OVERVIEW OF TOTAL MAXIMUM DAILY LOAD (TMDL) PROBLEMS AND SUPPORTING MODEL DEVELOPMENT

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Approximately 18,900 impaired water bodies are on the 303(b) state lists required by the Clean Water Act. Of the 300 types of impairments on the 1996 and 1998 lists, 24% involve sediments, suspended solids, or turbidity. Nutrient problems account for 15% of the listings, and pathogens, 14%. The EPA Office of Research and Development (ORD) and the Office of Water are working closely together to develop protocols and models to address TMDL problems in order of frequency of occurrence. The ORD is developing TMDL models under its Ecological Research and Restoration Strategy, and the Office of Water under its pioneering watershed approach. The National Exposure Research Laboratory is developing methods for simpler sediment budgets and more complex sediment routing from watersheds through stratified lakes and estuaries. The EPA Office of Water is working with David Rosgen and interagency partners to develop and test the components method of sediment routing based on extensive experience in stream geomorphology. The range of simple sediment balances, the geomorphical components analysis, and the more complex multidimensional routing techniques should provide adequate science-based tools to address most sediment TMDLs. Data are being collected for the South Fork of the Broad River in Georgia and with data available from U.S. Agricultural Research Service, the Forest Service, and the U.S. Geological Survey, sufficient testing of new methods and protocols should be possible. By 2004 a case study for nutrient TMDLs is expected that will probably focus on the Neuse River in North Carolina. The ORD expects to focus on pathogens and toxic chemicals during 2005 until 2008. Each component model is being developed using a multimedia modeling context by ORD. In the short-term, the Office of Water has developed the BASINS system to manage data bases and existing water quality models in a manner that can be adapted for each state unless other methods are available.

Acknowledgments **B** The provision of overheads on the ORD Ecological Research and Restoration Strategy by Rick Linthurst and the other ORD eco associate lab directors is appreciated.

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Overview

- TMDL Definitions
- Impaired Waters in the U.S.
- Litigation
- FACA Report
- Model and Protocol Development
- Longer Range Plans of ORD

What is a TMDL?

- TMDL -- Total Maximum Daily Load
- A calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards
- The sum of the allowable loads from all point and non-point sources, plus a margin of safety and considering seasonality

TMDL Definition

$$TMDL = \Sigma WLA_i + \Sigma LA_i + MOS$$

ΣWLA_i: Sum of waste loads (point sources)

ΣLA_i: Sum of loads (nonpoint sources)

MOS: Margin of Safety

Terms must also consider seasonal variation.

Clean Water Act requires. . .

- States to identify waters not meeting water quality standards and set priorities
- States to develop a TMDL for each pollutant for each listed water
- EPA to approve or disapprove State submissions, and if disapproved, to act in lieu of State

CWA §303(d)(1)(C)

1998 State Lists of Impaired Waters

- For the 56 States and Territories:
  - EPA approved 42 lists
  - EPA partially approved 7
  - EPA still reviewing 7 lists
- Expect 21,000 waters (18,900 to date)
  - 2% with no identified impairment
  - 43% with single impairment identified
  - 55% with multiple impairments

