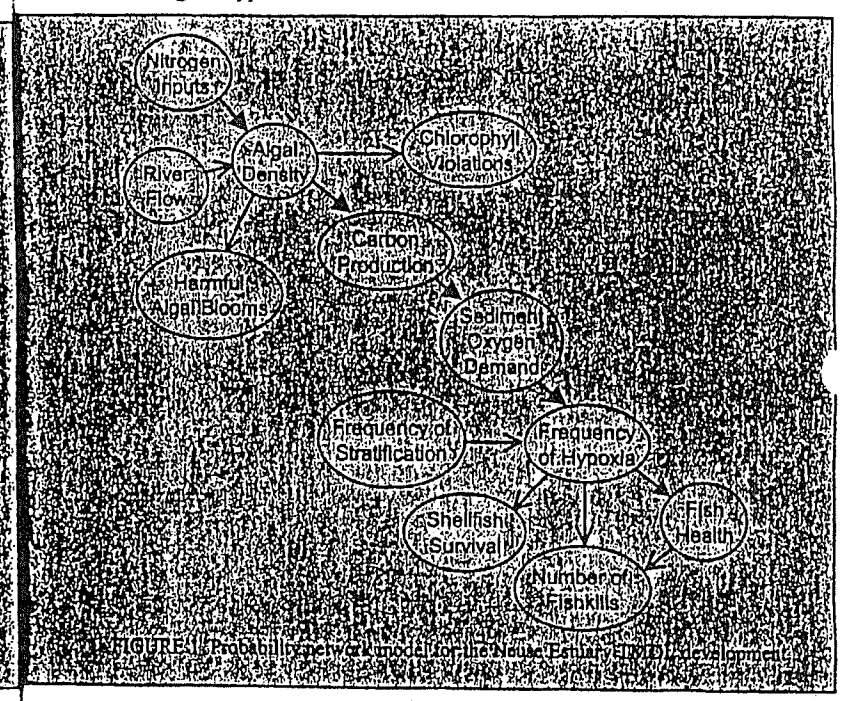

FIGURE 1 Probability network model for the Neuse Estuary TMDL development.

and more difficult issue is that of gaining assurance of a cause–effect relationship between chemical predictors and biotic metrics. The construction of empirical models of biotic condition would benefit greatly from (1) observational data that show the effects of changes in chemical concentrations over a time period when other factors have remained relatively constant and (2) inclusion of as many factors that are relevant to biotic condition as possible. The latter, of course, increases the requirement for observational data. Despite these limitations, in the near term, empirical models may more easily fill the need for biological response models than would mechanistic models.

Conclusions and Recommendations

1. EPA should promote the development of models that can more effectively link environmental stressors (and control actions) to biological responses. Both mechanistic and empirical models should be

explored, although empirical models are more likely to fill short-term needs. Such models are needed to promote the wider use of biocriteria at the state level, which is desirable because biocriteria are a better indicator of designated uses than are chemical criteria.

ADDITIONAL MODEL SELECTION ISSUES

Data Required

The use of complex mechanistic models in the TMDL program is warranted if it helps promote the understanding of complex systems, as long as uncertainties in the results are reported and incorporated into decision-making. However, there may be a tendency to use complex mechanistic models to conduct water quality assessments in situations with little useful water quality data and/or involving major remediation expenditures or legal actions. In these situations, there is usually a common belief that the expected realism in the model can compensate for a lack of data, and the complexity of the model gives the impression of credibility. However, given that uncertainty in models is likely to be exacerbated by a lack of data, the recommended strategy is to begin with a simple modeling study and iteratively expand the analysis as needs and new information dictate.

For example, a simple analysis using models like those described by EPA (Mills et al., 1985) as screening procedures could be run quickly at low cost to begin to understand the issues. This understanding might suggest (perhaps through sensitivity analysis) that data should be collected on current land use, or that a limited monitoring program is warranted. Following acquisition of that information/data, a revised (perhaps more detailed) model could be developed. This might result in the TMDL (to be further evaluated using adaptive implementation as described in Chapter 5), or it might lead to further data collection and refinement of the model. This strategy for data-poor situations makes efficient use of resources and targets the effort toward information and models that will reduce the uncertainty as the analysis proceeds.

The data required for TMDL model development will be a function of the water quality criterion and its location and the analytical procedures used to relate the stressors to the criterion. Data needs may include hydrology (streamflow, precipitation), ambient water quality measures, and land use and elevation in a watershed (see Box 4-4 for more infor-

BOX 4-4

Data Requirements for TMDL Modeling of Pollutants

The data and information required for TMDL modeling must reflect the parameters that affect attainability of water quality standards. Many of the models used today have extremely large data requirements, a fact that must be addressed prior to TMDL development so that adequate data collection can occur.

Flow Data. Critical to the process of calibrating and verifying models are flow data from sources and various locations in the receiving water. Flow data are generally high in quality if gathered as part of unidirectional stream surveys but become less reliable in areas subject to tidal effects. The USGS is generally considered to be the most reliable source for long-term, high-quality data sets. Tidal records are available historically and for predictive purposes for many coastal waters in the United States from the National Oceanic and Atmospheric Administration. Some states have maintained long-term gages in coastal waters but these are usually few in number.

Ambient Water Quality Data. A number of federal agencies, state agencies, regional organizations, and research groups collect surface water quality data. Many of these data are retrievable over the Internet, particularly data from the USGS and EPA. Although there is no universal repository for all surface water quality data, the STORET database is the most comprehensive. Because methods of collection and analysis may vary, there is a need for QA/QC of these data.

Land Use Data. All states should have access to a series of land use records and projections. For ease of use, the land use data sets should be made available as Geographic Information System (GIS) coverages. EPA has provided default coverages as a component of its BASINS model. For TMDL purposes, land use data are required for the time period over which water quality data are available in order to calibrate and validate models. Projected land use data are needed for predicting future scenarios. The overall quality of these land use data will vary, often as a function of the level of ground truthing that was done or the accuracy of the predictions for future land use changes.

Point Source Data. Model inputs may include measured values of pollutant loading from point sources (e.g., based on information reported on NPDES Discharge Monitoring Reports submitted by permitted facilities). Other possible data sources include results from periodic compliance inspections and wasteload allocation studies or data collected as part of field surveys done in support of the TMDL. Such data are generally available and reliable.

continues

BOX 4-4 Continued

Nonpoint Source Data. Data on pollutant loadings from nonpoint sources are much less available and reliable than data from point sources. This is partly because during high-flow, high-rainfall events, monitoring is only infrequently conducted. For nonpoint sources, Event Mean Concentrations (EMCs) are needed to estimate the loadings that are delivered from each significant land use in a basin. EMCs are useful tools in providing estimated nonpoint source loads. Given the wider range of actual loads that may be associated with nonpoint sources, these estimates frequently represent the best science available.

Atmospheric Deposition. Data on pollutant loadings from atmospheric deposition have been compiled by the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) using a nationwide network of precipitation-monitoring sites to generate reliable estimates of loads for many parameters. However, unlike watersheds, airsheds vary in size, depending upon the pollutant of concern and its specific forms and chemistry. Assessing the atmospheric contribution to any one basin is complicated by variations attributable to factors such as seasonal shifts in prevailing winds and distance from contributing sources. Thus, it is currently difficult to differentiate impacts from local sources vs. remote sources. For example, although significant work has been done in the northeastern United States to link sources of nitrous oxides with the areas subject to impact, similar studies elsewhere are not routinely available. Data for parameters other than those covered by NADP sites, as well as data on basin-specific wet and dry atmospheric deposition rates, are also scant.

Legacy/Upstream Sources. For many impaired waters, states will need to identify and estimate loads attributed to legacy sources (e.g., PCBs/DDT, or the phosphorus-laden lake sediments) and upstream sources (those entering a waterbody segment upstream of the watershed currently being studied). The availability and reliability of such data vary widely across the nation.

Best Management Practices. TMDL development will in many cases require estimates of the treatment efficiency for a best management practice (BMP). Such data are generally not available except for a small number of well-studied stormwater BMPs and a limited number of pollutants (see NRC, 2000). To account for these deficiencies, states might use best professional judgment to estimate the percent reduction, taking into account treatment provided by similar BMPs and stakeholder input. EPA has recently provided funding for a national database designed to help states track the effectiveness of BMPs as they are developed and evaluated. Databases of BMP effectiveness are currently available at ASCE (1999) and Winer (2000).

mation). TMDL development will also likely require data on point/ nonpoint sources and pollutant loads, atmospheric deposition, the effectiveness of current best management practices, and legacy/upstream pollutant sources. Because the amount of available data varies with site, there is no absolute minimum data requirement that can be universally set for TMDL development. Data availability is one source of uncertainty in the development of models for decision support. Although there are other sources of uncertainty as well, models should be selected (simple vs. complex) in part based on the data available to support their use.

Simple vs. Complex Models

The model selection criteria concerning cost, flexibility, adaptability, and ease of understanding (Box 4-2) all tend to favor simple models, although they may fail to adequately satisfy the first criterion. There are many situations, however, when an exceedingly simple model is all that is needed for TMDL development, particularly when combined with adaptive implementation (to be discussed in Chapter 5). For example, it is not uncommon in many states for farm fields to straddle small streams, with cows being allowed to freely graze in and around the stream. If a downstream water quality standard is violated, a simple mental model linking the cows to the violation, and subsequent actions in which the first step might be to limit cow access to the riparian corridor, may ultimately be sufficient for addressing the impairment. This example is certainly not intended to suggest that all TMDLs will be simple, but it does suggest the value of simple analyses and iterative implementation. Box 4-5 presents a relatively simple modeling exercise (based on a statistical rather than mechanistic model) that was used successfully to develop a TMDL for clean sediment.

With regard to mechanistic models, there is no intrinsic reason to choose the particular scales that have become the basis for representing processes in the majority of mechanistic water quality models. As an alternative, Borsuk et al. (2001) have shown that it is possible to specify relatively simple mechanistic descriptions of key processes in aquatic ecosystems, which limits the dimension of the parameter space so that parameters may be estimated using least squares or Bayesian methods on the available data. The SPARROW model (Smith et al., 1997) is another more statistically based alternative that includes terms and functions that reflect processes. These efforts suggest that a fruitful research direction for the TMDL program is the development of models that are based on

BOX 4-5

Use of a Simple Empirical Model: Suspended Sediment Rating Curve for Deep Creek, MT

One relatively simple form of model that has been used successfully in many TMDL applications is a statistical regression of a water quality indicator on one or more predictor variables. The indicator may be either the pollutant named in the TMDL or a related metric used to determine impairment but not directly involved in the TMDL analysis. Such a model was used to develop a TMDL for suspended sediment in Deep Creek, MT (see Endicott, 1996). The designated use of that waterbody was to support a cold water fishery and its associated biota, especially to provide high-quality spawning areas for rainbow and brown trout from a nearby reservoir. The reservoir and the river provide a blue-ribbon trout fishery. Analyzing the effects of suspended sediment on salmonids is complicated by the fact that sediment concentrations in western trout streams increase dramatically with streamflow in healthy as well as sediment-impaired streams, but are lower at any given flow in the healthy streams than in the impaired streams. Suspended sediment concentrations at all stages of the hydrograph are important biologically.

To develop a sediment TMDL at this site, modelers compared the relationship of sediment concentration to streamflow (known as the "sediment rating curve") at the impaired site to the corresponding sediment rating curve for an unimpaired reference site. Rating curves were developed by regressing sediment concentration on streamflow. In the case of Deep Creek, the sediment–flow relationship is approximately linear with a slope of 0.51 mg l^{-1} per ft^3 sec^{-1}. Based on rating curves for reference streams of similar size in the area (Endicott, 1996), an appropriate slope would be 0.26 mg l^{-1} per ft^3 sec^{-1}. Thus, the goal of TMDL implementation is to lower the Deep Creek ratio by about half. According to the approved TMDL management plan, certain channel modifications and a combination of riparian and grazing BMPs are expected to reduce the slope of the sediment rating curve and restore the health of the trout fishery. Determination of whether the control measures have reduced the rating curve slope to the target level can be accomplished in the future by a hypothesis test on the slope parameter of the revised regression of concentration on flow. The Type 1 and Type 2 error rates for this decision-making method will relate directly to the statistical confidence limits on the estimated slope parameter and are controllable through the quantity of monitoring data collected after the control measures are in place.

There are several aspects of this modeling approach that make it well suited to the TMDL problem. The analysis was simple to carry out and relatively easy for stakeholders to understand. Despite its simplicity, the model focuses on a critical aspect of the Deep Creek ecosystem—suspended sediment concentrations over the entire hydrograph. Future decision-making on the success of the management plan can be based on an objective test with known error rates that are controllable through monitoring.

process understanding yet are fitted using statistical methods on the observational data.

Pilot Watersheds

Another approach to consolidate modeling efforts and develop TMDLs more efficiently is the pilot watershed concept[1]. Many TMDLs involve small- to medium-sized watersheds that have a dominating nonpoint source pollution problem (e.g., the Corn Belt region, watersheds draining forested areas, or suburban watersheds). Watersheds located in the same ecoregion may have similar water quality problems and solutions. Thus, a detailed modeling study of one or two benchmark watersheds can provide problem identification and solutions. These findings could potentially be extrapolated to less investigated but similar watersheds.

Conclusions and Recommendations

If accompanied by uncertainty analysis, many existing models can be used to develop TMDLs in an adaptive implementation framework. Adaptive implementation, discussed in detail in Chapter 5, will allow for both model development over time and the use of currently available data and methods. It provides a level of assurance that the TMDL will ultimately be successful even with high initial forecast uncertainty.

1. EPA should not advocate detailed mechanistic models for TMDL development in data-poor situations. Either simpler, possibly judgmental, models should be used or, preferably, data needs should be anticipated so that these situations are avoided. The strategy of accounting for data-limited TMDLs with increasingly detailed models

[1] In various forms, "pilot watersheds" have for years been the basis for understanding land use impacts on water quality. The concept is implicit in the acceptance and use of export coefficients for pollutant load assessment. A prominent example is the series of PLUARG (Pollution from Land Use Activities-Reference Group) studies to determine the total loads of pollutants to the Great Lakes. The group used several pilot watersheds on each side of the border and extrapolated the detailed monitoring and modeling results into the entire Great Lakes basin.

needs rigorous verification before it should be endorsed and implemented. Starting with simple analyses and iteratively expanding data collection and modeling as the need arises is the best approach.

2. EPA needs to provide guidance for determining the level of detail required in TMDL modeling that is appropriate to the needs of the wide range of TMDLs to be performed. The focus on detailed mechanistic models has resulted in complex, costly, time-consuming modeling exercises for single TMDLs, potentially taking away resources from hundreds of other required TMDLs. Given the variety of existing watershed and water quality models available, and the range of relevant model selection criteria, EPA should expand its focus beyond mechanistic process models to include simpler models. This will support the use of adaptive implementation.

3. EPA should support research in the development of simpler mechanistic models that can be fully parameterized from the available data. This would lead to models that meet several model selection criteria present in Box 4-2, such as consistency with theory, assessing uncertainty, and consistency with available data.

4. To more efficiently use scarce resources, EPA should approve the use of pilot watersheds for TMDL modeling. Rather than detailed models being prepared for every impaired waterbody, pilot TMDLs could be prepared in detail for a benchmark watershed (e.g., a typical suburban or agricultural watershed), and the results could be extrapolated to similar watersheds located in the same ecoregion. The notion of extending modeling results to similar areas, which underlies the present-day use of export coefficients, is reasonable if applied in the framework of adaptive implementation. Such a framework, coupled with the rapid application of specific controls/approaches in a number of watersheds, can reveal where techniques do or do not work and can allow for appropriate modifications.

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5
Adaptive Implementation for Impaired Waters

Water quality assessment is a continuous process. The finding of an impaired waterbody during assessment triggers a sequence of events that may include listing of the water, development of a Total Maximum Daily Load (TMDL), planning of state and federal actions, and implementation events designed to comply with water quality standards—all of which are characterized by uncertainty. This chapter describes the process of adaptive implementation of a water quality plan. Adaptive implementation simultaneously makes progress toward achieving water quality standards while relying on monitoring and experimentation to reduce uncertainty.

SCIENCE AND THE TMDL PROCESS

The planning sequence of moving from data to analysis to information and knowledge is supposed to provide confidence that the sometimes costly actions to address a water quality problem are justified. desire for this confidence is often behind the call for "sound science" in the TMDL program. However, the ultimate way to improve the scientific foundation of the TMDL program is to incorporate the *scientific method*, not simply the results from analysis of particular data sets or models, into TMDL planning. The scientific method starts with limited data and information from which a tentatively held hypothesis about cause and effect is formed. The hypothesis is tested, and new understanding and new hypotheses can be stated and tested. By definition, science is this process of continuing inquiry. Thus, calls to make policy decisions based on the "the science," or calls to wait until "the science is complete," reflect a misunderstanding of science. Decisions to pursue some actions must be made, based on a preponderance of evidence, but there may be a need to continue to apply science as a process (data col-

lection and tools of analysis) in order to minimize the likelihood of future errors.

Many debates in the TMDL community have centered on the use of "phased" and "iterative" TMDLs. Because these terms have particular meanings, this report uses a more general term—adaptive implementation. Adaptive implementation is, in fact, the application of the scientific method to decision-making. It is a process of taking actions of limited scope commensurate with available data and information to continuously improve our understanding of a problem and its solutions, while at the same time making progress toward attaining a water quality standard. Plans for future regulatory rules and public spending should be tentative commitments subject to revision as we learn how the system responds to actions taken early on.

Like other chapters, this chapter discusses a framework for water quality management (shown in Figure 5-1, which is the same as Figure 3-1). Before turning to adaptive implementation, it discusses an important prior step—review of water quality standards. Before a waterbody is placed on the action (303d) list, it is suggested that states conduct a review of the appropriateness of the water quality standard. The standards review may result in the water not being listed as impaired if the standard used for the assessment was found to be inappropriate. On the other hand, the same process may result in a "stricter" standard than was used in the assessment process, in which case the waterbody would have a TMDL plan developed to achieve that revised standard. A review of the water quality standard will assure that extensive planning and implementation actions are directed toward clearly conceived designated uses and associated criteria to measure use attainment.

REVIEW OF WATER QUALITY STANDARDS

Water quality standards are the benchmark for establishing whether a waterbody is impaired; if the standards are flawed (as many are), all subsequent steps in the TMDL process will be affected. Although there is a need to make designated use and criteria decisions on a waterbody and watershed-specific basis, most states have adopted highly general use designations commensurate with the federal statutory definitions. However, an appropriate water quality standard must be defined *before* a TMDL is developed. Within the framework of the Clean Water Act (CWA), there is an opportunity for such analysis, termed use attainability analysis (UAA).

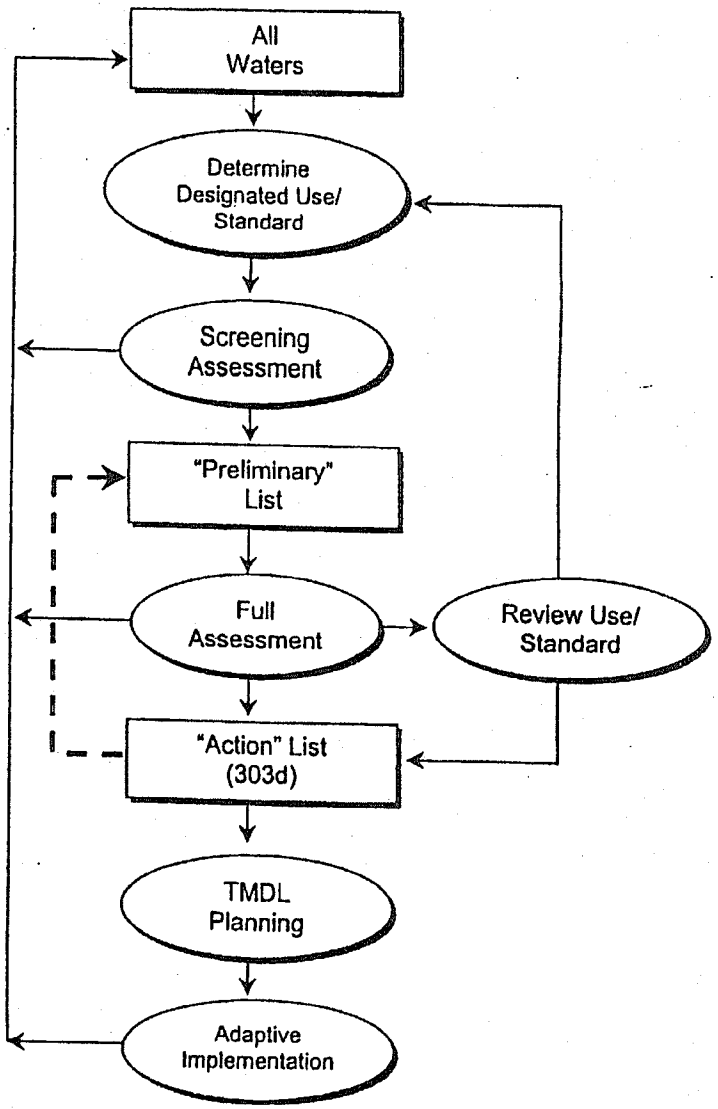

FIGURE 5-1 Framework for water quality management.

A UAA determines if impairment is caused by natural contaminants, nonremovable physical conditions, legacy pollutants, or natural conditions (see Box 5-1). More importantly, a UAA can refine the water quality standard. UAA should result in more stratified and detailed narrative statements of the desired use and measurable criterion. For example, a UAA might refine the designated use and criterion from a statement that the water needs to be fishable to a statement calling for a reproducing trout population. Then one or more criteria for measuring attainment of this designated use are described; these might include minimum dissolved oxygen or maximum suspended sediment requirements. Alternatively, an index to measure biological condition appropriate to the trout fishery designated use, such as an index of biological integrity (IBI), may be defined.

In the 1990s, TMDLs were undertaken for some waterbodies where the designated use was not attainable for reasons that could have been disposed of by a UAA. For example, TMDLs conducted in Louisiana resulted in the conclusion that even implementing zero discharge of a pollutant would not bring attainment of water quality standards (Houck, 1999). A properly conducted UAA would have revealed the true problem—naturally low dissolved oxygen concentrations—before the time and money were spent to develop the TMDL. Unfortunately, UAA has not been widely employed. Novotny et al. (1997) found that 19 states reported no experience with UAA. The majority of states reported a few to less than 100 UAAs, while five states (Indiana, Nebraska, New York, Oklahoma, and Pennsylvania) performed more than 100.

One possible explanation for the failure to widely employ UAA analysis is the absence of useful EPA guidelines. The last technical support manuals were issued in the early 1980s (EPA, 1983) and are limited to physical, chemical and biological analyses. It is presently not clear what technical information constitutes an adequate UAA for making a change to the use designation for a waterbody that will be approved by the EPA.

In addition to being a technical challenge, standards review also has important socioeconomic consequences (see point 6 in Box 5-1). EPA has provided little information on how to conduct socioeconomic analyses or how to incorporate such analyses in the UAA decision. The socioeconomic analysis suggested by EPA is limited to narrowly conceived financial affordability and economy-wide economic impact assessments (e.g., employment effects) (Novotny et al., 1997). However, when setting water quality standards, states may be asked to make decisions in consideration of a broader socioeconomic benefit–cost framework than

BOX 5-1

Six Reasons for Changing the Water Quality Standard

The following six situations, which can be revealed by UAA, constitute reasons for changing a designated use or a water quality standard (EPA, 1994). Conducting a UAA does not necessarily preclude the development of a TMDL.

1. Naturally occurring pollutant concentrations prevent attainment of the use.
2. Natural, ephemeral, intermittent or low flow water levels prevent the attainment of the use unless these conditions may be compensated for by a sufficient volume of effluent discharge without violating state conservation requirements to enable uses to be met.
3. Human-caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place (e.g., as with some legacy pollutants).
4. Dams, diversions, or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use.
5. Physical conditions related to the natural features of the waterbody, such as the lack of proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses.
6. Controls more stringent than those required by the CWA mandatory controls (Sections 301b and 306) would result in substantial and widespread adverse social and economic impact. This requires developing a TMDL and conducting a socioeconomic impact analysis of the resulting TMDL (Novotny et al., 1997).

what is currently expected in a UAA. Finally, EPA has offered no guidance on what constitutes an acceptable UAA in waterbodies of different complexity and on what decision criteria will be accepted as a basis for changing a use designation. This is significant because EPA retains the authority to approve state water quality standards. These uncertainties discourage state use of UAA because there is no assurance that EPA will accept the result of the UAA effort as an alternative to a TMDL, especially if the EPA expectation for a UAA will result in significant analytical costs.

Conclusions and Recommendations

1. **EPA should issue new guidance on UAA.** This should incorporate the following: (1) levels of detail required for UAAs for waterbodies of different size and complexity, (2) broadened socioeconomic evaluation and decision analysis guidelines for states to use during UAA, and (3) the relative responsibilities and authorities of the states and EPA in making use designations for specific waterbodies following a UAA analysis.

2. **UAA should be considered for all waterbodies before a TMDL plan is developed.** The UAA will assure that before extensive planning and implementation actions are taken, there is clarity about the uses to be secured and the associated criteria to measure use attainment. UAA is especially warranted if the water quality standards used for the assessment were not well stratified. However, the decision to do a UAA for any waterbody should rest with each state.

ADAPTIVE IMPLEMENTATION DESCRIBED

Once a waterbody is on the 303d list, a plan to secure the designated use is developed and a sequence of actions is implemented. The adaptive implementation process begins with initial actions that have a high degree of certainty associated with their water quality outcome. Future actions must be based on (1) continued monitoring of the waterbody to determine how it responds to the actions taken and (2) carefully designed experiments in the watershed. This concurrent process of action and learning is depicted in Figure 5-2.

The plan includes the following related elements: immediate actions, an array of possible long-term actions, success monitoring, and experimentation for model refinement. In choosing *immediate actions*, watershed stakeholders and the state should expect such actions to be undertaken within a fixed time period specified in the plan. If the impairment problem is attributable to a single cause or if the impairment is not severe, then the immediate actions might be proposed as the final solution to the nonattainment problem. However, in more challenging situations, the immediate actions alone should not be expected to completely eliminate the impairment.

Regardless of what immediate actions are taken, there may not be an immediate response in waterbody or biological condition. For example,

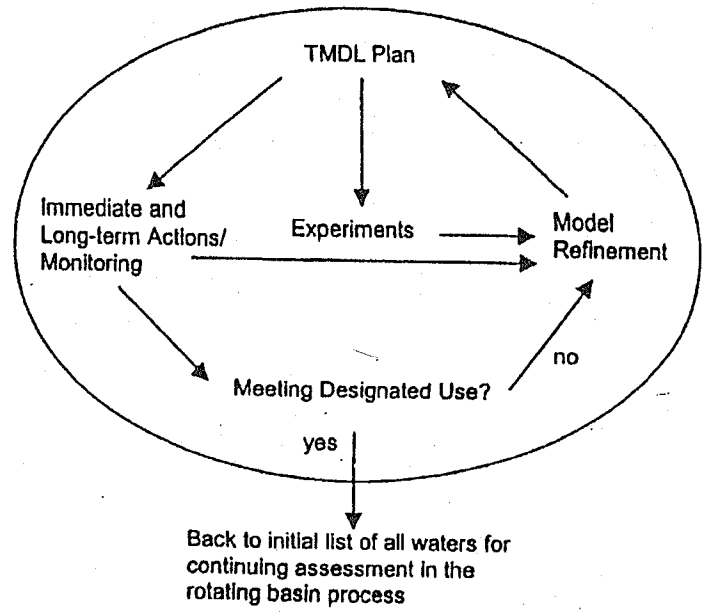

FIGURE 5-2 Adaptive implementation flowchart.

there may be significant time lags between when actions are taken to reduce nutrient loads and resulting changes in nutrient concentration. This is especially likely if nutrients from past activities are tightly boun. to sediments or if nutrient-contaminated groundwater has a long residence time before its release to surface water. For many reasons, lags between actions taken and responses must be expected. As discussed below, the waterbody should be monitored intensively to establish whether the "trajectory" of the measured water quality criterion points toward attainment of the designated use.

Longer-term actions are those that show promise, but need further evaluation and development. They should be formulated in recognition of emerging and innovative strategies for waterbody restoration. The commitment in the plan is to further evaluate such actions based on the collection of additional data, data analysis, and modeling. An adaptive implementation plan would specify analyses of specific long-term alter-

natives, a schedule for such analyses to be conducted, and a mechanism for supporting such analyses.

Success monitoring follows after implementation actions. If success monitoring shows that the waterbody is meeting water quality standards including designated uses, then no further implementation actions would be taken. Waterbodies should be returned to the "all waters" list (see Figure 5-1) where they will be monitored as a part of the rotating basin process. A primary purpose of success monitoring is to establish compliance with water quality standards and ultimately make the delisting decision. Because state ambient monitoring programs typically have limited resources, it may be necessary to design and implement success monitoring for the TMDL program outside the rotating basin process. Those stakeholders affected by 303d listing and TMDL development may have an incentive to make a significant contribution to the monitoring effort to assure that the water is truly impaired and that the best possible models are being used for plan development. Stakeholder monitoring would be conducted with input on its design by the state.

One of the most important applications of success monitoring data is to revise and improve the initial TMDL forecast over time. This revision of the TMDL model can be formally accomplished using techniques such as Bayesian analysis, data assimilation, or Kalman filtering. For example, a TMDL for total phosphorus, based on a model forecast that included uncertainty analysis, might be implemented to address a chlorophyll *a* standard violation. As part of the implementation program, monitoring would be undertaken to assess success and compliance. At the end of the five-year rotating basin cycle, the original chlorophyll *a* forecast could be combined with the monitoring-based chlorophyll *a* time trajectory to yield a revised forecast of ultimate chlorophyll *a* response. This revised forecast could provide the basis for changes to be implemented during the next five-year cycle in order to meet the water quality standard.

Techniques to accomplish model refinement have existed for some time in a Bayesian context (Reckhow, 1985), and under various labels and modifications, they are being applied in other areas. For example, "data assimilation" (Robinson and Lermusiaux, 2000), a derivative of Bayesian inference, is being widely used in the earth sciences to augment uncertain model forecasts with observations. The Bayesian approach holds particular appeal for adaptive TMDLs because it involves "knowledge updating" that is based on pooling precision-weighted information.

The need for *experimentation* to be part of the plan depends on the complexity of the problem and the need to learn more about the system

for subsequent model refinement and decision-making. Experiments can, for example, be developed to test the site-specific effectiveness and response time of best management practices (BMPs) (like riparian buffers), to determine the fate and transport of pollutants in runoff, or to answer other questions critical to model refinement. Experiments must be carefully designed and adequately supported (with both funding and staff) to study the effectiveness of actions in the watershed context and to study and learn about watershed processes that are not well understood. TMDL plans for waterbodies with relatively simple problems that can be addressed with high certainty about cause and effect might not include experimentation.

All the actions described above can be used to refine the origin. TMDL plan so that it better reflects the current state of knowledge about the system and innovative modeling approaches. When revising the TMDL plan, water managers should consider whether the longer-term actions discussed above, or other new alternatives, should be implemented in addition to the immediate actions called for in the original plan. TMDL plans for complicated systems (e.g., a reservoir impacted by multiple nonpoint sources of pollution) can be expected to undergo more revisions before water quality standards (including designated uses) are met than will TMDL plans developed for simple systems.

TMDL IMPLEMENTATION CHALLENGES

Allocation Issues

Plan implementation involves actions taken to reduce all the stressors responsible for the impairment. The allocation of financial and legal responsibility for taking those actions will fall on stakeholders in the watershed, who may not receive public subsidies for taking such actions. Because of these cost consequences, stakeholders want to be sure that water quality standards are appropriate and that total load limits and the limits proposed on other stressors (e.g., flow modifications) are necessary to secure the designated use.

The committee's charge included a request to evaluate the reliability of "the information required to allocate reductions in pollutant loadings among sources." Allocation is *first and foremost a policy decision* on how to distribute costs among different stakeholders in order to achieve a water quality goal. Consider a hypothetical example where three differ-

ent actions are possible: reduction of pollutant loads from a treatment plant, reductions in pollutant load in runoff from urban areas and farm fields, and increases in stream flow from reduced consumptive irrigation water use. Also suppose that different combinations of all of these actions can achieve the designated use. Allocation becomes a difficult decision because the different combinations will have a different total cost and different levels of perceived fairness. One suggestion might be to choose the combination of actions that minimizes total cost. However, this may result in a cost distribution that places most of the burden on the customers of the treatment plant (for example). An alternative may be to reduce loads from the plants and from runoff by the same proportion; however, this leaves unanswered whether any cost responsibility should fall on the irrigators. Other combinations of actions would have other cost distribution effects.

Although the allocation process is primarily a policy decision, there is one important role that science can play—determining when actions are "equivalent." Water quality management actions are defined to be "equivalent" when their implementation achieves the designated use, taking uncertainty into consideration. Note that there are two aspects of this definition of equivalency. First, equivalency is established with respect to ambient outcomes for the watershed and not in terms of pollutant loading comparisons, which is the way the allocations are described in the standard TMDL equation. Second, the definition recognizes that equivalency must account for the relative uncertainty of different actions with respect to meeting the applicable water quality standard.

One common scenario might be the need to establish equivalency between nitrogen load reductions from a proposed agricultural BMP vs. a proposed wastewater treatment plant improvement. Estimates of the effectiveness of the BMP and wastewater treatment technology can be made in a controlled setting, perhaps with field studies of the BMP and with experiments at the treatment plant. To achieve equivalency, these load reductions must have the same effect on meeting the water quality standard, which would normally be determined using a modeling approach as described in Chapter 4. It is quite possible that the nitrogen load reductions at the sources (the agricultural BMP and the wastewater treatment plant) are different, but they are equivalent in that they are predicted to have an identical effect on the standard. Further, as noted above, equivalency is a function of both the forecasted mean and forecast uncertainty. Thus, if the BMP and wastewater treatment improvement are both forecast to have the same mean effect on the water quality standard, but the wastewater treatment improvement response has less uncertainty, then the actions are not equivalent.

Determining equivalency across sources requires predicting or measuring the results of control actions, rather than simply noting the presence or absence of a particular control technology (the results of which may vary depending on how it is operated and on many other factors). Careful thought must be given to determining meaningful results, especially in those watersheds where actions like flow augmentation or planting of oysters in an estuary are being used as substitutes for, or necessary complements to, load reduction to meet the designated use.

Finally, because it should be focused on water quality outcomes, allocation is dependent on modeling the effects of different actions on waterbody response. Thus, the issues of model selection and uncertainty that were described in Chapter 4 for TMDL development also apply to TMDL allocation. If there is uncertainty about the effect of certain control actions, those who bear the costs may resist taking such actions without further evidence of their worth. Adaptive implementation would support a cautious approach of taking low-cost actions with a high degree of certainty about the outcome, while taking parallel longer-term actions to improve model capabilities and revise control strategies.

Progressing Toward Adaptive Implementation

The TMDL program is limited by an incomplete conceptual understanding of waterbodies and watersheds, by models that are necessarily abstractions from the reality of natural systems, and by limited data for testing hypotheses and/or simulating systems. As result, it is possible for a waterbody to be identified as impaired when it is not; in such cases, the costs to plan and implement control actions are wasted. On the other hand, it is also possible that an impaired waterbody will not be identified, resulting in other adverse consequences. Many of the stakeholders who addressed the committee expressed concern about the ramifications of uncertainty in the TMDL process. Some cautioned against listing errors, noting that the listing decision can trigger a linear and inflexible process of potentially expensive controls on land use and pollutant discharges that may ultimately prove unwarranted. Others who are concerned that impaired waterbodies will go unidentified advocated more aggressive and comprehensive actions to address problems quickly. These differences in viewpoint can be traced to the policy context that

now governs the TMDL program. The committee views adaptive implementation as accommodating this spectrum of opinions.

If adaptive implementation is to be adopted, three policy issues that stand in the way of acceptance of the approach must be addressed. These issues are described without specific recommendations on their solution, except to note that their resolution is needed in order for the TMDL program to fully embrace the scientific method. Criticism of the TMDL program is too often, and sometimes inappropriately, directed at the quality of the data and information, rather than at these underlying policy issues.

1. The listing of a waterbody and the initiation of the TMDL process appear to call for a constraint on total pollutant loading associated with population growth and land use shifts until the designated use is obtained. Given the often weak water quality standards that underlie a listing, the long lag times between actions taken and measured responses, and the uncertainty in our ability to predict what actions will secure a designated use, it is unrealistic to expect that there will be no changes in economic activity and in land uses in a watershed until the designated use has been achieved. A basis for accommodating growth and change in watersheds needs to be established as adaptive implementation proceeds.

2. Many waterbody stressors currently lie outside the CWA regulatory framework, where the only federal enforcement tool available is point source discharge limits. Recognition of this fact was a motivation for EPA's endorsement of the watershed approach in 1991 (EPA, 1993). Nonetheless, in some cases point source permitting is used to impose conditions on point sources that essentially require them to finance control practices for unregulated nonpoint sources (NAPA, 2000). Perceptions of the inequity and the ineffectiveness of such a requirement may be manifested as technical critiques of the TMDL analysis itself. Distributing the cost and regulatory burdens for designated use attainment in a way that is deemed equitable by all stakeholders is critical to future TMDL program success.

3. Watersheds can range in size from a few acres to an area that covers several states, and their diversity can be as far reaching as the diverse climate, soils, topography, and physiography of the entire United States. Consequently, the approaches and solutions to water quality problems must be responsive to the unique characteristics of the surrounding watershed. EPA can set broad guidelines for each state's water quality program and can provide technical assistance in helping

states meet the guidelines. There may be a leadership role for EPA on waterbodies that cross state boundaries, like the Chesapeake Bay. However, EPA cannot write and review all the designated uses that will apply to each of the nation's waterbodies, it cannot conduct all the monitoring and make all the listing decisions, and it cannot conduct the model analyses for all waterbodies. The scientific foundation for adaptive implementation must rely on state initiative and leadership. Today, EPA retains an extensive oversight role for the TMDL program. This raises the possibility that in an effort to ease the administrative burdens of reviewing and approving every TMDL, EPA will establish requirements for uniformity. This may result in standard setting listing/delisting, and modeling approaches that are nationally consiste but are scientifically inappropriate for the planning and decision-making needs of the diversity of waterbodies. In the National Pollution Discharge Elimination System (NPDES) permitting program, EPA has helped states assume responsibility for point source permitting such that EPA does not review every permit that is issued. Using similar logic, EPA need not review every TMDL. The concern that the states cannot be relied upon to take action (Houck, 1999) needs to be tempered by the reality that continued extensive EPA oversight may not be feasible, it may place a premium on developing plans instead of taking actions, and it may inhibit the nation's progress toward improved water quality. The adaptive implementation approach may require increased state assumption of responsibility for individual TMDLs, with EPA oversight focused at the program level instead of on each individual water segment.

Conclusions and Recommendations

The call for adaptive implementation may not satisfy those who seek more definitive direction from the scientific community. Stakeholders and responsible agencies seek assurance that the actions they take will prove correct; they desire predictions of the costs and consequences of those actions in as precise terms as possible. However, waterbodies exist inside watersheds that are subject to constant change. For this reason and others, even the best predictive capabilities of science cannot assure that an action leading to attainment of designated uses will be initially identified. Adaptive implementation will allow the TMDL program to move forward in the face of these uncertainties.

1. EPA should act (via an administrative rule) to incorporate the elements of adaptive implementation into TMDL guidelines and regulations. To increase the scientific foundation of the TMDL program, the scientific method, which is embodied by the adaptive implementation approach, must be applied to water quality planning.

2. If Congress and EPA want to improve the scientific basis of the TMDL program, then the policy barriers that currently inhibit adoption of an adaptive implementation approach to the TMDL program should be addressed. This includes the issues of future growth, the equitable distribution of cost and responsibility among sources of pollution, and EPA oversight.

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Appendix A
Guest Presentations at the First Meeting of the NRC Committee[1]
January 24–26, 2001

Introduction to the TMDL Program: Current Status and Future Plans
Don Brady, EPA Office of Water

Congressional Request for the Study—Senate
John Pemberton and Peter Washburn, Senate Committee on Environment and Public Works

Congressional Request for the Study—House
Susan Bodine, House Subcommittee on Water Resources and Environment

March 2000 GAO Report on Status of Water Quality Data
Patricia McClure, General Accounting Office

Environmental Perspective on the TMDL Program and this Study
Nina Bell, Northwest Environmental Advocates

State Perspectives on the TMDL Program and this Study
Robbi Savage, Association of State and Interstate Water Pollution Control Administrators
Shawn McGrath, Western Governors' Association

EPA's Pressing Science Issues for the TMDL Program
Lee Mulkey and Tom Barnwell, EPA Office of Research and Development

TMDL Case Studies
Bruce Zander, EPA Region VIII
Gail Mitchell, Bob Ambrose, and Tim Wool, EPA Region IV

[1] The NRC committee does not necessarily agree with all the comments or testimony given but all were taken into account.

Water Environment Research Foundation Support of TMDL Research

Dean Carpenter, Water Environment Research Foundation
Paul Freedman, Limno-Tech, Inc.
Kent Thornton, FTN & Associates

Stakeholder Presentations

Fred Andes, Federal Water Quality Coalition
Doug Barton, National Council of the Paper Industry for Air and Stream Improvement
Richard Bozek, Edison Electric Institute
Faith Burns, National Cattleman's Association
John Cowan, National Milk Producers Federation
Cynthia Goldberg, Gulf Restoration Network
Jay Jensen, National Association of State Foresters
Norman LeBlanc, Association of Metropolitan Sewerage Agencies
Mike Murray, National Wildlife Federation
Rick Parrish, Southern Environmental Law Center
Rob Reash, American Electric Power and the Utility Water Act Group
Dave Salmonsen, American Farm Bureau Federation

Appendix B
Biographies of the Committee Members and NRC Staff

Kenneth H. Reckhow (chair) is a professor at Duke University wi. faculty appointments in the School of the Environment and the Department of Civil and Environmental Engineering. In addition, he is director of The University of North Carolina Water Resources Research Institute and an adjunct professor in the Department of Civil Engineering at North Carolina State University. He currently serves as president of the National Institutes for Water Resources and is chair of the North Carolina Sedimentation Control Commission. He has published two books and over 80 papers, principally on water quality modeling, monitoring, and pollutant loading analysis. In addition, Dr. Reckhow has taught several short courses on water quality modeling and monitoring design, and he has written eight technical guidance manuals on water quality modeling. He is currently serving, or has previously served, on the editorial boards of *Water Resources Research, Water Resources Bulletin, Lake and Reservoir Management, Journal of Environmental Statistics, Urban Ecosystems, and Risk Analysis.* He received a B.S. in engineering physic from Cornell University in 1971 and a Ph.D. from Harvard University . environmental systems analysis in 1977. Dr. Reckhow is currently a member of the NRC's Committee to Improve the USGS National Water Quality Assessment Program.

