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Guidelines for Preparation of the Comprehensive State Water Quality Assessments (305(b) Reports) and Electronic Updates:

Supplement

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ACRONYM LIST

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
ALUS	Aquatic life use support
ASTM	American Society for Testing Materials
AWQMN	Ambient Water Quality Monitoring Network
BMP	Best management practice
BPJ	Best professional judgement
CAFO	Concentrated animal feeding operation
CCC	Criteria continuous concentration
CLPMS	Clean Lakes Program Management System
CMC	Criteria maximum concentration
CSO	Combined sewer overflows
CU	USGS watershed cataloging unit
CWA	Clean Water Act
CZARA	Coastal Zone Act Reauthorization Amendments
DNREC	Delaware Department of Natural Resources and Environmental Conservation
DLG	Digital line graph (database)
DO	Dissolved oxygen
DOE	Washington State Department of Ecology
DQO	Data quality objective
DWFG	305(b) Drinking Water Focus Group
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
FDA	U.S. Food and Drug Administration
FIPS	Federal Information Processing Standard
FWS	U.S. Fish and Wildlife Service
GIS	Geographic information system
GPS	Global positioning satellite system
GRIS	Grants Reporting and Tracking System
HUC	Hydrologic Unit Code

ACRONYM LIST (continued)

ITFM	Intergovernmental Task Force on Monitoring Water Quality
IWI	Index of Watershed Indicators
LAN	Local Area Network
LWQA	Lake Water Quality Assessment
MCL	Maximum contaminant level
MDL	Method detection limit
NAS	National Academy of Science
NAWQA	National Ambient Water Quality Assessment Program
NBS	National Biological Service
NHD	National Hydrographic Dataset
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
NRCS	Natural Resources Conservation Service
NSTP	NOAA's National Status and Trends Program
NWQMC	National Water Quality Monitoring Council (formerly ITFM)
OGWDW	Office of Ground Water and Drinking Water
OPPE	EPA Office of Policy, Planning, and Evaluation
ORD	EPA Office of Research and Development
OST	Office of Science and Technology
OW	EPA Office of Water
OWM	EPA Office of Wastewater Management
OWOW	EPA Office of Wetlands, Oceans, and Watersheds
PACE	Annual Census Bureau Survey of Pollution Abatement Costs and Expenditures
PCB	Polychlorinated biphenyl
PCS	EPA Permit Compliance System
POTW	Publicly owned treatment works
PPA	Performance Partnership Agreements
PS	Point source
PSP	Paralytic shellfish poisoning
PWS	Public water supply

ACRONYM LIST (continued)

QA	Quality assurance
QC	Quality control
RBP	Rapid bioassessment protocol
REMAP	Regional Environmental Monitoring and Assessment Program
RF3	EPA Reach File Version 3
RTI	Research Triangle Institute
SCRF1	Waterbody System Screenfile 1
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
SOC	Semi-volatile organic compound
SOP	Standard operating procedure
STORET	EPA STOrage and RETrieval system
TDS	Total dissolved solids
TMDL	Total maximum daily load
TVA	Tennessee Valley Authority
UAA	Use attainability analysis
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile organic compound
WBS	EPA Waterbody System
WQC	Water quality criteria
WET	Whole effluent toxicity
WLA	Waste load allocation
WQL	Water quality limited
WQS	Water quality standard
WRC	Water Resource Council

SECTION 1

WATER QUALITY ASSESSMENTS UNDER SECTION 305(b)

This section describes the basic components of a water quality assessment including degree of use support, causes (pollutants and other stressors), and sources of impairment. It also explains several concepts that may have resulted in inconsistencies in the past, such as the fully supporting but threatened category, presumed assessments, and natural sources.

1.1 What is an Assessment?

In setting their water quality standards, States assign one or more designated uses to each individual waterbody. Designated uses are beneficial uses that States want their waters to support. Examples are aquatic life support, fish consumption, swimming, and drinking water supply. Under Section 305(b), assessment of an individual waterbody (e.g., a stream segment or lake) means analyzing biological, habitat, physical/chemical, and/or toxicity data and other information to determine

- The degree of designated use support of the waterbody (fully supporting, fully supporting but threatened, partially supporting, or not supporting)
- If designated uses are impaired, the causes (pollutants or other stressors) and sources of the problem
- Degree of achievement of biological integrity using State biological criteria or other measures.
- Descriptive information such as the type and quality of data used in the assessment.

Figure 1-1 illustrates how monitoring, assessment, and reporting are related for an individual waterbody. Figure 1-2 shows actual assessment results for a waterbody.

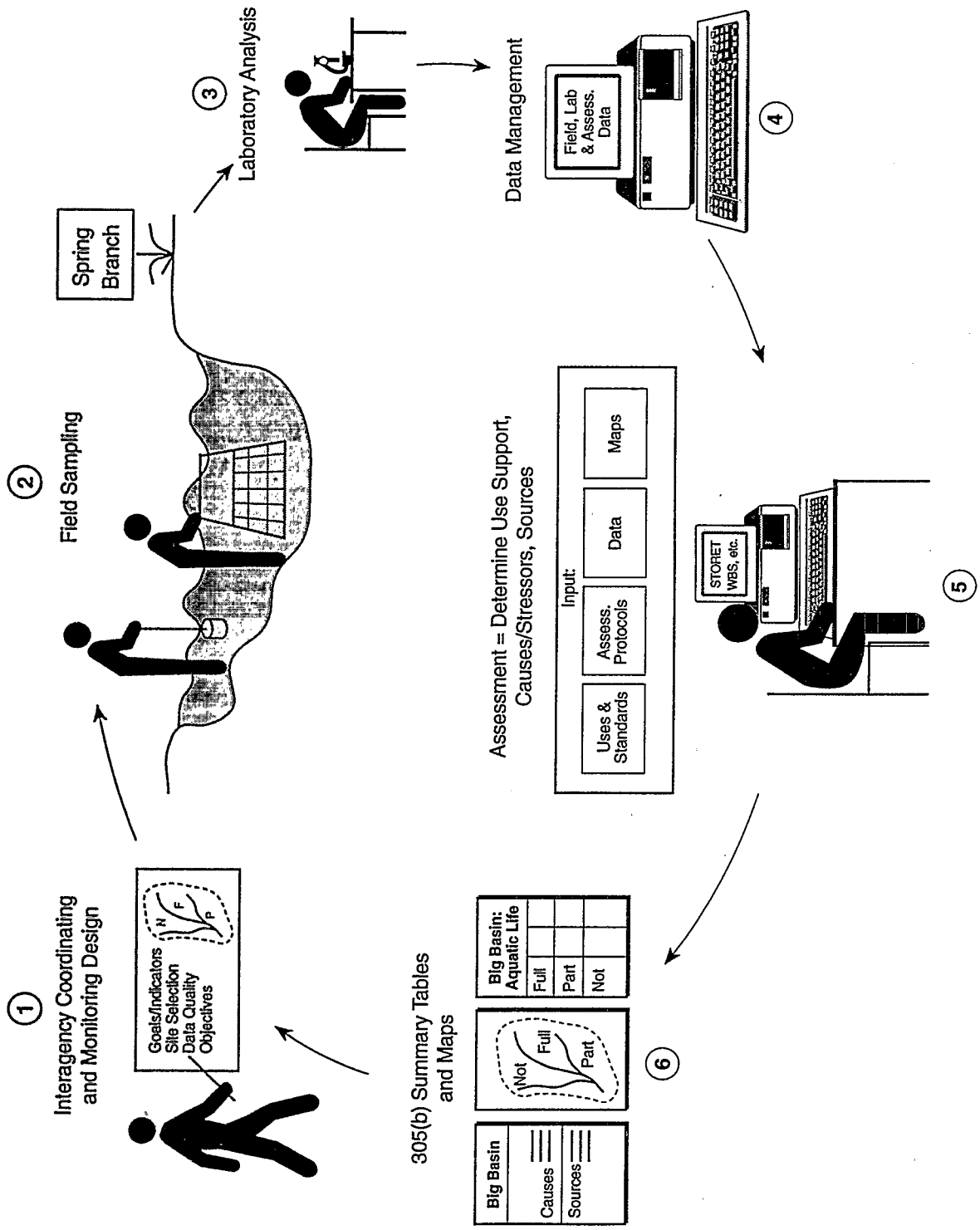


Figure 1-1. Monitoring, assessment and 305(b) reporting as an interrelated process

General Report of All Waterbody Data
(Partial Listing for a Single Waterbody)

08-11-95

Waterbody ID : VT08-01 Segment Number: 00
Waterbody Name: Lower Winooski River

Waterbody Type: River Size: 20.00 Miles
---------- Waterbody Location ----------
Basin: 08-Winooski
CU: Not Available
Stream Order: Not Available
Monitoring Stations: Not Available
Boundary States: Not Available

Counties: FIPS Number County Name

Ecoregion number: Not entered
Ecoregion name : Not entered

Description of the Waterbody:
Main Stem - Mouth to Confluence of Alder Brook
---------- Reach Indexing ----------
Next Assessment: Not Available
========== Waterbody Assessment - Date: 9401 ==========

Begin Sampling: Not Available End Sampling: Not Available

----------AQUATIC LIFE SUPPORT----------

Fully Supported	=>	0.00	Threatened	=>	2.50
Partially Supported	=>	17.50	Not Supported	=>	0.00
Not Attainable	=>	0.00	Not Assessed	=>	0.00

---------- SWIMMABLE ----------

Fully Supported	=>	2.50	Threatened	=>	0.00
Partially Supported	=>	17.50	Not Supported	=>	0.00
Not Attainable	=>	0.00	Not Assessed	=>	0.00

---------- Media/Pollutants Assessed ----------

Toxics Monitoring => Y

10-Metals in sediments

---------- Nonattainment Causes ----------

Cause	Size	Mag
0300-Priority organics	17.50	S
0400-Nonpriority organics	2.50	T
0500-Metals	17.50	S
0900-Nutrients	17.50	M
1100-Siltation	17.50	M
1200-Organic enrichment/Low DO	17.50	S
1500-Flow alteration	17.50	M
1700-Pathogens	17.50	M
1900-Oil and grease	17.50	M
2000-Taste and odor	17.50	M

---------- Nonattainment Sources ----------

Source	Size	Mag
0100-INDUSTRIAL POINT SOURCES	17.50	M
0200-MUNICIPAL POINT SOURCES	17.50	M
1000-AGRICULTURE	17.50	S
3200-Land Development	17.50	H
4000-URBAN RUNOFF/STORM SEWERS	17.50	H
6300-Landfills	17.50	S
6600-Hazardous Waste	2.50	T
7400-Flow Regulation/Modification	17.50	M
8300-Highway Maintenance And Runoff	17.50	M
8400-Spills	17.50	S
8800-Upstream Impoundment	17.50	M

Figure 1-2. Waterbody System printout summarizing assessment results for a waterbody

1.2 Degree of Use Support

Each designated use has its own requirements for a finding of fully supporting, fully supporting but threatened, partially supporting, or not supporting. **Section 3 of this *Guidelines Supplement* gives EPA's detailed recommendations for determining the degree of use support for various designated uses.**

Throughout these *Guidelines*, the term "impairment" means either partially supporting or not supporting a designated use.

The category "fully supporting but threatened" requires further explanation. A waterbody is fully supporting but threatened for a particular designated use when it fully supports that use now but may not in the future unless pollution prevention or control action is taken because of anticipated sources or adverse pollution trends. Such waters are treated as a separate category from waters fully supporting uses. States should use this category to describe waters for which actual monitoring or evaluative data indicate an apparent declining water quality trend (i.e., water quality conditions have deteriorated, compared to earlier assessments, but the waters still support uses). States may also choose to include waters for which monitoring or evaluative data indicate potential water quality problems requiring additional data or verification.

Fully supporting but threatened is not appropriate during temporary impairment of designated uses (e.g., due to a construction project in a watershed). The threatened category may be appropriate prior to anticipated impairment, but while actual impairment is occurring, partial support or nonsupport should be reported.

Summarizing Assessment Results in the Report to Congress

EPA uses the following descriptive terms in graphical presentations of degree of designated use support:

Good Water Quality	=	Fully Supporting or Fully Supporting but Threatened
Fair Water Quality	=	Partially Supporting
Poor Water Quality	=	Not Supporting

Note: Impaired means Partially Supporting or Not Supporting (Fair or Poor)

1.3 Types of Assessment Information

Each State reports assessments of those waterbodies for which use support decisions can be based on reliable water quality information. Such assessments are not limited to waters that have been directly monitored -- it is appropriate in many cases to make judgments based on other information (see Section 1.4). Waterbodies assessed prior to the current reporting period can be included in 305(b) reports if the State has the technical basis to conclude that the assessment results are still valid. **It is not appropriate, however, to claim that waterbodies are fully supporting uses by default in the absence of sufficient information to make an assessment (see also Section 1.5).**

If statistical survey (probability) designs are used, the results can be reported relative to the entire resource (e.g., headwater streams in an ecoregion), not just those waterbodies actually monitored.

Table 1-1 lists categories of information for assessments. These Assessment Type Codes are from the EPA Waterbody System (WBS). They provide a wealth of information about the basis for individual assessments.

Assessment Database Managers—For 1997 and beyond, EPA is strongly encouraging the use of Assessment Type Codes in WBS and other State assessment data systems. They are important data elements for annual electronic updates (see Section 6 of the main *Guidelines* volume).

1.4 Monitored and Evaluated Waters

EPA asks the States to distinguish between assessments based on monitoring and assessments based on other information.

- "Evaluated waters" are those waterbodies for which the use support decision is based on information other than current site-specific ambient data, such as data on land use, location of sources, predictive modeling using estimated input variables, and some questionnaire surveys of fish and game biologists. *As a general guide*, if an assessment is based on older ambient data (e.g., older than five years), the State should also consider it "evaluated."

Table 1-1. Assessment Type Codes from the Waterbody System

100	**Qualitative (evaluated) assessment--unspecified**[a]
110	Information from local residents
120	Surveys of fish and game biologists/other professionals
130	Land use information and location of sources
140	Incidence of spills, fish kills, or abnormalities
150	Monitoring data that are more than 5 years old
175	Occurrence of conditions judged to cause impairment (e.g., channelization, dredging, severe bank erosion)
180	Screening models (desktop models; models are not calibrated or verified)
190	Biological/habitat data extrapolated from upstream or downstream waterbody
191	Physical/chemical data extrapolated from upstream or downstream waterbody
200	**Physical/chemical monitoring**[b]
210	Fixed-station physical/chemical monitoring, conventional pollutants only
211	Highest quality fixed-station physical/chemical monitoring, conventional pollutants; frequency and coverage sufficient to capture acute and chronic events, key periods, high and low flows
220	Non-fixed-station physical/chemical monitoring, conventional pollutants only
222	Non-fixed-station monitoring, conventional, during key seasons and flows
230	Fixed-station physical/chemical monitoring, conventional plus toxic pollutants
231	Highest quality fixed-station physical/chemical monitoring, conventional plus toxicants; frequency and coverage sufficient to capture acute and chronic events, key periods, high and low flows
240	Non-fixed-station physical/chemical monitoring, conventional plus toxic pollutants
242	Non-fixed-station physical/chemical monitoring, conventional plus toxicants, during key seasons and flows
250	Chemical monitoring of sediments
260	Fish tissue analysis
270	Community water supply chemical monitoring (ambient water)
275	Community water supply chemical monitoring (finished water)
300	**Biological monitoring**[b]
310	Ecological/habitat surveys
315	Regional reference site approach
320	Benthic macroinvertebrate surveys
321	RBP III or equivalent benthos surveys
322	RBP I or II or equivalent benthos surveys
330	Fish surveys
331	RBP V or equivalent fish surveys
340	Primary producer surveys (phytoplankton, periphyton, and/or macrophyton)
350	Fixed-station biological monitoring

Table 1-1 (continued)

360	**Habitat assessment**
365	Visual observation, usually at road crossings; professional not required
370	Visual observation, use of land use maps, reference conditions, professional not required
375	Visual observation, may quantify some parameters; single season typically; by professional
380	Quantitative measurements of instream parameters, channel morphology, floodplain; one or two seasons; by professional
400	**Pathogen monitoring**[b]
410	Shellfish surveys
420	Water column surveys (e.g., fecal coliform)
430	Sediment analysis
440	Community water supply pathogen monitoring (ambient water)
450	Community water supply pathogen monitoring (finished water)
500	**Toxicity testing**[b]
510	Effluent toxicity testing, acute
520	Effluent toxicity testing, chronic
530	Ambient toxicity testing, acute
540	Ambient toxicity testing, chronic
550	Toxicity testing of sediments
600	**Modeling**[c]
610	Calibrated models (calibration data are less than five years old)
700	**Integrated intensive survey**[b] (field work exceeds one 24-hour period and multiple media are sampled)
710	Combined sampling of water column, sediment, and biota for chemical analysis
720	Biosurveys of multiple taxonomic groups (e.g., fish, invertebrates, algae)
Assessments Based on Data from Other Sources	
800	**Assessments based on data from other sources**[c]
810	Chemical/physical monitoring data by quality-assured volunteer program
820	Benthic macroinvertebrate surveys by quality-assured volunteer program
830	Bacteriological water column sampling by quality-assured volunteer program
840	Discharger self-monitoring data (effluent)
850	Discharger self-monitoring data (ambient)
860	Monitoring data collected by other agencies or organizations (use the assessment comment field to list other agencies)
870	Drinking water supply closures or advisories (source-water quality based)

Table 1-1 (continued)

Discrepancy in Aquatic Life Assessment Results[d]	
900	**Discrepancy in Aquatic Life Assessment Results**
910	Discrepancy among different data types; aquatic life assessment is based on physical/chemical data
920	Discrepancy among different data types; aquatic life assessment is based on biological data
925	Discrepancy among different data types; aquatic life assessment is based on habitat data
930	Discrepancy among different data types; aquatic life assessment is based on toxicity testing data
940	Discrepancy among different data types; aquatic life assessment is based on qualitative (evaluated) assessment data

[Note: New codes have been added to include information types in Tables 3-2 and 3-3.]

[a] Generally considered to be evaluated assessment types.

[b] Generally considered to be monitored assessment types.

[c] Considered to be monitored or evaluated assessment types depending on data quality and State assessment protocols.

[d] States are requested to use these codes to identify cases when biological, habitat, toxicity, and/or physical/chemical data show different assessment results.

- "Monitored waters" are those waterbodies for which the use support decision is principally based on current, site-specific, ambient monitoring data believed to accurately portray water quality conditions. Waters with data from biosurveys should be included in this category along with waters monitored by fixed-station chemical/physical monitoring or toxicity testing. To be considered "monitored" based on fixed-station chemical/physical monitoring, waters generally should be sampled quarterly or more frequently. For specifics on biological monitoring, see Section 3.

States may use some flexibility in applying these guidelines. For example:

- For the 800 series of codes in Table 1-1, if State-approved quality assurance/quality control procedures have been applied to volunteer monitoring programs, waters sampled under these programs could be considered monitored. However, a State may use its discretion in making an Assessment Category determination of evaluated vs. monitored. The State may wish to conduct a comparison to determine the sensitivity or power of the volunteer method compared to the State's methods (e.g., volunteer data may prove more useful for identifying severe impacts than for determining full support). Note: EPA has developed *The Volunteer Monitor's Guide to Quality Assurance Project Plans*. To obtain a copy, contact the Monitoring Branch at (202) 260-7018.

- If older ambient data exist for high-quality waters located in remote areas with no known pollutant sources, and if those data are believed to accurately portray water quality conditions, those waters could be considered monitored.

EPA and States have been working together to better define the kinds of data upon which assessment decisions are made. See Tables 3-1 through 3-4.

1.5 Presumed Assessments

The 305(b) Consistency Workgroup determined that presumed assessments are unacceptable. Examples of presumed assessments are

- Assuming that waterbodies are fully supporting by default unless there is information to the contrary

- Extrapolating assessments from one waterbody or watershed to others unless they have very similar characteristics

- Extrapolating the "percentage of assessed stream miles that are fully supporting" to all streams in the State without adequate scientific basis such as probability-based monitoring design.

Note: If waterbodies are monitored using survey designs, results can be extrapolated.

EPA encourages States to report on all waters for which there is a reasonable technical basis for evaluation. A reasonable basis could include a judgment that a stream is not supporting uses based on channelization, a highly disturbed watershed, or data from nearby streams with similar characteristics.

In addition, EPA recommends that data from a single monitoring station not be used to generate a monitored assessment of an entire watershed. Rather, a monitoring station can be considered representative of a waterbody for that distance upstream and/or downstream in which there are no significant influences to the waterbody that might tend to change water quality within the zone represented by the monitoring station. See Section 2.1.

1.6 Causes of Impairment (Pollutants and Other Stressors)

Causes of impairment are those pollutants and other stressors that contribute to the impairment of designated uses in a waterbody. In the remainder of these *Guidelines* the term "cause/stressor" is used. Table 1-2 lists cause/stressor codes from the WBS. States can also add their own codes to WBS to track additional causes. At the States' request, EPA has added new subcategories under Code 0500 and Code 0900 to track specific metals and nutrients.

How to Avoid Double-counting of Causes/Stressors

WBS Users—If you use the new subcategories for metals/nutrients or add cause/stressor codes to WBS, *you must enter a total size for each major category of causes/stressors (the **bold categories** in Table 1-2; e.g., **0500--Metals or 0200--Pesticides**) for each waterbody.* This is necessary because there may be overlap among the subcategories of causes/stressors.

Non-WBS Users—Like WBS, most customized waterbody-level databases must also track a total size for each major category of causes/stressors (the **bold categories** in Table 1-2) in order to avoid overlap among subcategories.

Table 1-2. Cause/Stressor Codes from the Waterbody System

0000	**Cause Unknown**	**1000**	**pH**
0100	**Unknown Toxicity**	**1100**	**Siltation**
0200	**Pesticides**	**1200**	**Organic Enrichment\Low Dissolved Oxygen**
0300	**Priority Organics**		
0400	**Nonpriority Organics**		
0410	**PCBs**	**1300**	**Salinity/Total Dissolved Solids/Chlorides/Sulfates**
0420	**Dioxins**		
0500	**Metals**	**1400**	**Thermal Modifications**
	0510 Arsenic	**1500**	**Flow Alterations**
	0520 Cadmium	**1600**	**Habitat Alterations (other than flow)**
	0530 Copper		
	0540 Chromium	**1700**	**Pathogens**
	0550 Lead	**1800**	**Radiation**
	0560 Mercury	**1900**	**Oil and Grease**
	0570 Selenium	**2000**	**Taste and Odor**
	0580 Zinc	**2100**	**Suspended Solids**
0600	**Ammonia (un-ionized)**	**2200**	**Noxious Aquatic Plants (native macrophytes)[a]**
0700	**Chlorine**		
0720	**Cyanide**	**2210**	**Excessive Algal Growth/ Chlorophyll a**
0750	**Sulfates**		
0800	**Other Inorganics**	**2400**	**Total Toxics**
0900	**Nutrients**	**2500**	**Turbidity**
	0910 Phosphorus	**2600**	**Exotic Species**
	0920 Nitrogen		
	0990 Other		

NOTES: In addition to the above, WBS users can enter their own customized cause codes. See WBS Users Guide.

Codes 0200 through 0800 are toxicants for purposes of WBS reports.

Filling and draining is considered a source (Source Code 7800) and no longer appears in the above table.

Bold type indicates a major cause category; regular type indicates a subcategory.

[a]Non-native plants should be handled under Category 2600.

In Table 1-2, bold type indicates a major cause/stressor category and regular type indicates a subcategory. **See the highlight box entitled "How to Avoid Double-counting of Causes/Stressors" regarding the importance of storing size data for major cause/stressor categories, not just subcategories.**

1.7 Sources of Impairment

Sources are the activities, facilities, or conditions that contribute pollutants or stressors resulting in impairment of designated uses in a waterbody. Table 1-3 lists source codes from the WBS. States can also add their own source codes to the WBS. Appendix G provides definitions of selected source categories.

In Table 1-3, bold type indicates a major source category and regular type indicates a subcategory of that major category. **See the highlight box entitled "How to Avoid Double-counting of Sources" regarding the importance of storing size data for all applicable major source categories, not just subcategories.**

Determining the sources of designated use impairment can be a difficult process. Ambient monitoring data can give good evidence of the causes of impairment. In some cases, field observations can provide information on obvious, nearby problems; e.g., land use, substrate, and habitat may provide a basis for identifying sources. This is especially the case for "hydromodification" sources.

In most cases, additional information is needed--watershed land use inventories, records of permit compliance, locations of areas with highly erodible soils, areas with poor best management practice (BMP) implementation, measurements of in-place contaminants, or loadings from atmospheric transport or ground water.

Assessment Database Managers—Agriculture is the only source category with three tiers of codes (see Table 1-3). EPA asks States to track size data for the "1000—Agriculture" code and at least the next tier ("1050—Crop-related Sources", etc.)

Table 1-3. Source Categories (with National Codes from the Waterbody System)

0100 Industrial Point Sources
- 0110 Major Industrial Point Sources
- 0120 Minor Industrial Point Sources

0200 Municipal Point Sources
- 0210 Major Municipal Point Sources—dry and/or wet weather discharges
- 0212 Major Municipal Point Sources—dry weather discharges*
- 0214 Major Municipal Point Sources—wet weather discharges*
- 0220 Minor Municipal Point Sources—dry and/or wet weather discharges
- 0222 Minor Municipal Point Sources—dry weather discharges*
- 0224 Minor Municipal Point Sources—wet weather discharges*
- 0230 Package Plants (Small Flows)

0400 Combined Sewer Overflow

0500 Collection System Failure*

0900 Domestic Wastewater Lagoon

1000 Agriculture**
- **1050 Crop-related Sources***
  - 1100 Nonirrigated Crop Production
  - 1200 Irrigated Crop Production
  - 1300 Specialty Crop Production (e.g., horticulture, citrus, nuts, fruits)
- **1350 Grazing-related Sources***
  - 1400 Pasture grazing—Riparian and/or Upland
  - 1410 Pasture Grazing--Riparian*
  - 1420 Pasture Grazing--Upland*
  - 1500 Range Grazing—Riparian and/or Upland
  - 1510 Range Grazing--Riparian*
  - 1520 Range Grazing--Upland*
- **1600 Intensive Animal Feeding Operations***
  - 1620 Concentrated Animal Feeding Operations (CAFOs; permitted, PS)
  - 1640 Confined Animal Feeding Operations (NPS)
  - 1700 Aquaculture

2000 Silviculture
- 2100 Harvesting, Restoration, Residue Management
- 2200 Forest Management (e.g., pumped drainage, fertilization, pesticide application)
- 2300 Logging Road Construction/Maintenance
- 2400 Silvicultural Point Sources

Table 1-3 (continued)

3000	**Construction**	
	3100	Highway/Road/Bridge Construction
	3200	Land Development
4000	**Urban Runoff/Storm Sewers**	
	4100	Nonindustrial Permitted
	4200	Industrial Permitted
	4300	Other Urban Runoff
	4400	Illicit connections/illegal hook-ups/dry weather flows*
	4500	Highway/Road/Bridge Runoff*
	4600	Erosion and Sedimentation*
5000	**Resource Extraction**	
	5100	Surface Mining
	5200	Subsurface Mining
	5300	Placer Mining
	5400	Dredge Mining
	5500	Petroleum Activities
	5600	Mill Tailings
	5700	Mine Tailings
	5800	Acid Mine Drainage
	5900	Abandoned mining*
	5950	Inactive mining*
6000	**Land Disposal**	
	6100	Sludge
	6200	Wastewater
	6300	Landfills
	6350	Inappropriate Waste Disposal/Wildcat Dumping*
	6400	Industrial Land Treatment
	6500	Onsite Wastewater Systems (Septic Tanks)
	6600	Hazardous Waste
	6700	Septage Disposal
7000	**Hydromodification**	
	7100	Channelization
	7200	Dredging
	7300	Dam Construction
	7350	Upstream Impoundment
	7400	Flow Regulations/Modification

Table 1-3 (continued)

7550 Habitat Modification (other than Hydromodification)
- 7600 Removal of Riparian Vegetation
- 7700 Bank or Shoreline Modification/Destabilization
- 7800 Drainage/Filling of Wetlands

7900 Marinas and Recreational Boating*
- 7910 In-water releases*
- 7920 On-land releases*

8050 Erosion from derelict land*
8100 Atmospheric Deposition
8200 Waste Storage/Storage Tank Leaks (above ground)
8250 Leaking underground storage tanks*
8300 Highway Maintenance and Runoff
8400 Spills (Accidental)
8500 Contaminated Sediments
8520 Debris and bottom deposits*
8530 Internal nutrient cycling (primarily lakes)*
8540 Sediment resuspension*
8600 Natural Sources

8700 Recreation and Tourism Activities (other than Boating; see 7900)
- 8710 Golf courses*

8900 Salt Storage Sites
8910 Groundwater Loadings
8920 Groundwater Withdrawal
8950 Other
9000 Unknown Source
9050 Sources outside State Jurisdiction or Borders*

Notes:
Bold type indicates a major source category; regular type indicates a subcategory.
In addition to the above codes, WBS users can enter their own customized source codes.
Code 8000 for "Other" has been deleted because it resulted in significant loss of detail nationwide.
See Appendix G for definitions of selected source categories.
* Codes changed or added since 1996 Guidelines.
** Agriculture is the only major source category with three tiers of codes (such as codes 1000, 1050, and 1100). EPA asks States to report size data for the "1000—Agriculture" code plus one or both of the other two tiers.

How to Avoid Double-Counting of Sources

WBS Users—WBS can be used to generate the 305(b) summary report, "Total Sizes of Waters Impaired by Various Source Categories." *However, to use the WBS to generate this table, enter a total size for each major category of sources (i.e,, the **bold categories** in Table 1-3 such as **1000--Agriculture** and **2000--Silviculture**).* This is necessary because there may be overlap among the subcategories of sources.

Non-WBS Users—Your customized database must also track major source categories (the **bold categories** in Table 1-3) at the waterbody level.

A modeling framework can be helpful, especially where a variety of sources could be involved. Even a simple annual average export-coefficient screening model can help determine if particular source categories are significant contributors to impairment. A well-rounded assessment process, therefore, might involve monitoring, an inventory of land uses and point source contributions for a watershed, and, where appropriate, a screening-level model to rank and prioritize the relative impacts of different source categories.

Appendix H lists types of information that can be used to determine sources of water quality impairment.

Natural Sources

The Natural Sources category should be reserved for waterbodies impaired due to naturally occurring conditions (i.e., not caused by, or otherwise related to, past or present human activity) or due to catastrophic conditions. In the past, some States have used natural sources as a catch-all category for unknown sources. This gives an inaccurate picture of the extent of natural sources at both State and national levels. States should use the natural sources category only for clearly defined cases, including:

- Saline water due to natural mineral salt deposits
- Metals due to naturally occurring deposits
- Low dissolved oxygen (DO) or pH caused by poor aeration or natural organic materials, where no human-related sources are present or where impairment would occur even in the absence of human activity

- Excessive siltation due to glacial till or turbidity due to glacial flour, where such siltation is not caused by human activity or where impairment would occur even in the absence of human activity

- Habitat loss or pollutant loads due to catastrophic floods that are excluded from water quality standards or other regulations

- High temperature, low DO, or high concentrations of pollutants due to catastrophic droughts with flows less than design flows in water quality standards.

The Natural Sources category does **not** include, for example, low flows due to diversions resulting in low DO; drainage from abandoned mines resulting in low pH; stormwater runoff resulting in habitat destruction, high temperatures, or other impacts except under catastrophic conditions; or atmospheric deposition of heavy metals where human-induced emissions are a factor.

In many cases, State water quality standards already take into account natural conditions (e.g., a "fish and wildlife/swamp waters" classification in the Southeast where naturally-occurring low DO is allowed). In such cases, the waterbody is not reported as impaired. In other cases where standards do not allow for natural conditions, impairment by a natural source may still be beyond a State's capability to correct for technical or economic reasons. A use attainability analysis (UAA) should be done to determine if designated uses are attainable or if other uses are more appropriate for a waterbody. Regional Water Quality Standards Coordinators can provide information on conducting UAAs. In the absence of a UAA, EPA recognizes that States should report impairment due to natural sources even in cases where standards could be overly restrictive or in need of revision.

1.8 Cause/Source Linkage

States are requested to link causes/stressors with sources for waterbodies in their assessment databases where possible. A special cause/source link field is provided in WBS for this purpose. Linked cause/source data are important for answering State resource management questions. For example, the question "Which waterbodies are impaired due to nutrients from agricultural runoff?" cannot be answered if the cause/source link is not used.

The following chart illustrates what happens when causes and sources are not linked. Although valuable information is stored, one cannot tell which sources are associated with which pollutants or stressors:

Causes and Sources Not Linked

Waterbody	Causes (pollutants/stressors)	Sources (not linked with causes)
WBID = XX-012 Mill Creek above Brook Branch	Nutrients, siltation, thermal modification	Urban runoff, removal of riparian vegetation, municipal point sources

The following chart shows how the same causes and sources can be associated with each other using the WBS link variable:

Causes and Sources Linked

Waterbody	Causes (pollutants/stressors)	Sources (linked with causes)
WBID = XX-012 Mill Creek above Brook Branch	Nutrients	Urban runoff
	Nutrients	Municipal point sources
	Siltation	Removal of riparian vegetation
	Thermal modification	Urban runoff
	Thermal modification	Removal of riparian vegetation

For help in accomplishing this link, WBS users and non-WBS users are urged to contact WBS Technical Support at the number on page ii for more information.

1.9 Major/Moderate/Minor Contribution to Impairment

Section 4 of the main *Guidelines* volume requests determination of the relative contribution to impairment of causes and sources of pollution.

The definitions of major/moderate/minor contributions in these *Guidelines* now reflect the severity of impairment rather than the number of sources contributing. The 1994 definitions, for example, required that a source be labeled "major" if it is the only source of impairment on a waterbody, regardless of the severity of impairment. The current definitions are:

- Major contribution: A cause/stressor or source makes a major contribution to impairment if it is the only one responsible for *nonsupport* of any designated use or it predominates over other causes/sources.

- Moderate contribution: A cause/stressor or source is the only one responsible for partial support of any use, predominates over other causes/sources of partial support, or is one of multiple causes/sources of nonsupport that have a significant impact on designated use attainment.

- Minor contribution: A cause/source is one of multiple causes/sources responsible for nonsupport or partial support and is judged to contribute relatively little to this nonattainment.

The major/moderate/minor designations are difficult to quantify and will continue to reflect the best professional judgment of the data analyst. For example, multiple minor causes/stressors or sources or multiple moderate causes/sources could be interpreted to add up to nonsupport. States are asked to clarify how they use magnitude codes in their annual electronic reporting data dictionaries.

SECTION 2

DESIGNING ASSESSMENTS AND MANAGING INFORMATION

This section discusses several topics related to the overall operation of State water quality assessment programs:

- The extent of individual assessments
- Comprehensively characterizing waters of the State through a combination of targeted and probabilistic monitoring designs
- Delineating waterbodies and watersheds
- Managing assessment data

2.1 Extent of Individual Assessments

The extent or size of a waterbody that is represented by a given monitoring station is important because it affects the quality of assessment results. For example, low assessment quality can result when a large segment of stream or a large lake is assessed based on a single monitoring site. The 305(b) Consistency Workgroup discussed this topic in 1994 and concluded that only general guidance can be given at this time, as follows.

Because of the importance of site-specific considerations, EPA discourages the use of uniform default values for the

A monitoring station can be considered representative of a stream waterbody for a distance upstream and downstream that has no significant influences that might tend to change water quality or habitat quality. A significant influence can be

- A point or nonpoint source input to the waterbody or its tributaries
- A change in watershed characteristics such as land use
- A change in riparian vegetation, stream banks, substrate, slope, or channel morphology
- A large tributary or diversion
- A hydrologic modification such as channelization or a dam.

size of waterbody represented by a single monitoring site. For streams, States should consider the upstream and downstream characteristics of each monitoring station and its watershed in arriving at an extent of assessment. A single site should not be used to assess an entire watershed unless land use, sources, and habitat are relatively homogeneous (e.g., as is sometimes the case in undeveloped areas) and the observed stressor is consistent with watershed-wide impacts.

In general, a wadable stream station probably should represent no more than five to 10 miles of stream. For large rivers, EPA believes that 25 miles is a reasonable upper limit for a single station unless stream-specific data demonstrate otherwise. However, some large western rivers may have no significant influences for more than 25 miles, as is the case in New Mexico where a few stations on large rivers are believed to represent 50 to 75 miles each.

For lakes, the factors that affect the number of monitoring sites needed per lake are complex. They include purpose of the sampling, lake size, stratification, morphometry, flow regime, and tributaries. No simple guideline for size assessed per station can be given. Reckhow and Chapra (1983) discuss monitoring design for lakes and the potential problems associated with sampling only a single site. Similarly, no specific guidelines are available for the extent of assessment of estuarine monitoring sites. The Washington Department of Ecology (DOE) has used a GIS to draw circles around each monitoring site; the site is considered to represent the area within its circle. Open water stations represent an area within a 4-mile radius, most bay stations represent an area within a 2-mile radius, and highly sheltered bay sites represent an area within a 0.5-mile radius. DOE uses circles in part to emphasize the uncertainty associated with the extent of assessment for estuarine sites.

EPA asks States to provide information in the Assessment Methodology Sections of their 1998 305(b) reports on how they determine extent of waterbody represented by a single assessment or monitoring site.

2.2 Comprehensive Statewide Assessment

EPA, States and Tribes are moving toward a goal of **comprehensively characterizing waters** of the States and Tribes using a variety of monitoring techniques based on the condition of, and goals for, the waters. Achieving this goal would mean a significant increase in the percentage of waters assessed throughout the Nation. For example, in their 1996 305(b) reports, the States assessed approximately 19 percent of the Nation's total stream miles (including intermittent streams, canals, and ditches); this amounted to less than half of the Nation's perennial stream miles. Achieving the goal of

comprehensive coverage will require a combination of monitoring approaches including both targeted and probability-based monitoring as well as aggregation of acceptable data from a variety of agencies and sources. Figure 2-1 shows several aspects of monitoring, assessment, and reporting that will be important to realizing the goal.

The traditional means used by EPA to meet the 305(b) requirements has been to compile information from individual States, Territories, Tribes, and interstate basin commissions. In general, such data come from a diverse set of monitoring programs, each of which is based on its own valid purpose. One of the difficulties that arises from this process is differences in overall objectives. On the one hand, EPA is required to report on the condition of the Nation's aquatic resources as a whole, implying either a national census of the resource or a sample survey from which inferences about the entire resource can be drawn. On the other hand, States often select monitoring locations with specific, local purposes in mind. A compilation of such data for regional or national assessments is subject to question about the representativeness of these locations for making comprehensive assessments; i.e., to what extent might the resultant assessment be biased by the non-random selection of monitoring locations as well as the incomplete coverage of the State or Tribal lands?

Comprehensive Assessment: An evaluation of resources that provides complete spatial coverage of the geographic area or resource being studied; it provides information on assessment value (condition of the resource), spatial and temporal trends in resource condition, causes/stressors and sources of pollution, and locational information.

Sample Survey (Probability-Based) Design: A sampling design based on selection of sites or sample locations using some aspect of randomization; allows statistically-valid inferences to be drawn on a population as a whole.

Conventional or Targeted Design: Targeted site selection is used to answer specific questions regarding the condition of a site or area.

Judgmental (Sample Survey) Design: Non-random selection of sampling sites with the intent of using assessment results for drawing inferences on a population as a whole.

Vision: Multi-year State andTribal Monitoring Strategy resulting in comprehensive State & Tribal assessment of water quality at various geographic scales. Reporting of the information to foster risk-based management decisions and inform Congress and the public.

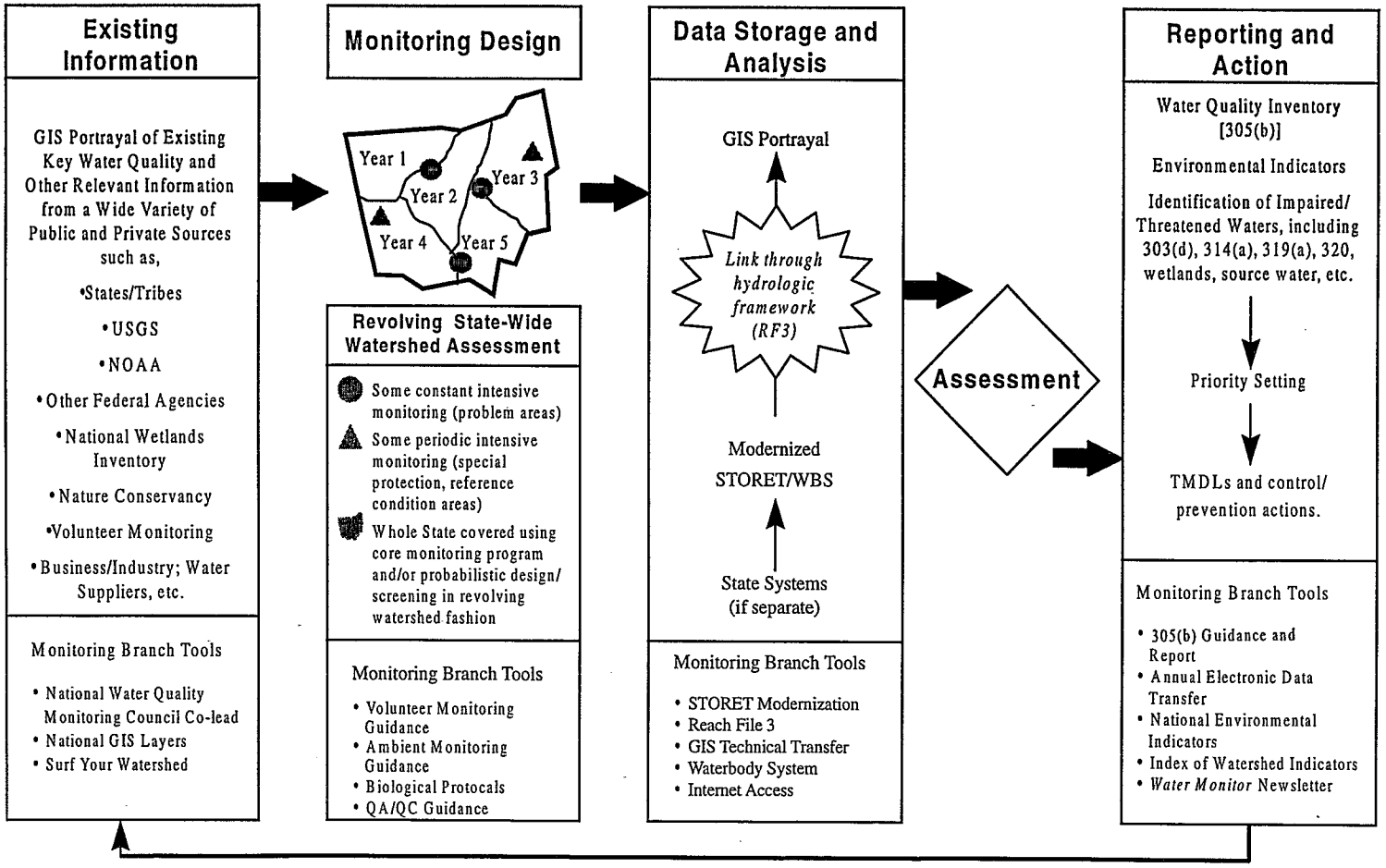


Figure 2-1. Comprehensive Statewide and Tribal water quality assessment

2.2.1 General Types of Monitoring Designs

The section is intended to expand upon these fundamental differences in general objectives; to describe the types of questions each of the monitoring approaches is intended to address and some of the strengths and weaknesses of the approaches; and to provide some initial recommendations toward more comprehensive assessments. The term "sample survey" is used to describe monitoring designs for producing representative data for regional (statewide, basinwide, ecoregional) or national assessments. The term "conventional or targeted" is used to describe monitoring designs that are more local in scope and that tend to focus on a particular problem, or on sites that are selected for a specific local issue. A "judgmental" monitoring design refers to selecting sites for assessing a broader geographic area and assuming that they are representative of that area (non-random selection). EPA recognizes that most States would need to make programmatic or design adjustments in their monitoring efforts to meet national-, regional-, or State-scale objectives as well as more site-specific data needs.

