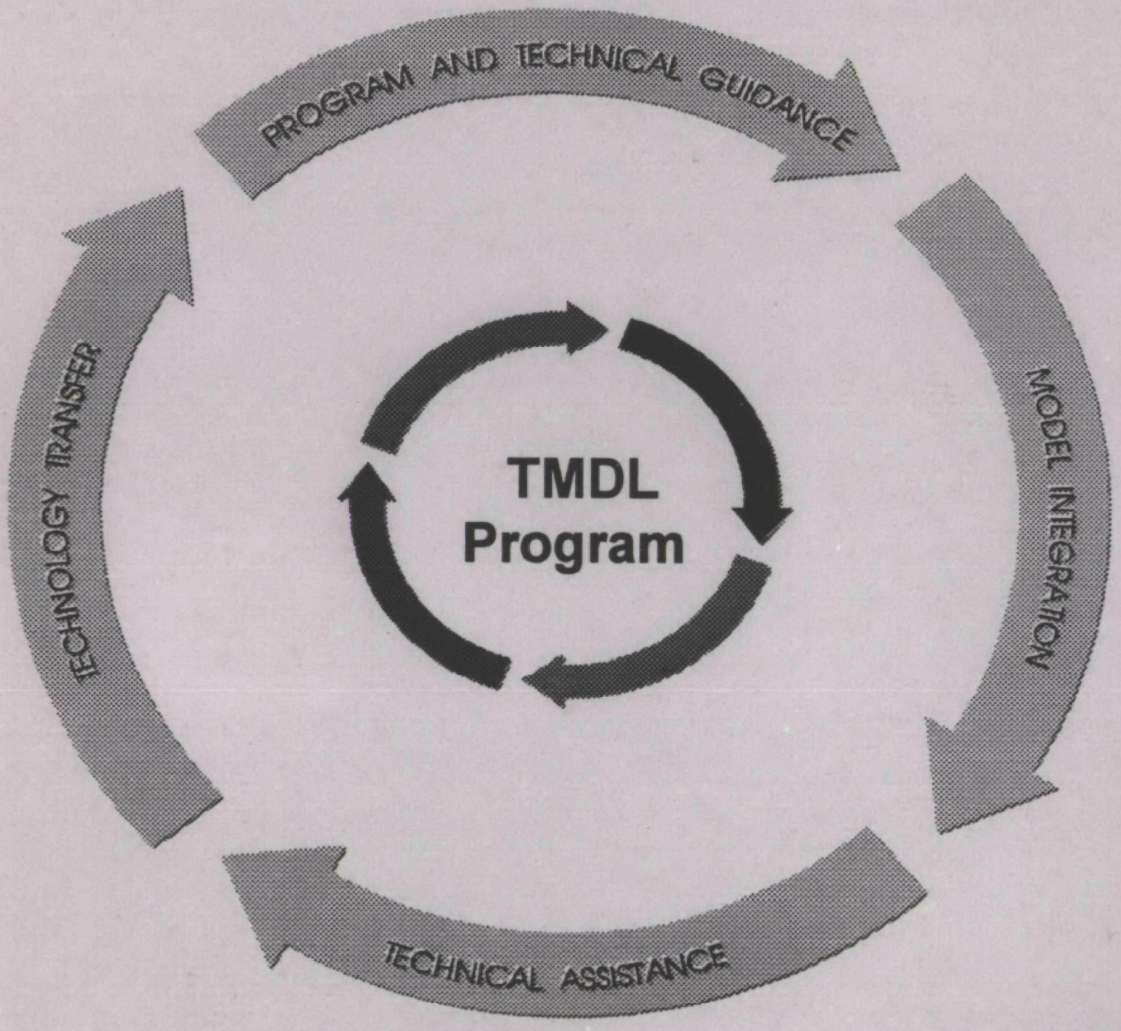
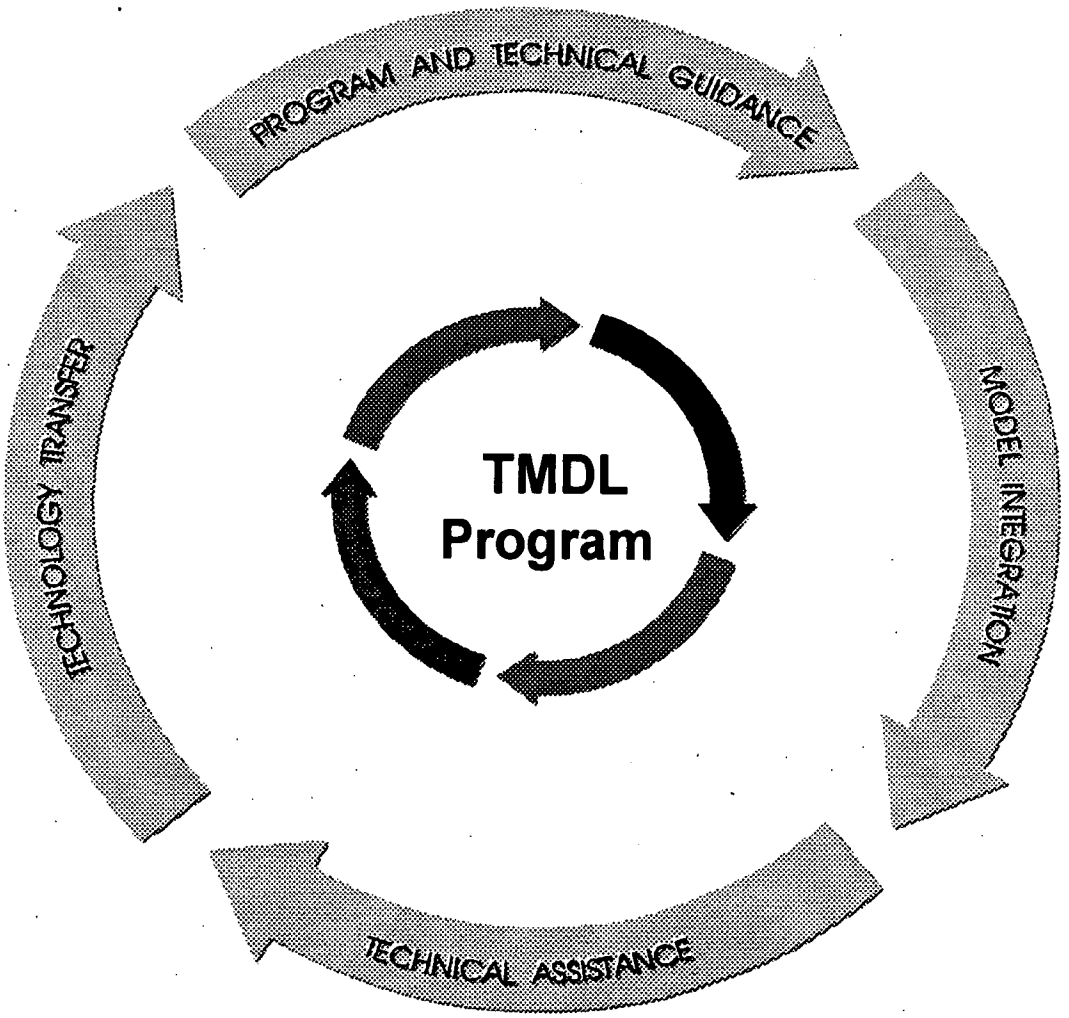
TMDL Framework for Action



U.S. Environmental Protection Agency
Office of Science and Technology
Office of Wetlands, Oceans and Watersheds
October 1992

★1992★
THE YEAR OF
CLEAN WATER
Celebration & Commitment

TMDL Framework for Action



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EXECUTIVE SUMMARY

This document is a joint effort of the U.S. Environmental Protection Agency's Office of Science and Technology (OST) and Office of Wetlands, Oceans and Watersheds (OWOW). The purpose of this document is to identify the needs and priorities for execution of the Total Maximum Daily Load (TMDL) process and the respective responsibilities of each Office. The identified needs and priorities are multi-year. The Exposure Assessment Branch (EAB) of the Standards and Applied Science Division (SASD) and the Watershed Branch (WB) of the Assessment and Watershed Protection Division (AWPD) will work jointly to meet these needs. In some cases EAB and WB will contribute staff time and contract resources during the same fiscal year. In others EAB and WB will sequence project responsibilities. For example, WB may initiate work in one year, with EAB taking up project responsibilities in the second year.

To address the technical issues related to implementation of the TMDL program, a Workshop on the Water Quality-based Approach for Point and Nonpoint Source Controls was held in Chicago in June 1991 (USEPA, 1991a). This document responds to the needs outlined by the Chicago Symposium. In addition, this document incorporates comments provided by the Regional TMDL Coordinators on earlier drafts of the Framework for Action.

To support the TMDL process a total of 35 projects are identified in this Framework (Table 1). The document presents these needs in two major categories, program needs and research needs. Program needs are divided into two sub-categories: program and technical guidance and technical assistance. Research needs are also presented in two sub-categories: model integration and technology transfer. In the first sub-category of program needs, technical guidance, typical projects include guidance on targeting and prioritizing water bodies, guidance on TMDL development, and guidance on monitoring to support TMDL development. In the second sub-category, key technical assistance projects include a variety of workshops, technical assistance for high priority TMDLs involving court cases, demonstration projects, SWAT team response, and short term information exchange on available models and TMDL case studies. In the research needs area, the model integration section identifies projects to update existing models, develop screening models, test models for TMDL screening, and evaluate and develop ecological modeling tools. The technology transfer section outlines a variety of projects to enhance model use through the development of user's manuals, pre- and post-processors, and innovative training techniques.