Anthony S. Donigian, Jr., is president and principal engineer for AQUA TERRA Consultants. His expertise is in watershed modeling; nonpoint pollution and water quality modeling; chemical fate, transport, and exposure assessment; and model validation and testing. Mr. Donigian has 30 years of a broad range of experience in the development, testing, and application of modern analytical techniques for the assessment of environmental contamination and water resources planning problems. He is an internationally recognized authority on modeling nonpoint pol-

lution and chemical migration in the environment, primarily for water, soil, and groundwater systems. His recent research and applications studies have concentrated on regional and watershed-scale modeling of nutrients and impacts of management practices, movement of contaminants through the vadose zone, groundwater contamination by pesticides and hazardous wastes, model validation issues and procedures, and the evaluation of control alternatives such as best management practices, conservation tillage, and remedial actions at waste sites. Mr. Donigian received an A.B. in engineering sciences and a B.S. in engineering from Dartmouth College and an M.S. in civil engineering from Stanford University.

James R. Karr is a professor of aquatic sciences and zoology and an adjunct professor of environmental engineering, environmental health, and public affairs at the University of Washington, Seattle. He was on the faculties of Purdue University, University of Illinois, and Virginia Polytechnic Institute and State University; he was also deputy director and acting director at the Smithsonian Tropical Research Institute in Panama. He has taught and done research in tropical forest ecology, ornithology, stream ecology, watershed management, landscape ecology, conservation biology, ecological health, and science and environmental policy. He is a fellow in the American Association for the Advancement of Science and the American Ornithologists' Union. Dr. Karr has served on the editorial boards of *BioScience, Conservation Biology, Ecological Applications, Ecological Monographs, Ecology, Ecosystem Health, Freshwater Biology, Ecological Indicators,* and *Tropical Ecology.* He developed the index of biotic integrity (IBI) to directly evaluate the effects of human actions on the health of living systems. Dr. Karr holds a B.S. in fish and wildlife biology from Iowa State University and an M.S. and Ph.D. in zoology from the University of Illinois, Urbana-Champaign.

Jan Mandrup-Poulsen is an environmental administrator with the Watershed Assessment Section of the Florida Department of Environmental Protection. He is responsible for evaluating surface water quality, surface water/groundwater interactions, and mixing zones, and for determining the Total Maximum Daily Loads (TMDLs) allowable to support designated uses. He has coauthored materials on nonpoint source regulation in Florida and permitting guidance documents for point source discharges in Florida with consideration of the TMDL program. He is a frequent speaker on the topics related to the Florida Department of Environmental Protection watershed management approach, TMDLs, and the

Impaired Waters Rule. Mr. Mandrup-Poulsen received his B.S. in atmospheric and oceanic science from the University of Michigan and his M.S. in biological oceanography and M.B.A. from Florida State University.

H. Stephen McDonald is a principal with Carollo Engineers. He has 22 years of experience in the areas of wastewater planning, watershed management, wastewater disinfection, biosolids treatment/reuse/disposal, and chemical and biological wastewater treatment/reuse. He is currently project manager for the development of TMDLs for several watersheds, including the Truckee River from Lake Tahoe to Pyramid Lake and the Calleguas Watershed in California. For the Truckee River he is developing the Coordinated Monitoring Program and an adaptive management watershed/water quality modeling and stakeholder process to establish TMDLs for nutrients (nitrogen and phosphorus) and total dissolved solids (TDS). Mr. McDonald has developed master plans for water and wastewater treatment facilities in many western regions, including Sacramento County, the city of Fresno, CA; and the cities of Reno, Sparks, and Washoe County, NV. He holds a B.S. in biology from Portland State University and a B.S. in chemical engineering from Oregon State University. He has an MBA from California State University in Hayward and is a registered professional engineer in California.

Vladimir Novotny is a professor of environmental and water resources engineering at Marquette University and director of the Institute for Urban Environmental Risk Management. He is also president of the consulting firm Aqua Nova International, Ltd. His research has included risk-based urban watershed management integrating water quality and flood-control objectives, development of an adaptive methodology for online computerized modeling and real-time control of wastewater treatment facilities, and development of algorithms for control of urban sewer systems. He developed nationwide manuals on attainment of water quality goals (use attainability analysis) and abatement of winter diffuse pollution by road deicing operations. He is a past chair of an international group of specialists dealing with diffuse pollution and watershed management with the International Water Association. Dr. Novotny received a diploma engineer degree in sanitary engineering and a candidate of science degree in sanitary and water resources from the Technical University of Brno, Czechoslovakia and a Ph.D. in environmental engineering from Vanderbilt University.

Richard A. Smith joined the Water Resources Division of the U. S. Geological Survey (USGS) in 1975 and began working with a small research team on statistical methods in water quality and their applications to the extensive and diverse water quality monitoring records maintained by the USGS. Throughout the 1980s, his research dealt with patterns of change in the nation's water quality and with statistical analysis of data collected from the more than 400 stream and river monitoring stations in the Survey's NASQAN program. In the early 1990s he began to investigate the possibility of using the rapidly advancing technology of GIS to enable the use of monitoring data in making statistically based predictions of water quality in unmonitored waters. For more than a decade he has also been very interested in the question of the adequacy of the nation's monitoring programs. He recently served on a panel of scientists charged with making recommendations for a comprehensive monitoring plan for the drinking-water supply watersheds serving New York City. Dr. Smith received his B.S. and M.S. in biology from the University of Richmond and his Ph.D. in environmental engineering from Johns Hopkins University.

Chris O. Yoder is manager of the Ecological Assessment Section of the State of Ohio Environmental Protection Agency. His current responsibilities include ecological evaluation of Ohio's surface water resources including streams, rivers, lakes, and wetlands; development of ambient biological, physical, and chemical assessment methods, indicators, and criteria for rivers, streams, inland lakes, wetlands, Lake Erie, and the Ohio River; reporting on the condition of Ohio surface water resources on a local, regional, and statewide scale; and development of environmental indicators for the surface water program. Previously he was a principal investigator of a cooperative agreement with the U.S. EPA Office of Water for developing approaches to implementing bioassessments and biological criteria within state and federal water quality management programs. Mr. Yoder received a B.S. in agriculture from Ohio State University and his M.A. in zoology from DePauw University.

NRC Staff

Leonard Shabman is a professor in the Department of Agricultural and Applied Economics at the Virginia Polytechnic Institute and State University and director of the Virginia Water Resources Research Center. He earned his Ph.D. in resource and environmental economics from

Cornell University. His research interests include water supply, water quality, and flood hazard management; fishery management; and the role of economists in public policy formulation. Dr. Shabman was a member of the NRC's Committee on Watershed Management, Committee on USGS Water Resources Research, Committee on Flood Control Alternatives in the American River Basin, and the Committee on Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy.

Laura J. Ehlers is a senior staff officer for the Water Science and Technology Board of the National Research Council. Since joining the NRC in 1997, she has served as study director for seven committees, including the Committee to Review the New York City Watershed Management Strategy, the Committee on Riparian Zone Functioning and Strategies for Management, and the Committee on Bioavailability of Contaminants in Soils and Sediment. She received her B.S. from the California Institute of Technology, majoring in biology and engineering and applied science. She earned both an M.S.E. and a Ph.D. in environmental engineering at the Johns Hopkins University. Her dissertation, entitled RP4 Plasmid Transfer Among Strains of *Pseudomonas* in a Biofilm, was awarded the 1998 Parsons Engineering/Association of Environmental Engineering Professors award for best doctoral thesis.

EXHIBIT "5"

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

In the Matter of the Petition of NATURAL RESOURCES DEFENSE COUNCIL, INC. For Review of Waste Discharge Requirements Order No. 90-079 of the California Regional Water Quality Control Board, Los Angeles Region for Los Angeles County and Co-Permittees. NPDES Permit No. CA0061654. Our File No. A-693.	ORDER NO. WQ 91-04

BY THE BOARD:

On July 18, 1990, the State Water Resources Control Board (State Board) received a petition from Natural Resources Defense Council, Inc. (petitioner), seeking review of waste discharge requirements which the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) adopted in Order No. 90-079, regulating discharges of storm water from municipal separate storm sewers throughout Los Angeles County.

Many of the issues raised by the petitioner are discussed in great detail in Order No. WQ 91-03, which we are also issuing today, and which concerns a permit issued by the Regional Water Quality Control Board, San Francisco Bay Region (San Francisco Bay Regional Board) regulating discharges of storm water from municipalities in the Santa Clara Valley. Given the similarity of these issues, we will discuss most of the

petitioner's contentions in only a summary manner, and will refer to our determinations in Order No. WQ 91-03.[1] In adopting that Order, we did consider the petitioner's arguments, and also those of the Regional Board, the dischargers, and interested persons.

I. BACKGROUND

As we discussed in Order No. WQ 91-03, over the last twenty years, the Environmental Protection Agency (EPA), has developed a program to regulate discharges of storm water and urban runoff through the National Pollutant Discharge Elimination System (NPDES) of permits. The requirements for this program are contained in Clean Water Act Section 402(p). In this case, as in the case of the San Francisco Bay Regional Board, the Regional Board adopted its permit regulating discharges from municipal separate storm sewer systems prior to EPA's promulgation of regulations implementing Section 402(p).

As did the San Francisco Bay Regional Board, the Los Angeles Regional Board also proceeded to take earlier steps to study and control storm water discharges while EPA's program development was delayed. In 1975, the Regional Board adopted its Water Quality Control Plan (Basin Plan).[2] The Basin Plan characterized constituents commonly found in runoff and roughly estimated runoff wasteloads through the Los Angeles River and

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1 A major portion of our other Order involved discussion of Clean Water Act Section 304(l). That section does not apply here. However, the discussion concerning the regulations which EPA adopted to implement Section 304(l), i.e. 40 CFR Section 122.44(d), is also relevant to this matter.

2 Water Quality Plan Report, Santa Clara River Basin (4A) and Los Angeles River Basin (4B) (March 1975). The Basin Plan was approved by the State Board in Resolution No. 75-21.

Santa Clara River sub-basins.[3] The Basin Plan also compared local runoff data with the results of several investigations conducted elsewhere in the nation.

The Basin Plan identified beneficial uses of the surface waters within the region, established water quality objectives to protect and enhance these uses, and described a detailed "Implementation Plan" to achieve those objectives. The beneficial uses of the surfaces waters typically include ground water recharge (replenishment), contact and non-contact recreation and wildlife habitat.[4] A few creeks also support warm and cold water habitat, fish migration and fish spawning uses. Some reservoirs also provide municipal, industrial supply and industrial process water uses.[5] Rare and endangered habitat and agricultural supply were identified as existing beneficial uses of several surface waters also.[6] The Basin Plan listed marine habitat, contact and non-contact recreation, commercial and sport fishing, navigation, and shellfish harvesting as the beneficial uses of the Pacific Ocean.

The Basin Plan also established water quality objectives. First, it referred to several state policies for water quality control and statewide plans. These include the "Water Quality Control Policy for the Enclosed Bays and Estuaries

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3 The 1975 Basin Plan divided its region into two sub-basins: the Santa Clara River Basin ("4A") and the Los Angeles River Basin ("4B").

4 1975 Basin Plan, Table 2-3.

5 Id.

6 Id.

of California"[7] and the "Water Quality Control Plan for Ocean Waters of California".[8] The Basin Plan stated that the Ocean Plan and the Bays and Estuaries Policies established effluent quality requirements for certain discharges. "Land runoff", however, was specifically excluded from the effluent requirements.[9]

The receiving water quality objectives set forth in the Basin Plan included several general requirements and narrative objectives. For inland surface waters, enclosed bays, and estuaries in the Los Angeles River sub-basin, narrative receiving water quality objectives were specified for tastes and odors, floating material, suspended material, settleable material, oil and grease, sediment, turbidity, bacteria, and several other pollutants.[10] The narrative toxicity objective required that all waters be maintained free of "toxic substances in concentrations that are toxic to, or produce detrimental physiological responses in human, plant, animal, or aquatic life."[11] The Basin Plan

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7 The "Bays and Estuaries Policy", as this document is know, was adopted on May 16, 1974.

8 The State Board first adopted this plan, commonly known as the "Ocean Plan", on July 6, 1972. The State Board approved amendments to the Ocean Plan on March 22, 1990 by Resolution No. 90-27.

9 The 1975 Basin Plan states:

> *"This policy does not apply to wastes from vessels or land runoff except as specifically indicated for siltation and combined sewer flows." See page I-4-5.*

10 1975 Basin Plan, pages I-4-6 through I-4-8.

11 Ibid., at page I-4-8.

further specified "limiting concentrations" for inorganic chemical constituents (primarily heavy metals) in waters used as domestic and municipal supply.[12] It also prescribed "mean mineral quality objectives" for the Los Angeles River, the San Gabriel River and their "tributaries".[13]

The Basin Plan also contained an "Implementation Plan" to reduce wasteloads from various pollutant sources and their effects on the basin's waters. For urban runoff and storm water discharges, the Basin Plan indicated that the pollutants found in runoff discharges varied considerably and exhibited a seasonal nature. More specifically, the Plan stated that the "bulk of these mass emissions is normally experienced in only a few days of wet weather during the rainy season."[14] Although certain beneficial uses, such as groundwater recharge and recreational uses, may be temporarily impaired during storm flow conditions, the Basin Plan noted few traditional "end-of-pipe" controls existed for runoff flows. It explained:

> "...there is little, if anything, that can be done to mitigate the effects of such runoff except for improved air pollution control practices, improved urban housekeeping, and improved environmental levels of performance for automotive equipment."[15]

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12 *Ibid., at page I-4-9.*

13 *Ibid., at Table 4-1 and pages 1-4-11 and I-4-12.*

14 *1975 Basin Plan, "Impact of Runoff Waste Loads", page II-15-94.*

15 *Id.*

Although much runoff data was included in the Basin Plan, limited information about the significance or effects of runoff discharges on receiving water quality existed.

The Basin Plan specified requirements and controls for "traditional" point sources,[16] but storm water discharges were not covered, based on the difficulty of their regulation:

> "...no practical and economical means has yet been developed for containment and treatment of urban runoff wastes for reduction of pollutants prior to downstream release, nor are standards for such measures presently in existence or contemplated for the foreseeable future, at least on a widespread basis....There are presently no generally applicable effluent limits nor water pollution control facilities in connection with urban runoff that appear practical or economical. The emphasis for water quality control from this standpoint should be public education, public cooperation in improved (outdoor) housekeeping, and continued search of solutions to the air pollution problems."[17] (Emphasis added)

The Regional Board has not amended the portions of its Basin Plan relating to storm water and urban runoff since 1975. Therefore, we conclude that the Basin Plan does not address controls on such discharges, except for the few practices listed above. Clearly, the effluent limitations listed for other point sources are not meant to apply. In addition, there are no

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16 As was explained in Order No. WQ 91-03, throughout the years many documents have treated storm water discharge as a nonpoint source, even though it is legally a point source. This has led to some confusion in terminology. However, it is often obvious from statements in the document that decision makers have sought to exclude storm water from requirements otherwise applicable to point sources.

17 Ibid., at pages I-5-87 and I-5-88.

numeric water quality standards which have yet been developed.[18] On April 11, 1991, the State Board adopted the Water Quality Control Plan for Inland Surface Waters (Inland Plan) which is applicable here. The Inland Plan establishes numeric water quality objectives but allows dischargers of storm water a maximum of ten years to achieve compliance.

As was discussed in Order No. WQ 91-03, in 1987 the federal Clean Water Act was amended[19] to add provisions specifically requiring a regulatory program for storm water discharges. Section 402 of the Clean Water Act was amended to add subsection 402(p), which establishes NPDES permit application requirements for municipal storm water discharges and for storm water discharges associated with industrial activities.[20]

Section 402(p) includes the following requirements for municipal discharges of storm water:

> "Permits for discharges from municipal storm sewers--(i) may be issued on a system- or jurisdiction-wide basis; (ii) shall include a requirement to effectively prohibit non-stormwater discharges into the storm sewers; and (iii) shall require controls to reduce the discharge of pollutants to the <u>maximum extent practicable</u>, including management practices, control techniques and system, design and engineering methods, and such other provisions as the [EPA] Administrator or the State determines appropriate for the control of such pollutants." (Emphasis added.)

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18 The petitioner contends that numerical objectives contained in the Ocean Plan apply to discharges of storm water. We shall discuss that contention <u>infra</u>.

19 The amendments are entitled, <u>Water Quality Act of 1987</u>, Public Law 100-4 (February 4, 1987).

20 Section 405(p) of the Water Quality Act of 1987.

The Water Quality Act of 1987 also added Section 320 to the Clean Water Act. This amendment created the National Estuaries Program, an effort to develop and implement comprehensive conservation and management plans for estuaries of national importance. In December 1987, a federal appropriations act formally included Santa Monica Bay in EPA's National Estuaries Program.[21] The State of California then organized the Santa Monica Bay Restoration Project to coordinate local, state, and federal activities to develop the required plan which would improve the condition of Santa Monica Bay. The nomination document for this project indicated that urban runoff and storm water discharges may contain heavy metals, organic constituents, pathogens, and other pollutants that threaten or may impair the beneficial uses of Santa Monica Bay.[22] As a part of this project, the Los Angeles Regional Board--and the numerous local and regional governments and environmental interest groups that also participate in the project--began a more thorough investigation of runoff discharges to Santa Monica Bay. Because existing runoff data was incomplete or inconsistent, the Santa Monica Bay Restoration Project initiated detailed monitoring studies to identify pollutants in runoff flow, especially pathogens, and to assess their effects on the bay. This monitoring work is now in progress.

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21 National Estuary Program, The Nomination of Santa Monica Bay, Environmental Affairs Agency, May 1988.

22 Ibid., see "Executive Summary", page viii, and "Storm Drains and Runoff", page 41.

The permit which we are reviewing here was the result of a cooperative effort of the "Storm Water Permit Work Group," which was established to fulfill part of the objectives of the Santa Monica Bay Restoration Project. The Work Group assisted in drafting the permit.

In order to implement the Basin Plan, the provisions of state law regarding adoption of waste discharge requirements,[23] and the Clean Water Act provisions regarding storm water permits, the Regional Board issued a draft NPDES permit to regulate urban runoff and storm water discharged throughout Los Angeles County. The revised draft permit designated the County of Los Angeles as the "Principal Permittee" and 16 cities as "Co-permittees" (the dischargers). A workshop was held by the Regional Board on April 23, 1990, and a public hearing was held on June 18, 1990, and on the latter date the Regional Board adopted the NPDES permit (NPDES permit CA-0061654; Regional Board Order No. 90-079). Subsequently, the petitioner filed a timely petition for review of the NPDES permit.

II. CONTENTIONS AND FINDINGS

The petition raises a number of contentions which all address whether the permit must include numeric, water quality-based effluent limitations. The petitioner argues that the Clean Water Act requires permits regulating municipal discharges of storm water to prescribe numeric effluent limitations for toxic pollutants. The petitioner also contends that the permit does

23 *California Water Code Section 13000 et seq.*

not require controls which reduce pollutants to the "maximum extent practicable". Finally, the petitioner argues that the permit does not comply with the three-year time schedule required in Clean Water Act Section 402(p).

A. The Need for Numeric Effluent Limitations

The petitioners' arguments are based on the premise that the dischargers' municipal separate storm sewer system discharges pollutants to Santa Monica Bay, and that these discharges violate numeric water quality standards in the bay. The numeric standards which the petitioner relies upon are found in the Ocean Plan. As we shall explain, the petitioner's broad assertions vastly oversimplify the complex nature of the dischargers' flood control and drainage facilities, imply that the storm sewer system discharges only into Santa Monica Bay, and misconstrue ambient water quality criteria, receiving water quality standards and effluent limitations.

The County of Los Angeles, Department of Public Works' municipal separate storm sewer system serves a geographic area greater than 4,000 square miles[24] and includes more than 87 overlapping local governmental jurisdictions. This system, a vast network of catchments, street gutters, conduits, pipes, and channels that were designed for drainage and flood control purposes, collects urban runoff flows and storm water flows from throughout Los Angeles County. The County's Department of Public Works and 87 cities own, operate, or maintain this enormous

24 *See Regional Board's Response to Petition, page 10.*

municipal separate storm sewer system. More than 5,000 outfalls or "point sources" discharge these runoff flows into both constructed works and the natural streams, rivers, and other surface water bodies that comprise the Los Angeles River hydrologic unit.

As we discussed in Order No. WQ 91-03, the specific location at which the storm water outfall intersects receiving waters is where the "point source" discharge occurs. While the precise location of each of the several thousand outfalls in Los Angeles County is understandably omitted from the record, the substantial majority of these outfalls discharge urban runoff and storm water flows to surface waters--such as Ballona Creek, Coyote Creek, and San Antonia Creek, the Los Angeles River and the San Gabriel River, Rio Hondo, and other water bodies--throughout the hydrologic basin.[25]

Obviously, not all of the dischargers' 5,000 municipal separate storm sewer system outfalls actually discharge directly to Santa Monica Bay. Although the numerous natural water courses which receive storm water generally are ultimately tributary to Santa Monica Bay, they are the receiving waters. As such, these natural water courses cannot be considered elements of the dischargers' municipal separate storm sewer system. In fact, many of these surface waters are clearly identified in the Los Angeles Regional Board's Basin Plan.

25 The nomination document for the Santa Monica Bay Restoration Project stated that "over 60 storm drains" empty into the Bay.

In the Los Angeles Basin, the storm sewer outfalls generally discharge to the water courses upstream from Santa Monica Bay. Both Santa Monica Bay and the water courses which receive the storm water discharges have beneficial uses. However, the uses of the streams, creeks, reservoirs and rivers in the Los Angeles River Basin are not the same as the uses of Santa Monica Bay. The upstream waters support fresh water uses, while Santa Monica Bay sustains marine water uses.

As was described above, while the Basin Plan does include narrative water quality objectives for the upstream surface waters, the Regional Board has not yet developed numeric objectives for all of the pollutants the petitioner enumerates. Although the Inland Plan does contain numeric objectives, up to ten years is allowed for compliance. The Ocean Plan also includes numeric standards, but these do not apply to discharges of storm water.

The Ocean Plan states that all parts are applicable to point source discharges to the ocean. Narrative water quality objectives and toxic materials limitations (Table B) do apply to nonpoint sources, but compliance is determined by direct measurement in receiving waters. The petitioner requests that the storm water discharges be subject to Table B, and also to Table A (which is meant only to apply to publicly-owned treatment works).

While on its face, Table B may appear to apply to storm water discharges, it is clear from reading the Functional

Equivalent Document,[26] which was adopted by the State Board at the same time as the Ocean Plan, that neither Table A nor Table B are meant to apply to storm water discharges:

> "The attainability analysis did not include stormwater discharges because there are few data available on pollutant concentrations in stormdrains. EPA's proposed regulations for stormwater discharges do not use water quality-based effluent limits for stormdrains.[27] Instead, an approach based on Best Management Practices is proposed, following an initial period of characterization.
>
> "We do not propose to apply water quality-based effluent limits such as Table B to stormdrains at this time. Technology-based standards will not be based on Table A, but on Best Management Practices. Since the Table B objectives represent levels of pollutants that are protective of beneficial uses they may be applied to stormdrains at some future date. We do not anticipate that this would occur until adequate characterization data are available so that attainability can be assessed and implementation measures established."

Following the above statement, the Functional Equivalent Document states that the Plan explains how to apply Table B objectives to <u>nonpoint sources</u>. From this statement, it is clear that in drafting the Ocean Plan the State Board was viewing storm water discharges as nonpoint sources. This characterization is understandable. Storm water discharges,

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26 Functional Equivalent Document, Amendment of the Water Quality Control Plan for Ocean Waters of California, California Ocean Plan (March 1990), at pages 33 and 34.

27 It appears that the reference here was to <u>numeric</u> water quality-based limitations, since such limitations are required in Table B. As we explained in Order No. WQ 91-03, water quality-based limitations need not always be numeric.

while ultimately flowing through a point source to receiving waters, are by nature more akin to nonpoint sources as they flow from diffuse sources over land surfaces. This point is discussed in the Preamble to EPA's storm water regulations:

> "For the purpose of [national assessments of water quality], urban runoff was considered to be a diffuse source or nonpoint source pollution. From a legal standpoint, however, most urban runoff is discharged through conveyances such as separate storm sewers or other conveyances which are point sources under the [Clean Water Act]." 55 Federal Register 47991.

We therefore conclude that the petitioner has misinterpreted appropriate criteria and the applicability of Ocean Plan provisions to storm water. There are no numeric objectives or numeric effluent limits required at this time, either in the Basin Plan or in any statewide plan that apply to storm water discharges. This absence, however, will not in any way diminish the permit's enforceability or its ability to reduce pollutants in storm water discharges substantially. While numeric objectives are contained in the Inland Plan, these need not be achieved for up to ten years. In addition, the Plan endorses the application of "best management practices" rather than numeric limitations as a means of reducing the level of pollutants in storm water discharges.

The permit which the Regional Board adopted is very similar to that reviewed in Order No. WQ 91-03. The NPDES permit employs a two-fold strategy: It effectively prohibits non-storm

water discharges and illicit connections; and, it requires a comprehensive series of regulatory, governmental, and educational control measures.

As in the case of the permit issued by the San Francisco Bay Regional Board, the method by which the specific control activities will be implemented is that the dischargers must submit an Implementation Plan for approval by the Regional Board's Executive Officer, and then must implement the Plan. Thus, the permit lists some, but certainly not all of the management practices which will be undertaken. The remaining specific practices will be developed over a two-year period starting with adoption of the NPDES permit. In addition, the "co-participant" cities, which have not yet been added to the permit, are also being required to select appropriate control measures.

Although the permit does not make specific reference to violation of water quality standards, the permit will be read so as to require the implementation of practices which will achieve compliance with applicable standards. Such a requirement is implicit in the issuance of an NPDES permit, since that is a minimum requirement of a permit, as we discussed in Order No. WQ 91-03. The requirement is also a part of the California Water Code. Water Code Section 13263. The permit does provide that the Regional Board may, in the future adopt numeric water quality objectives and limitations.[28]

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28 Permit, Finding 19.

We concluded in Order No. WQ 91-03 that permits for municipal separate storm sewer systems issued pursuant to Clean Water Act Section 402(p) must contain effluent limitations based on water quality standards. In addition, the applicable water quality standards are those established for the receiving waters of the storm water discharges. We further concluded there that even if such effluent limitations are intended to require compliance with water quality standards, "best management practices" constitute legally acceptable effluent limitations. We find here, as we did in Order No. WQ 91-03, that the permit includes a comprehensive and stringent program for reducing pollutants in storm water discharge, and that it will implement the Basin Plan, including the protection of beneficial uses.

We note that the dischargers argued in their response that the fact that the permit was derived from a cooperative effort, prior to the promulgation of regulations by EPA, had relevance to its enforceability. While we are certainly pleased that the dischargers and the Regional Board have been able to work together in a cooperative and positive manner, the permit which was adopted is a lawfully adopted NPDES permit, and is fully enforceable as such. The fact that it was adopted prior to the deadline for adoption of such permits, and prior to promulgation of the regulations, has no relevance to its enforceability. The prohibitions and practices contained in the

permit must be obeyed, and those prohibitions and practices must result in compliance with any applicable water quality standards.

Just as in our review of the San Francisco Bay Regional Board's permit, we have reviewed the appropriateness and propriety of this permit. We find here also that the approach of the Regional Board, requiring the dischargers to implement a program of best management practices which will reduce pollutants in runoff, and prohibiting non-storm water discharges, is appropriate and proper. We base our conclusion on the difficulty of establishing numeric effluent limitations which have a rational basis, the lack of technology available to treat storm water discharges at the end of the pipe, the huge expense such treatment would entail, and the level of pollutant reduction which we anticipate from the Regional Board's regulatory program. We feel compelled to note here our agreement with the Regional Board that this permit does truly represent a massive undertaking. No other permit in the State, and perhaps in the nation, will control the number of outfalls in a metropolitan area as this permit undertakes to regulate.

B. The Maximum Extent Practicable Standard

The petitioners contend that the permit must include specified management practices in order to comply with the requirement in Clean Water Act Section 402(p) of reducing pollutants in municipal separate storm sewer discharges to the maximum extent practicable (MEP). The petitioner states that MEP means, "what can be done now, must be done now." As we stated in

Order No. WQ 91-03, however, we find that the Regional Board's approach of requiring the dischargers to prepare a plan with proposed control measures for approval by the Regional Board is preferable to specifying all such measures in the permit. The petitioner gives as an example a requirement for catch basin cleaning, which it claims would reduce pollutants. However, an effective and cost-effective storm water program requires an analysis of the specific area subject to regulation, and should not involve a simple listing of practices that all municipalities must follow. As EPA stated in its Preamble to the draft storm water regulations:

> "A wide variety of control measures to reduce the discharge of pollutants from municipal storm sewer systems are currently available. The performance of appropriate control measures is highly dependent on site-specific factors. It is therefore not practicable to define one standard set of controls which will control all pollutants in all municipalities." 53 Federal Register 49456[29]

We also note that, while we share the petitioner's goal of rapid achievement of an effective practices program, the Clean Water Act does not require implementation of all measures <u>now</u>, but rather has set forth a three-year time schedule for compliance. We shall discuss this point further in the next section.

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29 This point was also made in the preamble to EPA's final regulations. 55 Fed. Reg. 48038. There a reference to the legislative history of Clean Water Act Section 402(p) makes clear that Congress' intent was not to dictate specific practices.

C. Time Schedule for Compliance

The petitioner contends that the permit violates the Clean Water Act by not requiring timely compliance with water quality standards. We addressed this point in Order No. WQ 91-03. Here, also, we find that the permit contains provisions requiring such compliance.

The permit includes a very aggressive and comprehensive program of developing and implementing best management practices over a three-year period. The permit does require a program aimed at compliance with applicable water quality standards and all practices necessary to achieve such compliance must be in place within three years of adoption of the permit. Therefore, the permit complies with the time schedule requirements of the Clean Water Act. The permit also specifically provides that the Regional Board may include more stringent effluent limitations, including numeric effluent limitations if necessary.

III. CONCLUSIONS

After review of the record and consideration of the contentions of the petitioners, and for the reasons discussed above, and in Order No. WQ 91-03, we conclude:

1. Impacts of storm water discharges on receiving waters and Santa Monica Bay are complicated, and at this time, it would be infeasible to establish numeric effluent limitations on

discharges to storm drains in the Los Angeles River Basin, which are validly associated with impacts in Santa Monica Bay.

2. The permit adopted by the Regional Board requires implementation of specific source control measures and effectively prohibits discharges of non-storm water and violation of water quality standards.

3. The provisions in the Clean Water Act regulating municipal storm water discharges require effluent limitations and achievement of water quality standards, but the limitations may consist of source control measures, rather than numeric effluent limitations.

4. It is appropriate and proper to issue a permit regulating municipal separate storm sewer systems which requires specific practices, rather than containing numeric effluent limitations.

5. The specific control measures requested by the petitioner should be considered by the Regional Board when approval of the dischargers' control plan is sought, rather than by this Board.

6. The permit complies with the time schedule requirements of the Clean Water Act.

IV. ORDER

IT IS ORDERED that the petition is denied.

CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on May 16, 1991.

AYE: W. Don Maughan
Edwin H. Finster
Eliseo M. Samaniego
John Caffrey

NO: None

ABSENT: None

ABSTAIN: None

Maureen Marché
Administrative Assistant to the Board

EXHIBIT "6"

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

In the Matter of the Petition of **Save San Francisco Bay Association, et al.,** for Review of Waste Discharge Requirements Order No. 95-180, NPDES Permit No. CAS029718, by the California Regional Water Quality Control Board, San Francisco Bay Region. File No. A-992.	ORDER NO. WQ 96-13

BY THE BOARD:

On August 23, 1995, the California Regional Water Quality Control Board, San Francisco Bay Region (SFBRWQCB) adopted waste discharge requirements for storm water discharges from municipal separate sewer systems throughout the Santa Clara Valley.[1] The waste discharge requirements constituted a national pollutant discharge elimination system (NPDES) permit pursuant to Section 402(p) of the federal Clean Water Act (CWA). The co-permittees include Santa Clara Valley Water District, County of Santa Clara, and thirteen cities (dischargers).

On September 25, 1995, the State Water Resources Control Board (SWRCB) received a petition from Save San Francisco Bay Association, San Francisco BayKeeper, Peninsula Conservation Center Foundation, Sierra Club Bay Chapter, Sierra Club Loma Prieta Chapter, Citizens Committee to Complete the Refuge, and

[1] For an extensive discussion of the system, see Order No. WQ 91-03 which concerned an earlier version of waste discharge requirements for the same discharges.

Silicon Valley Toxics Coalition (petitioners), contesting the issuance of the NPDES permit.[2]

I. BACKGROUND

The NPDES permit is a reissuance of a permit first issued in 1990 for discharges of storm water from municipal separate storm sewer systems (MS4s) throughout the Santa Clara Valley to creeks and streams tributary to South San Francisco Bay. The earlier permit (Order No. 90-094) was reviewed and upheld by the SWRCB in Order No. WQ 91-03. That order included extensive discussion of the federal statutory and regulatory requirements for storm water discharges from MS4s, which will not be repeated here.

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[2] This order is based on the record before the SFBRWQCB. In addition, the record is supplemented by the following documents: "Municipal Separate Storm Sewer System Permit Reapplication Policy," transmitted by "Interpretative Policy Memorandum on Reapplication Requirements for Municipal Separate Storm Sewer Systems," U.S. Environmental Protection Agency (EPA), May 17, 1996 (hereafter, Reapplication Policy); Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits," EPA, August 1, 1996 (hereafter Effluent Limitations Policy); "Antibacksliding: Effect on Water Quality-Based Effluent Limitations," EPA, August 8, 1994 (hereafter Antibacksliding Brief); and letter from Terry Oda, EPA Region 9, dated June 26, 1996, concerning the Orange County storm water permit (hereafter, letter from EPA Region 9). Following the close of the public comment period, several letters were received from interested persons. These are not part of the record, except for the comments received on the draft order from counsel for the parties.

II. CONTENTIONS AND FINDINGS[3]

The petition contends that the SFBRWQCB should not have issued the NPDES permit because the permit application was incomplete and that various aspects of the permit are inadequate or improper.

Contention: The NPDES permit should not have been reissued because the permit application was insufficient.

Findings: The petitioners contend that the permit application submitted by the dischargers was insufficient and that the SFBRWQCB was, therefore, prohibited from issuing the permit. The petitioners cite regulations adopted by the EPA.

The EPA set forth detailed permit application requirements for large and medium municipal separate storm sewer discharges, such as the discharges at issue here, in 40 CFR Section 122.26(d). These requirements include extensive information about the storm sewer system and the methods by which the municipal entities will regulate and monitor their discharges. A part of these application requirements is submission of a storm water management plan (SWMP) to reduce the discharge of pollutants to the maximum extent practicable (MEP). (40 CFR Section 122.26(d)(2)(iv).) The petitioners claim that the dischargers' SWMP does not contain adequate control measures. The petitioners also claim that other information required in Section 122.26(d) was missing, including source identification,

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[3] All other contentions raised in the petition which are not discussed in this order are dismissed. (23 Code of California Regulations (CCR) Section 2052; *People* v. *Barry* (1987) 194 Cal.App.3d 158.)

characterization data, and assessment of controls. The petitioners contend that the SFBRWQCB was precluded from issuing the NPDES permit by 40 CFR Section 122.21(e), which limits the issuance of NPDES permits where an application is incomplete.

It is not necessary to address the contention that Section 122.21(e) prevents the SFBRWQCB from issuing an NPDES permit if an application is incomplete since the EPA has issued a policy and interpretative memo clarifying that, while reapplication for a second-round permit is required, the permit application requirements in 40 CFR Section 122.26(d)(2) apply only to first-round permit applications for large and medium MS4s, and not to the second round of permits. Instead, the reapplication requirements are "flexible" and are based on the minimum application requirements for all NPDES permits contained in 40 CFR Section 122.21(f). (Reapplication Policy.) The EPA encourages the reapplication package to consist only of the dischargers' fourth annual report,[4] which would include the proposed SWMP. (Id.) As explained above, the NPDES permit is a second-round storm water permit and the EPA policy is, therefore, applicable. The dischargers' permit application was consistent with the Reapplication Policy.

Administrative agencies are generally accorded a high degree of deference in the areas of law which they regulate.

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[4] Annual reports are required components of all MS4 permits. Each permit operates for five years and use of the fourth annual report allows for timely preparation of a new permit.

(See, e.g., *Chevron U.S.A.* v. *Natural Res. Def. Council* (1984) 467 U.S. 837.) In interpreting EPA's regulations, it is proper to accord significant deference to EPA's policy expressions. The SWRCB will therefore follow the Reapplication Policy, and other EPA policy statements discussed in this order, in determining compliance with the Clean Water Act and EPA's regulations promulgated thereunder.

Contention: The petitioners contend that the permit lacks control measures.

Finding: The petitioners contend that the permit improperly requires the dischargers to implement their SWMP, and instead should specify the control measures that dischargers must implement. The petitioners believe that control measures must be specified in the permit pursuant to CWA Section 402(p)(3)(B)(iii). The petitioners argue the SFBRWQCB should not have incorporated the SWMP requirements into the permit without circulating the SWMP as a part of the permit and that the permit should have specified further control measures.

CWA Section 402(p)(3)(B)(iii) states that permits for MS4s:

> "[S]hall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as . . . the State determines appropriate for the control of such pollutants."

The petitioners have misconstrued this section to mean that the SFBRWQCB must dictate the specific controls that

dischargers must implement. Instead, the SWRCB interprets the section to mean that the permit must contain provisions that will require the dischargers to select and implement adequate controls. It is perfectly appropriate for the SFBRWQCB, as it did here, to implement this section by requiring the dischargers to comply with their own SWMP, and to make revisions to the SWMP in the areas where the document was found lacking. While the SFBRWQCB did incorporate the SWMP into the permit, it also provided for amendments to the SWMP as necessary to achieve MEP and water quality standards. The SWRCB interprets the incorporation not as applying to the SWMP as it existed on the date the permit was adopted, but as a continuing duty to comply with any current SWMP provisions. In other words, the permit requires continual improvements to the SWMP and compliance with the plan requirements. This approach is consistent with the federal law and is in concert with the approach favored by the EPA.

The permit requires the dischargers to implement control measures and BMPs to reduce pollutants in storm water discharges to the MEP, as provided by federal law. The federal law does not require the SFBRWQCB to dictate the specific controls. The permit recognizes the SWMP as a dynamic document which requires ever-changing revisions and improvements as monitoring and assessment of BMPs to provide new information. The annual report is the mechanism for such assessment, and the

permit anticipates that assessment will result in modification of the SWMP.

The SFBRWQCB's approach is supported by the EPA's policy documents. The Reapplication Policy transmitted by the EPA acknowledges that the best management practices (BMPs) that will be implemented are contained in the SWMP and explains that each annual report must include proposed revisions to the SWMP. (Reapplication Policy, at page 3; 40 CFR Section 122.42(c)(2).) The EPA encourages use of the fourth annual report as the basic application package. In other words, the EPA acknowledges the SWMP as a dynamic document which should be revised more frequently than the permit is reissued. The SFBRWQCB has appropriately accommodated the needed flexibility in the SWMP while also specifying the standards to be attained (MEP and compliance with water quality objectives) and the areas requiring improvement.

The SFBRWQCB found that the SWMP was generally adequate, although it required certain improvements to resolve deficiencies in some of the actions and the time frame. (NPDES Permit, finding 5.) Provision C of the permit includes specific requirements to improve and implement the SWMP. The permit requires implementation of BMPs stated in the SWMP, ensures coverage of all major source areas known to the SFBRWQCB, and mandates improvements where necessary. The implementation and effectiveness of the BMPs must be evaluated in the annual reports. This combination of extensive control measures and an

annual evaluation of the implementation and effectiveness of the control measures is a program that meets the MEP standard.[5]

Contention: The petitioners claim that the permit unlawfully "backslides" from the prior permit.

Findings: Section 402(o) of the CWA contains limitations on the ability of the permitting authority to reissue NPDES permits that contain effluent limitations less stringent than in a prior NPDES permit. The provisions of Section 402(o) are detailed and contain several exceptions. The petitioners claim that Section 402(o) was violated because the permit deleted some of the activities specifically listed in the earlier permit where these activities are covered by the SWMP. Further, the petitioners claim that the SWMP includes a time schedule and that the time schedule violates the EPA order *In the Matter of Star-Kist Caribe, Inc.*, NPDES Appeal No. 88-5.

The SWRCB does not agree that Section 402(o) has been violated. First, as explained above, the SFBRWQCB appropriately ordered the dischargers to achieve MEP by complying with their SWMP and by making improvements where necessary. In revising the language from the first permit (which specified all areas the SWMP must cover) to the second permit (which instead ordered the dischargers to comply with the SWMP where it did adequately address those areas), the SFBRWQCB did not adopt a less stringent

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[5] While the permit does not require the dischargers to estimate the expected reduction of pollutant loads for each source control measure, the EPA has acknowledged that in most cases permitting authorities do not have the ability at this time to link directly the BMPs implemented with impacts on receiving waters. (Effluent Limitations Policy.)

permit. Second, as explained below, the SFBRWQCB has latitude to revise BMP requirements without violating Section 402(o).

The petitioners argue that CWA Section 402(o) prohibits the SFBRWQCB from eliminating any previous requirements for BMPs because the requirements were necessitated both to achieve MEP and to protect water quality, and that Section 402(o) prohibits the adoption of less stringent effluent limitation if the original limitation was adopted to protect water quality. While the SWRCB agrees that the NPDES permit requirements to implement BMPs are, in part, water-quality based effluent limitations,[6] the SWRCB does not read Section 402(o) to prohibit the SFBRWQCB from revising the BMP requirements, even if that may include eliminating the need for some previously implemented BMPs.[7]

Section 402(o) contains exceptions where

> ". . . information is available which was not available at the time of permit issuance . . . and which would have justified the application of a less stringent effluent limitation . . . ." (Section 402(o)(2)(B)(i).)

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[6] In Order No. WQ 91-03, the SWRCB addressed the contention that the requirement to implement BMPs did not constitute the water quality-based effluent limitations required by the Clean Water Act. There it was stated:

> "Our review of the relevant law reveals that the permit's scheme of prohibitions, source control measures and best management practices constitutes valid effluent limitations consistent with requirements of 'maximum extent practicable' controls and water quality standards."