Sample surveys are intended to produce snapshots of the condition of an entire resource when that resource cannot be subject to a census (monitoring of every waterbody). Sample surveys rely on the selection of monitoring sites that are representative of the resource. Randomization in the site selection process is one way to ensure that the sites represent the resource of interest. These surveys are often called **probability-based** or statistical sample surveys.

Examples of Monitoring Questions

Site Specific: What is the biological condition of Jamster Creek? (targeted monitoring design most often used)

Regional: What is the biological condition of lakes in the mid-Atlantic coastal plain? (requires probability-based monitoring design or defensible judgmental design in the absence of a census)

An alternative is to select sites **judgmentally**, based on some criterion other than randomness. Judgmental selection of sites is based on the judgment of the monitoring agency that the sites are representative of the target resource. Such judgmentally-based sample surveys require strong defense regarding the representativeness of the sites so selected, and it may not be possible to estimate the uncertainty with which inferences are made as it is when using probability-based sample surveys.

Targeted designs allow questions to be addressed that are focused on site-specific problems, and the aggregation of these site-specific results to make

comprehensive assessments is open to question regarding the representativeness of those sites to the resource as a whole. State monitoring programs that combine aspects of the two general approaches (survey designs and targeted designs) may be necessary to provide data and assessments useful at multiple geographic scales from site-specific to national. Appendix I provides some of the advantages and disadvantages of probability-based, targeted, and judgmental monitoring and also examples of the types of questions that can be addressed by each.

2.2.2 Planning Process for Probability-based Sampling in a Rotating Basin Design

Considerable planning is required to define the particular classes of waterbodies of interest, but the end result can be a cost-effective, defensible and rigorous process for making inferences about all waterbodies in an area.

The initial step in random selection is definition of the target population (e.g., all lakes over 10 acres or all streams of the State). To characterize all streams of a State, basin, or watershed, the agency would do a simple random selection of locations from within the appropriate boundaries (Figure 2-2). However, stream segments could be stratified based on watershed, stream sizes (e.g., first, second, or third-order), ecoregion, or even predominant land use/land cover. Random selection of stream locations for sampling then occurs within each grouping. Figure 2-3 represents the stratification of streams into three classes. Techniques are available to ensure even distribution of sampling sites among the classes or strata and across the resource (or State or basin). The selection process would depend on geographic scale or monitoring questions and objectives. Such a probability-based design can provide assessment data that are useful not only for each class of streams individually, but that can be aggregated into a broader-scale resource assessment. It would also allow extrapolation of sources and causes/stressors to broader geographic scales.

> ***Target Population (Stratum)***: A group of potential sampling locations (or assessment units) that is some subset of the total population of sampling units.
>
> ***Geographic Scale***: Spatial breadth or size; can be based on political unit (e.g., state, county, or municipality), basin or watershed (e.g., the Anacostia River Watershed, the Columbia River Basin), region (e.g., the Huron-Erie Lake Plain ecoregion, the Pacific coastal Mountain ecoregion), or resource (e.g., the Okefenokee Swamp, the Everglades).

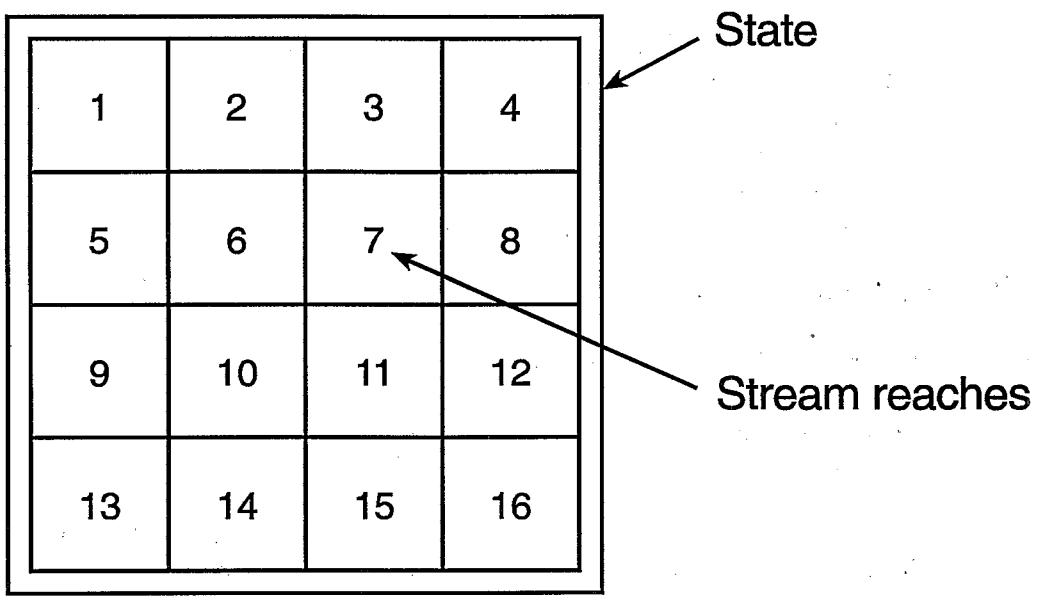


Figure 2-2. Universe of streams from which to draw a random sample

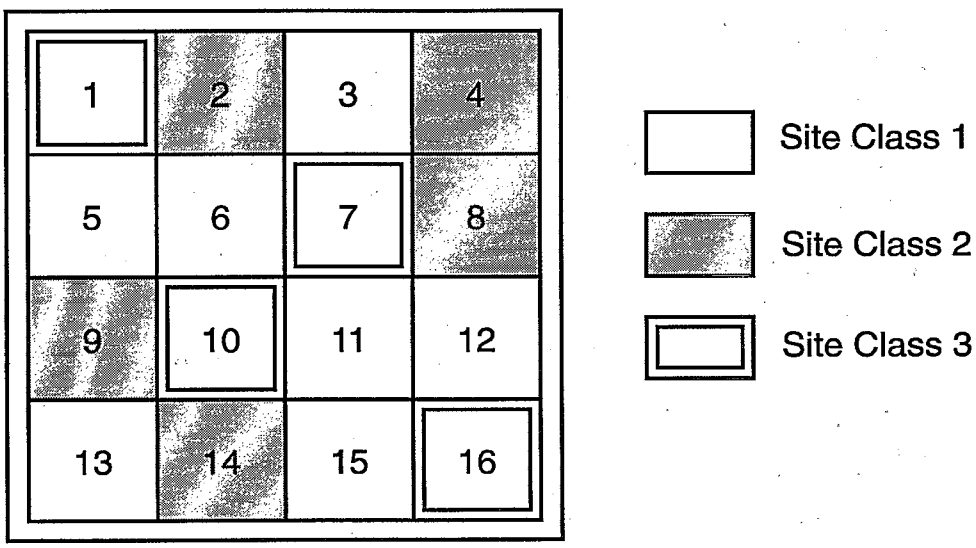


Figure 2-3. Stratification of streams into three classes

2.2.3 Stratified Probability in a Rotating Basin Design

Year	1997	1998	1999	2000	2001
Basin No.	7	9	4	1	10
	15	2	14	5	13
	8	11	3	16	12
	6	-	-	-	-

Incorporating stratified probability design into a monitoring program could enable a more efficient and effective sampling of all of a State's major basins. If a State is willing to select its order of rotating basins randomly, the State could potentially obtain results, even in the early year(s), that are meaningful and valid for statewide assessment. To apply such a design, begin with a random selection of three to four basins to be sampled in each year (Figure 2-4a). The sampling schedule in the text box above is an example of the results for a State with 16 basins. Randomized selection of basins is not necessary, and the State can select the order of basins on a priority basis.

The second phase of site selection is random selection of stream reaches from within each of the basins. For example, there are 16 stream segments in Basin 6 (Figure 2-4b). Random selection of a subset of stream segments from within Basin 6 allows aggregation of assessment results into a statistically-valid basinwide assessment.

Referring to the above schedule box, following the 1997 sampling season, there would be four basin assessments to aggregate for a statewide assessment; after 1999, there would be 10 basin assessments to aggregate for a statewide assessment, and so forth. With each subsequent year, the confidence associated with statewide assessments increases. In the first year of the second cycle (2002 in this example), the basin rotation would begin again.

A stratified design can be used to focus on a class of waterbodies for which there has been little previous data collection. For example, larger rivers and streams of some States are well-represented by historical, fixed-station sampling networks, while only a small percentage of headwater streams are assessed. Maryland has applied stratified random design to first- through third-order streams to greatly increase the percentage of its total miles assessed. Delaware selects sampling from all points where roads cross streams.

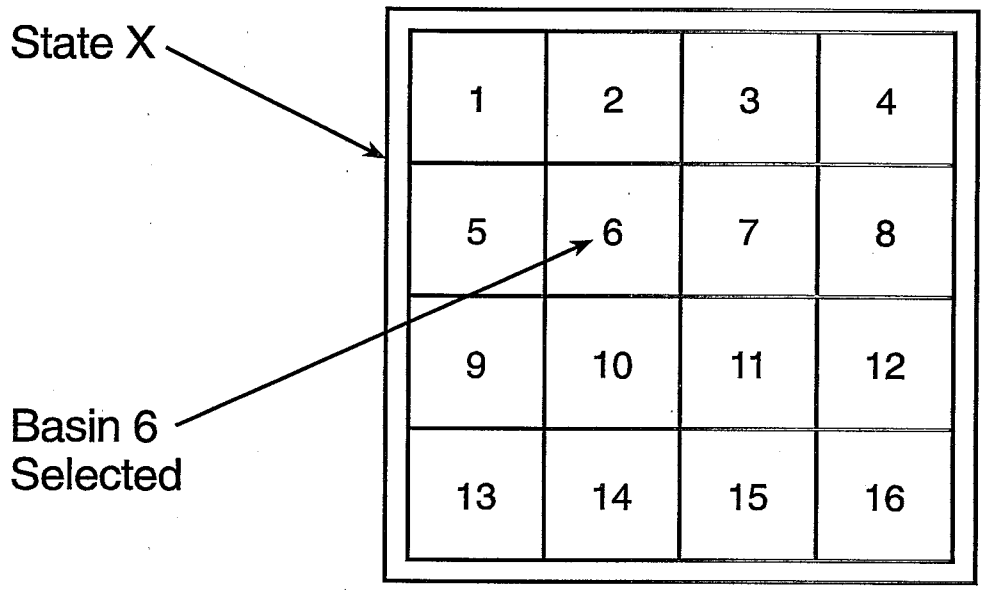


Figure 2-4a. Random selection of basins

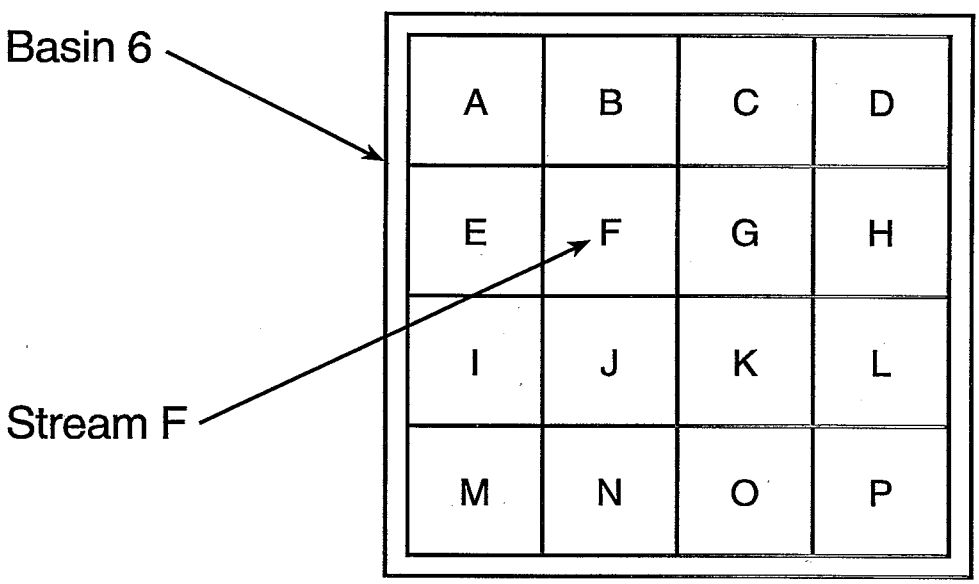


Figure 2-4b. Random selection of streams within a basin

Note: The above is one approach to incorporating probability-based sampling into rotating basin monitoring. Another approach is to use a repeated statewide survey yearly, complimented by targeted monitoring and assessment according to the State's rotating-basin schedule.

EPA/ORD Corvallis is available to provide technical support in designing probability-based rotating basin surveys through coordination with the Regional 305(b) Coordinator. EPA's Environmental Monitoring and Assessment Program (EMAP) has developed expertise in the area of probability surveys and in establishing a mechanism to help States investigate and implement probability-based designs for their specific needs.

2.2.4 Case Studies of Different Types of Monitoring Designs

Probability-based Sample Survey Design: State of Delaware

A probability-based sampling design was developed to assess the ecological condition of Delaware's nontidal streams by the Department of Natural Resources and Environmental Conservation (DNREC). The results were used to produce unbiased estimates of biological and physical habitat condition for the State's 305(b) reports. The area of the State containing nontidal streams was estimated from National Wetlands Inventory data on the State's 35 major watersheds. A list of 3,200 locations where roadways cross a nontidal stream was produced using a GIS. Sampling sites were then selected randomly from this list and sampled during the Fall of 1993. The design was selected to reduce the time necessary to reach specific locations on nontidal streams. The underlying assumption is that road crossings are an accurate representation of nontidal stream resources in Delaware. This assumption is currently being tested.

Ninety-six sites were selected in the northern two counties using this approach; benthic macroinvertebrate and habitat data were collected at all locations. Results of the habitat assessment were presented in Delaware's 1994 305(b) report. The majority of the 1357 miles of nontidal streams in the two counties had impaired physical habitat; 65% were severely impaired (i.e., 'poor') and 22% were moderately impaired (i.e., 'fair'). The habitat results were also reported as three strata within the two counties: one stratum comprising all of Kent County (32 sites); another, the piedmont region of New Castle County (26 sites); and the third, the coastal plain of New Castle County (38 sites). Thus, the probability design allowed reporting of results at two geographic scales: 1) the two counties aggregated, and 2) the two counties individually and separated by physiographic region or topography.

The above description of the Delaware program is taken directly from "The use of a probability-based sampling design to assess the ecological condition of Delaware streams" (Maxted, 1996).

Judgmental Sample Survey Design: State of Washington

This approach is referred to as the 'representative sampling approach' by the staff of the State of Washington, Department of Ecology. They reviewed all existing monitoring stations to determine why existing sampling locations were selected. If stations were selected because they were judged to be representative of the type of water within a watershed, they will be used in the sampling network and aggregated to a statewide assessment. Alternatively, if stations were selected because of their position relative to a known problem, such as those downstream of a specific discharge, they will not be used as part of a statewide assessment. Data from the latter sites will continue to be used strictly for site-specific assessments; the former will provide site-specific assessments that can be aggregated into a regional (statewide, ecoregional) assessment.

All sites determined as appropriate for the statewide assessment will be initially stratified by ecoregion and waterbody type under the assumption that collectively these sites are representative of all waters within their particular stratum. This assumption will be tested by direct comparison to results provided by the strictly probabilistic design of EPA Region 10 REMAP. Although one concern may be that the selection process could be biased against selecting problem sites, preliminary results show an increased percentage of stations exhibiting impairment compared to a strict probability design.

The Washington Department of Ecology provided background material for the above description of their program.

Combined Probability-based Sample Survey and Conventional Designs: Prince George's County, Maryland

The Prince George's County Department of Environmental Resources (DER) recently designed and piloted a county-wide biological monitoring program. The County is located in the middle Atlantic coastal plain region and has flowing surface waters that drain into the Patuxent and Potomac Rivers, which themselves drain into the Chesapeake Bay. The County wants to answer questions at various geographic scales including stream-specific, watershed-wide, and county-wide and to have sampled all watersheds over a 5-year period. It was necessary to be able to have valid county-wide assessments from the first year of the program and to be able to address problems from known point sources.

NPS Monitoring and Evaluation Guide

A nonpoint source (NPS) pollution monitoring and evaluation (M&E) guide is available for use by those who fund and approve M&E plans and those who perform the monitoring. The guide discusses the various objectives of NPS pollution M&E, biological monitoring for NPS pollution, and qualify assurance/quality control aspects, and includes an extensive chapter on statistical methods for the evaluation of NPS pollution monitoring data. Appendices contain abstracts and content listings of over 40 guidance documents related to monitoring both point and nonpoint source pollution programs.

Federal, State and regional agencies that support M&E activities might use the guide to assess the technical merit of proposed plans. Those agencies, private groups, and university personnel that perform M&E might use the guide to formulate their plans. The guide is in no way intended to supersede proven NPS pollution M&E plans currently in use, but it is intended as both a check against existing plans and an outline for developing new NPS pollution M&E plans. To obtain a copy contact the NPS Branch at (202) 260-7110.

The unit of assessment was defined as a channel segment of a wadable, nontidal river or stream into which no tributary flows. The number of assessment units within the County was determined from maps to be approximately 1000. This target population was prestratified (subdivided or grouped) by the following: northern and southern parts of the County, watershed, and order (first through fourth). Step 1 was to randomly select four to five watersheds (alternating between north and south) until about 25 percent of the total population, or 200 stream segments, had accumulated. Then, from within each watershed, approximately 25 percent from each of the groups of first, second, and third order segments were randomly selected. Fourth order segments, if they were represented in a particular watershed, were automatically selected since their occurrence was so rare within the County. This process resulted in a rotating basin design where, over a 6-year period, a total of 254 probability sites would be sampled per index period. Each of the 41 watersheds would have 25 percent of its first order streams sampled, 25 percent of its second order, and 25 percent of its third order.

Twenty to 25 specific streams with known problems or special projects would also be sampled and would be used for evaluating the effectiveness of stream restoration projects, remediation of stormwater outfalls, implementation of BMPs, or the effects of specific discharges.

2.2.5 Improving Monitoring Designs through Modeling

Calibrated empirical and process models hold the potential to estimate in-stream quality based on landscape and other stressor factors. This active

area of research links landscape ecology with instream indicators of biological, habitat and chemical quality (e.g., correlating the Index of Biological Integrity with land use and other factors). While probability-based monitoring gives reliable estimates of condition over wide areas, models can provide comprehensive screening for potential problem areas that should be sampled to confirm problems. That is, calibrated empirical and/or process models relating landscape and other stresses to instream condition can potentially provide reliable estimates of where additional problems are likely to be found and thus can result in better targeted monitoring approaches. Statisticians refer to this approach as "model-based inferences." These models may be an additional tool for States in their efforts to use all available monitoring network approaches to answer key questions such as: "what is the desired condition, where are our problems, and are we making progress over wide areas over time?" A potential synergy among approaches is that data from probability-based efforts could be used to construct the models needed for better screening and targeting. References regarding linking landscape ecology with instream indicators of biological habitat and chemical quality include Zucker and White (1996), Roth et al. (1996), Jones et al. (1996), and U.S. Department of Agriculture, 1996.

2.3 Watershed and Waterbody Delineation

The waterbody is the basic unit-of-record for water quality assessment information. That is, most States assess individual waterbodies and store assessment results at this level--results such as degree of use support, causes/stressors, sources, and type of monitoring. The States have defined waterbodies in various ways, from short stream segments and individual lakes to entire watersheds.

The paragraphs below describe features of watersheds and waterbodies and common approaches to their delineation. One goal of this section is to help States make the best decisions about watershed and waterbody delineation, thereby avoiding their need to repeat the process later. Another goal is to ensure that whatever process is selected, it will result in data that can be related to standard watersheds such as USGS Cataloging Units and Natural Resources Conservation Service (NRCS) watersheds to allow data aggregation at various scales. **The proper delineation of individual waterbodies is time-consuming but critically important to a State's 305(b) program. Many States have found it necessary to re-delineate waterbodies after only a few years based on previously unrecognized data needs. EPA urges any State that is considering re-delineating its waterbodies to contact the National 305(b) Coordinator for information about approaches and the experience of other States.**

USGS Hydrologic Units

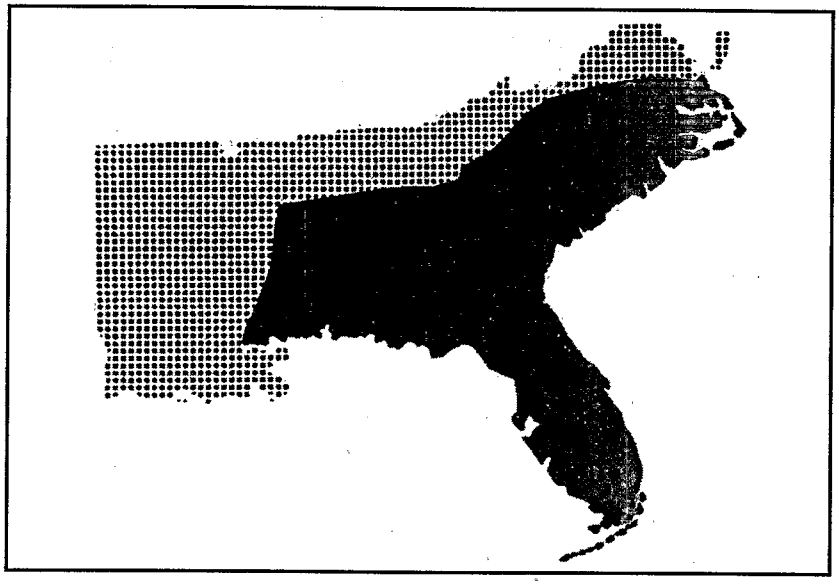
The Hydrologic Unit Code (HUC) is a system developed by the USGS and adopted as a national standard. This system divides the United States into four levels of hydrologic units for purposes of water resources planning and data management:

- Region (2-digit code)
- Subregion (4-digit code)
- Accounting Unit (6-digit code)
- Cataloging Unit (8-digit code)

Note: NRCS has added two additional levels of watersheds. Figure 1-3 shows an 8-digit USGS Cataloging Unit and a 14-digit NRCS small watershed.

The following illustrations show how the hydrologic unit classification is applied to a portion of the State of South Carolina.

South Atlantic - Gulf Region 03

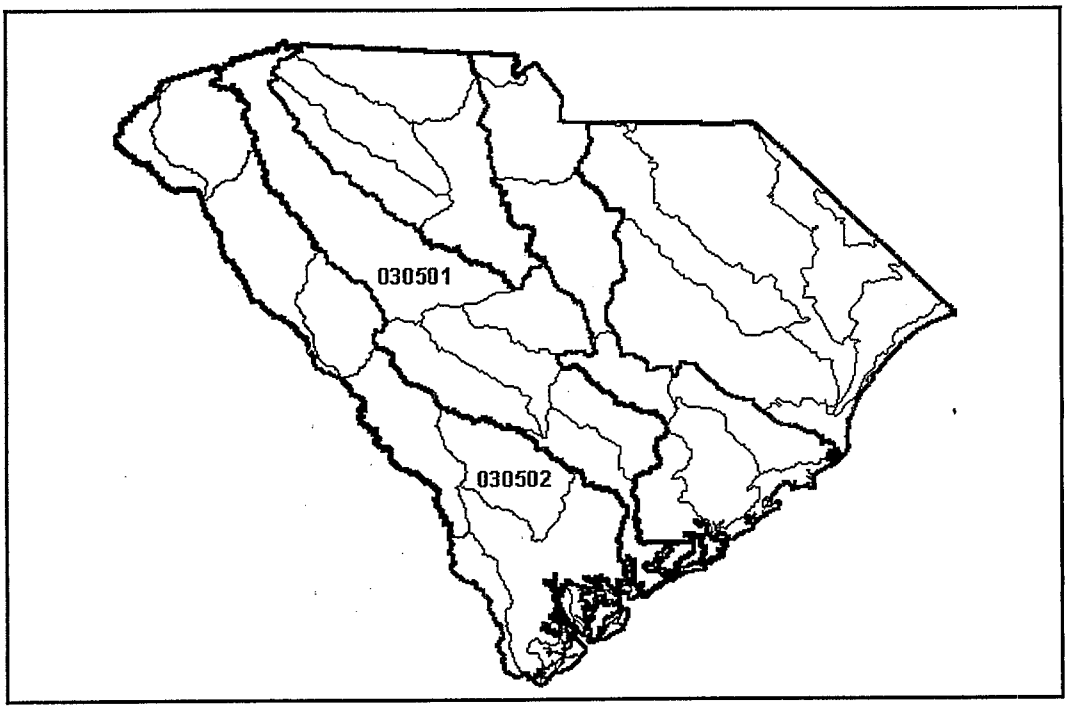


Regions - The Region is the largest unit that USGS uses for comprehensive planning. For example, the South Atlantic-Gulf Region 03 extends from the coastline to the Blue Ridge, and from southern Virginia through the Southeast to New Orleans, Louisiana. There are 18 regions in the conterminous United States, with a national total of 21 (including Alaska, Hawaii, and Puerto Rico and the Virgin Islands).

Subregions and Accounting Units - Subregions are defined by major river basins. For instance, in South Carolina, subregion 0305 includes the Saluda, Broad, and Santee Rivers and the Edisto system. Accounting Units are aggregations of Cataloging Units used by USGS to organize water resource data into manageable units. The South Carolina data in Subregion 0305 are organized into 030501--the Santee, Saluda, Broad Rivers accounting unit--and 030502--the Edisto River accounting unit.

Cataloging Units (CUs) - The CU is the lowest level of hydrologic classification by USGS for planning and data management. There are 2,111 CUs in the continental United States. The 8-digit HUC number designates each individual CU. In the previous graphic, the lines within Accounting Unit 030501 are CU boundaries and each CU has a unique 8-digit HUC.

The HUC has been adopted as a Federal Information Processing Standard (FIPS); i.e., the HUC is a mandatory standard for Federal agencies describing hydrologic data. The HUC classification is well accepted by professional planners and hydrologists at all levels of government and in the private sector.

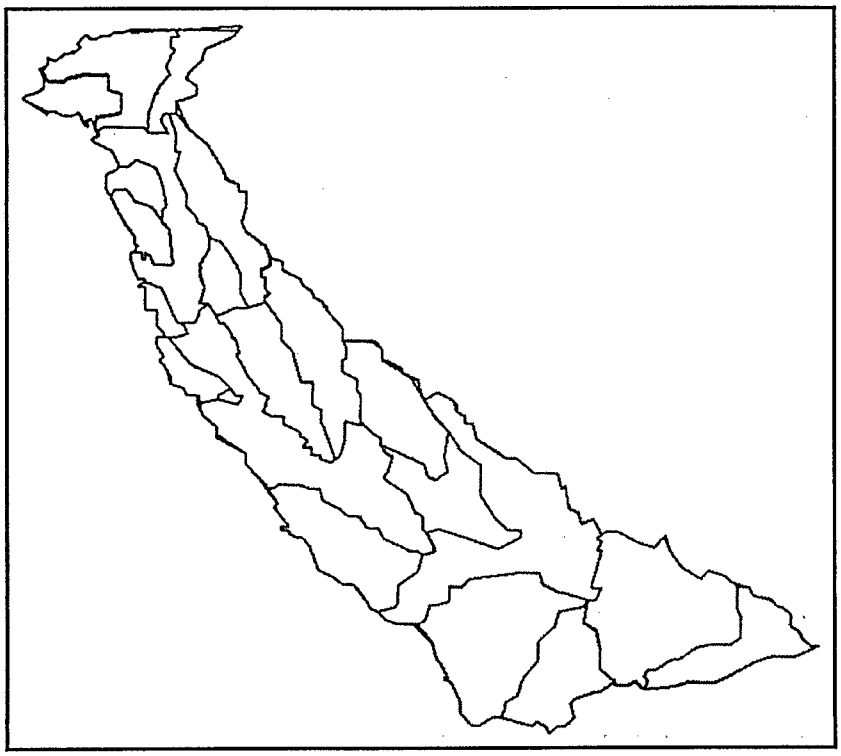


NRCS Watersheds

Years ago, the Soil Conservation Service (now the Natural Resources Conservation Service) subdivided the CUs into watersheds, appending three digits to the eight digit HUC (CU + 3). The designations were made by each State Conservationist to create smaller units for planning activities. There were some consistency problems with the earlier designations, with inharmonious sizes from State to State and a lack of common standards for base maps. Now NRCS Headquarters, working with USGS, EPA, and others, is aggressively pursuing better coherence in the nationwide delineation and standardizing use of the 11-digit watershed code. NRCS is in the process of subdividing States into 14-digit small watersheds (CU + 3 + 3) for planning and analysis at an even finer scale. For example, NRCS in North Carolina worked closely with State environmental agencies to delineate 1,640 14-digit watersheds averaging about 19,000 acres each (see Figure 2-5).

Figure 2-5. 14-digit SCS Watersheds in Eastern North Carolina
(dark lines are county boundary)

NRCS 11-Digit Watersheds in Cataloging Unit 03050109



NRCS Watersheds as a Common Watershed Base

Many States are seeking to establish common watersheds for use by all State agencies, an approach EPA endorses. The watershed level that seems to offer the most advantages, and is the most frequently chosen by the States, is the NRCS watershed. Use of these watershed boundaries allows easy access to NRCS data and improves coordination of nonpoint source assessments with other agencies.

South Carolina was the first State to index its waterbodies to RF3 and it used the NRCS watershed as the basis for waterbody designation. At first, use support, cause/stressor, and source information was tracked only at the watershed level, but this proved too generalized for use in some specific State decisions. The State then went back and identified use support, causes/stressors, and sources for individual stream segments, which proved to be a useful level of resolution. One goal in any delineation scheme is to assemble data at a resolution sufficient to answer the questions that are important for management, without spending more resources than necessary to obtain data.

South Carolina, on the basis of information developed in its first GIS effort, also developed some important locational information at significantly higher resolution. They used global positioning system (GPS) technology to accurately identify the location of discharges. They are proceeding basin by basin throughout the State. Their GIS now has obvious value as a tool for management.

This type of functionality will become increasingly important as tools such as ArcView become available.* These tools, together with the GIS coverages produced by EPA's Reach Indexing project, will allow States to analyze their waterbody and stream reach data spatially. The WBS route system data model (RTI, 1994) allows the State to geographically identify specific use support classifications down to the reach segment level. The EPA contact for georeferencing waterbodies to RF3 is given on page ii.

Waterbody Delineation

Waterbodies have been defined on a wide range of criteria--from individual RF2 reaches, frequently used from 1986 to 1988, to NRCS watersheds or other groupings conforming to administrative boundaries. Tracking of individual RF3 reaches for the 305(b) report gives detailed resolution to waterbody data but can complicate workload management. On the other hand, watershed-scale waterbodies may fail to give sufficient detail for mapping and management decisions unless they identify the actual locations of use support classifications and causes/stressors and sources of impairment.

EPA recommends that States delineate waterbodies to be compatible with NRCS 11- or 14-digit watersheds. "Compatible" can mean for example that multiple stream and lake waterbodies lie entirely within the watershed's boundaries but can be mapped individually (i.e., do not cross NRCS watershed boundaries). Where 14-digit watersheds will be delineated in the near future, a State might consider waiting for these boundaries before redelineating waterbodies. Figure 2-5 shows some of the 14-digit watersheds agreed upon by NRCS and the State of North Carolina.

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* Mention of trade names in this document does not constitute endorsement. ArcView is a program that enables nonprogrammers to utilize ARC/INFO coverages to do mapping and spatial analysis. ARC/INFO and ArcView (Environmental Systems Research Institute, Inc., ESRI) are the only GIS packages currently in wide use by EPA and State water agencies.

Table 2-1 describes an approach to delineating waterbodies that is consistent with aggregating data at the watershed level. A cornerstone of any approach should be flexible data management. That is, the level of detail of assessment data can vary from watershed to watershed depending on the unique causes/stressors and sources in each watershed. **EPA urges any State that is considering re-delineating its waterbodies to contact the National 305(b) Coordinator for more information about options and experiences of other States.**

Aggregating Assessment Data at Watershed, Basin, and Ecoregion Levels

EPA recommends that States store assessment data at the most detailed level of resolution they can manage—generally at the level of stream segment, individual lake, or very small homogeneous watershed. EPA encourages States to develop the **capability** to aggregate their waterbody-level assessment data to the watershed, basin, and ecoregion levels. EPA is not asking States to present aggregated assessment data by NRCS watershed, USGS HUC or ecoregion in the 305(b) report, but rather to develop the capability to do so by including appropriate locational data. However, if States prepare basin management plans, States are encouraged to begin reporting aggregated data in them (see Appendix E).

Using CUs or NRCS watersheds as basic units for aggregating water quality assessment data will aid in data integration and in making other agencies' data available to the States. Sufficient locational information should be included to allow aggregation of detail at a minimum at the CU level. CU numbers can be stored, for example, in WBS SCRF1 or SCRF2 files. At a minimum, WBS or other State 305(b) databases should contain watershed identification numbers for each waterbody and, to the extent possible, waterbodies should not cross NRCS or CU watershed boundaries. Assessments can also be aggregated by ecoregion if ecoregion codes are stored in WBS for each waterbody, or in combination with a GIS coverage of ecoregions. Note: If waterbodies are georeferenced to RF3, and a GIS is available, aggregation of assessments to watersheds and ecoregions can be done with the GIS.

Reach Indexing Waterbodies to RF3

Reach indexing or georeferencing is the process of electronically linking a State's waterbodies and other water quality information to the EPA Reach File. Within the next year, RF3 will be incorporated into a new National Hydrography Dataset (NHD), with increased flexibility, accuracy, and GIS compatibility. The NHD will become the official hydrologic database for USGS, EPA, and other agencies. The main product of reach indexing is a GIS coverage containing locations of waterbodies, stream networks and

Table 2-1. Approaches for Delineating Waterbodies

Approach	Description	Advantages, Disadvantages, Comments
Waterbodies include individual stream segments, stream networks, and lakes	Several States use a mix of waterbodies: • mainstem stream segments • individual tributaries or segments • individual lakes • stream networks--tributaries in a small homogeneous watershed can make up one waterbody • lakes in a small watershed can make up one waterbody • individual estuaries or portions of estuaries (polygons) Waterbodies do not cross CU or NRCS watershed boundaries	Provides flexibility in the number of waterbodies and in level of detail State wants to track ARC/INFO route systems and dynamic segmentation can be used to add greater detail for selected waterbodies if needed. States can learn from other States' experiences Ideally, the number of waterbodies should be in a tractable range--recommend keeping the total below 2,000 to 4,000 waterbodies depending on the size of the State With georeferencing to RF3, this approach is powerful in its ability to interface with GIS and EPA databases. For tracking and reporting by watershed, watershed boundaries can be overlaid on these waterbodies using a GIS, or watershed ID numbers can be stored in WBS

flows, and other information. This gives the State powerful mapping and spatial analysis capabilities. In 1996, at least a dozen States incorporated color maps of uses support, causes and sources into their 305(b) reports and other documents such as basin plans. The reaction to this mapping capability has been very positive. Assessment results displayed in map form are much easier for managers and the public to understand than the traditional tabular or printout form.

2.4 Managing Assessment Data

The EPA Waterbody System (WBS) is a PC system of water quality assessment information used by nearly half of the States with 305(b) databases. Most other States have developed and maintain their own customized systems. WBS was developed by EPA for States and other entities specifically for tracking and reporting assessments under 305(b). It provides a standard format for water quality assessment information and includes a software program for adding and editing data, linking to other water databases, generating reports, and transferring data between the PC and GISs.

WBS has four main functions:

- To reduce the burden of preparing reports required under Sections 305(b), 303(d), 314, and 319 of the Clean Water Act
- To improve the quality and consistency of water quality reporting among the States
- To provide data for national level assessments and for analyzing water quality issues outside of 305(b)
- To be a useful water quality management tool for State agencies.

These 305(b) *Guidelines* and user requests determine the features of the WBS. The *Guidelines* require States to track dozens of data types for each waterbody (each State has from several hundred to several thousand waterbodies) in order to generate the summary tables required in Section 4 of the main volume of these *Guidelines*. Although most WBS features result from the 305(b) *Guidelines*, WBS also contains some data elements that States have requested for internal management purposes (e.g., georeferencing fields and memo fields).

WBS contains over 100 data elements in such categories as:

- Descriptors — waterbody name, number, description, type (stream, lake, etc.), size

- Locational data elements — Reach File coordinates, basin and watershed identifiers

- Assessment data — degree of use support for each use, size impaired, causes/stressors and sources, type of monitoring, type of assessment, assessment confidence.

For detailed information about the WBS, see the *WBS Users Guide*. EPA also provides ongoing technical support to WBS users. Between January and August 1996, EPA provided consultations to more than 30 agencies, including States, Territories, Tribes, and Interstate Commissions, on the use of WBS and RF3 for 305(b) programs. Contact WBS Technical Support at the telephone number on page ii.

Data Management Options for Aggregating Data by Watershed

At least three options are available for aggregating assessment data by watershed for basin management plans and other purposes. These options are compatible with WBS and the approaches described in Table 4-1.

1. Entirely within WBS or other State assessment database. If waterbody records contain CU or NRCS watershed numbers, the database can aggregate data to that level automatically.

2. WBS or other State assessment database in combination with a GIS program. WBS can be used to store assessment data in combination with GIS programs such as ARC/INFO or ArcView, which enable users to analyze spatial data and prepare maps. ArcView runs on personal computers and users do not need to learn the ARC/INFO programming language. It uses standard ARC/INFO data coverages (e.g., reach-indexed waterbodies or STORET monitoring stations). (See previous note regarding mention of trade names.)

3. Entirely within the GIS environment. States with full GIS capability (e.g., having access to ARC/INFO programmers and workstations) can manage assessment data within the GIS environment and export results to WBS or other programs for reporting.

SECTION 3

MAKING USE SUPPORT DETERMINATIONS

This section presents EPA's recommended approaches to making use support decisions. Designated uses are assigned to individual waterbodies in a state's water quality standards. Types of designated uses include: aquatic life, fish consumption, recreational uses such as swimming, and drinking water. This guidance is drafted for wadeable streams and rivers. However, the approach is applicable to other types of waterbodies, as well.

3.1 ITFM Recommendations for Monitoring

The Intergovernmental Task Force on Monitoring Water Quality (ITFM) was formed in 1992 to develop recommendations on monitoring to achieve more comparable and scientifically defensible information, interpretations, and evaluations of water-quality conditions across the nation. The ITFM comprised both Federal and State agencies responsible for monitoring and assessment programs as well as an associated advisory committee including municipalities, academia, industry, etc. (ITFM 1995). The ITFM subsequently developed a model for stream monitoring for different types of designated uses based on a combination of biological, physical, and chemical monitoring (Figure 3-1). The model defines the relationship between parameters that directly measure the condition of the biotic community and its response over time to stressors, such as fish and benthic macroinvertebrate indices, and parameters that measure either stressors or exposure of organisms to stressors, such as levels of pH, nutrients, and toxicants. For streams, EPA recommends that States incorporate ITFM's suite of parameters in their monitoring programs for evaluating attainment of designated uses. These are general recommendations to consider when developing and revising monitoring programs. For example, monitoring for aquatic life use would include the base monitoring program parameters in the box--community level biological data from at least two assemblages, habitat, and physical/chemical field parameters—plus ionic strength, nutrients, and toxicants in water and sediment.

The ITFM in May 1997 became a permanent National Water Quality Monitoring Council to facilitate, among other tasks, the development and implementation of the recommendations on specific methods for measuring

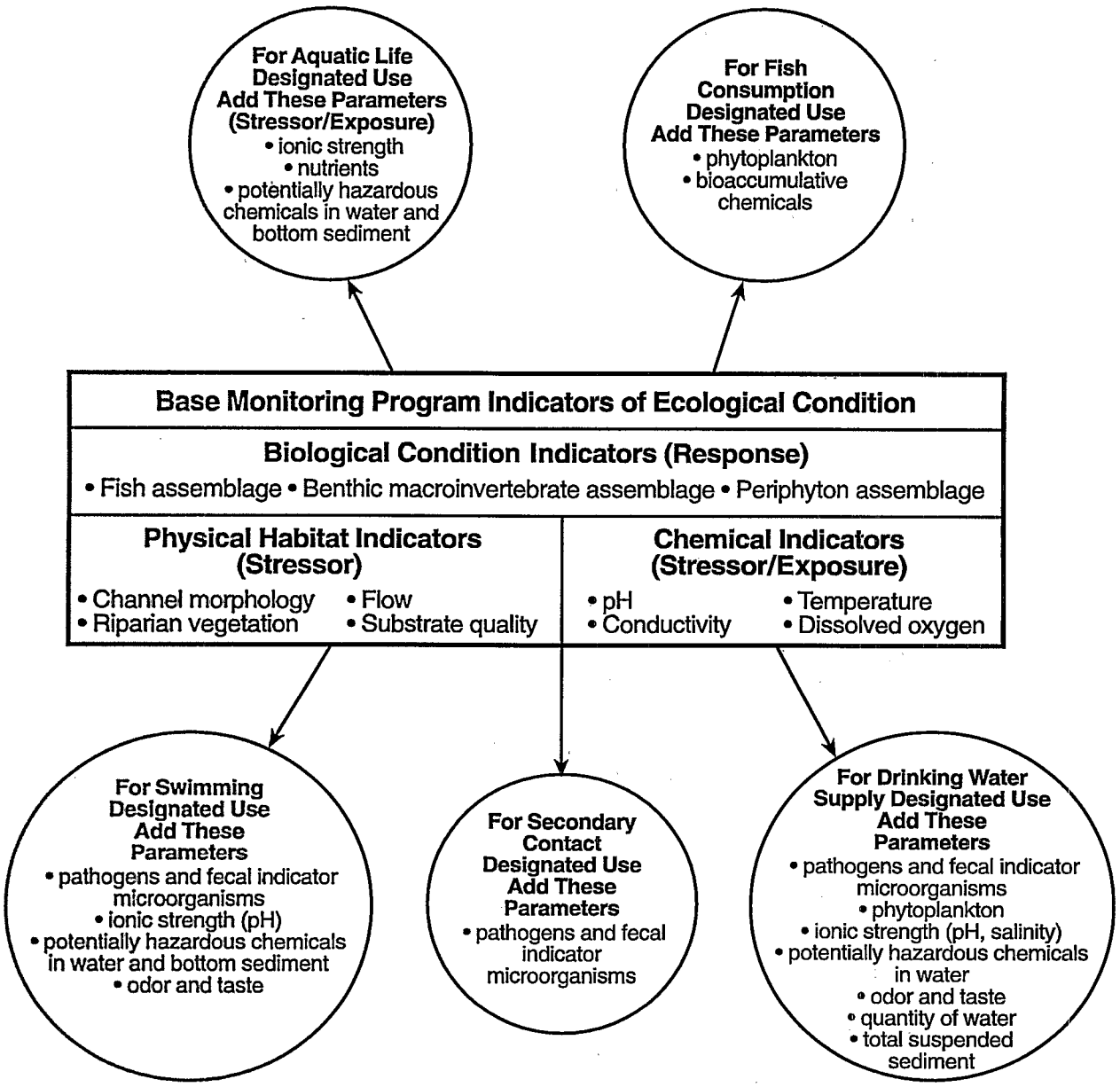


Figure 3-1. Monitoring for different designated uses based on a combination of biological, physical, and chemical measures

the parameters shown in Figure 3-1. Standard methods for measuring the chemical parameters and conducting toxicity tests are well established among the States, but methods for biological and habitat assessments are not standardized for all types of waterbodies. Recent work by the Ohio EPA suggests that bioassessment methods differ widely in their accuracy and discriminatory power for aquatic life use determinations (Yoder et al., 1994). Ohio evaluated a hierarchy of bioassessment approaches relevant to differing levels of rigor and confidence. In their State, Ohio EPA found that less intensive bioassessment approaches tend to be accurate **in detecting impairment,** but may give a false indication of full support in reaches where the methods are not rigorous enough to detect subtle problems.