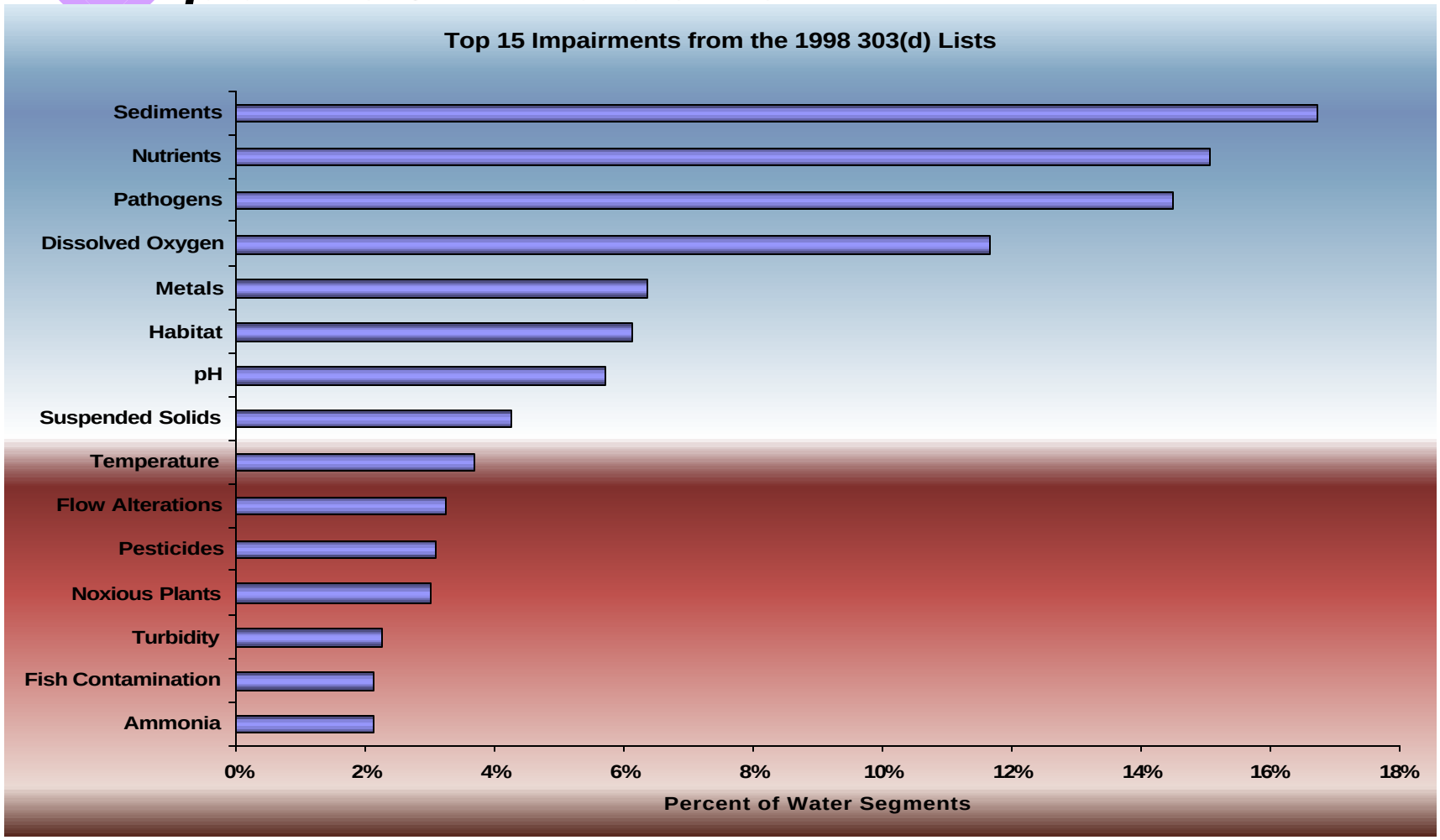
*Information as of 7/16/1999

1998 State Lists of Causes of Impaired Waters

- More than 300 types of impairments identified on the 1996 and 1998 lists
- 15 types comprise 76% of total
- Top three impairments are:
  - sediments 17% (24% including susp. solids & turbidity)
  - nutrients 15%
  - pathogens 14%

*Information as of 6/23/1999

1998 State Lists of Causes of Impaired Waters



*Information current as of 6/23/99

1998 State Lists of Sources of Impaired Waters

- Source of Impairments
  - Both point and nonpoint sources 46%
  - nonpoint sources alone 39%
  - point sources alone 3%
- 25% of point sources are on impaired waters
- 23% to 34% of silvicultural and agricultural sources are on impaired waters

*not all states provide this information

TMDL Litigation

- About 45 legal actions in more than 34 States (one action involving four States is very old)
- EPA under court order/consent decree to ensure TMDLS established in 13 States
- 3 cases dismissed since 1993

See website: http://www.epa.gov/OWOW/tmdl for litigation summary

Major Litigation Issues

- Lists -- adequacy, basis, underlying data
- Pace of TMDL development -- when will they all be done?
- Plaintiffs typically want--
  - Schedules for completing all TMDLs
  - EPA guarantee to do TMDLs when State does not
  - Settlement agreements/consent decrees to ensure continued court oversight

TMDL FACA Report

- Consensus on many issues
  - Restoring impaired waters must be high priority
  - Implementing TMDLs is key to success
  - Communication with public is critical
  - Stakeholder involvement key to successful implementation
  - Strengthen governments capacity to do TMDLs
  - Iterative approach best way to make progress in uncertain situations