A number of quick response projects have already been initiated in FY '92 mostly to address short term needs. For planning purposes at EPA Headquarters and the Regions, OST and OWOW have identified projects and personnel needs for FY '93, after considering all regional comments and suggestions on the Framework. A funding level at 100% of FY'92 is assumed in this planning exercise to continue implementation of at least a portion of the projects identified in the Framework for Action. Table 1 summarizes the proposed funding levels by activity for FY '93.

PREFACE

Water quality-based point and nonpoint source controls, particularly in the watershed framework, pose new technical and programmatic challenges which must be faced jointly by a number of offices within the Office of Water. In many cases other Federal Agencies such as Agriculture, Interior and Defense as well as States will play key roles in developing and implementing Total Maximum Daily Loads (TMDL's) in targeted watersheds.

To develop a broad perspective of the technical challenges related to implementing the TMDL program, the Office of Science and Technology (OST) and the Office of Wetlands, Oceans and Watersheds (OWOW) jointly hosted a symposium on the water quality-based approach for point and nonpoint source controls in June 1991. National experts and representatives of EPA Regions, States and other Federal Agencies participated in this symposium. This Framework document reflects the needs outlined at the Symposium. The Framework also reflects the comments and suggestions made by various reviewers.

This document is intended to provide a roadmap for EPA support efforts in areas such as developing appropriate guidance for national use, providing necessary technical assistance to the regulated community, developing or updating appropriate watershed and water quality models for screening and control purposes, and maintaining an effective technology transfer program. This Framework should help communicate national TMDL program development priorities to the EPA and State TMDL coordinators. Additionally, we hope that this document will help EPA collaborate with other Federal agencies.

In order to maximize the TMDL program implementation, the TMDL Framework for Action identifies short- and long-term needs and priorities. As the needs and priorities change with time, the Framework will be updated to reflect those changes and the Framework will be used in defining TMDL objectives and establishing budget priorities.

Suggestions concerning EPA's priorities are welcome and may be sent to: Russell S. Kinerson, Chief, Exposure Assessment Branch (WH-585) or Bruce Newton, Chief, Watershed Branch (WH-553), 401 M Street, SW., Washington DC 20460.

Tudor T. Davies, Director
Office of Science and Technology

for Robert H. Wayland, Director
Office of Wetlands, Oceans and Watersheds

TABLE OF CONTENTS

1. INTRODUCTION

This document is a joint effort of the U.S. Environmental Protection Agency's Office of Science and Technology (OST) and Office of Wetlands, Oceans and Watersheds (OWOW). The purpose of this document is to clarify the needs and priorities for execution of the TMDL (total maximum daily load) process and the respective responsibilities of each Office. The following framework presents technical support and guidance needs that must be met to effectively implement the TMDL process. These needs are prioritized based on the available resources of each Office. High priority needs identified by OST, OWOW or the Regions that could not be addressed due to funding constraints were listed to illustrate the full range of program needs and are expected to be funded in subsequent years. The specific roles that OWOW and OST will play in the development of technical tools and guidance are identified as well. A common view of TMDL program needs and goals will help to maximize the effectiveness of the TMDL program implementation.

To address the technical issues related to implementation of the TMDL program, a Workshop on the Water Quality-based Approach for Point and Nonpoint Source Controls was held in Chicago in June 1991 (USEPA, 1991a). The purpose of the workshop was to explore the state of the science with national experts and the user community and determine technical guidance needs for implementing section 303(d) of the CWA. A large portion of this framework document is based on the discussions and recommendations of workshop participants. This document also incorporates comments received from EPA TMDL Regional Coordinators.

Since the TMDL process is ideally implemented as a watershed-based approach, all factors influencing the effective apportionment of nonpoint source load allocations (LAs) and point source wasteload allocations (WLAs) need to be addressed. In addition to broad technical issues such as guidance, modeling, and technology transfer in support of the TMDL process, issues specific to point and nonpoint sources are discussed. Such issues include, but are not limited to, combined sewer overflows (CSOs), stormwater discharges, and nonpoint source loadings.

The regulatory background and procedural needs related to TMDLs are discussed in chapter 2. Chapter 3 presents four types of program needs: program and technical guidance, technical assistance, model integration, and technology transfer. Also included are two appendices that elaborate on the issues raised in chapters 2 and 3. Appendix A details specific projects in the areas of technical guidance and technical assistance that will be initiated to meet the program needs outlined in chapter 3. Appendix B details the specific modeling and technology transfer projects that will be initiated. Each project

description in Appendices A and B is presented as a one-page summary that provides details on the project, the major issues to be addressed, project priority, and project implementation timeframe.

2. *REGULATORY BACKGROUND AND PROCEDURAL NEEDS*

Section 303(d) of the Clean Water Act (CWA) established the TMDL process to provide for more stringent water quality-based controls when technology-based controls are inadequate to achieve State Water Quality Standards (WQSs). The water quality-based approach encompasses the TMDL process, which contains five steps: (1) identification of water quality-limited waters and, subsequently, waters that require TMDLs; (2) priority ranking and targeting of those waters; (3) TMDL development; (4) implementation of pollution control actions; and (5) monitoring and assessment of control actions. Step 5 provides for continuous evaluation and improvement of the TMDL and any pollution control actions.

A TMDL is the sum of the individual wasteload allocations for point sources, the load allocations for nonpoint sources and natural background pollutant levels, and a margin of safety (MOS) that reflects the degree of uncertainty involved in the calculations (TMDL = ΣWLA + ΣLA + MOS). Historically, however, implementation of the 303(d) process has focused on point source wasteload allocations; nonpoint sources were not considered in detail, largely because nonpoint sources are more difficult to quantify and control.

It is clear now, however, that we must go beyond point source controls to effectively attain State WQSs. All sources of pollution must be considered, including nonchemical stressors such as habitat alteration and hydromodification. Therefore, it is necessary to look beyond the traditional chemical evaluation of water quality and incorporate evaluations of the physical and biological components of aquatic ecosystems.

EPA has recently issued a guidance document on the water quality-based approach and the TMDL process (USEPA, 1991b). The document outlines the TMDL process and the respective responsibilities of EPA and the States. The document also stresses the importance of addressing all point and nonpoint factors that may influence the allocation of WLAs and LAs. To evaluate the effectiveness of the WLAs and LAs, and to ensure that all significant factors have been identified, the guidance document recommends the use of a "phased approach," defined as a TMDL that includes monitoring and re-assessment schedules designed to evaluate the TMDL's success in meeting WQSs.

Table 1: Summary of Proposed 1993 TMDL Budget for EAB/OST and WB/OWOW[1]

Item #	Description	OST ($1,000) FY93	OWOW ($1,000) FY93	Total
	Program and Technical Guidance			
1	Guidance on Targeting and Prioritizing Water Bodies*		50	50
2	Guidance on TMDL Development	100		100
3	Guidance on Monitoring to Support TMDLS			
4-8	Supplementary Technical Guidance (Wet Weather and Clean Sediment Criteria) *	100	100	200
9	Comprehensive Guidance Document for Variable Loadings			
	Technical Assistance			
10	Workshops*	65	50	115
11	Workshops on Contaminated Sediments Criteria			
12	Direct Support to TMDL Related Court Cases*	75		75
13	TMDL SWAT Team*	75	100	175
14-18	Information Exchange (Case Studies/Model Review/Mini-grant)*	65	215	280
	Model Integration			
19	Model Integration (CORMIX/Screening Model Development)*	225	50	275
20	Ecological Models/Restoration		150	150
21	Data Access Tools*	20	20	40
22	Design Storm Event			
23	Biological Criteria			
24	BMP Effectiveness**			
25	Model Revision			
26	Adaptation of Models to GIS Platforms			
27	Sediment Quality Models			
28	TMDL Model Testing *		50	50
29	Guidance on Default Parameter Selection			
	Technology Transfer			
30	Conduct Training and Workshops	65		65
31	Innovative Delivery Systems			
32	User's Manuals			
33	Pre- and Post-Processor Development	100		100
34	Technical Assistance			
35	Joint Federal Interagency Clearinghouse			

[1]This table summarizes EAB's and WB's proposed contract funding for TMDL support only Other branch activities are not included

* These projects have been initiated in FY92 ** This project has been initiated in FY92 by the NPS branch of AWPD and funding continues

3. *TMDL PROGRAM AND RESEARCH NEEDS*

3.1 Background

The TMDL process is implemented using the watershed-based approach. Effective allocation of WLAs and LAs relies on the ability to identify, gather, and integrate data that reflect the relationships among the physical, chemical, and biological characteristics of a watershed, and the contribution of point and nonpoint pollution sources. Water quality-based management must depend heavily on technology such as monitoring to gather data and various levels of computer models to simulate the water system at various levels of complexity. Over time technological advances in the area of remote sensing will be used more frequently in the data collection process. Preliminary assessments may often rely on available data and simple screening models. The phased approach will allow for incremental fine-tuning of TMDLs as additional data are collected and more detailed analyses are performed.

Listed below are the needs that will have to be addressed to move the TMDL Program forward. These needs are presented in priority order according to the Office responsible for leading the programs. General guidance needs and technical assistance projects are to be led by OST and OWOW. Research, model development, and related technology transfer projects are to be implemented by OST and OWOW with support and assistance from the Office of Research and Development (ORD) when necessary.

In order to address immediate Regional and State needs for assistance in TMDL development, a number of short term projects have already been initiated in FY '92. After considering all Regional comments and suggestions on the Framework, EPA Headquarters and the Regions, OST, and OWOW have also identified projects and personnel needs for FY '93. A funding level at 100% of FY'92 is assumed in this planning exercise to continue implementation of at least a portion of the projects identified in the Framework for Action. Table 1 summarizes the proposed funding levels by activity for FY '93.

3.2 Program Needs

3.2.1 Program and Technical Guidance Needs

This section addresses guidance needs for implementation of the five-step TMDL development process. Participants at the Chicago workshop recommended the following TMDL-related technical guidance (USEPA, 1991a). Those projects having funding in FY '92 and/or FY '93 are marked **($)**.