ITFM (1995) recommends that to combine data for assessment, monitoring data produced by different organizations should be comparable, of known quality, available for integration with information from a variety of sources, and easily aggregated spatially and temporally. This is important at a variety of scales, up to and including national assessments. If different methods are similar with respect to the quality of data each produces, then data from those methods may be used interchangeably or together (Diamond et al. 1996). As data quality (i.e., precision, sensitivity) increases, the confidence in the assessment increases. Data quality objectives should be defined for each method so that assessments can be validated by imposing a known level of confidence in the results.

Monitoring Design

Any monitoring and assessment program begins with setting goals and a monitoring design that can meet those goals. The history of water quality monitoring is replete with programs that could not answer key questions. Examples include:

- A watershed study where the monitoring organization assumes that flow data can be obtained after the fact based on "reference point" measurements from bridges, only to learn later that many streams lack the channel morphometry to develop a stage-discharge relationship;

- An intensive survey where the laboratory's detection levels for metals prove inadequate to detect even concentrations above water quality standards;

- A basin survey where management or the legislature poses the question "What is the statistical trend in biological condition of our streams?" too late to be incorporated into the monitoring design.

As discussed in Section 2, EPA has a goal of comprehensively characterizing the Nation's streams, rivers, lakes, wetlands, estuaries, and shorelines. These assessments will include monitored and evaluated assessments and may involve probability-based as well as targeted monitoring. To achieve this goal, EPA encourages States to incorporate a formal process of goal setting and monitoring design while meeting their own State-specific goals. ITFM provides general guidelines for the topics to consider in monitoring design in a technical appendix of its final report (ITFM, 1995), and EPA's Section 106/604(b) monitoring guidance tailors the ITFM guidelines to the 106/305(b) process.

The Data Quality Objectives (DQO) process developed by EPA's Quality Assurance Management Staff is a specific approach to monitoring design that has been applied to monitoring programs in all media. The DQO process involves the stakeholders in the program in the design. Stakeholders itemize and clarify the questions being asked of a monitoring program, including the required level of accuracy in the answers. Generally, these questions are stated in quantitative terms ("What are the index of biotic integrity [IBI] and invertebrate community index [ICI] values for wadable streams in Big River Basin, and what is the trend in IBI across the basin, with 80 percent certainty?"), and statistical methods may be recommended for selecting sites or sampling frequency. For information about DQOs for water quality monitoring contact the Assessment and Watershed Protection Division at (202) 260-7023.

To date, States have taken three main approaches to monitoring a large portion of their waterbodies:

- Fixed-station networks with hundreds or thousands of sites (most large networks have been reduced in the past 10 years)

- Rotating basin surveys with a large number of monitoring sites covering thousands of miles of waters (Ohio EPA's bioassessment program)

- Rotating basin surveys with a probabilistic monitoring design; a statistically valid set of sites are selected for sampling in each basin (Delaware's benthic macroinvertebrate program).

The National Water Quality Monitoring Council may make recommendations about monitoring design; in the meantime, however, EPA encourages States to consider existing approaches such as Ohio's and Delaware's. In particular, EPA urges States to take advantage of monitoring data provided by other agencies such as USGS, NOAA, or the U.S. Fish and Wildlife Service (USFWS). See Section 2 for more information about comprehensive assessments using different monitoring designs.

3.2 Aquatic Life Use Support (ALUS)

The EPA/State 305(b) Consistency Workgroup has begun to implement the ITFM recommendations including how to integrate the results of biological, habitat, chemical and toxicological assessments in making a determination of aquatic life use support (ALUS). This approach includes consideration of assessment quality as indicated by levels of information of the different data types in evaluating the degree of impairment (partial support vs nonsupport) when there are differences in assessment results. Level of information is discussed below and described for each data type in Sections 3.2.1 through 3.2.4, Tables 3-1 through 3-4. Guidance on making assessments of ALUS for each individual data type is included in Sections 3.2.1 through 3.2.4. Guidance and case studies on integration of the assessment results from different data types, including consideration of level of information and site specific conditions, are presented in Section 3.2.5.

Level of Information

In 1994, the 305(b) Consistency Workgroup concluded that descriptive information characterizing the level of information, or rigor, in the method is needed to more fully define an assessment of use support. Documenting this information is important because users often need to know the basis of the underlying information. The Workgroup recommends that assessment quality information become a part of State assessment data bases. Consequently, the Workgroup has developed guidance for evaluating the level of information of methods used in making ALUS.

Data types are grouped into four categories: biological (Table 3-1), habitat (Table 3-2), toxicological (Table 3-3) and physical/chemical (Table 3-4). A hierarchy of methods corresponding to each data type and ordered by level of information is summarized in the tables. The rigor of a method within each data type is dictated by its technical components, spatial/temporal coverage, and data quality (precision and sensitivity). In the data type tables, Level 4 data are of highest quality for a data type and provide relatively high level of certainty. Level 1 data represent less rigorous approaches and thus provide a level of information with greater degree of uncertainty. However, in situations where severe conditions exist, a lower level of assessment quality will be adequate. For example, a severely degraded site can be characterized as impaired with a high level of confidence based on a cursory survey of biota or habitat, as in the case of repeated fish kills or severe sedimentation from mining. Data in Levels 1 through 4 vary in strengths and limitations, and, along with site-specific conditions, should be evaluated carefully for use in assessments. Data not adequate for ALUS determinations should be excluded from the assessment.

Table 3-1. Hierarchy of Bioassessment Approaches for Evaluation of Aquatic Life Use Attainment Based on Resident Assemblages

Level of Info[a]	Technical Components	Spatial/ Temporal Coverage	Data Quality[b]	WBS Codes[c]
1	Visual observation of biota; reference conditions not used; simple documentation	Limited monitoring; extrapolations from other sites	Unknown or low precision and sensitivity; professional biologist not required	310, 320, 350, 322
2	One assemblage (usually invertebrates); reference conditions pre-established by professional biologist; biotic index or narrative evaluation of historical records	Limited to a single sampling; limited sampling for site-specific studies	Low to moderate precision and sensitivity; professional biologist may provide oversight	310, 320, 322, 350
3	Single assemblage usually the norm; reference condition may be site-specific, or composite of sites (e.g., regional); biotic index (interpretation may be supplemented by narrative evaluation of historical records)	Monitoring of targeted sites during a single season; may be limited sampling for site-specific studies; may include limited spatial coverage for watershed-level assessments	Moderate precision and sensitivity; professional biologist performs survey or provides training for sampling; professional biologist performs assessment.	310, 315, 320, 321, 330, 331, 350
4	Generally two assemblages, but may be one if high data quality; regional (usually based on sites) reference conditions used; biotic index (single dimension or multimetric index)	Monitoring during 1-2 sampling seasons; broad coverage of sites for either site-specific or watershed assessments; conducive to regional assessments using targeted or probabilistic design	High precision and sensitivity; professional biologist performs survey and assessment	310, 315, 320, 321, 330, 331, 340, 350

NOTE: Table is based on use in lotic systems. With some modification, these approaches would apply to other waterbody types.

[a] Level of information refers to rigor of bioassessment, where 1 = lowest and 4 = highest.

[b] Refers to ability of the ecological endpoints to detect impairment or to differentiate along a gradient of environmental conditions.

[c] WBS Assessment Type Codes from Table 1-1.

Table 3-2. Hierarchy of Habitat Assessment Approaches for Evaluation of Aquatic Life Use Attainment

Level Of Info[a]	Technical Components	Spatial/ Temporal Coverage	Data Quality[b]	WBS Codes[c]
1	Visual observation of habitat characteristics; no true assessment; documentation of readily discernable land use characteristics that might alter habitat quality; no reference conditions	Sporadic visits; sites are mostly from road crossings or other easy access	Unknown or low precision and sensitivity; professional scientist (biologist, hydrologist) not required	365
2	Visual observation of habitat characteristics and simple assessment; use of land use maps for characterizing watershed condition; reference condition pre-established by professional scientist	Limited to annual visits and non-specific to season; generally easy access; limited spatial coverage and/or site-specific studies	Low precision and sensitivity; professional biologist or hydrologist not involved or only correspondence	370
3	Visual-based habitat assessment using standard operating procedures (SOPs); may be supplemented with quantitative measurements of selected parameters; conducted with bioassessment; data on land use compiled and used to supplement assessment; reference condition used as a basis for assessment	Assessment during a single season usually the norm; spatial coverage may be limited or broad and commensurate with biological sampling; assessment may be regional or site-specific	Moderate precision and sensitivity; professional biologist or hydrologist performs survey or provides oversight and training	375
4	Assessment of habitat based on quantitative measurements of instream parameters, channel morphology, and floodplain characteristics; conducted with bioassessment; data on land use compiled and used to supplement assessment; reference condition used as a basis for assessment	Assessment during 1-2 seasons; spatial coverage usually broad and commensurate with biological sampling; assessment may be regional or site-specific	High precision and sensitivity; professional biologist or hydrologist performs survey and assessment	380

NOTE: Table is based on use in lotic systems. With some modification, these approaches would apply to other waterbody types.

[a] Level of information refers to rigor of habitat assessment, where 1 = lowest and 4 = highest.

[b] Refers to ability of the habitat endpoints to detect impairment or to differentiate along a gradient of environmental conditions.

[c] WBS Assessment Type Codes from Table 1-1.

Table 3-3. Hierarchy of Toxicological Approaches and Levels for Evaluation of Aquatic Life Use Attainment

Level of Info[a]	Technical Components	Spatial/ Temporal Coverage	Data Quality[b]	WBS Codes[c]
1	Any one of the following: • Acute or chronic WET • Acute ambient • Acute sediment	1-2 WET tests/yr or 1 ambient or sediment sample tested in a segment or site	Unknown/low; minimal replication used; laboratory quality or expertise unknown	510, 520, 530, 550
2	Any of the following: • Acute or chronic ambient • Acute sediment • Acute and chronic WET for effluent-dominated system	3-4 WET tests/yr or 2 ambient or sediment samples tested in a segment or site at different times	Low/moderate—little replication used within a site; laboratory quality or expertise unknown or low	510, 520, 530, 540, 550
3	Any of the following: • Acute and chronic WET for effluent-dominated system • Chronic ambient or acute or chronic sediment	Monthly WET tests or total of 3 tests based on samples collected in a segment at 3 different times	Moderate/high—replication used; trained personnel and good laboratory quality	510, 520, 540, 550
4	Both of the following: • Acute and chronic ambient and • Acute or chronic sediment	≥ 4 tests in total based on samples collected in a segment at 4 different times including low flow conditions	High—replication used; trained personnel and good laboratory quality	530, 540, 550

[a] Level of information refers to rigor of toxicity testing, where 1 = lowest and 4 = highest

[b] Refers to ability of the toxicity testing endpoints to detect impairment or to differentiate along a gradient of environmental conditions

[c] WBS Assessment Type Codes from Table 1-1.

Table 3-4. Hierarchy of Physical/chemical Data Levels for Evaluation of Aquatic Life Use Attainment

Level of Info[a]	Technical Components	Spatial/Temporal Coverage	Data Quality[c]	WBS Codes[d]
1	Any one of the following: • Water quality monitoring using grab water sampling • Water data extrapolated from an upstream or downstream station where homogeneous conditions are expected • Monitoring data >5 years old without further validation • Best professional judgment based on land use data, source locations	Low spatial and temporal coverage: • Quarterly or less frequent sampling with limited period of record (e.g., 1 day) • Limited data during key periods or at high or low flows (critical hydrological regimes)[b].	Unknown/ Low	210, 220, 230, 240, 850, 150, 130
2	Any one of the following: • Water quality monitoring using grab water sampling • Rotating basin surveys involving multiple visits or automatic sampling • Synthesis of existing or historical information on fish contamination levels • Screening models based on loadings data (not calibrated or verified).	Moderate spatial and temporal coverage: • Bimonthly or quarterly sampling during key periods (e.g., spring/ summer months • Fish spawning seasons, including limited water quality data at high and low flows • Short period of record over a period of days or multiple visits during a year or season.	Low/ Moderate	210, 220, 222, 230, 240, 242, 260, 810, 180
3	Any one of the following: • Composite or a series of grab water sampling used (diurnal coverage as appropriate) • Calibrated models (calibration data <5 years old).	Broad spatial and temporal (long-term, e.g., > 3 years) coverage of site with sufficient frequency and coverage to capture acute events: • Typically, monthly sampling during key periods (e.g., spring/ summer months, fish spawning seasons), multiple samples at high and low flows • Lengthy period of record (sampling over a period of months).	Moderate/ High	211, 222, 242, 250, 610
4	All of the following: • Water quality monitoring using composite or series or grab samples (diurnal coverage as appropriate) • Limited sediment quality sampling and fish tissue analyses at sites with high probability of contamination.	Broad spatial (several sites) and temporal (long-term, e.g., > 3 years) coverage of site with sufficient frequency and parametric coverage to capture acute events, chronic conditions, and all other potential P/C impacts • Monthly sampling during key periods (e.g., spring/summer months • Fish spawning seasons) including multiple samples at high and low flows • Continuous monitoring.	High	231, 242, 250

NOTE: Physical refers to physical water parameters (e.g., temperature, pH, dissolved oxygen, turbidity, color, conductivity)

[a] Level of information refers to rigor of physical/chemical sampling and analysis, where 1 = lowest and 4 = highest.

[b] Even a short period of record can indicate a high confidence of *impairment* based on P/C data; 3 years of data are not required to demonstrate impairment. For example, a single visit to a stream with severe acid mine drainage impacts (high metals, low pH) can result in high confidence of nonsupport. However, long-term monitoring may be needed to establish full support.

[c] Refers to ability of the physical/chemical endpoints to detect impairment or to differentiate along a gradient of environmental conditions.

[d] WBS Assessment Type Codes from Table 1-1.

At the Workgroup's recommendation, EPA is applying levels of information to wadable streams and rivers where EPA's Rapid Bioassessment Protocols or other comparable methods can be applied. This is because, at this time, monitoring methods for wadable streams and rivers are better documented and standardized (Gibson et al. 1996, Plafkin et al., 1989) than for other surface water resources such as lakes and estuaries.

EPA asks States to document the level of information that characterizes their methods for biological, habitat, toxicological, and chemical evaluations. The approach may be extended to ALUS determinations in other types of waterbodies as well as other designated uses in future 305(b) cycles based on the experience with ALUS in streams and rivers and as methods for other waterbody types are standardized. The Waterbody System will contain fields to track level of information for each data type (first columns of Tables 3-1 through 3-4).

EPA encourages States to store and provide this information for each river and stream assessment in addition to WBS Assessment Type Codes. See Section 6, especially Table 6-1, of the main *Guidelines* volume regarding data elements for annual electronic reporting.

3.2.1 Bioassessment

Biological survey methods are desirable for ALUS determinations, because they measure ecosystem health and integrity more directly than surrogate techniques and serve as response indicators to a variety of stressors. Certain biological survey and assessment techniques are useful for screening; i.e., they are intended to be sufficient for detecting problems and may not be as rigorous as techniques used to assess the degree of use support or prioritize sites for further study or some mitigation action. However, simple biological screening techniques are usually sufficient to identify severely degraded or the other extreme (i.e., excellent) biological conditions. A hierarchy of biological approaches can be developed that incorporates certain technical considerations and are relevant to various levels of information (Table 3-1). The data quality elements emphasize a determination of precision (i.e., measurement error at a site as evidenced by the reproducibility of metric values or bioassessment scores for a given site during the same index period) and sensitivity (i.e., the ability to detect impairment relative to the reference condition).

Based on considerable information already available, EPA strongly endorses the regional reference approach for State bioassessment programs for streams (Gibson et al. 1996), which is a level 3 or 4 assessment in Table 3-1. If States choose not to implement a reference site approach, they are still encouraged to monitor two organism assemblages (level 4),

with detailed taxonomy, a multimetric approach, and habitat evaluation. In calling for two assemblages, EPA seeks to include critical groups in the food chain that may react to different ecosystem stressors or differently to the same stressor. EPA recognizes that the use of two assemblages or the regional reference approach may not be feasible in certain cases (e.g., streams in the arid west due to naturally occurring conditions such as extreme temperatures and lack of flow). EPA also recognizes that some State bioassessment programs are in their early stages and may not yet have the capability to use a regional reference site approach or to monitor more than one assemblage.

Many States (Davis et al. 1996) are currently assessing a single assemblage, benthic macroinvertebrates, with detailed taxonomy, a multimetric approach, and habitat evaluation (Level 2 or 3 assessment in Table 3-1). These States are monitoring a critical assemblage that often gives the greatest information about ecosystem health for the available resources. For fish sampling, some rely on their fish and game agencies, which are mainly oriented to game fish. As resources permit, EPA encourages State water quality agencies to develop the capability for fish assemblage monitoring themselves or work with the fish and game staff to develop the needed capabilities.

ALUS Determination Based on Biological Assessment Data

A. Fully Supporting: Reliable data indicate functioning, sustainable biological assemblages (e.g., fish, macroinvertebrates, or algae) none of which has been modified significantly beyond the natural range of the reference condition.

B. Partially Supporting: At least one assemblage (e.g., fish, macroinvertebrates, or algae) indicates moderate modification of the biological community compared to the reference condition.

C. Not Supporting: At least one assemblage indicates nonsupport. Data clearly indicate severe modification of the biological community compared to the reference condition.

The interpretation of the terms "modified significantly," "moderate modification," and "severe modification" is State-specific and depends on the State's monitoring and water quality standards programs. For example, Ohio EPA reports nonattainment (not supporting) if none of its 3 indices (2 for fish and 1 for macroinvertebrates) meet ecoregion criteria or if one assemblage indicates severe toxic impact (Ohio's poor or very poor category), even if the other assemblage indicates attainment. Partial support exists if 1 of 2 or 2 of 3 indices do not meet ecoregion criteria and are in the poor or very poor category.

Additional Considerations for Lakes

State lake managers should address more than one biological assemblage in making lake ALUS decisions. Many parameters of these assemblages may not have specific criteria (e.g., algal blooms, growth of nuisance weeds) but have important effects on lake uses. Many are also response indicators of the level of lake eutrophication.

Lake resources vary regionally, even within States, due to variations in geology, vegetation, hydrology, and land use. Therefore, regional patterns of lake water quality, morphometry (physical characteristics such as size, shape, and depth), and watershed characteristics should ideally be defined based on comparison to natural conditions using an ecoregion approach. The State can then set reasonable goals and criteria for a variety of parameters. These regional patterns currently apply to natural lakes, but are being evaluated for use with reservoirs.

EPA is developing guidance on bioassessment protocols and biological criteria development for lakes and reservoirs (*Guidance on Lake and Reservoir Bioassessment and Biocriteria*, draft, U.S. EPA, 1996). Draft guidance is currently being revised to address a review of comments by EPA's Science Advisory Board. Notice of availability for public review and comment in the *Federal Register* is planned for 1997.

3.2.2. Habitat Assessment

Assessment of the physical habitat structure is necessary for aquatic life support evaluations because the condition and/or potential of the biological community is dependent upon supportive habitat. Aquatic fauna often have very specific habitat requirements, independent of water quality (Barbour et al. 1996a). The technique of habitat assessment has evolved substantially over the last decade to provide adequate information on the quality of the habitat. Numerous State and Tribal agencies are well-versed in habitat assessment and have incorporated appropriate techniques into their monitoring programs. Results from nonpoint-source assessments suggest that habitat alteration is a major source of perturbation of the Nation's surface waters. The strengths of habitat assessment are: (1) enhances interpretation of biological data; (2) provides information on non-chemical stressors, and (3) leads to informed decisions regarding problem identification and restoration.

Most often, habitat assessment is conducted in conjunction with bioassessment. A general habitat assessment incorporates physical attributes from microhabitat features such as substrate, velocity, depth, to channel morphology features such as width, sinuosity, flow or volume, to

riparian and bank structure features. All of these features are stressor indicators. The approach also can integrate habitat information into an index or summary of overall habitat condition.

The rigor of the habitat assessment ranges from a visual-based characterization (Level 1), which documents specific characteristics without placing a value, to a true assessment (Levels 2 through 4), which places a value on the quality of the physical habitat structure (Table 3-2). Habitat assessments may be visual-based (e.g., RBPs), patterned after Ohio EPA (1987), Plafkin et al. (1989), Florida DEP (1994), and Idaho DEQ (1995), or more quantitative as suggested by the Environmental Monitoring and Assessment Program (EMAP). The data quality associated with habitat assessment is more difficult to define than with bioassessment, but can be done by a comparison among investigators.

ALUS Determination Based on Habitat Assessment Data.

A. Fully Supporting: Reliable data indicate natural channel morphology, substrate composition, bank/riparian structure, and flow regime of region. Riparian vegetation of natural types and of relatively full standing crop biomass (i.e., minimal grazing or disruptive pressure).

B. Partially Supporting: Modification of habitat slight to moderate usually due to road crossings, limited riparian zones because of encroaching land use patterns, and some watershed erosion. Channel modification slight to moderate.

C. Not Supporting: Moderate to severe habitat alteration by channelization and dredging activities, removal of riparian vegetation, bank failure, heavy watershed erosion or alteration of flow regime.

Habitat assessment is mostly conducted in conjunction with bioassessment. However, degradation of habitat associated with aquatic resources is a primary stressor limiting the attainment of aquatic life use support in many regions of the country. Land use patterns involving urban development and impervious surface, agriculture and ranching, silviculture, mining, and flood control/regulation are generally the principal factors in habitat degradation.

3.2.3. Aquatic and Sediment Toxicity Methods

EPA recommends that information from toxicity tests be separated from the physical/chemical data. Although chemical criteria are based on toxicity tests, actual testing done to evaluate an aquatic life use should be treated as an additional ecological indicator.

Toxicity tests are a well-established tool for examining effects of both point and nonpoint sources of chemicals or effluents in surface waters (i.e., stressor and exposure indicators). Most States require whole effluent toxicity (WET) testing of waste water dischargers under the NPDES program. For ALUS, ambient water column and whole sediment toxicity tests may be most relevant, particularly if the early life stages of test organisms and sublethal (chronic) endpoints are used (Table 3-3). Ambient tests use samples that are collected from sites and that are typically used whole (i.e., no dilution). Toxicity tests, like chemical analyses, use temporally discrete samples which, in the case of water column tests, typically have short holding times (< 36 hours according to EPA guidance). Sediment samples may be held for longer periods (2 to 8 weeks) prior to testing if stored properly. Samples used in aquatic toxicity testing are usually collected over no more than a 24-hour period. Sediment samples, by their very nature, are grab samples which are also collected over a short time period (hours) at any one site. As a result, all toxicity tests, even those involving prolonged chronic exposures (such as EPA 7-day chronic tests or 28-day chronic sediment tests), yield data that are a "snapshot" in time. The longer the period of time over which site water or sediment samples are collected and used in testing, the longer the "snapshot" and the higher confidence that the test result is representative of prevailing water or sediment quality conditions at that time. The strengths of ambient toxicity tests are:

- They aid in identifying point and nonpoint source water-quality impairments that may otherwise be undetectable using other monitoring tools;

- They are used for confirming that observed impairment is not due to chemical or toxicity-related sources. Ohio EPA and the North Carolina Division of Water Quality, for example, used toxicity tests to demonstrate that habitat or physical stressors were the major causes of impairment in some systems and not point-source toxicity as previously assumed;

- They integrate biological effects of most chemical stressors present, thereby giving a more accurate estimate of the actual water or sediment quality as compared to chemical concentration measurements; this has been shown to be particularly true for certain water column metals, bulk sediment chemical measurements that do not take into account total organic carbon or acid volatile sulfide concentrations (for nonpolar organics and metals, respectively), and for sites in which potential pollutants were unmeasured or unknown.

WET tests are potentially useful for ALUS at sites in which an effluent contributes the major flow instream (i.e., effluent-dominated or effluen dependent systems). These tests are well standardized and relatively sy to interpret, however, their relationship to ALUS is dependent on many factors that may or may not be identifiable for the system of interest (iller et al. 1996; LaPoint et al. 1996).

Sediment toxicity tests are especially useful for ALUS since sediments n be prominent sources as well as sinks. For this reason, sediment samp may represent a somewhat longer "snapshot" in time than water colum samples. Also, because sediment samples can be stored for longer per ls than water samples, they are more convenient se in testing. Colle on of sediment pore water or elutriates further e es the use of sedim ts in ALUS because these fractions may contai nc of the bioavailable pollutants present and because these fractio a amenable to standa aquatic toxicity test methods. Combined w b ssessments and sec ent chemical analyses, sediment toxicity is a p erf tool to evaluate and identify causes of impairment. Whole se nent sting, using the mor standardized 10-day acute tests, may b nost a opriate for ALUS. ese are the least labor-intensive and costly t ts and a lso easiest to interpret. The more recently developed PA chronic diment te ethods (which should be available by the end 1997) are also omis g tools for ALUS. Sediment testing is most relev t if there are appr e reference site sediments available with which to ompare different site samples. Usually, such reference sites are avail le, but in some instances are defined by trial and error. The use of clean l oratory-formulated reference sediments as a means of comparison s also a viable option, particularly if factors such as sediment particle siz are similar to that observed at the site of interest.

Concerns with sedi t te) for representativeness, many sediment samples ay need to be composited at a site to overcome physical and chemical h rogeneity; (2) storage and manipulation of samples prior to testing may ch ge the chemical characteristics and toxicity of a sample in unknown ways; an (3) for some species, physical characteristics of the sediment (e.g., partic e size or TOC) may be suboptimal for the test species resulting in a false positive or apparently toxic conditions when there are none. This may necessitate the use of two or more different test species for a given sediment sample.

Several EPA, American Society for Testing Materials (ASTM), and State agency toxicity test methods exist, both for saltwater and freshwater aquatic and sediment toxicity tests, ranging from short-term acute or lethality tests (usually 48 to 96h in length for aquatic and pore water or elutriate tests and 10d for whole sediments) to longer term early life stage

(7 day for pore water and elutriates and 28 day for whole sediments) and full life-cycle (> 21 day for aquatic tests) chronic tests that measure sublethal endpoints. Some sublethal tests such as those for saltwater bivalve embryo-larval development or echinoderm fertilization, may be much shorter in duration (48 and 1.5 hour, respectively). Appropriate sample collection is critical to ensure representative and accurate results. In addition, chemically inert sampling equipment must be used and depth and/or width integrated composite samples should be considered for ALUS determination.

ALUS Determinations Based on Aquatic and/or Sediment Toxicity Data

A. Fully Supporting: No toxicity noted in either acute or chronic tests compared to controls or reference conditions.

B. Partially Supporting: No toxicity noted in acute tests, but may be present in chronic tests in either slight amounts and/or infrequently within an annual cycle.

C. Not Supporting: Toxicity noted in many tests and occurs frequently.

Other Considerations

For certain species such as planktonic ones, ambient aquatic samples may appear more or less toxic due to the presence of certain natural water quality conditions or eutrophication effects. Ambient tests are a "snapshot" in time and may be unrepresentative of other times, seasons, or flows. Non-toxic conditions include naturally high dissolved solids, hardness, or conductivity, or naturally low alkalinity and hardness. Appropriate reference site or control samples for comparison may not be readily available in some systems resulting in a certain amount of uncertainty in extrapolating laboratory control or simulated reference conditions to actual natural conditions at a site. WET tests are best incorporated into the NPDES program; for ALUS, the results obtained using tools in the 305(b) process such as bioassessment, ambient aquatic and sediment toxicity tests, and chemical monitoring are more appropriate.

3.2.4 Physical/Chemical Methods

The use of physical/chemical data as stressor and exposure indicators for determining ALUS has long been a basis of State monitoring programs. Established criteria exist for many chemical parameters and standard sampling and analysis protocols have been developed for ensuring consistency and quality control. These data are separated into categories of toxicants (priority pollutants, chlorine, and ammonia), conventionals

(dissolved oxygen, pH, temperature) in reference to the physical constituents of water quality, and metals. Although SOPs exist for physical/chemical parameters, States still differ in their design and implementation of chemical sampling and analysis (Table 3-4). Sampling frequency and intensity vary among states. The number of parameters sampled and analyzed also varies among programs which influences comparability in assessments.

Analyses of chemical concentrations in fish tissues are included in Table 3-4. Though not a traditional or required measure of ALUS, fish tissue concentrations are useful for evaluating the potential impacts to wildlife that depend on aquatic systems for food and/or habitat.

ALUS Determinations Based on Physical/Chemical Assessment Data

EPA recognizes that many States may not always collect a broad spectrum of chemical data for every waterbody. Therefore, States are expected to apply the following guidance to whatever data are available and to use a "worst case" approach where multiple types of data are available. If, for example, chemical data indicate full support but temperature data indicate impairment, the waterbody is considered impaired.

Conventionals (dissolved oxygen, pH, temperature)

A. Fully Supporting: For any one pollutant or stressor, criteria exceeded in ≤10 percent of measurements. In the case of dissolved oxygen (DO), national ambient water quality criteria specify the recommended acceptable daily average and 7-day average minimums and the acceptable 7-day and 30-day averages. States should document the DO criteria being used for the assessment and should discuss any biases that may be introduced by the sampling program (e.g., grab sampling in waterbodies with considerable diurnal variation).

B. Partially Supporting: For any one pollutant, criteria exceeded in 11 to 25 percent of measurements. For DO, the above considerations apply.

C. Not Supporting: For any one pollutant, criteria exceeded in >25 percent of measurements. For DO, the above considerations apply.

Special Considerations for Lakes

For lakes, States should discuss their interpretation of DO, pH, and temperature standards for both epilimnetic and hypolimnetic waters. In addition, States should consider turbidity and lake bottom siltation.

Toxicants (priority pollutants, metals, chlorine, and ammonia)

A. Fully Supporting: For any one pollutant, no more than 1 exceedance of acute criteria (EPA's criteria maximum concentration or applicable State/Tribal criteria) within a 3-year period based on grab or composite samples and no more than 1 exceedance of chronic criteria (EPA's criteria continuous concentration or applicable State/Tribal criteria) within a 3-year period based on grab or composite samples.

B. Partially Supporting: For any one pollutant, acute or chronic criteria exceeded more than once within a 3-year period, but in $\leq$10 percent of samples.

C. Not Supporting: For any one pollutant, acute or chronic criteria exceeded in >10 percent of samples.

Note: The above assumes at least 10 samples over a 3-year period. If fewer than 10 samples are available, the State should use discretion and consider other factors such as the number of pollutants having a single violation and the magnitude of the exceedance(s).

Other Considerations Regarding Toxicant Data

- EPA maintains that chronic criteria should be met in a waterbody that fully supports its uses. Few States and Tribes, if any, are obtaining composite data over a 4-day sampling period for comparison to chronic criteria. EPA believes that 4-day composites are not an absolute requirement for evaluating whether chronic criteria are being met. Grab and composite samples (including 1-day composites) can be used in water quality assessments if taken during stable conditions. This should give States more flexibility in utilizing chronic criteria for assessments.

- States should document their sampling frequency. Sampling frequency should be based on potential variability in toxicant concentrations. In general, waters should have at least quarterly data to be considered monitored; monthly or more frequent data are considered abundant. More than 3 years of data may be used, although the once-in-3-years consideration still applies (i.e., two violations are allowed in 6 years of abundant data).

- The once-in-3-years goal is not intended to include spurious violations resulting from lack of precision in analytical tests. Therefore, using documented quality assurance/quality control (QA/QC) assessments, States may consider the effect of laboratory imprecision on the observed frequency of violations.

- If the duration and frequency specifications of EPA criteria change in the future, these recommendations should be changed accordingly.

- Samples should be taken outside of designated mixing zones or zones of initial dilution.

Special Considerations Regarding Metals

The implementation and application of metals criteria is complex due to the site-specific nature of metals toxicity. EPA's policy is for States to adopt and use the dissolved metal fraction to set and measure compliance with water quality standards, because dissolved metal more closely approximates the bioavailable fraction of metal in the water column than does total recoverable metal. One reason is that a primary mechanism for water column toxicity is adsorption at the gill surface which requires metals to be in the dissolved form. Table 3-5 provides guidance for calculating EPA dissolved criteria from the published total recoverable criteria. The dissolved metal criteria, expressed as percentage, are presented as recommended values and ranges. If a State is collecting dissolved metal data but does not yet have dissolved criteria, Table 3-5 might be useful for estimating screening values. Also, if total recoverable metal concentrations are less than the estimated dissolved metal criteria calculated from Table 3-5, the State could be relatively certain that toxic concentrations are not present.

Some States have already developed and are using dissolved metals criteria and should continue to do so. In the absence of dissolved metals data and State criteria, States should continue to apply total recoverable metals criteria to total recoverable metals data because this is more conservative and thus protective of aquatic life. In some situations, a State may choose to use total recoverable metals criteria when there are indications that total metal loadings could be a stress to the ecosystem. The ambient water quality criteria are neither designed nor intended to address the fate and effect of metals in an ecosystem, e.g., protect sediments, prevent effects due to food webs containing organisms that dwell in the sediments and those that dwell in the water column and filter or ingest suspended particles. However, since consideration of sediments or bioaccumulative impacts is not incorporated into the criteria methodology, the appropriateness and degree of conservatism inherent in the total recoverable approach is unknown.

Historical metals data should be used with care. Concern about the reliability of the data are greatest below about 5 to 10 ppb due to the possibility of contamination problems during sample collection and analysis. EPA believes that most historical metals concentrations above this level are valid if collected with appropriate quality assurance and quality control.

Table 3-5. Recommended Factors for Converting Total Recoverable Metal Criteria to Dissolved Metal Criteria

Metal	Recommended Conversion Factors	
	CMC[a]	CCC[a]
Arsenic (III)	1.000	1.000
Cadmium[b]		
Hardness = 50 mg/L	0.973	0.938
Hardness = 100 mg/L	0.944	0.909
Hardness = 200 mg/L	0.915	0.880
Chromium (III)	0.316	0.860[c]
Chromium (VI)	0.982	0.962
Copper	0.960	0.960
Lead[b]		
Hardness = 50 mg/L	0.892	0.892
Hardness = 100 mg/L	0.791	0.791
Hardness = 200 mg/L	0.690	0.690
Nickel	0.998	0.997
Selenium	0.922	0.922
Zinc	0.978	0.986

[a] CMC = Criterion Maximum Concentration
CCC = Criterion Continuous Concentration

[b] The recommended conversion factors (CFs) for any hardness can be calculated using the following equations:

Cadmium
CMC: CF = 1.136672 - [(ln hardness) (0.041838)]
CCC: CF = 1.101672 - [(ln hardness) (0.041838)]

Lead (CMC and CCC): CF = 1.46203 - [(ln hardness) (0.145712)]

where:
(ln hardness) = natural logarithm of the hardness. The recommended CFs are given to three decimal places because they are intermediate values in the calculation of dissolved criteria.

[c] This CF applies only if the CCC is based on the test by Stevens and Chapman (1984). If the CCC is based on other chronic tests, it is likely that the CF should be 0.590, 0.376, or the average of these two values.

Source: Stephen, C. E. 1995. *Derivation of Conversion Factors for the Calculation of Dissolved Freshwater Aquatic Life Criteria for Metals*. U.S. EPA, Environmental Research Laboratory, Duluth.

3.2.5 Integration of Different Data Types in Making an ALUS Determination

The following guidelines apply to ALUS determinations for wadable streams and rivers when biological, habitat, chemical, and/or toxicity data types are available (Figure 3-2, Table 3-6). These guidelines strongly emphasize the use of biological data for the assessment of ALUS specific to wadeable streams and rivers. However, the basic principles are applicable to other waterbody types. This guidance has undergone external peer-review (Dickson et al. 1996) and has been revised to address the principle peer-review recommendations to improve the guidance. In addition, peer review recommendations were made to expand the guidance to (1) develop a confidence icon for the overall assessment and (2) develop guidelines that consider the results from biological, chemical and physical assessments in relation to their role as response, stressor or exposure indicators. The peer review specifically recommended that EPA develop a weighting algorithm for biological results (as response indicator) in relation to results from physical/chemical, habitat, and toxicological assessments (as stressor/exposure indicators). These latter recommendations will be evaluated for future guidelines. EPA considers the current guidelines, particularly consideration of level of information, as providing the initial basis for addressing these additional peer review recommendations.

EPA recommends consideration of the level of information of the different data types in evaluating degree of impairment (partial support vs nonsupport). Case studies follow that demonstrate how ALUS determinations could be made based on types of data, level of information, and site specific information and conditions, and are not intended to cover all possible situations but to highlight commonly encountered scenarios. These case studies are based on actual State examples that represent a State's decision process in making an ALUS determination, and are presented in a uniform manner for illustration. Different states use different ordinal scales for assessment.

Generally, assessments based on data with high levels of information should be weighted more heavily than those based on data with low levels of information, and biological data should be weighted more heavily than other data types. In particular, it is recommended that the results of biological assessments, especially those with high levels of information, be the basis for the overall ALUS determination if the data indicate impairment. This is because the biological data provide a direct measure of the status of the aquatic biota and detect the cumulative impact of multiple stressors on the aquatic community, including new or previously undetected stressors. This approach is consistent with EPA's Policy on Independent Application while incorporating a weight of evidence approach in determining the degree of impairment (partial or nonsupport). The Policy does not allow for a

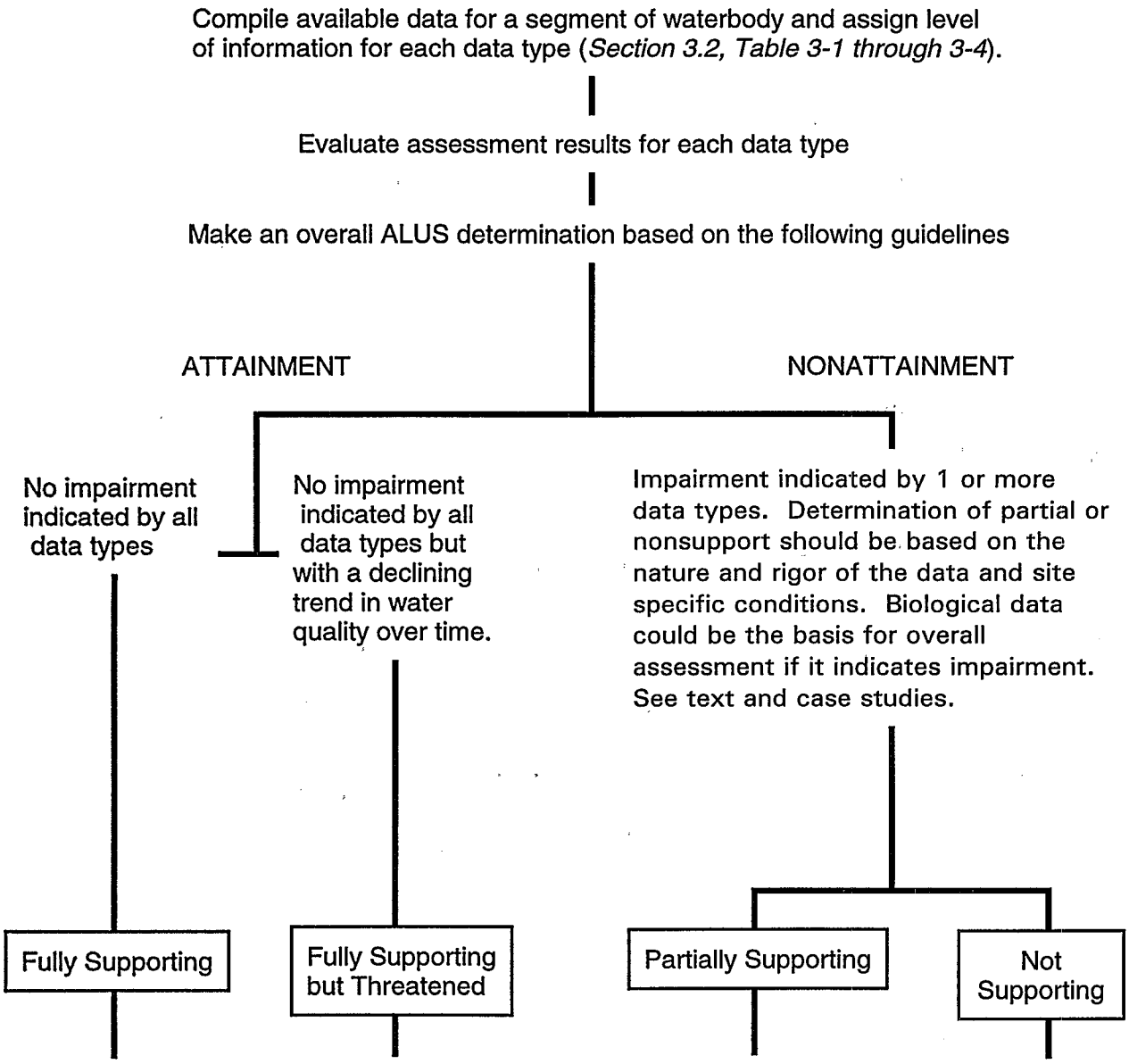


Figure 3-2. Determination of ALUS using biological, chemical, toxicological, and/or habitat data.

Table 3-6. Determination of ALUS Using More Than One Data Type

ALUS Attainment	
A. Fully Supporting:	No impairment indicated by all data types
B. Fully Supporting but Threatened:	No impairment indicated by all data types; one or more categories indicate an apparent decline in ecological quality over time or potential water quality problems requiring additional data or verification, or Other information suggests a threatened determination (see Section 3.2)
ALUS Non-attainment	
C. *Partially Supporting:	Impairment indicated by one or more data types and no impairment indicated by others.
D. *Not Supporting:	Impairment indicated by all data types
* A determination of *partially supporting* or *not supporting* could be made based on the nature and rigor of the data and site-specific conditions in the results of the data types. If bioassessment (usually Level 3 or 4) indicates impairment, then a determination of not supporting should be made. See case studies that follow.	