[7] As stated above, there is, in fact, no evidence that the BMP requirements in this permit are less stringent or that any BMPs have been eliminated.

According to the EPA, in its Antibacksliding Brief, revisions to water quality-based effluent limitations based on new information are appropriate so long as there is a net reduction in pollutant loadings. Any revisions to BMPs incorporated into or anticipated by the permit clearly fall within this exception, since they will be the result of new information from monitoring or analysis of effectiveness, and the dischargers remain bound to the same standards of compliance. The EPA has also acknowledged that the process of developing the SWMP will result in revising BMPs as new information becomes available. (Reapplication Policy.) It is absurd to assume that such revisions would violate the antibacksliding prohibition.

The SWRCB also finds that the SFBRWQCB did not violate the EPA's rule in *Star-Kist Caribe* by allowing time for BMPs to work and be evaluated and implemented. While the SWRCB agrees that an NPDES permit cannot include a time schedule for compliance with water quality objectives established prior to July 1, 1977,[8] the SFBRWQCB has not established such a time schedule here. Under the provisions of the permit, the effluent limitations (i.e., the requirements to implement BMPs pursuant to a SWMP) are in place and effective immediately. The time schedule for assessment and improvements are meant to increase the ability of the SFBRWQCB and the dischargers to ensure that the dynamic nature of selecting, evaluating, and implementing BMPs occurs throughout the term of the permit.

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[8] See, *City of Stockton*, Order No. WQ 96-09.

Contention: The petitioners claim the permit does not provide for compliance with water quality standards.

Findings: Storm water permits for MS4s must achieve compliance with water quality objectives, but they may do so by requiring the implementation of BMPs. (Order No. WQ 91-03.) The petitioners claim that although the permit specifically prohibits discharges that cause violation of water quality objectives, that prohibition is "nullified" by stating that the dischargers "shall comply . . . through the timely implementation of control measures and other actions to reduce pollutants in the discharge." (Permit, Provision C.1.) Provision C.1. also authorizes the SFBRWQCB to reopen the permit if necessary to require further BMPs or revision of the SWMP. (Id.) Petitioners claim the lengthy process of reopening the permit would result in delays in achieving water quality objectives.

The petitioners' concerns are not warranted. The NPDES permit clearly requires the implementation of BMPs that will not cause a violation of water quality objectives. The method for achieving compliance is through implementation of a SWMP and BMPs which must, throughout the term of the permit, be evaluated, assessed, and improved. The reopener provision in C.1. simply provides that if, notwithstanding these processes, adverse impacts to receiving waters persist, the permit may be reopened.

The approach taken by the SFBRWQCB is consistent with statements from the EPA concerning the most effective regulation of MS4s. The Effluent Limitations Policy encourages a permitting

approach using "expanded or better-tailored" BMPs in second-round permits. The EPA states that most MS4 permits include "educational and programmatic BMPs," and describes this approach as one where dischargers are required to "adopt and implement adequate BMPs." In other words, the permitting approach, wherein the discharger is required to implement a SWMP with BMPs, has been found by the EPA to be the most effective way to ensure compliance with water quality standards, at least until more information is available definitively tying storm water discharges to impacts on receiving waters. Finally, a similar approach taken by the RWQCB for the Santa Ana Region, was sanctioned by the EPA as follows:

> "The Orange County storm water permit states that receiving water limitations may not exceeded [sic], but then provides that if there are exceedences, [sic] the permittees would not be in violation of the permit if they follow up with certain actions. We appreciate the concerns . . . regarding the way the permit seems to say that 'a violation is not a violation.' However, the net effect of this condition is to focus on BMP implementation for now, and this is consistent with the draft national policy." (Letter from EPA Region 9.)

III. CONCLUSIONS

After review of the record and consideration of the contentions of the petitioners, and for the reasons discussed above, the SWRCB concludes that the Regional Water Quality Control Board, San Francisco Bay Region, acted appropriately and

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properly in adopting the NPDES permit for storm water discharges from municipal separate storm sewers in the Santa Clara Valley.

IV. ORDER

IT IS ORDERED that the petition is denied.

CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted a meeting of the State Water Resources Control Board held on September 19, 1996.

AYE: John P. Caffrey
John W. Brown
James M. Stubchaer
Mary Jane Forster

NO: Marc Del Piero

ABSENT: None.

ABSTAIN: None.

Maureen Marché
Administrative Assistant to the Board

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

AUG 08 1994

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EXECUTIVE OFF

Mr. Walt Pettit
Executive Director
California State Water Resources
Control Board
P.O. Box 100
Sacramento, CA 95812-0100

re: Antibacksliding Related to Water Quality-Based Effluent Limitations

Dear Walt:

The issue of antibacksliding has been at the forefront of discussions regarding water quality-based effluent limitations. Many dischargers are concerned with being bound to effluent limitations they may not be able to meet. As a result they have been reluctant to accept permits containing stringent water quality-based effluent limitations. This has resulted in delays in issuing some permits.

To allay those concerns we have prepared a brief on antibacksliding as it relates to water quality-based effluent limitations. The interpretation reflects the Agency's current thinking on this matter and relies on published documents. In summary we do not believe that antibacksliding is as onerous as some would believe. The statute provides sufficient exceptions to the prohibition against antibacksliding that allow for reasonable relaxation of effluent limitations. The brief is enclosed.

I hope this will be of assistance to the State and Regional Boards. I am taking the liberty to forward copies to the Regional Boards, CASA and Tri-TAC.

Sincerely,

Catherine Kuhlman

Catherine E. Kuhlman
Chief
Permits and Compliance Branch

cc: Regional Water Quality Control Boards

ANTIBACKSLIDING
EFFECT ON WATER QUALITY-BASED EFFLUENT LIMITATIONS

Due to doubts about complying with effluent limitations based on stringent water quality criteria, the effect of antibacksliding (section 402(o) of the Clean Water Act) on modifications of effluent limitations has become an important issue. Dischargers are loath to accept permits with stringent water quality-based effluent limitations, even where the effectiveness of those effluent limitations are delayed through the use of compliance schedules. The concern is the fear of being forever bound to effluent limitations that can not be met.

To allay those concerns, two of the most prominent issues are addressed in this brief. The first issue is whether antibacksliding prohibits relaxation of water quality-based effluent limitations whose compliance date has not yet passed, i.e., the effective date of those limitations are delayed by a compliance schedule. The second issue is whether antibacksliding prohibits relaxation of water quality-based effluent limitations which a discharger has been unable to achieve.

The CWA prohibits reissuing or modifying a permit to include effluent limitations less stringent than comparable effluent limitations in the previous permit unless certain exceptions are met. Those exceptions are set forth in sections 303(d)(4) and 402(o)(2) of the CWA. These two sections of the CWA provide independent exceptions to the prohibition. Meeting any one of the exceptions of either section is sufficient basis for relaxing the effluent limitations. [see 40 FR, p. 20837, Vol. 58 No. 72, April 16, 1993, Proposed Great Lakes Initiative (GLI); and Technical Support Document for Water Quality-Based Toxics Control (TSD), p. 113, EPA/505/2-90-001, March 1991]

1) Effect on Water Quality-Based Effluent Limitations prior to the Compliance Date.

Antibacksliding does not apply to changes made to an effluent limitation prior to its compliance date. If a permit is issued with a compliance schedule delaying the effective date of a water quality-based effluent limitation, that limitation may be relaxed without concern for antibacksliding if the modification is made prior to the effective date of the limitation. (see GLI, pp. 20837, 20981 and 21045)

2) Effect on Water Quality-Based Effluent Limitations being Violated.

The exceptions to the prohibition set forth in section 402(o)(2) of the CWA applies to water quality-based and best professional judgement (BPJ) based effluent limitations. Water quality-based effluent limitations may be relaxed if any of the following is met (TSD, p. 113):

a) There have been material and substantial alterations or additions to the permitted facility which justify the application of less stringent effluent limitations.

b) Good cause exists due to events beyond the permittee's control and for which there is no reasonably available remedy.

c) The permittee has installed the treatment facilities required to meet the effluent limitations in the previous permit and has properly operated and maintained the facilities but still has been unable to meet the effluent limitations (relaxation may only be allowed to the treatment levels actually achieved).

d) New information (other than revised regulations, guidance, or test methods) justifies relaxation of water quality-based permit limitations. (This applies to water quality-based limitations only when revised limitations result in a net reduction in pollutant loadings and are not the result of another discharger's elimination or substantial reductions of its discharge for reason's unrelated to water quality, e.g., plant shutdown.)

Anyone of the above section 402(o)(2) exceptions may be used as a basis to justify relaxation of water quality-based effluent limitations. Alternatively, the provisions of 303(d)(4) may be used to obtain such relief.

Section 303(d)(4) allows establishment of less stringent water quality-based effluent limitations. The criteria for the exceptions varies for attainment and nonattainment waters:

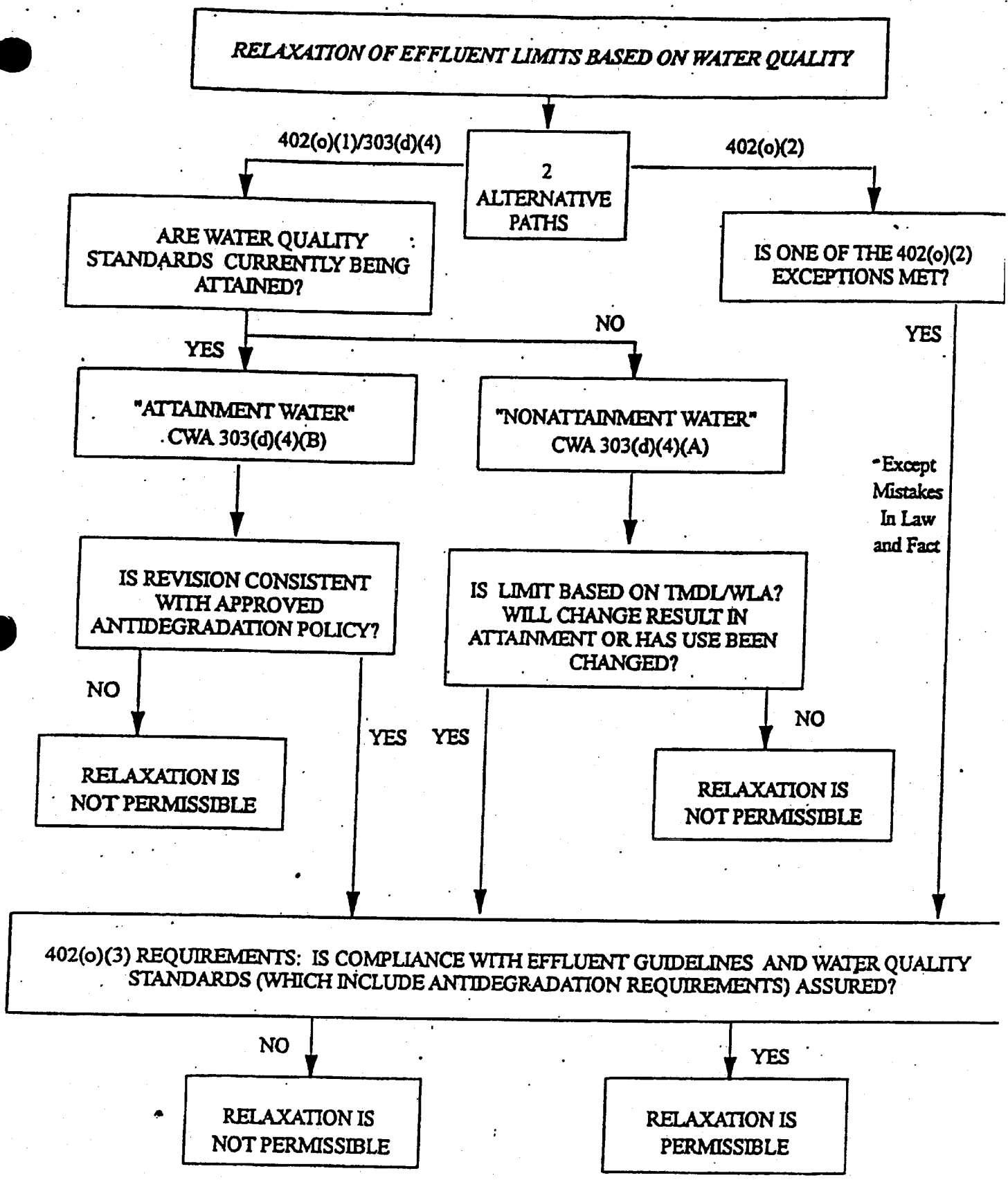
a) Attainment Waters: In waters where the applicable water quality standard has been attained, a water quality-based effluent limitation may be relaxed to the extent that the less stringent limitation is consistent with the State's antidegradation policy.

b) Nonattainment Waters: In waters where the applicable water quality standard has not yet been attained, an effluent limitation based on a total maximum daily load (TMDL) or other waste load allocation may be made less stringent if the cumulative effect of all such revisions assures attainment of the water quality standard, or the designated use which is not being attained is removed in accordance with the applicable regulation (40 CFR 131.10).

It should be noted that any relaxation of an effluent limitation can not be less stringent than the technology-based requirement set forth in the applicable effluent limitations guideline, or cause a violation of the applicable water quality standard. (see section 402(o)(3) of the CWA)

The processes discussed above are illustrated in the attached diagram (Flow Charts

FLOW CHART A
ANTIBACKSLIDING



FLOW CHART B
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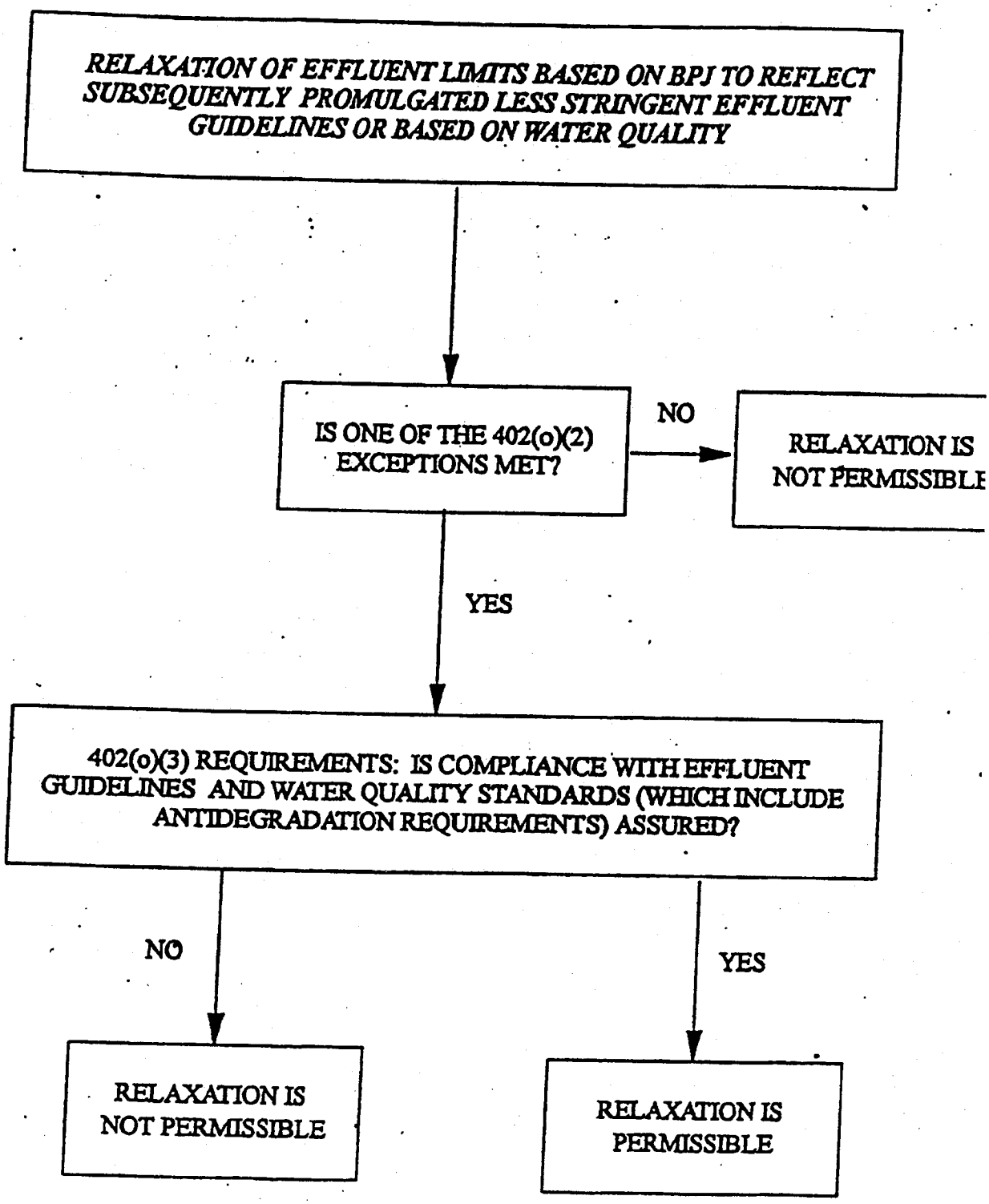

FLOW CHART C
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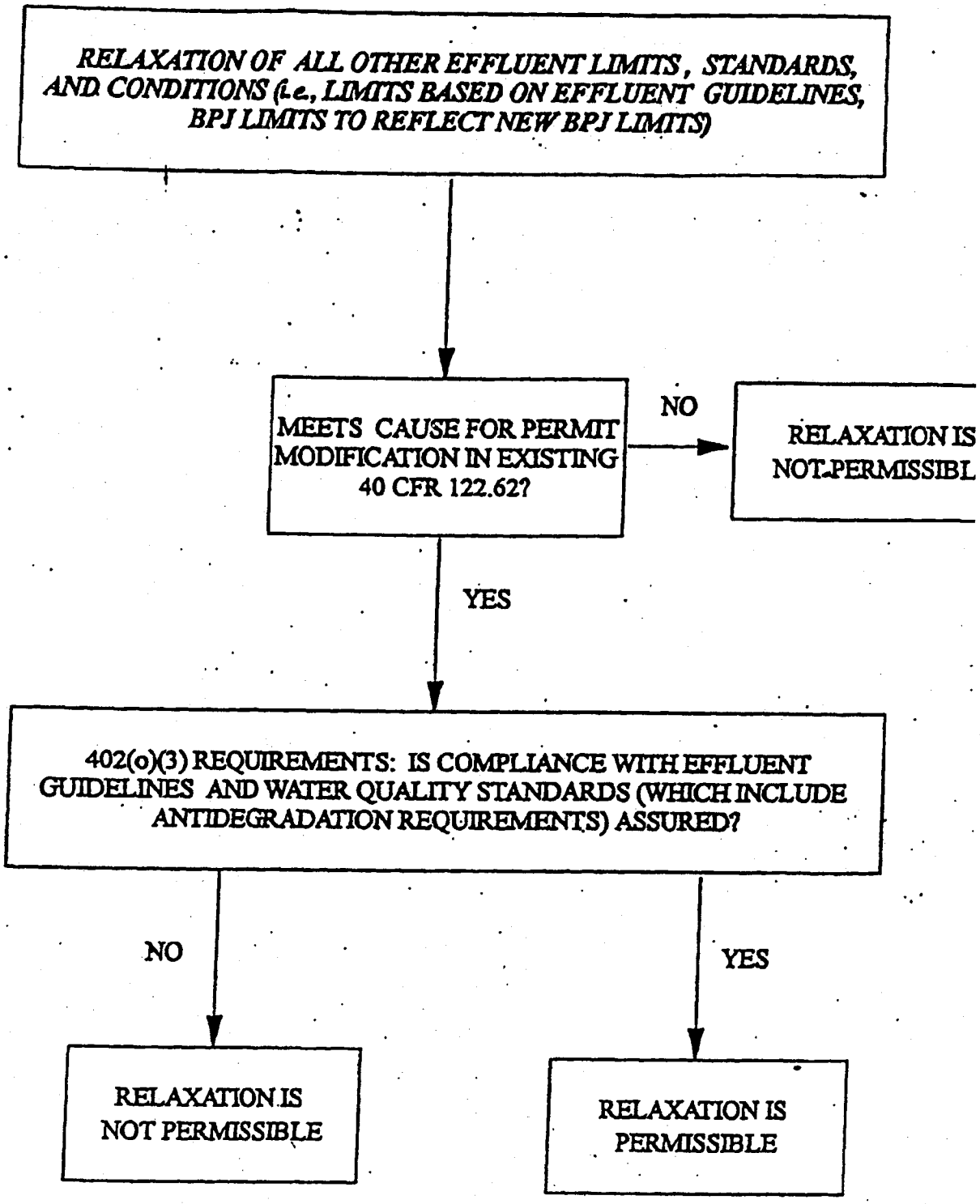

EXHIBIT "7"

KCB

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

ORDER WQ 98-01

Own Motion Review of the Petition of
ENVIRONMENTAL HEALTH COALITION
to Review Waste Discharge Requirements Order 96-03,
NPDES Permit No. CAS0108740,
for Storm Water and Urban Runoff from the
Orange County Flood Control District
and the
Incorporated Cities of Orange County
Within the San Diego Region,
Issued by the
California Regional Water Quality Control Board,
San Diego Region.

SWRCB/OCC File A-1041

BY THE BOARD:

On August 8, 1996, the Regional Water Quality Control Board, San Diego Region (Regional Water Board), adopted Waste Discharge Requirements Order 96-03, NPDES No. CAS0108740, for storm water discharge from municipal separate sewer systems for the incorporated cities of Orange County within the San Diego Regional Water Board's boundaries (Orange County permit).[1] The waste discharge requirements constitute a national pollutant discharge elimination system (NPDES) permit pursuant to section 402(p) of the federal Clean Water Act (CWA).

[1] On March 8, 1996, the Regional Water Quality Control Board, Santa Ana Region, issued waste discharge requirements for storm water discharge to the incorporated cities of Orange County within the Santa Ana Regional Water Board's boundaries that are essentially identical to the permit adopted by the San Diego Regional Water Board.

On September 6, 1996, the State Water Resources Control Board (SWRCB) received a petition from the Environmental Health Coalition (petitioner) contesting certain provisions of the NPDES permit.[2] The SWRCB did not take formal action on the petition within the 270 days specified in Title 23, California Code of Regulations, section 2052(d). The SWRCB will, on its own motion, review the Regional Water Board's action as authorized by California Water Code section 13320(a).

I. BACKGROUND

The primary issue raised by petitioner concerns the Regional Water Board's implementation of the CWA requirement that all NPDES permits must include technology-based effluent limitations and any more stringent limitation necessary to meet water quality standards. Federal and state requirements relevant to the issues raised in the petition are discussed below.[3]

CWA section 301(a) prohibits the discharge of any pollutant unless pursuant to an NPDES permit. (33 U.S.C. § 1311(a).) Section 301(b)(1)(A) requires compliance with effluent limitations necessary to achieve compliance with technology-based standards (e.g., best practicable control technology currently available or secondary treatment). Section 301(b)(1)(C) also requires compliance with any more stringent effluent limitation "necessary to meet water quality standards." (33 U.S.C.

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[2] This order is based on the record before the Regional Water Board. The Regional Water Board also issued an NPDES permit to the Department of Transportation and a petition was filed challenging that permit. In preparing this order, we have reviewed the record for the petition challenging that permit and other documents noted in this Order.

[3] See State Water Resources Control Board Order WQ 91-03 (*Citizens For a Better Environment, et al.*) for an extensive discussion of the regulatory framework for municipal separate storm sewer systems.

§ 1311(b)(1)(c).) CWA section 402 establishes requirements for NPDES permits. (33 U.S.C. § 1342.) NPDES permits must comply with section 301. Section 402(p) establishes specific NPDES permit requirements for municipal storm water discharges and for storm water discharges associated with industrial activities. Section 402(p) includes a technology-based standard for storm water permits issued to municipal separate storm sewer systems. Such permits must require:

> ". . . controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants." (33 U.S.C. § 1342(p)(3)(B)(iii).)

To comply with CWA sections 301 and 402 for municipal separate storm water discharges, a municipal storm water NPDES permit must include effluent limitations to meet the technology-based standard to reduce pollutants to the "maximum extent practicable" and any more stringent effluent limitations necessary to meet water quality standards. The United States Environmental Protection Agency (EPA) has promulgated regulations to implement NPDES requirements in CWA section 402, including storm water requirements of CWA section 402(p).[4] (See 40 C.F.R. Part 122.26.)

[4] CWA Section 402(p) specifies that permits for industrial discharges are required to comply with all technology-based and water quality-based requirements. (Section 402(p)(3)(A).) In contrast, CWA Section 402(p) specifies that permits for municipal separate storm water discharges shall require controls to comply with technology-based requirements but does not specifically state that municipal permits must require controls to comply with water quality-based requirements. (Section 402(p)(3)(B).) EPA, however, has interpreted the Clean Water Act to require permits for municipal separate storm water discharges to include requirements to achieve compliance with water quality standards. See memorandum "Compliance with Water Quality Standards in NPDES Permits Issued to Municipal Separate Storm Sewer Systems" from E. Donald Elliott, General Counsel, EPA, to Nancy J. Marvel, Regional Counsel, EPA Region 9 (January 9, 1991).

CWA section 303 requires states to adopt water quality standards for surface waters. (33 U.S.C. § 1313.) Water quality standards consist of the designated uses of waters and the water quality criteria for such waters that would support the designated uses. The Regional Water Board in its Water Quality Control Plan for the San Diego region has adopted water quality standards by designating the beneficial uses for waters in the region and establishing water quality objectives (i.e., water quality criteria) to protect those uses. See Water Quality Control Plan for the San Diego Basin (9), September 8, 1994, at Chapters 2 and 3. The SWRCB has also adopted water quality control plans and policies that specify water quality standards which are relevant to this permit (e.g., the SWRCB Ocean Plan). To comply with CWA section 301, municipal storm water permits must include effluent limitations where necessary to meet these water quality standards.

NPDES permits issued by the Regional Water Boards, including municipal storm water permits, typically include a requirement entitled "discharge limitations" or "effluent limitations" that specifies the technology-based effluent limitations and a requirement entitled "receiving water limitations" or "receiving water standards" that specifies the water quality objectives in the Water Quality Control Plan relevant to the discharge and limitations necessary to attain those objectives. The receiving water limitations provision is used to implement the requirement of CWA section 301(b)(1)(C) to include more stringent effluent limitations necessary to meet

water quality standards.[5] The limitations necessary to meet water quality standards are also called the water quality-based effluent limitations. NPDES permits are generally required to include numeric effluent limitations to implement the technology-based standard and water quality-based effluent limitations to attain the water quality standards.[6] (40 C.F.R. § 122.44.) However, the federal regulations allow the use of best management practices (BMPs) to control or abate the discharge of pollutants when numeric effluent limitations are infeasible. (40 C.F.R. § 122.44(k).) The SWRCB has determined that for municipal separate storm water permits, BMPs constitute valid effluent limitations to comply with both the technology-based and water quality-based effluent limitation requirements.[7] See SWRCB Orders WQ 91-03 and WQ 91-04. In fact, narrative effluent limitations requiring implementation of BMPs are generally the most appropriate form of effluent limitations when designed to satisfy technology requirements, including reduction of pollutants to the maximum extent practicable, and water quality-based requirements of the CWA.

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[5] SWRCB Order WQ 91-03 concluded that municipal permits must include effluent limitations necessary to achieve water quality standards. See Order WQ 91-03 at slip op. 36. Orange County and other interested persons have argued that section 402(p) does not require municipal permits to meet water quality standards. While disagreeing, it should be noted that section 402(p) contains explicit authority for states to require provisions in addition to the "maximum extent practical" controls.

[6] See memorandum "Numeric Effluent Limitations in NPDES Permits" from Elizabeth Miller Jennings, Senior Staff Counsel, State Water Resources Control Board, to Central Valley Regional Water Quality Control Board (Aug. 1, 1997).

[7] EPA has issued a national policy entitled "Interim Permitting Approach for Water Quality-Based Effluent Limitations in Stormwater Permits," 61 Fed. Reg. 43761 (Aug. 26, 1996), that addresses issues related to the type of effluent limitations that are appropriate to provide for attainment of water quality standards. The policy applies only to EPA, but EPA has encouraged states to adopt similar policies for storm water permits. The policy states that storm water permits need not include numeric water quality-based effluent limitations. Rather, BMPs should be used to attain water quality-based effluent limitations, which should be expanded in later permits if necessary to provide for attainment of water quality standards.

II. CONTENTIONS AND FINDINGS[8]

The petitioner seeks review of the Orange County permit adopted by the Regional Water Board. The Orange County NPDES permit, adopted by the Regional Water Board, applies to the incorporated cities in Orange County within the boundaries of the San Diego region. The Santa Ana Regional Water Board, on March 8, 1996, adopted an NPDES permit for storm water discharges from the incorporated cities of Orange County within the boundaries of the Santa Ana region.[9] Orange County had requested that the Santa Ana Regional Water Board adopt one permit for all of Orange County. The San Diego Regional Water Board preferred to retain jurisdiction but agreed to adopt a permit consistent with the permit adopted by the Santa Ana Regional Water Board. Both permits for Orange County are essentially identical and require the permittees to develop a plan establishing BMPs to control discharges to the "maximum extent practicable." The Orange County permittees adopted a plan called the "drainage area management plan" (DAMP) that was approved by the San Diego Regional Water Board on April 6, 1996.[10] Both permits also contain the same provision addressing receiving water limitations, which, in relevant part, states:

> "1. Receiving water limitations have been established based on beneficial uses, water quality objectives, and water quality standards contained in the Basin Plan, and amendments thereto, and on ambient water quality. They are intended to protect the beneficial uses and attain the water quality objectives contained in the Basin Plan. The discharge of urban storm water, or non-storm water, from a municipal storm sewer system

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[8] All other contentions raised in the petition which are not discussed in this order are dismissed. (Cal. Code Regs., tit. 23, § 2052; *People* v. *Barry* (1987) 194 Cal.App.3d 158 [239 Cal.Rptr. 349].)

[9] No petition was filed challenging the permit issued by the Santa Ana Regional Water Board.

[10] The DAMP was also approved by the Santa Ana Regional Water Board.

for which the permittees are responsible under the terms of this permit shall not cause continuing or recurring impairment of beneficial uses or exceedances of water quality objectives. The permittees will not be in violation of this provision so long as they are in compliance with the requirements set forth [in the following provision]."

"a. If the Executive Officer determines that a continuing or recurring impairment of beneficial uses or exceedances of water quality objectives has been caused by urban storm water discharges from the municipal storm sewer system, the following steps shall be taken. . . ."

The remainder of the provision requires the Executive Officer to evaluate the DAMP and if the Executive Officer determines that implementation of the DAMP will not have a reasonable likelihood of preventing future impairment of beneficial uses or exceedances of water quality objectives, the permittees would be required to submit a report evaluating impacts on water quality and proposing changes to implementation of the existing DAMP or proposing revisions to the DAMP. The permittees would then be required to implement the revised DAMP.

Petitioner contends that for several reasons, this receiving water limitations provision is inadequate under the CWA and its implementing regulations and under the Porter-Cologne Water Quality Control Act (Porter-Cologne Act). Petitioner points out that CWA section 402(b), and implementing regulations, require that NPDES permits issued by state agencies comply with the CWA. (33 U.S.C. 1342(b), 40 C.F.R. § 123.25.) The Porter-Cologne Act provides that permits issued subject to federal law must "ensure compliance with all applicable provisions of the [CWA and its implementing regulations], together with any more stringent effluent standards or limitations necessary to implement water quality control plans, or for the protection of

beneficial uses, or to prevent nuisance." (Cal. Water Code § 13377.) Petitioner contends that the receiving water limitations language fails to require attainment of water quality standards.

1. Contention: The receiving water limitations section fails to comply with the CWA and the Porter-Cologne Act because it does not prohibit discharges that "contribute to" as well as "cause" exceedances of water quality objectives as required by federal regulations.

Finding: The SWRCB agrees that the NPDES permit must prohibit discharges that "cause" or "contribute" to violations of water quality standards. Federal regulations specify requirements that must be included in each NPDES permit. (40 C.F.R. § 122.44.) Each NPDES permit must include limitations necessary to achieve water quality standards:

> "Limitations must control all pollutants or pollutant parameters (either conventional, nonconventional, or toxic pollutants) which the Director determines are or may be discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion above any State water quality standard, including State narrative criteria for water quality." (40 C.F.R. § 122.44(d)(1)(i).)[11] (Emphasis added.)

The receiving water limitations language of the Orange County NPDES permit requires the permittees to be responsible for those discharges that "cause continuing or recurring impairment of beneficial uses or exceedances of water quality objectives." To comply with the CWA, the phrase quoted in the immediately preceding sentence shall be interpreted so as to require permittees to control discharges that contribute to exceedances

[11] This provision applies to state programs. See 40 C.F.R. section 123.25.

of water quality objectives. Of course such contributions would have to be substantial (in more than a *de minimis* amount) contributions.

2. Contention: The petitioner contends that the receiving water limitations section in the permit violates the CWA and implementing regulations because it does not require compliance with water quality standards. The permit states that the permittees "will not be in violation of [receiving water limitations] so long as they are in compliance with the requirements" for evaluating the DAMP.

Finding: The SWRCB disagrees with petitioner's contention. In SWRCB Order WQ 96-13, the SWRCB reviewed and approved the storm water permit for certain permittees in the Santa Clara Valley issued by the San Francisco Bay Regional Water Board. The Santa Clara Valley permit contains a receiving water limitations section that specifically prohibits discharges that cause or contribute to a violation of water quality objectives, and states that the permittees "shall comply . . . through the timely implementation of control measures and other actions to reduce pollution in the discharge." (Emphasis added.) The receiving water limitations provision in the Orange County permit prohibits discharges that cause exceedances of water quality objectives, and states that the "permittees will not be in violation of this provision so long as they are in compliance with the requirements" for evaluating and improving the effectiveness of the DAMP. The Orange County permit receiving water limitations section is not, as a practical matter, different than the Santa Clara Valley permit approved by this SWRCB. In each case, compliance with the receiving water limitations is achieved by following a

procedure to evaluate and improve the BMPs where necessary to comply with water quality standards.

The SWRCB has already determined that the use of BMPs to achieve both the technology-based effluent limitations and the water quality-based effluent limitations complies with the CWA and the Porter-Cologne Act. See SWRCB Order WQ 91-03. Accordingly, the SWRCB agrees that use of the phrase that the "permittees will not be in violation of . . ." complies with the CWA and, in fact, used that same phrase in SWRCB Water Quality Order 97-03-DWQ (Waste Discharge Requirements for Discharges of Storm Water Associated with Industrial Activities Excluding Construction Activities, NPDES General Permit No. CAS000001) (the General Industrial Permit).

3. Contention: The petitioner contends that the receiving water limitations provision violates the CWA and implementing regulations because the mechanism for determining exceedances of receiving water limitations is unworkable and, therefore, would not result in achievement of water quality standards. The permittees are not considered to be in violation of receiving water limitations as long as the process for evaluating the DAMP are followed. This process, however, will not result in achievement of water quality standards because (1) it is very difficult to demonstrate that urban runoff has "caused" an exceedance of water quality objectives; (2) Regional Water Board staff stated at the Board hearing at which the permit was adopted that there were inadequate resources to oversee the storm water program; (3) the permit does not require submittal of information on the adequacy of the DAMP until after the Executive Officer determines that the plan will not result in achievement of water quality objectives;

and (4) the permit places no time schedule on review of the adequacy of the plan to meet water quality standards. The permit does not require any change to the DAMP until directed by the Executive Officer. Due to these limitations, water quality standards are not likely to be achieved.

Finding: Petitioner has raised legitimate concerns. As discussed above, permittees will be required to control discharges that contribute to exceedances of water quality objectives. The SWRCB's charge under Water Code section 13320 is to determine whether the Regional Water Board has acted appropriately. In this case, the Regional Water Board has directed its Executive Officer to determine when receiving water limitations have been exceeded. In order for such determinations to be made the Executive Officer must devote sufficient resources to make such determinations in a timely manner. Provided this is the case, it can be concluded that the permit is adequate to achieve water quality standards. This conclusion to uphold the permit language is further predicated on the fact that to do otherwise would result in two inconsistent storm water permits for Orange County.

III. ADDITIONAL ISSUES

While upholding the permit as appropriate, the SWRCB has concerns that future storm water permits contain the strongest and clearest possible language to protect water quality. As evidenced by the discussion at the January 7, 1998 workshop review of this petition, there are serious disagreements as to how best to ensure such protection. A review of the record leads to the following conclusions:

- Future storm water permits should contain consistent requirements to ensure water quality protection.
- Such permits must comply with CWA and Porter-Cologne Water Quality Control Act requirements.
- Storm water permits must achieve compliance with water quality standards, but they may do so by requiring implementation of BMPs in lieu of numeric water quality-based effluent limitations.
- Permittees must ultimately be responsible for evaluating and revising BMPs to achieve compliance with water quality standards.
- Permits should be written to clearly identify water quality standards and to clearly require that permittees, through the implementation of BMPs, shall not cause or contribute to exceedances of such water quality standards.
- Given the unique nature of the storm water discharges, it is reasonable that implementation take place, where appropriate, on a phased basis.
- Determinations that additional BMPs are necessary to achieve water quality standards should be based on findings by the permittees or the Regional Boards that storm water discharges are a substantial (in more than a *de minimis* amount) contributor to continuing or recurring exceedances of such standards.

Based upon these conclusions and as a precedent decision,[12] the following receiving water limitation language shall be included in future municipal storm water permits.

RECEIVING WATER LIMITATIONS

1. Storm water discharges and authorized non-storm water discharges to any surface or ground water shall not adversely impact human health or the environment.

2. The SWMP shall be designed and implemented, or shall be in the process of being revised in accordance with the procedures set forth below to ensure that discharges authorized by this permit shall not cause or substantially (in more than a *de minimis* amount) contribute to a continuing or recurring exceedance of any applicable water quality standards contained in a Statewide Water Quality Control Plan or the applicable Regional Water Quality Control Board's Basin Plan.

3. If the discharges cause or contribute to an exceedance of the applicable water quality standards, permittee shall take the following steps:

   a. Upon a determination by either the facility operator or the Regional Water Board that discharges are causing or contributing to an exceedance of an applicable water quality standard, the facility operator shall promptly notify and thereafter submit a report to the appropriate Regional Water Quality Control Board that describes BMPs that are currently being implemented and additional BMPs that will be implemented to prevent or reduce any pollutants that are causing or contributing to the exceedance of water quality standards. The report may be incorporated in the annual update to the SWMP unless the Regional Water Board directs an earlier submittal. The report shall include an implementation schedule. The Regional Water Quality Control Board may require modifications to the report;

   b. Submit any modifications to the report required by the Regional Board within 30 days of notification;

[12] In SWRCB Order WR 96-1, the SWRCB determined that water quality orders are precedent decisions. (See Gov. Code § 11425.60.)

c. Within 30 days following approval of the report described above by the Regional Water Quality Control Board, the facility operator shall revise its SWMP and monitoring program to incorporate the approved modified BMPs that have been and will be implemented, the implementation schedule, and any additional monitoring required;

d. Implement the revised SWMP and monitoring program in accordance with the approved schedule; and

e. Reduce pollutants in storm water discharges and authorized non-storm water discharges, following implementation of the SWMP revised in accordance with paragraph 3 above, to levels which shall not cause or contribute to an exceedance of any applicable water quality standards.

4. So long as permittees have complied with the procedures set forth in paragraph 3 above and are implementing the revised SWMP, they do not have to repeat the same procedure for continuing or recurring exceedances of the same receiving water limitations unless directed by the Regional Water Board to develope additional BMPs.

IV. CONCLUSIONS

After review of the record and consideration of the contentions of the petitioner, and for the reasons discussed above, we conclude:

1. The federal regulations implementing CWA section 402(p) require NPDES permits to prohibit discharges of pollutants that "cause or contribute" to exceedances of water quality standards and the permit will be so interpreted.

2. The specific portion of the receiving water limitations provision that states that "permittees will not be in violation of this provision so long as they are in compliance with the requirements" specifying the process for evaluating and improving the effectiveness of the DAMP complies with the CWA.

3. The Regional Water Board acted appropriately in adopting the permit.

4. Receiving water limitation provisions of future municipal storm water permits shall be consistent with this Order.

V. ORDER

IT IS ORDERED that Order 96-03 shall be interpreted as discussed above. It is further ordered that in other respects, the petition is denied.

CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on January 22, 1998.

AYE:	John Caffrey Marc Del Piero Mary Jane Forster John W. Brown
NO:	None
ABSENT:	James M. Stubchaer
ABSTAIN:	None

Maureen Marché
Administrative Assistant to the Board

EXHIBIT "8"

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

ORDER: WQ 2000 - 11

In the Matter of the Petitions of
THE CITIES OF BELLFLOWER, ET AL., THE CITY OF ARCADIA, AND WESTERN STATES PETROLEUM ASSOCIATION
Review of January 26, 2000 Action of the Regional Board
and
Actions and Failures to Act
by both the
California Regional Water Quality Control Board,
Los Angeles Region and Its Executive Officer
Pursuant to Order No. 96-054,
Permit for Municipal Storm Water and Urban Run-Off Discharges Within
Los Angeles County
[NPDES NO. CAS614001]

SWRCB/OCC FILES A-1280, A-1280(a) and A-1280(b)

BY THE BOARD:

On July 15, 1996, the Los Angeles Regional Water Quality Control Board (Regional Water Board) issued a revised national pollutant discharge elimination system (NPDES) permit in Order No. 96-054 (permit) to the 85 incorporated cities and the county within Los Angeles County (the County).[1] The permit covers storm water discharges from municipal separate storm sewer systems throughout the County.[2]

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[1] This was the second storm water permit adopted for Los Angeles County and its cities. The first permit was the subject of an earlier Order. (In the Matter of Natural Resources Defense Council, Inc., Order WQ 91-04). In this permit, the County is designated as the Principal Permittee, and each city is designated as a permittee. The County is required to submit various documents on behalf of all of the permittees.
[2] The Regional Water Board has since issued a separate permit for one city, Long Beach. The relevant provisions of the Long Beach permit are similar to those in Order No. 96-054.