- **Guidance on targeting and prioritizing water bodies:** OWOW (AWPD) has already begun to develop a handbook to help States target and prioritize watersheds. The handbook describes the various "geotargeting" techniques that have been used to target and prioritize watersheds. The handbook focuses on techniques that

are appropriate for TMDL applications. Targeting techniques include the following major categories: weighting factor, decision tree, data overlay (GIS), and programmatic approaches. The development of this handbook has high priority since targeting and prioritizing is a crucial first step in initiating the TMDL process. [*Item #1, OWOW*] ($)

- **Guidance on TMDL development:** To build on the programmatic requirements of the water quality-based approach, as outlined in the existing guidance document, a more technically based guidance document is needed. This document will build on existing EPA publications. The guidance document should include a description of various models, procedures to select watershed and water quality simulation models, the tie between modeling applications and ambient water quality standards, use of models and analytical techniques to develop a fully articulated TMDL/WLA/LA for both point and nonpoint sources, and TMDL case study examples. A number of projects have already been initiated to provide preliminary technical assistance including: a compendium of available models for watershed-based screening, detailed TMDL case study examples for distribution to the States and Regions, and TMDL minigrants for Regions, States, and local water quality agencies (see also *Items #15 and #16*). The results of these preliminary projects can eventually be incorporated in the guidance document. [*Item #2, OST and OWOW*] ($)

- **Guidance on monitoring to support development of TMDLs:** This document should describe the data needs and recommended monitoring techniques for the development of TMDLs. It should also include the various chemical and biological methods that can be used to generate site-specific data for use in particular models. Special monitoring needs in the area of habitat limitation, NPS, clean sediment, and high flow TMDLs, and TMDL effectiveness should be addressed as well. Multiple documents may be required to address the variety of waters that are monitored (e.g., streams, lakes, reservoirs and estuaries). [*Item #3, OST and OWOW*]

- **Supplementary technical guidance:** Since TMDLs are implemented on the watershed level, a wide variety of pollutant sources need to be considered. More specific technical guidance is needed in the areas listed below. These should be developed in coordination with and in support of the guidance mentioned above. The development of guidance in the areas of CSO/stormwater discharges, contaminated and clean sediments, whole effluent toxicity, and biological criteria, will assist in the implementation of the TMDL process.

  - **CSOs/stormwater discharges:** Directed studies, assessment, and guidance are needed to evaluate CSOs and stormwater discharges as part of watershed processes. The variable nature of these rainfall-driven discharges requires the development of new assessment tools. Effective control of CSO and stormwater discharges may require the development of wet weather criteria for some pollutants. Crosscutting CSO and

stormwater discharge issues include modeling, design storm events, and BMP effectiveness. [*Item #4, OST*] (**$**)

- **Contaminated sediments:** Contaminated sediments have the potential to cause toxicity, bioaccumulation, and other water quality impacts even when the overlying water column is deemed to be in compliance with existing water quality criteria. In conjunction with EPA's efforts to establish sediment criteria, guidance that clearly outlines the influence of contaminated sediments on water quality is needed so that Regions and States can make informed decisions. These impacts must then be considered in terms of the TMDL process. [*Item #5, OST*] (**$**)

- **Clean sediment criteria:** Clean sediments can have adverse impacts on aquatic ecosystems. Research studies are needed to determine the ecological and biological endpoints related to sediment embeddedness. More particularly criteria need to be developed to assess impacts of sediment embeddedness on cold as well as warm water fisheries. Criteria will need to be developed based on the results of research. Tools will be needed to estimate the range of impacts and determine the effects of land use activities on sedimentation. Case studies can be used to demonstrate that criteria and estimation procedures are effective. [*Item #6, OST and OWOW*] (**$**)

- **Whole effluent toxicity (WET):** The impacts of toxic chemicals on water quality and the biological components of an aquatic ecosystem need to be determined, particularly the combined impacts of multiple toxic chemicals from industrial, urban, and agricultural sources. The use of whole effluent toxicity within the TMDL process needs to be evaluated, and guidance provided to the Regions and States. [*Item #7, OST*] (**$**)

- **Biological criteria:** States have been instructed to incorporate narrative biological criteria into existing water quality standards. Guidance that stresses the value of such criteria as an aid to existing methods is necessary, as well as guidance that aids States in the design, selection, and implementation of such criteria. [*Item #8, OST and OWOW*]

- **Development of a Comprehensive Guidance Document for Assessing Variable Loadings:** The TSD currently does not adequately address the variable loadings from CSOs, stormwater, and nonpoint sources. A new comprehensive document should be developed which addresses variable loadings in relation to the standards-to-permits process. This new document will encompass the TMDL approach. The new document will include the basic elements of TMDL implementation for conventional as well as nonconventional pollutants, toxics, and clean sediments. The new document will also address models for nonpoint source assessment and load estimation, development of LAs for nonpoint sources, and integration of point and nonpoint source models. [*Item #9, OST and OWOW*]

3.2.2 Technical Assistance Needs

This section addresses technical assistance needed to implement and facilitate the five-step TMDL development process. This assistance falls into three general categories: (1) training and workshops, (2) direct support services to Regions and States, and (3) information exchange activities.

- **Workshops:** OST- and OWOW-led workshops are needed to provide guidance to the Regions and States on the technical skills required for the development of TMDLs. Workshops will include discussion of the regulatory aspects, monitoring, modeling, data management, and interpretation techniques required for the development of TMDLs. Technical workshops may need to be presented at more than one level (i.e., intermediate and advanced) and include additional technical skills such as statistical analysis for model verification and calibration, sampling design, and data analysis. Local presentations would allow the discussion to be tailored to meet Region-specific needs. At least five workshops per year are recommended so that each Region will have at least one workshop every two years. Because of funding limitations, it may be advantageous to offer workshops at a centralized facility and require participants to pay a nominal fee to defray expenses. To provide on-going assistance a TMDL modeling user's group may be advantageous. [*Item #10, OST and OWOW*] ($)

- **Workshops on the implementation of contaminated sediment criteria:** Workshops will be conducted for Regions and various Federal and State agency personnel to help implement contaminated sediment criteria through the State WQS process and to bring contaminated sediment within the TMDL process. Workshops would also serve to identify modeling and other technical needs concerning contaminated sediments. (EPA is currently working toward developing criteria for contaminated sediments.) [*Item #11, OST*]

- **Direct support for high-priority TMDL-related court cases:** OST and OWOW will provide expert support and consulting services for selected TMDL-related court cases. [*Item #12, OST and OWOW*] ($)

- **TMDL SWAT team:** The surface water assessment technical (SWAT) team consists of experts who are familiar with the technical aspects of TMDL development. The SWAT team will provide short-term expertise to EPA Regions, States, and local governments that are developing targeting programs and TMDLs (with special emphasis on nonpoint sources and watershed scale projects) under the 303(d) program. The program provides immediate expert assistance to TMDLs which are under development. [*Item #13, OWOW*] ($)

- **Information exchange:** Access to information on other case studies, court cases, related modeling studies, and available models will assist Regions and States in implementing TMDLs. This service will be provided by developing a clearinghouse, data bases, annotated bibliographies, and review documents. Rapid dissemination of this information will assist Regions and States in the early stages of TMDL development. TMDL mini-grants will be made available for Regions, States, and local water quality agencies for TMDL development. Information on TMDL development will be collated, standardized, and disseminated.

- **Coordination with Regions and States on the TMDL process.** OST and OWOW will work with the Regions and States on improving technologies and approaches to support the TMDL process. Innovative technologies such as remote sensing, GIS, IBI, RBP, etc... will be made available to the user community. [*Item #14, OST and OWOW*]

- **Case study examples.** Case studies are proposed for inclusion in TMDL guidance (see *Item #2*). There is an immediate need for technical assistance to the Regions and States. By means of information exchange, case study examples would be provided to the Regions and States on an accelerated basis. [*Item #15, OST and OWOW*] **($)**

- **Model reviews.** Model descriptions and testing are proposed for inclusion in a comprehensive TMDL Technical Guidance document (See *Item #2*). An on-going OWOW project is reviewing available models for TMDL development. This compendium identifies a range of methods from very simple to detailed which can be applied for TMDL screening, targeting and development. The compendium will be provided to the Regions and States on an accelerated basis. [*Item #16, OWOW*] **($)**

- **Electronic bulletin board:** A TMDL special interest group (SIG) is in the process of being established as a part of NPS Bulletin Board System (BBS). [*Item #17, OWOW and OST*] **($)**

- **Legal support:** Information on current and/or pending lawsuits will be provided to Regions and States on a continuing basis. [*Item #18, OWOW*] **($)**

3.3 Research Needs

3.3.1 Model Integration and Related Needs

A wide variety of models can be used to identify impaired waters, prioritize such waters, and develop TMDLs. Simple screening models are necessary to identify water quality-impaired or threatened waters that require TMDLs. More complex models are needed for diagnostic purposes in order to target and prioritize point and nonpoint source activities requiring pollution controls. Technically defensible models are needed to develop TMDL allocations.

Models are available in a variety of forms. **Watershed models** are used to estimate loadings from both point sources and nonpoint sources for urban and rural land use activities, and are particularly useful in the pollutant allocation phase of the TMDL process. Some watershed models can be used to simulate the loadings produced by periodic combined sewer overflows and stormwater discharges. **Mixing zone models** evaluate localized impacts from point sources and nonpoint sources on water quality. These are typically steady-state models used primarily for point source permitting. **Water quality models** are available to determine the impacts of loadings on receiving waters using either dynamic or steady-state techniques. **Ecological models** address ecosystem response to particular land use activities. The four general model types are described in greater detail below.