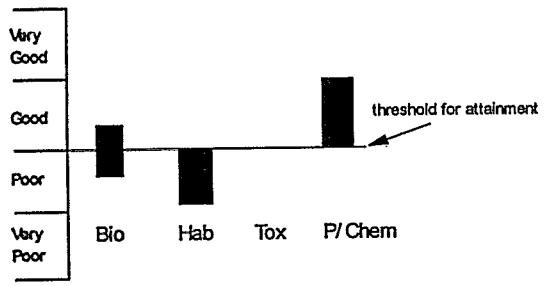
Ten Mile River, MA-Site TM01 Dec. 1991

Waterbody Description
ALUS: Class B, warm water fishery Reach Size: 0.8 miles, Headwaters to Bacon Street, Plainville, site upstream of electroplating facility Drainage Area: ? Stressors: urban development, impoundment Number of sites monitored: 1

Assessment Quality

Data Type	Level 1	2	3	4	Description
Biological			✓		• RBP (Benthic and Fish) survey, 1990
Habitat			✓		• Vis.-based RBP
Toxicity					• None
P/Chemical		✓			• Conventionals, no metals

Assessment Findings



Results Summary:

a. Benthos show some impairment, but fish indicate no impairment
b. Habitat is degraded from impoundments and urban development
c. Analysis of conventional pollutants shows no exceedances

Result = Partially Supporting

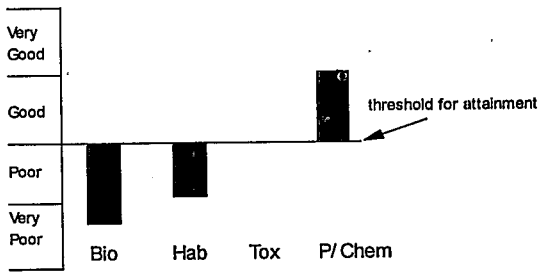
Ten Mile River, MA-Site TM02 Dec. 1991

Waterbody Description
ALUS: Class B, warm water fishery Reach Size: 0.1 miles,Bacon Street, Plainville, site downstream of electroplating facility Drainage Area: ? Stressors: urban development, impoundment Number of sites monitored: 1

Assessment Quality

Data Type	Level 1	2	3	4	Description
Biological			✓		• RBP (Benthic and Fish) survey, 1990
Habitat			✓		• Vis.-based RBP
Toxicity					• None
P/Chemical		✓			• Conventionals, no metals

Assessment Findings



Results Summary:

a. Both benthos and fish show impairment
b. Habitat is degraded from impoundments and urban development
c. Analysis of conventional pollutants shows no exceedances

Result = Not Supporting

Little River, Kentucky, 1994-95

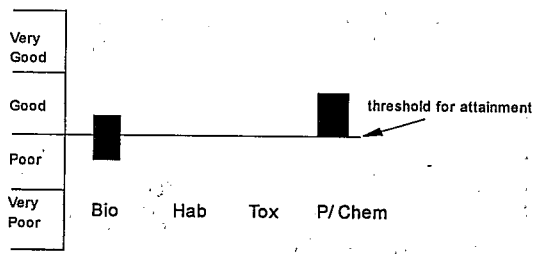
Waterbody Description

ALUS: Warmwater Aquatic Life
Reach Size: 37.4 mi
Drainage Area: 250 mi²
Stressors: Municipal WWTPs, agriculture
Number of sites monitored: 1

Assessment Quality

Data Type	Level 1	2	3	4	Description
•Biological	✓			✓	• Fish, macroinvertebrates (Level 4), algae survey by division biologists; survey form submitted by regional fisheries biologiest
•Habitat •Toxicity •P/Chemical			✓		• Monthly ambient monitoring network station

Assessment Findings



Results Summary:

a. Analysis of conventional pollutants and metals show no results greater than water quality criteria
b. Biological assessment of 3 assemblages indicates only partial u support, mostly from macroinverte e. data
c. Survey of district fisheries biologist indicates fair fishery

Result = Partially Supporting

Middle Fork Kentucky River, Kentucky, 95

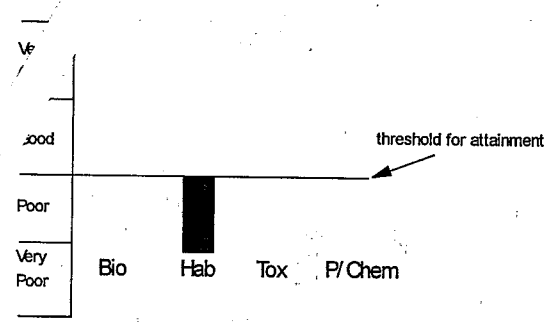
Waterbody Description

ALUS: Warmwater Aquatic Life
Reach Size: 27.1 mi
Drainage Area: 205 mi²
Stressors: Coal mining
Number of sites monitored: None; asses is visual observation and general knowledge of o of fishery

Assessment ty

Data Type	Level 1	2	3	Description
•Biological •Habitat	✓			• Survey submitted by regional fisheries biologies
•Toxicity •P/Chemical				

Assessment Findings



Results Summary:

a. Fisheries biologist familiar with this river indicates poor fishery because of heavy siltation from surface mining smothering the cobble substrate

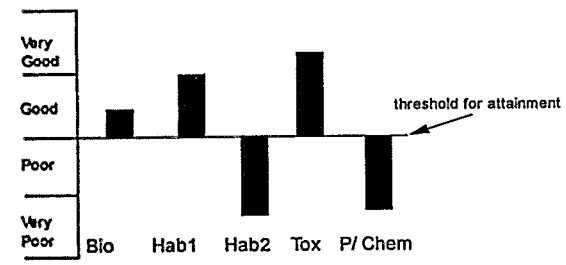
Result = Not Supporting

Blackstone River, MS 62-06, Massachusetts, 1994

Waterbody Description
ALUS: Class B, Warmwater Fishery **Reach Size:** 3.7 mi **Drainage Area:** ? **Stressors:** WWTP treating industrial center of Blackstone, urban runoff, contaminated sediments **Number of sites monitored:** 1

Assessment Quality					
Data Type	Level 1	2	3	4	Description
•Biological			✓		• RBP (Benthic) Survey
•Habitat			✓		• Visual-based done at 2 sites
•Toxicity		✓			• Instream chronic test
•P/Chemical		✓			• Toxics (water column and sediments

Assessment Findings



Results Summary:

a. Benthic assemblage diverse, but dominated by relatively tolerant taxa
b. Habitat good at site 1, but water withdrawal causes stream to go dry at 2.
c. No instream chronic toxicity
d. Cd, Cu, Pb exceed chronic criteria; Cu also exceeds acute criterion

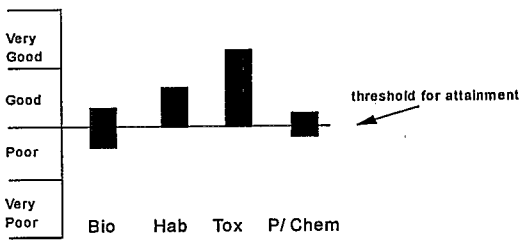
Result = Partially Supporting

Naugatuck River CT 6900, Connecticut, 1996

Waterbody Description
ALUS: Fish and Wildlife Habitat Reach Size: 19 miles Torrington to Waterbury Drainage Area: 155 mi^2 Stressors: 2 POTWS, 3 metal finishers, urban runoff Number of sites monitored: 4 biol., 1 chem., long term sites

Assessment Quality					
Data Type	Level 1	2	3	4	Description
•Biological				✓	• RBP III Benthos • RBP IV Fish
•Habitat			✓		• RBP Visual obs.
•Toxicity	✓				• WET acute
•P/Chemical			✓		• Conventional, metals, longterm fish tissue

Assessment Findings



Results Summary:

a. Benthos show moderate impairment, fish show no impairment.
b. Habitat is fair to good.
c. Toxicity - WET testing indicates no exceedance.
d. Conventional pollutants show no exceedance, some exceedance of copper chronic criteria at low flows.

Result = Partially Supporting

determination of full support when there are differences in assessment results when at least one assessment indicates impairment. For example, it is possible to arrive at an overall assessment of partial support where biological data indicate full support and other data types indicate some level of impairment.

3.2.6 Additional Information on Biological Assessment of ALUS for Wadable Streams and Rivers

The following information may be useful to States in making ALUS determinations based on biological and associated habitat data. Biological assessments are evaluations of the biological condition of waterbodies using biological surveys and other direct measurements of resident biota in surface waters and comparing results to the established biological criteria. They are done by qualified professional staff trained in biological methods and data interpretation. The utility of biological measures has been demonstrated in assessing impairment of receiving waterbodies, particularly that caused by nonpoint sources and nontraditional water quality problems such as habitat degradation. Biological assessments are key to determining whether functional, sustainable communities are present and whether any of these communities have been modified beyond the natural range of the reference condition. Functional and sustainable implies that communities at each trophic level have species composition, population density, tolerance to stressors, and healthy individuals within the range of the reference condition and that the entire aquatic system is capable of maintaining its levels of diversity and natural processes in the future (see Angermeier and Karr, 1994).

The techniques for biosurveys are still evolving, but there have been significant improvements in the last decade. Appropriate methods have been established by EPA (e.g., Plafkin et al., 1989), State agencies (e.g., Ohio EPA, 1987; Massachusetts DEP, 1996; Florida DEP, 1994; Idaho DEQ, 1995), and other investigators assessing the condition of the biota (e.g., Karr et al., 1986). Guidance for development of biocriteria-based programs is provided in the *Biological Criteria: National Program Guidance for Surface Waters* (U.S. EPA, 1990) and *Biological Criteria: Technical Guidance for Streams and Small Rivers* (Gibson et al., 1996). As biosurvey techniques continue to improve, several technical considerations apply:

- *The identification of the REFERENCE CONDITION is basic to any assessment of impairment or attainment of aquatic life use and to the establishment of biological criteria.*

  Reference conditions are described from an aggregate of data best acquired from multiple sites with similar physical dimensions, represent

minimally impaired conditions, and provide an estimate of natural variability in biological condition and habitat quality. For determining reference condition, alternative approaches to selection of reference sites include use of historical data, paleoecological data for lakes, experimental laboratory data for select cases, quantitative models, and best professional judgment (Hughes 1995).

Reference conditions must be stratified (i.e., put into homogenous waterbody classes) to account for much of the natural physical and climatic variability that affects the geographic distribution of biological communities. The Ecoregion Concept (Omernik, 1987) recognizes geographic patterns of similarity among ecosystems, grouped on the basis of environmental variables such as climate, soil type, physiography, and vegetation. Currently, efforts are under way in several parts of the country to refine these ecoregions into a more useful framework to classify waterbodies. Procedures have begun in several ecoregions and subecoregions to identify reference conditions within those particular units. In essence, these studies are developing reference databases to define biological potential and physical habitat expectations within ecoregions. The concept of reference conditions for bioassessment and biocriteria is discussed further below.

In developing community bioassessment protocols, reference conditions against which to compare test sites and to judge impairment are needed. Ideally, reference conditions represent the highest biological conditions found in waterbodies unimpacted by human pollution and disturbance. That is, the regional reference site concept is meant to accommodate natural variations in biological communities due to bedrock, soils, and other natural physicochemical differences. Recognizing that pristine habitats are rare (even remote lakes and streams are subject to atmospheric deposition), resource managers must decide on an acceptable level of disturbance to represent an achievable or existing reference condition. Acceptable reference conditions will differ among geographic regions and States and will depend on the aquatic life use designations incorporated into State water quality standards.

Characterization of reference conditions depends heavily on classification of natural resources. The purpose of a classification is to explain the natural biological condition of a natural resource from the physical characteristics. Waterbodies vary widely in size and ecological characteristics, and a single reference condition that applies to all systems would be misleading. A classification system that organizes waterbodies into groups with similar ecological characteristics is required to develop meaningful reference conditions.

The best approach to classifying and characterizing regional reference conditions is determined by the estimated quality of potential reference sites that are available in the region. If a sufficient number of relatively undisturbed waterbodies exist (e.g., primarily forested watersheds), then it is possible to define watershed conditions that are acceptable for reference sites. If no reference sites exist, then reference conditions can be characterized based on an extrapolation of the biological attributes representative of the aquatic biota expected to be found in the region (see Gibson et al., 1996) or through other quantitative models (Hughes 1995). EPA sees the use of a regional reference condition as an important component and goal of State biological programs. The Agency also recognizes that other approaches, such as upstream/downstream sampling, may be necessary (U.S. EPA, 1990).

The Ohio Environmental Protection Agency has been very active in the development of biocriteria based on reference conditions. Ohio's experiences and methods may be useful to other States in developing their biological monitoring and biocriteria programs (see, for example, Ohio EPA, 1987, 1990). Florida DEP has developed a similar approach for defining reference conditions (Barbour et al., 1996); Arizona DEQ has oriented its reference condition by elevation (Spindler, 1996); and Maine DEC uses a statistically derived-decision model technique that is based on a knowledge of the ecology and expectations in the response to perturbation of the biological attributes to classify and assess its streams (Davis et al., 1993). For further information on the development and implementation of biological criteria and assessments, States should consult *Biological Criteria: National Program Guidance for Surface Waters* (U.S. EPA, 1990), *Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish* (Plafkin et al., 1989), and *Biological Criteria: Technical Guidance for Streams and Small Rivers* (Gibson et al., 1996).

- *A MULTIMETRIC APPROACH TO BIOASSESSMENT is recommended to strengthen data interpretation and reduce error in judgment based solely on population indices and measures.*

The accurate assessment of biological integrity requires a method that integrates biotic responses through an examination of patterns and processes from individual to ecosystem levels (Karr et al., 1986). The early conventional approach to using individual population measures has been to select some biological parameter that refers to a narrow range of changes or conditions and evaluate that parameter (e.g., species distributions, abundance trends, standing crop, or production estimates). Parameters are interpreted separately with a summary statement about the overall health. This approach is limited in that the key parameters

emphasized may not be reflective of overall ecological health. The preferred approach is to define an array of metrics that individually provide information on each biological parameter and, when integrated, function as an overall indicator of biological condition. The strength of such a multimetric approach, when the component metrics are calibrated for a particular stream class, is its ability to integrate information from individual, population, assemblage, and zoogeographic levels into a single, ecologically-based index of water resource quality (Karr et al., 1986). The development of metrics for use in the biocriteria process can be partitioned into two phases (Barbour et al., 1995). First, an evaluation of candidate metrics is necessary to eliminate nonresponsive metrics and to address various technical issues (i.e., associated with methods, sampling habitat and frequency, etc.). Second, calibration of the metrics determines the discriminatory power of each metric and identifies thresholds for discriminating between "good" and"poor" sites. Known impaired sites are used to provide a test of discriminatory power. This process defines a suite of metrics that are optimal candidates for inclusion in bioassessments. Subsequently, a procedure for aggregating metrics to provide an integrative index is needed. For a metric to be useful, it must be (1) relevant to the biological community under study and to the specified program objectives; (2) sensitive to stressors; (3) able to provide a response that can be discriminated from natural variation; (4) environmentally benign to measure in the aquatic environment; and (5) cost-effective to sample. A number of metrics have been developed and subsequently tested in field surveys of benthic macroinvertebrate and fish assemblage (Barbour et al., 1995).

- *Assessment of HABITAT STRUCTURE as an element of the biosurvey is critical to assessment of biological response.*

  Interpretation of biological data in the context of habitat quality provides a mechanism for discerning the effects of physical habitat structure on biota from those of chemical toxicants. If habitat is of poor or somewhat degraded condition, expected biological values are lowered; conversely, if habitat is in good condition (relative to regional expectations), high biological condition values are expected. Poor habitat structure will prevent the attainment of the expected biological condition, even as water quality problems are ameliorated. If lowered biological values are indicated simultaneously with good habitat assessment rating scores, toxic or conventional contaminants in the system may have caused a suppression of community development. Additional chemical data may be needed to further define the probable causes (stressors). On the other hand, high biological metric scores in poor habitat could indicate a temporary response to organic enrichment,

natural variation in colonization/mortality, change in predation pressures, change in food source/abundance, or other factors.

- *A standardized INDEX PERIOD is important for consistent and effective monitoring.*

  The intent of a statewide bioassessment program is to evaluate overall biological conditions. The capacity of the aquatic community to reflect integrated environmental effects over time can be used as a foundation for developing bioassessment strategies (Plafkin et al., 1989). An index period is a time frame for sampling the condition of the community that is a cost-effective alternative to sampling on a year-round basis. Ideally, the optimal index period will correspond to recruitment cycles of the organisms (based on reproduction, emergence, and migration patterns). In some instances, an index period would be oriented to maximize impact of a particular pollutant source (e.g., high-temperature/low-flow period for point sources). Sampling during an index period can (1) minimize between-year variability due to natural events, (2) optimize accessibility of the target assemblages, and (3) maximize efficiency of sampling gear.

- *STANDARD OPERATING PROCEDURES and an effective QUALITY ASSURANCE PROGRAM are established to support the integrity of the data.*

  The validity of the ecological study and resultant conclusions are dependent upon an effective QA Plan. An effective QA Plan at the onset of a study provides guidance to staff in several areas: objectives and milestones for achieving objectives throughout the study; lines of responsibility; accountability of staff for data quality objectives; and accountability for ensuring precision, accuracy, completeness of data collection activities, and documentation of sample custody procedures. Documented SOPs for developing study plans, maintenance and application of field sampling gear, performance of laboratory activities, and data analyses are integral quality control components of QA that can provide significant control of potential error sources.

- *A determination of PERFORMANCE CHARACTERISTICS of the bioassessment provides an understanding of the data quality for the assessment.*

  Perhaps the most important component in making bioassessments useful to water resource programs is the data quality of different assessment methods currently in use and the level of comparability among methods in performing an assessment. The comparability of methods should be

judged by the degree of similarity in their performance characteristics (i.e., a performance-based approach) rather than by direct comparison of their respective scores or metric values (ITFM 1995, Diamond et al. 1996). To enable a sharing of data and results from various techniques that might be used by different agencies or other groups, some level of confidence in making an assessment must be established for each method based on the quality of data. This performance characteristic is precision, which is dependent upon the sampling methodology and the range in natural variation of the reference condition (note -- use of stream classification will increase precision).

The ability to detect impairment also depends on the sensitivity of the method. In some cases, the desirable sensitivity level depends on how severe or subtle the impairment. For example, it does not require a very rigorous method to detect impairment following an extensive fish kill or algal bloom. It is the subtle impact areas that require some level of rigor that minimizes Type I and Type II errors in a judgment of condition.

Based on preliminary information obtained from bioassessments conducted in Florida (Barbour et al. 1996a, Diamond et al. 1996), Ohio (Stribling et al. 1996), and New Hampshire (Stribling et al. 1994), quantitative criteria for precision and sensitivity can be set conservatively at "high" being less or equal to 20%, "moderate" being between 21 and 49%, and "low" being more or equal to 50%. High precision is equated to having low measurement error (coefficient of variation $<20\%$) and sensitivity is the ability to detect small differences ($<20\%$ difference) between reference and the site being assessed.

- *AN IDENTIFICATION OF THE APPROPRIATE NUMBER OF SAMPLING SITES that are representative of a waterbody is an important consideration in evaluating biological condition.*

The spatial array of sampling sites in any given watershed or region and the extrapolation of biological condition and water quality to areas beyond the exact sampling point must be established in any type of assessment. Two primary guidelines can be identified for extrapolating biological assessment data to whole watersheds. First, the structure of aquatic communities in lotic (flowing water) systems changes naturally with an increase in size of the stream. Thresholds in this continuum of change can be established through an analysis of regional databases. The biological condition at any particular site can only be used to represent upstream and downstream areas of the same physical dimensions and flow characteristics. Likewise, lake size will influence the number of sites needed to adequately characterize a lake or area of a lake. In small lakes, one site will generally be sufficient. In large lakes

with multiple basins or in reservoirs with various zones (inflow, midsection, outflow), a site representative of each basin or zone may be needed.

A second consideration for site identification is the change in land use patterns along a stream gradient or lake shoreline. Changes from agricultural land use to urban centers, forested parkland, etc., would warrant different representative sampling sites. A waterbody with multiple dischargers may also require numerous sampling sites to characterize the overall biological condition of the waterbody.

Technical Support Literature

The Peer Review Team for ALUS recommended several technical papers to be used in support of specific technical issues associated with bioassessment. Information from these and other relevant literature will be incorporated into the revision of this chapter, pending comments and guidance from the Technical Experts Panel. The technical papers recommended by the ALUS Peer Review Team are as follows:

Cummins, K. W. 1988. Rapid bioassessment using functional analysis of running water invertebrates. In: T. P. Simon, L. L. Holst and L. J. Shepard (eds.). EPA -905-9-89-003. Proceedings of the First National Workshop on Biological Criteria. U.S. Environmental Protection Agency, Chicago.

Cummins, K. W. and M. A. Wilzbach. 1985. Field procedures for analysis of functional feeding groups of stream macroinvertebrates. Contribution 1611. Appalachian Environmental Research Laboratory, University of Maryland, Frostburg, Maryland.

Davis, W. S. and T. P. Simon (eds). 1995. Biological assessment and criteria: tools for water resource planning and decision making. Lewis Publishers, Boca Raton, Florida.

Hauer, F. R. and G. A. Lamberti (eds). 1996. Methods in Stream Ecology. Academic Press, San Diego.

Rosenberg, D. M. and V. H. Resh. 1993. Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman and Hall, New York.

3.3 Primary Contact Recreation Use

All States have recreational waterbodies with bathing areas, as well as less heavily used waterbodies with a designated use of swimming. In some States, nearly all waters are designated for swimming, although the great

majority of waters are not used heavily for this purpose. States are asked to first target their assessments of primary contact recreation use to high-use swimming areas such as bathing beaches, a risk-based approach to targeting resources to protect human health.

3.3.1 Bathing Area Closure Data

States should acquire data on bathing area closures from State and local health departments and analyze them as follows.

A. Fully Supporting: No bathing area closures or restrictions in effect during reporting period.

B. Partially Supporting: On average, one bathing area closure per year of less than 1 week's duration.

C. Not Supporting: On average, one bathing area closure per year of greater than 1 week's duration, or more than one bathing area closure per year.

Some bathing areas are subject to administrative closures such as automatic closures after storm events of a certain intensity. Such closures should be reported along with other types of closures in the 305(b) report and used in making use support determinations if they are associated with violation of water quality standards.

3.3.2 Bacteria

States should base use support determinations on their own State criteria for bacteriological indicators.

EPA encourages States to adopt bacteriological indicator criteria for the protection of primary contact recreation uses consistent with those recommended in *Ambient Water Quality Criteria for Bacteria—1986* (EPA 440/5-84-002). This document recommends criteria for enterococci and *E. coli* bacteria (for both fresh and marine waters) consisting of:

- Criterion 1 = A geometric mean of the samples taken should not be exceeded, **and**

- Criterion 2 = Single sample maximum allowable density.

Many State criteria for the protection of the primary contact recreation use are based on fecal coliform bacteria as previously recommended by EPA (*Quality Criteria for Water—1976*). The previous criteria were:

- Criterion 1 = The geometric mean of the fecal coliform bacteria level should not exceed 200 per 100 mL based on at least five samples in a 30-day period, **and**

- Criterion 2 = Not more than 10 percent of the total samples taken during any 30-day period should have a density that exceeds 400 per 100 mL.

If State criteria are based on either of EPA's criteria recommendations outlined above (based on the 1976 or 1986 criteria), States should use the following approach in determining primary contact recreational use support:

A. Fully Supporting: Criterion 1 and Criterion 2 met.

B. Partially Supporting:

   - For *E. coli* or enterococci: Geometric mean met; single-sample criterion exceeded during the recreational season, **or**

   - For fecal coliform: Geometric mean met; more than 10 percent of samples exceed 400 per 100 mL.

C. Not Supporting: Geometric mean not met.

This guidance establishes a minimum baseline approach; should States have more restrictive criteria, these may be used in place of EPA's criteria. Please indicate when this is the case.

3.3.3 Other Parameters

In addition to pathogens, some States have criteria for other pollutants or stressors for Primary Contact Recreation. As noted by the ITFM, potentially hazardous chemicals in water and bottom sediment, ionic strength, turbidity, algae, aesthetics, and taste and odor can be important indicators for recreational use support determinations. The following guidelines apply where appropriate (i.e., where States have water quality standards for other parameters).

A. Fully Supporting: For any one pollutant or stressor, criteria exceeded in ≤10 percent of measurements.

B. Partially Supporting: For any one pollutant, criteria exceeded in 11 to 25 percent of measurements.

C. Not Supporting: For any one pollutant, criteria exceeded in >25 percent of measurements.

3.3.4 Special Considerations for Lakes

Trophic Status—

Trophic status is traditionally measured using data on total phosphorus, chlorophyll *a*, and Secchi transparency. As mentioned above, comparison of trophic conditions to natural, ecoregion-specific standards allows the best use of this measure.

In this context, user perception surveys can be a useful adjunct to trophic status measures in defining recreational use support. Smeltzer and Heiskary (1990) offer a basis for linking trophic status measures with user perception information. This can provide a basis for categorizing use support based on trophic status data. If user perception data are not collected in the State, extrapolations using data from another State, i.e., best professional judgment, might provide the opportunity to characterize recreational use support in a similar fashion.

Pathogens—

States should consider pathogen data in determining support of recreational uses. Guidelines above also apply to lakes.

Additional Parameters—

In addition to trophic status and pathogens, States should consider the following parameters in determining support of recreational uses:

- Frequency/extent of algal blooms, surface scums and mats, or periphyton growth
- Turbidity (reduction of water clarity due to suspended solids)
- Lake bottom siltation (reduction of water depth)
- Extent of nuisance macrophyte growth (noxious aquatic plants)
- Aesthetics.

3.4 Fish/Shellfish Consumption Use

Fish/Shellfish Consumption Advisory Data

A. Fully Supporting: No fish/shellfish restrictions or bans are in effect.

B. Partially Supporting: "Restricted consumption" of fish in effect (restricted consumption is defined as limits on the number of meals or size of meals consumed per unit time for one or more fish/shellfish species); or a fish or shellfish ban in effect for a subpopulation that could be at potentially greater risk, for one or more fish/shellfish species.

C. Not Supporting: "No consumption" of fish or shellfish ban in effect for general population for one more fish/shellfish species; or commercial fishing/shellfishing ban in effect.

In addition, the ITFM recommended specific indicators for assessing fish and shellfish consumption risks: levels of bioaccumulative chemicals in fish and shellfish tissue for fish and shellfish consumption, and, for shellfish only, paralytic shellfish poisoning (PSP)-type phytoplankton and microbial pathogens.

In areas where shellfish are collected for commercial or private purposes and removed to cleaner waters for depuration, the originating waterbodies should be considered Partially Supporting for Shellfish Consumption use.

3.5 Drinking Water Use

The following guidelines provide a framework for assessment of drinking water use support. These guidelines were developed by EPA in conjunction with the 305(b) Drinking Water Focus Group (DWFG), which consists of interested State and EPA personnel. EPA and States participating in the DWFG made it their goal to develop a workable set of guidelines that would serve to elevate the awareness of drinking water as a designated use within the 305(b) program, increase the percentage of waters assessed for drinking water use support, and enhance the accuracy and value of the assessments.

It was agreed by all parties involved in the development of these drinking water guidelines that no single template is suitable for every reporting State. The guidelines must incorporate flexibility and rely heavily on the judgment of the professional staff of each State's public water supply supervision program to meet the challenges of assessing source waters for drinking water use support.

For purposes of the 1998 305(b) Water Quality Reports, States are asked to focus their assessments on water resources that support significant drinking water supplies. It is generally assumed that most States will initially focus their assessments on surface water resources; however, these guidelines are non-resource-specific and the framework may be applied to any waters within a State that are designated for drinking water use.

EPA and States participating in the DWFG discussed at length the issues and difficulties involved in assessing source waters for drinking water use support. EPA and these States recognize and fully accept that there will be significant variability in the information that States are able to provide in the 1998 305(b) reporting cycle. However, EPA expects that the direction of future reporting cycles will be evident, and that States will begin to develop plans and mechanisms to improve the overall accuracy and value of the assessments.

Key features of these guidelines include:

- assessment of State's water resources in phases over two 305(b) reporting cycles
- flexibility to perform assessments using a tiered approach
- identification of multiple data sources that may be used in the assessments
- assessment of water resources using a target list of contaminants reflecting the interests and goals of the State, and
- interpretation of data.

3.5.1 Prioritization and Phases of Source Water Assessment

EPA and the DWFG recognize that assessment of source waters for drinking water use support within the framework of the following guidelines is revised to achieve the key features listed above. EPA and the DWFG also recognize that assessment of the entire State's water resources for drinking water use support is a monumental task. To ease the burden, States may choose to perform drinking water use support assessments using a phased approach.

States may consider prioritizing their water resources and performing drinking water use support assessments for a limited percentage of their water resources. States are encouraged to expand their drinking water assessment efforts to include additional waters each subsequent reporting

cycle. In this way, an increasingly greater percentage of waters will be assessed. Furthermore, this phased approach provides States with the opportunity to develop and implement plans and mechanisms for compilation, organization, and evaluation of drinking water data for improved reporting. EPA encourages States to set a goal of assessing drinking water use support for most of the State (approximately 75 percent of the waterbodies used for drinking water) by the year 2000.

For 1998, States are encouraged to set a priority for reporting results for waters of greatest drinking water demand. For these waters, States may elect to further prioritize with respect to vulnerability or other State-priority factors.

Identifying the presence of "treatment beyond conventional means" is one example of a technique that may be used to screen water resources for potential vulnerability and aid in prioritization of source waters for drinking water assessments. If "treatment beyond conventional means" is present (i.e., treatment beyond coagulation, sedimentation, disinfection, and conventional filtration), it may signify that the source water has been impacted to some degree and warrants more detailed investigation; however, it should be recognized that this information is generally not explicit, and therefore, neither the presence nor the absence of "treatment beyond conventional means" can be positively correlated to drinking water designated use support without additional investigation.

Prioritization of water resources for assessment may best be achieved in coordination with State professionals responsible for collecting and maintaining water quality data for sources of drinking water. It is generally these professionals that are most familiar with the data needed to assess drinking water designated use support and the conditions under which that data were collected. Their insight is integral to assuring the accuracy and value of these assessments.

3.5.2 Tiered Approach for Source Water Assessments

In addition to assessing only a limited percentage of State waters for drinking water use support, EPA and the DWFG encourage States to consider using a tiered approach in the assessments. A tiered approach accommodates the different types of data currently available to States with which to make an assessment and allows for differing levels of assessment.

Initially, States may use the most readily available information such as regional data, agency files, or other existing records or reports to conduct a preliminary assessment. As State programs develop and become more sophisticated, the preliminary assessments can be progressively upgraded

through the incorporation of more detailed data (e.g., monitoring data). For 1998, EPA encourages States to provide a short narrative explaining how their assessments were performed and the level of detail incorporated into each assessment.

3.5.3 Data Sources

By instituting the tiered approach to conducting drinking water designated use assessments, EPA and the DWFG are acknowledging that data collection and organization varies among the States, and that a single data source for assessing drinking water designated use does not exist for purposes of the 1998 305(b) reports. EPA encourages States to use available data that they believe best reflect the quality of the resource. EPA is not asking States to conduct additional monitoring that does not fit in with other State priorities.

It is generally accepted that for purposes of the 1998 305(b) reports, States may need to be resourceful to acquire the data necessary to conduct preliminary assessments of source waters for drinking water designated use. States noted during the previous 1996 305(b) reporting cycle that the *Guidelines* placed heavy emphasis on the use of ambient water quality data. Frequently these data were not available and States defaulted to the use of finished water quality data. It was noted by many States that the default to finished water quality data might yield a jaded view of the source water quality.

EPA and the DWFG concur that the use of finished water quality data is not the best possible source of data for assessing source water quality; however, EPA and the DWFG also recognize the difficulties in obtaining data for use in drinking water assessments. By encouraging States to prioritize their water resources and perform drinking water use support assessments in a phased approach over two 305(b) cycles, EPA hopes that acquiring the necessary data will continue to become less difficult in time.

Within the numerous 1996 Amendments to the Safe Drinking Water Act (SDWA), the States are encouraged to use the Source Water Assessment Program (SWAP) to promote assessment of drinking water sources. EPA's August 1997 guidance suggests that States complete source water delineations and source inventory/susceptibility analyses for the public water supplies in the State within two years after EPA approval of the program. These assessments, when completed by the States, are an additional source of data for evaluating drinking water designated use and should contribute considerably to the assessment of drinking water quality.

For the 1998 305(b) reporting cycle, EPA is encouraging States to be resourceful in acquiring and using available data. EPA is not asking States to perform additional monitoring.

EPA and the DWFG identified several potential data sources that States might consider using in their 1998 assessments, including:

- Available ambient water quality data
- Untreated water quality data from public water supply (PWS) wells and/or surface water intakes[1]
- PWS drinking water use restrictions
- STORET database
- Independent water suppliers databases
- Source water assessments (SDWA 1996 Amendments)
- U.S. Geological Survey NAWQA studies
- Private water association studies
- Independent studies
- Other 305(b) use support impairments (e.g., aquatic life impairments).

States that have access to other data sources that can be used to assess source water quality for drinking water purposes are encouraged to use them if, in the judgment of the drinking water professionals, the data have undergone sufficient quality assurance/quality control checks.

Ideally, one or several of the above data sources will be available for States to use in assessing drinking water use support. However, lacking any of the above, States may have no choice but to default to the PWS compliance monitoring data required under the SDWA (i.e., finished water quality data). These data should only be used if the distinct source water can be identified (i.e., mixed systems do not qualify). Information on contamination-based

[1]States that designate for drinking water use only at the point of intake should assess an appropriate area of the source water for drinking water use support. This may require assigning an appropriate area around or distance upstream of the point of intake.

drinking water use restrictions imposed on a source water may also be considered.

3.5.4 Contaminants Used in the Assessment

In many cases, the source of the data will determine the contaminants used in the assessment. For example, if a State has access to ambient monitoring data, the assessment is limited to the monitored contaminants.

Each State should develop a target list of contaminants that best represents the State's assessment goals; this list may be based on monitoring or other sources of data. EPA and the DWFG recommend that States use the contaminants regulated under the SDWA as a starting point in developing their target list of contaminants (a list of the contaminants regulated under the SDWA and their associated maximum contaminant levels is provided in Appendix O). States are not expected to include all of the contaminants regulated under the SDWA as part of their target list.

EPA and the DWFG acknowledge that there are no specific guidelines or hierarchical structure to follow for developing a target list of contaminants for use in drinking water assessments and States must use their best professional judgment in the decision-making process. Important considerations include the availability and quality of data and the level of assessment States are prepared to make. To assist States in reducing the comprehensive list of contaminants regulated under the SDWA to a final, more manageable, grouping of contaminants, EPA and the DWFG recommend that States consider any of the following:

- MCL violations
- detections greater than the action trigger limits
- vulnerability studies
- occurrence data
- chemical waivers
- contamination-based drinking water use restrictions
- treatment beyond conventional means
- treatment objectives
- treatment processes
- treatment technique violations, and/or
- ambient turbidity levels.

EPA and the DWFG realize that the list of contaminants regulated under the SDWA is not an all-inclusive list and States may decide to add contaminants to their target group based on their best professional judgment. For example, States may choose to add contaminants that are not regulated

under the SDWA but are of special interest or concern within the State (e.g., pesticides, herbicides, algae, phosphates).

3.5.5 Data Interpretation

EPA and the DWFG developed a framework to assist States in assigning use support categories based on data availability. As shown in Table 3-7, assessments can be based on actual monitoring data that are compared to water quality criteria (e.g., State-specific water quality standards or National Primary Drinking Water Regulations). If States do not have actual monitoring data available, finished water quality data and/or drinking water use restrictions could be used to infer source water quality. Use restrictions include:

- closures of source waters that are used for drinking water supply
- contamination-based drinking water supply advisories lasting more than 30 days per year
- PWSs requiring more than conventional treatment (i.e., other than coagulation, sedimentation, disinfection, and conventional filtration) due to known or suspected source water quality problems
- PWSs requiring increased monitoring due to confirmed detections of one or more contaminants (excluding cases with minimum detection limit issues).

3.5.6 Conclusion

Relatively few source waters have been adequately characterized for drinking water use support during the past 305(b) reporting cycles. EPA and States worked to develop a workable set of *Guidelines* that would serve to elevate the awareness of drinking water as a designated use within the 305(b) program, increase the percentage of waters assessed for drinking water use support, and enhance the accuracy and value of the assessments. These Guidelines provide a flexible framework for assessing drinking water designated use support. Using this framework is expected to result in better, more comprehensive assessments of source waters.

Table 3-7. Assessment Framework for Determining Degree of Drinking Water Use Support

Classification	Monitoring Data		Use Support Restrictions
Full Support	Contaminants do not exceed water quality criteria[a]	and/or	Drinking water use restrictions are not in effect.
Full Support but Threatened	Contaminants are detected but do not exceed water quality criteria[a]	and/or	Some drinking water use restrictions have occurred and/or the potential for adverse impacts to source water quality exists.
Partial Support	Contaminants exceed water quality criteria[a] intermittently	and/or	Drinking water use restrictions resulted in the need for more than conventional treatment with associated increases in cost.
Nonsupport	Contaminants exceed water quality criteria[a] consistently	and/or	Drinking water use restrictions resulted in closures.
Unassessed	Source water quality has not been assessed for contaminants used or potentially present.		

[a] For purposes of this assessment, EPA encourages States to use the maximum contaminant levels (MCLs) defined under the SDWA. However, if State-specific water quality standards exist, and constituent concentrations are at least as stringent as the MCL levels defined under the SDWA, State-specific water quality criteria can be used for assessment purposes.

SECTION 4

MEASURING AND REPORTING THE BIOLOGICAL INTEGRITY INDICATOR

4.1 Voluntary Pilot Biological Integrity Indicator

EPA is considering the addition of a new item to the 305(b) report, the biological integrity indicator. EPA has previously presented its concept of how this indicator would be assessed to States, both through its 305(b) Consistency Workgroup and in earlier drafts of these Guidelines, which were distributed to States for comment. Some States have supported the inclusion of biological integrity as a separate indicator while others have questioned its usefulness given that biological integrity is already considered in the assessment of aquatic life use support (ALUS). EPA believes that while much of the field work to assess biological integrity is already performed by States in their assessment of ALUS, a separate biological integrity indicator would add useful information to the 305(b) report (see box).

EPA is currently preparing to submit this indicator to the Office of Management and Budget (OMB) for approval under the Paperwork Reduction Act. As part of this process, States will be given a formal opportunity to comment to both EPA and OMB on the practical utility of this indicator, the additional burden associated with assessing it, and any other concerns they may have regarding its inclusion in the report. EPA is aware that some States are already preparing to assess biological integrity as part of their

The Biological Integrity Indicator

The biological integrity indicator describes the condition of the biota and habitat in an ecosystem having minimal influence from human activities. The indicator measures the degree to which an ecosystem approaches this condition. Many States with biomonitoring programs can already measure some form of this indicator.

The traditional aquatic life use support (ALUS) assessment takes into account socioeconomic factors in State water quality standards. It can also be based on chemical data alone. The biological integrity indicator, on the other hand, must be based on biological and habitat monitoring and on comparison to reference conditions.

1988 305(b) reports. EPA would welcome submission of these assessments and will use them in its ongoing evaluation of this item for possible inclusion in future 305(b) reports. States are not required to include assessments of biological integrity in their 1988 reports, although of course they should continue to consider biological and habitat monitoring in their assessment of ALUS.

For the benefit of those States that wish to submit with their 1988 reports the results of any biological integrity assessments they are already conducting, as well as to further inform subsequent comment on the inclusion of this indicator in future reports, EPA is providing these guidelines.

Biological integrity is "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of a region" (Karr and Dudley, 1981; see also Angermeier and Karr, 1994). The State members of the 305(b) Consistency Workgroup asked that the biological integrity indicator be reported electronically rather than in their hard-copy 305(b) reports. This will avoid presenting assessments of aquatic life use support and biological integrity in the same State document, which might confuse the public. The voluntary pilot biological integrity indicator is thus included in the list of data elements in Section 6 of the main *Guidelines* volume.

The recommended approach for developing and reporting on the indicator is presented in Section 4.2 as three phases:

- Develop reference conditions, the framework for making judgements of biological impairment
- Design the monitoring network, including both historical sampling locations and new ones
- Implement the monitoring program.

The information to develop a biological integrity indicator is described in detail below. This approach is compatible with biological and habitat assessment levels 3 and 4 in Tables 3-1 and 3-2 as well as the case studies for making ALUS determinations in Section 3. States may develop alternative approaches for measuring the biological integrity indicator, provided such approaches are compatible with levels 3 or 4 in Tables 3-1 and 3-2. Note that a good monitoring program should integrate biological monitoring with water column sampling; habitat, sediment and tissue monitoring; and other monitoring. Biosurvey monitoring should not be a

separate program or done in a vacuum without other important types of monitoring.

The following outline of the three phases is **not** intended to be a complete description of the process for developing the biological integrity indicator. More complete technical guidance is available for many of the biological monitoring concepts and procedures described in this section. See *Biological Criteria: Technical Guidance for Streams and Rivers* (Gibson et al., 1996; EPA 822-B-96-001) and *Rapid Bioassessment Protocols for Use in Streams and Rivers* (Plafkin et al., 1989, EPA /440/4-89-001). For additional information, contact the EPA/OWOW Monitoring Branch at the number given on page ii.

The approach below has been applied to streams and rivers. Protocols for the measurement of biological integrity in lakes and estuaries are not fully developed. When these protocols are completed, reporting of biological integrity will expand into these waterbody types. In the interim, the States that have developed such protocols are encouraged to report biological integrity for as many waterbody types as possible.

4.2 Phases and Steps in Developing the Indicator

Although the steps in these phases are presented in a linear fashion below, the overall process is quite iterative, with some of the later steps providing information that allows testing of previous steps and refinement of the process.

Phase 1 - Develop Reference Conditions

The majority of the tools necessary for routine data analysis and site assessment are developed during this phase of the process. The approach presented here involves the use of reference sites; EPA recognizes that States may have other approaches for developing reference conditions.

a. Classify Natural Landscape and Waterbody Types Contained within Region of Interest.

- ✓ Partition the landscape on maps based on, for example, ecoregions, subecoregions, physiographic regions, watershed size, waterbody type, vegetation types, elevation, etc. Categories will serve as **preliminary** site classes.

b. **Select Reference Sites.**

✓ Identify multiple sites per site class that exhibit minimal physical or chemical degradation and meet specified reference site criteria.

c. **Select Stressor Sites.**

✓ Identify multiple sites per site class with various degrees of known and documented physical and/or chemical degradation.

d. **Sample Reference and Stressor Sites.**

✓ Using appropriate biological methods, sample sites.

e. **Test Site Classification; Select and Calibrate Metrics** (assumes a multimetric approach).

✓ Calculate all potential metrics, indicate probable direction of change in presence of stressors

✓ Exclude metrics that have no ecological meaning

✓ Compare individual metric value ranges (from multiple reference sites) within and among preliminary site classes

- If value ranges cannot be separated, combine 2 or more site classes and aggregate reference site data from combined classes

- If metric values are highly variable within classes, examine alternative site classifications

- Test final classification with analytical methods such as discriminant analysis, MANOVA, or ordination

✓ Compare metric value ranges of reference sites vs. stressor sites within new site classes (i.e., test ability of each metric to discriminate between impaired and non-impaired)

- Exclude metrics that fail to respond to stressors within a site class and lack discriminatory power (use statistical tests, if necessary).

f. Develop Performance Characteristics of Calculated Values.

- ✓ Need to know precision and uncertainty of index and metric estimates (preliminary estimates can be developed with single year of data).

- ✓ Final determination requires repeated (replicate) samples, multiple year samples, and knowledge of site class variability.

g. Develop Metric Scoring Criteria.

- ✓ After metrics have been selected, choose threshold for determining impairment (depending on direction of change in presence of stressor) as some percentile of reference value distribution. Divide remainder of range into successively lower scoring categories.

h. Determine Assessment (Index) Rating Scales

- ✓ States use different approaches to continuous rating scales, typically using three, four and five categories. Currently, EPA is recommending a five-category scale such as excellent, good, fair, poor, and very poor (where *excellent* would be considered minimally impaired, that is, achieving biological integrity.

Phase 2 - Develop Monitoring Network Design

a. Determine Types and Geographic Scale(s) of Questions to be Addressed (Site-Specific, Watershed-wide, or Region-wide)

- ✓ Determine appropriate approach for site selection (random selection), special (targeted selection), or combined approach.

b. Determine Acceptable Data Quality Objectives (DQOs) for Assessment Results.

- ✓ Base on *estimates of precision and uncertainty* of metrics and index (developed in Phase 1), as well as on availability of resources.

c. Select Sampling Sites.

- ✓ Select sampling sites using probability design, targeted design, or combined approach. Take advantage of historical sampling sites where feasible.

Phase 3 - Implement Monitoring Program

This is the routine monitoring program that will be performed regularly over specified time intervals, depending on the program. During Phases 1 and 2:

- Metrics have been selected and calibrated; scoring criteria already developed
- Sampling locations have been selected based on monitoring objectives
- Field sampling and laboratory methods have been defined
- Index period has been defined
- Data management system has been defined and
- DQOs have been defined

a. Schedule field teams to complete sampling within index period.

b. Complete all sampling (as well as field taxonomy for fish) within defined time period; take duplicate samples (complete) at approximately 10% of sites.

c. Perform laboratory sorting and subsampling (benthos and periphyton, only).

d. Perform laboratory taxonomy (fish, where necessary; benthos; and periphyton) using a standard level of effort (i.e., consistent taxonomic levels for different organisms).

e. Using raw data from laboratory results, calculate selected *metrics* (selected during Phase I) for each sample.

f. Normalize metric values into unitless scores by comparison to *scoring criteria* (developed during Phase I).

g. Sum all metric scores for each sample.

h. Compare summed metric total to *assessment rating scale* developed during Phase I.

✓ this step provides the site assessment of "excellent, very good, good, fair, or poor" (or other narrative rating terms)

i. Compare precision and uncertainty values to the *DQOs* (developed in Phase I).