The permit contains provisions for the regulation of storm water discharges from development planning and construction.[3] Pursuant to these provisions, the County was required to submit Standard Urban Storm Water Mitigation Plans (SUSMPs).[4] The SUSMPs are plans that designate best management practices (BMPs) that must be used in specified categories of development projects. The County submitted SUSMPs, but the Regional Water Board approved the SUSMPs only after making revisions. The Executive Officer issued the revised SUSMPs on March 8, 2000.[5]

On February 25, 2000, the State Water Resources Control Board (State Water Board or Board) received a petition for review of the actions and failures to act regarding the SUSMPs from a number of cities, the Building Industry Association of Southern California and the Building Industry Legal Defense Foundation (jointly referred to as Cities). A second petition was received from the City of Arcadia. And a third petition was received from the Western States Petroleum Association (WSPA). On April 7, 2000, the petitioners filed amendments to their petitions, concerning the March 8, 2000 issuance of the SUSMPs. The Cities' amendment also revised the list of cities included in the petition. The Cities' petition now includes 32 cities. The petitions are legally and factually related, and have therefore been consolidated for purposes of review.[6] The petitioners also requested a stay of the SUSMPs. This request was denied by letter, dated May 11, 2000.

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[3] Permit, Part 2.III. These provisions focus more on post-construction impacts of development than on discharges from construction activities.
[4] Permit, Part 2.III.A.1.c.
[5] These are referred to herein as the Final SUSMPs. The Final SUSMPs also apply to Long Beach, even though it is subject to a separate permit.
[6] Cal. Code of Regs., tit. 23, section 2054.

On June 7 and 8, 2000, the Board held a hearing in Torrance. Several entities, including the petitioners, the Regional Water Board, and several environmental groups[7], were designated parties. The evidence from that hearing has been included in the record before the Board. The record for comments on the petition was kept open until the end of the hearing. The parties were allowed to submit post-hearing briefs.[8]

I. BACKGROUND

In prior Orders[9] this Board has explained the need for the municipal storm water programs and the emphasis on BMPs in lieu of numeric effluent limitations. The emphasis for preventing pollution from storm water discharges is still on the development and implementation of effective BMPs, but with the expectation that the level of effort will increase over time. In its Interim Permitting Approach[10], the United States Environmental Protection Agency (U.S. EPA) stated that first-round permits should include BMPs, and expanded or better-tailored BMPs in subsequent permits where necessary to attain water quality standards. Dischargers, consultants, and academic institutions in California and nationwide have conducted numerous studies on the effectiveness of BMPs and appropriate design standards. While many questions are still

[7] The environmental groups are Natural Resources Defense Council, Inc., Santa Monica BayKeeper, and Heal the Bay.

[8] There are several documents that were not timely received and, therefore, are not made a part of the record before the Board. The hearing notice specified that all evidence from parties must be received by May 31, 2000. The Regional Water Board submitted documents on June 6, 2000. The hearing notice specified that policy statements were due by the close of the hearing. Several comment letters were received June 12, 13, and 19, 2000. None of these submittals are a part of the record. The post-hearing briefs were subject to a 10-page limit. The environmental groups submitted objections to the post-hearing brief submitted by the Cities. First, the environmental groups challenge the length of the brief. All briefs were subject to a 10-page limit. The Cities submitted a 10-page brief, with a 22-page attachment showing extensive proposed revisions to the SUSMPs. This submittal violates the page limit, and only the brief is considered part of the record. Second, the environmental groups claim that an e-mail message referred to by the petitioners is subject to attorney-client privilege and should not have been used in this hearing. This e-mail message, from the Regional Water Board's counsel to one of its engineers, was placed in the Regional Water Board's administrative record and submitted to the State Water Board. Any privilege that may have attached to the message has been waived and no longer exists. Finally, the post-hearing brief from the City of Arcadia was received late and will not be considered. Documents submitted late for interim deadlines (such as the deadline for submitting responses to the petitions), have been included in the record.

[9] See, especially Orders WQ 91-03 (In the Matter of Citizens for a Better Environment et al.) and WQ 91-04.

[10] Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits. (61 Federal Register 57425.)

outstanding, more is expected of municipal dischargers, and many are implementing more effective programs.

While storm water management plans are improving, our knowledge of the impacts is also growing. Urban runoff has been determined to be a significant contributor of impairment to waters throughout the state. In Los Angeles specifically, beach closures are sometimes associated with urban runoff. In adopting the SUSMPs, the Regional Water Board took note of the urgent need for preventing further pollution from urban runoff and storm water discharges.

It is important to emphasize the role of the SUSMPs within the totality of regulating storm water discharges, and the purpose of these particular control measures. The requirement to prepare SUSMPS was part of the development controls in the permit. In addition to development controls, the permit requires education, public outreach, programs to restrict illicit connections and discharges, and controls on public facilities. In the context of the entire effort required by the permit, the development controls can be seen as preventing the existing situation from becoming worse.

The Final SUSMPs include a list of mandatory BMPs for nine categories of development. There are provisions that are applicable to all categories and lists of BMPs for individual categories. Requirements applicable to all categories include provisions to limit erosion from new development and redevelopment, requirements to conserve natural areas, protection of slopes and channels, and storm drain stenciling. Examples of BMPs specific to categories of discharge include design of loading docks for commercial projects and design of fueling areas for retail gasoline outlets. In most respects, the Final SUSMPs were similar to those proposed by the County. The significant departures were the inclusion of a numeric design standard for structural or treatment control BMPs, and the inclusion of certain types of projects that were not

covered in the County's proposal. The design standard creates objective and measurable criteria for the amount of runoff that must be treated or infiltrated by BMPs.

The record indicates that the purpose of the development controls, including the SUSMPs, is not simply to prevent pollution associated with construction runoff. As the petitioners point out, construction discharges are already subject to this Board's Statewide Construction Permit. The development controls in the SUSMPs, on the other hand, focus on post-construction runoff. They are aimed at limiting not just the pollutants in runoff from the new development, but also the volume of runoff that enters the municipal storm sewer system. By limiting runoff from new development, the SUSMPs prevent increased impacts from urban runoff generally. There is adequate technical information in the record to show that by controlling the volume of runoff from new development, BMPs can be effective in reducing the discharge of pollutants in storm water runoff.

The Procedure for Adopting the SUSMPs

The permit requires a program for controls on Development Planning and Construction. It involved a number of submissions by the County in consultation with the Cities. The first step was submission of a checklist for determining priority projects and exempt projects. The checklist was due on January 30, 1998. A list of recommended BMPs for development projects was also due on that date. The SUSMPs were due within six months of approval of the BMP list, and were to incorporate BMPs for certain categories of development. Following approval of the SUSMPs, the cities and County were to implement development programs for priority projects, consistent with the BMP list and the SUSMPs.

The BMP list was not approved until April 22, 1999. Thereafter, the County submitted proposed SUSMPs on July 22, 1999. The Regional Water Board held a public workshop on

August 10, 1999. Following the workshop, the County submitted revisions to the SUSMPs on August 12, 1999. On August 16, 1999, the Regional water Board gave notice that it would discuss the SUSMPs in a public meeting on September 16, 1999. There was significant discussion at that meeting regarding the intent of the Executive Officer to approve the SUSMPs, but with revisions including a numeric design standard. At the conclusion of the meeting, the Regional Water Board members asked the Executive Officer to revise the SUSMPs and bring them back to another meeting. On December 7, 1999, the Executive Officer circulated revised SUSMPs for public review. This document incorporated a numeric design standard and made other revisions to the permittees' proposal. The Regional Water Board held a hearing on the SUSMPs on January 26, 2000. At that meeting, the Regional Water Board endorsed the SUSMPs revised by the Executive Officer, but directed him to make further changes. The Executive Officer issued the Final SUSMPs on March 8, 2000.

The Contents of the Final SUSMPs

The permit provides that the SUSMPs must incorporate the appropriate elements of the BMP list and, at a minimum, apply to seven development categories: 100-plus home subdivisions; 10-plus home subdivisions; 100,000-plus square foot commercial developments; automotive repair shops; retail gasoline outlets; restaurants; and hillside single-family dwellings.

The SUSMPs proposed by the County applied to these seven categories. Various BMPs applied to the different categories, and the SUSMPs contained narrative mitigation requirements for source control and treatment. The July proposals stated:

> "The development must be designed so as to mitigate (infiltrate and/or treat) the site runoff generated from impervious directly connected areas that may contribute pollutants of concern to the storm water conveyance system."

There were no numeric design criteria for mitigation. According to various participants, earlier County drafts had included design standards to mitigate flows from 0.6-inch storm events. But any numeric criteria had been removed from the version that was submitted.

In its revised SUSMPs, submitted on August 12, the County explained in its cover letter that the mitigation language did not mean that all runoff must be mitigated. Rather, the County's intent was to omit a numerical standard from the SUSMPs. The revised SUSMPs no longer referred to mitigation at all. Instead, the following language replaced the mitigation requirement:

> "The development must be designed so as to minimize, to the maximum extent practicable (MEP), the introduction of pollutants of concern that may result in significant impacts, generated from site runoff of directly connected impervious areas (DCIA), to the storm water conveyance system as approved by the building official."

The Final SUSMPs, as approved by the Executive Officer and the Regional Water Board, included several revisions from the County's submittal. The revision that is of greatest concern to the petitioners is the addition of Design Standards for Structural or Treatment Control BMPs.[11] The design standards require that developments subject to the SUSMPs shall be designed to mitigate storm water runoff (by treatment or infiltration) from one of the following:

> "1. The 85th percentile 24-hour runoff event determined as the maximized capture storm water volume for the area..., or
>
> 2. The volume of annual runoff based on unit basin storage water quality volume, to achieve 80 percent or more volume treatment..., or
>
> 3. The volume of runoff produced from a 0.75 inch storm event, prior to its discharge to a storm water conveyance system, or
>
> 4. The volume of runoff produced from a historical-record based reference 24-hour rainfall criterion for "treatment" (0.75 inch average for the Los Angeles County area) that achieves approximately the same reduction in pollutant loads achieved by the 85th percentile 24-hour runoff event."

[11] The Final SUSMPs also include the narrative language quoted from the County's August 22, 1999 proposal.

The Final SUSMPs also applied to two additional categories of development: parking lots over 5,000 square feet or with 25 or more spaces and exposed to storm water, and to developments in environmentally-sensitive areas. Other revisions included application to all projects in the categories instead of discretionary projects only and the definition of redevelopment.

II. CONTENTIONS AND FINDINGS[12]

Contention: The petitioners contend that the Regional Water Board erred in not complying with the Administrative Review Process within the permit, and acted arbitrarily and capriciously and in violation of the Clean Water Act and state law.

Finding: The permit required the County, in consultation with the cities subject to the permit, to submit SUSMPs. The permit includes some general minimum requirements for the SUSMPs.[13] The Executive Officer is granted authority to approve the SUSMPs.[14]

The permit also contains an administrative review process.[15] The permit states that the administrative review process "formalizes the procedure for review and acceptance of reports and documents" and "provides a method to resolve any differences in compliance expectations between the Regional Board and Permittees, prior to initiating enforcement action."[16] Following this introductory statement, the permit includes two procedures. The first is for review and approval or disapproval of reports and documents. The second is the dispute resolution section that must be followed prior to enforcement action.

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[12] This Order does not address all of the issues raised by the petitioners. The Board finds that the issues that are not addressed are insubstantial and not appropriate for State Water Board review. (See *People v. Barry* (1987) 194 Cal.App.3d 158, [239 Cal.Rptr. 349], Cal. Code Regs., tit. 3, § 052.)
[13] Permit, Part 2, III.A.1.c.
[14] Permit, Part 2, III.A.2.
[15] Permit, Part 2, I.G.
[16] *Id.*

The process for review of documents that are subject to the Executive Officer's approval is that the Executive Officer will notify the permittees of the results of the review and approval or disapproval within 120 days. If the Executive Officer does not do so, the permittees must notify the Regional Water Board of their intent to implement the documents without approval. The Executive Officer then has 10 days to respond, or the permittees may implement the program and the Executive Officer may not make modifications.

The dispute resolution procedure is to be used when the Executive Officer determines that a permittee's storm water program is insufficient to meet the permit's provisions. The Executive Officer must send a "Notice of Intent to Meet and Confer" with the permittee. A meet and confer period then ensues, resulting in a written "Storm Water Program Compliance Amendment (SWPCA)." The permittee is provided time to comply with the SWPCA. The Executive Officer is not allowed to take enforcement action against a permittee until the Executive Officer notifies the permittee in writing that the administrative review process has been exhausted and that a violation exists warranting enforcement.

The petitioners contend that the Executive Officer failed to notify the permittees that their SUSMPs were inadequate within 120 days of its submittal. The petitioners also argue that, by revising the SUSMPs without pursuing the dispute resolution process, the Regional Water Board "violated" the terms of the permit.

The provision for review of documents, which clearly includes the SUSMPs, requires that the Executive Officer notify the permittees of the results of the review and approval or disapproval within 120 days. The County submitted the revised SUSMPs on August 12, 1999. Within 120 days, the Regional Water Board held a workshop where staff expressed their concerns with the SUSMPs. Also within 120 days the Regional Water Board itself held a public

meeting where there was extensive discussion and concern by board members that the SUSMPs did not include a numeric standard. And, prior to any notification by the permittees that they would proceed with implementing their SUSMPs, the Regional Water Board held a hearing January 26, 2000, where it directed the Executive Officer to issue the SUSMPs with revisions. The Executive Officer did so on March 8, 2000.

It is clear from the record that the Executive Officer, and the Regional Water Board itself, did inform the permittees that the SUSMPs were inadequate. There was no requirement for a specific form for expressing disapproval of documents. The extensive discussion and meetings on the need for revisions to the SUSMPs, and the Executive Officer's approval of revised SUSMPs, plainly refutes the allegation that the Regional Water Board never notified the permittees of its disapproval of the County's proposed SUSMPs.

The permittees also claim that the Regional Water Board "violated" the permit by failing to institute the meet and confer process.[17] The dispute resolution process, which includes meet and confer, did not apply to the decision to disapprove the proposed SUSMPs. That process is only required when the Regional Water Board ultimately takes an enforcement action against a permittee. It is separate from the process for review and approval or disapproval of documents, and does not even appear to relate to possible enforcement actions for submission of inadequate documents. This is illustrated by the fact that the provision regarding documents refers to submittals from both the Principal Permittee and the individual permittees, while the dispute resolution provision refers only to the permittees. This distinction is relevant because the County is charged with submitting the documents, while the individual permittees are responsible for compliance. A fair reading of the entire section on the administrative review process is that the

[17] We note that permits are issued to permittees to allow discharges to waters of the state. It is only permittees, and not Regional Water Boards, who can be charged with violating permits.

review and approval or disapproval of documents applies to submission of documents by the County on behalf of the cities, while the dispute resolution process applies to enforcement actions against any permittees for failing to implement adequate programs.

Contention: The petitioners contend that the Regional Water Board was not authorized to revise the SUSMPs to add more stringent requirements.

Finding: The petitioners contend that the mitigation standards in the SUSMPs are more stringent than the requirement in the permit to reduce pollutants in storm water runoff to the maximum extent practicable (MEP)[18]. The issue of what level of protection constitutes MEP will be discussed *Infra*, in the discussion of the reasonableness of the numeric standards. But the petitioners also make certain procedural claims on this point. They argue that in approving the BMP list, the Regional Water Board determined that those BMPs constituted MEP and that the Board could not add additional BMPs in the SUSMPs. They also contend the Regional Water Board itself had no authority to "usurp" the Executive Officer's role in reviewing the SUSMPs.[19] Finally, the petitioners contend that the Regional Water Board was not authorized to mandate a program for the permittees without amending the permit.

The permit requires the County to submit a list of BMPs for approval. The Regional Water Board approved this list. Following approval of the list, the County was required to submit the SUSMPs, which must "incorporate the appropriate elements of the recommended BMPs list."[20] The petitioners contend that by approving the list, the Regional Water Board determined that those BMPs constituted MEP, and that under the terms of the permit the Regional Water Board could not require additional BMPs.

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[18] The technology-based standard for controls under municipal storm water permits is MEP. For a fuller discussion of this standard, see Order WQ 91-03.
[19] It is undisputed that, at its January 26, 2000 meeting, the Board directed the Executive Officer to make additional revisions to the SUSMPs.
[20] Permit, Part 2, III.A.1.c.

In addressing this contention, we face what appears to be a fundamental misunderstanding of the numeric design standards on the part of the petitioners. The design standards are objective criteria that developers must achieve in designing their BMPs. The design standards are not separate BMPs. The standards tell what magnitude of storm event the BMPs must be designed to treat or infiltrate. They do not specify the BMPs that must be employed.

The SUSMPs as submitted by the County specify BMPs for various categories of development. Many of these BMPs are designed to minimize the pollutants in storm water runoff, by reducing flow through infiltration or by treatment. Examples of BMPs proposed by the County include infiltration basins and trenches, oil/water separators, and media filtration. The County's proposed SUSMPs also included language requiring minimizing the introduction of pollutants to the storm water conveyance system. That language remains unchanged in the Final SUSMPs. The only significant difference between the two versions of the SUSMPs was that the Regional Water Board established numeric criteria for designing the BMPs.

In adopting the Final SUSMPs, the Regional Water Board based its decision on the MEP standard.[21] The Regional Water Board did not significantly revise the BMP list or specify further the actions that developers must take to comply with the SUSMPs. Thus, we find that the Regional Water Board did not inappropriately revise its determination of what constituted MEP.

The Regional Water Board is the political body responsible for water quality control in the Los Angeles region.[22] While the Regional Water Board may delegate specified powers and duties to its Executive Officer,[23] it can at any time act on its own behalf. The fact that the Board authorized its Executive Officer to approve the SUSMPs in the permit did not mean that the Board thereby denied itself the opportunity to provide direction to the Executive Officer in his

[21] Resolution R-00-02.
[22] Water Code sections 13200 and 13225.
[23] Water Code section 13223.

approval. Such an interpretation of its delegation authority would result in an improper failure of the Board to assume responsibility for water quality in the region.

We also find that the Regional Water Board was authorized to revise the SUSMPs to achieve compliance with the permit's requirements. The SUSMPs are a part of implementation of the permit. Because the permit regulates storm water discharges throughout the entire Los Angeles region and it is implemented by 85 cities and the County, it is obvious that the permit could not spell out every detail of the program for the five-year term of the permit. Instead, the implementation is through the submission, review and approval, and implementation of various programs, including the SUSMPs.[24] Where it receives a submission that it finds is not consistent with the requirements of the permit, it is reasonable for the Regional Water Board to be able to require revisions. The Regional Water Board is not required to amend the permit each time it approves a submittal or approves a submittal with revisions. On the other hand, if the Regional Water Board's action in requiring revisions is inconsistent with the terms of the permit, then the Board should not act without first amending the permit. While the Regional Water Board could have required the County to make the revisions rather than making them itself, we see no harm in the Regional Water Board's approach.

As will be discussed below, in most respects the Final SUSMPs are consistent with the permit. But there are some portions of the SUSMPs that are not consistent, and in those cases the SUSMPs provisions are further revised in this Order.

Contention: The petitioners make various procedural claims, including that they were denied due process, and that the Regional Water Board violated the Administrative Procedure

[24] A fuller discussion of the use of storm water management plans to incorporate a developing program is found in Order No. WQ 91-03.

Act, the California Environmental Quality Act (CEQA), and the California Constitution, Article XIII B, section 6 (regarding state mandates).

Finding: The petitioners point out that at the January 26, 2000 Regional Water Board hearing, there was some confusion over late changes to the SUSMPs and they contend they were not provided adequate opportunity to comment. There was significant discussion of the SUSMPs over several months. We do not agree with the petitioners that a program of this magnitude must necessarily take years to develop. But we are concerned that at the January 26, 2000 hearing, interested persons and permittees were not given adequate time to review late revisions or to comment on them. Given the intense interest in this issue, the Regional Water Board should have diverged from its strict rule limiting individual speakers to three minutes and conducted a more formal process. Such a process should provide adequate time for comment, including continuances where appropriate.[25] But to the extent the Regional Water Board's process caused any harm, this Board cured those harms. We held a two-day hearing in Los Angeles County, where all parties were allowed significant time to present their positions and testimony. In addition, we allowed the introduction of new evidence that had not been presented to the Regional Water Board. At this point, all parties have been afforded a full opportunity to review the Final SUSMPs, to present their positions and evidence, and to engage in cross-examination. The petitioners' due process rights have been protected.

The Board has already addressed the contentions regarding compliance with other laws in prior decisions. The Administrative Procedure Act exempts the adoption of permits from its requirements.[26] While the SUSMPs are not a permit, they are implementing documents for a

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[25] For future adjudicative proceedings that are highly controversial or involve complex factual or legal issues, we encourage regional water boards to follow the procedures for formal hearings set forth in Cal. Code of Regs., tit. 23, section 648 et seq.

[26] Government Code section 11352; See, Order No. 95-4 (In the Matter of the City and County of San Francisco).

permit, and are therefore subject to the exemption. Moreover, they are relevant only to this permit, and are not a general rule of application. The constitutional provisions regarding state mandates also do not apply to NPDES permits.[27] As will be explained below, the SUSMPs as revised herein, are consistent with MEP and therefore are federally mandated. The provisions of CEQA requiring adoption of environmental documents also do not apply to NPDES permits.[28] Again, as an implementing document for the permit, there is no requirement for a separate CEQA analysis.[29]

Contention: The petitioners contend that the SUSMPs do not properly apply the maximum extent practicable standard.

Finding: The permit, consistent with Clean Water Act section 402(p)(3)(B)(iii), requires controls to reduce the discharge of pollutants to the maximum extent practicable, or MEP.[30] In approving the Final SUSMPs, the Regional Water Board acknowledged that one of the primary objectives of the municipal storm water program is the requirement to reduce the discharge of pollutants from storm water conveyance systems to the MEP.[31] While all parties appear to agree that the standard for the SUSMPs is MEP, they disagree about what level of effort is necessary to comply with that standard.

The petitioners approach this issue from two angles. First, they contend that the SUSMPs will not provide water quality benefits that reflect MEP. Second, they contend that there could be adverse impacts on groundwater quality that have not been adequately evaluated.

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[27] See, Order No. WQ 90-3 (In the Matter of San Diego Unified Port District).
[28] Water Code section 13389.
[29] We do note with interest the environmental groups' comment that if the permittees believed it was necessary to comply with the APA and CEQA prior to adoption of the SUSMPs, then they themselves would have violated those acts in their submissions of the proposed SUSMPs.
[30] Permit, Finding 13.
[31] Final SUSMPs, at page 2; Resolution No. R-00-02, at page 3.

Storm Water Design Standards as MEP

In adopting the Final SUSMPs, the Regional Water Board found that many rivers and streams in Los Angeles County are impaired for pollutants found in storm water and urban runoff, and that storm water runoff carries pollutants from nearly all types of developed properties.[32] Pollutant loading from the aggregate of development in the basin results in impairments from sediments, metals, complex organic compounds, oil and grease, nutrients, and pesticides.[33] The Final SUSMPs reflect two goals: to reduce the amounts of these pollutants in runoff and to reduce the ability of runoff to act as a conveyance system to deliver more pollutants to receiving waters. The Final SUSMPs, which include lists of BMPs and design standards requiring treatment or infiltration, address these two goals.

Clean Water Act section 402(p)(3)(B)(iii), which sets forth the requirements for establishing MEP in municipal storm water permits, provides that such permits "shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants." The United States Environmental Protection Agency (U.S. EPA), in a guidance document, explains that BMPs should be used in first-round storm water permits, and "expanded or better-tailored BMPs in subsequent permits, where necessary, to provide for the attainment of water quality standards."[34] The Clean Water Act, as interpreted by U.S. EPA, does require that, in a second-round permit,[35] expanded BMPs may be appropriate. In light of the number of water

[32] Resolution No. R-00-02.
[33] *Id.*
[34] Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits, 61 Federal Register 57425 (1996).
[35] The original permit was issued in 1990. The 1996 permit is a second-round permit.

bodies impaired by runoff in Los Angeles County, it was appropriate to expand the scope of BMPs during the permit term.

The regulations implementing section 402(p) specifically require municipalities to have controls to reduce the discharge of pollutants from their storm sewer systems that "receive discharges from areas of new development and significant redevelopment," including post-construction discharges.[36] Clearly, it was appropriate for the Regional Water Board to require BMPs for new development and significant redevelopment. The permittees, who submitted their own version of SUSMPs with listed BMPs for categories of development, appear to have no real quarrel with this general mandate.

This Board has already endorsed requirements to limit the flow of the "first flush" of storm water, which may contain more significant pollutants.[37] The permittees' own version of the SUSMPs required mitigation of storm water runoff by treatment or infiltration, thus conceding the propriety of these two approaches to lessening the impact of storm water discharges. The crux of the disagreement is that the Regional Water Board added numeric design standards to establish the amount of runoff that must be treated or infiltrated, and required the mandatory application of these standards to categories of development.

The addition of measurable standards for designing the BMPs provides additional guidance to developers and establishes a clear target for the development of the BMPs. The U.S. EPA guidance manual suggests the use of design criteria and performance standards for post-construction BMPs.[38] The numeric criteria the Regional Water Board adopted essentially

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[36] 40 CFR section 122.26(d)(2)(iv)(A)(2).
[37] In the Matter of National Steel and Shipbuilding Company, et al., Order WQ 98-07, at slip opinion 7.
[38] Guidance Manual for the Preparation of Part 2 of the NPDES Permit Applications for Discharges from Municipal Separate Strom Sewer Systems, at page 6-4 (November 1992).

requires that 85 percent of the runoff from the development be infiltrated or treated.[39] In adopting these standards, the Regional Water Board based its decision on a research review of standards in other states and a statistical analysis of the rainfall in the area. The standard was set to gain the maximum benefit in mitigation while imposing the least burden on developers.[40] In light of the evidence of the use of this or more stringent standards in other states, the expert testimony supporting this standard, the endorsement by U.S. EPA in its comments, and the cost-effectiveness of its implementation (discussed below), the Regional Water Board acted appropriately in determining that the standards reflect MEP.[41]

We also find that the Regional Water Board appropriately applied these standards to seven of the categories listed in the SUSMPs: single-family hillside residences, 100,000 square foot commercial developments, automotive repair shops, restaurants, home subdivisions with 10 to 99 housing units, home subdivisions with 100 or more housing units, and parking lots with 5,000 square feet or more or with 25 or more parking spaces and potentially exposed to storm water runoff.[42] These categories, except for parking lots, were already targeted for special treatment in the permit. The evidence shows that each listed category can be a significant source of pollutants and/or runoff following development. It is appropriate that the design standards apply so that BMPs for these categories of development result in the infiltration or treatment of a significant about of the runoff.

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[39] Four different methods of calculation are permitted, so the percentage of capture may vary slightly.

[40] At the hearing in this matter, Regional Water Board staff explained that the standard was set at the bottom of the "knee" of the curve where the benefits of the mitigation requirements decrease and the cost increases. Other states have set the standard higher along this curve, requiring 90 to 95 percent mitigation.

[41] This conclusion in no way departs from our acceptance of BMPs in lieu of numeric effluent limitations in storm water permits. (See, e.g., Order WQ 91-03 and Order WQ 91-04.) The numeric standard is a design standard for BMPs. It does not quantify or limit the pollutants in the effluent. It also does not specify which of the listed BMPs must be employed.

[42] As discussed below, this Board is revising the SUSMPs to delete the application of the design standards to retail gasoline outlets and to locations within or directly adjacent to or discharging directly to environmentally-sensitive areas.

Potential Impacts on Ground Water

The petitioners contend that infiltration of runoff may lead to ground water pollution, and that the Regional Water Board did not properly consider such potential impacts. The mitigation standards provide for a waiver where there is a risk of ground water contamination because a known unconfined aquifer lies beneath the land surface or an existing or potential underground source of drinking water is less than ten feet from the soil surface.[43] The Final SUSMPs also include a discussion on how to use infiltration so that the risk of contamination of groundwater is reduced, and where infiltration is not appropriate.[44]

The Regional Water Board did consider the potential impacts to groundwater from infiltration, and included appropriate limitations and guidance on its use as a BMP. These provisions will ensure adequate protection of groundwater from any adverse impacts due to infiltration.

Contention: The petitioners contend the Regional Water Board failed to show that the SUSMPs as adopted are cost-effective and that the benefits to be obtained outweigh the costs.

Finding: The petitioners refer to the Preamble to the Phase II storm water regulations[45] as the basis for their economic argument. The quoted language, however, does not wholly support the petitioners' contention. The Preamble states that President Clinton's Clean Water Initiative clarifies "that 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."[46] It is clear that cost should be considered in determining MEP; this does not mean that

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[43] Final SUSMP, page 14.
[44] *Id.*, at page 15.
[45] 64 Federal Register 68722 and following. These regulations do not apply to the permit, but the general language on MEP is relevant to EPA's interpretation of the standard.
[46] 64 Federal Register 68722, 68732 (December 8, 1999).

the Regional Water Board must demonstrate that the water quality benefits outweigh the economic costs.

While the standard of MEP is not defined in the storm water regulations or the Clean Water Act, the term has been defined in other federal rules. Probably the most comparable law that uses the term is the Superfund legislation, or CERCLA, at section 121(b). The legislative history of CERCLA indicates that the relevant factors, to determine whether MEP is met in choosing solutions and treatment technologies, include technical feasibility, cost, and state and public acceptance.[47] Another example of a definition of MEP is found in a regulation adopted by the Department of Transportation for onshore oil pipelines. MEP is defined as to "the limits of available technology and the practical and technical limits on a pipeline operator . . . ."[48]

These definitions focus mostly on technical feasibility, but cost is also a relevant factor. There must be a serious attempt to comply, and practical solutions may not be lightly rejected. If, from the list of BMPs, a permittee chooses only a few of the least expensive methods, it is likely that MEP has not been met. On the other hand, 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, it would have met the standard. MEP requires permittees to choose effective BMPs, and to reject applicable BMPs only where other effective BMPs will serve the same purpose, the BMPs would not be technically feasible, or the cost would be prohibitive. Thus while cost is a factor, the Regional Water Board is not required to perform a cost-benefit analysis.

In reviewing the record, it is apparent that the Regional Water Board did evaluate the cost of the SUSMPs. While the petitioners claim there is no evidence in the record to show the

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[47] 132 Cong. Rec. H 9561 (Oct. 8, 1986).
[48] 49 CFR section 194.5.

SUSMPs are necessary and cost effective, the opposite is true. The record is replete with documentation of costs of pilot mitigation projects, studies from similar programs in other states, and research studies. The Regional Water Board complied with the requirement to consider cost.

The Regional Water Board found that the cost to include BMPs that will meet the mitigation criteria will be one to two percent of the total development cost. This amount appears reasonable, especially in light of the amount of impervious surface already in Los Angeles County and the impacts on impaired water bodies. In considering the cost of compliance, it is also important to consider the costs of impairment. The beach closures in the Los Angeles region, well documented in the evidence, have reached critical proportions. These beach closures clearly have a financial impact on the area, and should be positively affected by the SUSMPs.

We do note that there could be further cost savings for developers if the permittees develop a regional solution for the problem. We recommend that the cities and the County, along with other interested agencies, work to develop regional solutions so that individual dischargers are not forced to create numerous small-scale projects. While the SUSMPs are an appropriate means of requiring mitigation of storm water discharges, we also encourage innovative regional approaches.[49]

Contention: The petitioners have raised contentions regarding details of the SUSMPs, including the amount of time allowed for inclusion of SUSMPs in local ordinances, and their application to both "discretionary" and "non-discretionary" projects. In addition, during the hearing certain ambiguities in the wording of the Final SUSMPs became apparent, including the provisions regarding redevelopment and environmentally-sensitive areas. In this portion of the

[49] We note that the SUSMPs as written do not in any way preclude the development of regional solutions approved by the Regional Water Board as a means to comply with the BMP and design standard requirements.

Order we address these issues and also the application of the design standards to retail gasoline outlets (RGOs) and the waiver funding requirements.

Finding: The testimony at the hearing in this matter revealed that there are specific provisions of the SUSMPs that create confusion as to the types of development projects subject to the mitigation design standards. The petitioners also contend that application of the standards to specific types of development either is unreasonable or is inconsistent with the terms of the permit. The specific requirements are discussed below.

Retail Gasoline Outlets

Petitioner WSPA contends that RGOs should be excluded from the SUSMPs. Its petition raised the same general contentions as the other petitioners, but at the hearing WSPA presented evidence specific to RGOs. In particular, WSPA raised questions about the propriety of applying the design standards for BMPs to RGOs. In considering this issue, we conclude that construction of RGOs is already heavily regulated and that owners may be limited in their ability to construct infiltration facilities. Moreover, in light of the small size of many RGOs and the proximity to underground tanks, treatment may not always be feasible, or safe. The mandatory BMPs that are included in the SUSMPs may be adequate to achieve MEP at RGOs, but the Regional Water Board should add additional mandatory BMPs, such as use of dry cleanup methods (e.g. sweeping) for removal of litter and debris, use of rags and absorbents for leaks and spills, restricting the practice of washing down hard surfaces unless the wash water is collected and disposed of properly, annual training of employees on proper spill cleanup and waste disposal methods, and the inclusion of BMPs to address trash receptacle areas and air/water supply

areas.[50] We conclude that because RGOs are already heavily regulated and may be limited in their ability to construct infiltration facilities or to perform treatment, they should not be subject to the BMP design standards at this time, and recommend that the Regional Water Board undertake further consideration of a threshold relative to size of the RGO, number of fueling nozzles, or some other relevant factor. This Order should not be construed to preclude inclusion of RGOs in the SUSMP design standards, with proper justification, when the permit is reissued.

Redevelopment Projects

The SUSMPs were written to apply to new development and to some types of redevelopment in nine categories of projects. The definition of "redevelopment" reflected the intent of the Regional Water Board to define the scope of redevelopment projects subject to the requirements. That definition[51], however, was somewhat confusing, and it was apparent from testimony at the hearing that the parties had different understandings of the scope of redevelopment subject to the SUSMPs. In their post-hearing briefs, the various parties appeared to agree on the actual intent of the Regional Water Board in including redevelopment in the SUSMPs. This intent was to include redevelopment that adds or creates at least 5,000 square feet of impervious surface to the original development and, where the addition constitutes less than 50 percent of the original development, to limit the application of the BMP design standards to the addition.

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[50] These BMPs are from a list of BMPs in a publication of the California Storm Water Quality Task Force. (Best Management Practice Guide – Retail Gasoline Outlets. March 1997.) This publication includes BMPs in addition to those listed in the SUSMPs. All BMPs recommended in this publication should be mandated.

[51] The SUSMPs state: "Redevelopment" means, on an already developed site, the creation or addition of at least 5,000 square feet of impervious surfaces or the creation or addition of fifty percent or more of impervious surfaces or the making of improvements to fifty percent or more of the existing structure. Redevelopment includes, but is not limited to: the expansion of a building footprint or addition or replacement of a structure; structural development including an increase in gross floor area and/or exterior construction or remodeling; replacement of impervious surface that is not part of a routine maintenance activity; and land disturbing activities related with structural or impervious surfaces.

While some parties requested further requirements for development, it appears that the Regional Water Board's original intent was relatively simple to apply and results in a fair and appropriate application of the SUSMPs' requirements to redevelopment. Therefore, we will revise the definition in the SUSMPs accordingly.

Environmentally-Sensitive Areas

The permit required that the SUSMPs address at least seven development categories.[52] The final SUSMPs added two more categories: parking lots of 5,000 square feet or more or with 25 or more parking spaces and potentially exposed to storm water runoff; and location within or directly adjacent to an environmentally-sensitive area (ESA). The petitioners contend that the addition of ESAs was inappropriate because the permit refers only to "development categories"[53] and ESA is a location category.

Whether or not the Regional Water Board went beyond the permit's terms in including this category, we find a fundamental problem with the language of the SUSMPs regarding ESAs. All of the other categories are relatively simple to apply because they describe the types of development that fall within the category. For instance, the threshold for a commercial development is 100,000 square feet. If the development is smaller, it is not subject to the SUSMPs. But for developments within ESAs, the SUSMPs contain no threshold. This absence led to speculation by the petitioners that something as small as a new patio on a home in an ESA would make the SUSMPs applicable. The Regional Water Board, at the hearing and in its post-hearing brief, conceded that there should be some threshold. While the Regional Water Board

[52] The categories listed in the permit are: single-family hill residences, 100,000 square-foot commercial developments, automotive repair shops, retail gasoline outlets, restaurants, home subdivisions with 10 to 99 housing units, and home subdivisions with 100 or more housing units. Permit, Part 2, III.A.1.c.
[53] *Id.*

did recommend a specific threshold, we believe that it is inappropriate for this Board to add a threshold that has not been fully discussed by all interested persons.

While it may be appropriate to include more stringent controls for developments in ESAs, we also note that such developments are already subject to extensive regulation under other regulatory programs. Moreover, in light of the permit language limiting the SUSMPs to development categories, ESAs are not an appropriate category within the SUSMPs. The Regional Water Board may choose to consider the issue further when it reissues the permit.

Discretionary and Non-Discretionary, or Ministerial, Projects

The petitioners contend that the SUSMPs should apply only to projects that are considered "discretionary" within the meaning of California Environmental Quality Act (CEQA).[54] They argue that the inclusion of non-discretionary, or ministerial, projects is inconsistent with the terms of the permit.

The permit provisions on development projects do refer to "discretionary" projects in several places. The permittees are directed to develop a checklist for determining priority and exempt projects.[55] Priority projects are defined as development and redevelopment projects requiring discretionary approval, which may have a potential significant effect on storm water quality.[56] The permittees are also required to develop a BMP list.[57] In developing the SUSMPs, the permittees are required to incorporate appropriate elements of the BMP list.[58] Next, the permittees must develop a program on planning control measures for priority projects (which are limited to projects requiring discretionary approval), consistent with the list of BMPs and the

[54] Public Resources Code section 21000 *et seq.*
[55] Permit, Part 2, III.A.1.a.
[56] *Id.*
[57] Permit, Part 2, III.A.1.b.
[58] Permit, Part 2, III.A.1.c.

SUSMPs.[59] The permit further states that, in order to assure compliance with these requirements, the permittees must develop guidelines on preparing CEQA documents that link mitigation conditions to "local discretionary project approvals."[60]

Taken as a whole, the provisions of the permit appear to link the development requirements for SUSMPs to developments that receive discretionary approval by local governments, as defined in CEQA. The SUSMPs are an implementation tool for the permit and must be consistent with the permit. While the limitation of the SUSMPs to discretionary projects may not be sufficiently broad for an effective storm water control program, the Regional Water Board acted inappropriately in expanding the SUSMPs to include non-discretionary projects. The Regional Water Board may consider expanding the development controls beyond CEQA discretionary projects when it reissues the permit. But at this time, the SUSMPs must be revised so that they are limited to development projects requiring discretionary approval within the meaning of CEQA.[61]

Waiver Funding Requirement

Where a waiver is granted from the design standard requirements, the Final SUSMPs provide that the permittee must require the project proponent to transfer the cost savings to a storm water mitigation fund. The fund is to be operated by a public agency or a non-profit entity, to promote regional or alternative solutions for storm water pollution in the same storm watershed. The petitioners contend that the funding requirement will create an additional administrative burden.

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[59] Permit, Part 2, III.a.2.
[60] Permit, Part 2, III.a.3.b.
[61] We note that the Final SUSMPs already include a definition of "discretionary project" consistent with the definition in the CEQA guidelines. Final SUSMPs at page 4 of 25; Title 14, California Code of Regulations, section 15357. Apparently this definition was inadvertently retained after the Regional Water Board decided to expand the SUSMPs beyond discretionary projects.

The concept of a mitigation fund or "bank" is a positive idea for obtaining regional solutions to storm water runoff. As a long-term strategy, municipal storm water dischargers should work to establish regional mitigation facilities, which may be more cost-effective and more technically effective than mitigation structures at individual developments. But at this point there are not sufficient resources in place to require all permittees to establish such funds or to find appropriate non-profit organizations. Before mandating funding, preliminary questions should be answered, including who will manage the fund, what types of projects it will be used for, what entities can legally operate such funds, and how permittees will determine the amount of the assessments. It would be appropriate for the County to consider developing a program with the appropriate flood control agency, or as a model for the separate cities to develop. There may be suitable agencies to administer such funds, but the development of programs may take some time. The Regional Water Board should consider adopting such a program when it reissues the permit, after consultation with the appropriate local agencies.

III. CONCLUSIONS

Based on the discussion above, the Board concludes that:

1. The Regional Water Board complied with the procedural requirements of the permit, including the Administrative Review Process, in approving the Final SUSMPs.
2. The Regional Water Board was authorized to revise the SUSMPs by including more stringent requirements than the permittees had proposed.
3. The Regional Water Board complied with did not violate the Administrative Procedure Act, CEQA, or the Constitutional provisions on state mandates. The petitioners' due process rights have been protected
4. The Regional Water Board considered the costs of the SUSMPs, and acted reasonably in requiring these controls in light of the expected benefits to water quality.

5. The Final SUSMPs reflect a reasonable interpretation of development controls that achieve reduction of pollutants in storm water discharges to the maximum extent practicable.
6. The SUSMPs include adequate protections of groundwater quality from any impacts from infiltration.
7. The SUSMPs will be revised to clarify the intent of the Regional Water Board and to make them consistent with the permit. Specifically, retail gasoline outlets should not be subject to the BMP design standards because they are already heavily regulated and may be limited in their ability to construct infiltration facilities or to perform treatment. Redevelopment projects should be subject to the SUSMPs only if they result in creation or addition of 5,000 square feet of impervious surfaces. Environmentally-sensitive areas should not be listed as a category in the SUSMPs. The SUSMPs should only apply to discretionary projects. The requirement for funding by project proponents who receive waivers should be deleted. The SUSMPs will be amended as shown in the attachment to this Order.
8. In light of the revisions of the SUSMPs made by this Order, and to allow the permittees adequate time to adopt implementing ordinances, the deadline for adopting ordinances will be revised to January 15, 2001, and the effective date of the Final SUSMPs will be revised to February 15, 2001.

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IV. ORDER

IT IS HEREBY ORDERED that the Standard Urban Storm Water Mitigation Plans for Los Angeles County and Cities in Los Angeles County is revised consistent with the amendments attached hereto. In all other respects the petitions are dismissed.

CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on October 5, 2000.