For more information:

http://www.epa.gov//OWOW/tmdl

Proposed Changes to Regulations and Guidance

- FACA Committee Report sent to Administrator July 1998
- Recommendations guide proposed changes to TMDL regulations and guidance
- Proposed changes scheduled for Summer 1999 publication in *Federal Register*
- Final regulations in 2000

TMDL Information Sources

- Statute
  - Clean Water Act Sections 301-308
- Regulations
  - 40 CFR Parts 130-131
- Guidance documents
  - 1991 TMDL Guidance
  - Supplemental memoranda
  - Perciasepe memorandum “New Policies for Establishing and Implementing TMDLs.” August 8, 1997.
- See web site: www.epa.gov/OWOW/tmdl/

Model and Protocol Development

- BASINS by Office of Water
- Sediment Work by Office of Water
- Ecological Research Strategy, ORD
- Sediment, Nutrient, and Pathogen Protocol Development

Ecological Research and Restoration Strategy: An Overview

Office of Research and Development

http://www.epa.gov/ORD/WebPubs/final/....


Ecological Research Program
Core Research Capabilities
Monitoring
Modeling and Process Res.
Assessment
Risk Mgmt. & Restoration
Environmental Hazards
Acid Deposition
Ozone
Mercury
UVB
Nitrogen
Global Change
Contaminated Sediments
Wet Weather Flows
Toxic Algal Blooms
Eco-Criteria
TMDL
Endocrine Disruptors
Pesticides
Landcover Change
Geographic Research
Mid-Atlantic
Pacific Northwest
South Florida
Great Lakes
NLERAs
National Scale Studies

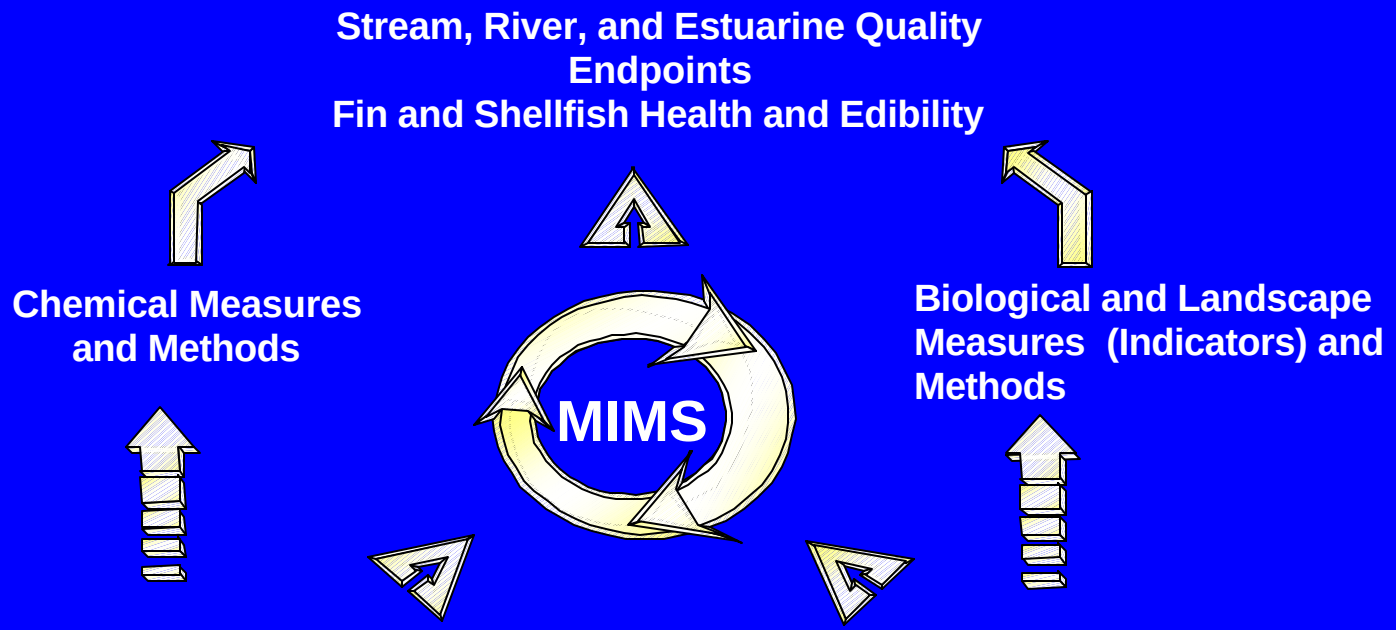
Primary Emphasis

- Chemical and Microbiological Stressors
  - Eutrophication/Acidification/Nitrogen/P
  - Mercury and other PBTs
  - Pathogens
- Habitat Stressors
  - Wet Weather Flows
  - Sedimentation
- Habitat
  - Riparian
  - Wetlands