Watershed Models: EPA currently supports and distributes two detailed models: the Hydrologic Simulation Program - FORTRAN (HSPF) for urban and rural mixed land use activities and the Storm Water Management Model (SWMM) for urban land use activities. Detailed model documentation is available; however, no simplified guidance on model application is available. EPA also provides some limited support for these models, but such support needs to be expanded if these models are to used on a wider scale. The U.S. Department of Agriculture Soil Conservation Service (USDA-SCS) has developed six relatively simple and user-friendly models that may be useful for TMDL development in agricultural areas (e.g., Agricultural Non-Point Source Pollution Model (AGNPS), Simulator for Water Resources in Rural Basin-Water Quality model (SWRRBWQ), Erosion-Productivity Impact Calculator (EPIC), Groundwater Loading Effects of Agricultural Management Systems (GLEAMS), Chemicals, Runoff, Erosion from Agricultural Management Systems (CREAMS), and Nitrate Leaching and Economic Analysis Package (NLEAP)).

GLEAMS, CREAMS, EPIC, and NLEAP are field scale models and therefore have limitations with regard to the watershed-based TMDL process. The SWRRBWQ model can be applied on a watershed basis for continuous simulation, but additional development of model components for nutrient and pesticide transport is under way. The AGNPS model is watershed-based but is currently limited by application to design storms only. USDA is currently upgrading AGNPS to include continuous simulation as well.

Some watershed models have the capability to assess pollutant loadings due to CSOs. The EPA-distributed SWMM model was originally developed for CSO modeling (WPCF, 1989). It has the capacity to route flows and pollutants through complex sewer systems and to evaluate the impact of storage and special structures. The HSPF model can also be used for CSO assessment but has a more limited capacity for detailed flow and pollutant routing. Other notable models with CSO capabilities include STORM (COE), DR3M-QUAL (USGS), and ILLUDAS (Illinois State Water Survey) (WPCF, 1989).

Although hydrologic and hydraulic characteristics have been successfully modeled, quality modeling is generally less reliable, because of the complexity of pollutant transport and the number of parameters that must be estimated for successful calibration (Nix et al., 1991).

Screening models: A number of simpler screening models are commonly used by the Regions, States, local governments, research institutions, and the private sector for watershed assessment, targeting and TMDL development. No simple watershed screening models are currently distributed or supported by EPA.

Mixing zone models: Five EPA near-field mixing zone models were developed primarily in the late 1970s to meet 301(h) needs. They are UPLUME, UMERGE, UOUTPLM, UDKHDEN and ULINE. To implement existing mixing zone policies at the State and Federal levels, the Environmental Research Laboratory at Athens and the Office of Water jointly funded development of the CORMIX mixing zone models. CORMIX 1 is designed to address submerged single port discharges; CORMIX 2 is designed to address submerged multiport discharges; and CORMIX 3 is designed to address surface discharges. CORMIX 1 and 2 are currently available, and CORMIX 3 is in the last stage of its development under a two-year cooperative agreement with Cornell University. The first test version of CORMIX 3 has been distributed for comments ahead of schedule. OWOW provided $60K for the first year of the two-year agreement. Many features of these models are similar. For this reason, Environmental Research Laboratory-Narragansett (ERL-N), at the Newport, Oregon field office, is planning through FY 92 and 93 to consolidate the five EPA models into two models, and CORMIX 1, 2, and 3 into one CORMIX model. These models are provided to the user community with detailed documentation manuals, but no easy to follow user's manuals or tutorial diskettes. ERL-N has initiated plans to address these problems.

Based on recent arrangements, all near-field models are now distributed through ERL-Athens, and all model development, maintenance and technical assistance is accomplished through ERL-N.

Water quality models: Some important water quality models supported by EPA include DYNTOX, EXAMS, MINTEQ (metals speciation), QUAL2E, WASP4, SMP and SMPTOX. These models are used to simulate water quality in receiving waters (e.g., lakes, rivers, and estuaries) using fate and transport processes. These models are also difficult to apply because of the lack of simple user's manuals.

Ecological models: EPA does not currently support and/or distribute ecological models for assessing either aquatic or terrestrial habitats. Several simple and reliable ecological models that are available in the private sector may be helpful in implementing ecocriteria and promoting habitat restoration. Most of these ecological response models are not yet at the stage of predicting "true" ecological response (i.e., changes in production, biomass, recruitment, etc.), but offer stream managers a scale by which to compare relative magnitudes of improvement or success of restoration efforts.

During the TMDL Workshop, the Watershed Modeling Workgroup discussed the application of models for the development of TMDLs (USEPA, 1991a). Major concerns were raised regarding the accuracy and reliability of models for TMDL development, the limited data available for model application, and the multiple Federal agencies supporting the models. A number of short- and long-term

modeling needs were determined by the Workgroup. The project list below responds to many of the needs identified by the Workgroup. The TMDL Regional Coordinators identified the development, support and testing of screening models as a major research need. An emphasis on screening models and facilitating and simplifying the use of existing models is also reflected in the items below. Other concerns addressed below are model input requirements, model support and revision, and model testing.

Short-term Needs

- **Model integration:** Models are not currently designed to be used in a combined fashion. The watershed-based approach will often require that multiple models be used to evaluate a watershed. Although models are available to address most components of watershed-based analysis, each model is designed for a specific need. The use of multiple models for a watershed-based analysis is complicated by the various time scales, data formats, and model assumptions. For example, a daily simulation from a watershed model may need to be meshed with a water quality simulation for a receiving water. To facilitate this process pre- and post-processors need to be developed to link model input and output. For example, output from SWMM (a watershed model) could be reformatted to provide input to WASP4 (a water quality model).

  The CORMIX mixing zone model is currently distributed as three models. Future work will combine the three models into one. A single user's manual and documentation will be prepared for the new combined model.

  Screening models are needed for the initial targeting phase of the TMDL development process. These models, although limited in accuracy, require minimal data collection and can be used effectively in the preliminary stages of TMDL development. A review of models has been initiated in *Item #16.* Simple screening level models are available; however, many are site-specific, lack detailed documentation, and are not widely distributed. In this task a screening methodology will be developed, building on available models. Components of the screening model may include enhanced capabilities for data retrieval from EPA mainframe resources, a user-friendly interface, output statistics and graphics, and a detailed user's manual. The development of a screening model has been initiated in cooperation with Region IV as part of the screening model compendium. [*Item #19, OWOW and OST*] ($)

- **Ecological models:** Habitat and ecological restoration techniques are currently being explored and developed. Simple models that can predict response(s) of an ecosystem to a particular impact (e.g., restoration activity) need to be developed, evaluated, and validated. [*Item #20, OWOW and OST*] ($)

- **Data access tools:** Most models used to evaluate nonpoint source pollution have data requirements that include region- or site-specific information on rainfall, soil type, hydrology (including stream flow), topography, and land use. Data-access

tools (software packages) are needed so that data from national data bases are readily available and compatible for use with such models. A new methodology is currently under development to link mainframe data bases with a regional evaluation procedure and PC-based screening model (Region IV/OWOW). As our data bases improve, data access tools will be upgraded as well. Ongoing mainframe data base improvements which may be beneficial to the TMDL program include indexing of RF3 to STORET and PCS. Future enhancements may include streamflow and reservoir information associated with RF3. [*Item #21, OWOW and OST*] (**$**)

- **Design storm event:** Wet weather conditions are critical in determining the extent and impact of nonpoint source pollutants. While water quality assessments for point sources are often based on critical low-flow conditions, nonpoint source assessments must take high-flow conditions into account. The frequency of exceedence of water quality criteria is directly related to critical conditions for rainfall-driven impacts including size of event, moisture condition, time since previous storm event, and land use activities. For variable, rainfall driven impacts the development of wet weather criteria may be appropriate. If an appropriate design storm for assessing wet weather impacts can be selected, the initial model analyses could be more easily performed. A team of national experts should be convened to identify a methodology for selecting a design storm for wet weather loading estimates. A prototype design storm selection methodology should then be tested under a variety of conditions using case studies. [*Item #22, OWOW and OST*]

Long-term Needs

- **Biological criteria:** The Office of Water is currently working on an initiative to develop biological criteria for aquatic ecosystems. While the use of biological criteria for stream evaluations has already been initiated in ecological assessment programs, biological criteria will allow identification of ecosystems under stress, the sources and causes of the stress, and the ecosystems at the greatest potential for risk. One goal of the research is to be able to directly link physical and biological stress with ecosystem dysfunction. [*Item #23, OST*]

- **BMP effectiveness:** The effectiveness of best management practices (BMPs) or other control measures required by a TMDL can be determined only through regular monitoring and assessment activities. Participants at the Chicago workshop identified the need for a compendium of BMPs (including follow-up monitoring data) and their measured effectiveness. The NPS Branch is working on this topic through the Coastal Zone Management Act (CZMA) efforts. Future work will need to focus on development and testing of models for BMP assessment. [*Item #24, OST*] (**$**)

- **Model Revision:** It is necessary to identify areas where models should be revised (e.g., air/water, sediment/water, and ground/surface water interfaces) because many of the currently supported EPA and USDA models calculate runoff, erosion,

nutrient loading, and chemical transport using older techniques. Existing models would be selectively updated, thereby enhancing model capabilities and improving accuracy. [*Item #25, OST*]

- **Adaptation of models to GIS platforms:** GIS is a tool that can be used to integrate basinwide data for water quality assessments. GIS can overlay information on soils, land use, wetlands, topography, and critical areas. It can be used to evaluate watersheds for targeting purposes and develop model inputs. GIS implementation requires a significant level of effort for initial digitization of data. As more and more data become available in GIS format, this technology will have wider applicability. Future work on models should acknowledge the need for GIS interfaces. To improve the portability of information into models and results from one model to another, EPA-supported models should be updated in the future to interface with a common (GIS) environment. [*Item #26, OWOW and OST*]