AYE: Arthur G. Baggett, Jr.
Mary Jane Forster
John W. Brown

NO: None

ABSENT: Peter S. Silva

ABSTAIN: None

/s/
Maureen Marché
Administrative Assistant to the Board

AMENDMENTS TO SUSMPS

[These amendments are to the Final SUSMP, as published March 8, 2000]

Page 3 of 25

First full paragraph:

All **discretionary development and redevelopment** projects that fall into one of ~~seven~~ **the following** categories are ~~identified in the Los Angeles County MS4 Permit as requiring~~ **subject to these** SUSMPs. These categories are:

- Single-family Hillside Residences
- 100,000 Square Foot Commercial Developments
- Automotive Repair Shops
- Retail Gasoline Outlets
- Restaurants
- Home Subdivisions with 10 to 99 housing units
- Home Subdivisions with 100 or more housing units
- **Parking lots 5,000 square feet or more or with 25 or more parking spaces and potentially exposed to storm water runoff**

Second full paragraph:

~~The Regional Board Executive Officer has designated two additional categories subject to SUSMP requirements for the Los Angeles County MS4 Permit. These categories are:~~

- ~~Location within or directly adjacent to or discharging directly to an environmentally sensitive area, and~~
- ~~Parking lots 5,000 square feet or more or with 25 or more parking spaces and potentially exposed to storm water runoff~~

Fourth full paragraph:

Permittees shall amend codes, if necessary, not later than ~~September 8, 2000~~ **January 15, 2001**, to give legal effect to the SUSMP requirements. The SUSMP requirements for projects identified herein shall take effect not later than ~~October 8, 2000~~ **February 15, 2001**.

Page 4 of 25

Delete definition of "Environmentally Sensitive Area"

Revise Definition of "Redevelopment":

"Redevelopment" means, on an already developed site, the creation or addition of at least 5,000 square feet of impervious surfaces ~~or the creation or addition of fifty percent or more of impervious surfaces or the making of improvements to fifty percent or more of the existing structure~~. Redevelopment includes, but is not limited to: the expansion of a building footprint or addition or replacement of a structure; structural development including an increase in gross floor area and/or exterior construction or remodeling; replacement of impervious surface that is not part of a routing maintenance activity; and land disturbing activities related with structural or impervious surfaces. **Where redevelopment results in an increase of less than fifty percent of the impervious surfaces of a previously existing development, and the existing development was not subject to these SUSMPs, the Design Standards apply only to the addition, and not to the entire development.**

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Add to "Limited Exclusion": Retail Gasoline Outlets

Page 15 of 25

Delete the first full paragraph (storm water mitigation funding)

EXHIBIT "9"

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

ORDER WQ 2001-15

In the Matter of the Petitions of

BUILDING INDUSTRY ASSOCIATION OF SAN DIEGO COUNTY
AND
WESTERN STATES PETROLEUM ASSOCIATION

For Review Of Waste Discharge Requirements Order No. 2001-01
for Urban Runoff from San Diego County
[NPDES No. CAS0108758]
Issued by the
California Water Quality Control Board,
San Diego Region

SWRCB/OCC FILES A-1362, A-1362(a)

BY THE BOARD:

On February 21, 2001, the San Diego Regional Water Quality Control Board (Regional Water Board) issued a revised national pollutant discharge elimination system (NPDES) permit in Order No. 2001-01 (permit) to the County of San Diego (County), the 18 incorporated cities within the County, and the San Diego Unified Port District. The permit covers storm water discharges from municipal separate storm sewer systems (MS4) throughout the County. The permit is the second MS4 permit issued for the County, although the first permit was issued more than ten years earlier.[1]

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[1] NPDES permits generally expire after five years, but can be extended administratively where the Regional Water Board is unable to issue a new permit prior to the expiration date. As the record in this matter amply demonstrates, the Regional Water Board engaged in an extensive process of issuing draft permits, accepting comments, and holding workshops and hearings since at least 1995.

The permit includes various programmatic and planning requirements for the permittees, including construction and development controls, controls on municipal activities, controls on runoff from industrial, commercial, and residential sources, and public education. The types of controls and requirements included in the permit are similar to those in other MS4 permits, but also reflect the expansion of the storm water program since the first MS4 permit was adopted for San Diego County 11 years ago.[2]

On March 23, 2001, the State Water Resources Control Board (State Water Board or Board) received petitions for review of the permit from the Building Industry Association of San Diego County (BIA) and from the Western States Petroleum Association (WSPA).[3] The petitions are legally and factually related, and have therefore been consolidated for purposes of review.[4] None of the municipal dischargers subject to the permit filed a petition, nor did they file responses to the petitions.

I. BACKGROUND

MS4 permits are adopted pursuant to Clean Water Act section 402(p). This federal law sets forth specific requirements for permits for discharges from municipal storm sewers. One of the requirements is that permits "shall require controls to reduce the discharge of pollutants to the maximum

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[2] For a discussion of the evolution of the storm water program, consistent with guidance from the United States Environmental Protection Agency (U.S. EPA), see Board Order WQ 2000-11.

[3] On March 23, the State Water Board also received brief letters from the Ramona Chamber of Commerce, the North San Diego County Association of Realtors, the San Diego County Apartment Association, the National Association of Industrial and Office Properties, and the California Building Industry Association. All of these letters state that they are "joining in" the petition filed by BIA. None of the letters contain any of the required information for petitions, which is listed at Cal. Code of Regs., tit. 23, section 2050. These letters will be treated as comments on the BIA petition. To the extent the authors intended the letters be considered petitions, they are dismissed.

[4] Cal. Code of Regs., tit. 23, section 2054.

extent practicable [MEP]." States establish appropriate requirements for the control of pollutants in the permits.

This Board very recently reviewed the need for controls on urban runoff in MS4 permits, the emphasis on best management practices (BMPs) in lieu of numeric effluent limitations, and the expectation that the level of effort to control urban runoff will increase over time.[5] We pointed out that urban runoff is a significant contributor of impairment to waters throughout the state, and that additional controls are needed. Specifically, in Board Order WQ 2000-11 (hereinafter, LA SUSMP order), we concluded that the Los Angeles Regional Water Board acted appropriately in determining that numeric standards for the design of BMPs to control runoff from new construction and redevelopment constituted controls to the MEP.[6]

The San Diego permit incorporates numeric design standards for runoff from new construction and redevelopment similar to those considered in the LA SUSMP order.[7] In addition, the permit addresses programmatic requirements in other areas. The LA SUSMP order was a precedential decision,[8] and we will not reiterate our findings and conclusions from that decision.[9]

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[5] Board Order WQ 2000-11.

[6] As explained in that Order, numeric design standards are not the same as numeric effluent limitations. While BIA contends that the permit under review includes numeric effluent limitations, it does not. A numeric design standard only tells the dischargers how much runoff must be treated or infiltrated; it does not establish numeric effluent limitations proscribing the quality of effluent that can be discharged following infiltration or treatment.

[7] The San Diego permit also includes provisions that are different from those approved in the LA SUSMP Order, but which were not the subject of either petition. Such provisions include the inclusion of non-discretionary projects. We do not make any ruling in this Order on matters that were not addressed in either petition.

[8] Government Code section 11425.60; State Board Order WR 96-1 (Lagunitas Creek), at footnote 11.

[9] BIA restates some of the issues this Board considered in the LA SUSMP order. For instance, BIA contends that it is inappropriate for the permit to regulate erosion control. While this argument was not specifically addressed in our prior Order, it is obvious that the most serious concern with runoff from construction is the potential for increased erosion. It is absurd to contend that the permit should have ignored this impact from urban runoff.

The petitioners make numerous contentions, mostly concerning requirements that they claim the dischargers will not be able to, or should not be required to, comply with. We note that none of the dischargers has joined in these contentions. We further note that BIA raises contentions that were already addressed in the LA SUSMP order. In this Order, we have attempted to glean from the petition issues that are not already fully addressed in Board Order Board Order WQ 2000-11, and which may have some impact on BIA and its members. WSPA restated the contentions it made in the petition it filed challenging the LA SUSMP order. We will not address those contentions again.[10] But we will address whether the Regional Water Board followed the precedent established there as it relates to retail gasoline outlets.[11]

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[10] On November 8, 2001, following the October 31 workshop meeting that was held to discuss the draft order, BIA submitted a "supplemental brief" that includes many new contentions raised for the first time. (Interested persons who were not petitioners filed comments on the draft order asking the State Water Board to address some of these.) The State Water Board will not address these contentions, as they were not timely raised. (Wat. Code § 13320; Cal. Code of Regs., tit. 23, § 2050(a).) Specific contentions that are not properly subject to review under Water Code section 13320 are objections to findings 16, 17, and 38 of the permit, the contention that permit provisions constitute illegal unfunded mandates, challenges to the permit's inspection and enforcement provisions, objections to permit provisions regarding construction sites, the contention that post-construction requirements should be limited to "discretionary" approvals, the challenge to the provisions regarding local government compliance with the California Environmental Quality Act, and contentions regarding the term "discharge" in the permit. BIA did not meet the legal requirements for seeking review of these portions of the permit.

[11] On November 8, 2001, the State Water Board received eight boxes of documents from BIA, along with a "Request for Entry of Documents into the Administrative Record." BIA failed to comply with Cal. Code of Regs., tit. 23, section 2066(b), which requires such requests be made "prior to or during the workshop meeting." The workshop meeting was held on October 31, 2001. The request will therefore not be considered. BIA also objected in this submittal that the Regional Water Board did not include these documents in its record. The Regional Water Board's record was created at the time the permit was adopted, and was submitted to the State Water Board on June 11, 2001. BIA's objection is not timely.

II. CONTENTIONS AND FINDINGS[12]

Contention: BIA contends that the discharge prohibitions contained in the permit are "absolute" and "inflexible," are not consistent with the standard of "maximum extent practicable" (MEP), and financially cannot be met.

Finding: The gist of BIA's contention concerns Discharge Prohibition A.2, concerning exceedance of water quality objectives for receiving waters: "Discharges from MS4s which cause or contribute to exceedances of receiving water quality objectives for surface water or groundwater are prohibited." BIA generally contends that this prohibition amounts to an inflexible "zero contribution" requirement.

BIA advances numerous arguments regarding the alleged inability of the dischargers to comply with this prohibition and the impropriety of requiring compliance with water quality standards in municipal storm water permits. These arguments mirror arguments made in earlier petitions that required compliance with water quality objectives by municipal storm water permittees. (See, e.g., Board Orders WQ 91-03, WQ 98-01, and WQ 99-05.) This Board has already considered and upheld the requirement that municipal storm water discharges must not cause or contribute to exceedances of water quality objectives in the receiving water. We adopted an iterative procedure for complying with this requirement, wherein municipalities must report instances where they cause or contribute to exceedances, and then must review and improve BMPs so as to protect the receiving

[12] This Order does not address all of the issues raised by the petitioners. The Board finds that the issues that are not addressed are insubstantial and not appropriate for State Water Board review. (See *People v. Barry* (1987) 194 Cal.App.3d 158 [239 Cal.Rptr. 349]; Cal. Code Regs., tit. 23, § 2052.) We make no determination as to whether we will address the same or similar issues when raised in future petitions.

waters. The language in the permit in Receiving Water Limitation C.1 and 2 is consistent with the language required in Board Order WQ 99-05, our most recent direction on this issue.[13]

While the issue of the propriety of requiring compliance with water quality objectives has been addressed before in several orders, BIA does raise one new issue that was not addressed previously. In 1999, the Ninth Circuit Court of Appeals issued an opinion addressing whether municipal storm water permits must require "strict compliance" with water quality standards.[14] (*Defenders of Wildlife v. Browner* (9th Cir. 1999) 191 F.3d 1159.) The court in *Browner* held that the Clean Water Act provisions regarding storm water permits do not require that municipal storm-sewer discharge permits ensure strict compliance with water quality standards, unlike other permits.[15] The court determined that: "Instead, [the provision for municipal storm water permits] *replaces* the requirements of [section 301] with the requirement that municipal storm-sewer dischargers 'reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator . . . determines appropriate for the control of such pollutants'." (191 F.3d at 1165.) The court further held that the Clean Water Act does grant the permitting agency discretion to determine what pollution controls are appropriate for municipal storm water discharges. (*Id.* at 1166.) Specifically, the court stated that U.S.

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[13] In addition to Discharge Prohibition A.2, quoted above, the permit includes Receiving Water Limitation C.1, with almost identical language: "Discharges from MS4s that cause or contribute to the violation of water quality standards (designated beneficial uses and water quality objectives developed to protect beneficial uses) are prohibited." Receiving Water Limitation C.2 sets forth the iterative process for compliance with C.1, as required by Board Order WQ 99-05.

[14] "Water quality objectives" generally refers to criteria adopted by the state, while "water quality standards" generally refers to criteria adopted or approved for the state by the U.S. EPA. Those terms are used interchangeably for purposes of this Order.

[15] Clean Water Act § 301(b)(1)(C) requires that most NPDES permits require strict compliance with quality standards.

EPA had the authority either to require "strict compliance" with water quality standards through the imposition of numeric effluent limitations, or to employ an iterative approach toward compliance with water quality standards, by requiring improved BMPs over time. (*Id.*) The court in *Browner* upheld the EPA permit language, which included an iterative, BMP-based approach comparable to the language endorsed by this Board in Order WQ 99-05.

In reviewing the language in this permit, and that in Board Order WQ 99-05, we point out that our language, similar to U.S. EPA's permit language discussed in the *Browner* case, does not require strict compliance with water quality standards. Our language requires that storm water management plans be designed to achieve compliance with water quality standards. Compliance is to be achieved over time, through an iterative approach requiring improved BMPs. As pointed out by the *Browner* court, there is nothing inconsistent between this approach and the determination that the Clean Water Act does not mandate strict compliance with water quality standards. Instead, the iterative approach is consistent with U.S. EPA's general approach to storm water regulation, which relies on BMPs instead of numeric effluent limitations.

It is true that the holding in *Browner* allows the issuance of municipal storm water permits that limit their provisions to BMPs that control pollutants to the maximum extent practicable (MEP), and which do not require compliance with water quality standards. For the reasons discussed below, we decline to adopt that approach. The evidence in the record before us is consistent with records in previous municipal permits we have considered, and with the data we have in our records, including data supporting our list prepared pursuant to Clean Water Act section 303(d). Urban runoff is causing and contributing to impacts on receiving waters throughout the state and impairing their

beneficial uses. In order to protect beneficial uses and to achieve compliance with water quality objectives in our streams, rivers, lakes, and the ocean, we must look to controls on urban runoff. It is not enough simply to apply the technology-based standards of controlling discharges of pollutants to the MEP; where urban runoff is causing or contributing to exceedances of water quality standards, it is appropriate to require improvements to BMPs that address those exceedances.

While we will continue to address water quality standards in municipal storm water permits, we also continue to believe that the iterative approach, which focuses on timely improvement of BMPs, is appropriate. We will generally not require "strict compliance" with water quality standards through numeric effluent limitations and we will continue to follow an iterative approach, which seeks compliance over time.[16] The iterative approach is protective of water quality, but at the same time considers the difficulties of achieving full compliance through BMPs that must be enforced throughout large and medium municipal storm sewer systems.[17]

We have reviewed the language in the permit, and compared it to the model language in Board Order WQ 99-05. The language in the Receiving Water Limitations is virtually identical to the language in Board Order WQ 99-05. It sets a limitation on discharges that cause or contribute to violation of water quality standards, and then it establishes an iterative approach to complying with the limitation. We are concerned, however, with the language in Discharge Prohibition A.2, which is

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[16] Exceptions to this general rule are appropriate where site-specific conditions warrant. For example, the Basin Plan for the Lake Tahoe basin, which protects an outstanding national resource water, includes numeric effluent limitations for storm water discharges.

[17] While BIA argues that the permit requires "zero contribution" of pollutants in runoff, and "in effect" contains numeric effluent limitations, this is simply not true. The permit is clearly BMP-based, and there are no numeric effluent limitations. BIA also claims that the permit will require the construction of treatment plants for storm water similar to the publicly-owned treatment works for sanitary sewage. There is no basis for this contention; there is no requirement in the permit to treat all storm water. The emphasis is on BMPs.

challenged by BIA. This discharge prohibition is similar to the Receiving Water Limitation, prohibiting discharges that cause or contribute to exceedance of water quality objectives. The difficulty with this language, however, is that it is not modified by the iterative process. To clarify that this prohibition also must be complied with through the iterative process, Receiving Water Limitation C.2 must state that it is also applicable to Discharge Prohibition A.2. The permit, in Discharge Prohibition A.5, also incorporates a list of Basin Plan prohibitions, one of which also prohibits discharges that are not in compliance with water quality objectives. (See, Attachment A, prohibition 5.) Language clarifying that the iterative approach applies to that prohibition is also necessary.[18]

BIA also objects to Discharge Prohibition A.3, which appears to require that treatment and control of discharges must always occur prior to entry into the MS4: "Discharges into and from MS4s containing pollutants which have not been reduced to the [MEP] are prohibited."[19] An NPDES permit is properly issued for "discharge of a pollutant" to waters of the United States.[20] (Clean Water Act § 402(a).) The Clean Water Act defines "discharge of a pollutant" as an "addition" of a pollutant to waters of the United States from a point source. (Clean Water Act section 502(12).) Section 402(p)(3)(B) authorizes the issuance of permits for discharges "from municipal storm sewers."

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[18] The iterative approach is not necessary for all Discharge Prohibitions. For example, a prohibition against pollution, contamination or nuisance should generally be complied with at all times. (See, Discharge Prohibition A.1.) Also, there may be discharge prohibitions for particularly sensitive water bodies, such as the prohibition in the Ocean Plan applicable to Areas of Special Biological Significance.

[19] Discharge Prohibition A.1 also refers to discharges into the MS4, but it only prohibits pollution, contamination, or nuisance that occurs "in waters of the state." Therefore, it is interpreted to apply only to discharges to receiving waters.

[20] Since NPDES permits are adopted as waste discharge requirements in California, they can more broadly protect "waters of the state," rather than being limited to "waters of the United States." In general, the inclusion of "waters of the state" allows the protection of groundwater, which is generally not considered to be "waters of the United States."

We find that the permit language is overly broad because it applies the MEP standard not only to discharges "from" MS4s, but also to discharges "into" MS4s. It is certainly true that in most instances it is more practical and effective to prevent and control pollution at its source. We also agree with the Regional Water Board's concern, stated in its response, that there may be instances where MS4s use "waters of the United States" as part of their sewer system, and that the Board is charged with protecting all such waters. Nonetheless, the specific language in this prohibition too broadly restricts all discharges "into" an MS4, and does not allow flexibility to use regional solutions, where they could be applied in a manner that fully protects receiving waters.[21] It is important to emphasize that dischargers into MS4s continue to be required to implement a full range of BMPs, including source control. In particular, dischargers subject to industrial and construction permits must comply with all conditions in those permits prior to discharging storm water into MS4s.

Contention: State law requires the adoption of wet weather water quality standards, and the permit improperly enforces water quality standards that were not specifically adopted for wet weather discharges.

Finding: This contention is clearly without merit. There is no provision in state or federal law that mandates adoption of separate water quality standards for wet weather conditions. In arguing that the permit violates state law, BIA states that because the permit applies the water quality

[21] There are other provisions in the permit that refer to restrictions "into" the MS4. (See, e.g., Legal Authority D.1.) Those provisions are appropriate because they do not apply the MEP standard to the permittees, but instead require the permittees to demand appropriate controls for discharges into their system. For example, the federal regulations require that MS4s have a program "to reduce pollutants in storm water runoff from construction sites to the municipal storm sewer system . . . ." (40 C.F.R. § 122.26(d)(2)(iv)(D).)

objectives that were adopted in its Basin Plan, and those objectives were not specifically adopted for wet weather conditions only, the Regional Water Board violated Water Code section 13241. These allegations appear to challenge water quality objectives that were adopted years ago. Such a challenge is clearly inappropriate as both untimely, and because Basin Plan provisions cannot be challenged through the water quality petition process. (See Wat. Code § 13320.) Moreover, there is nothing in section 13241 that supports the claim that Regional Water Boards must adopt separate wet weather water quality objectives. Instead, the Regional Water Board's response indicates that the water quality objectives were based on all water conditions in the area. There is nothing in the record to support the claim that the Regional Water Board did not in fact consider wet weather conditions when it adopted its Basin Plan. Finally, Water Code section 13263 mandates the Regional Water Board to implement its Basin Plan when adopting waste discharge requirements. The Regional Water Board acted properly in doing so.

BIA points to certain federal policy documents that authorize states to promulgate water quality standards specific to wet-weather conditions.[22] Each Regional Water Board considers revisions to its Basin Plan in a triennial review. That would be the appropriate forum for BIA to make these comments.

Contention: BIA contends that the permit improperly classifies urban runoff as "waste" within the meaning of the Water Code.

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[22] These documents do not support the claim that U.S. EPA and the Clinton Administration indicated that the absence of such regulations "is a major problem that needs to be addressed," as claimed in BIA's Points and Authorities, at page 18.

Finding: BIA challenges Finding 2, which states that urban runoff is a waste, as defined in the Water Code, and that it is a "discharge of pollutants from a point source" under the federal Clean Water Act. BIA contends that the legislative history of section 13050(d) supports its position that "waste" should be interpreted to exclude urban runoff. The Final Report of the Study Panel to the California State Water Resources Control Board (March, 1969) is the definitive document describing the legislative intent of the Porter-Cologne Water Quality Control Act. In discussing the definition of "waste," this document discusses its broad application to "current drainage, flow, or seepage into waters of the state of harmful concentrations" of materials, including eroded earth and garbage.

As we stated in Board Order WQ 95-2, the requirement to adopt permits for urban runoff is undisputed, and Regional Water Boards are not required to obtain any information on the impacts of runoff prior to issuing a permit. (At page 3.) It is also undisputed that urban runoff contains "waste" within the meaning of Water Code section 13050(d), and that the federal regulations define "discharge of a pollutant" to include "additions of pollutants into waters of the United States from: surface runoff which is collected or channeled by man." (40 C.F.R. § 122.2.) But it is the waste or pollutants in the runoff that meet these definitions of "waste" and "pollutant," and not the runoff itself.[23] The finding does create some confusion, since there are discharge prohibitions that have been incorporated into the permit that broadly prohibit the discharge of "waste" in certain circumstances.

[23] The Regional Water Board is appropriately concerned not only with pollutants in runoff but also the volume of runoff, since the volume of runoff can affect the discharge of pollutants in the runoff. (See Board Order WQ 2000-11, at page 5.)

(See Attachment A to the permit.) The finding will therefore be amended to state that urban runoff contains waste and pollutants.

Contention: BIA contends that the Regional Water Board violated California Environmental Quality Act (CEQA).

Finding: As we have stated in several prior orders, the provisions of CEQA requiring adoption of environmental documents do not apply to NPDES permits.[24] BIA contends that the exemption from CEQA contained in section 13389 applies only to the extent that the specific provisions of the permit are required by the federal Clean Water Act. This contention is easily rejected without addressing whether federal law mandated all of the permit provisions. The plain language of section 13389 broadly exempts the Regional Water Board from the requirements of CEQA to prepare environmental documents when adopting "any waste discharge requirement" pursuant to Chapter 5.5 (§§ 13370 et seq., which applies to NPDES permits).[25] BIA cites the decision in *Committee for a Progressive Gilroy v. State Water Resources Control Board* (1987) 192 Cal.App.3d 847. That case upheld the State Water Board's view that section 13389 applies only to NPDES permits, and not to waste discharge requirements that are adopted pursuant only to state law. The case did not concern an NPDES permit, and does not support BIA's argument.

Contention: WSPA contends that the Regional Water Board did not follow this Board's precedent for retail gasoline outlets (RGOs) established in the LA SUSMP order.

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[24] Water Code section 13389; see, e.g., Board Order WQ 2000-11.

[25] The exemption does have an exception for permits for "new sources" as defined in the Clean Water Act, which is not applicable here.

Finding: In the LA SUSMP order, this Board concluded that construction of RGOs is already heavily regulated and that owners may be limited in their ability to construct infiltration facilities. We also noted that, in light of the small size of many RGOs and the proximity to underground tanks, it might not always be feasible or safe to employ treatment methodologies. We directed the Los Angeles Regional Water Board to mandate that RGOs employ the BMPs listed in a publication of the California Storm Water Quality Task Force. (*Best Management Practice Guide – Retail Gasoline Outlets* (March 1997).) We also concluded that RGOs should not be subject to the BMP design standards at this time. Instead, we recommended that the Regional Water Board undertake further consideration of a threshold relative to size of the RGO, number of fueling nozzles, or some other relevant factor. The LA SUSMP order did not preclude inclusion of RGOs in the SUSMP design standards, with proper justification, when the permit is reissued.

The permit adopted by the Regional Water Board did not comply with the directions we set forth in the LA SUSMP order for the regulation of RGOs. The permit contains no findings specific to the issues discussed in our prior order regarding RGOs, and includes no threshold for inclusion of RGOs in SUSMPs. Instead, the permit requires the dischargers to develop and implement SUSMPs within one year that include requirements for "Priority Development Project Categories," including "retail gasoline outlets." While other priority categories have thresholds for their inclusion in SUSMPs, the permit states: "Retail Gasoline Outlet is defined as any facility engaged in selling gasoline."[26]

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[26] Permit at F.1.b(2)(a)(x).

The Regional Water Board responded that it did follow the directions in the LA SUSMP order. First, it points to findings that vehicles and pollutants they generate impact receiving water quality. But the only finding that even mentions RGOs is finding 4, which simply lists RGOs among the other priority development project categories as land uses that generate more pollutants. The Regional Water Board staff also did state some justifications for the inclusion of RGOs in two documents. The Draft Fact Sheet explains that RGOs contribute pollutants to runoff, and opines that there are appropriate BMPs for RGOs. The staff also prepared another document after the public hearing, which was distributed to Board Members prior to their vote on the permit, and which includes similar justifications and references to studies.[27] The LA SUSMP order called for some type of threshold for inclusion of RGOs in SUSMPs. The permit does not do so. Also, justifications for permit provisions should be stated in the permit findings or the final fact sheet, and should be subject to public review and debate.[28] The discussion in the document submitted after the hearing did not meet these criteria. There was some justification in the "Draft Fact Sheet," but the fact sheet has not been finalized.[29] In light of our concerns over whether SUSMP sizing criteria should apply to RGOs, it was incumbent on the Regional Water Board to justify the inclusion of RGOs in the permit findings or in a final fact sheet, and to consider an appropriate threshold, addressing the concerns we stated. The Regional Water Board also responded that when the dischargers develop the SUSMPs, the dischargers

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[27] See "Comparison Between Tentative Order No. 2001-01 SUSMP Requirements and LARWQCB SUSMP Requirements (as Supported by SWRCB Order WQ 2000-11)."

[28] See 40 C.F.R. sections 124.6(e) and 124.8.

[29] U.S. EPA regulations require that there be a fact sheet accompanying the permit. (40 C.F.R. § 124.8.) The record contains only a draft fact sheet, which was never published or distributed in final form. The Regional Water Board should finalize the fact sheet, accounting for any revisions made in the final permit, and publish it on its web site as a final document.

might add specific BMPs and a threshold as directed in the LA SUSMP order. But the order specifically directed that any threshold, and the justification therefore, should be included in the permit. The Regional Water Board did not comply with these directions.

III. CONCLUSIONS

Based on the discussion above, the Board concludes that:

1. The Regional Water Board appropriately required compliance with water quality standards and included requirements to achieve reduction of pollutants to the maximum extent practicable. The permit must be clarified so that the reference to the iterative process for achieving compliance applies not only to the receiving water limitation, but also to the discharge prohibitions that require compliance with water quality standards. The permit should also be revised so that it requires that MEP be achieved for discharges "from" the municipal sewer system, and for discharges "to" waters of the United States, but not for discharges "into" the sewer system.

2. The Regional Water Board was not required to adopt wet-weather specific water quality objectives.

3. The Regional Water Board inappropriately defined urban runoff as "waste."

4. The Regional Water Board did not violate the California Environmental Quality Act.

5. The permit will be revised to delete retail gasoline outlets from the Priority Development Project Categories for Standard Urban Storm Water Mitigation Plans. The Regional Water Board may consider adding retail gasoline outlets, upon inclusion of appropriate findings and a threshold describing which outlets are included in the requirements.

IV. ORDER

IT IS HEREBY ORDERED that the Waste Discharge Requirements for Discharges of Urban Runoff from the Municipal Separate Storm Sewer Systems in San Diego County (Order No. 2001-01) are revised as follows:

1. Part A.3: The words "into and" are deleted.

2. Part C.2: Throughout the first paragraph, the words ", Part A.2, and Part A.5 as it applies to Prohibition 5 in Attachment A" shall be inserted following "Part C.1."

3. Finding 2: Revise the finding to read: **URBAN RUNOFF CONTAINS "WASTE" AND "POLLUTANTS"**: Urban runoff contains waste, as defined in the California Water Code, and pollutants, as defined in the federal Clean Water Act, and adversely affects the quality of the waters of the State.

4. Part F.1.b(2)(a): Delete section "x."

In all other respects the petitions are dismissed.

CERTIFICATION

The undersigned, Clerk to the Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on November 15, 2001.

AYE: Arthur G. Baggett, Jr.
Peter S. Silva
Richard Katz

NO:

ABSENT:

ABSTAIN:

/ s/

Maureen Marché
Clerk to the Board

EXHIBIT "10"

STATE OF CALIFORNIA

STATE WATER RESOURCES CONTROL BOARD

ORDER WQ 2006-0012

In the Matter of the Petition of

BOEING COMPANY

For Review of Waste Discharge Requirements (WDR) Orders
R4-2004-0111, R4-2006-0008, and R4-2006-0036 for the
Santa Susana Field Laboratory
Issued by the
California Regional Water Quality Control Board,
Los Angeles Region

SWRCB/OCC FILES A-1653 AND A-1737

BY THE BOARD:

The Boeing Company (Boeing) operates the Santa Susana Field Laboratory (SSFL) in Ventura County.[1] The Los Angeles Regional Water Quality Control Board (Los Angeles Water Board) has regulated wastewater discharges from SSFL to waters of the United States since at least 1992.[2] The regulated discharges include storm water runoff, discharges from groundwater remediation systems, industrial wastewater from ongoing operations such as engine test stands, and domestic wastewater from two sewage treatment plants.

On July 1, 2004, the Los Angeles Water Board re-issued a permit to Boeing for discharges from SSFL. (Waste Discharge Requirements Order No. R4-2004-0111 (2004 Permit).) On August 2, 2004, Boeing filed a petition with the State Water Resources Control

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[1] Boeing owns SSFL with the National Aeronautical Space Agency (NASA). The United States Department of Energy (DOE) also owns several buildings at the site. NASA and DOE are not named in the permit reviewed herein, and their participation is not an issue before us.

[2] Waste Discharge Requirements Order No. 92-092, adopted December 7, 1992. The permit was reissued in 1998 (1998 Permit). Waste Discharge Requirements Order No. 98-051, adopted June 29, 1998. This is a national pollutant discharges elimination system (NPDES) permit, No. CA0001309.

Board (State Water Board) challenging the 2004 Permit.[3] (Our File No. A-1653.) Boeing requested that its petition be held in abeyance.[4]

On January 19, 2006, the Los Angeles Water Board modified the 2004 Permit, adding and revising the outfalls listed and the effluent limitations. (Waste Discharge Requirements Order No. R4-2006-0008; January 2006 Permit.) On February 21, 2006, Boeing filed a petition challenging the January 2006 Permit and the failure of the Los Angeles Water Board to adopt a Cease and Desist Order with a compliance schedule and interim effluent limitations. (Our File No. A-1737.) Boeing also asked the State Water Board to activate its 2004 petition, File No. A-1635. On March 9, 2006, the Los Angeles Water Board again revised Boeing's permit, this time adding additional effluent limitations. (Waste Discharge Requirements Order No. R4-2006-0036; March 2006 Permit.) On March 16, 2006, Boeing filed a petition challenging the March 2006 Permit.[5] Boeing also requested a stay of various effluent limitations. The State Water Board denied the stay request in Order WQ 2006-0007.[6]

Many of Boeing's contentions concern the propriety and legality of numeric effluent limitations in the Permit. In particular, Boeing emphasizes that its discharges are largely storm water, and it points to the issues this Board faces as to whether to include numeric effluent limitations in storm water permits. As we will explain, the issues addressed in this Order are relevant only to a unique industrial operation subject to an individual NPDES permit. Our conclusions here do not apply to the issue of numeric effluent limitations for general permits

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[3] Committee to Bridge the Gap (CBG) also filed a petition challenging the permit. (Our File No. A-1653(a).) The State Water Board dismissed CBG's petition on February 14, 2005.

[4] The State Water Board's regulations allow a petitioner to request its petition be held in abeyance. (California Code of Regulations (Cal. Code Regs.), tit. 23, § 2050, subd. (d).) When a petition challenging a permit is held in abeyance, the State Water Board does not act upon the petition until it is activated and the challenged permit remains in full force and effect. (*Ibid.*)

[5] The March 16 petition was not assigned a separate file number, and instead is considered to be an amendment to File No. A-1737. All of the petitions filed by Boeing have been consolidated for purposes of review. (Cal. Code Regs., tit. 23, § 2054.) The 2004 Permit, as modified, is referred to as "the Permit." Where necessary, the different versions are referred to as the 2004 Permit, the January 2006 Permit, and the March 2006 Permit.

[6] The State Water Board received the administrative record and responses to the petitions on May 15, 2006. Part of the record was a report Boeing submitted to the Los Angeles Water Board for its February 2006 meeting. CBG asks this Board to limit the use of that report. All portions of the record were before the Los Angeles Water Board in its actions and are appropriately part of our administrative record. On October 13, 2006, Boeing submitted a new report to the State Water Board and asks that it be considered a part of our administrative record. We decline to do so. That report was received long after the Los Angeles Water Board acted and only two weeks before the State Water Board issued its draft order in this matter. Moreover, Boeing refused to place its petitions in abeyance, which would have allowed time for the State Water Board to review the report and for interested persons to respond to the permit. (See, Cal. Code Regs., tit. 23, § 2050.6.) Boeing's request is denied.

regulating discharges of storm water from thousands of entities engaged in construction and industrial activities.

In this Order, the State Water Board upholds the Permit in most respects. We conclude that the Los Angeles Water Board acted properly in issuing the Permit and in including requirements more akin to a typical individual NPDES permit than the General Permit for Industrial Activities.[7] We also conclude that the Permit includes appropriate monitoring requirements and sites. Moreover, we conclude that at least until Boeing submits a report of waste discharge describing its changed discharge, the Permit must continue to regulate many of the discharges from SSFL as commingled wastewater, rather than as storm water discharges. We also conclude Outfall 001 is duplicative with Outfall 011 and that Outfall 002 is duplicative with Outfall 018 for enforcement purposes. Only two of these outfalls should be regulated with numeric effluent limitations as compliance points. The numeric effluent limitations contained in the Permit were properly calculated and were properly based on the "reasonable potential" for discharges from SSFL to cause or contribute to exceedances of water quality standards and it is appropriate and proper for the Permit to retain these numeric effluent limitations. Finally, we conclude that the Los Angeles Water Board erred in failing to issue a cease and desist order (CDO), including a compliance schedule with interim effluent limitations, following a catastrophic fire at SSFL in September 2005. We will remand the Permit to the Los Angeles Water Board to make revisions consistent with this Order. The compliance schedule shall apply retroactively to the adoption of the January 2006 Permit.[8]

I. BACKGROUND

Boeing's SSFL is located at the top of Woolsey Canyon Road in Simi Hills. The site includes approximately 1500 acres of developed land and 1200 acres of undeveloped land. Industrial activities have occurred at the site for more than 50 years. These activities have included research, development, assembly, disassembly, and testing of rocket engines, missile components, and chemical lasers. There have also been nuclear reactors at SSFL, and the administrative record shows evidence of accidents with these reactors. As of the time the Permit was issued, Boeing activities that contributed to discharges, include rocket engine

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[7] General Permit for Discharges of Storm Water Associated with Industrial Activities Excluding Construction Activities (WQO No. 97-03-DWQ).

[8] All contentions not discussed in this Order are not sufficiently substantial to warrant review. (See *People v. Barry* (1987) 194 Cal.App.3d 158; Cal. Code Regs., tit. 23, § 2052(a)(1).)

testing, fire suppression, pressure-testing of equipment to support rocket engine testing, domestic wastewater treatment, and contaminated groundwater treatment.

Boeing representatives have recently stated, including in testimony at the hearing on its stay request, that the only existing discharges from the site are storm water runoff. In particular, Boeing representatives state that it has stopped all rocket engine testing and will not resume testing, if at all, until it can remove all wastewater associated with testing from the site (presumably by trucking the wastewater offsite). In addition, they testified that the treatment plants (groundwater remediation and domestic sewage treatment) are no longer discharging at the site, but instead all wastewater is trucked away. There is nothing in the record to indicate that Boeing has submitted a report of waste discharge regarding these changes in its discharge or requested that the Permit be modified.[9]

Because of the historical activities at SSFL, the site is subject to remediation requirements pursuant to the Resource Conservation and Recovery Act of 1976 (RCRA).[10] The lead agency for the RCRA cleanup is the California Department of Toxic Substances Control (DTSC). DTSC regulates nine closed surface impoundments. The site had radioactive waste that the United States Department of Energy (DOE) is responsible for decontaminating and decommissioning. Boeing still uses radioisotopes for calibrating radiation detectors and counting equipment, but there is no surface water discharge associated with these activities. There is surface runoff from throughout the site, including areas subject to RCRA cleanup. The record shows that there are instances where runoff from SSFL has been contaminated with, or has the potential to be contaminated with, constituents associated with the historical activities at the site and the RCRA remediation. For example, the catchment area of Outfall 004 is comprised of a landscape with surface soil contaminated with mercury and other constituents from the former Sodium Reactor Experiment site. Until the contaminated soil is removed (a likely final remediation solution for this area), Boeing has covered the soil with an impermeable cover and, at the bottom of the catchment, implemented BMPs to treat the runoff. If the cover were compromised, discharges from the site could enter surface waters. There are also constituents that have been detected in runoff from the site that are associated with historic

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[9] Dischargers must submit a report of waste discharge for any material change or proposed change in the character, location, or volume of their discharge. (Wat. Code, § 13260, subdivision (c).) The discharges characterized in the Permit generally occur only when there is wet weather runoff from the site. Thus, it is within Boeing's knowledge and control whether it will ensure that process water is not commingled with storm water in the future.

[10] 42 United States Code Annotated (U.S.C.A.) §§ 6901 et seq.

activities. For example, perchlorate, a chemical associated with rocket propellant testing, has been detected at an outfall near the rocket propellant testing area.

SSFL is situated in the Simi Hills. Because of its location and topography, and the large size of the facility, there is runoff from the site to several watersheds. Most of the runoff flows to Bell Creek, which is tributary to the Los Angeles River. There is also runoff into various drainages of Arroyo Simi and to Runkel, Dayton, and Woolsey Canyons. The Permit establishes eighteen outfalls.[11] Outfalls 001 and 002 are at the southerly perimeter of the SSFL, and approximately sixty percent of the runoff from the facility discharges through these two outfalls, which lead to Bell Creek, and then to the Los Angeles River. Outfall 008 discharges to Happy Valley, and ultimately to Bell Creek and the Los Angeles River. Discharges through Outfalls 003, 004, 005, 006, 007, 009, and 010 flow to small watersheds to the northwest of SSFL. These are not tributary to the Los Angeles River. Outfalls 011, 012, 013, 014, 015, 016, 017, and 018 each are sited near areas of specific activities on SSFL, including the two domestic sewage treatment plants, the groundwater treatment plant, and the rocket engine test stand. Outfalls 012-017 each discharge to waters that flow through Outfalls 011 or 018, which in turn flow through Outfalls 001 and 002, respectively. There are several points that are important to our deliberations regarding these outfalls: (1) Outfalls 001-010 are each situated along the perimeter of SSFL, while Outfalls 011-018 are situated in the interior of the site and discharge through perimeter outfalls; (2) Outfalls 001, 002, and 011-018 are authorized to discharge commingled storm water, industrial process water (from groundwater treatment and rocket engine testing) and domestic wastewater (from the sewage treatment plants); and (3) Outfalls 003-010 are the only outfalls designated in the Permit as discharging only storm water runoff.

The Los Angeles Water Board initially adopted the Permit that Boeing now challenges in July 2004. It amended the Permit in January and March 2006, adding and revising effluent limitations each time. In January 2006, the Los Angeles Water Board considered but refused to adopt a CDO, which would have included a time schedule and interim effluent limitations. Boeing filed a petition challenging the July 2004 Permit, but did not seek active review of its challenge to the Permit until February 21, 2006, when Boeing also challenged the January modification.[12] Boeing also challenged the failure to adopt the CDO.

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[11] These are designated Outfalls 001 through 018.

[12] It later challenged the March modification also.

In addition to the Permit modifications, which generally made the Permit more stringent, there was also a significant physical event at SSFL that impacted permit compliance. Beginning on September 28, 2005, the Topanga Fire swept through the site and burned approximately seventy percent of the site. The fire destroyed numerous plants that had served as vegetative cover to control runoff. At the time, BMPs Boeing employed to minimize pollutants in runoff were largely vegetative cover, and the fire destroyed most of this cover. The fire also resulted in ash deposition throughout the site, the result of burned material from both the site and adjacent areas, which contained contaminants regulated by the Permit. Since the fire, Boeing has been engaged in stabilizing and restoring vegetative cover and also in building new structural BMPs at the site.

II. CONTENTIONS AND FINDINGS[13]

Contention: Boeing contends that most, if not all, of its discharge is storm water runoff and that it should be regulated in a similar manner as the State Water Board's General Permit for Industrial Activities.

Finding: The discharges from SSFL are unusual in many respects. SSFL is a very large industrial site in a remote area, with no other industrial sites nearby. It occupies a large area on hillsides, with runoff flowing into a number of different watersheds. There are vast areas of historical contamination and development, and also large areas of open space and native vegetation. Calculations show that SSFL has the potential, in a 24-hour 10-year storm, to discharge an estimated 272 million gallons of storm water runoff. It is the subject of ongoing RCRA cleanup and groundwater remediation. While greatly reduced from its peak activity, there are still ongoing industrial activities occurring. While it originally was situated in a remote location, there are now many residential developments nearby SSFL. The Permit allows Boeing to discharge not only storm water runoff from the site, but also industrial process water, wastewater from groundwater treatment facilities, and domestic wastewater from sewage treatment plants.