4.3 Reporting the Biological Integrity Indicator: Case Study

This section presents an example of metric calculation, index scoring, and judgement of impairment using actual data for a site. This is performed following the selection of reference sites and metrics, determination of final site classes, and development of reference conditions (i.e., scoring criteria). (Note: alternative methods are acceptable providing they are compatible with level 3 or 4 assessments in Tables 3-1 and 3-2). This example uses a benthic macroinvertebrate sample taken from a low gradient stream in the eastern United States and compares the laboratory results to the appropriate reference conditions. The text box on Page 4-7 presents definitions of the final metrics that were selected (Phase 1/step e above), the reference conditions used as the basis for scoring calculated metric values (Phase 1/step g above) and categories used for translating total bioassessment scores to narrative ratings (Phase 1/step h above).

Following sampling using appropriate methods for the stream type and region under study, the benthic macroinvertebrate sample is returned to the laboratory for sorting and taxonomic identification. An example of what results from laboratory processing of a single sample is shown in Table 4-1 and is a list of taxa, the number of individuals of each taxon, and their tolerance values and functional feeding group designations. This set of raw data represents Step 1 of the site assessment process.

Using the data produced in Table 4-1, the selected metrics are calculated, resulting in a set of metric values (Table 4-2). Each metric value is compared to the metric scoring criteria that were previously developed and normalized to scores, resulting in a list of metric scores (Table 4-2). For example, the site used for this example had a calculated value of 19.4 for the metric '% EPT (metric 3)'. Comparing that value to the scoring criteria, this site receives a '3' for this metric. This comparison, or scoring, once done for all seven metrics, results in a list of metric values (Table 4-2) that can then be summed for a total bioassessment score. Comparing total bioassessment, or index, score to the narrative rating categories allows translation to a narrative assessment--**in this case, a Biological Integrity Indicator rating of "good" (Table 4-2). The State's electronic database**

(WBS or other) would then be updated to show this rating for the appropriate number of miles of this waterbody (e.g., 5 miles = "good").

The exact sampling methods, reference site selection criteria, metrics, scoring criteria, and narrative rating categories will vary according to the waterbody type and region, sampling index period, and sample handling procedures.

Tools Developed During the Phase 1 Process that are Used During Bioassessment

Metric Definitions

1. Taxa Richness - the number of distinct taxa in the sample.
2. EPT Taxa - the number of distinct Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) taxa in the sample.
3. Percent EPT - the number of EPT individuals as a proportion of the total sample.
4. Percent Chironomidae - the number of chironomid individuals as a proportion of the total sample.
5. Number of Trichoptera Taxa - the number of distinct Trichoptera taxa in the sample.
6. Hilsenhoff Biotic Index - measures the abundance of tolerant and intolerant individuals in a sample by the following formula, where x_i is the number of individuals in the ith species, t_i is the tolerance value of the ith species, and n in the total number of species in the sample:

$$HBI = \sum \frac{x_i t_i}{n}$$

7. Percent Collector-Filterers - the number of individuals that are members of the Functional Feeding Groups Collector or Filterer as a proportion of the total sample.

Reference Conditions

Metrics	Scoring Criteria		
	5	3	1
1. Total Taxa	≥23	22-12	11-1
2. EPT Taxa	≥8	7-4	3-0
3. %EPT	≥22.3	22.3-11.2	11.16-0
4. %Chironomidae	≤33.6	33.6-67.3	>67.3
5. No. Trichoptera Taxa	≥6	5-3	2-0
6. HBI	≤5.5	5.5-7.8	>7.8
7. %Collector-Filterers	≥57.2	57.2-28.1	28.1-12

Narrative Rating Categories

Narrative Rating	Total Bioassessment Score
very good	≥31
good	25-30
poor	18-24
very poor	<18

Table 4-1. An example of laboratory results from sorting and identification of a single benthic macroinvertebrate sample.

Taxon	No.	TV	FFG
DIPTERA	2	-	-
CHIRONOMIDAE	19	5	-
Tanypodinae	52	5	-
Orthocladiinae	7	5	-
Chironominae	1	5	-
Tipula	4	4	SHR
Dixella	1	1	COL
Limnophila	1	4	PRE
Chrysops	2	7	PRE
Pseudolimnophila	2	2	PRE
Hexatoma	1	3	PRE
Simulium	7	6	FIL
Culicoides	2	10	PRE
Bezzia/Palpomyia	2	6	PRE
Mallochohelea	5	-	-
Phylocentropus	1	5	FIL
Hydatophylax	4	2	SHR
Pycnopsyche	7	4	SHR
Ptilostomis	1	4	SHR
Ironoquia	12	3	SHR
Cheumatopsyche	2	5	FIL
Paranemoura	7	2	SHR
Leptophlebia	3	4	SHR
Centroptilum	2	2	COL
Baetis	2	6	COL
Boyeria	1	2	PRE
Calopteryx	2	5	PRE
Neohermes	1	2	PRE
Gammarus	23	6	COL
Caecidotea	6	6	COL
Crangonyx	5	4	COL
OLIGOCHAETA	7	10	COL
Pisidium	16	5	FIL
Pseudosuccinea	1	6	COL
Total No. Individuals	**211**		

Abbreviations: FFG-functional feeding group, TV-tolerance value, SCR-scrapers, PRE -predators, SHR -shredders, FIL-filterers, COL-collectors.

Table 4-2. Determining the biological integrity indicator for the waterbody*.

Note: Each of the seven metrics are calculated using raw data resulting from laboratory analysis. Metric values are normalized by comparison to scoring criteria, allowing them to be summed to a total index, or bioassessment, score. Comparing the total index score to narrative rating categories results in the a condition narrative .

Metric	Value	Score
TotTax	32	5
EPT Tax	10	5
%EPT	19.4	3
%Chir	37.4	3
TrichTax	6	5
HBI	5.2	5
%ColFil	12.3	1
Total Index Score		27

BIOLOGICAL INTEGRITY INDICATOR:
Good

* See previous box entitled "Metric Definitions." As noted in Section 4.1, other approaches to achieving biological assessment and habitat levels 3 or 4 (Tables 3-1 and 3-2) can be used to determine the biological integrity for a waterbody. See also example case studies for ALUS assessments in Section 3 for more information about assessment quality.

SECTION 5

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Provisions of the Clean Water Act

APPENDIX A

PROVISIONS OF THE CLEAN WATER ACT

Section 305. Water Quality Inventory

(b)(1) Each State shall prepare and submit to the Administrator by April 1, 1975, and shall bring up to date by April 1, 1976, and biennially thereafter, a report which shall include--

(A) a description of the water quality of all navigable waters in such State during the preceding year, with appropriate supplemental descriptions as shall be required to take into account seasonal, tidal, and other variations, correlated with the quality of water required by the objective of this Act (as identified by the Administrator pursuant to criteria published under section 304(a) of this Act) and the water quality described in subparagraph (B) of this paragraph;

(B) an analysis of the extent to which all navigable waters of such State provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water;

(C) an analysis of the extent to which the elimination of the discharge of pollutants and a level of water quality which provides for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allows recreational activities in and on the water, have been or will be achieved by the requirements of this Act, together with recommendations as to additional action necessary to achieve such objectives and for what waters such additional action is necessary;

(D) an estimate of (i) the environmental impact, (ii) the economic and social costs necessary to achieve the objective of this Act in such State, (iii) the economic and social benefits of such achievement, and (iv) an estimate of the date of such achievement; and

(E) a description of the nature and extent of nonpoint sources of pollutants, and recommendations as to the programs which must

be undertaken to control each category of such sources, including an estimate of the costs of implementing such programs.

(2) The Administrator shall transmit such State reports, together with an analysis thereof, to Congress on or before October 1, 1975, and October 1, 1976, and biennially thereafter.

Sec 106. Grants For Pollution Control Programs

(e) Beginning in fiscal year 1974 the Administrator shall not make any grant under this section to any State which has not provided or is not carrying out as a part of its program--

(1) the establishment and operation of appropriate devices, methods, systems, and procedures necessary to monitor, and to compile and analyze data on (including classification according to eutrophic condition), the quality of navigable waters and, to the extent practicable, ground waters including biological monitoring; and provision for annually updating such data and including it in the report required under section 305 of this Act;

Section 204. Limitations and Conditions

(a) Before approving grants for any project for any treatment works under section 201(g)(1), the Administrator shall determine--

(2) that (A) the State in which the project is to be located (i) is implementing any required plan under section 303(e) of this Act and the proposed treatment works are in conformity with such plan, or (ii) is developing such a plan and the proposed treatment works will be in conformity with such plan, and (B) such State is in compliance with section 305(b) of this Act.

Section 303. Water Quality Standards and Implementation Plans

(d)(1) (A) Each State shall identify those waters within its boundaries for which the effluent limitations required by Section 301(b)(1)(A) and Section 301(b)(1)(B) are not stringent enough to implement any water quality standard applicable to such waters. The State shall establish a priority ranking for such waters, taking into account the severity of the pollution and the uses to be made of such waters.

(B) Each State shall identify those waters or parts thereof within its boundaries for which controls on thermal discharges under Section 301 are not stringent enough to assure protection and

propagation of a balanced indigenous population of shellfish, fish, and wildlife.

(C) Each State shall establish for the waters identified in Paragraph (1)(A) of this subsection, and in accordance with the priority ranking, the total maximum daily load, for those pollutants which the Administrator identified under Section 304(a)(2) as suitable for calculation. Such load shall be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.

(D) Each State shall estimate for the waters identified in Paragraph (1)(B) of this subsection the total maximum daily thermal load required to assure protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife . . ."

(d)(2) Each State shall submit to the Administrator, from time to time, with the first submission not later than one hundred and eighty days after the date of publication of the first identification of pollutants under Section 304(a)(2)(D), for his approval the waters identified and the loads established under Paragraphs (1)(A), (1)(B), (1)(C), and (1)(D) of this subsection . . ."

NOTE: EPA published final revisions to 40 CFR 130.7 (the regulations implementing Section 303(d)) in the Federal Register on July 24, 1992. The revisions define "from time to time" as a biennial reporting requirement for submitting prioritized lists of water quality-limited waters. (Note that the regulatory revisions pertain exclusively to 303(d) lists of waters requiring TMDLs and do not require biennial submittals of TMDLs). The regulations also specify that the State submittals under Section 303(d) coincide with State Submittals under Section 305(b) and may be submitted as part of the 305(b) report. From the 303(d) regulations:

"(d) Submission and EPA approval.

(1) Each State shall submit biennially to the Regional Administrator, beginning in 1992, the list of waters, pollutants causing impairment, and the priority ranking including waters targeted for TMDL development within the next two years as required under Paragraph (b) of this section. For the 1992 biennial submissions, these lists are due no later than October 22, 1992. Thereafter, each State shall submit to EPA lists required under Paragraph (b) of this section on April 1 of every even-numbered year. The list of waters may be submitted as part of the State's biennial water quality report required by Section 130.8 of this part and Section 305(b) of the CWA or submitted under separate cover."

Section 314. Clean Lakes

(a) Each State shall prepare or establish, and submit to the Administrator for his approval--

(A) an identification and classification according to eutrophic condition of all publicly owned lakes in such State;

(B) a description of procedures, processes, and methods (including land use requirements), to control sources of pollution of such lakes;

(C) a description of methods and procedures, in conjunction with appropriate Federal agencies, to restore the quality of such lakes;

(D) methods and procedures to mitigate the harmful effects of high acidity, including innovative methods of neutralizing and restoring buffering capacity of lakes and methods of removing from lakes toxic metals and other toxic substances mobilized by high acidity;

(E) a list and description of those publicly owned lakes in such State for which uses are known to be impaired, including those lakes which are known not to meet applicable water quality standards or which require implementation of control programs to maintain compliance with applicable standards and those lakes in which water quality has deteriorated as a result of high acidity that may reasonably be due to acid deposition; and

(F) an assessment of the status and trends of water quality in lakes in such State, including but not limited to, the nature and extent of pollution loading from point and nonpoint sources and the extent to which the use of lakes is impaired as a result of such pollution, particularly with respect to toxic pollution.

(2) Submission as part of 305(b)(1) Report.--The information required under paragraph (1) shall be included in the report required under section 305(b)(1) of this Act, beginning with the report required under such section by April 1, 1988.

Appendix B

Benefits of Rotating Basin Monitoring and Assessment: South Carolina

Benefits of Rotating Basin Monitoring and Assessment

Prepared for the 305(b) Consistency Workgroup
October 1996

David Chestnut
South Carolina Department of Health and Environmental Control

Over a dozen States are implementing statewide basin management approaches that include rotating basin monitoring. In some cases, States are already benefiting from adopting the approach, e.g., through improved staff morale or increased miles of streams monitored each year. For more information about the benefits and start-up requirements, see *Watershed Protection: A Statewide Approach* (EPA 841-R-95-004), available from the EPA Watershed Protection Branch, (202) 260-7074.

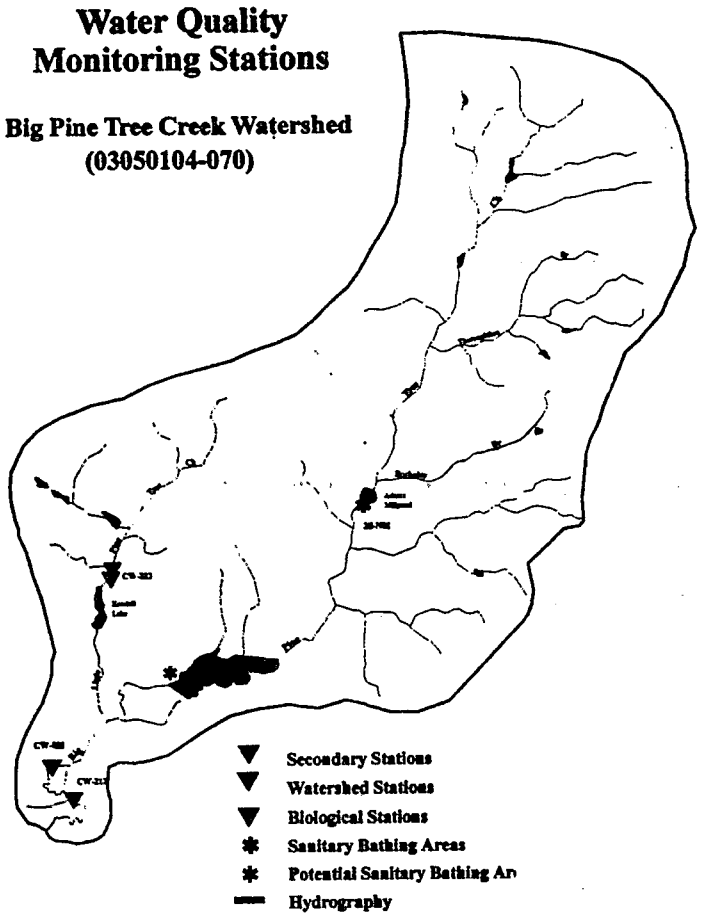
Overview of South Carolina's Watershed Water Quality Management Process

The South Carolina Department of Health and Environmental Control (SCDHEC) has defined five 'basins' in the State, maintaining the integrity of the USGS 8-digit cataloging units and grouping them to equalize the number major and minor NPDES permits between basins. A Watershed Water Quality Management Strategy is prepared for each basin, one per year on a fixed rotating basis. As part of the Watershed Water Quality Management Program, all NPDES permits within the target basin are reissued in the same year.

The main 'product' of this program is a Watershed Water Quality Management Strategy (WWQMS) document for each basin. The basic organizational and reporting unit for the WWQMS document is the 11-digit USDA Natural Resources Conservation Service (NRCS) watershed unit. Each watershed unit forms a chapter of the final document. Each chapter contains maps showing the locations of important features: monitoring site location, NPDES end of pipe locations, water intakes, landfill and mine locations, wetlands, occurrence of endangered species, etc.

Monitoring Strategy for the Basin

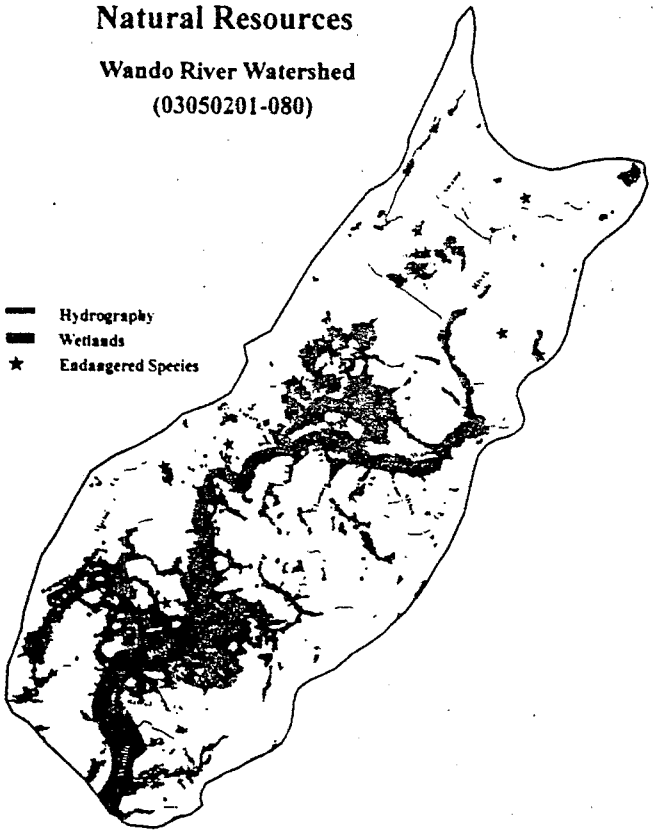
The WWQMS development process begins with a water quality monitoring strategy for the target basin. This includes the identification of spatial gaps in the routine fixed monitoring network and the establishment of monitoring sites to provide

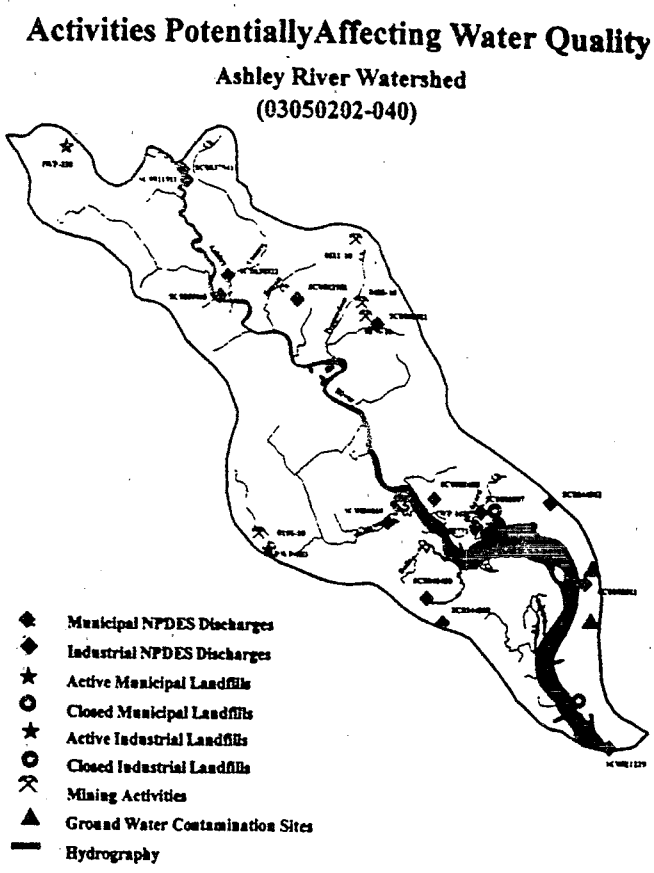


representative coverage, with at least one monitoring site at the most downstream access of each NRCS watershed unit in the basin. Additional sites are added for larger watershed units or in significant land use and waterbody types. This monitoring strategy is implemented for one year. Any additional wasteload allocation needs are identified and necessary data are collected in this year.

Data Collected for Each Watershed Unit

For each NRCS watershed unit, a compilation of land use statistics, growth potential, identified nonpoint source impacts, known groundwater contamination problems, and lists of permitted dischargers, water intakes, landfills, mining sites, waterbodies on the 303(d) or 304(l) lists, etc. is prepared. An initial assessment of water quality at each monitoring site in the NRCS watershed unit is prepared, and other data or study results for the waterbody that are readily available from other sources are reviewed. All of this information is assembled into a comprehensive summary of what is known about an individual watershed unit. The program makes extensive use of an in-house GIS to store, analyze, and report this information.





Coordination Among Agencies and Public Participation

Once a draft WWQMS document is assembled, a meeting is convened with representatives from SCDHEC ambient monitoring and assessment, compliance and enforcement, groundwater monitoring, permitting, nonpoint source, wasteload allocation, environmental health, and district monitoring programs. At this meeting, the compiled information and preliminary assessment results are presented for discussion. Individual monitoring sites for which the preliminary assessment indicates less than full support of aquatic life or recreational uses receive special attention. The stressors of concern are identified and everyone provides input on likely sources or natural origins. Assessment conclusions are finalized by consensus and a recommended course of action (Implementation Strategy) for each NRCS watershed unit is formulated.

Public participation and external review of the document is very important. We are beginning to solicit input from outside entities, requesting comments about nonpoint source pollution from NRCS and the South Carolina Forestry Commission.

Concurrent with the preparation of the final WWQMS document, wasteload allocation modeling is conducted. Then, all of the NPDES permits in the basin are revised for reissuance.

The resulting document contains very detailed information at a local scale. This information can then be distributed--either in the form of the WWQMS for the whole basin or as individual chapters--to other groups with resource management concerns at differing scales. These groups include other State and federal agencies, councils of government, NRCS conservation districts, county councils, lake homeowners associations, and individual citizens.

Annual Electronic Reporting

In the case of water quality assessment data, SCDHEC maintains a separate 305(b) database that is linked to the GIS for detailed mapping of use support, stressors, and sources by waterbody, watershed, or basin. As each WWQMS is completed, the 305(b) database and associated GIS coverages for that basin can be provided to EPA to satisfy the new Annual Electronic Reporting process.

Benefits of this Approach to the State

This rotating basin, watershed management approach has resulted in improvements in the efficiency of our water quality management programs. Many of these benefits are related to the increased ability to provide information, rather than raw data, to potential partners in water quality management activities. Some of the following benefits were originally described in *Watershed Protection: A Statewide Approach* (EPA 841-R-95-004), and SCDHEC is seeing them take form in actual practice.

- *Systematic, detailed review of water quality data.*

- *The Watershed Water Quality Management Strategy document is an valuable resource that provides information, not just data, at a scale where implementation of corrective activities is feasible.* With the ability to provide assessments and associated support data at a more local scale, interest and cooperation with other entities has improved. Even a single basin was too large an area to interest many groups organized at a regional level, e.g. county, conservation district, or lake homeowner association. NRCS has requested that SCDHEC representatives attend regional meetings with their field agents so they can focus on identified nonpoint source concerns. Other natural resource management agencies have used the watershed documents to direct their own activities.

  The watershed approach with information provided at a local scale focuses on a discrete resource (the watershed) around which citizens can rally. This enhances public support and involvement. Opportunities for this interaction occur during basin plan development and activities such as workshops.

- *With an established order of rotation and predictable sampling period for each basin, coordination and cooperation with other water quality data generating*

entities are enhanced. Several other groups that collect water quality data for their own purposes are looking at adjusting the timing of their activities to coincide with our intensive monitoring activities in a particular basin. This leads to increased opportunities for data sharing. The pooling of resources and data by multiple stakeholders tends to increase the amount and types of data available for carrying out assessments. We have noticed a distinct increase in communication and the exchange of information with other agencies.

- *Resources are better directed to priority issues.* Improved information bases and assessments can facilitate identification of water quality issues, allow for comprehensive review of within-basin needs. Improved coordination among stakeholders promotes the leveraging of resources.

- *Focusing on functional watersheds emphasizes environmental results: water quality monitoring and management programs can focus more directly on the resource.* Historically, EPA and State agencies have measured success in terms of bean counts - numbers of permits, compliance orders, inspections, etc.

- *Consistency and continuity are encouraged.* The approach reduces the tendency to operate in a reactive or crisis mode. Continuity is assured by the predictable schedule of management actions in a particular basin. Consistency is improved because all NPDES permit limits along a major river may be adjusted at the same time using the same water quality model.

- *The basis for management decisions is improved.* Organizing around basins can improve the scientific basis for management decisionmaking in many ways. Basin-oriented monitoring and assessment results in more detailed information being made available for management decisions.

  The approach encourages gathering of information from a variety of sources on all significant stressors, including those that tend to be overlooked by traditional programs (e.g., ecosystem effects due to habitat loss). Information derived from water quality parameters without standards can also be considered, such as long term trends in nutrients, turbidity, etc.

- *Program efficiency is enhanced.* Focusing on individual basins can improve program efficiency within the State water quality agency. For example:

  Modeling studies can be consolidated to increase the stream miles of waterbody modeled per unit of effort. Also, NPDES permits can be consolidated by basin to limit the number of public notices; this requires adjusting permit expiration schedules so that all permits in a basin have the same expiration dates.

  Basinwide assessment results can support 305(b) reporting if a common database is used for basin plans and 305(b) reports, such as the Waterbody System (WBS).

Basin plans can satisfy Section 303(d) reporting requirements since strategies for addressing impaired waters can be included in basin plans.

- *Encourages Innovative solutions.* Some problems in a basin, such as habitat destruction, inadequate stream flow, wetlands loss, atmospheric deposition, and introduced aquatic species, are difficult for traditional water quality programs to address. Some nontraditional solutions that may be more feasible under a basin approach: ecological restoration; protection of critical areas such as headwaters, riparian buffers, and biotic refuges; wetlands mitigation banking; market-based solutions such as pollutant trading.

- *Provides a means to educate the public about our Agency's efforts and limitations in protecting water quality.*

- *Increased use of GIS as a management tool.* The watershed program is driving the development of GIS coverages.

- *Brings to light gaps in the Agency's water quality protection efforts.* Allows us to identify opportunities for improvement.

- *Eliminated the backlog in expired major NPDES permits.* The backlog of expired major permits following implementation of Watershed Water Quality Management dropped from 50 in 1992, to 20 in 1993, to 8 in 1994, to 3 in 1995. By reissuing all NPDES permits within the target basin in the same year, the backlog of expired permits has been eliminated.

Acknowledgement

Mike McCarthy of Research Triangle Institute provided ideas and assistance in putting together this summary.

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Appendix C

Water Environmental Indicators and 305(b) Reporting

Table 1. Water Environmental Indicators and 305(b) Reporting

Indicator Number and Description	Source of Data * = State data	Current Reporting Vehicle and Frequency	Proposed and Reporting Vehicle Frequency State 305(b) Annual	5-yr	State Non-305(b) Annual	Nat. 305(b)[a] Biennial	5-yr	Comments and Issues Raised by Focus Group	Action Items
Data Provided by States/Tribes									
10a. **Drinking Water Supply Use**--% of assessed surface waters that fully support the use	*State 305(b) reports	State 305(b) reports; biennial	X	X		X	X	Some States assess very low % of waters for this use. Differences in State WQSs, assessment methods, and monitoring hamper national analyses & mapping.	Guidelines increase emphasis on assessing more waters for this use; DW Focus Group also addressing this issue.
10b. **Shellfish and Fish Consumption Use**--% of assessed surface waters that fully support the use	*State 305(b) reports	State 305(b) reports; biennial	X	X		X	X	Differences in State fish consumption limits, WQSs, assessment methods, and monitoring hamper national analyses/mapping.	Continue to promote consistent risk methods among States (OST); resolve how to handle statewide advisories (EPA and 305(b) Workgroup)
10c. **Recreation Use**--% of assessed surface waters that fully support the use	*State 305(b) reports	State 305(b) reports; biennial	X	X		X	X	Some States assess very low % of waters for this use. Differences in State WQSs, assessment methods, and monitoring hamper national analyses/mapping.	Encourage selected States to assess more waters for this use; increase Guidelines emphasis
10d. **Aquatic Life Use**--% of assessed surface waters that fully support the use	*State 305(b) reports	State 305(b) reports; biennial	X	X		X	X	Differences in State WQSs, assessment methods, and monitoring hamper national analyses/mapping.	Improve ALUS Guidelines; ALUS Focus Group doing this now.
5. **Fish Consumption Advisories**--% of stream miles and lake acres with current advisories	* State Health or Environ. Depts.	EPA National Listing of Fish Advisories; freq. = annual		X	X	X	X	Indicator accurately reports extent of advisories, but may penalize States that do lot of tissue monitoring or set strict risk-based limits. Include only *active* advisories.	Continue annual updates of national advisory database (OST); continue to promote consistent methods among States (OST)

Indicator Number and Description	Source of Data * = State data	Current Reporting Vehicle and Frequency	Proposed and Reporting Vehicle and Frequency State 305(b) Annual	State 305(b) 5-yr	State Non-305(b) Annual	Nat. 305(b)* Biennial	Nat. 305(b)* 5-yr	Comments and Issues Raised by Focus Group	Action Items
7. **Biological Integrity--% of assessed waters that support healthy aquatic communities**	(*) 305(b) EMAP State bioassess-ments	New indicator; streams--could infer from ALUS for some States; estuaries--infer from EMAP	X	X		X	X	Excellent direct measure of ecological health but low % of waters assessed; need details; need flexibility for States with limited resources; lack of biocriteria may restrict the indicator in some States. Approx. 70% of States are close to being able to report this indicator.	Prepare brochure for State managers defining detailed procedures for measuring and reporting indicator and minimum State program; provide tech support to States; give examples in the Guidelines.
15. **Contaminated Sediments**	*EPA/Nat. Sediment Inventory	One-time survey; updates expected but not defined		X			X	States await WQSs for sediment; States with good monitoring or scattered problems appear heavily polluted on maps	Short term: involve States in ways to present to public and Congress (e.g., explanations on all maps). Long term: State WQSs for sed.; work with OST re: updates
16a. **Selected Point Source Loadings to Surface Water**--changes in loadings of selected pollutants	*PCS	Not currently reported			X		X	PCS misses loads from CSOs and from minor dischargers that impact small streams; some States don't require flows, data quality poor for some States; indicator too inaccurate for national use now	Short term: Publicize that EPA has begun major improvements in PCS loading data. Long term: address inconsistent reporting from facilities and States; increase coverage of facilities.
16b. **Sources of Point Source Loadings through Class V Wells to GW**--number of wells closed	*UIC	Unclear			X		X	Administrative, not a indicator of environmental improvement	Short term: Resolve issue of how and where EPA will use this indicator. Long term: substitute more direct measure
1. **Population Served by Community Drinking Water Systems Violating Health Standards**	*SDWIS/ FRDS	OW Indicators Reports; EPA will get directly from State SDWIS/FRDS databases; freq.=annual			X		X	SDWIS or equiv. not avail. in some States for few years; 305(b) staff prefer EPA obtain directly from SDWIS or State SDWA databases	EPA continue to develop SDWIS; decide on lag time before reporting this indicator; Workgroup encourage 305(b) staff to become familiar with SDWIS; GW Focus Group include in GW Guidelines?

Indicator Number and Description	Source of Data * = State data	Current Reporting Vehicle and Frequency	Proposed and Reporting Vehicle State 305(b) Annual 5-yr	 State Non-305(b) Annual	Frequency Nat. 305(b)[a] Biennial 5-yr	Comments and Issues Raised by Focus Group	Action Items
2. **Population Served by Unfiltered Surface Water Systems at Risk from Microbiological Pollution**	*SDWIS/ FRDS	OW Indicators Reports; EPA will get directly from State SDWIS/FRDS databases; freq.=annual		X	X	Same as previous indicator.	Same as previous indicator.
3. **Population Served by Community Drinking Water Systems Exceeding Lead Action Levels**	*SDWIS/ FRDS	OW Indicators Reports; EPA will get directly from State SDWIS/ FRDS databases; freq.=annual		X	X	Same as previous indicator.	Same as previous indicator.
4. **Source Water Protection** No. of community water systems with Source Protection Programs	*Wellhead reports	OW Indicators Reports; EPA will get from State SDWA programs; freq.= annual		X	X	Not an indicator of human health (administrative); focuses on GW sources	
12. **Surface Water Pollutants--**trends in rivers and streams (eventually: NH3, BOD, TN, NO3, pathogens, TP, susp. solids, Cd, Cu, Pb, Hg, phenols, tot. res. chlorine)	State and USGS	USGS reports and databases; NOAA; States via STORET	X	X	X	Include States' data. Modernized STORET must have easy-to-use data management and trend software and ability to compare values to State WQSs.	Establish workgroup to develop indicator for reporting trends; broaden to include other resource types
8. **Species at Risk--**% of freshwater aquatic or wetlands species	*TNC and State Nat. Heritage Programs	TNC report; freq. = ?		X	X	Poor connections between State 305(b) and TNC/Nat. Her. Programs; inconsistent reporting among States	Report only at the national level to avoid new burden on State 305(b) programs and issues resulting from publicizing/ locating endangered species; encourage coordination between State 305(b) and Nat. Heritage staff.

Indicator Number and Description	Source of Data * = State data	Current Reporting Vehicle and Frequency	Proposed and Reporting Vehicle State 305(b) Annual 5-yr	State Non-305(b) Annual	Frequency Nat. 305(b)* Biennial 5-yr	Comments and Issues Raised by Focus Group	Action Items
Data from EPA and Other Federal and Private Agencies							
6. **Shellfish Bed Conditions**--% of shellfish waters classified as approved, conditionally approved, restricted or prohibited	*Nat. Shellfish Sanitation Program	NOAA reports; freq. = 5 year		X	X	NSSP limited by funding to 5-year reporting	Investigate how States participate in NSSP and find linkage to 305(b)
9. **Wetland Acreage**--annual rate of wetland loss	FWS and NRCS	FWS data, NRI reports; freq.=5 year	X		X	Some States already report in 305(b). Some have more accurate data than F'S and NRI.	EPA allow States with more accurate data to override federal data. Long term: work toward functional or quality indicator. COE is source for acres under permit.
11. **Ground Water Pollutants: Nitrate** --population potentially exposed to nitrate in GW >10 mg/L	OGWDW	One-time Nat. Pesticide Survey; eventually SDWIS; freq. = ?			X?	Placeholder indicator based on one-time well survey. Not reflective of statewide or national GW quality. Opportunity lost: States do not store short-term well data.	Incorporate indicator into 305(b) Guidelines; much progress made in 1996 re: reporting by aquifer. Long term: Major increases in GW monitoring & reporting?
13. **Coastal Water Pollutants in Shellfish**--% change in 6 pollutants 1986/87-92/93	NOAA	NOAA reports; freq. = 5 year?			X		
14. **Estuarine Eutrophication Conditions**--trends	NOAA	NOAA reports; freq. = 5 year			X	Results from different estuaries may not be comparable due to methods	NOAA continue its process including workshops for improving aggregation techniques
17. **Nonpoint Source Sediment Loadings from Cropland**--annual rate of erosion	USDA	NRI reports; freq. = 5 year			X	Not a measure of ambient water quality problems; do not report in same document as State assessment data	Resolve issue of how and where EPA will use this indicator. Long term: identify alternatives & improvements.
18. **Marine Debris**--weight of debris collected during an annual event	Center for Marine Conserv.	CMC reports; freq. = annual			X		Interagency workgroup is developing a statistically valid method for this indicator

* May be reported more frequently in special indicators reports outside 305(b).

United States
Environmental Protection
Agency

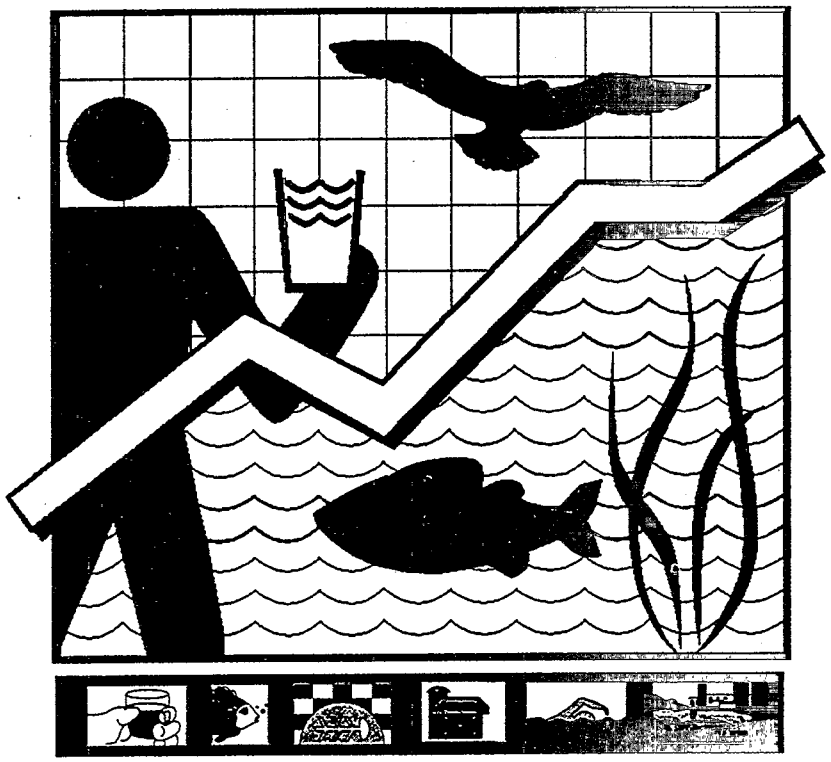
Office of Water
(4503F)

EPA 841-F-96-001
June 1996

EPA

Environmental Indicators of Water Quality in the United States

Fact Sheets



These fact sheets accompany the environmental indicators report. They provide further details on the 18 environmental indicators that measure progress toward national water goals and objectives.

The indicators were chosen through an intensive multi-year process involving public and private partners including EPA's Office of Water in collaboration with the Center for Marine Conservation; the Centers for Disease Control and Prevention; EPA's Office of Policy, Planning, and Evaluation and Office of Research and Development; the Intergovernmental Task Force on Monitoring Water Quality; Native American Tribes; the National Oceanic and Atmospheric Administration; The Nature Conservancy; the States; the U.S. Department of Agriculture; the U.S. Fish and Wildlife Service; and the U.S. Geological Survey.

National Environmental Goals for Water

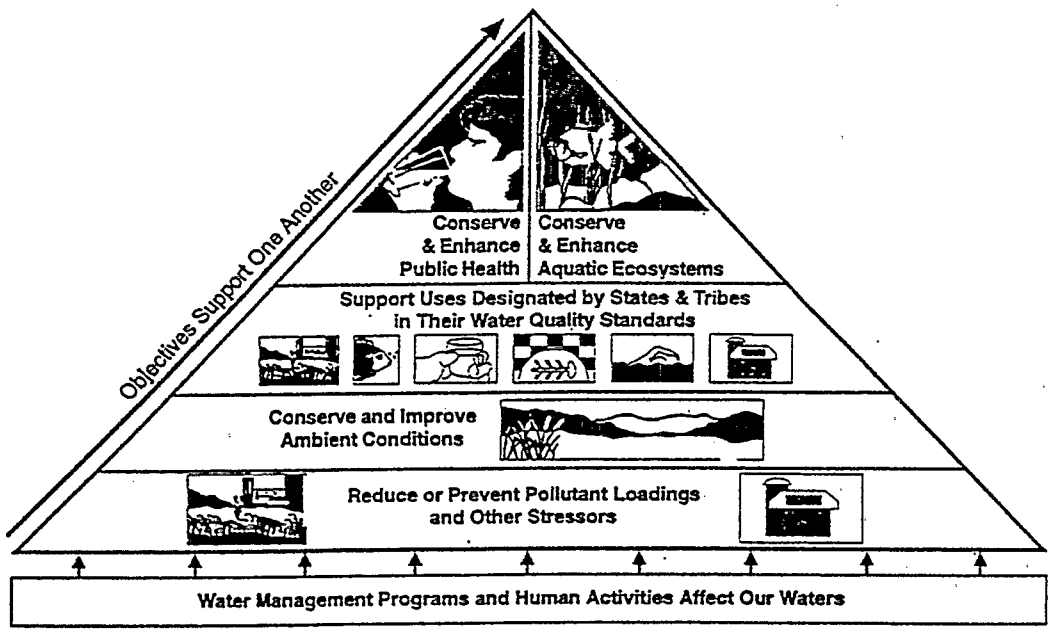
CLEAN WATERS: America's rivers, lakes, and coastal waters will support healthy communities of fish, plants, and other aquatic life, and will support uses such as fishing, swimming, and drinking water supply for people. Wetlands will be protected and rehabilitated to provide wildlife habitat, reduce floods, and improve water quality. Ground waters will be cleaner for drinking and other beneficial uses.

SAFE DRINKING WATER: Every American public water system will provide water that is consistently safe to drink.

Note: Goals taken from *Environmental Goals for America With Milestones for 2005: A Proposal from the Environmental Protection Agency.* Government Review Draft. EPA 230-D-96-002. Washington, DC: USEPA. In press.

Water Objectives to Meet These Goals

Objectives are measured by indicators presented in this report



The objectives adopted by EPA's Office of Water and its partners are shown above. These objectives are like building blocks in a pyramid, where success in reaching the goals at the top is dependent on successful attainment of those lower in the pyramid. For example, by reducing pollutant loads to waters, the overall quality, or ambient condition, of the water and sediment is improved. Consequently, the waters can support the uses designated for them by states and tribes in their water quality standards. Ultimately, the health of both the general public and aquatic ecosystems is protected.

Indicator Data Completeness

Indicators are used to show changes in environmental conditions and are only as good as the quality of the measurements that support them. The indicators presented in this report contain measurements of varying quality. These measurements might differ in precision, accuracy, statistical representativeness, and completeness. This comprehensive national report uses data from many agencies. While these data sources have undergone data quality assessment by their respective agencies, this first national report makes no attempt to describe data quality attributes other than completeness for the indicators. This report includes data of varying quality for two reasons: (1) the indicator describes an important, if as yet imperfect, way to measure a national objective, and (2) efforts are under way to improve indicator measurements in future reports. Further details on the data used to support each indicator are presented in individual fact sheets available from EPA in hard copy or on the Internet at the address at the end of this report. Each indicator graphic in this report shows the level of data completeness using the following symbols:

- ● Data consistent/sufficient data collected
- ◗ Data somewhat consistent/additional data needed
- ○ Data need to be much more consistent/much additional data needed

Water Quality Objectives and Indicators

Objective I: Conserve and Enhance Public Health

1. *Population served by community drinking water systems violating health-based requirements*—Population served by drinking water systems with one or more violations of health-based requirements.
2. *Population served by unfiltered surface water systems at risk from microbiological pollution*—Population served by, and number of, systems that have not met the requirements to filter their water to remove microbiological contaminants.
3. *Population served by drinking water systems exceeding lead action levels*—Population served by, and number of, systems with lead levels in drinking water exceeding the regulatory threshold.
4. *Source water protection*—Number of community drinking water systems using ground water that have programs to protect them from pollution.
5. *Fish consumption advisories*—Percentage of rivers and lakes with fish that states have determined should not be eaten, or should be eaten in only limited quantities.
6. *Shellfish growing water classification*—Percentage of estuarine and coastal shellfish growing waters approved for harvest for human consumption.

Objective II: Conserve and Enhance Aquatic Ecosystems

7. *Biological integrity*—Percentage of rivers and estuaries with healthy aquatic communities.
8. *Species at risk*—Percentage of aquatic and wetland species currently at risk of extinction.
9. *Wetland acreage*—Rate of wetland acreage loss.

Objective III: Support Uses Designated by the States and Tribes in Their Water Quality Standards

10. *Designated uses in state and tribal water quality standards*
    a. *Drinking water supply designated use*—Percentage of assessed waterbodies that can support safe drinking water supply use, as designated by the states and tribes.
    b. *Fish and shellfish consumption designated use*—Percentage of assessed waterbodies that can support fish and shellfish consumption, as designated by the states and tribes.
    c. *Recreation designated use*—Percentage of assessed waterbodies that can support safe recreation, as designated by the states and tribes.
    d. *Aquatic life designated use*—Percentage of assessed waterbodies that can support healthy aquatic life, as designated by the states and tribes.