- **Sediment quality models:** Based on the results of the workshop under Item #11, a research plan should be developed and implemented to address sediment quantity and quality models for application in lake, river, and estuarine situations to assess impacts of clean sediment deposition on cold and warm water fisheries. [*Item #27, OWOW and OST*]

- **TMDL model testing:** Site-specific testing of a selected number of models should be performed. Models applied to the TMDL process will need to be verified to ensure user confidence in model applications. A number of possible sites for model testing could be identified with a variety of problems (e.g., NPS, PS, groundwater...) and located in various regions of the country. Model testing will be performed in cooperation with the Regions and States to evaluate site specific issues. Additional testing should be performed in the West/Southwest. Model testing would be used to develop step-by-step guidance on model applications for inclusion in the TMDL Technical Guidance document (see also *Item #2*). [*Item #28, OWOW and OST*] **($)**

- **Guidance on default parameter selection:** Currently models such as HSPF and SWMM have limited guidance on input values, particularly in the areas of pollutant accumulation, washoff, and transport. Demonstration projects, model testing, and pilot studies should be used to determine a range of appropriate input parameters that can be used for planning-level assessments or as initial values for calibration. Parameters will be described as a range of possible input values based on documented research. A few carefully selected OST-led demonstration projects could be used to develop the appropriate inputs. [*Item #29, OST*]

3.3.2 Technology Transfer Needs

Effective transfer of TMDL technologies to the public depends on (1) improving the user-friendliness of tools and technologies; (2) conducting training, seminars, and workshops; and (3) providing project-specific technical

assistance on requests from individual users. Each topic is briefly described below.

- **Training and workshops:** EPA currently conducts (via ORD laboratories and contractor support) a limited number of workshops each year oriented toward ORD-supported models. To support TMDL technology transfer, these workshops should be enhanced with improved visual aids and sample applications. With the need for watershed-based modeling, there will be an increased demand for training that includes nonpoint source modeling. As a result, the technology transfer program will require additional expert support services. [*Item #30, OWOW and OST*]

- **Innovative delivery systems for technology transfer:** Hands-on training and telephone assistance are often needed to run the models that are distributed through EPA. Although EPA conducts a number of workshops at ORD and regional sites, the number is limited. Model training could reach even more potential users with videotaped presentations of workshops, which could be provided to a Region, a State, a local government, a university, or a private consultant on an as-needed basis. Demonstration diskettes and computer based training (CBT), using modern animation techniques, could be used as well. These types of technology transfer techniques could reach a wider audience than the current workshop format. [*Item #31, OST*]

- **User's manuals:** Currently, no simple user's manuals are available for the models that have been developed, supported, and distributed by EPA. Instead, ORD distributes models with a complete documentation manual that is often rather imposing. Knowledge of all of the assumptions that were involved in model development are necessary for many model applications. Even with such knowledge, hands-on training and telephone assistance are often needed to run the model. A simple user's manual with several pertinent examples would greatly facilitate widespread use of EPA-distributed models by States and local governments to develop TMDLs. User's manuals will include teaching aides such as a tutorial which takes the user through a sample application enhanced by graphics and animation. [*Item #32, OST*]

- **Pre- and post-processor development:** The development of user-friendly interfaces for computer models can greatly enhance the use of models for TMDL development. Typically the preparation of data, data input, and data interpretation for a model are very time consuming. In addition, input and output are in a different format for each model. In this activity pre- and post-processors would be developed for each supported model using modern PC technology for better graphics and animation. The pre-processor would provide menus for data entry, help screens for assistance in selecting input values, and a uniform format for all models. The post-processor would facilitate interpretation of model results and information transfer between models (see also *Item #19*). [*Item #33, OST*] (**$**)

- **Technical assistance:** Demands on EPA's technical assistance program are increasing

and will continue to increase as more groups and individuals use models that are distributed by EPA. In addition to EPA staff, cooperative agreements are established with other water quality modelers whose expertise is not shared by those within EPA. To ensure that user queries are answered completely and efficiently, guidance, model clearinghouses and expert support services must be expanded. [*Item #34, OWOW and OST*]. **($)**

- **Joint Federal interagency model clearinghouse:** To ensure a consistent approach to watershed modeling and interpretation of modeling results, it would be most helpful to coordinate EPA's modeling activities with those of other Federal agencies (e.g., Army Corps of Engineers, US Department of Agriculture, USDA/Forest Service, US Geological Survey, Bureau of Land Management, Bureau of Reclamation). This would eliminate duplication of effort, provide comprehensive support for Federal models, and facilitate technology transfer between the agencies, as well as with the public. [*Item #35, OWOW and OST*]

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APPENDIX A

PROGRAM NEEDS

PART I - TECHNICAL GUIDANCE NEEDS

PART II - TECHNICAL ASSISTANCE NEEDS

Item #1: Guidance on geographic targeting and prioritizing water bodies

OVERVIEW:

OWOW (AWPD) has drafted a handbook to help States target and prioritize watersheds. The handbook describes the various geographic targeting techniques that have been used to target and prioritize watersheds. It focuses on techniques that are appropriate for TMDL applications. Targeting techniques include the following major categories: weighting factor, decision tree, data overlay (GIS), and programmatic approaches. The most commonly used technique is a combination of weighting factor and programmatic approaches. Additional topics discussed are data integration for targeting and a simple loading rate model case study.

ISSUES:

- Limited resources require that Regions/States target and prioritize TMDL development and implementation efforts to key watersheds.
- Guidance on screening and targeting methods would provide valuable assistance to the Regions/States and facilitate the implementation process.

COMPLETED:

3 years

Item #2: Guidance on TMDL Development

OVERVIEW:

To build on the programmatic requirements of the water quality-based approach as outlined in the existing guidance document, a more technically based guidance document is needed. The document should illustrate the technical steps required to develop a variety of TMDLs. This document should include targeting and prioritization techniques, descriptions of various models, procedures to select watershed and water quality simulation models, the tie between modeling applications and ambient water quality standards, use of models and analytical techniques to develop a fully articulated TMDL/WLA/LA for both point and nonpoint sources, and TMDL case study examples. Models would be tested and application procedures clearly outlined to facilitate application by the Regions/States. Data requirements for model input including monitoring requirements would be clearly outlined.

ISSUES:

- Programmatic guidance on TMDL development was described in the TMDL guidance document.
- Implementation of TMDL development would be assisted by technical guidance. Discussion at the Chicago workshop clearly demonstrated the need for additional technical guidance.
- Technical guidance is needed in the area of model selection and application. The guidance should be specific to the needs of the TMDL process.

COMPLETED:

3 years

Item #3: Guidance on monitoring to support development of TMDLs

OVERVIEW:

This document should describe a variety of monitoring techniques that can be used in the development of TMDLs. It should also include the various chemical and biological methods that can be used to generate site-specific data that can be used for particular models. Different techniques may be needed at each phase in the development of a TMDL. Initial monitoring may be used for screening and targeting. Additional monitoring may be needed for watershed assessment and habitat assessment, and more detailed monitoring may be required to develop the TMDL. The document may include monitoring procedures to assess the effectiveness of TMDLs. Because of the high cost of monitoring, the guidance manual will be helpful to target resources and maximize results from monitoring programs.

Monitoring is needed in river, lake, and estuarine environments. Multiple guidance documents may be needed to address the unique needs of each type of water body.

ISSUES:

- A wide range of monitoring techniques may be needed to address the needs of TMDL development in keeping with the phased approach.
- Biological monitoring may in some cases be an appropriate surrogate or addition to chemical monitoring.

COMPLETED:

5 years

Items #4-8: Supplementary Technical Guidance

OVERVIEW:

More specific technical guidance should be considered in the areas listed below. Such guidance should be developed in coordination with and in support of guidance described in Item #2.

CSOs/stormwater discharges: Assessment, directed studies, and guidance are needed to evaluate CSOs and stormwater discharges as part of watershed processes. The variable nature of these rainfall-driven discharges requires the development of new assessment tools. Effective control of CSO and stormwater discharges may require the development of wet weather criteria. Crosscutting CSO and stormwater discharge issues include modeling, design storm events, and BMP effectiveness.

Contaminated sediments: Contaminated sediments have the potential to cause toxicity, bioaccumulation, and other water quality impacts even when the surrounding water column was deemed to be in compliance with existing water quality criteria. In conjunction with EPA's efforts to establish sediment criteria, guidance that clearly outlines the influence of contaminated sediments on water quality is needed so that Regions and States can make informed decisions. These impacts must then be considered in terms of the TMDL process.

Clean sediment criteria: Clean sediments can have adverse impacts on aquatic ecosystems. Research studies are needed to determine the ecological and biological endpoints due to sediment embeddedness. More particularly criteria need to be developed to assess impacts of sediment embeddedness on cold and warm water fisheries. Criteria will need to be developed based on the results of research. Tools will be needed to estimate the range of impacts and determine the effects of land use activities on sedimentation. Case studies can be used to demonstrate that criteria and estimation procedures are effective.

Whole effluent toxicity (WET): The impacts of toxic chemicals on water quality and the biological components of an aquatic ecosystem need to be determined, particularly the combined impacts of multiple toxic chemicals from industrial, urban, and agricultural sources. The use of whole effluent toxicity within the TMDL process needs to be evaluated, and then guidance must be provided to the Regions and States.

Biological criteria: States have been instructed to incorporate narrative biological criteria into existing water quality standards. Guidance that stresses the value of such criteria as an aid to existing methods is necessary, as well as guidance that aids States in the design, selection, and implementation of such criteria.

ISSUES:

- Since the TMDL process is ideally implemented as a watershed-based approach, a wide variety of issues need to be addressed in quantifying and analyzing the pollutant sources. Documents that can potentially support the process need to be developed and integrated into the TMDL guidance.