The conditions described above make SSFL a unique site, especially because of its size, the degree of historical contamination, and the site topography that results in large

[13] Boeing included various interrelated contentions in its 2004 Petition, its February 2006 Petition, and its March 2006 Petition. Each petition essentially restated and revised the grounds for the petition. Each petition also included a statement of points and authorities, which also stated the bases for the petition somewhat differently than the petition itself. The statement of contentions herein is an effort to summarize and articulate these various arguments, while not restating verbatim each of the contentions listed in the different documents.

amounts of runoff during storm events. The Permit regulates both storm water-only and commingled storm water, domestic, and industrial process water discharges. As will be described below, the legal requirements for the regulation of storm water-only discharges vary from those for the regulation of process water discharges. Wastewater that commingles storm water and process water is subject to the legal requirements for industrial process water. The Permit was based on Boeing's request, through its report of waste discharge, for authorization to discharge process water and storm water from several outfalls at SSFL. In its papers and testimony, Boeing states that it is no longer discharging process water from these facilities. If that is so, in order for its permit to be revised accordingly, it must file a report of waste discharge describing this change in its discharge.[14]

Eight of the eighteen outfalls at SSFL are storm water-only outfalls: Outfalls 003-010. These eight outfalls are all "perimeter" outfalls—flows through these outfalls leave SSFL through different watersheds. (The only other perimeter outfalls—Outfalls 001 and 002—receive all of the commingled flows and together discharge approximately sixty percent of the total flows from SSFL.) While these eight outfalls are designated as storm water-only, the record shows that they each have a significant potential to discharge water contaminated by the historical practices and remediation activities at SSFL. Each of these outfalls is associated with areas of the site with significant historical activities. Outfalls 003-007 receive runoff from past and existing radiological facilities: runoff to Outfall 003 is from the Radioactive Material Handling Facility, runoff to Outfall 004 is from the Sodium Reactor Experiment, runoff to Outfall 005 is from Sodium Burn Pit 1, runoff to Outfall 006 is from Sodium Burn Pit 2, and runoff to Outfall 007 is from Building 100. Outfall 008, which discharges to Happy Valley, is located near facilities that formerly used perchlorate, and that constituent has been found in the runoff. Outfall 009 receives WS-13 drainage and runoff to Outfall 010 is from Building 203, and these outfalls were added to the Permit based on monitoring in the areas.[15] There are numerous other operation areas at SSFL that do not have individual outfalls specifically assigned to them. Generally, the outfalls listed in the Permit are associated with operations over which the

[14] During the proceedings on the stay request, Boeing's attorney stated that the only process water currently discharged is well purge water, and that change in discharge would be raised to the Los Angeles Water Board when the Permit is modified or reissued. In any event, the Permit as adopted does regulate both process water and storm water, some of it commingled, and the evidence shows that Boeing requested such a permit.

[15] The specific activities and runoff potential are described in detail, *infra*.

Los Angeles Water Board, rather than DTSC, is the lead agency.[16] The outfalls along the perimeter of SSFL, however, do capture all of the runoff that is known to have the potential to contain contaminants associated with industrial activities.

Boeing argues that its site is comparable to other sites regulated by the General Permit for Industrial Activities. It contends that the Los Angeles Water Board was required to follow the assumptions contained in that permit, including the absence of numeric effluent limitations therein. We disagree with this premise.

SSFL is a unique site warranting thorough and detailed regulation. It is not at all the same as a typical facility subject to the General Permit for Industrial Activities. Moreover, it is not permitted as a storm water-only site, regardless of whether the vast majority of the runoff is storm water, rather than process water. The federal Clean Water Act requires that all discharges of wastewater containing pollutants from industrial sites must comply with the technology-based requirements of best practicable control technology currently available (BCT) and best available technology economically achievable (BAT) and with any more stringent limitations necessary to meet water quality standards. (33 U.S.C.A. § 1311(b).)[17] These same standards apply to discharges of storm water associated with industrial activities. (CWA § 402(p)(3)(A).)[18] While the same legal standards in section 301(b) apply to both industrial process water and industrial storm water, the decision whether to include numeric water effluent limitations varies depending whether the permit regulates process water (even if mixed with storm water) or storm water only[19]. The separate rules for storm water discharges apply only to discharges "composed *entirely* of storm water." (CWA § 402(p)(1) (emphasis added).) For this reason, the General Permit for Industrial Activities authorizes only storm water discharges. Only eight of the eighteen outfalls at SSFL (Outfalls 003-010) are composed entirely of storm water. The other ten outfalls, whether or not they may be composed of "mostly" or "almost entirely" of storm water, as Boeing contends, are subject to the same regulatory requirements as any other industrial process water. Thus, Boeing does not qualify for coverage under the General Permit.

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[16] The Fact Sheet to the Permit includes a thorough discussion of the location, operations, and constituents associated with each outfall.

[17] Clean Water Act (CWA) § 301(b). Hereafter, citations to the federal statute will refer only to the CWA citation.

[18] *Defenders of Wildlife v. Browner* (9th Cir. 1999) 191 F.3d 1159.

[19] As discussed in detail below, process water permits must include numeric effluent limitations unless it is not "feasible" to include such limitations. Storm water-only permits are not required to include numeric effluent limitations, without the necessity of determining infeasibility.

The Permit must include appropriate requirements for both process water and storm water discharges. Boeing also contends that numeric effluent limitations are not appropriate for process water discharges from SSFL, pursuant to federal regulations.[20] We will discuss in detail the propriety of numeric effluent limitations for the various outfalls regulated in the Permit. In general, however, we reject Boeing's contention that the Los Angeles Water Board was required to regulate the various discharges from SSFL in a similar manner to the General Permit for Industrial Activities.

Contention: Boeing contends that the monitoring and compliance points are inappropriate.

Finding: The Permit lists eighteen outfalls. Each outfall has numerous numeric effluent limitations for constituents for which the Los Angeles Water Board determined that discharges had the reasonable potential to cause or contribute to exceedances of water quality standards in surface waters. Boeing points out that prior permits for SSFL had fewer points where monitoring was required and where effluent limitations applied. A brief history of the Los Angeles Water Board's permitting strategy is necessary in order to understand this contention.

Boeing challenges the 2004 Permit and modifications in January and March of 2006. The prior permit was adopted in 1998. (Waste Discharge Requirements Order No. 98-051; 1998 Permit.) The 1998 Permit regulated storm water runoff, industrial and domestic wastewater, and groundwater treatment discharges from SSFL. The 1998 Permit established as compliance points Outfalls 001 and 002, which are 6,000 feet south of the final retention ponds, and Outfalls 003-007 to the north.[21] The 1998 Permit also stated that the storm water discharges were "covered by" the General Industrial Storm Water Permit and that "its requirements are incorporated in [the 1998 Permit] by reference."[22] For Outfalls 001 and 002, the 1998 Permit listed numeric effluent limitations for 49 constituents. Outfalls 003-007 in the 1998 Permit have numeric effluent limitations for 25 constituents. Most effluent limitations were for daily maximum and not for monthly average.

The 2004 Permit added the three perimeter outfalls that were not listed in the 1998 Permit (Outfalls 008-010) and the eight interior outfalls (Outfalls 011-018). The 2004

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[20] 40 Code of Federal Regulations (C.F.R.) § 122.44(k)(3).

[21] Thus, the 1998 Permit did not list as separate outfalls three of the perimeter outfalls listed in the 2004 Permit (008-010) and the eight interior outfalls that lead to 001 and 002 (011-018).

[22] 1998 Permit, Finding 27.

Permit also discussed the reasonable potential for discharges through the various outfalls to cause or contribute to exceedance of criteria in the California Toxic Rule (CTR).[23] The 2004 Permit included numeric effluent limitations for 40 constituents for Outfalls 001 and 002, 19 numeric effluent limitations for Outfalls 003-007, 11 numeric effluent limitations for Outfalls 008-010, and 14 numeric effluent limitations for Outfalls 015-017. (There were no numeric effluent limitations assigned to Outfalls 011, 012, 013, 014, or 018.) A significant change from the 1998 Permit was that the 2004 Permit included maximum daily loads in addition to the maximum daily concentrations in the prior permit. In addition, some of the limitations were more stringent, reflecting the CTR criteria, and some constituents changed. Thus, the major changes from the 1988 Permit to the 2004 Permit were not the inclusion of numeric effluent limitations in the permit—these were already in the 1998 permit, including numeric effluent limitations for storm water-only discharges. The major changes were the addition of numeric effluent limitations for three perimeter outfalls and for three interior outfalls, tightening of some numeric effluent limitations to implement the CTR criteria, and the addition of maximum daily loading limitations.

In January of 2006, based on monitoring results in the interim, the Los Angeles Water Board modified the 2004 Permit, adding numeric effluent limitations for Outfalls 011 and 018[24] and for Outfalls 012, 013, and 014[25]. This permit modification occurred shortly after the Topanga Fire. Finally, in March of 2006, the Los Angeles Water Board again modified the 2004 Permit, this time revising numeric effluent limitations to reflect two Total Maximum Daily Loads (TMDLs) the Board had adopted.[26] The result was more stringent and new numeric effluent limitations for outfalls with discharges ultimately flowing to the Los Angeles River: Outfalls 001, 002, 011, and 018.[27]

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[23] 40 C.F.R. title 131.36. In the CTR, the United States Environmental Protection Agency (U.S. EPA) adopted water quality standards for priority pollutants in California. The State Water Board adopted the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (State Implementation Plan, or SIP) in order to implement the CTR in permits. The CTR and the SIP were each adopted in 2000.

[24] The numeric effluent limitations for Outfalls 001, 002, 011 and 018 are identical.

[25] There are 19 numeric effluent limitations listed for Outfalls 012, 013, and 014.

[26] The TMDLs were for metals and for nutrient loading in the Los Angeles River. TMDLs are required by § 303 of the CWA. NPDES permits must be consistent with the assumptions and requirements of TMDLs. (40 C.F.R. § 122.44(d)(1)(vii).)

[27] Some interior outfalls ultimately flowing to the Los Angeles River also have TMDL-based effluent limitations.

For each effluent limitation at each outfall, the 2004 Permit requires monitoring. Boeing challenges both the number of outfalls listed as compliance points and the breadth of the monitoring requirements. NPDES permits generally must require monitoring at each outfall for each constituent for which there are effluent limitations.[28] The federal regulations do not require analytical monitoring at facilities that discharge storm water associated with industrial activities,[29] but this relaxation of requirements is generally associated with the "nature of the permit conditions."[30] Thus, where a permit regulating storm water discharges associated with industrial activity does contain numeric effluent limitations, "sampling requirements will be appropriate,"[31] while permits that include BMPs in lieu of numeric effluent limitations, may require inspections and BMP evaluation rather than sampling.[32] Therefore, to the extent that outfalls are properly listed as compliance points and that numeric effluent limitations are appropriate, then the monitoring requirements are appropriate. We turn then to the propriety of listing eighteen outfalls as compliance points.

In reviewing the specific locations for sampling and compliance, it is true that the number of outfalls has grown, from the 1998 permit, which listed seven outfalls, to the 2004 Permit, which lists 18 outfalls. Moreover, when the 2004 Permit was adopted, it listed 13 outfalls as compliance points, and when it was modified in 2006, it listed 18 outfalls as compliance points. The actual activities at the SSFL did not vary greatly from 1998 until 2006, although the Los Angeles Water Board did obtain more detailed monitoring data over these years. The chief change in regulatory strategy that resulted in the addition of outfalls was the inclusion of "interior" outfalls as compliance points. There are seven outfalls that all drain to Outfalls 001 and 002.[33] In addition, the number of perimeter outfalls grew from seven to ten.[34] In reviewing the propriety of adding these outfalls as compliance points, we address the interior and perimeter outfalls separately.

We first consider the perimeter outfalls. The 2004 Permit added Outfalls 008, 009, and 010. Storm water runoff discharges from Outfalls 009 and 010 to Arroyo Simi to the

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[28] 40 C.F.R. § 122.44(i).

[29] 40 C.F.R. § 122.44(i)(2)(i)(4) and (5).

[30] Vol. 57 Federal Register 11394, 11402.

[31] *Ibid.*

[32] *Ibid.*

[33] Outfalls 011-018.

[34] Outfalls 008-010 were added.

north of SSFL. Storm water runoff at Outfall 008 discharges from Happy Valley to Dayton Canyon Creek, which ultimately flows to Bell Creek and then the Los Angeles River. Outfalls 001-007, which have all been compliance points with numeric effluent limitations since at least 1998, each discharge to different watersheds around the perimeter of the site.

The Fact Sheet to the 2004 Permit describes in detail each outfall, the locations of former and current industrial activities that are drained, and the constituents of concern. All of the perimeter outfalls are placed so that they would pick up pollutants associated with industrial activities. The industrial activities at the site, including the prior activities for which there are historic contaminants, are indeed potentially substantial contributors of pollutants to surface waters. Outfalls 001 and 002 receive the vast majority of the site's runoff, including treated wastewater, water from the groundwater treatment systems, excess reclaimed water, water from the engine test stands, and storm water. While the other perimeter outfalls have much less runoff, and do not receive process wastewater, they each drain areas that may contain pollutants from the numerous industrial activities conducted at the site. For example, Outfall 010 drains Building 203, which is subject to significant remediation measures under the direction of DTSC. The building was used for repair and calibration of instruments containing mercury. Currently, the building houses operations related to laser research, including polishing fibers, hand wipe solvent, and chemical cleaning, assembly and testing of components.[35] Should BMPs fail, these contaminants would pose significant risks to surface waters. We conclude that each of these perimeter outfalls is properly situated as a compliance point.[36] We also conclude that the 2004 Permit properly requires monitoring at each of these outfalls.

The interior outfalls[37] raise different issues concerning their propriety. Each of these outfalls is authorized to receive commingled process and storm water. Flows through Outfalls 012, 013, 016 and 017 discharge through Outfall 018, and thence through Outfall 002. Flows through Outfalls 014 and 015 discharge through Outfall 011, and thence through Outfall 001. Each of the six outfalls that flow to Outfalls 011 and 012[38] is located near areas of significant past and present industrial activity. While the effluent limitations for 012-017 vary depending on the contaminants present at the specific areas drained, the effluent limitations for 001, 002, 011, and 018 are identical, reflecting that each drains large areas of SSFL and that

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[35] All wastes are currently placed in containers and transported off-site for disposal.

[36] We will discuss separately, *infra*, the propriety of the numeric effluent limitations assigned to these outfalls.

[37] Outfalls 011-018.

011 and 018 drain to 001 and 002, respectively. The Fact Sheet for the January 2006 Permit states: "Discharges from Outfalls 011 and 018 receive no additional treatment or additional discharges prior to exiting Outfalls 001 and 002."[39]

In considering the decision by the Los Angeles Water Board to list Outfalls 011-018 as separate outfalls, each with numeric effluent limitations, we again consider the uniqueness of the SSFL site—its large size, its hilltop location, the significant chemicals used in the past, and to a lesser extent, in the present. We also note Boeing's argument that it no longer intends to discharge non-storm water flows, although it has not yet submitted a report of waste discharge for a permit that would prohibit all discharges of industrial process and domestic wastewater. Since the Permit currently regulates process water discharges at each interior outfall, it is appropriate to apply numeric effluent limitations at each of these outfalls. U.S. EPA regulations require this approach:

> All permit effluent limitations, standards, and prohibitions shall be established for each outfall or discharge point of the permitted facility, except as otherwise provided under §122.44(k) (BMPs where limitations are infeasible) . . . . (40 C.F.R. § 122.45(a).)[40]

It is possible that, even if Boeing continues to discharge commingled runoff, some of the numeric effluent limitations in the interior and the perimeter may, in fact, count the same violation twice in such a manner as to treat a single violation as multiple violations. In other words, if discharges are unchanged from an interior outfall to a perimeter outfall, and the same numeric effluent limitations are exceeded at each outfall, Boeing could be cited twice for the same violation. The ongoing monitoring results required by the Permit should disclose whether that is the case. Therefore, if Boeing does not submit a report of waste discharge limiting its discharges to storm water only, the Los Angeles Water Board must consider whether there is double counting for violations at more than one outfall and, if there is, avoid this. The Los Angeles Water Board should undertake this review when it reissues a permit.

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[38] Outfalls 012-017.

[39] Fact Sheet for January 2006 Permit, at p.35 accompanying Order No. R4-2006-0111. In its Response to Comments on the draft NPDES permit, the Los Angeles Water Board explains that the property between Outfalls 001 and 011 and between Outfalls 002 and 018 is undeveloped land where no industrial operations have occurred and that "staff will not oppose a decision to delete Outfalls 001 and 002 as compliance points or a decision to require monitoring only at these locations." (Fact Sheet, at p.34.)

[40] Thus, so long as numeric effluent limitations are appropriate, each outfall must be regulated as a compliance point. In the next Contention we discuss Boeing's contention that the Los Angeles Water Board erred in including numeric effluent limitations and that it should have instead used BMPs pursuant to 40 C.F.R. § 122.44(k).

Even before the Permit might be modified or reissued, we conclude that it was not appropriate for the 2006 Permit to establish compliance points at both Outfalls 001 and 011 and at both Outfalls 002 and 018. As is clear from the Fact Sheet and the Response to Comments, there is no evidence that there will be any change in pollutants discharged between Outfalls 011 and 001 or between Outfalls 018 and 002. According to the administrative record, there are no industrial operations or other potential contributors of pollutants between each of these points; the only rationale provided was that the decision was within the discretion of the Los Angeles Water Board. But in the exercise of discretion there must be rationale provided. Normally the State Water Board would not review the designation of specific outfall locations. In this case, because of the large number of effluent limitations and constituents regulated, adding Outfalls 011 and 018 will have the effect of doubling the number of any permit violations of effluent limitations at Outfalls 001 and 002 without any observable benefit to water quality. We conclude that the Permit should not have established effluent limitations for Outfalls 011 and 018.[41]

Contention: Boeing contends that the Permit inappropriately contains numeric effluent limitations for storm water-only discharges, that the numeric effluent limitations for commingled wastewater are improperly calculated, and that the Permit improperly determines that Boeing's discharges have the reasonable potential to cause or contribute to many of the water quality standards cited in the Permit.

Finding: Before addressing these contentions, we will point out that there are only eight outfalls that are currently authorized to discharge storm water only. While the other ten outfalls may discharge mostly or, as Boeing claims, "almost entirely" storm water, the fact that the Permit authorizes the discharge of industrial process and domestic wastewater from these outfalls raises different issues in evaluating the propriety of the process the Los Angeles Water Board followed in determining "reasonable potential" and in establishing numeric effluent limitations.

For the commingled discharges—Outfalls 001, 002, and 011-018—the Los Angeles Water Board was required to adopt numeric effluent limitations unless it was infeasible to establish such limitations.[42] In adopting numeric effluent limitations, it was required

[41] We will leave to the sound discretion of the Los Angeles Water Board whether to delete the effluent limitations from Outfalls 001 and 002 or from Outfalls 011 and 018. Pending that determination, this Order will stay the effect of the effluent limitations for Outfalls 011 and 018.

[42] For process water discharges, 40 C.F.R. § 122.44(k)(3) permits non-numeric effluent limitations, generally in the form of BMPs, where numeric effluent limitations are not feasible. (*Communities for a Better Environment v. State Water Board* (2003) 109 Cal.App.4th 1089, 1105.)

to comply with the SIP for priority pollutants listed in the CTR. The SIP sets forth the methodology for determining which constituents exhibit "reasonable potential" and for calculating the numeric effluent limitations. In prior orders,[43] we have discussed in detail the requirements of the SIP and the required methodology for determining reasonable potential and calculating effluent limitations. We have reviewed the methodology employed by the Los Angeles Water Board and its explanation of its determinations and find these efforts to be exceptional.

We will address Boeing's contention that, in light of section 122.44(k)(3) allowing the use of BMPs in lieu of numeric effluent limitations where it is infeasible to establish numeric effluent limitations, the Los Angeles Water Board acted improperly or inappropriately in establishing numeric effluent limitations.[44] Boeing contends that it has proven that it cannot comply with numeric effluent limitations "immediately" and it claims that Los Angeles Water Board staff members concede "that Boeing cannot immediately comply" with the requirements.[45]

There is little precedent concerning the meaning of the term "infeasible" in section 122.44(k)(3). In *Communities for a Better Environment, Supra*, the court upheld the Boards' conclusion "that a numeric WQBEL was not feasible (i.e., 'not appropriate') . . . ." We view the issue of determining whether a numeric effluent limitation is "feasible" as concerning the ability or propriety of establishing such a limit, rather than the ability of the discharger to comply. In *Communities*, the court addressed the feasibility of a numeric effluent where the limitation implemented a narrative water quality objective, there was a need for ongoing study of the constituent, and there was an upcoming TMDL for the particular constituent. (Numerous other constituents were subject to numeric effluent limitations for the mixed storm water and process water discharge in that case.[46]) We disagree with Boeing's reading of the provision, i.e. that "feasibility" refers to its ability to comply with the limitations. Discharges of process

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[43] See, e.g., *In the Matter of Yuba City*, State Water Board Order No. WQO 2004-0013 and *In the Matter of County Sanitation District No.2* Order No. WQO 2003-0009.

[44] It is, frankly, difficult to determine whether Boeing does, in fact, make this contention. Because of its emphasis on commingled discharges being mostly (or perhaps, all) storm water and its use of the term "infeasible" to refer to the time in which it can achieve compliance (discussed below), it is not entirely clear that Boeing is challenging the use of numeric effluent limitations to regulate the commingled wastewater. Nonetheless, because it seeks to "vacate any new numeric effluent limits added to the 2004 or 2006 Permits applicable to combined storm water and wastewater dischargers" (Petition, 2/21/06), we will address this contention.

[45] Memorandum of Points and Authorities, 3/16/06, at p.23.

[46] See, also, *In the Matter of National Steel and Shipbuilding Company*, Order WQ 98-07 (approving numeric effluent limitations for facility discharging storm water along with some process water).

wastewater from industrial sites (and storm water-only discharges associated with industrial activity) must comply with water quality standards.[47] Whether the permit limitations are written as BMPs or as numeric effluent limitations, the legal standard is the same. As we have stated before, programs of prohibitions, source control measures, and BMPs constitute effluent limitations and can be written to achieve compliance with water quality standards.[48]

In any event, Boeing does not clearly argue that, for its commingled wastewater discharges, it cannot achieve compliance with the numeric effluent limitations. Rather, it argues that it cannot achieve "immediate" compliance. Much of its argument refers to the impacts of the Topanga Fire and the need for time to come into compliance. This argument is relevant to the need for compliance schedules, rather than whether numeric effluent limitations should be employed. We are also cognizant that Boeing has been subject to numeric effluent limitations for discharges through 001 and 002, which drain all of the commingled wastewater outfalls, since at least 1998. Finally, the amount of toxic chemicals historically and currently used at the site, in addition to the site topography that results in large amounts of runoff, all lead to the conclusion that it is feasible, i.e. appropriate, to establish numeric effluent limitations for the commingled runoff from the site. We conclude that the Los Angeles Water Board did not act inappropriately or improperly in refusing to find that numeric effluent limitations were infeasible pursuant to 40 C.F.R. section 122.44(k)(3).

However, the Los Angeles Water Board must modify (or reissue) the permit so that either Outfalls 001 and 002 or Outfalls 011 and 018 are subject to numeric effluent limitations, but not all four outfalls.

There are eight outfalls that are currently permitted to discharge only storm water runoff.[49] These outfalls, except for Outfall 008, discharge to the northeast of SSFL, into different watersheds than the major Outfalls 001 and 002. Outfall 008 discharges through Happy Valley and eventually to the Los Angeles River, but not through Outfalls 001 or 002. All of these outfalls, except for Outfall 008, have been regulated with numeric effluent limitations at least since the 1998 Permit. Each outfall is positioned so as to receive runoff from specific areas associated with historic or existing areas with contamination from industrial activities.

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[47] CWA § 301(b).

[48] *In the Matter of Citizens for a Better Environment, et al.* Order WQ 91-3, at p.30-31.

[49] Outfalls 003-010.

Federal regulations do not require numeric effluent limitations for discharges of storm water.[50] The Water Boards can include numeric effluent limitations in individual storm water permits or can choose not to. The Water Boards are also not required to perform a reasonable potential analysis for each constituent.[51] We have long held that storm water permits issued in California need not always include numeric effluent limitations.[52] This is not to say that numeric effluent limitations cannot be included in storm water permits. In adding subsection (2) to section 122.44(k), the U.S. EPA explained that it was employing the Interim Permitting Policy for Water Quality-Based Effluent Limitations in Storm Water Permits (Interim Permitting Policy).[53] (Vol. 64 Fed. Reg. 68722, 86788-9.) The Interim Permitting Policy generally endorses narrative effluent limitations based on BMPs, but it also supports numeric effluent limitations where either there is adequate information or the facility has long been subject to numeric effluent limitations:

> "In cases where adequate information exists to develop more specific conditions or limitations to meet water quality standards, these conditions or limitations are to be incorporated into storm water permits, as necessary and appropriate. This interim permitting approach is not intended to affect those storm water permits that already include appropriately derived numeric water quality-based effluent limitations." (Vol. 61 Fed. Reg. 43761; repeated at Vol. 64 Fed. Reg. 68788.)

U.S. EPA explains that the Interim Permitting Policy does not explicitly apply to states and that states are encouraged to adopt similar policies. (*Ibid.*) As Boeing points out in its papers, the State Water Board is currently reviewing the issues concerning whether storm water permits should, as a general matter, contain numeric effluent limitations. To assist us in this task, we appointed a Blue Ribbon Panel and recently received their report and recommendations.[54] The Panel was asked to address the feasibility of numeric effluent

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[50] 40 C.F.R. § 122.44(k)(2).

[51] *Divers' Environmental Conservation Organization v State Water Resources Control Board* (2006) ___ Cal.Rptr.3d ___, 2006 WL 3423150.

[52] See, e.g., *In the Matter of Citizens for a Better Environment, et al.* Order WQ 91-3, at p.30-31. Note that prior to 1999, there was no separate exemption for storm water discharges apart from the general rule requiring numeric effluent limitations except where infeasible. Thus, our older decisions and general permits made determinations regarding feasibility. In 1999, § 122.44(k) was amended to add the subsection (2), which authorizes the permitting authority to include BMPs in lieu of numeric effluent limitations in storm water permits, without the necessity of making a determination of infeasibility. (Vol. 64 Fed. Reg. 68722, 68847.)

[53] U.S. EPA issued the Interim Permitting Policy was issued on August 1, 1996. (Vol. 61 Fed. Reg. 43761.)

[54] The report is available at http://www.waterboards.ca.gov/stormwtr/docs/numeric/swpanel_final_report.pdf.

limitations in general industrial permits, general construction permits, and area-wide municipal permits.[55] Thus, while the report will help the State Water Board and Regional Water Boards to design these new permits, the purpose of the Report was never specifically intended to address individual storm water permits.[56] The issues explored by the Panel are not directly applicable to this permit and our decision here does not reflect or presage our future actions and policies on the Panel report and the general question of numeric effluent limitations for storm water permits.

We conclude that the Boeing site is unique both from a physical standpoint–the immense area covered, the extensive past contamination, existing activities, and the amount of runoff from the steep terrain–and from a regulatory standpoint, since it has been subject to individual permits with numeric effluent limitations for storm water discharges for many years. The runoff from remediation areas has the potential to contain contaminants from the historic industrial activities. For example, the catchment area of Outfall 004 is comprised largely of a landscape whose surface soil is contaminated with mercury and other contaminants from the former Sodium Reactor Experiment site. Boeing is remediating this site and may ultimately remove the contaminated soil and dispose of it off-site. Until DTSC authorizes such a final solution, the contaminated soil is covered and Boeing uses BMPs at the bottom of the catchment to treat the runoff. It was appropriate and proper for the Los Angeles Water Board to continue to apply numeric effluent limitations at the storm water-only outfalls (including the addition of Outfall 008) in the 2004 Permit and in its modifications.

Boeing also contends that the Los Angeles Water Board was prohibited from applying the SIP when it decided to establish numeric effluent limitations for the storm water-only outfalls. We disagree. U.S. EPA adopted water quality criteria for priority pollutants in California in the CTR. (40 C.F.R. Part 131.36.) In 2000, the State Water Board adopted the SIP to implement the CTR. The SIP includes instructions on determining "reasonable potential" and in calculating numeric effluent limitations for priority pollutants. Thus, the SIP is legally applicable only to priority pollutants listed in the CTR.

The SIP is also not legally applicable to storm water discharges. In footnote 1 of the SIP, we stated: "This Policy does not apply to regulation of storm water discharges. The [State Water Board] has adopted precedential decisions addressing regulation of municipal

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[55] *Ibid.*

[56] It is, of course, possible that some of the policy decisions we will make regarding whether and how to use numeric effluent limitations in general and area-wide storm water permits could ultimately impact our review of individual permits, but we have not even acted upon the report's recommendations yet. Moreover, the permit at issue is an individual permit that is a reissuance of a permit that for almost 10 years has always included numeric effluent limitations for its storm water-only discharges.

storm water discharges in Orders WQ 91-03, 92-04, 96-13, 98-01, and 990-05. The [State Water Board] has also adopted two statewide general permits regulating the discharge of pollutants contained in storm water from industrial and construction activities." All of the references in this footnote refer to area-wide municipal permits and general permits that do not include numeric water quality-based numeric effluent limitations. Thus, by this footnote, we made clear our policy that such permits are not *required* to determine reasonable potential for each constituent or to include numeric effluent limitations.

While the SIP does not legally apply to storm water discharges, that is not to say that if, in an appropriate case, a storm water permit includes numeric effluent limitations, the SIP procedures cannot be employed to determine reasonable potential and to calculate effluent limitations. We have already addressed the use of the SIP for non-priority pollutants.[57] Where a regional water board makes determinations concerning "reasonable potential" and calculating numeric effluent limitations for constituents not subject to the CTR, the regional water board must articulate the bases for its determinations.[58] In *Yuba City*, we found that the regional board properly relied on both the SIP and U.S. EPA's Technical Support Document for Water Quality-Based Toxics Control (TSD) in establishing numeric effluent limitations for non-priority pollutants.[59] This is precisely what the Los Angeles Water Board did in this case. Just as the SIP can be used for non-priority pollutants, it can also be used for storm water discharges, so long as the methodology is explained and justified. We conclude that the Permit appropriately relied on the SIP, the TSD, and also the California Permit Writers Training Tool in developing the numeric effluent limitations. Because none of these documents are required by a formal Policy or a regulation to be used to determine "reasonable potential" and to calculate numeric effluent limitations for storm water discharge, the Los Angeles Water Board was required to explain fully its procedures.[60] We conclude that the Los Angeles Water Board met that burden.

Contention: Boeing claims that the Los Angeles Water Board erred in refusing to issue a cease and desist order with a four-year compliance schedule and interim effluent limitations in 2006.[61]

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[57] See, e.g. *In the Matter of Napa Sanitation District*, Order WQO 2001-16 and *In the Matter of Yuba City*, Order WQO 2004-0013.

[58] *Ibid.*

[59] EPA/505/2-90-001, March 1991.

[60] See requirements for calculating numeric effluent limitations in 40 C.F.R. title 122.44(d).

[61] Boeing refers to draft Order No. R4-2006-0YYY, which was prepared by staff from the Los Angeles Water Board.

Finding: The request for a CDO with a compliance schedule raises different issues than Boeing's claims that numeric effluent limitations were inappropriate because compliance with those limitations was "infeasible." As we discussed, above, the issue regarding feasibility for inclusion of numeric effluent limitations pursuant to 40 C.F.R. section 122.44(k)(3) concerns whether it is "appropriate", or feasible from a regulatory perspective, to establish numeric effluent limitations. In any event, the discharge is subject to the strict requirements of compliance with water quality standards. The propriety for an enforcement action that includes a time schedule to come into compliance with the permit's effluent limitations does turn on the specific discharger's ability to comply.[62]

The permitting history alone does not appear to justify the need for additional time to comply with the Permit. Permits for SSFL have included numeric effluent limitations since at least 1998. The vast majority of new and revised effluent limitations were added in July 2004. When Boeing filed a petition in August 2004, it asked that the petition remain in abeyance and it did not allege that it had been improperly denied a compliance schedule and interim limits. These issues were raised in its appeals of the 2006 Permit modifications. The 2006 modifications, however, were generally limited to adding effluent limitations to the interior Outfalls 012-014 and 015-017. Thus, on the face of the permitting actions alone, it is difficult to justify the need for a compliance schedule and interim limitations, especially Boeing's request that these revisions be retroactive to July 2004.

Boeing also points out, however, the devastating effects of the Topanga Fire as a basis for a compliance schedule and interim limits. The record includes ample evidence that the Topanga Fire, which destroyed vegetation through 70 percent of SSFL, was indeed a major incident that would significantly affect its ability to comply with the numeric effluent limitations in the Permit. The photographs and testimony in the record provide strong evidence that the BMP's in place prior to the September 2005 fire were substantially destroyed and that, in addition, ash from the fire likely contains additional contaminants regulated by the Permit. In light of the large size of SSFL and the fact that most of the volume of discharges are associated with storm water runoff,[63] the natural landscape has been used as the major component in the treatment system. Thus, vegetation is used to prevent and remove pollutants from moving off-

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[62] *City of Sacramento v. State Water Resources Control Board* (1992) 2 Cal.App.4th 960, 965.

[63] While commingling of process water and storm water result in the legal treatment of the wastewater as process water, in reviewing the *factual* issues, such as whether a fire resulted in the need for a compliance schedule, it is relevant that the wastewater discharges are largely composed of storm water runoff.

site in storm water flows. Commenters including CBG contend that prior to the Topanga Fire Boeing's BMPs were inadequate and that a compliance schedule would, in effect, reward Boeing for past inadequacies. We do not find that argument persuasive. First, regardless of how effective the BMPs and treatment used prior to the fire, all would still be burned and unusable after the fire. Second, while we agree that some of the BMPs most recently installed do surpass the prior BMPs,[64] we find that these new systems are state of the art and their absence prior to the fire does not necessarily indicate that the prior BMPs were inadequate. As to the list of violations throughout the several years prior to the fire, while we do not in any way condone permit violations, the number of individual permit violations at a site the size and complexity of SSFL does not necessarily mean that the BMPs were wholly inadequate.

The record shows that on January 19, 2006, the Los Angeles Water Board considered whether to issue a cease and desist order. A CDO is an enforcement order. Water Code section 13301 provides that when a regional board finds that a discharge of waste is taking place, or threatening to take place, in violation of a permit, "the board may issue an order to cease and desist" and may issue an order requiring immediate compliance, compliance in accordance with a time schedule, and appropriate remedial activities. The State Water Board's Water Quality Enforcement Policy explains the use of cease and desist orders:

> "Cease and Desist Orders (CDOs) are adopted pursuant to California Water Code sections 13301-13303. CDOs may be issued to dischargers violating or threatening to violate WDRs or prohibitions prescribed by the RWQCB or the SWRCB. CDOs are often issued to dischargers with chronic non-compliance problems. These problems are rarely amenable to a short-term solution. Often, compliance involves extensive capital improvements or operational changes. The CDO will usually contain a compliance schedule, including interim deadlines (if appropriate), interim effluent limits (if appropriate), and a final compliance date. CDOs may also include restrictions on additional service connections to community sewer systems and combined stormwater/sewer systems."[65]

In light of the circumstances of the Topanga Fire, the nature of the site, including its topography, the fact that most of the discharges consist of runoff, the difficulty of ensuring compliance at numerous outfalls that receive discharges from many sources, and the ensuing impact on Boeing's ability to comply with the permit terms, we conclude that the Los Angeles

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[64] For example, at the stay hearing, Boeing presented evidence of a carbon filtration system now employed at some outfalls.

[65] Water Quality Enforcement Policy, at p.20.

Water Board acted inappropriately in refusing to issue an enforcement order with a compliance schedule and interim effluent limitations based on the impacts from the Topanga Fire.

We have stated above that the Permit appropriately required strict compliance with water quality standards through numeric effluent limitations. Our findings in this section do not take away from that conclusion. They address, instead, whether the Los Angeles Water Board acted inappropriately and improperly by refusing to issue an enforcement action with a time schedule where the site was subject to a fire that destroyed its control structures. We find that it was not justifiable to demand immediate compliance by Boeing. In view of the impacts of the fire, a time schedule was warranted based on the specific situation that Boeing faced. We note that, as an enforcement action, a CDO does not condone permit violations. Rather, it constitutes a finding of violation or impending violation of an order and it carries with it the potential for higher fines should it be violated.[56] On the other hand, there is no justification to make the compliance schedule retroactive to July 2004, before the fire and before Boeing even pressed its claim that it needed a compliance schedule. We will remand this issue to the Los Angeles Water Board to issue a CDO. Any CDO should include a compliance schedule that is as short as possible. The order should be retroactive to January 19, 2006, when the matter was considered.

III. CONCLUSIONS

1. The Boeing Permit is an individual permit for commingled storm water and industrial process water and should not be regulated the same as sites subject to the General Permit for storm water discharges associated with Industrial Activities.
2. The monitoring requirements in the Permit are appropriate.
3. Outfalls 001–010, which are situated on the perimeter of the property, are properly situated as compliance points.
4. Outfalls 012-017, which are situated in the interior of the property, are properly situated as compliance points, at least while Boeing is authorized to discharge industrial process water, treated groundwater, and domestic wastewater. But in any event, it is inappropriate to count the same violation twice in such a manner as to treat a single violation as multiple violations.
5. Outfalls 001 and 011 and Outfalls 002 and 018 are duplicative because Outfalls 011 and 018 flow directly to Outfalls 001 and 002, respectively, without any change in flows or discharge in the interim and with only open space between them. The Permit should

[56] Wat. Code, § 13385, subdivision (e) requires consideration of prior history of violations in establishing administrative liability for permit violations.

include only one set of these outfalls as compliance points subject to numeric effluent limitations.

6. The Permit appropriately contains numeric effluent limitations and these were properly calculated based on determinations of "reasonable potential" to cause or contribute to exceedance of water quality standards.
7. The Los Angeles Water Board properly used the SIP and federal guidance materials to calculate numeric effluent limitations for storm water discharges by explaining and justifying its methodology.
8. The Los Angeles Water Board acted inappropriately in refusing to issue Boeing a CDO, with a compliance schedule and interim effluent limitations, when it modified the Permit in 2006, based on the effects of the Topanga Fire.
9. Nothing in this Order prevents enforcement of the Permits, except insofar as the Los Angeles Water Board adds a compliance schedule in a CDO, which compliance schedule shall not be effective until January 19, 2006. Also, the CDO does not operate to excuse violations of any Permit.

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IV. ORDER

The Permit is remanded to the Los Angeles Water Board to revise the provisions concerning Outfalls 001, 002, 011, and 018, consistent with this Order. The effluent limitations from Outfalls 011 and 018 are stayed, pending a determination by the Los Angeles Water Board deleting either Outfalls 011 and 018 or Outfalls 001 and 002 as compliance points. The Los Angeles Water Board is also instructed to issue a CDO with the shortest possible compliance schedule, which shall be based on the impacts from the Topanga Fire, with interim effluent limitations, and which shall be effective January 19, 2006. The Los Angeles Water Board is instructed to review the Permit to ensure that numeric effluent limitations for different outfalls do not count the same violation twice in such a manner as to treat a single violation as multiple violations. In all other respects, the petitions are DENIED.

CERTIFICATION

The undersigned, Clerk to the Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on December 13, 2006.

AYE: Tam M. Doduc
Arthur G. Baggett
Charles R. Hoppin
Gary Wolff, P.E., Ph.D.

NO: None

ABSENT: None

ABSTAIN: None

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Clerk to the Board

EXHIBIT “11”

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

Panelists:

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"The opinions I express are my own and do not represent official US EPA policy."

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Background

The NPDES storm water permit program came into being as a result of the 1987 amendments to the federal Clean Water Act and its implementing regulations. In California, the State Water Resources Control Board (State Water Board) and the nine Regional Water Quality Control Boards (Regional Water Boards) implement the NPDES storm water program.

The Clean Water Act amendments, Section 402(p) require that discharges of storm water from large and medium municipal separate storm sewer systems (MS4s) and discharges of storm water 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). Discharges associated with industrial activities, were required to meet the technology based standards of best available technology economically achievable (BAT) or best conventional pollutant control technology (BCT), and to meet water quality standards.

In 1990, USEPA promulgated regulations (40 CFR Part 122.26) for the NPDES storm water program. These regulations clarified what industrial activities were subject to storm water permit. Construction that resulted in a land disturbance of five or more acres was included as an industrial activity subject to NPDES storm water permit. The regulations also delineated what was to be included in permit applications and the programmatic elements that were to be in a permit and storm water management program for MS4s or storm water pollution prevention plan for industrial activities.

California's Permits

In 1990, MS4 permits were issued to Santa Clara County by the San Francisco Bay Regional Water Board and to Los Angeles County by the Los Angeles Regional Water Board. These permits were appealed to the State Water Board. The primary basis of the appeals was the lack of numeric limits in the permits. The entities that brought the appeals argued that the permits needed to include numeric limits, as the discharges of pollutants must not only be reduced to the MEP, but they must also meet water quality standards. The State Water Board, in hearing these appeals, determined that it was not feasible at the time to develop numeric limits for MS4 permits, and that water quality standards could and should be achieved through the implementation of best management practices (BMPs). Since this ruling, the Regional Water Boards have typically not included numeric limits in storm water permits.

The State Water Board has adopted NPDES General Permits for the Discharge of Storm Water Associated with Industrial Activities and for the Discharge of Storm Water Associated with Construction Activities. Both of these permits contain language stating that developing numeric limitations is infeasible.

Court Decisions

In addition to these actions on MS4 permits at the State level, there have been a number of rulings from the federal courts regarding the NPDES Storm Water program.

One of the most significant is from the federal court, 9th District Court of Appeals from 1999. In its published opinion on Defenders of Wildlife vs. Browner, the Court held that MS4 permits need not require strict compliance with water quality standards. Rather, compliance was to be based upon the MEP standard. However, the permitting authority (the State Water Board/Regional Water Boards for California) could at their option require compliance with standards. The State Water Board through the permit and appeals process has in fact required that the discharges from MS4s meet water quality standards, but has stated that compliance with numeric standards can be achieved through the implementation of BMPs in an iterative fashion.

The Browner decision also found that discharges of storm water associated with industrial activities must be in strict compliance with water quality standards.

In 2004 the State Water Board conducted a public hearing on a draft General Industrial Storm Water permit. This draft permit met with significant opposition from non-government or non-industrial organizations (NGOs) due to the absence of numeric limits. Staff revised the draft permit to include the benchmarks contained in the USEPA multi-sector general permit. This change resulted in strong opposition from the regulated community.

The concerns that have been raised by the NGOs and the regulated community are similar, though they do not necessarily agree on the best way to address them. Both believe that permitting has become overly complex, and that it is extremely difficult, if not impossible to objectively determine if a facility, operation or municipality is in compliance with its permit requirements. The NGOs argue that requiring storm water permittees to comply with numeric effluent limits will result in an easier way to measure compliance. The regulated community agrees, to a degree, but they argue that it is not simply a matter of selecting a number that is suitable for a POTW or industrial waste discharge. Due to the unique nature of storm events and storm water discharges, any numeric limit that is placed in a storm water permit must take into consideration the episodic nature of storm events and be truly representative of storm water discharges. In addition, the regulated community has argued that there are going to be pollutants in storm water discharges that did not originate in the MS4 (run on) or that they do not have the means to control, and therefore should be given special consideration.