Objective IV: Conserve and Improve Ambient Conditions

11. *Ground water pollutants*—Population exposed to nitrate in drinking water. In the future, the indicator will report the presence of other chemical pollutants in ground water.
12. *Surface water pollutants*—Trends of selected pollutants found in surface water.
13. *Selected coastal surface water pollutants in shellfish*—The concentration levels of selected pollutants in oysters and mussels.
14. *Estuarine eutrophication conditions*—Trends in estuarine eutrophication conditions.
15. *Contaminated sediments*—Percentage of sites with sediment contamination that might pose a risk to humans and aquatic life.

Objective V: Reduce or Prevent Pollutant Loadings and Other Stressors

16. *Selected point source loadings to (a) surface water and (b) ground water*—Trends for selected pollutants discharged from point sources into surface water, and underground injection control wells that are sources of point source loadings into ground water.
17. *Nonpoint source loadings to surface water*—Amount of soil eroded from cropland that could run into surface waters. Future reports will include additional nonpoint source surface water pollutants as well as sources of nonpoint source ground water pollution.
18. *Marine debris*—Trends and sources of debris monitored in the marine environment.

POPULATION SERVED BY COMMUNITY DRINKING WATER SYSTEMS VIOLATING HEALTH-BASED REQUIREMENTS

What does the indicator tell us?

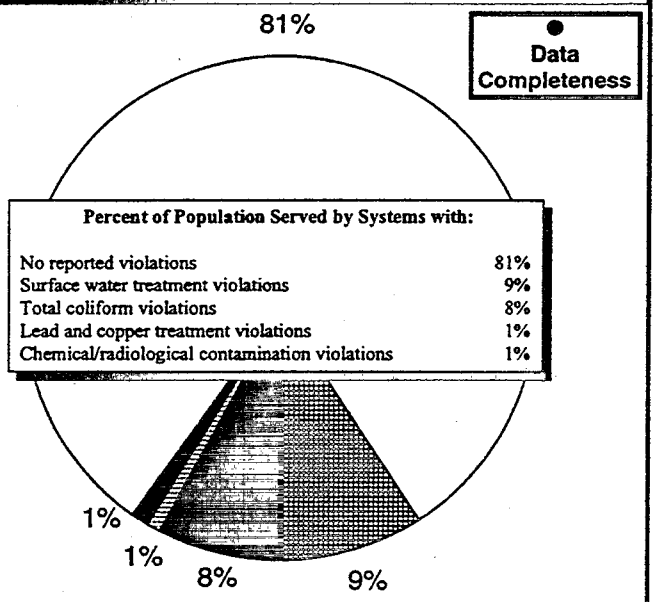
This indicator displays the population provided water in 1994 by community water systems that violated one or more of the health-based requirements during that year. By tracking drinking water violations, the relative risk to humans of exposure to harmful levels of contaminants in drinking water can be illustrated. In 1994, more than 45 million people (19 percent of the population) were served by community drinking water systems that violated health-based requirements at least once during the year. This measure is a "rough cut" indicator of potential exposure to harmful levels of contaminants that have the potential to adversely affect public health. This indicator does not illustrate the persistence of contaminants in drinking water or their level above the violation.

How will the indicator be used to track progress?

EPA and the states regulate approximately 200,000 public drinking water systems that serve more than 240 million people. Public water systems are defined as systems that provide piped water for human consumption to at least 15 service connections or serve an average of at least 25 people for at least 60 days each year. Approximately 60,000 of these water systems are known as community drinking water systems—systems that provide water to the same population year-round. The remaining 120,000 are noncommunity water systems that provide drinking water for nonresidential use (e.g., workplaces, schools, restaurants).

The concentration of contaminants in drinking water provided by water systems to consumers is strictly controlled by standards established to minimize or eliminate risk to human health. Under the 1974 Safe Drinking Water Act and the 1986 Amendments, EPA sets national limits on contaminant levels in drinking water to ensure that the water is safe for human consumption. These limits are known as Maximum Contaminant Levels (MCLs). For some regulations, EPA establishes treatment techniques in lieu of an MCL to control unacceptable levels of contaminants in water. In general, these standards or limits are referred to as health-based requirements and they address several areas including surface water treatment, total coliform, lead and copper treatment, and chemical/ radiological contamination.

INDICATOR 1: Population Served by Community Drinking Water Systems Violating Health-Based Requirements



Note: As many as one-fourth of the water systems did not complete all required monitoring. The compliance status of some of these could not be assessed from reported data. 243 million people were served by community drinking water systems in 1994

Source: State data in EPA Safe Drinking Water Information System, 1994

Proposed Milestone: By 2005, the population served by community water systems in violation of health requirements will be reduced from 19 to 5 percent.

When violations of health-based requirements occur, water systems are compelled to remove the contaminants or face penalties under EPA and state regulatory programs. More than 80 percent of the population is served by community water systems that reported no violations of drinking water health-based requirements during fiscal year 1994. EPA plans to use the newly developed Safe Drinking Water Information System (SDWIS) to report on the number and types of violations reported from public water systems.

The Agency also regulates how often public water systems monitor their water for contaminants and report the monitoring results to the states or EPA. Generally, the larger the population served by a water system, the more frequent monitoring and reporting are required. In addition, EPA requires PWSs to monitor for unregulated contaminants to provide data on occurrences for future regulatory development. EPA also requires PWSs to notify the public when they have violated any of the regulations.

What is being done to improve the indicator?

Data quality and the process used to report on drinking water system regulatory compliance are critical factors in determining the quality of this indicator. The current data quality can be improved for many states. The Government Accounting Office and EPA have concluded that the overall rate of noncompliance is understated.

In an effort to improve the data used by this indicator, EPA and the states are jointly pursuing a modernization initiative to upgrade and improve their drinking water information systems. EPA is replacing the Federal Reporting Data System with SDWIS. States are now testing the first components of SDWIS, which will improve both data quality and reporting of violations. With the cooperation of the states, EPA will be able to use SDWIS to improve the oversight and management of drinking water programs.

The objective of the SDWIS modernization is to improve the accessibility and quality of the drinking water data that EPA and states provide to the public. The data available through SDWIS might allow better and more targeted measures of the occurrence of contaminants in drinking water by providing information on the type of contaminant, the duration of occurrence, and the degree to which the maximum contaminant level was exceeded.

What is being done to improve conditions measured by the indicator?

EPA currently has drinking water standards in place for 81 contaminants, and several major new regulatory actions are in progress. EPA's drinking water program has promulgated standards designed to protect people from drinking water contaminated by fecal coliform, organic and inorganic chemicals, lead and copper, radionuclides, and by-products from water treatment chemicals. As part of the Safe Drinking Water Act reauthorization process, EPA has identified activities to address the major issues facing the drinking water program today:

- *Building State Capacity to Implement Programs*—Eliminating the gap between needs and funding by increasing federal grants while encouraging states to seek alternative financing.
- *Revising the Mandate to Add 25 New Standards Every 3 Years*—Reducing the number of regulated contaminants to allow EPA to focus on those contaminants which pose real, known public health risks.
- *Enacting a Source Water Protection Program*—Allowing states to ensure drinking water quality by protecting the water at the source, thereby reducing the amount of expensive treatment required.
- *Addressing Problems Facing Small Systems*—Reducing the regulatory burden on small water systems and providing support for building viable water systems.

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POPULATION SERVED BY UNFILTERED SURFACE WATER SYSTEMS AT RISK FROM MICROBIOLOGICAL CONTAMINATION

What does the indicator tell us?

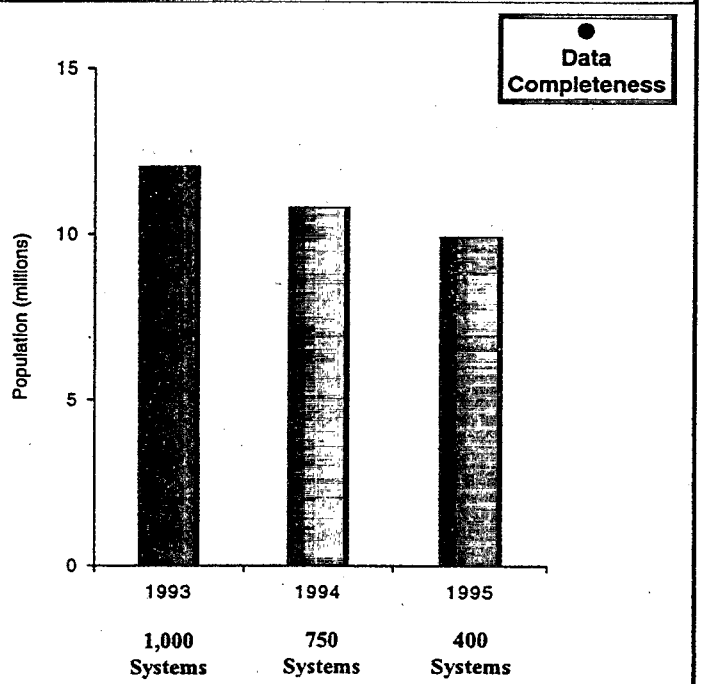
Drinking water systems supplied by surface waters can sometimes withdraw water that contains harmful levels of disease-causing microbiological contaminants, such as *Giardia lamblia, Legionella,* and viruses. Under the Surface Water Treatment Rule (SWTR), EPA and the states require all inadequately protected drinking water systems using surface water sources to install filtration and disinfection treatment to remove these microbiological contaminants from the drinking water. Compliance with the rule will dramatically reduce the probability of human exposure to harmful levels of microbiological contaminants from surface water sources.

This indicator displays the population provided water by unfiltered surface water systems that did not comply with the SWTR requirements that went into effect in 1993. Over 12 million people were provided drinking water from more than 1,000 unfiltered community water systems not in compliance with the SWTR in 1993. These numbers decreased in 1995, with approximately 9.9 million people being provided drinking water from 400 systems not in compliance with the rule.

How will the indicator be used to track progress?

EPA's Office of Ground Water and Drinking Water, in coordination with the Office of Enforcement and Compliance Assurance (OECA), will use the Safe Drinking Water Information System (SDWIS) to track both the number of systems in non compliance with the SWTR and the population served by these systems. States report this information to EPA on a quarterly basis, in accordance with regulations governing delegation of the drinking water program to the states.

INDICATOR 2: Population Served by Unfiltered Surface Water Systems at Risk from Microbiological Pollution



Source: State data in EPA Safe Drinking Water Information System, 1994

Proposed Milestone: By 2005, every person served by a public water system that draws from an unprotected river, lake, or reservoir will receive drinking water that is adequately filtered.

This indicator uses the SWTR compliance program status as a surrogate measure of the risk to the population from using drinking water from inadequately protected water sources. This program evaluation is being undertaken as a pilot project for EPA under the Government Performance and Results Act, which requires all federal agencies to have a strategic planning process including clearly stated goals and indicators to measure them.

What is being done to improve the indicator?

Data quality and the process used to report on drinking water system regulatory compliance are critical factors in determining the quality of this indicator. The current quality of the SWTR database is questionable in some states.

In an effort to improve the data for this indicator, EPA and the states are jointly pursuing a modernization initiative to upgrade and improve their drinking water information systems. EPA is replacing the Federal Reporting Data System with the Safe Drinking Water Information System. States are now testing the first components of SDWIS, which will improve both data quality and reporting of violations. With the cooperation of the states, EPA will be able to use SDWIS to improve the oversight and management of drinking water programs.

The objective of the SDWIS modernization is to improve the accessibility and quality of the drinking water data that EPA and states provide to the public. The SWTR database is now being integrated into SDWIS, which will make data management more efficient and improve data quality and analyses of program performance.

What is being done to improve conditions measured by the indicator?

Through aggressive action by EPA, the states, and the water systems themselves, the risk of human exposure to microbiological contaminants is being reduced. By the end of fiscal year 1995, the number of surface water systems not complying with the SWTR was reduced from 1,000 to 400. However, because most of the progress has been made in small and medium water systems, the population at risk has not dropped as dramatically—from 12 million to 9.9 million.

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Population Served By Community Drinking Water Systems Exceeding Lead Action Levels

What does the indicator tell us?

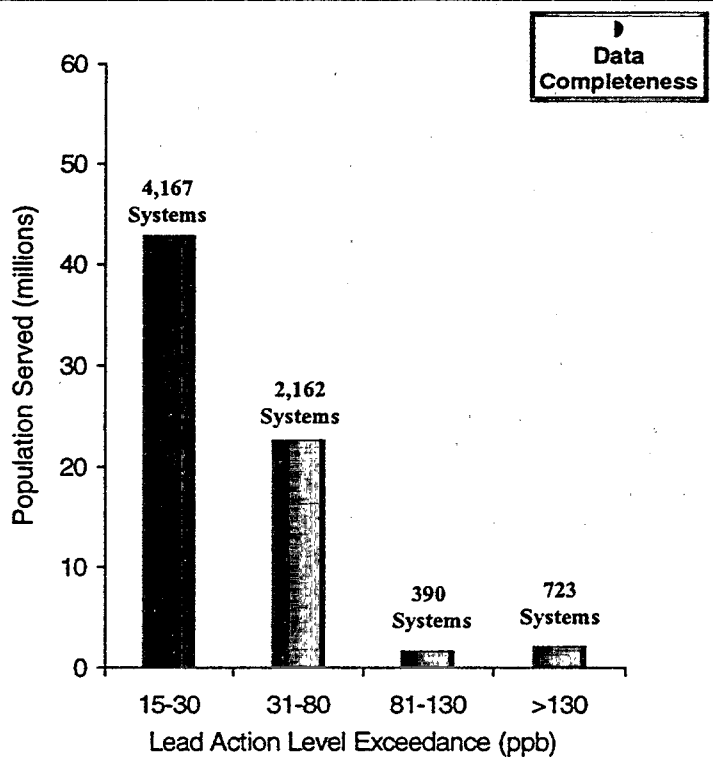
This indicator measures the population provided water by community water systems that have exceeded lead action levels and are required to take corrective action. It is not a precise predictor of the risk of exposure to the general population provided water by the targeted water systems. The monitoring results reflect the situation in only the worst portions of the distribution system and represent only the relative probability of risk for consumers of those targeted water systems.

Based on the results of lead monitoring through fiscal year 1995, 69.1 million people were provided drinking water by water systems that exceeded the action level of 15 parts per billion (ppb) at least once. Of that number, 42.8 million people were provided water by systems where sampling results showed lead levels between 15 and 30 ppb, and 26.3 million people received water from systems where sampling results showed lead levels over 30 ppb, which EPA views as a significant exceedance. About 2.1 million people received water from water systems where sampling results showed lead levels greater than 130 ppb. Higher exceedances increase the probability that people consuming water are at risk.

How will the indicator be used to track progress?

EPA, under its Lead and Copper Rule, requires that water systems follow a series of steps to reduce the likelihood of lead entering the drinking water from distribution system materials. Water systems are required to monitor for lead in their distribution systems and

INDICATOR 3: Population Served by Community Drinking Water Systems Exceeding Lead Action Levels



Source: State data in EPA Safe Drinking Water Information System, 1995

to take action when lead in more than 10 percent of the samples taken at the tap exceeds the regulatory action level of 15 ppb. Depending on the size and type of the system, actions range from establishing a public education program to implementing corrosion control treatment or replacing lead pipes. EPA requires large systems to install lead controls regardless of sampling results. The lead monitoring data for water systems exceeding the lead action level are contained in EPA's Safe Drinking Water Information System (SDWIS).

What is being done to improve the indicator?

Data quality and the process used to report on drinking water system regulatory compliance are critical factors in determining the quality of this indicator. This indicator measures the results of lead monitoring required under the Lead and Copper Rule. It shows exceedances of an action level defined in the rule to trigger additional actions. It is not in itself an indicator of a drinking water standard violation. The quality and completeness of the data for this indicator is questionable in some states.

In an effort to improve the indicator, EPA and the states are jointly pursuing a modernization initiative to upgrade and improve their drinking water information systems. EPA is replacing the Federal Reporting Data System with the Safe Drinking Water Information System. States are now testing the first components of SDWIS, which will improve both data quality and reporting of violations. With the cooperation of the states, EPA will be able to use SDWIS to improve the oversight and management of drinking water programs.

The objective of the SDWIS modernization is to improve the accessibility and quality of the drinking water data that EPA and states provide to the public. The new system will make reporting of lead monitoring results more efficient and data validation more complete.

What is being done to improve conditions measured by the indicator?

EPA estimates that 20 percent of human exposure to lead is attributable to lead in drinking water. Lead enters the drinking water through pipes in the distribution system, lead service lines, and household plumbing, including faucets and other fixtures. Lead in drinking water, however, is controllable through actions taken by water systems and their customers. Under the Lead and Copper Rule, EPA has established a series of steps that water systems must take to reduce the likelihood of lead entering drinking water from distribution system materials. These steps include corrosion control treatment and lead service line replacement.

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SOURCE WATER PROTECTION

What does the indicator tell us?

To protect drinking water sources even before water is withdrawn by a supplier, EPA has instituted the Source Water Protection Program. Currently, the program protects ground water used for drinking water by requiring the (1) delineation of the ground water area to be protected, (2) identification of potential sources of contamination, (3) development of contingency plans in case of a threat to the drinking water source, and (4) development of source management plans to control potential sources of contamination. Source water protection will be extended to surface waters.

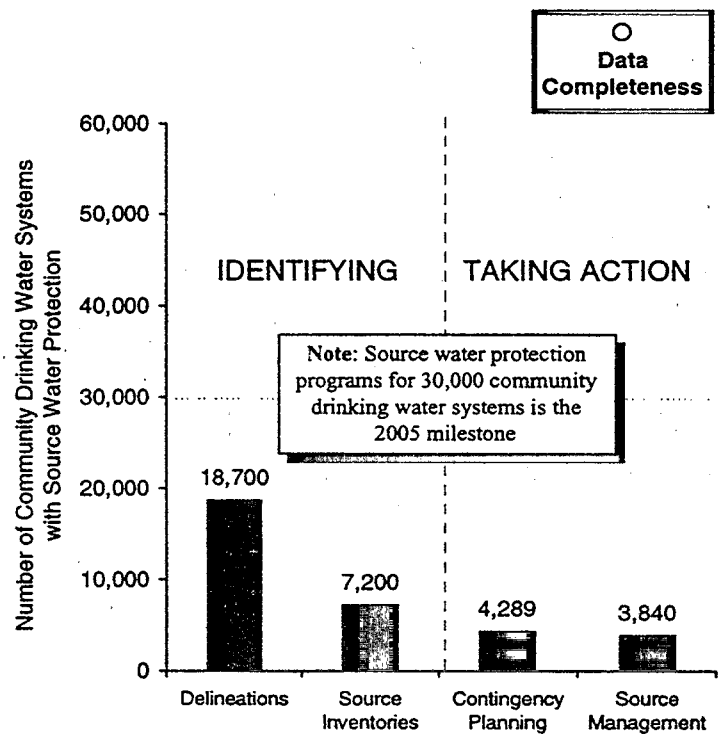
This indicator focuses on state progress in implementing the critical elements of ground water protection programs established to protect drinking water sources. Approximately 3,800 of the 60,000 community drinking water systems are covered by all four parts of the ground water protection program.

How will the indicator be used to track progress?

The Safe Drinking Water Act established EPA's Wellhead Protection (WHP) program. The WHP program requires states to develop systematic and comprehensive programs to protect public ground water supplies. To measure progress toward implementing ground water protection programs, EPA will track local-level implementation through the WHP program report. States are required to produce these reports every 2 years in an effort to update EPA and the public on the status of their drinking water protection programs.

These reports will help in determining the reduction in the number of people potentially exposed to harmful contaminants found in ground water used as a community drinking water source. It also will assess the adequacy of the pollution prevention controls that are critical to the safety of ground water used as drinking water supplies.

INDICATOR 4: Source Water Protection



Source: State Biennial Wellhead Reports to EPA, 1993

Proposed Milestone: By 2005, 60 percent of the population served by community water systems will receive their water from systems with source water protection programs in place.

What is being done to improve the indicator?

The 1995 guidelines for the wellhead protection report were expanded to include state reporting of communities relying on surface water. This tracking mechanism will measure not only the number of community water systems with ground water and surface water protection, but also the population protected. As more states begin to establish wellhead protection areas and implement ambient and compliance monitoring, the information might be used to validate the effectiveness of the source water protection program.

What is being done to improve conditions measured by the indicator?

The goal of reducing the number of people potentially exposed to harmful contaminants from community drinking water supplies is consistent with the compliance policies and programs of the current public water system regulatory program. Implementing source water protection programs around water systems reflects a new direction toward preventing pollution at the source.

Prevention is often more cost-effective than cleanup. This indicator might forecast dramatic changes in current EPA policies and programs and might alter what is expected of public water suppliers. The outline of the new approach is included in EPA's reauthorization recommendations, which would provide alternative regulatory programs for water systems in designated source water protection areas.

Well-implemented and enforced local prohibition ordinances can be a primary means for managing potential contamination sources. Also, data on maximum contaminant level violations for nitrates, volatile organic compounds, and pesticides can be used to illustrate the value of source water program implementation in preventing drinking water contamination.

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FISH CONSUMPTION ADVISORIES

What does the indicator tell us?

This indicator identifies the percentage of river miles and lake acres for which fish consumption advisories have been issued. A total of 46 states have issued fish consumption advisories. Information obtained by EPA's Office of Science and Technology from state reporting efforts indicates that one or more fish consumption advisories have been issued for 14 percent of the Nation's lake acres and 4 percent of the Nation's river miles.

States issue fish consumption advisories to warn recreational and subsistence anglers and other members of the public of the risks associated with consuming contaminated noncommercial fish. A fish consumption advisory may involve one or more of the following warnings: (1) do not eat any fish caught in a certain area; (2) eat only a specified limited amount of fish, particularly if you are in a high-risk group (e.g., pregnant women or young children); or (3) eat fish only after special preparation.

The U.S. Food and Drug Administration is responsible for protecting consumers from contaminants in fish sold through interstate commerce.

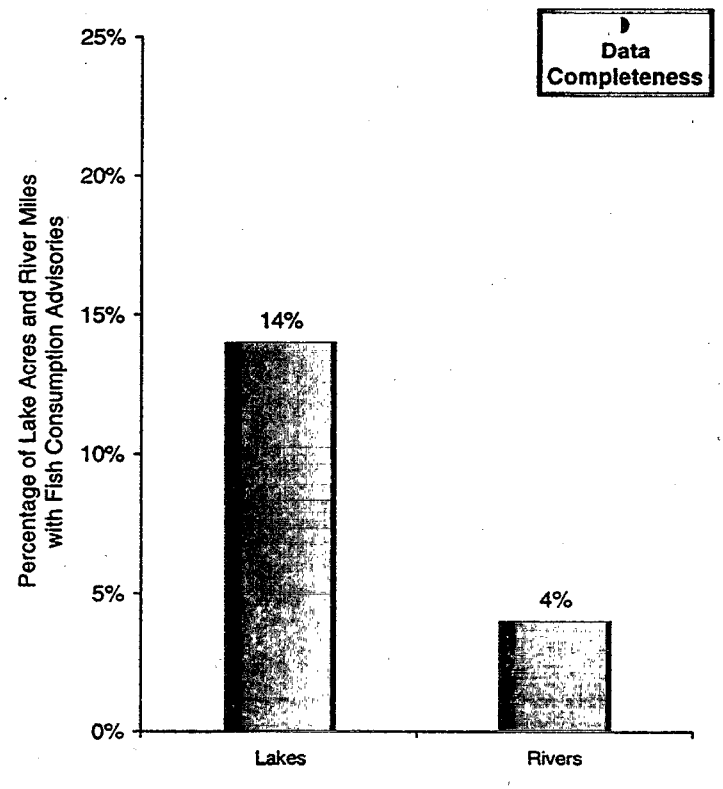
How will the indicator be used to track progress?

States provide EPA with information on fish consumption advisories. EPA collects and stores this information in the National Listing of Fish Consumption Advisories, which is updated annually. The database is used to map advisories by pollutant on a national, regional, state, and watershed basis. It helps identify the risks posed by a particular chemical on a geographic basis and could be used to target control, remediation, and risk management programs to high-risk areas.

What is being done to improve the indicator?

EPA is increasing the scope of the fish advisory program to include information on advisories for turtles, frogs, and waterfowl. The expanded database will be known as the National Listing of Fish and Wildlife

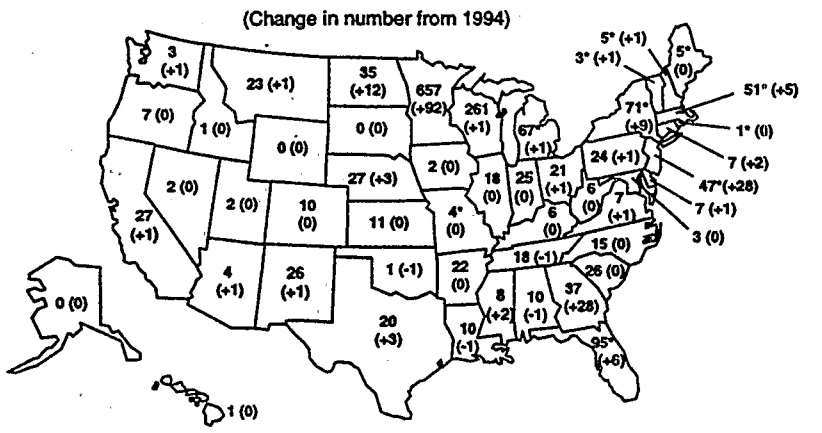
INDICATOR 5: Fish Consumption Advisories



Source: State data reported to EPA's Office of Science and Technology, 1994

Consumption Advisories. Other improvements to the information system include listing the total river miles and lake acres under advisory and automatically calculating the percentage of waters covered by state-issued fish consumption advisories for 37 particular contaminants, including mercury, dioxin, chlordane, PCBs, and DDT. In addition, the information system will overlay county and major city lines and index the advisories with a code for the stream or river segment to enable integration of the National Listing with other geographic information systems. The 1995 update will be available on CD-ROM, diskette, or the Internet.

Number of Fish Advisories Issued by Each State in 1995



Note: This map depicts the number of waterbodies, by state, where fish consumption advisories were in effect in 1995 based on information reported to EPA by the states. Because of the variability of the information reported, the numbers depicted here do not reflect the geographic extent of chemical contamination of fish tissue in each state nor the extent of a state's monitoring efforts. An asterisk(*) denotes a state that has issued statewide advisories for particular pollutants or types of waterbodies.

To improve the comparability and consistency of state-issued fish consumption advisories and accuracy in reporting, EPA has published guidance for states to use in developing advisories and in notifying recreational and subsistence anglers of potential risk from contaminated fish. EPA periodically sponsors conferences and technical training sessions, and serves as a national clearinghouse for related information to assist states with their fish advisory programs.

EPA also is working with the states to link information from state agencies that issue fish consumption advisories with the information other state agencies provide on attainment of the fish and shellfish consumption designated use, gathered in compliance with section 305(b) of the Clean Water Act. This approach should result in more consistent information on fish consumption issues.

What is being done to improve conditions measured by the indicator?

Fish can become contaminated because of proximity to (1) a hazardous waste site, (2) a discharge outfall, (3) a chemical spill, (4) a public recreation area, or (5) a nonpoint source. Pollutants from these sources can also collect and persist in sediment and bioaccumulate through the food chain, becoming a potential hazard to aquatic life and human health.

As a result, EPA is working with its partners to place further restrictions on pollution from point sources, clean up Superfund sites, improve containment of accidental spills, and reduce nonpoint source pollution. These efforts should reduce the incidence of contaminated fish.

EPA is also developing a guidance document on managing the risks associated with fish consumption. The document will help states and tribes reduce loadings of high-risk chemicals to water and sediment. It will also provide guidance on the types of actions that states and tribes can take to reduce the risks to particularly susceptible individuals.

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SHELLFISH GROWING WATER CLASSIFICATION

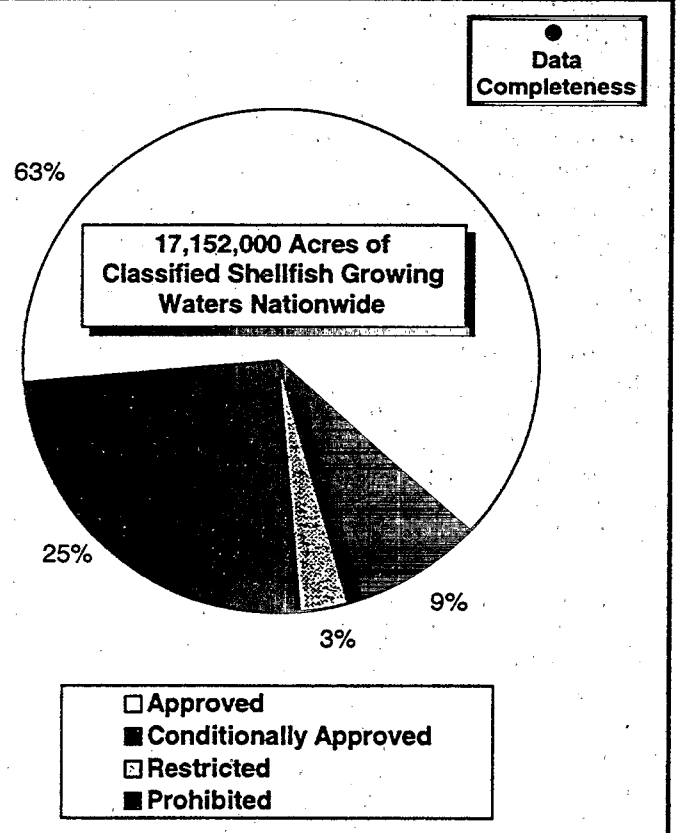
What does the indicator tell us?

This indicator shows the percentage of classifed shellfish growing waters nationwide where shellfish harvesting is (1) approved (waters may be harvested for direct marketing at all times); (2) conditionally approved (waters do not meet the criteria for approved waters if subjected to intermittent microbiological pollution, but may be harvested when criteria are met); (3) restricted (waters may be harvested if shellfish are subjected to a suitable purification process); and (4) prohibited (no harvest for human consumption at any time).

Harvest-limited classifications are assigned to waters based on water quality as well as management decisions. Classifications based on water quality are supported by sanitary surveys that identify actual pollution sources and water sampling data. Management decisions include mandatory buffer zones and wastewater treatment plant outfalls, marinas, and situations in which regulations requiring current and complete sanitary surveys have not been met. Thus, in cases where it is known that water quality problems are the cause of shellfish bed closures, this indicator could be used to determine the area and extent of pollution. Closures could also help determine pollution sources with the most impact and future problems that are likely to occur if no action is taken.

In 1990, 17 million estuarine acres were classified, with 63 percent approved for shellfish harvest—a 6 percent decline from 1985. Of the other 37 percent, termed harvest-limited acreage, 9 percent were conditionally approved for harvest under certain conditions, such as season, river stage, or amount of rainfall.

INDICATOR 6: Shellfish Growing Water Classification



Source: National Oceanic and Atmospheric Administration, 1990

How will the indicator be used to track progress?

All shellfish growing waters in the United States are classified using National Shellfish Sanitation Program guidelines developed by the Interstate Shellfish Sanitation Commission (ISSC) to protect the health of people who consume shellfish, such as oysters, clams, and mussels. These guidelines are based primarily on fecal coliform bacteria levels.

The ISSC includes representatives from states, industry, and the federal government. Every 5 years, the National Oceanic and Atmospheric Administration (NOAA), in cooperation with ISSC, produces the *National Register of Classified Estuarine Waters*, which catalogs the location, current acreage, classifications, and the reasons for the classifications.

What is being done to improve the indicator?

Although data on shellfish bed closures have been collected and published since 1966 for all 23 coastal states in the *Register*, it was not until 1990 that the collection process included information on the cause of harvest restrictions. The 1995 *Register*, the most accurate to date, will be released in late 1996 and will contain data for each shellfish growing area on (1) size, (2) location, (3) spatial extent, (4) harvest classification, (5) reason for harvest restriction, (6) relative abundance of the resources, (7) contributing pollution sources, and (8) the presence or absence of restoration activities, such as pollutant input reduction measures.

To perform trend analyses using this indicator, a base year must be established and data collected in subsequent years must reflect the same parameters and protocols used in the base year. Using 1995 as the base year would provide the most accurate baseline data on reasons for harvest-restricted classifications.

This is important because harvest restricted classifications might or might not be caused by problems with water quality. Other reasons for harvest restricted classifications include limited administrative resources, areas closed or opened for conservation purposes, or lack of a completed sanitary survey. However, accurately collecting data on the reasons for harvest restrictions ensures using only those harvest restrictions resulting from water quality problems.

In addition to the above improvements, changes should be considered in the way that NOAA collects *Register* information. Visiting all coastal states is extremely time-consuming, labor-ntensive, and expensive. If all states used the same geographic information system to track all elements of each shellfish growing water, data gathering, processing, and analysis could occur on a yearly basis.

What is being done to improve conditions measured by the indicator?

Shellfish are contaminated by several pollution sources including sewage treatment plants, industrial facilities, septic systems, and nonpoint sources. The largest increases in pollution of shellfish beds between 1985 and 1990 were attributed to urban runoff, septic systems, and boat pollution.

These increases reflect a common problem for shellfish areas—the influence of increased tourism and coastal development. As a result, EPA, NOAA, and their partners will enhance the protection of the Nation's shellfish areas by focusing on and improving coastal zone management efforts.

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BIOLOGICAL INTEGRITY

What does the indicator tell us?

This indicator shows data from (1) 31 states that currently have comprehensive biological monitoring programs in streams and wadeable rivers and (2) EPA's Environmental Monitoring and Assessment Program (EMAP), which uses biological monitoring to evaluate estuaries. Of those rivers and estuaries actually assessed for biological integrity, 50 percent of rivers and 74 percent of estuaries have healthy aquatic communities.

Pronounced changes in these biological communities indicate a disruption of healthy environmental conditions and can be useful in identifying cumulative effects of pollutants, habitat alteration that is difficult to see, effects from bioaccumulative chemicals, and other impacts that chemical monitoring does not reveal.

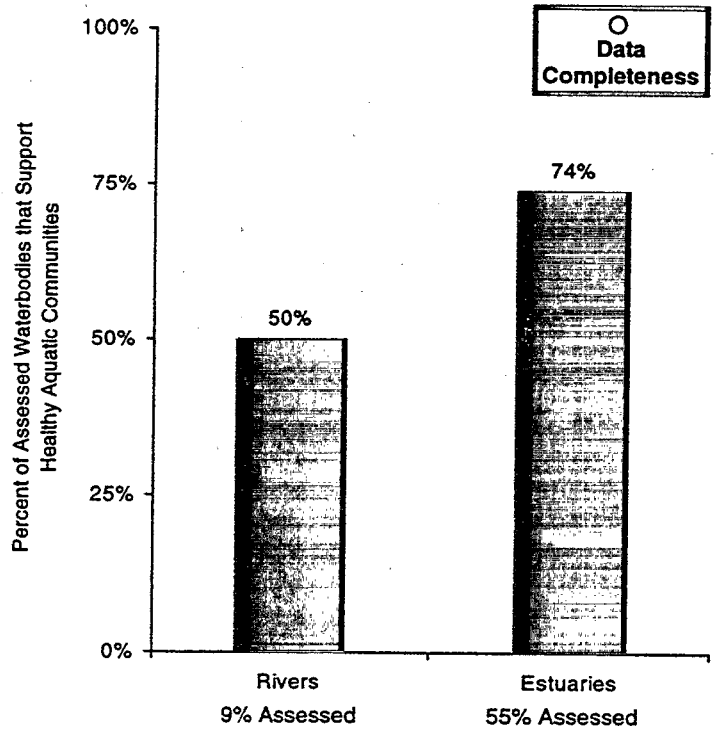
How will the indicator be used to track progress?

The data for rivers and streams are based on state monitoring programs that compare the aquatic organisms monitored at many locations to the expected composition, abundance, and condition of aquatic organisms typical of a minimally impaired reference condition. Information for estuaries is collected by EMAP, which uses a sample survey design to assess a wide area of waters.

What is being done to improve the indicator?

Assessing a water for healthy biological communities is a complex task, and the science to do so is newer and used less frequently than that used for chemical monitoring. EPA and its partners are working together to strengthen biological monitoring programs, assess more waters, and gather better data for producing

INDICATOR 7
Biological Integrity



Source: EPA EMAP, 1994, and state biological monitoring data, 1992-1994

Proposed Milestone: By 2005, 80 percent of the Nation's surface waters will support healthy aquatic communities.

the indicator. Methods for biological monitoring in lakes are not yet standardized, so there are not enough data to confidently report the number of lakes supporting healthy aquatic life.

This indicator could be improved by increasing the number of estuaries and rivers assessed and by beginning to perform lake biological assessments. Greater consistency in monitoring techniques must be ensured through the use of comparable methods and assessments. This could be accomplished through work done by the Intergovernmental Task Force on Monitoring Water Quality (ITFM). ITFM will also work to ensure consistency among federal and state data needed for representative reference conditions throughout a region.

EPA is working with states to develop methods and guidance to quantitatively measure the biological integrity of specific surface water types. Protocols for wadeable rivers and streams are available, and those for lakes are in draft form. Protocols for monitoring estuaries, wetlands, and large rivers are still needed.

To improve the amount and cross section of data used to characterize biological integrity, EPA is actively supporting states and tribes in the comprehensive biological assessment of their waters. EPA is also working with other federal agencies such as the Tennessee Valley Authority and the U.S. Geological Survey's National Water Quality Assessment program to determine how those data can be used to support this indicator.

What is being done to improve conditions measured by the indicator?

EPA and other federal and state agencies recognize that while most point sources are controlled with specific permit limits, less visible stormwater runoff and nonpoint sources of pollution also should be controlled. EPA and its partners are now placing greater emphasis on reducing the effects of habitat perturbation from grazing, farming, stream channelization, stormwater runoff, introduction of nonnative species, dam operations, and dredging. These activities affect aquatic ecosystems by reducing waterside vegetation, which provides both shade and bank stabilization; by increasing siltation; by scouring and removing important habitat components; and by raising water temperatures.

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SPECIES AT RISK

What does the indicator tell us?

This indicator shows the percentage of species dependent on freshwater aquatic or wetland habitats that are at risk. Currently, the groups of animals at greatest risk overall are those dependent on aquatic systems. More than 60 percent of freshwater mussels and crayfish are at risk, the highest imperilment ratio documented for any group of plants and animals in the United States.

How will the indicator be used to track progress?

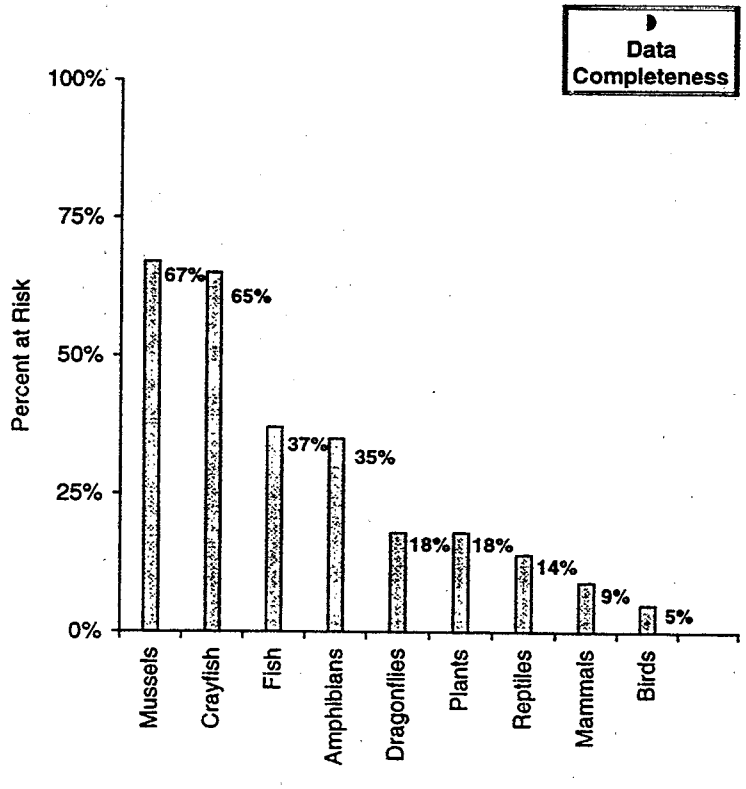
An important part of assessing the biological diversity and integrity in a waterbody is determining whether the aquatic species that should naturally exist in the waters are actually there and at the expected population size.

This indicator uses data from The Nature Conservancy and the Network of State Natural Heritage Data Centers, a public-private network of biological inventory and assessment programs. The biological and conservation status of species are assessed, and the species are ranked by the state agency-based Heritage Network as extinct, critically imperiled, imperiled, vulnerable, apparently secure, or demonstrably secure. Criteria for ranking a given species include the number of populations or occurrences known and their health, the estimated number of individuals, the distributional range and extent of appropriate habitat, the population and range trends, threats, and fragility or susceptibility to these threats. Approximately 30,000 U.S. species have been assessed and ranked, and rankings are updated as new information becomes available.

What is being done to improve the indicator?

These conservation status ranks are not legal categories, as are the U.S. Fish and Wildlife Service (USFWS) listings of threatened and endangered species. These status ranks focus on

INDICATOR 8:
Aquatic and Wetland Species at Risk

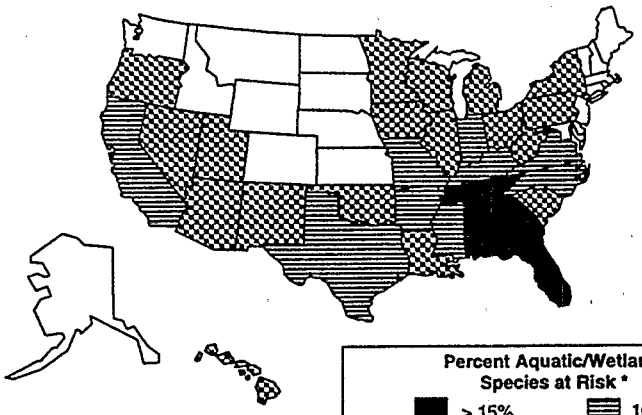


Source: The Nature Conservancy and State Natural Heritage Data Centers, 1996

known biological factors, with any individual status rank considered a hypothesis based on the best available information. Thus, ranks are less precise for species with less current inventory information.

To improve the confidence and accuracy of the ranks, additional inventory efforts are needed. The indicator will also need to distinguish between those species that are naturally rare and those that are imperiled because of human induced threats. Improvements to the National Wetlands Inventory, which provides information on wetland use by plants, and to the Natural Heritage Network, which covers habitat use generally, will result in a more complete list of wetland species and animal species habitat information.

Aquatic Species at Risk by State



Source: The Nature Conservancy and State Natural Heritage Data Centers, 1996

Although trend information, where available, is incorporated into the assessment of these conservation status ranks, the indicator cannot currently show specific trends. The indicator does not distinguish between those species that have stable or increasing populations and those that have declining populations. To allow the indicator to better differentiate between cause of imperilment and population trends, additional research is needed to carry out a trend monitoring strategy. EPA, The Nature Conservancy, and USFWS are working together to better integrate multiple data to support development of a second part to this indicator that will focus on trends.

What is being done to improve conditions measured by the indicator?

Degraded water quality and altered water flow are considered two of the primary threats affecting aquatic organisms and leading to these dramatic levels of imperilment. Any effort to prevent, control, or clean up water pollution or maintain or restore natural flow regimes should contribute to a decrease in species at risk by providing those species with a clean and safe habitat. More specifically, there are various programs that target species at risk for protection. Many of the species identified as at risk by The Nature Conservancy and Natural Heritage Network are also listed as threatened or endangered by USFWS. Listing a species as threatened or endangered guarantees that it will receive special protection.

The Nature Conservancy itself works to protect species at risk by determining which species are truly vulnerable and where they exist, and by working with partners to acquire or manage lands and waters harboring these rarities, as well as representative examples of ecological communities.

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WETLAND ACREAGE

What does the indicator tell us?