COMPLETED: 5 years

Item #9: Development of a Comprehensive Guidance Document for Assessing Variable Loadings

OVERVIEW:

The TSD currently does not adequately address the nonpoint source aspects of the TMDL program. A new comprehensive document should be developed which addresses variable loadings in relation to the standards-to-permits process. This new document will encompass the TMDL approach. The new document will include the basic elements of TMDL implementation for conventional as well as nonconventional pollutants, including toxics. Since clean sediments cause considerable water quality impairments, clean sediments will be included in the comprehensive guidance document. The new document will also address models for nonpoint source assessment and load estimation, development of LAs for nonpoint sources, and integration of point and nonpoint source models. Steady-state approaches are often not adequate for addressing these types of impacts. The new document would incorporate dynamic methodologies for handling a wider range of nonpoint and point (CSOs and stormwater) source impacts.

ISSUES:

- TMDLs must incorporate point and nonpoint sources into a watershed-based approach.
- The recent revision of the TSD focuses on steady-state impacts, not on the dynamic impacts typical of nonpoint sources, stormwater, and CSO discharges.
- The new document will be needed to incorporate the TMDL process and methodologies for addressing the dynamic rainfall-driven loadings, including CSOs and stormwater, as part of the watershed-based approach.

COMPLETED:

4-6 years

Item #10: Workshops

OVERVIEW:

OST and OWOW-led workshops would provide guidance to the Regions and States on the technical needs for implementation of the TMDL process. Workshops could be tailored to meet Region-specific needs. At least five workshops per year are recommended so that all Regions will have at least one workshop every 2 years. Because of funding limitations, it may be advantageous to offer workshops at a centralized facility and require participants to pay a nominal fee to defray expenses. Two types of workshops are needed under the technical assistance effort:

(a) **Regional workshops**: Each year a survey is conducted to determine specific regional training needs. Training materials for these workshops are tailored to meet those specific needs, and workshops are conducted at regional sites. The workshops may contain nontechnical as well as technical components. Each year EPA has conducted four or five workshops so that a workshop is given in each region at least once every two years. Capacities of these workshops are 30-35 persons with an approximate cost of $25-35K per workshop.

(b) **Information Exchange Workshop(s)**: Each year EPA conducts one or two workshops for information exchange, critical issues, or planning purposes. For example, in FY '91 a workshop was held in Chicago with national experts and the user community to define future TMDL program needs. Approximately 125 people (by invitation only) attended the workshop. Each year OST and OWOW meet with Regional/State TMDL coordinators to discuss yearly activities, regulatory schedules, and implementation problems and prospects.

ISSUES:

- Workshops are needed to address the specific requirements of TMDL development.
- Workshops should address the technical implementation of the phased approach including a range of models from simple screening methods to more complex models.
- Workshops can be used to develop consensus on future programmatic needs.

COMPLETED: Continuing

Item #11: Workshops on the Implementation of Contaminated Sediments Criteria

OVERVIEW:

Contaminated sediments have the potential to cause toxicity, bioaccumulation, and other water quality impacts even when the surrounding water was initially in compliance with existing water quality criteria. Workshops should be conducted for Regions and various Federal and State agency personnel to help implement contaminated sediment criteria through the State WQS process and to bring contaminated sediment within the TMDL process. Workshops would also identify modeling and other technical needs concerning contaminated sediments. (EPA is currently working toward developing criteria for contaminated sediments. Guidance development is proposed in *Item #5*.)

ISSUES:

- Workshops are needed to present contaminated sediment criteria to the Regions/States.
- Workshops are needed to address the technical issues related to contaminated sediment.
- Technical needs for addressing contaminated sediments within the context of the TMDL process need to be identified.

COMPLETED:

3 years

Item #12: Direct Support to High-Priority TMDL-Related Court Cases

OVERVIEW:

HQ would provide expert support and consulting services for selected TMDL-related court cases, including modeling and related monitoring. Many of the court cases of the past involved issues related to the appropriateness of water quality standards (WQSs) and modeling/monitoring assumptions. HQ assistance is provided on a case-by-case basis to improve the technical defensibility of the TMDL. The assistance may consist of (a) finding and using experts, (b) selecting and simulating with appropriate models, (c) assisting in generating monitoring data needed for the models, (d) interpreting model output, and (e) presenting TMDLs in the public participation process.

ISSUES:

- High-priority TMDLs may require expert assistance for interpretation of WQSs, model selection, and model application and/or development.
- Expert review can be used to evaluate the TMDL development methodology.
- Expert assistance may be required to develop technically defensible TMDLs.

COMPLETED:

Continuing

Item #13: TMDL SWAT Team

OVERVIEW:

The surface water assessment technical (SWAT) team will consist of a team of experts who are familiar with the technologies required for TMDL development. The SWAT team will provide short-term expertise to EPA Regions, States, and local governments that are developing targeting programs and TMDLs (with special emphasis on nonpoint sources) under the 303(d) program. The technical assistance will be provided primarily on a phone-in basis. Other advantages of the SWAT team approach include opportunities to field-test new technology and user feedback.

ISSUES:

- High-priority TMDLs may require expert assistance for interpretation of WQSs, model selection, and model application and/or development.
- Successful development and implementation of TMDLs, through expert assistance, can provide positive examples to the local State or Region.
- Expert review can be used to evaluate the TMDL development methodology.
- Expert assistance may be required to develop technically defensible TMDLs.

COMPLETED:

Continuing

Items #14-18: Information Exchange

OVERVIEW:

Regions and States will be assisted in implementing TMDLs by providing access to information on other case studies, court cases, and related modeling studies. This service includes development of a clearinghouse, data bases, annotated bibliographies, and reviews of recent model applications.

- **Coordination with Regions and States on the TMDL process.** OST and OWOW will work with the Regions and States on developing new technologies to support the TMDL process.

- **Case study examples.** Case studies are proposed for inclusion in TMDL guidance (see *Item #2*). There is an immediate need for technical assistance to the Regions and States. By means of information exchange, case study examples will be provided to the Regions and States on an accelerated basis.

- **Model reviews.** Description and testing of models are proposed for inclusion in *Item #2*. An OWOW project is under way to review available models for TMDL screening. A summary document will be provided to the Regions and States on an accelerated basis.

- **Electronic bulletin board:** A TMDL special interest group (SIG) is in the process of being established as a part of the NPS Bulletin Board System (BBS).

- **Legal clearinghouse:** Information on current and/or pending lawsuits will be provided to Regions and States on a continuing basis.

ISSUES:

- Information is available on models and related studies that might be helpful to the Region/States in the development of TMDLs.

- Existing information should be compiled and disseminated to the Regions/States in the form of reports.

COMPLETED:
Continuing

APPENDIX B

RESEARCH NEEDS

PART I - MODEL INTEGRATION AND RELATED NEEDS

PART II - TECHNOLOGY TRANSFER

Item #19: Model Integration

OVERVIEW:

Multiple models are often needed to evaluate TMDLs. Pre- and post-processors should have the capability to link model input and output so that models can be run in series. Although models are available to address most components of watershed-based analysis, each model is designed for a specific need. Models are not currently designed to be used in a combined fashion (i.e., integrated approach). The watershed-based approach will often require that multiple models be used to evaluate a watershed. To facilitate this process pre- and post-processors need to be developed to link model input and output. For example, output from SWMM (a watershed model) could be reformatted to provide input to WASP4 (a water quality model). Likely combinations of models should first be selected. Data management needs could then be incorporated into pre- and post-processor development (see also *Item #32*).

The CORMIX mixing zone model is currently distributed as three models. Future work will combine the three models into one. A single user's manual and documentation will be prepared for the new combined model.

Screening models are needed for the initial targeting phase of the TMDL development process. These models, although limited in accuracy, require minimum data collection and can be used effectively in the preliminary stages of TMDL development. A review of models has been initiated in ***Item #16***. Simple screening level models are available, however many are site-specific, lack detailed documentation, and are not generally distributed.. In this task a screening methodology will be developed, building on available models. Components of the screening model may include enhanced capabilities for data retrieval from EPA mainframe resources, a user-friendly interface, output statistics and graphics, and a detailed user's manual. The development of a screening model has been initiated in cooperation with Region IV.

ISSUES:

- Used separately, models may provide a fragmented picture of water quality.
- Improved data management techniques would facilitate the use of multiple models for watershed-based assessments.
- User friendly screening models are needed to assist the Regions and States in the initial phases of the TMDL development process.
- Screening model development and support was designated as a high priority item by the Regional TMDL coordinators.

COMPLETED:

5 years

Item #20: Ecological Models

OVERVIEW:

A few ecological models should be evaluated, verified, and selected for future support and development by EPA. Ecological restoration and predictive modeling of ecological response are rapidly emerging areas of research. The role of predictive models, however, is not necessarily to precisely quantify or to establish causality, but to communicate the relationships between ecological restoration efforts and the resulting benefits. For this reason, simple empirical relationships, as opposed to detailed, deterministic approaches, are generally recognized as being more important.

Modeling efforts to date have mostly focused on predicting the benefits of restoration. With the aid of simulations that combine the physical habitat preferences of riverine organisms and predictions of changes in hydraulic patterns after structure placement, the available habitat can be estimated. Response factors are used to weigh tolerances to certain conditions at each mitigation site. Most ecological response models, however, are not at the stage of predicting "true" ecological response (i.e., changes in production, biomass, recruitment, etc.), but offer stream managers a scale by which to compare relative magnitudes of improvement or success of restoration efforts.

One model that could be used to predict ecological response in the near future, if it were possible to construct "suitability for optimal colonization curves," is the Physical Habitat Simulation (PHABSIM). PHABSIM is maintained by the U.S. Fish and Wildlife Service as a portion of the Instream Flow Incremental Methodology. Other models that may be suitable include the Ecological Population Dynamics Model (LESLIEMATRICS), ERL-Athen's food chain model, and the FISHSED model (U.S. Fish and Wildlife). The FISHSED model is capable of assessing spawning potential as a function of sediment embeddedness.