Laboratory/Center Roles

Core Research Areas	Natl Health & Environmental Effects Research	Natl Exposure Research Laboratory	Natl Center for Environmental Assessment	Natl Risk Management Research Laboratory	Natl Center for Environmental Research & Quality Assurance
Monitoring and Monitoring Research	Primary	Primary	Supporting	Supporting	Supporting
Processes and Modeling Research	Primary	Primary	Supporting	Supporting	Supporting
Assessment Research	Secondary	Secondary	Primary	Secondary	Supporting
Risk Management & Restoration Research	Supporting	Supporting	Supporting	Primary	Supporting

Program Focus: Watershed Exposure Modeling & Exposure Assessment

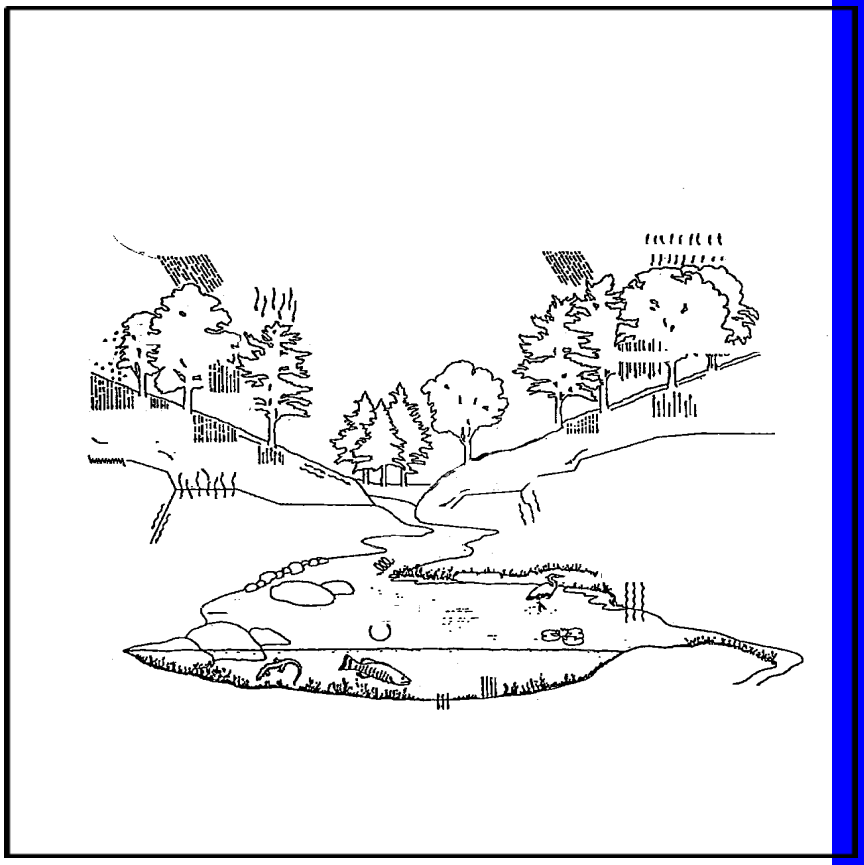


Rationale For Multimedia, Multipathway, Multiscale Modeling Approach

- Increased awareness of multiple stressor effects and a more holistic regulatory view
- Need for alternative, flexible, cost effective and certain management options
- Encouragement and need to use relative risk to assist in judging resource allocations
- Increasing recognition that spatial scale is critical in evaluating the success of management actions and the desirability of a different strategy for surface water protection is not far behind

Long-term Model Development Goal

- By 2008; Publicly release models, and the common software framework (MIMS), for computation of nutrient, toxics, sediments, and pathogen loadings into surface waters for determination of total maximum daily loadings including alternative management solutions.