More than 200 million acres of wetlands existed in the conterminous United States during colonial times. Today, less than half of those original wetlands remain. Many wetlands have been converted to farmland or dredged and filled to accommodate urban development. Twenty-two states have lost at least 50 percent of their original wetlands; 7 of those states have lost over 80 percent.

This indicator recognizes historical wetland loss but focuses on wetland loss trends. The U.S. Fish and Wildlife Service and the U.S Department of Agriculture report that from the mid-1970s to the mid-1980s approximately 290,000 acres of wetlands were lost annually on non-federal lands in the conterminous United States. During the mid-1980s to the early 1990s this trend slowed to about 70,000 to 90,000 acres annually. These non-federal lands represent about 75 percent of the Nation's lands.

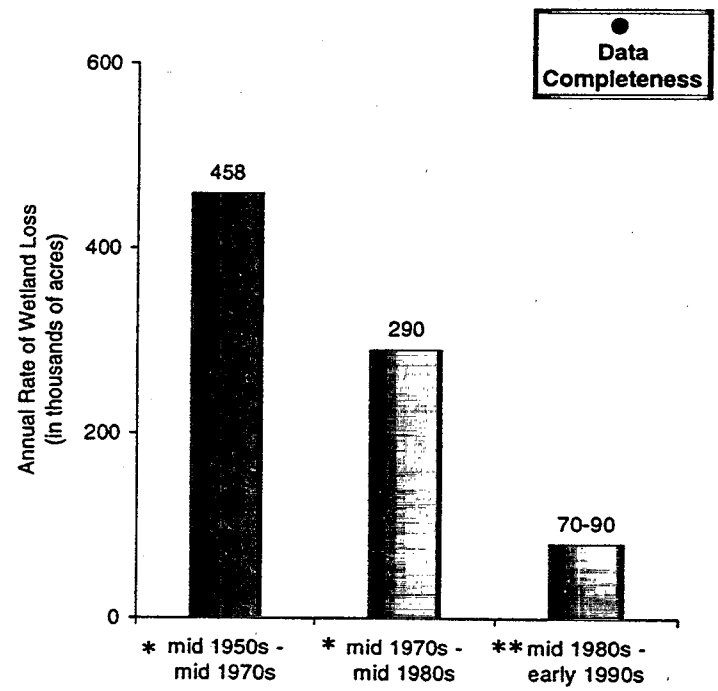
How will the indicator be used to track progress?

This indicator uses information from the U.S. Fish and Wildlife Service (USFWS) on wetland acreage on federal and non-federal lands. In addition to USFWS, the Natural Resource Conservation Service (NRCS) reports on wetland acreage on non-federal lands in *its National Resource Inventory*. EPA will continue to work with USFWS and NRCS to monitor wetland loss and report improvements in wetland acreage.

What is being done to improve the indicator?

Although efforts to eliminate wetland loss and realize a net gain in wetlands are under way, wetland loss is still a problem. Equally important, however, is the condition of existing wetlands. Wetland monitoring programs to

INDICATOR 9: Wetland Acreage



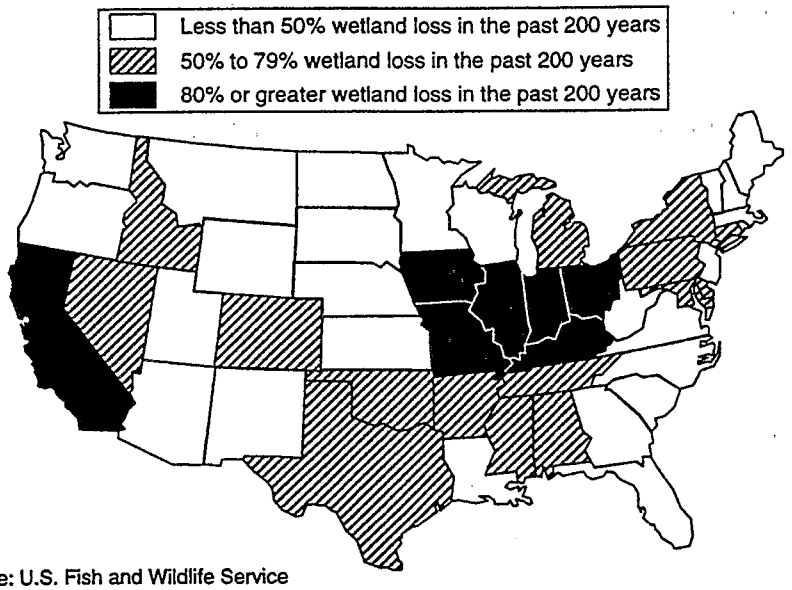
Sources: * U.S. Fish and Wildlife Service, 1990 (Data include federal lands)
** U.S. Department of Agriculture, 1992 (Data exclude federal lands)

Proposed Milestone: By 2005, there will be an annual net increase of at least 100,000 acres of wetlands, thereby supporting valuable aquatic life, improving water quality, and preventing health- and property-damaging floods and drought.

determine whether wetlands are healthy, functioning systems are still in their infancy.

Comprehensive studies of the extent of wetland degradation are just beginning to assess the condition of the biological life that is dependent on healthy wetlands. To improve the indicator's ability to assess wetland conditions, efforts to determine not only wetland acreage but also wetland quality will increase.

Historical Wetland Loss by State



Source: U.S. Fish and Wildlife Service

What is being done to improve conditions measured by the indicator?

As awareness of the importance of wetlands has increased, programs and initiatives to protect them have become more prevalent. In addition, several important trends have emerged that have supported wetland protection programs. Together, these programs, initiatives, and trends have led to a decrease in wetland losses and an increase in emphasis on wetland protection and restoration.

The support and continuation of these efforts and trends into the future will improve the health and status of our nation's wetlands. Some of the efforts and trends responsible for these improvements include:

- Decline in the profitability of converting wetlands for agricultural production.
- Passage of the Swampbuster provision in the 1985 and 1990 farm bills.
- Presence of Clean Water Act section 404 permit program and growth in state management programs.
- Greater public interest and support for wetland protection and restoration.
- Implementation of federal, state, and local programs that protect and restore wetlands, such as the Conservation Reserve Program, Partners for Wildlife, and Reinvest in Minnesota.

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DRINKING WATER SUPPLY DESIGNATED USE

What does the indicator tell us?

This indicator shows the percentage of assessed waterbodies that have attained the drinking water supply use designated by states and tribes as part of their water quality standards. This designated use requires that water obtained from the waterbody is safe to drink following conventional treatment, such as chlorination, by a water supplier.

States and tribes define their waterbodies, monitor their quality, and report the results to EPA, which publishes the individual and aggregated results in the *National Water Quality Inventory*. According to the 1994 *Inventory*, 83 percent of assessed rivers and streams and 87 percent of assessed lakes and reservoirs can be used safely as a drinking water supply.

How will the indicator be used to track progress?

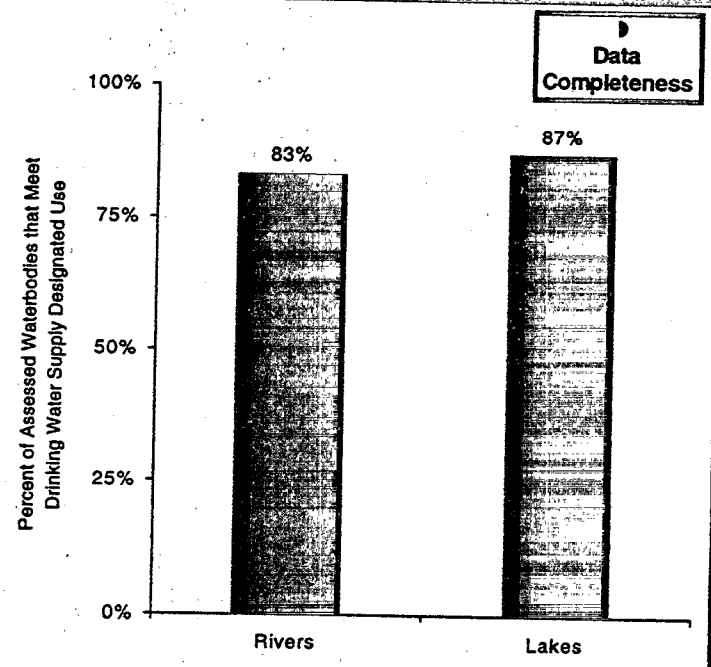
The Clean Water Act requires states and tribes (if authorized) to adopt standards with designated uses for waterbodies or waterbody segments. One of these designated uses is drinking water supply. Section 305(b) of the Clean Water Act requires that states and tribes assess the degree to which their surface waters support the designated uses.

States and tribes report the results of the assessments to EPA every 2 years through the issuance of 305(b) Reports. Data from the reports are then aggregated to form the *National Water Quality Inventory*, which is used to portray the status of the Nation's waters. The results reported in the *National Water Quality Inventory* will be used to track changes in the indicator.

What is being done to improve the indicator?

Section 305(b) of the Clean Water Act currently requires states and tribes to report water quality monitoring results to EPA. It is important to note that states, tribes, and other

INDICATOR 10a: Drinking Water Supply Designated Use



Source: *National Water Quality Inventory: 1994 Report to Congress*, 1995; 17 percent of all river and stream miles (48 percent of constantly flowing miles), 42 percent of lake and reservoir acres, and 78 percent of estuarine square miles were assessed.

Proposed Milestone: By 2005, 90 percent of the Nation's rivers, streams, lakes, and reservoirs designated as drinking water supplies will provide water that is safe to use after conventional treatment.

jurisdictions do not use identical survey methods or criteria to assess waters, in spite of guidelines issued by EPA and developed by the 305(b) Consistency Workgroup, composed of 25 states, 3 tribes, and 7 federal agencies. In addition, most states and tribes do not assess all of their waterbodies during the 2-year 305(b) reporting cycle, and they might even modify criteria or assess different waterbodies every 2 years. In 1994, only 17 percent of the Nation's total river and stream miles (48 percent of those which are constantly flowing), 42 percent of its lake and reservoir acres, and 78 percent of its estuaries were assessed for overall water quality.

305(b) data used to support this indicator might not represent general conditions in the Nation's waters because states, tribes, and other jurisdictions often focus on major perennial rivers, estuaries, and public lakes with suspected pollution problems in order to direct scarce resources to areas that could pose the greatest risk. Many states, tribes, and other jurisdictions lack the resources to collect information for nonperennial streams, small tributaries, and private ponds. This indicator does not predict the health of these or other unassessed waters. Because of these limitations, EPA must use caution in comparing data between states, tribes, and other jurisdictions, as well as between reporting periods.

In an effort to improve future reporting, EPA is pursuing several initiatives. First, EPA is working with the states and tribes to better link the source water assessment to the existing drinking water standards and to tighten the criteria used to identify actual or potentially impaired waters.

EPA is working with its partners to develop monitoring and assessment approaches that will improve state-to-state consistency in reporting. This will provide a more accurate picture of the Nation's waters when all of the data are aggregated on a national basis.

EPA is working with states, tribes, and other federal agencies to change the 305(b) reporting cycle from 2 years to 5 years, with annual reporting of key data for the waters assessed in each year. This will enable comprehensive reporting of waters meeting designated uses each 5-year period.

The 305(b) Consistency Workgroup and the Intergovernmental Task Force on Monitoring Water Quality (ITFM) are providing guidance and assistance in an effort to improve monitoring, assessment, and reporting.

What is being done to improve conditions measured by the indicator?

EPA's *National Water Quality Inventory* shows that states identify agriculture, urban runoff/ stormwater, and municipal point sources as the largest pollutant sources for rivers, lakes, and estuaries. These sources can adversely affect drinking water supply. In addition to continuing to control point sources, EPA and its partners also need to control nonpoint source pollution from both rural and urban areas.

EPA encourages states to use a place-based watershed framework and source water protection programs to identify the causes of water quality degradation, to determine appropriate controls, and to manage the control programs.

The watershed framework and source water protection programs assist water resource managers in reducing stresses on water quality, such as toxic chemicals, siltation, and nutrients from phosphate-based detergents and fertilizers, all of which can increase the cost and reduce the efficiency of treatment.

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FISH AND SHELLFISH CONSUMPTION DESIGNATED USE

What does the indicator tell us?

This indicator shows the percentage of assessed waterbodies that have attained the fish and shellfish consumption use designated by states and tribes as part of their water quality standards.

States and tribes define their waterbodies, monitor their quality, and report the results to EPA, which publishes the individual and aggregated results in the *National Water Quality Inventory*. According to the 1994 *Inventory*, 95 percent of assessed rivers and streams, 82 percent of assessed lakes and reservoirs, and 92 percent of assessed estuaries provide fish safe for human consumption. In addition, 74 percent of assessed estuaries provide shellfish safe for human consumption.

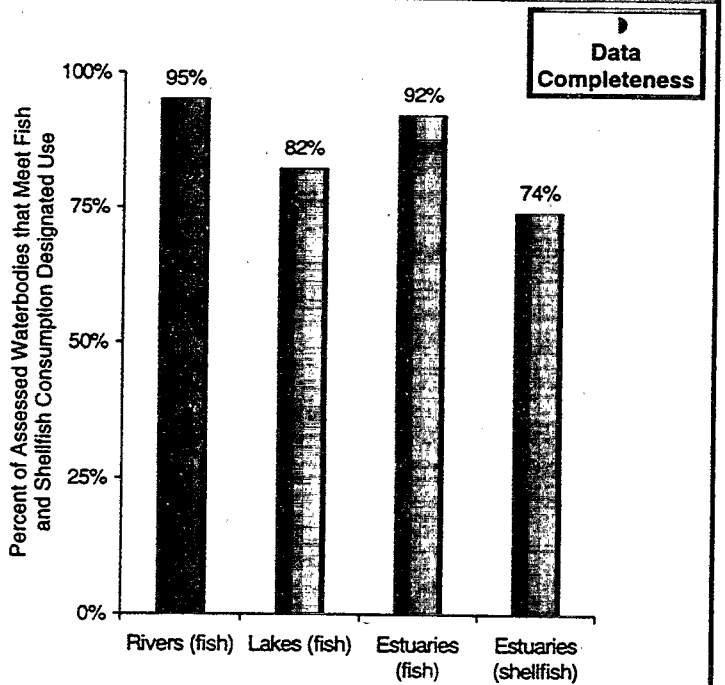
How will the indicator be used to track progress?

The Clean Water Act requires states and tribes (if authorized) to adopt standards with designated uses for waterbodies or waterbody segments. One of these designated uses is fish and shellfish consumption. Section 305(b) of the Clean Water Act requires that states and tribes assess the degree to which their surface waters support the designated uses. The results of the assessments are reported to EPA every 2 years through the issuance of 305(b) Reports. Data from these reports are then aggregated to form the *National Water Quality Inventory*, which is used to portray the status of the Nation's waters. The results reported in *the National Water Quality Inventory* will be used to track changes in the indicator.

What is being done to improve the indicator?

Section 305(b) of the Clean Water Act currently requires states and tribes to report water quality monitoring results to EPA. It is important to note that states, tribes, and other

INDICATOR 10b: Fish and Shellfish Consumption Designated Use



Source: *National Water Quality Inventory: 1994 Report to Congress*, 1995; 17 percent of all river and stream miles (48 percent of constantly flowing miles), 42 percent of lake and reservoir acres, and 78 percent of estuarine square miles were assessed.

Proposed Milestone: By 2005, 90 to 98 percent of the Nation's fish and shellfish harvest areas will provide food safe for people and wildlife to eat.

jurisdictions do not use identical survey methods or criteria to assess waters, in spite of guidelines issued by EPA and developed by the 305(b) Consistency Workgroup, composed of 25 states, 3 tribes, and 7 federal agencies. In addition, most states and tribes do not assess all of their waterbodies during the 2-year 305(b) reporting cycle, and they might even modify criteria or assess different waterbodies every 2 years. In 1994, only 17 percent of the Nation's river and stream miles (48 percent of those which are constantly flowing), 42 percent of its lake and reservoir acres, and 78 percent of its estuaries were assessed for overall water quality.

305(b) data used to support this indicator might not represent general conditions in the Nation's waters because states, tribes, and other jurisdictions often focus on major perennial rivers, estuaries, and public lakes with suspected pollution problems in order to direct scarce resources to areas that could pose the greatest risk. Many states, tribes, and other jurisdictions lack the resources to collect information for nonperennial streams, small tributaries, and private ponds. This indicator does not predict the health of these or other unassessed waters. Because of these limitations, EPA must use caution in comparing data between states, tribes, and other jurisdictions, as well as between reporting periods.

In an effort to improve future reporting, EPA is pursuing several initiatives. First, EPA is working with the states and tribes to link the information from state agencies that issue fish consumption advisories with the information other state agencies provide on use attainment.

EPA is working with its partners to develop monitoring and assessment approaches that will improve state-to-state consistency in reporting. This will provide a more accurate picture of the Nation's waters when all of the data are aggregated on a national basis.

EPA is working with states, tribes, and other federal agencies to change the 305(b) reporting cycle from 2 years to 5 years, with annual reporting of key data for the waters assessed in each year. This will enable comprehensive reporting of waters meeting designated uses each 5-year period.

The 305(b) Consistency Workgroup and the Intergovernmental Task Force on Monitoring Water Quality (ITFM) are providing guidance and assistance in an effort to improve monitoring, assessment, and reporting.

What is being done to improve conditions measured by the indicator?

EPA's *National Water Quality Inventory* shows that states identify agriculture, urban runoff/stormwater, and municipal point sources as the largest pollutant sources for rivers, lakes, and estuaries. These sources can contribute to excessive levels of pollutants in fish and shellfish. Pollutants can also collect and persist in sediments and bioaccumulate through the food chain, reaching excessive levels in fish and shellfish. Hydrologic modification, resource extraction, contaminated sediments, and natural sources, such as atmospheric deposition, however, also degrade water quality. In addition to continuing to control point sources, EPA and its partners also need to control nonpoint source pollution from both rural and urban areas.

EPA encourages states to use a place-based watershed framework to identify the causes of water quality and habitat degradation, to determine appropriate controls, and to manage the control programs. The watershed framework assists water resource managers in reducing stresses on water quality, such as toxic chemicals, siltation, habitat loss, nutrients from phosphate-based detergents and fertilizers, and elevated water temperatures resulting from loss of vegetative cover.

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RECREATION DESIGNATED USE

What does the indicator tell us?

This indicator shows the percentage of assessed waterbodies that have attained the swimming and recreation use designated by states and tribes as part of their water quality standards.

States and tribes define their waterbodies, monitor their quality, and report the results to EPA, which publishes the individual and aggregated results in *the National Water Quality Inventory*. According to the 1994 *Inventory*, 77 percent of assessed rivers and streams, 81 percent of assessed lakes and reservoirs, and 85 percent of assessed estuaries are safe for swimming. In addition, 87 percent of assessed rivers and streams, 86 percent of assessed lakes and reservoirs, and 83 percent of assessed estuaries are safe for other forms of recreation.

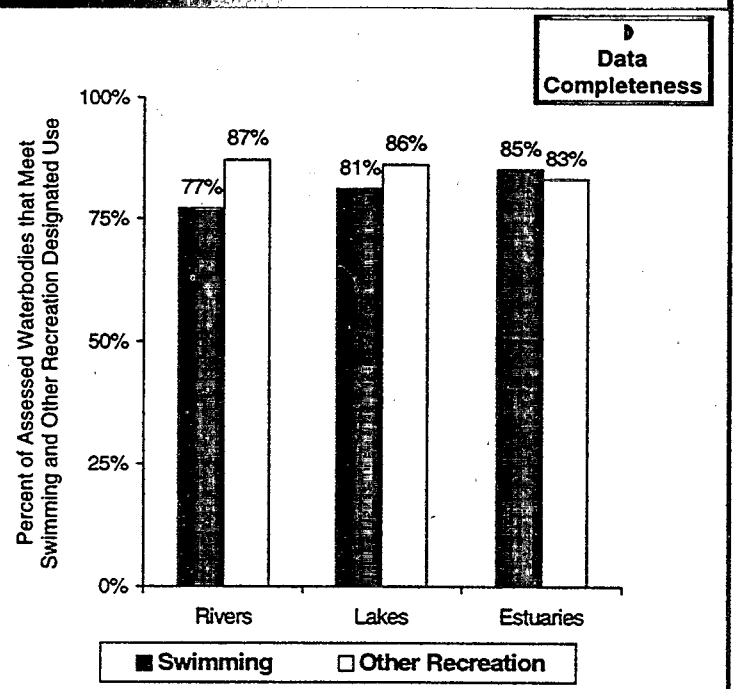
How will the indicator be used to track progress?

The Clean Water Act requires states and tribes (if authorized) to adopt standards with designated uses for waterbodies or waterbody segments. One of these designated uses is swimming and recreation. Section 305(b) of the Clean Water Act requires that states and tribes assess the degree to which their surface waters support the designated uses. States and tribes report the results of these assessments to EPA every 2 years through the issuance of 305(b) Reports. Data from the reports are then aggregated to form *the National Water Quality Inventory*, which is used to portray the status of the Nation's waters. The results reported in the *National Water Quality Inventory* will be used to track changes in the indicator.

What is being done to improve the indicator?

Section 305(b) of the Clean Water Act currently requires states and tribes to report water quality monitoring results to EPA. It is important to note that states, tribes, and other

INDICATOR 10c: Recreation Designated Use



Source: *National Water Quality Inventory: 1994 Report to Congress*, 1995; 17 percent of all river and stream miles (48 percent of constantly flowing miles), 42 percent of lake and reservoir acres, and 78 percent of estuarine square miles were assessed

Proposed Milestone: By 2005, 95 percent of the Nation's surface waters will be safe for recreation.

jurisdictions do not use identical survey methods or criteria to assess waters, in spite of guidelines issued by EPA and developed by the 305(b) Consistency Workgroup, composed of 25 states, 3 tribes, and 7 federal agencies. In addition, most states and tribes do not assess all of their waterbodies during the 2-year 305(b) reporting cycle, and they might even modify criteria or assess different waterbodies every 2 years. In 1994, only 17 percent of the Nation's river and stream miles (48 percent of those which are constantly flowing), 42 percent of its lake and reservoir acres, and 78 percent of its estuaries were assessed for overall water quality.

305(b) data used to support this indicator might not represent general conditions in the Nation's waters because states, tribes, and other jurisdictions often focus on major perennial rivers, estuaries, and public lakes with suspected pollution problems in order to direct scarce resources to areas that could pose the greatest risk. Many states, tribes, and other jurisdictions lack the resources to collect information for nonperennial streams, small tributaries, and private ponds. This indicator does not predict the health of these or other unassessed waters. Because of these limitations, EPA must use caution in comparing data between states, tribes, and other jurisdictions, as well as between reporting periods.

In an effort to improve future reporting, EPA is pursuing several initiatives. First, EPA is working with the states and tribes to more precisely define their recreational uses to differentiate, at a minimum, between contact recreation, such as swimming, and noncontact recreation, such as boating and wading, where immersion in the water is unlikely.

EPA is working with its partners to develop monitoring and assessment approaches that will improve state-to-state consistency in reporting. This will provide a more accurate picture of the Nation's waters when all of the data are aggregated on a national basis.

EPA is working with states, tribes, and other federal agencies to change the 305(b) reporting cycle from 2 years to 5 years, with annual reporting of key data for the waters assessed in each year. This will enable comprehensive reporting of waters meeting designated uses each 5-year period.

The 305(b) Consistency Workgroup and the Intergovernmental Task Force on Monitoring Water Quality (ITFM) are providing guidance and assistance in an effort to improve monitoring, assessment, and reporting.

What is being done to improve conditions measured by the indicator?

EPA's *National Water Quality Inventory* shows that states identify agriculture, urban runoff/stormwater, and municipal point sources as the largest pollutant sources for rivers, lakes, and estuaries. The ability of a waterbody to support recreation can be impacted by one or more of these sources.

In addition to continuing to control point sources, EPA and its partners also need to control nonpoint source pollution from both rural and urban areas. EPA encourages states to use a place-based watershed framework to identify the causes of water quality degradation, to determine appropriate controls, and to manage the control programs.

The watershed framework assists water resource managers in reducing stresses on water quality, such as toxic chemicals, nutrients from phosphate-based detergents and fertilizers, and bacterial contamination.

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AQUATIC LIFE DESIGNATED USE

What does the indicator tell us?

This indicator shows the percentage of assessed waterbodies that have attained the aquatic life use designated by states and tribes as part of their water quality standards. States and tribes define their waterbodies, monitor their quality, and report the results to EPA, which publishes the individual and aggregated results in the *National Water Quality Inventory*. According to the 1994 *Inventory*, 69 percent of assessed rivers and streams, 68 percent of assessed lakes and reservoirs, and 70 percent of estuaries can support healthy aquatic life.

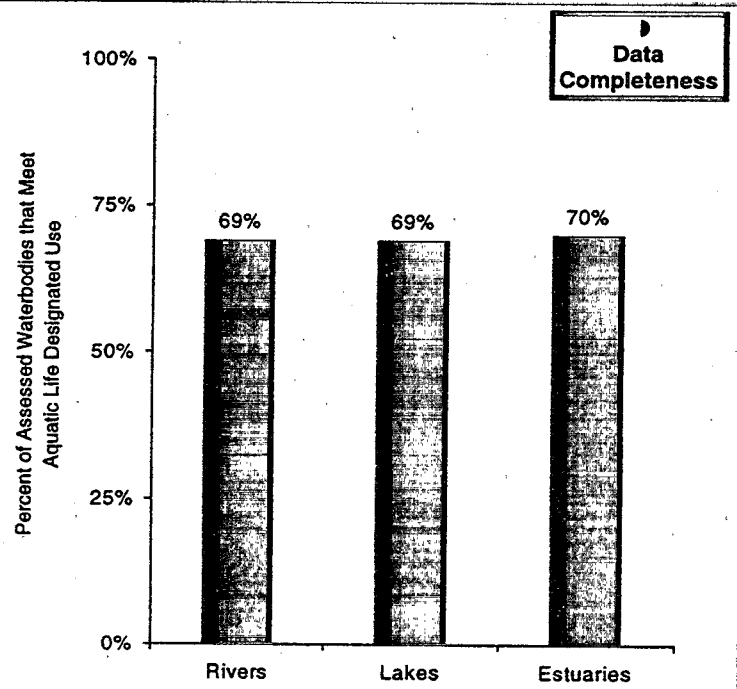
How will the indicator be used to track progress?

The Clean Water Act requires states and tribes (if authorized) to adopt standards with designated uses for waterbodies or waterbody segments. One of these designated uses is aquatic life. Section 305(b) of the Clean Water Act requires that states and tribes assess the degree to which their surface waters support the designated uses. State and tribes report the results of the assessments to EPA every 2 years through the issuance of 305(b) Reports. Data from the reports are then aggregated to form the *National Water Quality Inventory*, which is used to portray the status of the Nation's waters. The results reported in the *National Water Quality Inventory* will be used to track changes in the indicator.

What is being done to improve the indicator?

Section 305(b) of the CWA currently requires states and tribes to report water quality monitoring results to EPA. It is important to note that states, tribes, and other jurisdictions do not use identical survey methods or criteria to assess waters, in spite of guidelines issued by EPA and developed by the 305(b) Consistency Workgroup, composed of 25 states, 3 tribes, and 7 federal agencies. In addition, most states and tribes do not assess all of their waterbodies during the 2-year 305(b) reporting cycle, and they might even modify criteria or assess different waterbodies every 2 years. In 1994, only 17 percent of the Nation's river and stream miles (48 percent of those which are constantly flowing), 42 percent of its lake and reservoir acres, and 78 percent of its estuaries were assessed for overall water quality.

INDICATOR 10d: Aquatic Life Designated Use



Source: *National Water Quality Inventory: 1994 Report to Congress*, 1995; 17 percent of all river and stream miles (48 percent of constantly flowing miles), 42 percent of lake and reservoir acres, and 78 percent of estuarine square miles were assessed

Proposed Milestone: By 2005, 80 percent of the nation's surface waters will support healthy aquatic communities.

305(b) data used to support this indicator might not represent general conditions in the Nation's waters because states, tribes, and other jurisdictions often focus on major perennial rivers, estuaries, and public lakes with suspected pollution problems in order to direct scarce resources to areas that could pose the greatest risk. Many states, tribes, and other jurisdictions lack the resources to collect information for nonperennial streams, small tributaries, and private ponds. This indicator does not predict the health of these or other unassessed waters. Because of these limitations, EPA must use caution in comparing data between states, tribes, and other jurisdictions, as well as between reporting periods.

In an effort to improve future reporting, EPA is pursuing several initiatives. First, EPA is working with the states and tribes to more precisely define their aquatic life uses, such as salmon spawning in rivers and lakes, cold freshwater habitat, warm freshwater habitat, and marine habitat. EPA is also working with states and tribes to better link assessments to the particular aquatic life designated use and to evaluate and reconcile potentially conflicting chemical and biological data.

EPA is working with its partners to develop monitoring and assessment approaches that will improve state-to-state consistency in reporting. This will provide a more accurate picture of the Nation's waters when all of the data are aggregated on a national basis.

EPA is working with states, tribes, and other federal agencies to change the 305(b) reporting cycle from 2 years to 5 years, with annual reporting of key data for the waters assessed in each year. This will enable comprehensive reporting of waters meeting designated uses each 5-year period.

The 305(b) Consistency Workgroup and the Intergovernmental Task Force on Monitoring Water Quality (ITFM) are providing guidance and assistance in an effort to improve monitoring, assessment, and reporting.

In addition, EPA is working with states and tribes to develop a guidance document to improve the assessment of the aquatic life in our nation's waters. The guidance will include ecological risk assessment principles that will assist states and tribes in identifying causes of impairment. It will also include quantitatively based biological criteria for different types of waterbodies and ecological regions. The biological criteria will assist states and tribes in determining impairment of aquatic life. The criteria, in conjunction with habitat assessment methods, will also provide a more comprehensive and scientifically defensible basis for assessing aquatic life impairment.

What is being done to improve conditions measured by the indicator?

EPA's *National Water Quality Inventory* shows that states identify agriculture, urban runoff/ stormwater, and municipal point sources as the largest pollutant sources for rivers, lakes, and estuaries. Aquatic life may be impacted by one or more of these sources.

Hydrologic modification, resource extraction, contaminated sediments, and natural sources such as atmospheric deposition, however, also impair aquatic life uses. In addition to continuing to control point sources, EPA and its partners also need to control nonpoint source pollution from both rural and urban areas.

EPA encourages states to use a place-based watershed framework to identify the causes of water quality degradation, to determine appropriate controls, and to manage the control programs. The watershed framework assists water resource managers in reducing stresses on water quality, such as toxic chemicals, siltation, habitat loss, nutrients from phosphate-based detergents and fertilizers, and elevated water temperatures resulting from loss of vegetative cover.

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GROUND WATER POLLUTANTS: NITRATE

What does the indicator tell us?

Nitrate is the most widespread agricultural contaminant and is a human health concern since it can cause methemoglobinemia, or "blue-baby syndrome." Nitrate is also an environmental concern as a potential source of nutrient enrichment of coastal waters. High levels of nitrate in well water typically indicate that pollution is seeping in from septic tanks, animal wastes, fertilizers, municipal landfills, or other nonpoint sources. The Safe Drinking Water Act requires that EPA establish federal safety standards that limit the allowable levels of nitrate in water. This level is established at 10 milligrams per liter (mg/L).

This indicator uses information from the 1990 National Pesticides Survey to demonstrate the number of people exposed to nitrate concentrations above the EPA maximum contaminant level. The survey offers the first national look at pesticide and nitrate contamination in rural domestic wells and community drinking water systems. The survey indicates that 4.5 million people were potentially exposed to elevated levels of nitrate from drinking water wells.

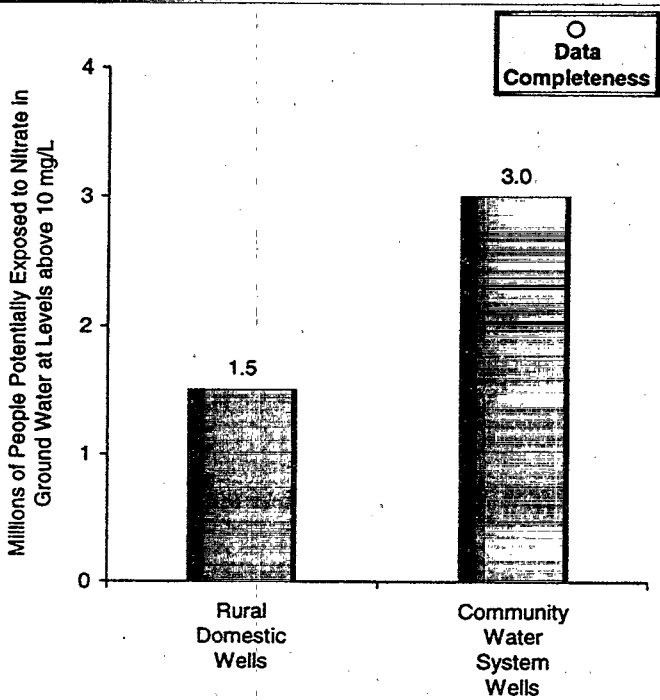
How will the indicator be used to track progress?

Most ground water studies use nitrate as an indicator because of its stability and solubility in water. Therefore, comparisons between nitrate concentrations can be made across many of these studies. It is also convenient to use nitrate concentration to track changes in ground water quality because it is a primary health-based drinking water standard. The lack of ambient ground water monitoring networks, however, hampers the tracking of any definitive trends on a national basis.

EPA will continue to review and analyze the data from public drinking water programs. It will also investigate the many studies conducted by the U.S. Geological Survey (USGS), other federal agencies, states, and local authorities that apply to existing conditions and threats to the quality of ground water. Those studies on nitrate contamination, as well as studies using other contaminants (e.g., pesticides and organic compounds) as indicators of ground water quality, will be used to update this indicator.

The modernization of the Safe Drinking Water Information System (SDWIS) and water quality monitoring data from EPA's Storage and Retrieval (STORET) systems will provide additional data to

INDICATOR 11: Ground Water Pollutants: Nitrate



Source: *National Survey of Pesticides in Drinking Water Wells*, 1990.

Proposed Milestone: By 2005, the number of Americans served by community and rural water wells containing high concentrations of nitrate, which can cause illness, will be reduced.

track sources of ground water contamination. SDWIS provides data on how well drinking water systems are meeting safety standards.

What is being done to improve the indicator?

Information on ground water quality is usually obtained from the monitoring of known or suspected contamination sites or from specific studies that monitor for various contaminants in limited areas. However, available data do not always provide an accurate representation of ambient ground water quality or an indication of the extent and severity of ground water contamination problems. In addition, there is considerable difficulty in using the results of ground water studies to project both the degree of contamination on a national level and decreases in the population served by contaminated systems. In the meantime, the best available source of ground water data is studies of drinking water supplies. Ultimately, however, this indicator should measure ground water quality directly. Achieving this will require the development and implementation of monitoring strategies and programs at the local, state, and regional levels.

EPA encourages states to conduct ground water monitoring and to build comprehensive monitoring programs through integration of existing efforts aimed at characterizing the overall quality of ground water resources. This will help develop a national picture of the needs and progress of ground water protection efforts. More research and development are also needed on the natural and human-induced factors affecting ground water quality and monitoring, as well as the selection of the best indicators. Agencies at all levels of government must address problems in their monitoring efforts, collect the most useful data for their own applications, and achieve the most economical use of their monitoring investment.

EPA also strongly encourages states, through the *National Water Quality Inventory* and the Intergovernmental Task Force on Monitoring Water Quality, to assess selected aquifers or hydrogeologic settings to provide a more meaningful interpretation of ground water within the states. It is anticipated that as states develop and implement ground water monitoring plans, programs, and collection mechanisms, information will become more uniform and trends in ground water quality in states, regions, and the Nation can be evaluated more reliably.

In the future, to provide a more accurate picture of overall ground water quality, this indicator might include other contaminants as well as other uses of the ground water resource.

What is being done to improve conditions measured by the indicator?

To prevent the contamination of ground water, both the Clean Water Act and the Safe Drinking Water Act, along with other federal laws, establish requirements for states and tribes to actively protect their ground water. Unfortunately, our knowledge of the extent and severity of ground water contamination is incomplete. Other than drinking water suppliers regulated by EPA, few keep detailed monitoring records. However, with more states recognizing the need to establish ambient ground water monitoring programs, drinking water data using samples from the distribution system or blended samples from various wells will be relied on less to obtain good-quality information.

The challenge for ground water includes protecting ground water—particularly wells that supply public water systems—from pollution and helping the public better understand the ways in which it becomes polluted. Much of this effort will be supported by voluntary implementation of local or regional management strategies by cooperating agencies. Expanded ambient and site-specific monitoring can target known or suspected pollution sources, yielding valuable information on ground water quality.

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SURFACE WATER POLLUTANTS

What does the indicator tell us?

This indicator shows changes in concentration levels for selected surface water parameters. Using data from the U.S. Geological Survey (USGS), currently the indicator presents six parameters USGS monitored in rivers and streams: dissolved oxygen, dissolved solids, nitrate, total phosphorus, fecal coliform, and suspended sediments. For example, from 1980 to 1989 USGS monitoring data from select National Stream Quality Accounting Network stations showed no change in nitrate concentration levels in 86 percent of the stations, a downward trend in 8 percent, and an upward trend in 6 percent.

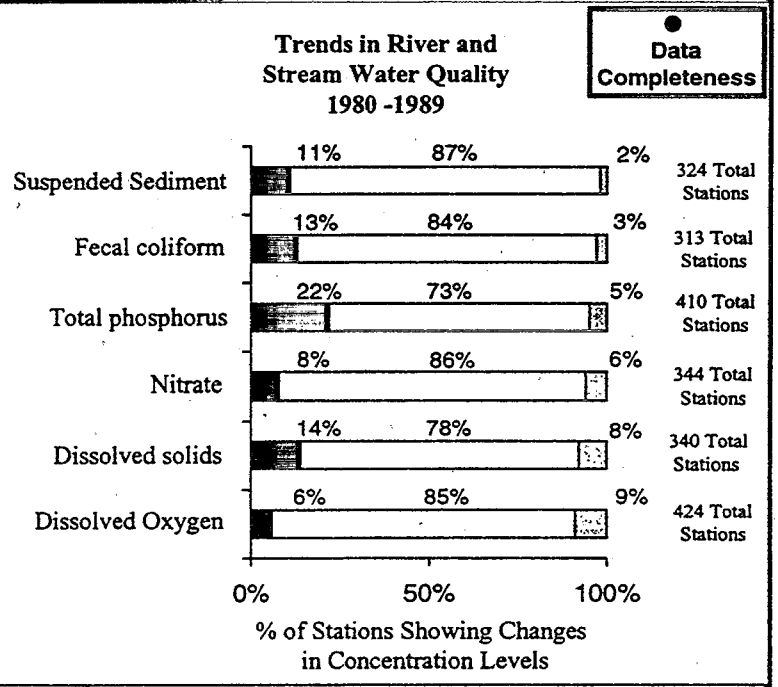
How will the indicator be used to track progress?

This indicator is intended to track, over time, the group of parameters that we have identified as significant pollutants in our rivers, streams, lakes, estuaries, and coastal waters. This is a measure of ambient surface water quality, ambient meaning the quality of waters in general, as opposed to waters at a specific point impacted by an identified pollutant.

What is being done to improve the indicator?

The information displayed by this indicator covers only rivers and streams and does not include all of the parameters being measured by the loading indicator (Indicator 16a). EPA and its partners intend to track the following list of parameters for both this ambient indicator and for the loadings indicator.

INDICATOR 12: Surface Water Pollutants



Note: The presence of an upward trend indicates an increase in the concentration of a particular constituent while a downward trend indicates a decrease in the concentration. Analyses were made on data from USGS National Stream Quality Accounting Network stations. Trend data for phosphorus is from 1982-1989.

Source: U.S. Geological Survey, 1990

Toxic Pollutants	*Conventional Pollutants*
• Cadmium	• Ammonia
• Copper	• BOD
• Lead	• Nitrogen (and nitrate)
• Mercury	• Pathogens
• Phenol	• Phosphorus
• Total residual chloride	• Suspended solids

These parameters would provide the basis for the national indicator providing general information on changes in the measurements taken in surface waters.

EPA will work with its partners, particularly states, tribes, USGS, and the National Oceanic and Atmospheric Administration (NOAA), to more accurately and consistently assess and report the data collected. Data sources that can be used for reporting this indicator are the USGS databases (particularly for rivers and streams); EPA's Storage and Retrieval information system (STORET), which contains state, USGS, and other data, for all surface waters; and NOAA for coastal waters. Partners will need to work together to determine the best method for aggregating, interpreting, and presenting the information for this indicator. Once agreement is reached, guidance can be provided to those collecting the data to ensure the data's quality and accuracy.

What is being done to improve conditions measured by the indicator?

This indicator provides only the general chemical information with which to assess national water quality conditions. The chemical information must be used along with physical and biological information (Indicator 7) to provide a holistic picture of water quality. However, this indicator does provide general trends for specific pollutants of concern and general water quality conditions, and it can indicate where additional action to control chemical impacts is necessary. For example, EPA and its partners might need to upgrade treatment at sewage treatment plants or industrial facilities, or recommend best management practices or policies to control nonpoint sources and address ambient water quality problems.

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SELECTED COASTAL SURFACE WATER POLLUTANTS IN SHELLFISH

What does the indicator tell us?

This indicator shows the percent change in concentration levels from 1986/87 to 1992/93 of six pollutants in shellfish (oysters and mussels) collected from about 140 locations along the Nation's coastline. The pollutants shown are six of the toxic chemicals of greatest concern in terms of their effects on the fish and other organisms in U.S. estuaries.

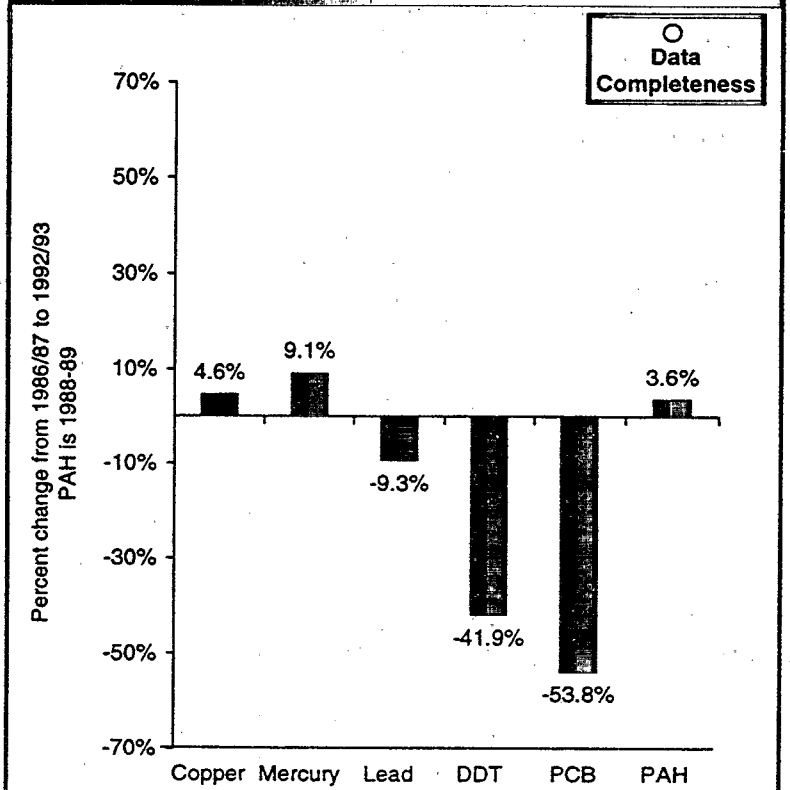
Three metals and three groups of organic chemicals are included. The metals copper, mercury, and lead are commonly used in our society for a number of purposes. The use of two of the organic chemicals included in this indicator, the DDT pesticides and the industrially important polychlorinated biphenyls (PCBs), was very common until about 20 years ago, and although these chemicals are now banned, they can still be found in the environment. The carcinogenic polycyclic aromatic hydrocarbons (PAHs) are common constituents of oil and are also produced by the burning of coal and wood.