ISSUES:

- EPA does not currently support and/or distribute ecological models.
- Ecological modeling is an emerging science.
- Ecological models will be necessary to implement ecocriteria and promote habitat restoration.

COMPLETED:

7 years

Item #21: Data Access Tools

OVERVIEW:

Most models used to evaluate nonpoint source pollution require a broad array of input variables. In most cases, data requirements include region- or site-specific information on rainfall, soil type, hydrology (including stream flow), topography, and land use. Although data are available from national data bases, data are not easily accessed by users from Regional, State, or local agencies. Data-access tools (software packages) are needed so that data from national data bases can be more readily accessed and formatted for use with models. As our data bases improve, data access tools will be upgraded as well. Ongoing mainframe data base improvements that may be beneficial to the TMDL program include indexing of RF3 to STORET and PCS. Future enhancements may include streamflow and reservoir information associated with RF3.

ISSUES:

- Watershed and water quality models often require data on rainfall, soil type, hydrology (including stream flow), topography, and land use/land coverage.
- Current access to national data bases is limited. The data, once accessed, cannot be easily formatted for input to a model.
- Different Federal agencies maintain national data bases (e.g., USGS-flow, NWS-precipitation, USDA-soils). (Note: Through an MOU, EPA has access to flow data from the USGS.)
- Some computerized data are incomplete on the national level.
- While national data bases reside on mainframe computers, typical NPS models are applied using PCs. Therefore, access tools will need to operate in a multiplatform environment.

COMPLETED:

5 years

Item #22: Design Storm Event

OVERVIEW:

An interagency plan to develop a technically defensible selection process for storm design event(s) for modeling urban, agricultural, and mixed land use areas should be initiated. The use of watershed models using design storms may be appropriate in preliminary screening or design applications for the TMDL process. The selection of the appropriate design storm that characterizes "critical" conditions for water quality is complex, depending on site, antecedent conditions, and receiving water conditions. Design storm applications of models can significantly reduce the level of effort for initial model analyses.

This activity is divided into four categories: (1) design storm selection for urban areas; (2) design storm selection for agricultural areas; (3) design storm selection for mixed land use areas, and (4) design storm selection for land under transition.

For each category the feasibility of defining a critical design storm for the TMDL process should be investigated. A process for selecting the design storm should be identified and guidance developed. The process could include the selection of multiple events for the purposes of developing a TMDL. In each, the unique characteristics of the contributing land use would be considered in selecting the key design storm parameters.

ISSUES:

- Design storm applications may be appropriate for preliminary screening and design applications.
- Model applications using design storms can reduce the level of effort for using models.
- In the short term, development of a design storm would facilitate the use of the AGNPS model for the TMDL process.
- The characteristics of the "critical" design storm for the TMDL process must take into consideration key parameters related to water quality and quantity. Parameters might include land use, watershed characteristics (such as time of concentration), antecedent conditions (moisture content of soils and time since last runoff event), precipitation, and runoff.
- Design storm development may vary depending on the contributing land use; therefore, separate development of urban, agricultural and mixed land use events is recommended.

COMPLETED:

5 years

Item #23: Biological Criteria

OVERVIEW:

It is EPA's policy that States develop and implement biological criteria into their water quality standards. Biological criteria or biocriteria may be expressed as numerical values or narrative expressions to describe the biological integrity of reference aquatic communities for a specific designated aquatic life use. States have been instructed to adopt minimum narrative biological criteria into their water quality standards during the FY 91- FY 93 triennium. Biocriteria are intended to supplement rather than replace chemical and toxicological methods. Impairments can be identified from a variety of sources including water column contamination, sediment contamination, nonchemical impacts, and alteration of physical habitat. Because of the unpredictable and fluctuating nature of storm events, measuring the biological community or using biocriteria may provide a good measure of the cumulative in-stream effects caused by nonpoint sources, CSOs, and stormwater.

ORD and OW are currently working on an initiative to develop biocriteria for aquatic ecosystems. Additional research on the development of biocriteria will provide technical assistance to the States. One goal of the research is to directly link stresses with ecosystem dysfunction.

ISSUES:

- Biological indicators may be a more effective measure of water quality than traditional chemical-based criteria.

COMPLETED:

7 years

Item #24: BMP Effectiveness

OVERVIEW:

The effectiveness of best management practices (BMPs) or other control measures required by a TMDL can be determined only through regular monitoring and assessment activities. As TMDLs are implemented through the phased approach, mitigation plans will need to be developed for control of nonpoint sources, stormwater discharges, and CSOs. The control of rainfall-driven loadings relies on the effective implementation of a wide variety of best management practices (BMPs). Participants at the Chicago workshop identified the need for a compendium of BMPs (including follow-up monitoring data) and their measured effectiveness. The NPS Branch is working on this topic through Coastal Zone Management Act (CZMA) efforts. The CZMA guidance document includes a detailed assessment of the available information on the effectiveness of BMPs. Little or no information is available on the effectiveness of many commonly used BMPs. Since testing on the effectiveness of BMPs is often limited to only a few regions of the country, widespread applicability is often questionable. BMPs need to be selected for further testing.

Models also have limited capabilities in the area of BMP assessment. Mitigation plans often incorporate a variety of BMPs throughout a watershed. Watershed models are typically used to evaluate the ability of the mitigation plan to meet the required TMDL. Existing models (e.g., HSPF and SWMM) can evaluate BMPs such as detention ponds based on sediment deposition. They do not account for the more complex chemical and biological removal typical of wet ponds or created wetlands. Models need to be enhanced/developed to allow for the evaluation of mitigation plans.

ISSUES:

- BMPs are needed to implement controls for nonpoint sources, stormwater discharges, and CSOs.
- Limited information is available on the effectiveness of some BMPs.
- Models typically do not estimate biological and chemical pollutant removal by BMPs.

COMPLETED:

10 years

Item #25: Model Revision

OVERVIEW:

Many of the currently supported EPA and USDA models are based on older techniques for calculation of runoff, erosion, nutrient and chemical transport. Research has been ongoing in improving these algorithms, particularly in the areas of air/water, sediment/water, and ground/surface interfaces. Existing models should be selectively evaluated for areas that need to be updated. Models should be revised and improved accordingly. This type of updating will enhance the capability of the models and improve their accuracy.

ISSUES:

- Model components should be enhanced with new technology as it becomes available.
- Algorithms could be added or improved in the areas of air/water, sediment/water, and ground/surface interfaces.
- The air/water interface component could be improved, especially in the area of chemical volatilization.
- Modeling of the sediment/water interface is crucial to the evaluation of pollutant resuspension and mixing due to storm events. Sediment-associated pollutants can constitute a significant source of pollutants in receiving waters.
- Modeling of the interface between ground water and surface water is necessary for the understanding of nonpoint source processes. When management practices are applied, the tradeoff between ground water and surface water loadings must be carefully evaluated.
- Additional areas where updating would be appropriate include: adding variable complexity capability, modeling of snow melt processes, and evaluating best management practices.

COMPLETED:

5 years

Item #26: Adaptation of Models to GIS Platforms

OVERVIEW:

GIS is an excellent tool for the integration of data from different sources. (Developing input data files for models and preparing graphs summarizing results can be a time-consuming effort.) At this time, few models operate in a GIS environment (AGNPS is one exception). To improve the portability of information into models and results from one model to another, our goal is to eventually update all EPA-supported models to operate in a common (GIS) environment. GIS systems and remote sensing data also provide analysis opportunities that do not exist with traditional modeling approaches.

ISSUES:

- EPA and SCS currently support ARC/INFO (vector-based) and GRASS (raster-based) as the GISs of choice, respectively. Tools for converting from raster- to vector-based data and vice versa are therefore needed.

- Because only limited staff with experience in GIS are available and initial costs for data entry are high, current projects tend to experience a slow turnaround. As models are converted to a GIS environment, additional effort on staff training will be necessary.

- A significant number of models will need to be revised to achieve this goal.

- Access tools will also need to link remote sensing data with models.

- The usefulness of remote sensing data for model verification and two-dimensional mixing zone modeling should be explored.

- The potential for multiplatform data (LANDSAT TM and SPOT PAN) integration should be explored.

COMPLETED:

10 years

Item #27: Sediment Quality Models

OVERVIEW:

Contaminated sediment criteria are currently under development by EPA. Workshops and guidance to support the implementation of contaminated sediment criteria are recommended under Items #5 and #11. Impacts due to clean sediment deposition on cold and warm water fisheries are also an emerging concern (see Item #6). With greater emphasis on the control of sediment impacts, improved tools will be required as well. Models will be needed to evaluate the washoff and transport of clean and contaminated sediments. The EPA HSPF watershed model has the ability to model erosion from land areas and sediment transport in rivers and fully mixed reservoirs. The SWMM model has more limited capabilities in area of erosion and sediment transport. The water quality models such as WASP4 have the most severe limitations with regard to sediment transport.

A research plan should first be developed to identify and prioritize model research needs. The workshop described in Item #11 will provide input on the modeling and other technical needs concerning contaminated sediments. The research plan should then be implemented by ORD.

ISSUES:

- Contaminated and clean sediments can have adverse impacts on aquatic ecosystems.
- Tools are needed to evaluate sediment and associated pollutant transport in rivers, lakes and estuaries
- Water quality models currently supported by EPA have limited capabilities in the area of sediment transport.