Objectives

Methods to Manage Sediment Loads in Different Segments of Southeastern Piedmont Streams

Evaluate Draft TMDL Protocols for Sediment, Coliform Bacteria, and Nutrients

Intensive, High-Quality Data To Validate Methods (models and other techniques)

Information for Georgia and EPA Reg. 4 to set Total Maximum Daily Loads for Sediment

Extrapolation to Other Geomorphologic Provinces

Measurements

78 Stream Cross Sections Every 1/2 Mile (Bed Forms, Bars, & Other Features)
Bank Pins, Surveys, Trenching, and Other Methods to Measure Bank Erosion
Measure Weather Conditions (i.e., Rainfall, Temperature, Solar Radiation) at 4 to 5 Sites to Simulate Runoff, Sediment Yield, and Stream Flow

- Water Surface Elevations, Flow, Suspended Sediment, & Bed Load
  - Hourly
  - Three Stations in the Cross Section
  - Eleven Bridges, Cabled Sites, or Sites that can be Waded
    During Every Rainstorm Projected >2 cm (Spring/Fall Frontal Movement)

Measure Dissolved Oxygen, pH, Temperature, Specific Conductance, and Turbidity (Later Fecal Coliform, and Nutrients) and ISCO Grab Samples at a Point in the Cross Section
Vertically Averaged Sediment Concentration (Pressure Transducers, UGA)

- Collect Data 2-5 Years Depending on the Results, Starting Fall 1999

Model Documentation, Support, and Development for Sedimentation

- Hydrodynamic, Sediment, and Contaminant Transport Model (SED2D) Finite Difference Model on Center for Exposure Assessment Modeling Web Page (www.epa.gov/CEAM)
- SED3D Documentation Expected in Fall 1999
- Course Training Notes for HSPF on CEAM Web Page in Spring 1999
- Hotline Support for HSPF & Other Models (Waterways Experiment Station)
- Comprehensive Review of Water Quality and Sediment Transport Models to Document State of the Art (Aqua Terra using OW Report on Sediment Transport Models)
- Testing Sediment Mass Balance Simulations of Lumped Parameter (HSPF) and Distributed Watershed Models (CASC2D and MODELX) in the South Fork of the Broad River (Waterways Experiment Station)
- Develop New Generation of In-Channel Sediment Transport Algorithms -- First Step to Channel Geomorphology Model (Tetra Tech, Aqua Terra, Earl Hayter, NERL-Athens)
- Riparian Zone Model to Guide Evaluation of Best Management Practices

Next Generation In-Channel Fate and Transport Models for Sedimentation

- Phase I (Tetra Tech and Aqua Terra, Expected 2000)
  - 1D Box Model for Simplified TMDL In-Stream Sediment Balance Spread Sheet Model, and HSPF, WASP, and EXAMS
  - Advanced Cohesive and Noncohesive Erosion and Deposition, Bed Consolidation and Mobilization
  - Shear Stress for Bioengineering
  - Multiple Particle Sizes
  - Distributed Sources
  - Model Testing with Existing Data Sets
  - Documentation and Support
- Phase II (Hayter, Tetra Tech, Aqua Terra: Prelim. Version 1999)
  - 1D Model for In-Stream Processes to Upgrade HSPF and Distributed Watershed Models
  - Same Processes as Above but With Armoring and Finite Strain Consolidation of Bed

Next Generation In-Channel Fate and Transport Models -- Continued

- Phase III (Expected in 2000)
  - Model Selection Hinges on Model Evaluation by Aqua Terra in 1999
  - 3D Sediment Fate and Transport Model for Difficult TMDLs in Lakes and Estuaries
  - Expect to Build on Models Being Developed by the EPA Office of Water (EFDM by Hamrick), NERL-Athens (SED3D), WES (CH3D-SED3D), NOAA (Blumberg-Mellor), and USGS (Woods-Hole and WRD, TRIM)
- Ultimate Goals
  - Stream Geomorphology and Riparian Zone Models Nested in Distributed Watershed Models for TMDL Analysis, Stream Bioengineering, and Stream Ecosystem Restoration
  - 3D Hydrodynamics and Multi particle Size Sediment Models Combined With Distributed Watershed Models to Link Ecological and Specific Biological Effects in Stratified Lakes and Estuaries to Land Use
  - Nested in Next Generation Multimedia Risk Assessment Systems (2008)

Nutrient and Pathogen Modeling

- Look at molecular characteristics to simulate fate and transport parameters
- Carbon cycling
- Biological endpoints or links with ecosystem models
- Case study: Neuse River, NC 2004
- Next generation of pathogen and toxic chemical models for 2005-2008

Summary

- TMDL issues to the forefront due to litigation
- Extensive impairment of surface waters
- Ecosystems and multimedia modeling for long-term development
- Sediment models in the next two years
- Nutrient modeling by 2004
- Pathogen and toxics models after 2005