In response to these arguments, State Water Board directed staff to convene a panel of storm water experts to examine the feasibility of developing numeric

limits for storm water permits. Specifically, this panel of experts was asked to consider the following:

> "Is it technically feasible to establish numeric effluent limitations, or some other quantifiable limit, for inclusion in storm water permits? How would such limitations or criteria be established, and what information and data would be required?"
>
> "The answers should address industrial general permits, construction general permits, and area-wide municipal permits. The answers should also address both technology-based limitations or criteria and water quality-based limitations or criteria. In evaluating establishment of any objective criteria, the panel should address all of the following:
>
> (1) The ability of the State Water Board to establish appropriate objective limitations or criteria; (2) how compliance determinations would be made; (3) the ability of dischargers and inspectors to monitor for compliance; and (4) the technical and financial ability of dischargers to comply with the limitations or criteria."

Staff invited 10 individuals from the academic and scientific community to participate on the panel. Of the 10, eight agreed to participate. These eight met in a public session on September 14, 2005 and heard presentations from the regulated and NGO communities. They also heard comments from the public at large. They met again on September 15, 2005 to discuss the public comments and to begin to formulate a response. It was also decided at this meeting that they would form sub-committees to address municipal (MS4), industrial and construction discharges separately. These sub-committees worked on drafts statements for each of these, circulating them over the course of a number of months.

The panel met again in private session on April 3 and 4, 2006. The purpose of these meetings was to address unresolved issues and to develop the final response to the State Water Board. It was also decided to combine the three working statements into one Statement of Findings. The following discussion is the panel's findings and is broken into three program element areas: municipal, construction, and industrial.

Panel's Findings on Feasibility of Numeric Effluent Limits Applicable to Municipal Activities

Municipal Observations

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.

   - The California 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 several to many times per year, BMPs require more maintenance than other types of stormwater control facilities. Since urban BMP maintenance is generally left to untrained homeowner associations and maintenance personnel for commercial properties, 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.

<u>The Problem with Existing Effluent Limit Approaches</u>

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:

- 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 DO; 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

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. The *Stormwater Effects Handbook: A Tool Box for Watershed Managers, Scientists, and Engineers* (Burton, G.A. Jr., and R. Pitt, ISBN 0-87371-924-7. CRC Press, Inc., Boca Raton, FL. 2002. 911 pages) was written to be used as a guide for stormwater managers to identify their local receiving water problems and to assist in identifying the causative factors. The methods described would need to be applied to a specific area or region to obtain an understanding of local conditions and problems. Although expensive, comprehensive investigations such as these should be considered an investment to help minimize wasteful expenditures due to the application of inappropriate control practices in a watershed.

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.

Technical Issues

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.

Drawing upon the body of knowledge that currently exists regarding pollutant removal efficiency, it is possible to estimate mean effluent concentrations and variances for a number of constituents for different types of BMPs, albeit not in a legally enforceable sense. Effluent concentration distributions for a number of BMPs are available in the International BMP Database (www.bmpdatabase.org) from more then 250 studies throughout the US. The following outlines key issues that have been identified regarding the technical feasibility of setting objective criteria for both existing areas and new or redeveloping areas:

- Effluent concentration estimates could be made for a given constituent and a particular BMP from a larger number of BMPs than available in the BMP Database using literature values of percent removal and local or national data on stormwater runoff EMC data. However, the results from this work would be significantly less reliable then the BMP Database data as it could be biased if the influent concentrations for the studied BMP types did not match general urban runoff.
- Designing the facility more rigorously with respect to the physical, chemical and biological processes (e.g. unit processes) that are active in the BMP would give confidence that the BMP would perform at least as well, if not better than the average performance determined from the literature. A WEF/ASCE task force is currently updating their Urban Runoff Quality Management Manual of Practice; design guidance of BMPS will make better use of the physical, chemical, and biologic processes taking place in the BMP before, during and after a storm event. This manual will build upon recent research efforts employing a unit process based approach for BMP design and selection. These research efforts were supported by the Water Environment Research Foundation (WERF) and the National Cooperative Highway Research Program (NCHRP).
- A BMP *designed* and *constructed* according to a set of criteria described above, could be ***presumed*** to deliver an effluent with a mean constituent concentration and variance similar to the performance numbers developed from the literature ***if it is properly maintained***. Enforcement would comprise periodic inspection of the facility using a checklist of items to be inspected. While not an effluent limit, this seems practical and quantifiable.

- Most all existing development rely on non-structural control measures, making it difficult, if not impossible to set numeric effluent limits for these areas because little is known about the quantity and quality performance of non-structural controls. However, certain development characteristics in some existing development areas that minimize the amounts of impervious areas in a drainage area have been shown to be quite effective in reducing adverse hydromodifications in the receiving waters, and should be encouraged.

Municipal Recommendations

It is not feasible at this time to set enforceable numeric effluent criteria for municipal BMPs and in particular urban discharges. However, it is possible to select and design them much more rigorously with respect to the physical, chemical and/or biological processes that take place within them, providing more confidence that the estimated mean concentrations of constituents in the effluents will be close to the design target. Moreover, with this more rigorous design and an enforceable maintenance program, it can be presumed that these facilities will continue to deliver effluent qualities that are reasonably close to the design effluent concentrations over the life of the facility. And if proper maintenance is performed (enforced), the facilities can be expected to perform throughout their design life at the same or better efficiency as when newly constructed. 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.

For catchments not treated by a structural or treatment BMP, setting a numeric effluent limit is basically not possible. However, the approach of setting an "upset" value, which is clearly above the normal observed variability, may be an interim approach that would allow "bad actor" catchments to receive additional attention. For the purposes of this document, we are calling this "upset" value an ***Action Level*** because the water quality discharged from such locations are enough of a concern that most all could agree that some action should be taken. Action Levels could be developed using at least three different approaches. These approaches include: 1) consensus based approach; 2) ranked percentile distributions; 3) statistically-based population parameters.

The consensus-based approach would be to agree upon effluent concentrations that all parties feel are not acceptable. For example, most parties would likely agree that an average concentration of dissolved copper above 100 ug/l from an urban catchment would not be acceptable. This would be an Action Level value that would trigger an appropriate management response. This approach may not directly address the issue of establishing numeric effluent criteria and achieving desired effluent quality, but the consensus-based approach would ensure that the "bad actor" watersheds received needed attention.

The ranked percentile approach (also a statistical approach) relies on the average cumulative distribution of water quality data for each constituent developed from many water quality samples taken for many events at many locations. The Action Level would then be defined as those concentrations that consistently exceed some percentage of all water quality events (i.e. the 90th percentile). In this case, action would be required at those locations that were consistently in the outer limit (i.e. uppermost 10th percentile) of the distribution of observed effluent qualities from urban runoff.

The statistically based population approach would once again rely on the average distribution of measured water quality values developed from many water quality samples taken for many events at many locations. In this case, however, the Action Level would be defined by the central tendency and variance estimates from the population of data. For example, the Action Level could be set as two standard deviations above the mean, i.e. if measured concentrations are consistently higher than two standard deviations above the mean, an Action situation would be triggered. Other population based estimators of central tendency could be used (i.e. geomean, median, etc.) or estimates of variance (i.e. prediction intervals, etc.). Regardless of which population-based estimators are used (or percentile from above), the idea would be to identify the [statistically-derived] point at which managers feel concentrations are significantly beyond the norm.

The ranked percentile and population-based estimators are highly dependent upon the data sets used to calculate them. There are a number of options that were considered by the Panel, but ultimately they were broken into two distinct categories. The first category was for new development/redevelopment and the second was for built out urban environments. For new development/redevelopment, the panel recommends using the data set associated with the international BMP database (www.bmpdatabase.org). This data set represents the variety of water quality from the most up to date, best conducted and reported BMP studies. The database effort does not limit itself to BMPs types or designs; it focuses on technically sound monitoring studies and reporting information. Therefore there could be some screening of studies to those thought to be well designed BMPs to then develop effluent quality distributions and statistics on performance. Certainly, there is no expectation that urban stormwater managers could improve water quality beyond what would be reported in this dataset.

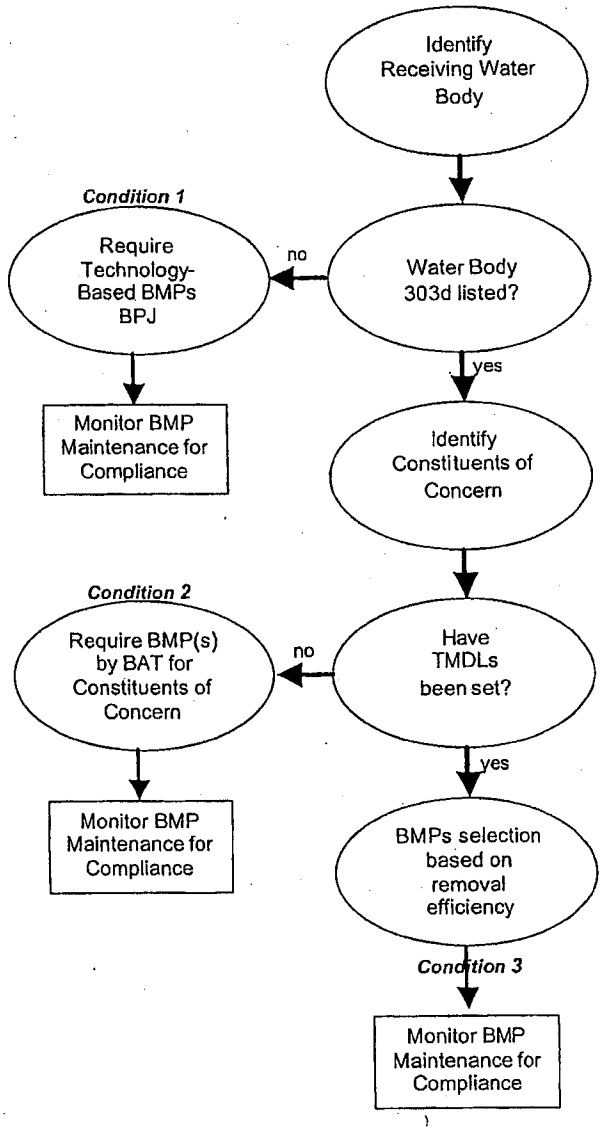
In built-out urbanized environments, there are greater opportunities to examine various data sets for setting Action Levels. For the Panel, these opportunities were a function of spatial scale. The first opportunity would be at the local scale. Some urban stormwater monitoring programs have been in existence for 10 years or longer. Examples include the Los Angeles County Department of Public Works, City of Sacramento, Orange County, San Diego County, amongst others. Using permit specific data sets may make sense if issues of climatic variability or

localized geomorphology are important. The next scale would be to combine these California municipal permit monitoring data sets, especially if lack of data for specific constituents of concern in any one location or region is an important issue. The largest scale would be the National Stormwater Quality Database (NSQD) from municipal monitoring programs across the nation (http://unix.eng.ua.edu/~rpitt/Research/ms4/Paper/Mainms4paper.html). This data set includes monitoring data from urban areas such as residential, commercial, industrial, freeway, institutional, and mixed use which is especially useful if small sample size limits the use of local data. One advantage of using smaller (and local), rather than larger, spatial scales is the ability to update data sets for revising Action Levels. The NSQD may not be updated for quite some time, but local data sets can be updated periodically (annual amendments, 10-year rolling averages, every permit cycle, etc). Ultimately, Action Levels would be expected to become lower as outliers are removed from data sets and as improved water quality data are collected through targeted management actions. It may be appropriate to eliminate older data sets as well over time.

One element to consider when comparing monitoring data to Action Levels is the concept of a design volume for water quality (also known as the Water Quality Capture Volume – WQCV, WEF #23 and ASCE publication #87, 1998) or a design flow rate. The WERF and NCHRP efforts mentioned above include recommendations regarding design sizing using continuous simulation techniques for both volume-based and rate-based BMPs. The Panel acknowledged that several to more times each year, the runoff volume or flow rate from a storm will exceed the design volume or rate capacity of the BMP. Stormwater agencies should not be held accountable for pollutant removal from storms beyond the size for which a BMP is designed.

A Technically Sound and Pragmatically Enforceable BMP Design and the Permit Process

The diagram below provides guidance for determining what BMPs are required in a newly developing watershed. Under ***Condition 1*** where the receiving water quality is not impaired, determination of the appropriate BMP would be by Best Professional Judgment (BPJ). Any of the "state approved" BMPs could be used. The permittee would be required to design the treatment facilities in accordance with the California BMP Handbook, ***which should be revised as a criteria manual***, rather than a guidance manual *and include more physiobiochemically based design criteria designed to address an agreed upon set of "Pollutants and Parameters of Concern" based upon knowledge of the pollutants and parameters that generally are of concern in urban runoff, with perhaps some differences on receiving water type.*



A detailed maintenance plan and schedule would be required 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 would 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.

Under ***Condition 2*** where water quality impairment exists but a TMDL has not yet been performed, BAT would be required, which means applying the BMPs that can practicably (to be defined) be employed to produce the lowest effluent concentrations (e.g. the lower grouping of BMP effluent quality) of the constituent(s) of concern. Several types of BMPs may fulfill the BAT standard if these BMPs have performance that is not statistically or practically differentiable. This case will allow flexibility in choosing among that sets of BMPs that demonstrate superior performance. As in the case of C*ondition 1*, compliance with the maintenance plan and schedule would constitute compliance with the design effluent criteria.

Condition 3, which occurs when a TMDL has been specified for the BMP or for the tributary watershed, may (or may not be) actually be less stringent that *Condition 2* if the TMDL allows for a higher effluent concentration of the constituents of concern than that discharged by a BAT facility. The same requirements would apply for the design criteria, and the maintenance plan and schedule would constitute the guarantee of design effluent concentrations from the BMP.

Strategies for Stormwater Management to Protect Urban Water Environments

Stormwater effluent limits can become very complex if all the issues are to be directly addressed. If complex, they are not likely to be workable. However, too much simplification can also lead to ineffective programs. Therefore, a reasonable first step is needed, based on local data. Compliance monitoring (e.g. BMP inspections) is also needed to ensure that the goals are likely to be met. Most likely goals will have to be revised over time. The overall strategy should contain these objectives:

- Effectiveness
- Affordability
- Enforceability, and
- Flexibility

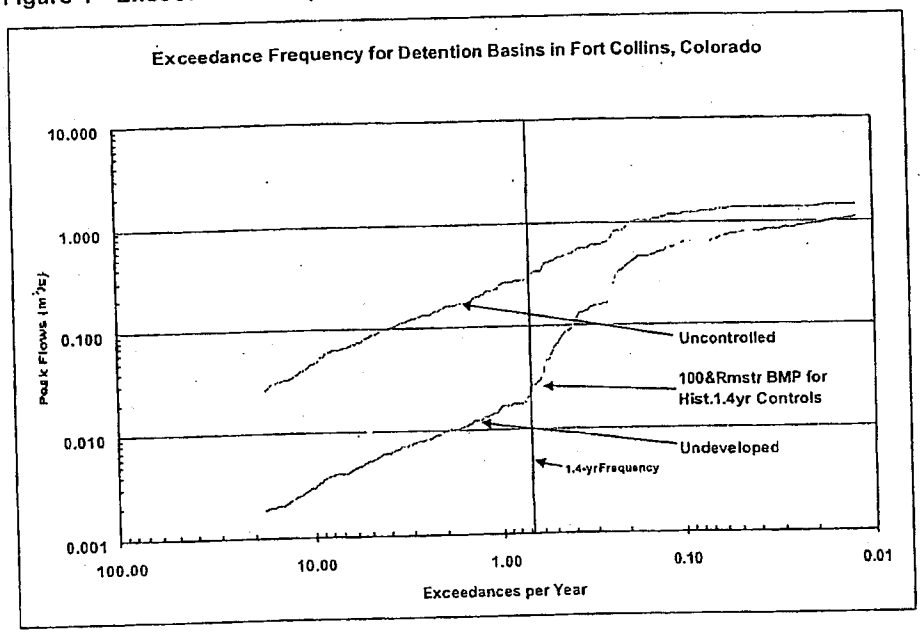
Table 1 - Effects of Urbanization on Hydrologic Regime in Colorado and Georgia

Location	Annual Precipitation	Mean Storm Depth*	Runoff Events per Year		Annual Runoff (mm)	
	Millimeters per Year	Millimeters	Undeveloped	Developed	Undeveloped	Developed
Fort Collins, CO	335	11	27	47	12	124
Atlanta, GA	1262	18	48	78	36	500

* Values obtained from Fig. 5.3 ASCE MOP (1998)

Runoff volume and peak flows have been recognized as two of the most important stormwater factors needing control. **Table 1** (Roesner and Nehrke) shows that urbanization dramatically changes the hydrologic regime of urban waterways. In both Atlanta (a higher rainfall area) and Fort Collins (a semiarid area), 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 as shown in **Figure 1** below, but as also seen on the figure, the peak flow frequency curve can be adjusted back to its predevelopment character by the proper application of runoff controls. But 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.

Figure 1 - Exceedance Frequencies for Detention Basins in Fort Collins, Colorado



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:

- 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 303D 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.

Panel's Findings on Feasibility of Numeric Effluent Limits Applicable to Construction Activities

Construction Observations

Regarding the question of the technical feasibility of Numeric Limits for stormwater discharges from construction activities, the Panel bases its recommendations on the following observations.

1. Limited field studies indicate that traditional erosion and sediment controls are highly variable in performance, resulting in highly variable turbidity levels in the site discharge.
2. Site-to-site variability in runoff turbidity from undeveloped sites can also be quite large in many areas of California, particularly in more arid regions with less natural vegetative cover and steep slopes.
3. Active treatment technologies involving the use of polymers with relatively large storage systems now exist that can provide much more consistent and very low discharge turbidity. However, these technologies have as yet only been applied to larger construction sites, generally five acres or greater. Furthermore, toxicity has been observed at some locations, although at the vast majority of sites, toxicity has not occurred. There is also the potential for an accidental large release of such chemicals with their use
4. To date most of the construction permits have focused on TSS and turbidity, but have not addressed other, potentially significant pollutants such as phosphorus and an assortment of chemicals used at construction sites.
5. Currently, there is no required training or certification program for contractors, preparers of soil erosion and sediment control Stormwater Pollution Prevention Plans, or field inspectors.
6. The quality of stormwater discharges from construction sites that effectively employ BMPs likely varies due to site conditions such as climate, soil, and topography.
7. The States of Oregon and Washington have recently adopted similar concepts to the Action Levels described earlier.

Construction Recommendations

It is the consensus of the Panel that active treatment technologies make Numeric Limits technically feasible for pollutants commonly associated with stormwater discharges from construction sites (e.g. TSS and turbidity) for larger construction sites. Technical practicalities and cost-effectiveness may make these technologies less feasible for smaller sites, including small drainages within a larger site, as these technologies have seen limited use at small construction sites. If chemical addition is not permitted, then Numeric Limits are not likely feasible. Whether the use of Numeric Limits is prudent, practical or necessary to more effectively achieve nonpoint pollution control is a separate question that

needs to be answered, but is outside the scope of this Panel. However, Action Levels are likely to be more commonly feasible. For small sites or smaller drainages within larger sites, or where chemicals cannot be used, the Panel recommends that Action Levels be specified.

Advanced systems lend themselves to Numeric Limits because of historically reliable treatment, while non-active controls are less predictable. Advanced systems have been in use in some form since the mid-1990s. At this time, there are two general types of systems. With each general system the stormwater is retained on-site, treated, and released more slowly. One system employs polymer coagulation and sedimentation. The second system employs polymer coagulation with direct filtration. Both types of systems are considered reliable, and can consistently produce a discharge less than 10 NTU. These systems have been used successfully at many sites in several states since 1995 to reduce turbidity to very low levels. Non-active erosion and sediment control BMPs, while effective when applied and adequately maintained, produce more highly variable in effluent quality, making setting Numeric Limits difficult, if not impossible.

An important consideration in setting Numeric Limits or Action Levels is that in many locations in California the natural background turbidity and/or TSS levels in stormwater runoff are quite high. This is particularly true in semi-arid or arid regions, which tend to have less vegetative cover. For example, natural runoff concentrations in Emerald Creek, on the Newport Coast, above any developed areas have been over 5,000 mg/l during runoff events. The Los Angeles County Monitoring Data sets included an open land use watershed that also showed TSS levels significantly above other types of urban land uses. Therefore, it is important to consider natural background levels of turbidity or TSS in setting Numerical Limits or Action Levels for construction activities. The difficulty in determining natural background concentrations/levels for all areas of the state could make the setting of Numeric Limits or Action Levels impractical from an agency resource perspective.

While the Panel concludes that Numeric Limits or Action Levels are technically feasible, the Panel has several reservations and concerns.

1. The active treatment systems have generally been employed on sites five acres or larger. While the systems are technically feasible for sites of any size, including sites or drainages as small as an acre or less, the cost may be prohibitive. The cost-effectiveness of active treatment systems is greatly enhanced for large drainage areas, at which construction occurs for an extended period of time, over one or more wet season. There is also a more "passive" active system that is employed in New Zealand that uses captured rainfall to release the chemical into flows entering a detention system that requires less instrumentation and flow measurement infrastructure. Even more passive systems such as the use of polymer

logs and filter bags are currently under development for small sites. Regardless, the Panel recommends that the Board give particular attention to improving the application of cost-effective source controls to small construction sites.

2. In considering widespread use of active treatment systems, full consideration must be given to whether issues related to toxicity or other environmental effects of the use of chemicals has been fully answered. Consideration should be given to longer-term effects of chemical use, including operational and equipment failures or other accidental excess releases.
3. Consideration should be given to the seasonality of applying Numerical Limits. There may be sites where summer only construction that complies with Action Levels may be preferred to year-round that sites that include winter construction that complies with Numeric Limits. In such cases, applying Numeric Limits to summer construction may be a disincentive to scheduling active grading during dry periods. Allowing summer only construction sites to comply with action levels would discourage winter construction activities.
4. Consideration should be given to whether Numeric Limits would apply to all construction sites or only those with significant disturbed soil areas (e.g. active grading, un-vegetated and/or un-stabilized soils). A site could meet certain conditions to be considered "Stabilized" for the runoff season.
5. Where Numeric Limits are not feasible or where they would not apply during designated seasons or site conditions, the Panel recommends that the Board consider the concept of Action Levels for sites where only traditional erosion and sediment controls are applied or construction sites that are considered "stabilized" for the runoff season. An Action Level indicates a failure of BMPs (within some storm size limits).
6. The Board should consider Numeric Limits or Action Levels for other pollutants of relevance to construction sites, but in particular pH. It is of particular concern where fresh concrete or wash water from cement mixers/equipment is exposed to stormwater.
7. The Board should consider the phased implementation of Numeric Limits and Action Levels, commensurate with the capacity of the dischargers and support industry to respond.
8. The Panel recommends that a Numeric Limit or Action Level should be compared to the average discharge concentration. The minimum number of individual samples required to represent the average discharge concentration for a storm will need to be defined.
9. The Board should set different Action Levels that consider the site's climate region, soil condition, and slopes, and natural background conditions (e.g. vegetative cover) as appropriate and as data is available. With active treatment systems, discharge quality is relatively independent of these conditions. In fact, active treatment systems could result in turbidity and TSS levels well below natural levels, which can also be a problem for receiving waters.

10. The Board should consider whether the Numeric Limits or Action Levels should differ between receiving waters that are water quality limited with respect to turbidity, sediment or other pollutants associated with construction, from those water bodies that are not water quality limited.
11. The Panel recommends that Numeric Limits and Action Levels not apply to storms of unusual event size and/or pattern (e.g. flood events). The determination of Water Quality Capture Volume should consider the differing climate regions to specify these events.
12. The Board should set Numeric Limits and Action Levels to encourage loading reductions as appropriate as opposed to only numeric concentrations. Examples include phased construction (e.g. limited exposed soil areas or their duration), infiltration, and spraying captured runoff in vegetated areas as means to reduce loading.
13. The Panel is concerned that the monitoring of discharges to meet either the Action Levels or Numeric Limits may be costly. The Panel recommends that the Board consider this aspect.

Panel's Findings on Feasibility of Numeric Effluent Limits Applicable to Industrial Activities

Industrial Observations

The Panel believes that Numeric Limits are feasible for some industrial categories. Industries have control over their facilities. They control access, construction practices, product substitution to affect pollution prevention and the types of treatment systems to be used to mitigate stormwater runoff. There are many treatment systems or prevention practices that have been in place for lengthy periods, extending back to the 1980s in many cases. For example, there is much known today about construction materials, such as roofing materials (roofing composition, gutters, paints and coatings, products that abrade or tend to create solids or litter, etc). Other examples include development of pervious surfaces, or infiltration methods.

The decision for the value of Numeric Limits should be made in one of two ways. When there is a TMDL that defines the permissible load for a watershed, the Numeric Limits should be set to meet the TMDL. Consideration must be given for both the pollutant concentration as well as the volume of runoff, since both contribute to the impacts that required the TMDL to be implemented.

When there is no TMDL, the Numeric Limits should be based upon sound and established practices for storm water pollution prevention and treatment, using an approach analogous to that used in the NPDES wastewater process in the 1970s. In this approach phased, Numeric Limits were first set that were based upon the use of best currently available technology, and permittees were given a defined period for compliance. Permits were established based upon industry types or categories, with the recognition that each industry has its own specific problems and financial viability.

To establish Numeric Limits for industrial sites requires a reliable database, describing current emissions by industry types or categories, and performance of existing BMPs. The current industrial permit has not produced such a database for most industrial categories because of inconsistencies in monitoring or compliance with monitoring requirements. The Board needs to reexamine the existing data sources, collect new data as required and for additional water quality parameters (the current permit requires only pH, conductivity, total suspended solids, and either total organic carbon or oil and grease) to establish practical and achievable Numeric Limits.

In cases where the industrial activity is similar to activities covered by the MS4 permit (roofs, parking lots, etc), the approach or limits for industries should be the same as for MS4 permittees. In cases where the industrial activity is similar to land disturbance activities (e.g. landfills, gravel mines, etc.), there exists data and design experience with runoff control, capture and advanced treatments systems (e.g. systems using polymer to enhance total suspended solids removal – see

the construction section) that may make Numeric Limits feasible for new facilities, and the approach and limits should be the same as for construction permittees. The same conditions and issues related to active treatment discussed in the construction section apply here.

In cases where there is less certainty in the data for both stormwater characterization or BMP performance to establish Numeric Limits, there maybe sufficient data to establish Action Levels. Action Levels set for industrial sites that discharge to MS4s should not exceed those set for MS4 permittees.

The Panel recognizes that existing and new facilities may have to be treated differently and recommends the approach in **Table 2**.

Table 2- Approach to Establish Numeric Limits or Action Levels at Existing or New Facilities

		Numeric Limits	Action Levels	Notes
Existing Facility	Indoor	No	Yes, similar to MS4	
	Outdoor	Yes if data are adequate for the specific industrial activity and BMP	Yes, using industrial database	Action Levels should approach MS4 action levels.
New Facility	Indoor	Yes – BMP Database		Technology based, similar to MS4 New Development
	Outdoor	No, unless sufficient data exist for the specific industrial activity and BMP	Yes when sufficient data are available	

Industrial Recommendations

The Panel has several reservations and concerns:

- The Panel recognizes the inadequacy of current monitoring data sets and recommends improved monitoring to collect data useful for establishing Numeric Limits and Action Levels.
- Required parameters for future monitoring should be consistent with the type of industrial activity instead of the current parameters (i.e., monitor for heavy metals when there is reasonable expectation that the industrial activity will cause greater heavy metals concentrations in the storm water).
- Insofar as possible, the Panel prefers the use of California data (or National data if it can be shown to be applicable to CA) in setting Numeric Limits and Action Levels.
- The Panel recognizes that economies of scale exist for large facilities and large groups of single facilities.
- Industrial facilities that do not discharge to MS4s should have to implement BMPs for their non-industrial exposure (e.g., parking lots, roof runoff) similar to commercial facilities in MS4 jurisdictions.
- Regardless of Action Levels or Numeric Limits, the permittees should implement a suite of minimum BMPs – good housekeeping, employee training, preventing materials from exposure to rain, etc.
- SIC categories are not a satisfactory way of identifying industrial activities at any given site. The Board should develop a better method of characterizing industrial activities that can impact storm water.
- The Panel recognizes this is a large task and recommends prioritizing the implementation of this approach to achieve the greatest reduction of pollutants statewide.
- Increasingly, a number of industries have moved industrial activities indoors, preventing storm water pollution. The Panel recognizes that these facilities should be granted some sort of regulatory relief from industrial Numeric Limits or action levels, but should still be required to comply with MS4 permit requirements.

The Panel recognizes the need to make progress in monitoring and reducing storm water discharge from industrial facilities, but urges the Board to consider the total economic impact and not unduly penalize California industries with respect to industries outside of California.

EXHIBIT "12"

Linda S. Adams
Secretary for Environmental Protection

State Water Resources Control Board

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Arnold Schwarzenegger
Governor

April 18, 2008

Ms. Paula Higashi, Executive Director
Commission on State Mandates
980 Ninth Street, Suite 300
Sacramento, CA 95814

Dear Ms. Higashi:

STORM WATER POLLUTION CONTROL REQUIREMENTS, FILES 03-TC-04, 03-TC-19, 03-TC-20, 03-TC-21: RESPONSE TO TEST CLAIMS 03-TC-04, 03-TC-19, 03-TC-20, 03-TC-21

The State Water Resources Control Board ("State Water Board") and the Los Angeles Regional Water Quality Control Board ("Los Angeles Water Board") jointly file this opposition to Test Claims 03-TC-04, 03-TC-19, 03-TC-20, and 03-TC-21. All of these test claims arise from a single permit that was issued by the Los Angeles Water Board as Order No. 01-182, Waste Discharge Requirements for Municipal Storm Water and Urban Runoff Discharges within the County of Los Angeles, and the Incorporated Cities therein, Except the City of Long Beach ("the Permit").[1] The requests for reimbursement in the test claims arise almost entirely from two requirements in the Permit and consolidation is therefore proper.

The Permit was issued by the Los Angeles Water Board pursuant to requirements in the federal Clean Water Act ("CWA").[2] The State Water Board and Los Angeles Water Board have been authorized by the United States Environmental Protection Agency ("U.S. EPA") to issue NPDES permits—which are mandated by the CWA—in lieu of issuance of these permits by U.S. EPA. The Permit regulates the discharge of storm water runoff from the municipal separate storm sewer system (MS4) of 84 cities and County of Los Angeles to rivers and the Santa Monica Bay.

The federal Clean Water Act mandates that municipalities must apply for and receive permits regulating discharges of pollutants from their MS4s to waters of the United States. Pursuant to federal regulations, the Permit contains numerous requirements for the cities and County to take actions to reduce the flow of pollutants into the rivers and the Bay, known as Best Management Practices (BMPs). These test claims, filed by 20 cities and the County, seek reimbursement by the State of California for expenses they incur in implementing two of the requirements of the Permit: (1) Inspections of commercial and industrial facilities; and (2) Placement of trash receptacles at transit sites.

[1] The Permit serves as National Pollutant Discharge Elimination System permit (NPDES) No. CAS004001. It was issued by the Los Angeles Water Board on December 13, 2001.

[2] Federal Water Pollution Control Act [FWPCA; 33 U.S.C.A. §§ 1251 et seq.] The federal Act is referred to herein by its popular name, the Clean Water Act ("CWA") and the code sections used are those for the CWA.

In order to obtain reimbursement, the claimants must show that the requirements constitute a new program or higher level of service. They must prove either: (1) the program must carry out a governmental function of providing services to the public, or (2) the requirements, to implement a state policy, impose unique requirements on local governments and do not apply generally to all residents and entities in the state. The claimants must also prove that the costs are mandated on them by the state, rather than by federal law. Finally, they must prove that any additional costs beyond the federal mandate are substantial and not *de minimis*. The claimants do not meet any of these tests.

The Permit as a whole, and including the inspection and trash receptacle provisions, is mandated on the local governments by federal law. The federal mandate applies to many dischargers of storm water, both public and private, and is not unique to local governments. The federal mandate requires that the Permit be issued to the local governments; it is not a question of "shifting" the costs from the state to the local governments. The specific requirements challenged are consistent with the minimum requirements of federal law. Even if the Permit were to be interpreted as going beyond federal law, any additional state requirements are *de minimis*. Moreover, the costs are not subject to reimbursement because the programs were proposed by the cities and County themselves, and because they have the ability to comply with these requirements through charges and fees, and are not required to raise taxes. The U.S. EPA has submitted a letter to the State Water Board dated April 10, 2008, in agreement with this position.[3]

Description of the Test Claims

The test claims focus on two discrete requirements in the Permit: the requirement to inspect certain industrial and commercial facilities that discharge into the MS4 and the requirement for some of the permittees to place and maintain trash receptacles at transit stops.

Industrial and Commercial Facilities Control Program (Part 4.C.)

Test claims 03-TC-19, 03-TC-20, and 03-TC-21 claim subvention for costs of complying with permit requirements to reduce pollutants from industrial and commercial facilities. Test claims 03-TC-19 and 03-TC-20 are limited to Part 4.C.2.a. and b., the requirements to inspect industrial and commercial facilities. Test Claim 03-TC-21 refers broadly to Part 4.C., the entire industrial and commercial facilities control program, but the costs discussed in the test claim are those associated with inspections. (See, Declaration of Richard Montevideo, No. 4.) Therefore, the Boards' analysis of the subvention claims for Part 4.C. is generally limited to the inspection requirements.

Part 4.C. of the Permit requires permittees to implement pollutant reduction and control measures at industrial and commercial facilities within their jurisdictions. Permittees may choose from various pollutant reduction and control measures, alone or in combination and

[3] Letter dated April 10, 2008, from Alexis Strauss, Director, Water Division, U.S. EPA to Tam M. Doduc, Chair, and Dorothy R. Rice, Executive Director, State Water Board, Attachment 3.

before, during, or after the activities that generate pollutants. The permittees are required to track, inspect, and ensure compliance at those facilities that are critical sources of pollutants in storm water.

Critical sources are specified commercial facilities (restaurants and automobile-related businesses), and industrial facilities that are required by federal regulations to obtain their own NPDES storm water permits.

Part 4.C.2.a. and b. contain inspection requirements, which are generally to conduct two inspections of facilities over a 5-year period. The Permit describes what the inspector must look at. (For example, inspectors at restaurants must see if operators pour grease into the street, and gas station inspectors must observe whether fuel-dispensing areas are swept.) The Permit states that for industrial sites, inspection requirements do not apply if the Los Angeles Water Board conducted an inspection of the site within two years.

Trash Receptacle Requirements (Part 4.F.5.c.3)

Test claims 03-TC-04, and 03-TC-20, and 03-TC-21 claim subvention for costs of complying with permit requirements for some of the permittees to place trash receptacles at public transit stops. Claim 03-TC-21 states that it challenges the entirety of the storm drain operation and maintenance and streets and road maintenance requirements, but the only costs in these sections for which it seeks reimbursement are for the placement and maintenance of trash receptacles. The claims are limited to the trash receptacle requirements for those municipalities that are not subject to a separate federal requirement, the "trash TMDL."[4] The requirements are to place trash receptacles at all transit stops and to maintain these receptacles.

Discharge Prohibitions and Receiving Water Limitations (Parts 1 and 2)

Test claim 03-TC-21 appears to claim subvention for costs associated with Parts 1 and 2 of the Permit, which include general prohibitions and requirements to protect water quality. The claim itself fails to specify any particular costs associated with this claim, other than a general study that considers a hypothetical treatment plant. As discussed below, storm water permits are written with the assumption that there will be no treatment plant and the permit certainly does not require one. In any event, there are no signed declarations to support this claim and no estimate of costs to the specific claimants.

Background of Federal Law Requirements for Storm Water Permits

In order to understand the federal mandate that required this permit, some background of the federal law and of MS4s is necessary. In 1972, the federal Clean Water Act was extensively amended to implement a permitting system for all discharges of pollutants from "point sources"

[4] As will be explained below, the Los Angeles Water Board has also adopted a federally-mandated total maximum daily load ("TMDL") for the deposition of trash into rivers and the Bay. The claimants do not claim subvention for the trash receptacle requirements for those cities and portions of the County subject to the TMDL, presumably conceding that those requirements are not reimbursable.

to waters of the United States.[5] The permits are issued pursuant to the national pollutant discharge elimination system, and are known as "NPDES permits." The 1972 amendments allowed U.S. EPA to authorize states to issue these permits.[6] California was the first state in the nation to obtain such authorization. In order to obtain this authorization, the California Legislature amended the Water Code, finding that the state should implement the federal law in order to avoid direct regulation by the federal government.[7] The California legislature mandated that California's permit program must ensure consistency with federal law.[8] The Water Boards are the state agencies charged with implementing the federal program.[9] The State Water Board incorporates the U.S. EPA regulations for implementing the federal permit program.[10] Therefore, both the CWA and U.S. EPA regulations are applicable to the permit program in California.[11] In California, permits to allow discharges into state waters are termed "waste discharge requirements."[12] The term "waste discharge requirements" is equivalent to the term "permit" in the CWA, when the waste discharge requirements are issued to comply with the CWA.[13] Thus, waste discharge requirements that the Water Boards issue to comply with the CWA are NPDES permits under federal law. When the Los Angeles Water Board, a state agency, adopts an NPDES permit in lieu of U.S. EPA, it must adopt as stringent a permit as the federal agency would have.[14]

The discharge of pollutants from point sources to waters of the United States is illegal, except in compliance with an NPDES permit.[15] In 1973, U.S. EPA issued regulations that exempted certain types of discharges it determined were administratively infeasible to regulate, including storm water runoff. The reason that such regulation is difficult, as will be more fully explained below, is that storm water runoff generally is not subjected to any treatment. Instead, it simply runs off urban streets, into gutters and drainage ways, and flows directly into streams, lakes, and the ocean.[16] This exemption was overruled in *Natural Resources Defense Council v. Costle* (1977) 568 F.2d 1369, which held that the exemption was illegal, and ordered U.S. EPA

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[5] CWA §§ 301 and 402.

[6] CWA § 402(b).

[7] Wat. Code, § 13370 *et seq.*, adding Chapter 5.5 to the Porter-Cologne Water Quality Control Act.

[8] Wat. Code, § 13372.

[9] Wat. Code, § 13370.

[10] Cal. Code of Regs., tit. 23, (C.C.R.) § 2235.2.

[11] The permits *may* also include additional state requirements. (C.C.R., tit. 23, § 2235.3; *City of Burbank v. State Water Resources Control Bd.* (2005) 35 Cal.4th 613.)

[12] Wat. Code, § 13263.

[13] Wat. Code, § 13374.

[14] CWA § 402(b).

[15] CWA § 301(a). In general, "navigable waters" or "waters of the United States," includes all surface waters, such as rivers, lakes, bays and the ocean. (CWA § 502.)

[16] The chief traditional categories of discharges subject to NPDES permits are industrial process wastewater and sanitary sewer effluent. Both of these discharges are typically processed in a treatment plant before they are discharged to surface waters.

to require NPDES permits for storm water runoff. In *Costle*, the court suggested innovative methods for permitting, including using general permits for numerous sources and issuing permits that "proscribe industry practices that aggravate the problem of point source Pollution."[17] Where permits proscribe actions that dischargers must implement, these requirements are commonly called "best management practices" ("BMPs").

Despite the *Costle* decision, U.S. EPA had not adopted regulations implementing a permitting program for storm water runoff by 1987. That year, Congress amended the CWA, specifically requiring storm water permits for industrial and municipal storm water runoff.[18] The amendments require NPDES permits for "[a] discharge from a municipal separate storm sewer system ["MS4"] serving a population of 250,000 or more."[19] The CWA contains three provisions specific to permits for MS4s: (1) Permits may be issued on a system- or jurisdiction-wide basis; (2) Permits must include a requirement to effectively prohibit non-storm water discharges into storm sewers; and (3) Permits must require controls to reduce the discharge of pollutants to the maximum extent practicable ("MEP").[20] In describing the controls that permits must include, the statute states that the controls shall include: "management practices, control techniques and system, design and engineering methods, and such other provisions as the [permit writer] determines appropriate for the control of such pollutants."[21] Thus, the federal law mandates that permits issued to MS4s must require management practices[22] that will result in reducing pollutants to the MEP. The state is required, by federal law, to select the BMPs.[23]

In 1990, U.S. EPA adopted regulations to implement section 402(p).[24] The regulations define which entities need to apply for permits and also the information they must include in permit applications. The regulations define "industrial activity" to include numerous categories of manufacturing, construction, and other typically private enterprises.[25] The regulations define MS4s as storm sewer systems operated by numerous public agencies, including cities, counties, states, and the federal government.[26] While both industrial activities and MS4s must

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[17] *Costle, supra*, at 1380.

[18] CWA § 402(p).

[19] CWA § 402(p)(2)(C). U.S. EPA defines municipal separate storm sewer systems (MS4s) that serve a population over 250,000 as "large" MS4s. The population of the County of Los Angeles is approximately 9.5 million. (Permit, D.1.)

[20] CWA § 402(p)(B).

[21] *Ibid.*

[22] These are commonly referred to as "best management practices," or "BMPs."

[23] *NRDC v. USEPA* (9th Cir. 1992) 966 F.2d 1292.

[24] Vol. 55, Federal Register (Fed.Reg.) 47990 and following.

[25] 40 C.F.R. § 122.26(b)(14).