COMPLETED:

5 years

Item #28: TMDL Model Testing

OVERVIEW:

Models for the TMDL process need to be field-validated in various regions under a variety of land uses and soil types. Verified model applications will help to increase user confidence and understanding of the model limitations. Case studies are needed to evaluate the usefulness and applicability of models in the TMDL process. A number of simpler screening-level models will be selected for testing. Model testing will be performed in cooperation with the Regions and States to evaluate site specific concerns. The results of the model testing will be compiled and provided to the Regions/States as part of the information exchange program.

ISSUES:

- Models are currently difficult to apply, particularly for screening purposes, because of the lack of guidance on input parameters.
- Model testing would increase user confidence in models.
- Model testing would assist in the development of default parameters.
- Model testing could also be used to identify technical areas for future model upgrades.

COMPLETED:

5 years

Item #29: Guidance on Default Parameter Selection

OVERVIEW:

Initial input parameters for each model application are difficult to select. For screening applications with limited monitoring data few default parameters are available. As the need for screening applications increases, as part of the phased TMDL process, additional information for parameter selection would be valuable. Default parameters need to be defined for various regions, land uses, and soil types. Currently EPA-supported models such as HSPF and SWMM have limited guidance on input values particularly in the areas of pollutant accumulation, washoff, and transport. Other models, such as the USDA models, would also benefit from additional documentation of default parameters for input. Because of the variability of such inputs, the development of default parameters must take into account regional variations. A few carefully selected ORD-led demonstration projects could be used to test models and develop the appropriate inputs Parameters will be described as a range of possible input values based on documented research (see also Item #26).

ISSUES:

- Models are currently difficult to apply, particularly for screening purposes, because of the lack of guidance on input parameters.
- Default inputs are particularly lacking in the area of pollutant accumulation, removal, and transport.
- Default inputs should be developed on a regional basis.

COMPLETED:

10 years

Item #30: Conduct Training and Workshops

OVERVIEW:

Currently workshops on popular models (QUAL2E, WASP4, HSPF, etc.) are conducted by ERL-Athens and ERL-Narragansett, usually at the ERL-Athens site. The workshops are typically conducted on one model at a time. Sometimes, at Regional request, the modeling workshops are also conducted at Regional sites. Each workshop can accommodate 35-45 trainees. To support the TMDL process, modeling workshops that emphasize the application of models for TMDL development are needed. Additional workshops should be added to provide training in the application of screening models. Minor modifications to the current format would be sufficient to meet the needs of the TMDL program.

To make these workshops more effective, we need to improve the method of delivery by providing videotape presentations, improving visual aids, and using other modern forms of animation techniques (see also Item #33). With the expanding need to integrate point and nonpoint source modeling, there will be an increased demand for training that includes nonpoint source modeling. As a result, the technology transfer program will need to obtain additional expert support services (in-house or contractor support).

ISSUES:

- To support the TMDL process, there will be an increased demand for support/training on nonpoint source modeling.

- Current workshops are oriented toward point source modeling or specific models for nonpoint source assessments. The diversity of workshops will need to be expanded to include nonpoint source modeling with particular emphasis on its integration with the TMDL process. This expertise may not currently exist in-house, and expert support services may be necessary.

- To make use of limited resources, the Agency should consider innovative technology transfer methods such as videotape presentations.

- It will be necessary to identify Region-specific training needs to identify the most appropriate support services.

COMPLETED:

Continuing

Item #31: Innovative Delivery Systems for Technology Transfer

Prepare innovative delivery systems to improve visualization and animation of model output for effective technology transfer.

OVERVIEW:

Hands-on training and telephone assistance are often needed to run the models that are distributed through EPA. In response to this need, EPA conducts six or seven modeling workshops each year through its ORD laboratories and another four to six workshops at Regional sites each year. They are open to anyone who wishes to attend - from the public sector and the private sector, as well - and their popularity grows every year. The Regional workshops are tailored to meet Region-specific needs and are also quite popular among the user community. These workshops could reach even more potential users with videotaped presentations that could be provided to a Region, a State, a local government, a university, or a private consultant to study as needed, rather than waiting for a formally scheduled workshop. Using other modern forms of animation techniques, demonstration diskettes, and computer-based training (CBT) will improve visualization of model output and greatly enhance the speed and effectiveness of technology transfer.

ISSUES:

- Although more and more people request hands-on training and telephone assistance to run the models distributed by EPA, the number of those potential users who actually receive training and assistance is limited to a designated number of slots.
- The TMDL process will require training an increased number of potential users in the use of available models.
- The development of hands-on tutorials and video taped presentations could facilitate the training of potential users.
- Hands-on tutorials, provided on floppy disk, could be used to provide step by step guidance on model use. Tutorials could be provided with or without a formal workshop.
- Video tapes of a classroom style presentation with appropriate audio visual aides could be used to train model users. Tapes could be made available throughout the year supported by the technology assistance personal at EPA (see also Item #35).

COMPLETED:

3-5 years

Item #32: User's Manuals

Develop a user's manual separate from model documentation for each model supported and distributed by EPA.

OVERVIEW:

Currently no simple user's manuals are available for the models that have been developed, supported, and distributed by EPA. Instead, ORD distributes models with a complete documentation manual that is often rather imposing. Knowledge of all of the assumptions that were involved in model development can be helpful for many model applications. Even with such knowledge, however, hands-on training and telephone assistance are often needed to run the model. A simple user's manual with several pertinent examples would greatly facilitate widespread use of EPA-distributed models by States and local governments to develop TMDLs. The user's manuals will include teaching aides such as tutorials which guide the user through a sample application enhanced by graphics and animation.

ISSUES:

- Hands-on training and telephone assistance are often needed to run the models that are distributed by EPA, even when users have a high level of computer literacy.
- User's manuals should be developed that clearly outline the steps required for model implementation.
- User's manuals should include example applications oriented specifically to the use of the model for the TMDL process.

COMPLETED:

5 years

Item #33: Pre- and Post-Processor Development

Develop pre-processors and post-processors to enhance user-friendliness of old and new models.

OVERVIEW:

The development of user-friendly interfaces for computer models can greatly enhance the use of models for TMDL development. Typically the data preparation, data input, and data interpretation phases of a modeling project require a significant effort. Each model requires input in a unique format and presents results in different ways. Therefore, experience with one model is not directly transferable to the next. Pre- and post-processors should be developed for each supported model to facilitate model use using modern PC technology for better graphics and animation. The pre-processor provides a computer interface with the following features: menus for data entry, help screens for assistance in selecting input values, and a uniform format for all models. The post-processor provides assistance in the interpretation of model results and allows for the presentation of output data in tabular or graphical summaries. Options should be included for preparing output in forms that can be read by other programs and models (i.e., interface with spreadsheets such as Lotus 1-2-3 or input for receiving water models). (See Item #19.)

ISSUES:

- Models are currently difficult to use as a result of time-consuming data input preparation and data output interpretation.
- Each model currently has different format requirements for data input and output, making transition from one model to another difficult.
- Pre-processors can facilitate data input by providing consistent formats and user help.
- Post-processors can facilitate data output interpretation and provide interfaces with other programs and computer models.

COMPLETED:

5 years

Item #34: Technical Assistance

Augment the technical assistance program by streamlining our guidance and model clearinghouses, providing expert support services, and expanding site-specific monitoring and model application studies.

OVERVIEW:

Demands on our technical assistance program are increasing, and they will continue to increase as more groups and individuals use models that are distributed by EPA. To ensure that users' queries are answered completely and efficiently, our guidance, model clearinghouses, and expert support services must be expanded. We have already established a number of cooperative agreements with water quality model experts for which in-house expertise is not available. These experts provide a valuable service to the user community, and this service should continue on a larger scale so that more can be served.

ISSUES:

- The reliable use of models is enhanced by access to expert assistance for specific technical queries.
- It is through the technical assistance program that the weaknesses of our tools and technologies are identified. Technical support provides an opportunity to compile and evaluate model weaknesses providing input to future model development and revision.

COMPLETED:

Continuing

Item #35: Joint Federal Interagency Model Clearinghouse

Initiate contacts and exploratory meetings with Federal agencies to establish a joint model distribution and support center.

OVERVIEW:

In the area of watershed modeling, EPA supports complex models such as HSPF for urban and rural mixed land use activities and SWMM for urban land use activities. USDA-SCS has developed six relatively simple models that may be useful for TMDL assessments in rural areas. Agricultural Non-Point Source Pollution Model (AGNPS), Simulator for Water Resources in Rural Basin-Water Quality model (SWRRBWQ), Erosion-Productivity Impact Calculator (EPIC), Groundwater Loading Effects of Agricultural Management Systems (GLEAMS), Chemicals, Runoff, Erosion from Agricultural Management Systems (CREAMS), and Nitrate Leaching and Economic Analysis Package (NLEAP) are some that may be useful to EPA's TMDL program. USGS has developed the DR3M-QUAL model and COE supports the STORM model.

To be consistent in our approach to watershed modeling and interpretation of modeling results, it would be most helpful to coordinate our modeling activities with those of other Federal agencies. This would also eliminate duplication of effort and facilitate technology transfer between the agencies as well as with the public.

The ORD labs will be responsible for (1) initiating contacts and exploratory meetings with the appropriate Federal agency personnel to prepare a Memorandum of Agreement to establish a joint model distribution and support center, preferably at CEAM and (2) implementing the Memorandum of Agreement. Agencies which could potentially participate in the Model Clearinghouse include: Army Corps of Engineers, US Department of Agriculture, USDA/Forest Service, US Geological Survey, Bureau of Land Management, and the Bureau of Reclamation.

ISSUES:

- The reliable use of models is enhanced by access to expert assistance for specific technical queries.
- Numerous Federal agencies support the development, distribution, and use of various watershed models (i.e., EPA, USDA, COE, USGS). Our efforts need to be coordinated to ensure that the public receives consistent technical advice with respect to watershed modeling, duplication of effort is minimized, and technology transfer between agencies will occur.

COMPLETED:

Continuing