[26] 40 C.F.R. § 122.26(b)(8).

obtain permits, the requirements in the industrial permits must be more stringent than in MS4 permits.[27]

In order to obtain coverage under an NPDES permit, as required by the CWA, entities seeking coverage file an application with the permitting authority and the permitting authority holds a public hearing on contested permits.[28] U.S. EPA regulations specify the information that applicants for MS4 permits must include in their applications.[29] For large and medium MS4s, the application requirements are extensive.[30] Some of the application requirements relevant to these Test Claims are: management programs including procedures to control pollution resulting from construction activities (at § 122.26(d)(1)(v)), legal authority to control the contribution of pollutants associated with industrial activity (at § 122.26(d)(2)(i)(A)), programs to control illicit discharges to the MS4 (at § 122.26(d)(1)(v)), and conducting inspections to determine compliance with permit conditions (at § 122.26(d)(2)(i)(F)). The permit applicants must propose management programs that the permitting authority will consider in adopting the permit.[31] The management programs must address oversight of discharges into the system from the general population and from industrial and construction activities within its jurisdiction, and also maintenance and control activities by the permittees.[32]

Most NPDES permits are largely comprised of numeric limitations for pollutants. Compliance is measured by sampling the treated effluent, which is discharged from a treatment plant into surface waters. These permits are written assuming that an engineered treatment plant can be built and operated to obtain a specified effluent. Storm water permits, on the other hand, usually require dischargers to implement BMPs that will result in lessening the pollutants in the runoff, since without a treatment plant the pollutants can flow directly into surface waters. Storm water permits apply to several types of entities—industries, construction, and municipalities—and all usually mandate BMPs. For municipalities that operate MS4s, the BMPs require the municipalities take actions that will lessen the incidence of pollutants *entering* storm drains by regulating the *behavior and practices* of the municipalities, their residents, and their businesses.[33]

U.S. EPA has issued regulations and guidance documents that discuss the types of BMPs that must be included in storm water permits in order to reduce the discharge of pollutants in storm

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[27] *Defenders of Wildlife v. Browner* (9th Cir. 1999) 191 F.3rd 1159. The differences between municipal and industrial permits are complicated, but are relevant to the question whether this permit addresses a uniquely governmental program, and are therefore discussed in more detail below.

[28] CWA § 402(b)(3).

[29] 40 C.F.R. § 122.26(a)(4). The U.S. EPA regulations have varied requirements depending on the size of the population served by the MS4. A "large" MS4 serves a population of 250,000 or more. (40 C.F.R. § 122.26(b)(4).) Los Angeles County and the 84 cities regulated by this permit far exceed the minimum population for a large MS4.

[30] 40 C.F.R. § 122.26(d).

[31] 40 C.F.R. § 122.26(d)(2)(iv).

[32] *Ibid.*

[33] There may also be engineered solutions, and there are some in Los Angeles, but it is important to keep in mind that there is no single engineered storm sewer treatment plant as there is for sanitary sewage.

water to the "maximum extent practicable." Numerous guidance documents point to inspections of businesses and proper trash collection as important parts of an effective BMP program.[34] U.S. EPA has issued an MS4 Program Evaluation Guide, which includes a lengthy process for conducting inspections of businesses. This Guide makes clear that inspections of businesses are mandatory:

> Inspections
> Most effective industrial/commercial inspection programs maintain a complete facility inventory and group them according to priorities established by the permittee. An inspection frequency is determined based on priority, and a database is used to manage such information as inspection findings, enforcement actions, and required follow-up activities. Many permittees use and cross-train existing staff to perform industrial/commercial inspections, but some permittees may need to maintain an exclusive stormwater inspector due to a potentially large number of high-priority facilities. There should be an inspection standard operating procedure that has been formalized and documented. It should include a checklist to be used during the inspection and possibly a report format. Inspectors should be aware of federal, state, and local stormwater regulations that may apply to industrial/commercial facilities. Inspectors should be familiar with various types of BMPs commonly used at the types of facilities typically found in the permit area and should be able to educate facility operators about such BMPs. In addition, inspectors should understand and use the permittee's established enforcement escalation response plan to gain compliance as necessary. The inspection staff should be proficient in the enforcement escalation procedure and should properly document all enforcement actions accordingly. Inspections should be used not only to identify non-compliance issues, but as an opportunity to educate facility operators about proper stormwater BMPs.[35]

The Guide also states that MS4 programs must address trash and litter.[36]

Adoption of the Los Angeles MS4 Permit

Starting in 1990, pursuant to the CWA amendments of 1987, the Los Angeles Water Board issued storm water permits to the County of Los Angeles and to the cities therein.[37] Without such a permit, the cities would be discharging pollutants in violation of federal law.[38] The permit

[34] See, e.g., Guidance documents at http://cfpub.epa.gov/npdes/docs.cfm?document_type_id=1&view=Policy%20and%20Guidance%20Documents&program_id=6&sort=name , including http://www.epa.gov/npdes/pubs/owm0233.pdf (citing examples from MS4 permits throughout the country).

[35] MS4 Program Evaluation Guidance, at pp. 77-78.

[36] *Id.* at 79.

[37] For reasons not relevant to this matter, one city—Long Beach—has a separate permit. The current permit covers 84 cities.

[38] CWA §§ 301(a), 402(p)(3)(B).

that is the subject of these test claims is the third such permit, and was adopted December 13, 2001.[39] It is largely comprised of requirements to implement BMPs, most of which were proposed by the permittees.[40] The County and thirty-two of the cities challenged numerous aspects of the permit and the process by which it was issued, culminating in a court of appeal decision upholding the permit in its entirety.[41]

On February 1, 2001, the County, on behalf of all permittees,[42] submitted a Report of Waste Discharge (permit application), including a Stormwater Quality Management Plan (SQMP). The SQMP constituted the permittees' proposal for the BMPs that would be required in the permit.[43] (Permit C.) The permit that was ultimately adopted was based on the SQMP, with some revisions and additions necessary to meet minimum federal requirements. (*Id.*) The SQMP prepared by the County included several proposed BMPs that relate to inspections of commercial and industrial facilities and placement and maintenance of trash receptacles:

> (1) Municipalities must conduct site visits to industrial and commercial facilities, including automotive service businesses and restaurants, which must include, "a site walk-through to verify for, at a minimum, evidence of BMP implementation," and shall revisit facilities and take enforcement where illicit discharges are found;[44]
>
> (2) Municipalities will maintain a database of automotive and food service facilities, including whether they have "NPDES stormwater permit coverage;"[45] and
>
> (3) Municipalities must minimize trash from entering recreational water bodies,[46] remove trash from open channels;[47] and control litter and debris in streets.[48]

The SQMP included detailed requirements for municipalities to implement at construction sites, including inspections by the municipality.[49] The SQMP proposed that all municipalities be

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[39] NPDES permits generally expire after 5 years, and must be reissued thereafter.

[40] A single permit applies to the County and 84 cities. Thus, while some entities may disagree with some provisions, other entities will agree and the entire group may propose permit terms that some cities oppose. The entire group submits a single proposed storm water management plan.

[41] *County of Los Angeles v. State Water Resources Control Board* (2006) 143 Cal.App.4th 985; referred to hereafter as *County of Los Angeles*.

[42] All permittees include the County and 84 cities. The County and the 21 cities that filed these Test Claims participated jointly with the application and permitting procedures with the remaining 63 cities who did not file Test Claims.

[43] The SQMP is several hundred pages. Relevant sections are attached; the entire SQMP is available should the Commission request it.

[44] SQMP, pp. 22-23 and 28.

[45] *Ibid.*

[46] SQMP, ES-6

[47] SQMP, ES-7

[48] *Ibid.*

[49] SQMP, pp. 24-26.

required to collect trash along open channels and encourage voluntary trash collection in natural stream channels.[50] The SQMP contains an Illicit Connection and Illicit Discharge Elimination Program, which includes education of inspectors employed by the permittees who will investigate businesses.[51]

Following adoption of the permit and a petition to the State Water Resources Control Board ("State Water Board"), the County, 32 cities,[52] the Los Angeles County Flood Control District and industry groups representing builders filed suit challenging numerous provisions in the Permit. The Superior Court upheld the Permit, and the Court of Appeal affirmed the judgment in its entirety.[53] First, the court held that the permit as a whole "imposes reasonable pollutant discharge requirements." Because the minimum federal requirement is that the permit require the municipalities to reduce pollutants to the maximum extent practicable, the court clearly determined that the permit's requirement are MEP. In its discussion of the consideration of costs to the municipalities, the court found that the permit did not exceed any federal requirements:

> "The permit explicitly states it is intended to provide a cost-effective storm water pollution program to the maximum extent possible. The permit applies the same cost-effective analysis to efforts to reduce the flow of pollutants into receiving waters. Moreover, the [Los Angeles Water Board] in its finding referred to a report specifying how the 'maximum extent practicable' requirement includes considerations of costs and benefits."[54]

The court also discussed various cost analysis reports and U.S. EPA Guidance. It rejected the claim that the permit's requirements exceeded the federal mandatory standard. The court specifically upheld the inspection requirements, stating: "there is federal regulatory authority that required [the Los Angeles Water Board] to consider imposing the inspection requirements."

Several of the permittees filed these test claims with the Commission on State Mandates. The Commission rejected the claims, basing its determination on Government Code section 17516, subdivision (c), which exempted Water Board permits from the requirements to reimburse state-mandated local funds. That action also resulted in a Court of Appeal decision finding that subdivision to be unconstitutional and remanding to the Commission to determine the test claims.[55] In its decision, the court stated that the Commission must address factual issues

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[50] SQMP, p. 28

[51] SQMP, App. D

[52] These include 18 of the cities that filed the Test Claims, and Bellflower, Claremont, Diamond Bar, Gardena, Hawaiian Gardens, Industry, Irwindale, La Mirada, Lawndale, Monrovia, Paramount, Rosemead, Santa Clarita, Santa Fe Springs, Torrance, Walnut, and Whittier.

[53] *County of Los Angeles, supra.* Some of the determinations of the appellate court discussed here were not published and thus cannot be cited as precedent in other cases. They are binding on the claimants. A copy of the entire decision is attached.

[54] Unpublished decision, at p. 20.

[55] *County of Los Angeles v. Commission on State Mandates* (2007) 150 Cal.App.4th 898.

regarding the requirements to conduct inspections and to place and maintain trash receptacles constitute state or federal mandates.

Following *Commission on State Mandates*, each of the four test claims was re-filed without any revisions.[56] All of the test claims are based upon requirements in the permit. Test Claim 03-TC-04 was filed by the County of Los Angeles, and challenges the requirement to place trash receptacles at transit stops.[57] Test Claim 03-TC-19 was filed by the County of Los Angeles, and challenges the requirements to inspect industrial and commercial businesses.[58] Test Claim 03-TC-20 was filed by nine cities[59] and challenges the requirements for trash receptacles and inspections, and the general requirements for a construction program.[60] Test Claim 03-TC-21 was re-filed by ten cities[61] and challenges the following permit requirements: discharge prohibitions, receiving water limitations, industrial program, construction program, storm drain program, and street and road maintenance[62]. While Test Claims 03-TC-20 and 03-TC-21 appear to assert broader requests for reimbursement, they address in detail only the requirements for inspections and trash receptacles, and these are the only requirements that the court in *Commission on State Mandates* stated were subject to the test claims.[63] In light of the absence of the necessary information for such claims and the court's remand, we assume that any claims additional to the inspections and trash receptacles are not valid claims.

In addition to the litigation over this permit, cities made similar arguments against an MS4 permit adopted by the Santa Ana Regional Water Quality Control Board. In a published decision, an appellate court in that case made additional findings applicable to the arguments in this matter[64]. It found that there was no evidence to support an argument that the permit "exceeded federal requirements." This finding is important because the cities in *Rancho Cucamonga* had argued that a ground for overturning that permit was that it used the same provisions as had

[56] The State Water Board and Los Angeles Water Board received several Notices of Complete Test Filing: a letter dated October 16, 2007, stated 03-TC-21 was complete; a letter dated October 29, 2007, stated that 03-TC-04 was complete; a letter dated October 29, 2007, stated that 03-TC-19 was complete; and a letter dated December 12, 2007, stated 03-TC-20 was complete. On December 21, 2007, the Commission extended time to respond to all four test claims until April 21, 2008.

[57] 03-TC-04 challenges Permit Part 4.F.5.c.3.

[58] 03-TC-19 challenges Permit Part 4.C.2.a. and b.

[59] The cities that filed the test claim are Artesia, Azusa, Beverly Hills, Carson, Commerce, Norwalk, Rancho Palos Verdes, Westlake Village, and Vernon.

[60] 03-TC-20 challenges Permit Part 4.C.2.a. and b., 4.E, and 4.F.5.C.3.

[61] The cities that filed the test claim are Arcadia, Baldwin Park, Bellflower, Cerritos, Covina, Downey, Monterey Park, Pico Rivera, Signal Hill, South Pasadena, and West Covina.

[62] 03-TC-21 challenges Permit Parts 1, 2, 4.C, 4.E, 4.F.5 and 6. In a letter dated January 18, 2008, sent to the Commission from Howard Gest, he states that the cities he represents, which include five of the cities that filed the claim, "do not currently intend to pursue a claim" as to Parts 1 and 2, but that the limitation is "without prejudice." In light of the fact that Mr. Gest apparently does not represent all of the cities that filed the claim and the limited nature of this limitation, we will address Parts 1 and 2 and ask the Commission to determine that these parts do not create a reimbursable mandate.

[63] 150 Cal.App.4th 898, 903.

[64] *City of Rancho Cucamonga v. Regional Water Quality Control Board*, 135 Cal.App.4th 1377.

been crafted for other permittees, including the Los Angeles MS4 permit. The *Rancho Cucamonga* court specifically addressed inspection requirements, holding that federal law, either expressly or by implication, required NPDES permittees to perform inspections for illicit discharge prevention and detection, including inspection of industrial facilities and construction sites. Because the Los Angeles MS4 permit is based on BMPs and courts have determined that it is consistent with MEP, it is necessarily no more stringent than required by federal law.

State Mandate Law

Article XIIIB, Section 6 of the California Constitution requires subvention of funds to reimburse local governments for state-mandated programs in specified situations. There are several exceptions and limitations to the subvention requirements that provide bases for the Commission to determine that the Test Claims are not subject to subvention. Article XIIIB, Section 6 provides: "Whenever the Legislature or any state agency mandates a new program or higher level of service on any local government, the State shall provide a subvention of funds to reimburse that local government for the costs of the program or increased level of service."

Implementing statutes clarify that no subvention of funds is required if: (1) the mandate imposes a requirement that is mandated by a federal law or regulation and results in costs mandated by the federal government, unless the statute or executive order mandates costs that exceed the mandate in that federal law or regulation (Govt. Code, § 17556(c)); or (2) the local agency has the authority to levy service charges, fees, or assessments sufficient to pay (Govt. Code, § 17556(d)); or (3) the local agency proposed the mandate (Govt. Code, § 17556(a)). Each of these exceptions to subvention applies to these Test Claims. All of the mandates for which the Test Claims seek reimbursement are mandated by federal law or regulation. The County and cities can assess fees for all of the costs incurred. The claimants themselves, as part of the group of the County and 84 cities who applied for the permit, proposed most of the specific requirements challenged.

Numerous judicial decisions have further defined limitations on the requirements for subvention of funds. Specifically, subvention is only required if expenditure of tax monies is required, and not if the costs can be reallocated or paid for with fees.[85] In addition, reimbursement to local agencies is required only for the costs involved in carrying out functions peculiar to government, not for expenses incurred by local agencies as an incidental impact of laws that apply generally to all state residents and entities. Laws of general application are not entitled to subvention.[86] The fact that a requirement may single out local governments is not dispositive; where local agencies are required to perform the same functions as private industry, no subvention is required.[87]

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[85] *County of Los Angeles v. Commission on State Mandates* (2003) 110 Cal.App.4th 1176; *Redevelopment Agency v. Commission on State Mandates* (1997) 55 Cal.App.4th 976.

[86] *County of Los Angeles v. State of California* (1987) 43 Cal.3d 46.

[87] *City of Richmond v. Commission on State Mandates* (1998) 64 Cal.App.4th 1190.

The Permit is not subject to subvention; it meets each of these exceptions. The requirements that are the subject of the claims are part of permits that meet, but do not exceed, the minimum federal requirements. The federal mandate is specifically directed at the municipalities and not at the state in general. The costs for the programs can be paid for by levying service charges, including charges to companies for conducting their businesses, fees for collection of refuse, fees for transit services, and fees especially enacted for storm water programs.[68] Compliance with NPDES permits, and specifically with storm water permits, is required by private industry also. In fact, the requirements for industrial and construction entities are more stringent than for government dischargers. In addition, the government requirements apply to all governmental entities that operate MS4s, including state and federal facilities; local government is not singled out. The local agencies can assess fees to perform the required tasks; tax monies are not required. Finally, to the extent that any portion of the claims would otherwise qualify for subvention, they are *de minimis* and therefore do not qualify.

In its remand, the court stated that the most significant issue is "whether the two obligations in question constitute federal or state mandates" and that these present factual issues for the Commission to decide.[69] The court pointed to four cases that the Commission stated would apply in making this determination.[70] Each case is discussed below:

City of Sacramento v. State of California (1990) 50 Cal.3d 51: The court held that application of unemployment insurance law to state and local agencies was not subject to subvention. In discussing whether the requirement was a federal mandate, the court held that the issue is whether compliance with the federal law was "mandatory" or "optional," which is based on the following factors: "A determination in each case must depend on such factors as the nature and purpose of the federal program; whether its design suggests an intent to coerce; when state and/or local participation began; the penalties, if any, assessed for withdrawal or refusal to participate or comply; and any other legal and practical consequences of nonparticipation, noncompliance, or withdrawal."[71]

Hayes v. Commission on State Mandates (1992) 11 Cal.App.4th 1564: The court considered claims for subvention for a special education mandate. It concluded that, although the program was a federal mandate, the state had freely chosen to shift the costs to local governments and that subvention was proper. The court held that the test for whether there is a federal mandate is whether compliance with federal requirements is "a matter of true choice," in other words whether participation in the federal program is "truly voluntary."[72] The court listed the significant factual determinations: "In our view the determination whether certain costs were imposed upon a local agency by a federal mandate must focus upon the local agency which is ultimately

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[68] The claimants refer to limitations on assessing services fees under California law. The referenced law concerns only the percent of voters who must approve the assessment. In fact, the largest entity subject to the permit, the City of Los Angeles, has successfully adopted such an assessment.

[69] *Commission on State Mandates*, 150 Cal.App.4th 898, 918.

[70] *Id.*, at 919.

[71] 50 Cal.3d 51, 76.

[72] 11 Cal.App.4th 1564, 1582.

forced to bear the costs and how those costs came to be imposed upon that agency. If the state freely chose to impose the costs upon the local agency as a means of implementing a federal program then the costs are the result of a reimbursable state mandate regardless whether the costs were imposed upon the state by the federal government."[73]

Long Beach Unified School District v. State of California (1990) 225 Cal.App.3rd 155: The court held that subvention does apply where actions are mandated by the state, which go beyond the federal constitution or case law. Because federal law clearly would not have required steps for de-segregation where there was no finding of segregation, subvention applied.

San Diego Unified School District v. Commission on State Mandates (2004) 33 Cal.4th 859: A school district sought subvention of funds to conduct expulsion hearings. The federal law made expulsions discretionary, but where expulsions occurred, the federal law mandated certain hearing procedures. The state law mandated expulsions whenever firearms were involved, and made all other expulsions discretionary. It also mandated some hearing procedures in addition to the federal requirements. The Supreme Court held that for firearms expulsions, the state mandated a higher level of service, and that all hearing costs for these expulsions were reimbursable, even those attributable to procedures mandated by federal law. It also held that no hearing costs are reimbursable for expulsions that are discretionary under state law. Even if the hearing procedures are mandated by state law, the court found they are incidental to federal due process requirements and are *de minimis* and therefore not reimbursable. In determining that any additional state-mandated hearing costs were *de minimis*, the court found that the state reasonably set forth requirements that were intended to implement the federal hearing requirements: "challenged state rules or procedures that are intended to implement an applicable federal law-and whose costs are, in context, *de minimis*-should be treated as part and parcel of the underlying federal mandate."[74]

<u>The Claims do not Qualify for Subvention</u>

<u>The Programs are Federal Mandates that Apply Directly to Local Governments; the State has not Shifted the Burden; and the Mandates do not Exceed Federal Law</u>

The challenged provisions are mandated by federal law. Two appellate courts have determined that the provisions in this permit constitute MEP—the minimum requirements mandated by federal law. The court in *Los Angeles* has determined that the Permit is cost-effective and based on the MEP standard. The court in *Rancho Cucamonga* found that a very similar permit met the MEP standard and did not exceed the minimum federal standard. That case specifically stated that the requirement to conduct inspections reflected MEP. The federal law specifically requires that permits be issued to the local governments that operate MS4s and that permits must require programs and actions that will result in reducing the pollutants that discharge from the MS4 to waters of the United States to the maximum extent practicable. The permit is a federal mandate on the local governments. It is the local governments that must apply for and obtain a permit. Without the permit, the cities are discharging pollutants in violation of federal

[73] *Id.* at 1593-4.

[74] 33 Cal.4th 859, 889.

law.[75] If the Water Boards had not been authorized to issue the permit in lieu of U.S. EPA, that federal agency would have issued a similar permit directly to the local governments.

The claimants contend that the Los Angeles Water Board exercised discretion to impose requirements beyond those required by federal law because the Los Angeles Water Board had a choice in establishing the mandated programs and "[t]he [Water Boards] cannot point to any provisions of the Clean Water Act or related regulations that require the programs at issue in this claim."[76] The fact that some discretion is exercised in implementing a federal program does not mean that subvention is required. The court in *Hayes* explained that, where the state has some discretion in mandating the program but ultimately the factual situation requires some type of mandate, there is a federal mandate:

> "The remaining question is whether the state's participation in the federal program was a matter of "true choice" or was "truly voluntary." The alternatives were to participate in the federal program and obtain federal financial assistance and the procedural protections accorded by the act, or to decline to participate and face a barrage of litigation with no real defense and ultimately be compelled to accommodate the educational needs of handicapped children in any event. We conclude that so far as the state is concerned the Education of the Handicapped Act constitutes a federal mandate."[77]

The central issue before the Commission is whether the requirements to conduct inspections and to place trash receptacles at bus and train stops exceed the federal mandate for MS4 permits. As to the inspections, the claimants appear to concede that federal law specifically requires MS4s to conduct inspections of industrial facilities and construction sites, but claim that the Los Angeles Water Board could have conducted all of the inspections and instead exercised its discretion to "shift" the responsibility to the claimants. They base this contention on a permit issued by the State Water Board to industrial facilities[78] and contend that permit obligates the Regional Water Boards, including Los Angeles, to conduct inspections. Therefore, they claim, the Los Angeles Water Board has shifted that responsibility to the municipalities. They also contend that the federal law does not specify that restaurants and automobile-related businesses must be inspected. As to the trash receptacles, they claim that the federal law does not specify this particular BMP.

In order to evaluate these contentions, some more detailed discussion of the storm water permitting scheme established by U.S. EPA is necessary. Of particular importance are: the process of selecting BMPs that are included in MS4 permits; the obligation of MS4s to regulate discharges from businesses into their systems, including discharges that are simultaneously regulated by separate NPDES permits; the process for selecting which businesses to regulate; and the requirement for MS4s to conduct inspections.

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[75] CWA §§ 301(a), 402(p)(3)(B).

[76] Test Claim 03-TC-21, at page 10.

[77] 11 Cal.App.4th 1564, 1593.

[78] Order No. 97-03-DWQ; http://www.waterboards.ca.gov/stormwtr/docs/induspmt.pdf

The Process for Selecting BMPs

The chief argument regarding trash receptacles is that the federal law does not specify this particular BMP and that, therefore, it exceeds federal law. The claimants appear to rely on *Hayes* to argue that the exercise of any discretion in selecting requirements automatically results in a reimbursable state mandate. As discussed above, however, the federal law specifically requires that the Water Boards prescribe the BMPs that the MS4 must implement. This issue was addressed succinctly in *Rancho Cucamonga*:

> In creating a permit system for dischargers from municipal storm sewers, Congress intended to implement actual programs. [Cite to *NRDC, supra*.] The Clean Water Act authorizes the imposition of permit conditions, including: "management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants." [Cite to CWA § 402(p)(3)(B)(iii).] The Act authorizes states to issue permits with conditions necessary to carry out its provisions. [Cite to § 402(a)(1).] The permitting agency has discretion to decide what practices, techniques, methods and other provisions are appropriate and necessary to control the discharge of pollutants. [Cite to *NRDC*.] That is what the Regional Board has created in the 2002 permit."[79]

Because the federal mandate requires the Water Boards to choose specific BMPs that are included in MS4 permits as requirements, the "discretion" exercised in selecting those BMPs is necessarily a part of the federal mandate. It is not comparable to the discretion that the courts in *Hayes* or *San Diego* spoke of, where the state truly had a "free choice." The Los Angeles Water Board was mandated by federal law to select BMPs that would result in compliance with the federal MEP standard. "The [Water Board] must comply with federal law requiring detailed conditions for NPDES permits."[80] This is completely different from the state discretion exercised in *San Diego*, where the state law compelled expulsions for bringing firearms to school, while the federal law clearly did not mandate such expulsions. Therefore, it is clear that the mere exercise of discretion in selecting BMPs, does not create a reimbursable mandate.

It is conceivable that an MS4 permit issued in California could require practices that exceed the federal requirement of MEP. It is clear, however, that inspection requirements do not exceed MEP. That issue has been specifically ruled on by *Rancho Cucamonga* and there are federal regulations, discussed below, that require these inspections. The claimants allege, however, that there is no similar requirement for the placement of trash receptacles at transit stops. The trash receptacle requirements in the Permit are different for those cities subject to a "trash TMDL" than for other cities. The Los Angeles Water Board has adopted TMDLs for some of the water bodies that receive discharges from MS4s subject to the permit. As required by the TMDL and federal law, the permit contains specific provisions for permittees that are subject to the trash TMDLs. The claimants do not seek subvention for those requirements. For

[79] *Rancho Cucamonga, supra*, at 1389.

[80] *Ibid.*

permittees not subject to a trash TMDL, the permit requires they implement BMPs to reduce trash entering the MS4s, including placing trash receptacles at all transit stops that have shelters by August 1, 2002, and at all other transit stops by February 3, 2003, and that they maintain trash receptacles as necessary. (Permit, Part 4.F.5.c.3.)

The requirements regarding trash receptacles are found in the section of the Permit concerning public agency activities. (Part 4.F.) This section imposes BMPs concerning sewage treatment overflows, construction by public agencies, storm drain maintenance and operation, and municipal construction projects. In other words, these are BMPs concerning the municipalities' own activities, as opposed to its regulation of discharges into its system by others. U.S. EPA storm water regulations address BMP requirements for the MS4s' maintenance and operation of the storm sewer system. Specifically, the MS4s' plan must include maintenance activities and schedules, including a "description of practices for operating and maintaining public streets, roads and highways and procedures for reducing the impact on receiving waters of discharges from municipal storm sewer systems. . ."[81] As early as 1993, the Executive Officer of the Los Angeles Water Board directed all of the cities regulated by the permit to "increase cleaning frequency of and number of roadside trash receptacles in areas where needed."[82]

The requirements to control the release of trash into MS4s and surface waters are at the heart of the storm water program. "Storm sewer waters carry suspended metals, sediments, algae-promoting nutrients (nitrogen and phosphorus), *floatable trash*, used motor oil, raw sewage, pesticides, and other toxic contaminants into streams, rivers, lakes, and estuaries across the United States."[83] In carrying out the federal mandate to select BMPs, the decision to require trash receptacles at transit stops is a reasonable, practicable, and cost-effective method to reduce trash in storm water runoff. The claimants have not, and cannot, explain how such a requirement exceeds the federal standard of actions that reflect the "maximum extent practicable." The Permit also allows individual permittees to substitute BMPs for specific requirements in the Permit.[84]

At bottom, the trash receptacle requirements reflect the federal requirement to reduce pollutants from the MS4 to the maximum extent practicable. It is federal law that animates the requirement and federal law that mandates specificity in describing the BMPs.

The Role of MS4s in Regulating Discharges from Industrial and Commercial Activities

The claimants allege that because the Water Boards have a role in directly regulating businesses within the jurisdiction of MS4s, and therefore conduct inspections at such sites, that the requirements in the Permit for the MS4s to conduct inspections reflect a decision to shift the costs of a federal mandate from the state to local government. The court in *Hayes* discussed

[81] 40 C.F.R. § 122.26(d)(2)(iv)(A)(3).

[82] Letter dated June 17, 1993, from Robert P. Ghirelli to Thomas A. Tidemanson. Attachment 34.

[83] *Environmental Defense Center v. U.S. EPA* (9th Cir. 2003) 344 F.3d 832, 841; emphasis added.

[84] Permit, Part 4.A.1.

this issue. There, the mandate was to the state generally, and the state government decided to shift the cost for implementing special education to local school districts. Here, there is no general mandate addressed to the entire state. Instead, the federal law clearly required that municipalities that operate MS4s must obtain and comply with a permit. The state does not operate the MS4; the mandate is directed to the municipalities.

In addition to the requirements for permits issued to municipalities, the Water Boards are also mandated to issue permits to entities that discharge storm water "associated with industrial activity."[85] As part of its responsibilities for its in lieu program, the State Boards must administer and enforce all of its permits.[86] The State Water Board has issued permits for industrial and construction discharges of storm water, and the Los Angeles Water Board administers those permits within its jurisdiction. Therefore, the Los Angeles Water Board does conduct inspections at businesses in Los Angeles County to ensure compliance with the state permits. In addition, the MS4 Permit requires the permittees also to conduct inspections. This approach, which may result in two different entities inspecting the same businesses to review storm water practices, was specifically envisioned and required by U.S. EPA in adopting its storm water regulations.[87]

In promulgating its regulations for MS4s and industrial dischargers, U.S. EPA made clear its intent to require industrial facilities that discharge into municipal storm sewers to obtain their own NPDES permits and *also* to require MS4s to regulate and be liable for these same discharges. In 1990, U.S. EPA adopted the regulations that spell out the federal mandates for MS4s to develop and implement plans for regulation of industrial facilities. In its Preamble to the regulations, it explained that MS4 permits "are expected to require that controls be placed on storm water discharges associated with industrial activity which discharge through the municipal system." It presented the rationale for this dual regulatory approach:

> "[U.S. EPA] believes that municipal operators of large and medium municipal systems have an important role in source identification and the development of pollutant controls for industries that discharge storm water through municipal separate storm sewer systems is appropriate. Under the CWA, large and medium municipalities are responsible for reducing pollutants in discharges from municipal separate storm sewers to the [MEP]. Because storm water from industrial facilities may be a major contributor of pollutants to municipal separate storm sewer systems, municipalities are obligated to develop controls for storm water discharges associated with industrial activity through their system in their storm water management program."[88]

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[85] CWA § 402(p)(2)(B).

[86] CWA § 402(b).

[87] In fact, the Los Angeles Water Board acted to lessen any duplication of effort and costs to the municipal permittees by exempting them from inspection requirements if the same facility has been inspected by the Board.

[88] Vol. 55, Federal Register (Fed.Reg.), at 48009.

Thus, U.S. EPA specifically mandated that industrial facilities were to be subject to permits issued directly to them by the Water Boards and also through MS4 permits, where municipalities must regulate the facilities: "Dischargers of storm water associated with industrial activity through municipal separate storm sewer systems will be subject to municipal management programs that address such discharges as well as to an individual or general NPDES permit for those discharges."[89]

Requirements for MS4s to Conduct Inspections

The federal regulations also specifically require local storm water agencies, as part of their responsibilities under NPDES permits, to conduct inspections.[90] Throughout the federal law, there are numerous requirements for entities that discharge pollutants to waters of the United States to monitor and inspect their facilities and their effluent.[91] The claimants are the dischargers of pollutants into surface waters; as part of their permit allowing these dischargers, they must conduct inspections. The Los Angeles Water Board is charged with administering and enforcing the permit. Its policing responsibilities may also include inspecting the facilities and waters it regulates, but that does not mean it is shifting its responsibilities when it properly mandates inspections by MS4s.

The Process of Selecting Which Businesses MS4s Must Regulate

The claimants contend that federally mandated inspections do not include restaurants, automotive service facilities, retail gasoline outlets, or automotive dealerships. Instead, they claim that the federal mandate is limited to municipal landfills, hazardous waste sites, industrial facilities listed under the federal Superfund law, and industrial facilities that the permittees themselves determined are contributing substantial pollutants to their systems.

They base this contention on the U.S. EPA's regulations for MS4 applications. The federal regulation states that the storm water management plan that MS4s must submit must address the municipalities' enforcement against pollutants from "municipal landfills, hazardous waste treatment, disposal and recovery facilities, industrial facilities that are subject to section 313 of title III of [the federal Superfund law], and *industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the municipal storm sewer system.*"[92] The claim is essentially that, after MS4s submitted their first application for a permit, which was required by the U.S. EPA regulations in 1990,[93] and listed any industrial facilities they deemed to be contributors of substantial pollutant loading, the federal law did not mandate any further actions, regardless of whether new information or monitoring might reveal such

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[89] *Id.* at 48058.

[90] 40 C.F.R. § 122.26(d)(2)(iv)(C). While the U.S. EPA regulations are phrased as "application requirements," wherein the MS4 must propose the various BMPs that will achieve MEP, these requirements must be included in the mandatory storm water management program. (*Los Angeles, supra,* 143 Cal.App.4th 985, 993.)

[91] See, e.g. CWA § 402(b)(2)(B); 40 C.F.R. § 122.44(i).

[92] 40 C.F.R. § 122.26(d)(2)(iv)(C); emphasis added.

[93] Vol. 55, Fed.Reg. 47990.

contributors. This is not a reasonable reading of the federal regulation. In adopting this regulation, U.S. EPA acknowledged that this initial selection by MS4s was only a starting point and that the mandate was to follow where information and monitoring led:

> "The object of [the requirements in 122.26(d)(2)(iv)(C)] is initially to set priorities for monitoring requirements. Then, if the situation requires controls can be developed and instituted. . . . the selection of facilities is only a means of setting priorities for facilities for the development of municipal plans. ¶ EPA agrees. . . that there will be other facilities that are significant sources of pollutants and should be addressed by municipalities as soon as possible under management programs."

As early as 1993, the Executive Officer of the Los Angeles Water Board directed all of the cities regulated by the permit to implement facility inspections of "auto repair shops, auto body shops, auto parts and accessory shops, gasoline stations, and restaurants."[94] The letter noted that the BMPs listed therein constitute the minimum required for area-wide implementation, and that the list "is not an additional requirement, but incorporates BMPs already proposed by some permittees." Thus, it appears that the inspection requirements were, in fact, proposed by permittees.[95] In any event, MEP is not limited to the sources and controls proposed by the permittees. U.S. EPA Guidance documents make clear that MEP requires an iterative process, where municipalities assess sources, conduct investigations, and improve their programs.[96]

The Local Governments have the Authority to Levy Service Charges, Fees, or Assessments to Pay for the Programs

The County and cities need not spend tax monies to comply with the Permit. They can and do adopt fees from their residents and businesses that fund their storm water programs. The City of Los Angeles (the largest entity covered by the permit, and which has not filed any test claims) adopted a fee ordinance, based on property assessments, for implementation of the program. All of the municipalities have the ability to charge fees to businesses to cover inspection costs. The cities' trash collection responsibilities, which include placement of trash receptacles, are also paid for through existing fees. Moreover, the trash receptacle requirements that are the subject of the Test Claims are limited to public transit stops. Any additional costs associated with trash removal at these transit stops, a service cities already provide, could be borne by transit users through higher transit fees.

The cities and the County have failed to show that they must use tax monies to pay for these requirements. It is also clear that any "additional" costs that could conceivably be considered additional to the federal mandate would be *de minimis* and would not require payment from tax monies. For example, it is assumed that most cities routinely place trash receptacles at bus stops. In fact, the claimants make no allegation of any increased costs from this requirement;

[94] Letter dated June 17, 1993, from Robert P. Ghirelli to Thomas A. Tidemanson. Attachment 34.

[95] The issue of proposals by the permittees is discussed below.

[96] See, e.g. U.S. EPA document on Evaluating the Effectiveness of Municipal Storm Water Programs.

instead, they conflate any costs by listing "estimated trash receptacles, catch basin, and/or other treatment devices – capital and installation costs."[97]

The Local Governments Applied for the Permit and Proposed the Programs

The County and cities bound by the permit requested the mandate and the Permit allows alternatives in the manner of compliance. The County and cities jointly applied for the permit and proposed a management plan that is consistent with many of the requirements in the permit. Relevant portions of the Report of Waste Discharge that the County submitted are attached. The entire Report of Waste Discharge is available upon request. It is clear from these attachments, which include not only proposed programs but a draft permit, that many of the programs subject to the claims—including regulation of industrial and commercial sites, and specifically restaurants and automobile-service businesses—were proposed in the permittees' original plan submitted in February 2001. For example, the permittees proposed that the permit prohibit discharge of wash waters from gas stations, auto repair garages, and other automotive service facilities.[98] In addition, the permittees proposed a requirement that they "visit" automotive service and food service facilities every two years, and that they "revisit" facilities and take enforcement action if there is evidence of continuing illicit discharges.[99] The permittees submitted a lengthy list of proposed BMPs that site inspectors should look for during site visits.[100] Whether the term is "site visit" or "inspection," it is clear that the permittees proposed the mandate. The permittees also proposed that the permit mandate trash collection alongside, or in improved open channels.[101]

The permit was issued upon the joint request of all of the petitioners, with the County acting as the lead. Where the County and 84 cities apply for a single area-wide permit, the permit writer obviously is not required to write separate requirements for each entity and the County may be presumed to speak for the whole.

The Programs are not Mandates Peculiar to Government

Finally, the NPDES permit program, and the storm water requirements specifically, are not peculiar to local government. Industrial and construction facilities must also obtain NPDES storm water permits. These permits, however, are more stringent than municipal permits because the federal law requires that they meet more stringent technology-based standards and that they attain strict compliance with water quality standards in receiving waters.[102] As such, the only difference between the municipal storm water program and other storm water requirements is that federal law provides separate, more lax requirements for the municipalities.

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[97] Claim 03-TC-21, at p.2.

[98] Report of Waste Discharge at R0000026.

[99] *Id.* at R0000031.

[100] *Id.* at R0000273 – R0000360.

[101] *Id.* at R0000036.

[102] *Defenders of Wildlife v. Browner, supra.*

The Water Boards' implementation of federal law reflects this dichotomy and the fact that the municipalities receive their own permit, as required by CWA section 402(p)(3)(B) does not change the fact that storm water permit requirements are not peculiar to local government.

It is the municipalities who operate MS4s and who discharge pollutants to surface waters. It is the municipalities who must obtain permits and comply with those permits. Similarly, industrial dischargers who discharge storm water runoff to waters of the United States must also obtain and comply with permits. The state is not the discharger (except in those situations where state agencies operate MS4s, such as the Department of Transportation, where they are themselves subject to permits), and the state is not uniquely shifting a new program or higher level of service onto municipalities.[103]

Discussion of Test Claims that were not Substantiated

Development Construction Program (Part 4.E)

Test claim 03-TC-21 claims subvention of costs for the development construction program. It did not, however, include any substantiation of this claim.

Public Agency Activities Program (Part 4.F.5 and 6)

Test claims 03-TC-04, 03-TC-20, and 03-TC-21 claim subvention for portions of the public agency activities program. Test claim 03-TC-21 claims subvention for the all requirements concerning storm drain operation and streets and roads maintenance, while test claims 03-TC-04 and 03-TC-20 are limited to the requirements to place trash receptacles at transit stops and to maintain these receptacles. Test claim 03-TC-21, however, did not include any substantiation of this claim, apart from the discussion of trash receptacles, above.

Discharge Prohibitions and Receiving Water Limitations (Parts 1 and 2)

Test claim 03-TC-21 challenges the discharges prohibitions and receiving water limitations in the Permit. Parts 1 and 2 contain the basic prohibitions and requirements for attaining compliance with water quality standards through an iterative process. The whole of the claim is that, "if enforced and read to literarily [*sic*] to require the City to prevent any and all exceedances from urban runoff of all water quality standards or water quality objectives" the costs would be excessive. The court in *County of Los Angeles, supra,* rejected this exaggeration of the permit's terms and found the requirements to be entirely reasonable. In addition, the *Rancho Cucamonga* and *Building Industry Association* both upheld identical provisions and found them to be reasonable and to be consistent with the minimum federal standard of MEP.

[103] The State Water Board issues a separate permit to the Department of Transportation, for both its municipal activities (roads and freeways) and its industrial facilities (construction and maintenance yards). The permit is available at http://www.waterboards.ca.gov/stormwtr/docs/caltrans/caltranspmt.pdf.

Conclusion

For all the reasons set forth above, the Test Claims must be dismissed. The Permit requirements have already been upheld by the courts as reflecting the federal Clean Water Act's requirements for municipal storm water permitting. The permit in its entirety, including the Test Claim provisions, reflects the federally mandated, federal minimum standard of reducing pollutants to the "maximum extent practicable." Further, the cities can pay for any costs associated with the requirements by levying service charges or fees. Finally, to the extent that any portion of the claims would otherwise qualify for subvention, they are *de minimis* and therefore do not warrant subvention.

I certify and declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this document was executed on April 18, 2008, at Sacramento, California.

Sincerely,

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Continued on next page

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Interested Persons List

PROOF OF SERVICE

I, JEANNETTE L. BASHAW, declare that I am over 18 years of age and not a party to the within action. I am employed in Sacramento County at 1001 I Street, 22nd Floor, Sacramento, California 95814. My mailing address is P.O. Box 100, Sacramento, CA 95812-0100. On this date, I served the within documents:

LETTER TO COMMISSION ON STATE MANDATES DATED APRIL 18, 2008, REGARDING STORM WATER POLLUTION CONTROL REQUIREMENTS, FILES 03-TC-04, 03-TC-19, 03-TC-20, 03-TC-21: RESPONSE TO TEST CLAIMS 03-TC-04, 03-TC-19, 03-TC-20, 03-TC-21

	BY FACSIMILE: I caused a true and correct copy of the document to be transmitted by a facsimile machine compliant with rule 2003 of the California Rules of Court to the offices of the addresses at the telephone numbers shown on the service list.
X	**BY HAND DELIVERY:** I caused a true and correct copy of the document(s) to be hand-delivered to the person(s) as shown.
	BY OVERNIGHT MAIL TO ALL PARTIES LISTED: I am readily familiar with my employer's practice for the collection and processing of overnight mail packages. Under that practice, packages would be deposited with an overnight mail carrier that same day, with overnight delivery charges thereon fully prepaid, in the ordinary course of business.
X	**BY FIRST CLASS MAIL TO ALL PARTIES LISTED:** I am readily familiar with my employer's practice for the collection and processing of mail. Under that practice, envelopes would be deposited with the U.S. Postal Service that same day, with first class postage thereon fully prepaid, in the ordinary course of business. I am aware that on motion of the party served, service is presumed invalid if the postal cancellation date or postage meter date is more than one day after the date of deposit for mailing shown in this proof of service.

By placing a true copy thereof in separate, sealed envelopes addressed to:

See Exhibit A attached hereto and made a part hereof.

I certify and declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this document was executed on April 18, 2008, at Sacramento, California.

Jeannette L. Bashaw

JEANNETTE L. BASHAW

EXHIBIT A

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