As shown in the graph, concentration levels of DDT and PCBs decreased substantially from 1986/87 to 1992/93. During the same time period, concentration levels of lead and mercury showed evidence of a moderate decrease and increase, respectively, while copper showed little change. From 1988 to 1989 levels of PAHs also showed little change.

How will the indicator be used to track progress?

Data on these pollutant levels have been gathered by the National Oceanic and Atmospheric Administration (NOAA) since 1986. A survey to continue to measure the levels at the established study locations is being carried out every 2 years to furnish additional points for establishing trends in pollutant levels.

INDICATOR 13: Selected Coastal Surface Water Pollutants in Shellfish



Source: National Oceanic and Atmospheric Administration, 1995

What is being done to improve the indicator?

Additional results are being gathered as explained above. As part of NOAA's National Status and Trends monitoring program, additional chemicals (e.g., dioxin) are being added to the pollutants measured as concerns regarding these chemicals are identified.

What is being done to improve conditions measured by the indicator?

A number of control measures, such as eliminating the addition of lead to gasoline, forbidding the use of DDT and PCBs, and strengthening the requirements for removal of pollutants from treatment plant effluents, have been enacted over the past 25 years.

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ESTUARINE EUTROPHICATION CONDITIONS

What does the indicator tell us?

This indicator shows changes in specific constituents related to water quality that together can be used to assess the extent of eutrophication within an estuary, and thus assess its health and condition. Eutrophication is a process by which a body of water begins to suffocate from receiving more nutrients, such as nitrogen and phosphorus, than it can handle. The excess nutrients fuel the heavy growth of microscopic aquatic plants. As these plants die and decompose, the supply of dissolved oxygen in the water is depleted and its availability to other aquatic organisms, especially those which live on the bottom, is reduced. Symptoms of eutrophication include low levels of dissolved oxygen, extensive algal blooms, fish kills and reduced populations of fish and shellfish, high turbidity in the water, and diebacks of seagrasses and corals. Monitoring the changes in parameters such as chlorophyll *a*, nitrogen, and other nutrient concentrations; concentrations of dissolved oxygen; and the spatial coverage of seagrasses (or submerged aquatic vegetation) helps assess whether estuarine and coastal waters are receiving too many nutrients.

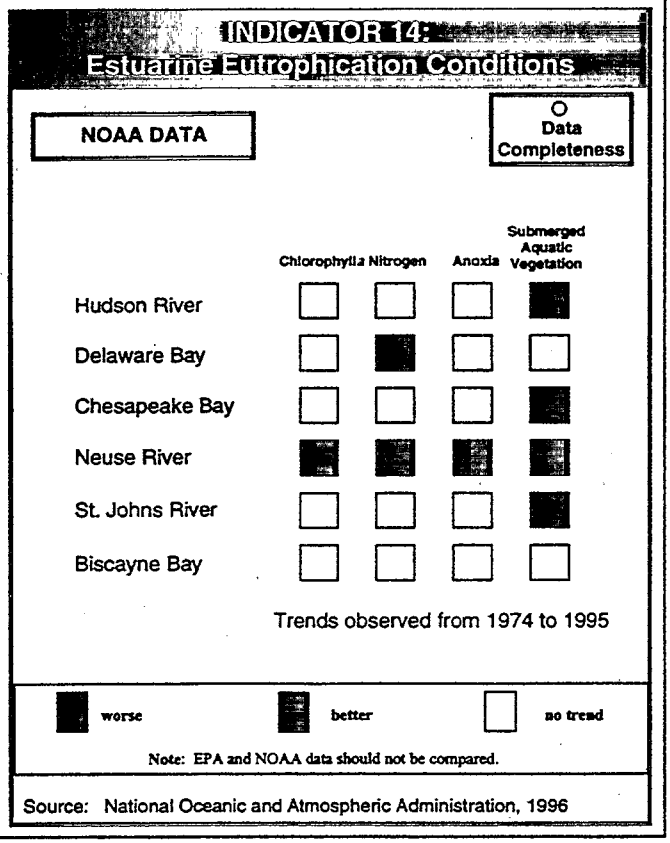
This indicator shows trends in eutrophication-related conditions from the 1960s to 1995 in selected estuaries throughout the country as measured by two different data sets. The nationwide framework for the indicator of estuarine eutrophication is NOAA's *National Estuarine Inventory*. The 129 estuaries contained in the inventory represent a consistent and complete framework for characterizing the Nation's estuarine resource base. NOAA is collecting information on 16 eutrophication-related water quality parameters for each estuary in the inventory through a knowledge-based consensus process with over 400 estuarine scientists. In 1990, NOAA estimated that nearly half the Nation's estuaries were susceptible to eutrophication. In 1992, NOAA initiated its *National Estuarine Eutrophication Survey* to evaluate which estuaries had problems in the following regions: North Atlantic (16 estuaries), Mid-Atlantic (22 estuaries South Atlantic (21 estuaries), Gulf of Mexico (36 estuaries), and the West Coast (34 estuaries).

This indicator also uses data from EPA's National Estuary Program (NEP). Currently, there are 28 estuaries around the country in the NEP. In many of these estuaries, state and local managers have identified eutrophication and excess nutrients as critical problems. NEPs are collecting historical and baseline monitoring information to assess the effectiveness of corrective actions being undertaken. Taken together, the NOAA and EPA efforts will provide the most comprehensive and complete information base possible for the foreseeable future.

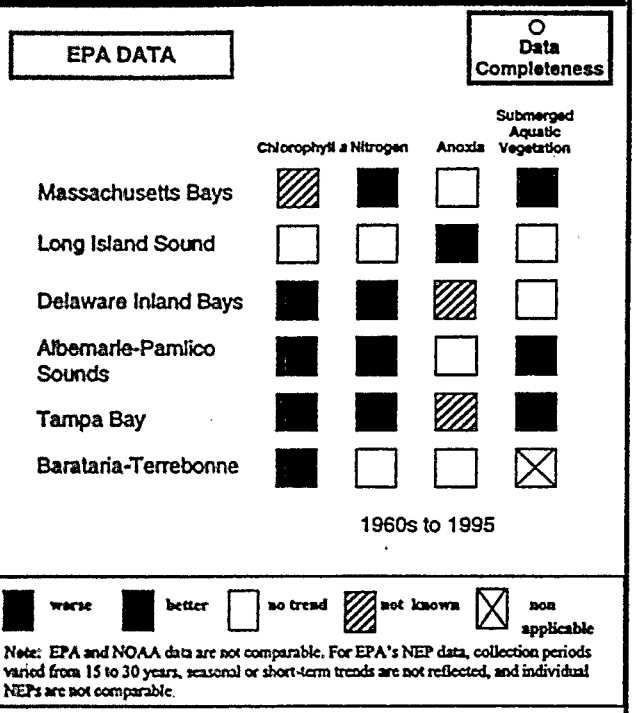
How will the indicator be used to track progress?

Based on data collected from mailed survey responses, individual interviews, and regional workshops in January 1995 and February 1996, NOAA compiled information on eutrophication trends from 1974 to 1995 and existing eutrophication conditions in estuaries in the Mid-Atlantic and South Atlantic regions. NOAA will be releasing a summary report of this information in mid-1996. The remaining regions will be completed later in 1996. Data will be collected and an indicator estimation made every 5 years.

For the NEP data, those NEPs which have identified eutrophication or its parameters as priority problems will develop monitoring plans to (1) evaluate trends in key variables, (2) link the observed patterns to specific management actions, and (3) provide information to redirect and refocus actions based on monitoring results. Because it is difficult to establish immediate causal relationships between specific actions and environmental change, NEP monitoring plans try to reinforce the understanding that tracking progress depends on a



INDICATOR 14: Estuarine Eutrophication Conditions



Note: EPA and NOAA data are not comparable. For EPA's NEP data, collection periods varied from 15 to 30 years, seasonal or short-term trends are not reflected, and individual NEPs are not comparable.

Source: Data from EPA's National Estuary Program, 1996

commitment to long-term data collection. At the national level, EPA has published examples of NEPs that have developed a "Bay Quality Index," which offers a suite of parameters and conditions, including eutrophication, that can be used to capture a composite picture of an estuary's overall quality and major components. Tracking the extent and changes in eutrophic conditions helps to highlight the water quality impacts of activities in a watershed and gauge the effectiveness of pollution controls and other management actions.

What is being done to improve the indicator?

Despite a variety of monitoring efforts by many different organizations and agencies, including EPA and NOAA, data on eutrophication parameters for most estuaries in the NEP are either incomplete or not comparable. Differences in monitoring parameters, methods, and sampling stations and periods make it difficult to establish trends even within a single estuary. Factors such as seasonality, spatial relationships, and level of monitoring effort also affect the interpretation and value of data. These difficulties are compounded when comparisons are made between different estuaries because each estuary responds to the stress of excess nutrients based on its own physical and biological circumstances.

NOAA has attempted to address this problem by applying a consistent survey technique to characterize the scale and scope of past and present eutrophication levels. NOAA has also initiated a process for improving the indicator that involves interviews and workshops at the local and regional levels. NOAA is planning a national eutrophication workshop later in 1996. The workshop will determine the best way to aggregate parameters estimated for each estuary into an overall indicator.

For the NEP data, EPA will participate with NOAA in its national workshop and facilitate the inclusion of data collected by individual estuary programs. By working together, NOAA, individual NEPs, and EPA hope to improve the availability of nationwide information on eutrophication and other indicators in the NEP. The integration of NOAA and EPA data into a single, unified indicator marks the beginning of these efforts.

What is being done to improve conditions measured by the indicator?

Control of nutrients is a critical factor in preventing eutrophication. Approaches for controlling nutrients range from expensive engineering to simple prevention and maintenance. In Long Island Sound, for example, effluent from wastewater treatment plants is the primary nutrient source, and many facilities have begun retrofitting their processes to remove nitrogen. In contrast, in other areas controlling fertilizer runoff from farms, residences, and managed greenways such as golf courses is the most effective solution. Yet other communities are establishing more stringent zoning or encouraging the use of denitrifying septic systems to reduce nitrogen loadings to ground water. What these approaches have in common is a process that reflects local conditions by carefully identifying the sources of nutrients, calculating their contributions to specific water-quality problems, and working with a variety of tools to reduce their impacts.

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CONTAMINATED SEDIMENTS

What does the indicator tell us?

This indicator shows the chemicals or chemical groups that are measured most frequently at concentrations that might cause adverse ecological or human health effects at a particular site. EPA and others determine concentration levels potentially causing risk by examining the results of field surveys, laboratory toxicity tests, and studies of the chemical's behavior in the environment and in living tissue.

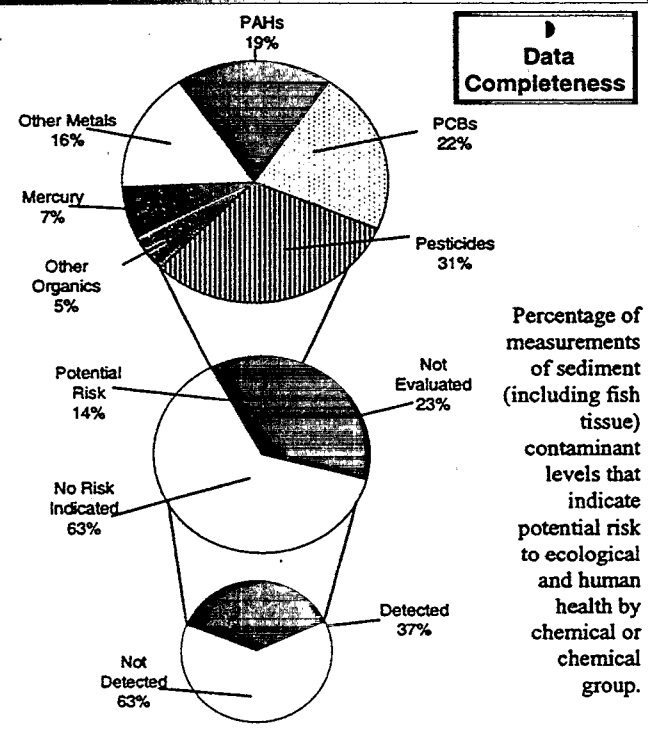
Certain types of chemicals in water tend to settle and collect in sediment. Chemicals in sediment often persist longer than those in water, in part because they tend to resist natural degradation and in part because conditions might not favor natural degradation. Also, these contaminants accumulate at distinct locations in sediment but will disperse in water.

When present at elevated concentrations in sediment, pollutants can be released back to water or accumulate in fish and shellfish and move up the food chain. In both cases, excessive levels of chemicals in sediment might become hazardous to aquatic life and humans.

EPA collects and analyzes sediment and fish tissue data from state, EPA regional, and other monitoring programs as part of the National Sediment Inventory (NSI). The goals of the NSI are to survey data regarding sediment quality nationwide, identify locations that are potentially contaminated, and describe the sources of contaminants responsible for contamination.

Environmental managers can use NSI data and assessments to determine the potential extent and severity of contamination and to identify areas that require closer inspection. In time, NSI data and assessments will reveal trends and help measure progress in minimizing risk.

INDICATOR 15: Contaminated Sediments



Source: National Sediment Inventory from EPA's Office of Science and Technology, 1993

Proposed Milestone: By 2005, point sources of contamination will be controlled in 10 percent of the watersheds where sediment contamination has been determined to be widespread.

How will the indicator be used to track progress?

EPA will report to Congress every 2 years on the condition of the Nation's sediments. As the NSI grows to include information on more locations and future measurements, EPA and other stewards of environmental quality will gain a better idea of the full extent of contaminated sites and whether conditions have improved or worsened on the whole and at single sites.

EPA's current assessment of sediment quality in the Nation is based largely on chemical concentrations in sediment and in the edible portion of fish that do not migrate and tend to live near sediment. These measures allow EPA assessors to determine the probability that contaminants at the site might cause adverse effects on aquatic life or human health. EPA classifies sites as having a higher probability of adverse effects, an intermediate probability of adverse effects, or no indication of potential adverse effects based on available data.

EPA's assessments can provide a national perspective and indicate the potential contamination problems at specific locations. However, site classification based on NSI data cannot substitute for additional study or application of knowledge at the regional, state, and local levels.

What is being done to improve the indicator?

Future assessments based on NSI data will benefit from the collection of a greater quantity of information addressing conditions at more locations. Although the NSI currently has data representing over 20,000 locations, this coverage represents only 11 percent of the Nation's rivers, lakes, and coastlines. EPA will continue to coordinate with the regional offices, states, tribes, and others to identify and compile additional data.

EPA is committed to using state-of-the-art assessment methods to determine whether sediment at a site poses a risk to ecological or human health. EPA has consulted extensively with experts within the Agency and has commissioned outside scientific review panels to examine its methods. EPA will continue to promote research and improve assessment methods as scientific knowledge in this relatively new field expands.

EPA will also make NSI data and assessments available to all interested individuals and organizations by placing data and summary reports on the Internet at EPA's World Wide Web site.

What is being done to improve conditions measured by the indicator?

EPA assessors can use the NSI to demonstrate the scope of contaminated sediments nationwide and to identify watersheds where further efforts are needed to address potentially serious contamination problems. Further assessment might indicate the need for pollution prevention or remediation. Environmental managers can use pollution prevention and control approaches to reduce point and nonpoint source discharges containing those types of contaminants which accumulate in sediment. This will enable some contaminated systems to recover naturally.

Where short-term risks and effects can be tolerated, the preferred treatment of a contaminated site is to implement prevention measures and source controls and to allow natural processes, such as natural degradation and the deposition of clean sediment, to diminish risk associated with the site. At sites where these measures will not reduce risk in an acceptable time frame, EPA might seek remediation under the appropriate statutory authority.

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SELECTED POINT SOURCE LOADINGS TO SURFACE WATER

What does the indicator tell us?

This indicator presents the change in point source loadings from 1990 to 1995 for two key pollutants—biochemical oxygen demand (BOD) and lead. The indicator shows whether the amount of contaminant being discharged increased, decreased, or remained stable for each state. The results show that the majority of states are showing a decrease in these point source loads.

How will the indicator be used to track progress?

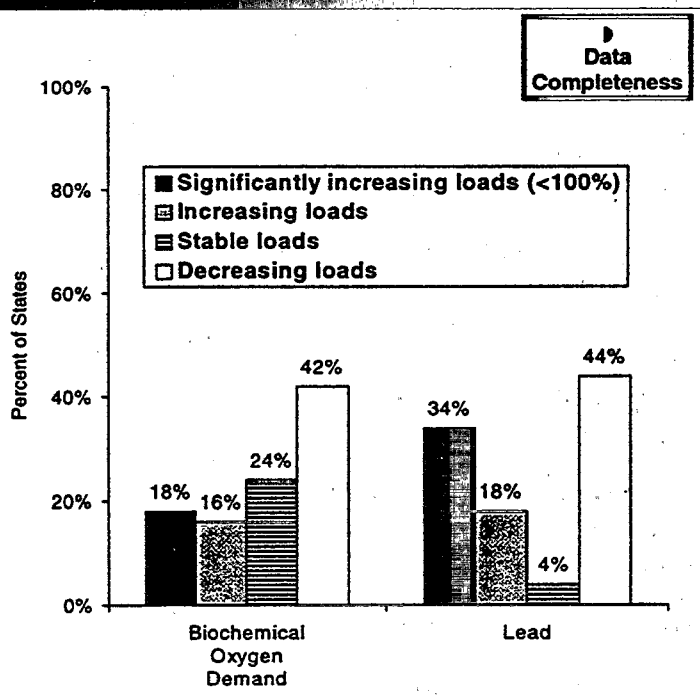
Information about these pollutants is contained in EPA's Permit Compliance System (PCS). The states report to EPA loadings numbers for those facilities permitted through the National Pollutant Discharge Elimination System (NPDES). The NPDES permitting process sets limits on the amount of discharge or the amount of contaminant contained in a discharge from facilities that discharge wastewater directly to a waterbody through a point source like a pipe.

What is being done to improve the indicator?

While the information displayed under this indicator covers only lead and BOD, many point sources contaminate our surface waters, many contaminants have been identified as a priority of particular concern, and PCS has information on many more. EPA and its partners have chosen several toxic and conventional pollutants to track as indicators of progress toward reducing point source pollution. In the future, this indicator should include all the pollutants in the following list:

Toxic Pollutants	*Conventional Pollutants*
• Cadmium	• Ammonia
• Copper	• BOD
• Lead	• Nitrogen (and nitrate)
• Mercury	• Pathogens
• Phenol	• Phosphorus
• Total residual chloride	• Suspended solids

INDICATOR 16a: Selected Point Source Loadings to Surface Water

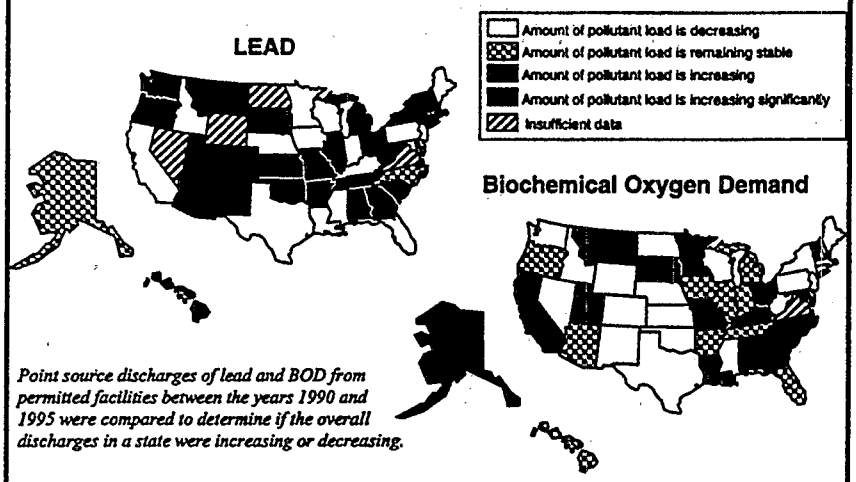


Source: Permit Compliance System, 1995

Proposed Milestone: By 2005, annual pollutant discharges from key point sources that threaten public health and aquatic ecosystems will be reduced by 3 billion pounds, or 28 percent.

In addition to including more contaminants in the future, other issues need to be addressed to improve the indicator. Although the number of NPDES permitted facilities remains fairly consistent, the contaminants covered by these permits can change. For example, the number of permits limiting lead in 1990 was 2,630, but this number increased to 4,134 in 1995. Therefore, comparison between 1990 and 1995 lead loadings can be misleading.

Point Source Loading Trends in the United States



Point source discharges of lead and BOD from permitted facilities between the years 1990 and 1995 were compared to determine if the overall discharges in a state were increasing or decreasing.

Source: State data in EPA's Permit Compliance System

In addition, some facilities, especially smaller facilities, do not consistently report the results of point source monitoring to PCS, while other facilities discharging contaminants of concern are not required to relay discharge information to PCS. EPA is working with its partners to more accurately and consistently report this indicator so that it presents a true picture of the amount and severity of point source loads nationally. EPA will take actions that address (1) changes in permitting requirements from year to year, (2) inconsistent reporting from facilities required to submit discharge data, (3) facilities not required to report discharge data but still responsible for releasing contaminants to receiving waters, and (4) differing chemical composition among contaminants in the same general category.

The National Oceanic and Atmospheric Administration has developed the Typical Pollutant Concentration (TPC) matrix, which will estimate point source loadings from dischargers based on the type of activity that occurs at the facility. USGS and EPA are working closely with NOAA to determine how best to use the TPC methodology with an improved PCS system to help ensure accurate, consistent reporting of this indicator. EPA also plans to provide guidance to regional and state permit writers on how to enter data more accurately and consistently into PCS to help facilitate improved reporting of this indicator.

What is being done to improve conditions measured by the indicator?

For surface waters, the major point sources of pollution are sewage treatment plants, industrial facilities, and "wet-weather" sources like combined sewer overflows (CSOs), sanitary sewer overflows (SSOs), and stormwater. Sewage treatment plants treat and discharge wastewater from homes, public buildings, commercial establishments, stormwater sewers, and some industries. Many industrial facilities treat and discharge their own wastewater. Combined sewers combine stormwater and sewage in the same system and can overflow directly to waterbodies without treatment during periods of intense rainfall. EPA will continue to permit and regulate these facilities to continue to reduce pollution from point sources.

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Sources of Point Source Loadings through Class V Wells to Ground Water

What does the indicator tell us?

This indicator characterizes industrial wastewater discharges to freshwater aquifers through shallow disposal wells, particularly septic systems. EPA considers septic systems to be Class V injection wells, subject to regulatory control, unless they are small and receive only sanitary wastes. Recent studies suggest that probably 10 percent of septic systems in the United States release as much as 4 million pounds of industrial waste each year—enough to contaminate trillions of gallons of drinking water. By 2005, EPA plans to reduce the number of pounds of ethylene glycol and other industrial wastes discharged through septic systems to zero.

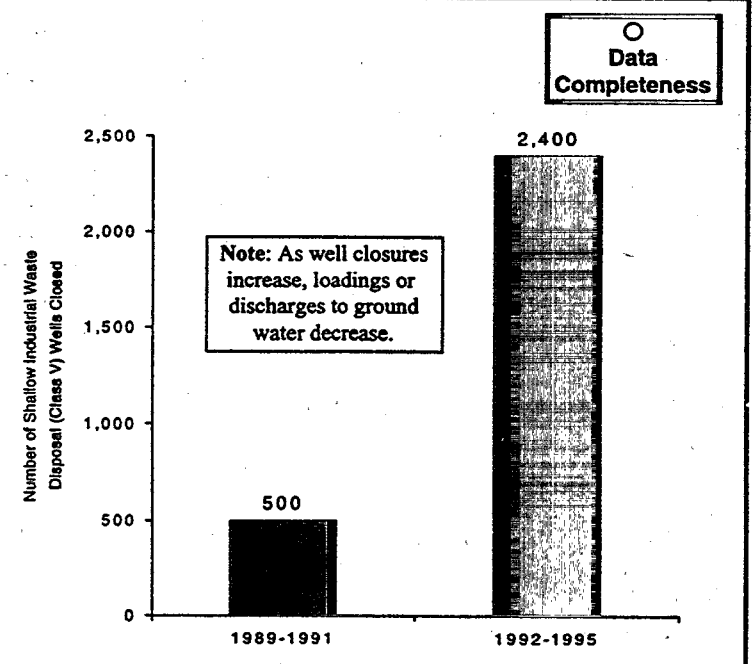
How will the indicator be used to track progress?

This indicator serves as a barometer of the effectiveness of a comprehensive Class V strategy initiated by EPA in 1995. EPA will determine the reduction in pollutant loadings from the number of septic systems that are "closed," that is, no longer injecting any industrial fluids to the subsurface. EPA will use Class V data from annual reports provided by EPA-approved state Underground Injection Control (UIC) programs. EPA will also conduct a special study to verify the number of systems reported closed, particularly in community wellhead protection areas.

What is being done to improve the indicator?

Septic systems are designed to treat solely sanitary wastes. However, some manufacturing and commercial businesses place their industrial wastes directly into the ground through a dry hole or cesspool or direct them into their septic tanks. Either way, the

INDICATOR 16b: Sources of Point Source Loadings Through Class V Wells to Ground Water



Source: EPA Office of Ground Water and Drinking Water, 1995

Proposed Milestone: By 2005, wellhead protection areas and vulnerable ground water resources will no longer receive industrial wastewater discharges from septic systems.

untreated waste might eventually find its way to a water-table aquifer. Contamination of freshwater aquifers can result in serious and costly consequences to public health and the environment, including onset of waterborne disease, expensive ground water remediation, loss of private and public domestic drinking water supplies, and degradation of aquatic ecosystems, wetlands, watersheds, and coastal zones.

Although the misuse of septic systems is a nationwide concern, the threat is not immediately obvious because it occurs, unseen, in the subsurface. The biggest problem is that Class V data on the actual volume of industrial waste released to ground water is currently speculative. For example, no one knows how many septic tanks are being misused. The results presented by the Class V indicator should be interpreted with caution until the data quality can be improved. Future EPA toxic release reports will distinguish between classes of injection wells. Currently, Class V waste release data are extrapolated from random sampling of typical high-risk wells. Class V data should improve as EPA's strategy for the comprehensive management of Class V wells proceeds and public awareness develops.

What is being done to improve conditions measured by the indicator?

EPA has documented Class V contamination of drinking water supplies across the United States (e.g., Colorado, Florida, Montana, New Hampshire, New York, Oregon, Pennsylvania, Virginia, and Washington). The EPA UIC program works with other federal agencies and state, tribal, and local governments to adequately manage this major source of pollution as part of source water protection programs, which will be developed for 30,000 community water supplies by the year 2005. This strategy recognizes that to reduce new high-risk injection practices, EPA will have to (1) raise public awareness through education and outreach; (2) provide technical assistance; (3) forge federal, state, and local government partnerships; (4) enlist the involvement of industry; and (5) support voluntary compliance initiatives. EPA will rely less on regulation, penalties, and other traditional approaches to permitting and enforcement, which are inadequate to deal with large numbers of shallow wastewater disposal wells with a potential to contaminate underground sources of drinking water.

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NONPOINT SOURCE SEDIMENT LOADINGS FROM CROPLAND

What does the indicator tell us?

Nonpoint source pollution is derived from a wide range of sources, including agriculture, forestry, hydromodification, onsite wastewater disposal, and construction sites. No single indicator can fully capture the extent of nonpoint sources and their impacts on the aquatic environment, but sediment delivery from cropland is a reasonably good indicator of the degree to which nonpoint source pollution is prevented on agricultural lands.

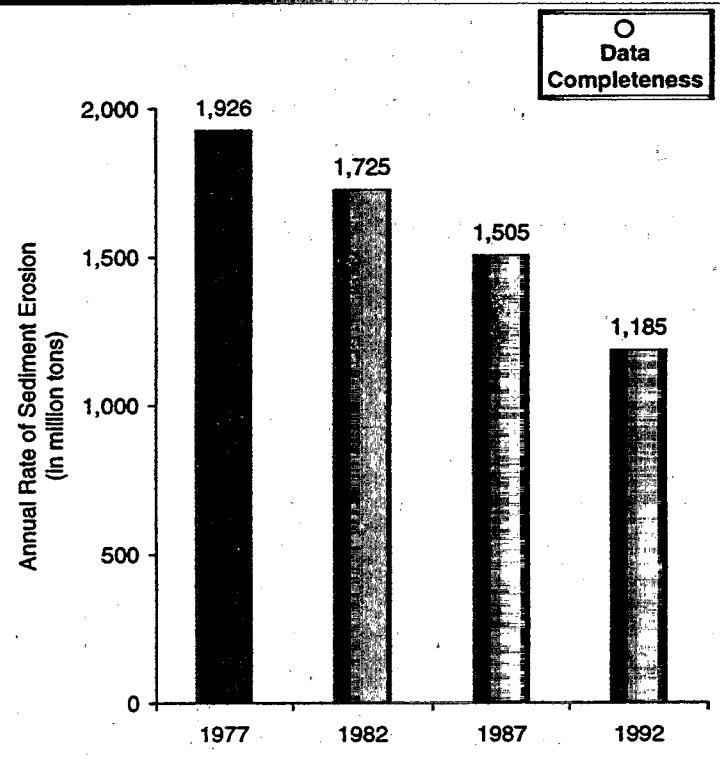
This indicator presents rates of erosion from agricultural cropland. From 1977 to 1992, the amount of sediment eroded from cropland decreased by about 750 million tons. Rates of erosion from cropland are an indirect indicator of the delivery of sediment to surface waters. In any given watershed, however, the reliability of erosion rates as predictors of sediment loads is dependent on the extent to which sediment is contributed by other sources, such as gully or streambank erosion.

How will the indicator be used to track progress?

In the absence of direct measures of nonpoint source pollution, it is necessary to estimate national nonpoint source loadings. The U.S. Department of Agriculture (USDA) estimates soil erosion with field measurements and statistical models, such as the universal soil loss equation. USDA tracks and reports progress in reducing erosion rates on the Nation's agricultural lands through the National Resources Inventory (NRI), which is conducted every 5 years.

The NRI is a multi-resource inventory based on soils and other resource data collected at scientifically selected random sampling sites. The NRI covers the 48 coterminous states, Hawaii, Puerto Rico, and the U.S. Virgin Islands, but excludes Alaska. Data for the 1992 NRI were collected at more than 800,000 locations by USDA field personnel and resource inventory specialists.

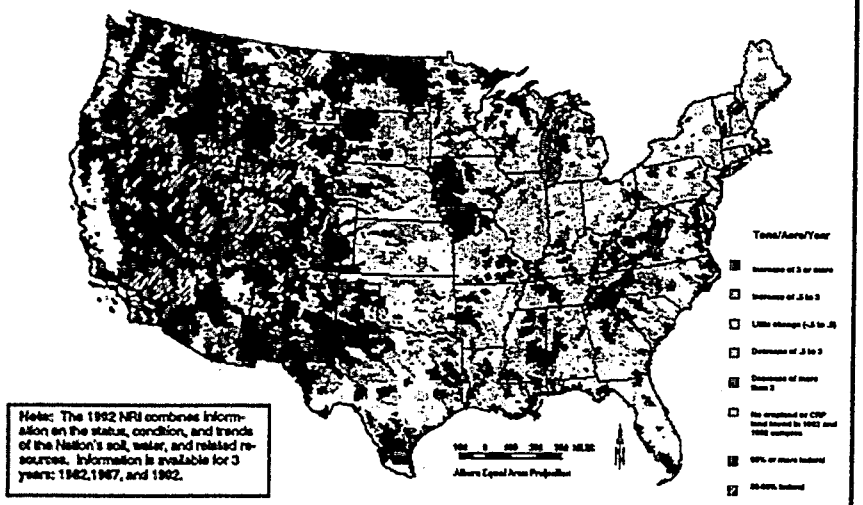
INDICATOR 17: Nonpoint Source Sediment Loadings from Cropland



Source: USDA, National Resource Inventory, 1992

Proposed Milestone: By 2005, the annual rate of soil erosion from agricultural croplands will be reduced 20 percent from 1992 levels to a total of 948 million tons per year.

Change In Average Annual Soil Erosion by Wind and Water on Cropland and Conservation Reserve Program Land, 1982 - 1992



Source: U.S. Department of Agriculture, Natural Resources Inventory, 1993

In addition, USDA will provide ecosystem-based assistance to landowners in the future. This effort will include a focus on reducing the offsite delivery of sediment and associated pollutants.

What is being done to improve the indicator?

Other national measures of nonpoint source pollution are under consideration and might be developed as more national data are made available. Another possible approach for examining nonpoint source loading focuses on selected watersheds. A combined approach, using both national and selected watershed studies, will be considered as improvements to the current indicator are pursued.

What is being done to improve conditions measured by the indicator?

The control of erosion and sedimentation from cropland is achieved by landowners and managers, often with the assistance of local, state, and federal technical experts. EPA will continue to work with representatives from USDA, state agencies, and local soil and water conservation districts to encourage the adoption of erosion and sediment control practices, such as conservation tillage, on agricultural cropland.

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MARINE DEBRIS

What does the indicator tell us?

The marine debris indicator includes trash left behind by visitors to the beach, discarded from boats, carried by inland waterways to the coast, or conveyed by overflowing sewer or storm systems. As an indicator, marine debris can be useful in ascertaining (1) early warning signs of possible human health risk associated with pollution, (2) biological health risk such as entanglement or ingestion by wildlife, (3) limits on coastal recreation and fishing, (4) the effectiveness of programs to control or prevent marine debris, (5) the aesthetic value of a coastal area and the economy it supports, (6) ambient conditions, and (7) human health risks through entanglement, injury, or exposure to medical waste.

How will the indicator be used to track progress?

To measure this indicator a total of 20 survey sites in each of nine regions of the United States will be sampled. Volunteers will sample each site monthly for a period of 5 years, measuring the status and trends of 30 specific debris items. The program has been designed to answer two specific questions:

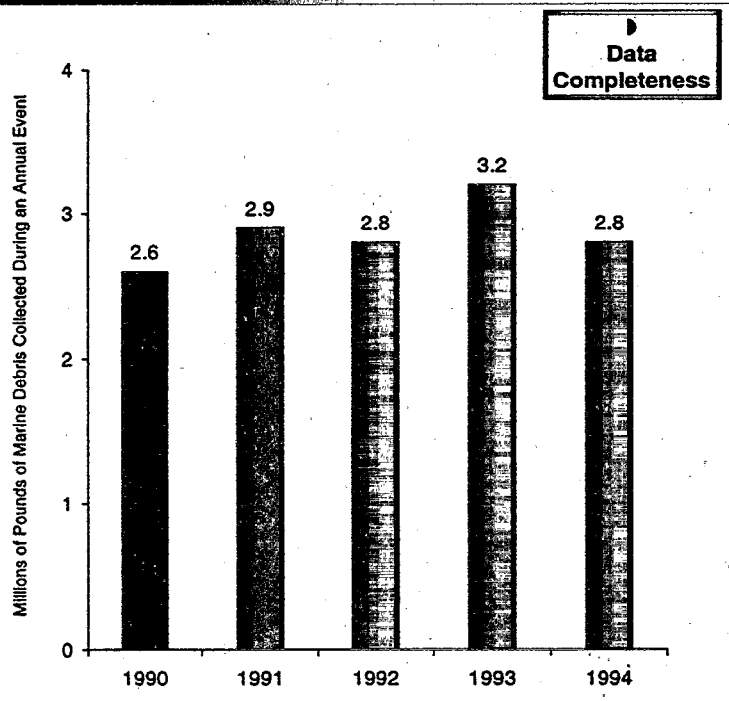
1. Is the amount of debris on our coastlines decreasing?

2. What are the major sources of the debris?

Even though this is a national survey, trend analysis will be computed for each region. Regional analyses can be combined to get a national picture of marine debris.

The National Marine Debris Monitoring Program is currently being coordinated by the Center for Marine Conservation (CMC) and is supported by EPA, the National Marine Fisheries Service, the National Park Service, and the U.S. Coast Guard.

INDICATOR 18: Marine Debris



Note: Data in this graph are variable by number of beaches cleaned, number of volunteers participating, and weather conditions on the day of cleanup.

Source: Center for Marine Conservation, 1995.

What is being done to improve the indicator?

EPA chairs an inter-agency workgroup that includes representatives from NOAA, the U.S. Park Service, the U.S. Coast Guard, and other federal organizations. The workgroup has developed a statistically valid methodology for monitoring the trends and sources of marine debris. Monitoring efforts using this methodology began in 1996, and currently are being coordinated by CMC with support from EPA and other federal agencies. Data obtained from these efforts will be used as a baseline for this indicator.

What is being done to improve conditions measured by the indicator?

Marine debris causes harm to marine life, damages boats, endangers human health, and can cripple coastal economies. More than 255 species of animals are known to ingest or become entangled in marine debris. Marine debris disables fishing and recreational boats by engaging propellers or clogging cooling water intakes.

The economic impacts of marine debris on coastal communities has been demonstrated by beach closures in New York and New Jersey in 1987 and 1988 due to medical wastes washing up on the beaches. As more is learned about the sources of marine debris, regulatory efforts (e.g., the International Convention for the Prevention of Pollution from Ships (MARPOL Annex V) and stormwater permits) can be implemented to reduce the flow of debris into the marine environment. In addition, public education can be used to improve the environment. EPA and CMC have both developed a marine debris curricula for teachers and fact sheets for the public and industry.

Marine debris clean-up efforts can also help to reduce the risk of marine entanglement through removal of debris. CMC conducts annual beach clean-up events that engage tens of thousands of volunteers. In addition, CMC's Million Points of Blight program is a storm drain stenciling project that reminds people that what they dump into the streets or down drains ends up in the connected waterway. Prevention is the best solution.

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Comments on the indicator fact sheets and requests for copies of the report should be sent to the address below:

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Appendix D

Contaminated Sediment Assessment Methods

The Incidence And Severity Of Sediment Contamination In Surface Waters Of The United States:

Volume 1: National Sediment Quality Survey

DRAFT

July 1997

Office of Science and Technology
United States Environmental Protection Agency
401 M Street, SW
Washington, DC 20460

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Chapter 2

Methodology

EPA faced two primary challenges to achieving the short-term goals of the National Sediment Inventory (NSI) and fulfilling the mandate of the Water Resources Development Act (WRDA) of 1992, as described in the introduction to this report. The first challenge was to compile a database of consistent sediment quality measures suitable for all regions of the country. The second challenge was to identify scientifically sound methods to determine whether a particular sediment is "contaminated," according to the definition set forth in the statute.

In many known areas of contamination, visible and relatively easy-to-recognize evidence of harmful effects on resident biota is concurrent with elevated concentrations of contaminants in sediment. In most cases, however, less obvious effects on biological communities and ecosystems are much more difficult to identify and are frequently associated with varying concentrations of sediment contaminants. In other words, bulk sediment chemistry measures are not always indicative of toxic effect levels. Similar concentrations of a chemical can produce widely different biological effects in different sediments. This discrepancy occurs because toxicity is influenced by the extent to which chemical contaminants bind to other constituents in sediment. These other sediment constituents, such as organic ligands and inorganic oxides and sulfides, are said to control the *bioavailability* of accumulated contaminants. Toxicant binding, or sorption, to sediment particles suspends the toxic mode of action in biological systems. Because the binding capacity of sediment varies, the degree of toxicity exhibited also varies for the same total quantity of toxicant.

The five general categories of sediment quality measurements are sediment chemistry, sediment toxicity, community structure, tissue chemistry, and pathology (Power and Chapman, 1992). Each of these categories has strengths and limitations for a national-scale sediment quality assessment. To be efficient in collecting usable data of similar types, EPA sought data that were available in electronic format, represented broad geographic coverage, and represented specific sampling locations identified by latitude and longitude coordinates. EPA found sediment chemistry and tissue chemistry to be the most widely available sediment quality measures.

As described above, sediment chemistry measures might not accurately reflect risk to the environment. However, EPA has recently developed assessment methods that combine contaminant concentration with measures of the primary binding phase to address bioavailability for certain chemical classes, under assumed conditions of thermodynamic equilibrium (USEPA, 1993d). Other methods, which rely on statistical correlations of contaminant concentrations with incidence of adverse biological effects, also exist (Barrick et al., 1988; FDEP, 1994; Long et al., 1995). In addition, fish tissue levels can be predicted using sediment contaminant concentrations, along with independent field measures of chemical partitioning behavior and other known or assigned fish tissue and sediment characteristics. EPA can evaluate risk to consumers from predicted and field-measured tissue chemistry data using established dose-response relationships and standard consumption patterns. Evaluations based on tissue chemistry circumvent the bioavailability issue while also accounting for other mitigating factors such as metabolism. The primary difficulty in using field-measured tissue chemistry is relating chemical residue levels to a specific sediment, especially for those fish species which typically forage across great distances.

Sediment toxicity, community structure, and pathology measures are less widely available than sediment chemistry and fish tissue data in the broad-scale electronic format EPA sought for the NSI. Sediment toxicity data are typically in the form of percent survival, compared to control mortality, for indicator organisms exposed to the field-sampled sediment in laboratory bioassays (USEPA, 1994b, c). Although these measures account for bioavailability and the antagonistic and synergistic effects of pollutant mixtures, they do not address possible long-term reproductive or growth effects, nor do they identify specific contaminants responsible for observed lethal toxicity. Indicator organisms also might not represent the most sensitive species. Community structure measures, such as fish abundance and benthic diversity, and pathology measures are potentially

indicative of long-term adverse effects, yet there are a multitude of mitigating physical, hydrologic, and biological factors that might not relate in any way to chemical contamination.

The ideal assessment methodology would be based on matched data sets of all five types of sediment quality measures to take advantage of the strengths of each measurement type and to minimize their collective weaknesses. Unfortunately, such a database does not exist on a national scale, nor is it typically available on a smaller scale. Based on the statutory definition of contaminated sediment in the WRDA, EPA can identify locations where sediment chemistry measures exceed "appropriate geochemical, toxicological, or sediment quality criteria or measures." Again based on the statutory definition, EPA can also use tissue chemistry and sediment toxicity measures to identify aquatic sediments that "otherwise pose a threat to human health or the environment" because there are either screening values (e.g., EPA risk levels for fish tissue consumption) or control samples for comparison. However, EPA believes it cannot accurately evaluate community structure or pathology measures to identify contaminated sediment, based on the statutory definition, without first identifying appropriate reference conditions to which measured conditions could be compared.

For this analysis, EPA evaluated sediment chemistry, tissue chemistry, and sediment toxicity data, taken at the same sampling station, individually and in combination using a variety of assessment methods. Because of the limitations of the available sediment quality measures and assessment methods, EPA characterizes this identification of contaminated sediment locations as a *screening-level* analysis. Similar to a potential human illness screen, a screening-level analysis should pick up potential problems and note them for further study. Thus, classification of sampling stations in this analysis is not meant to be definitive, but is intended to be inclusive of potential problems arising from presistent metal and organic chemical contaminants. For this reason, EPA elected to evaluate data collected from 1980 to 1993 and to evaluate each chemical or biological measurement taken at a given sampling station individually. A single measurement of a chemical at a sampling station, taken at any point in time over the past 15 years, could be sufficient to classify the sampling station as having an increased probability of association with adverse effects to aquatic life or human health.

EPA recognizes that sediment is dynamic and that great temporal and spatial variability in sediment quality exists. This variability can be a function of sampling (e.g., a contaminated area might be sampled one year, but not the next) or a function of natural events (e.g., floods can move contaminated sediment from one area to another, or can bury contaminated sediment). In this report, EPA associates sampling stations with their "probability of adverse effects on aquatic life or human health." Each sampling station falls into one of three categories (tiers): sediment contamination associated with a higher probability of adverse effects (Tier 1), sediment contamination associated with a lower to intermediate probability of adverse effects (Tier 2), or no indication of adverse effects (Tier 3). A Tier 3 sampling station classification does not neccesarily imply a zero or minimal probability of adverse effects, only that available data (which may be substantial or limited) do not indicate an increased probability of adverse effects. Recognizing the imprecise nature of the numerical assessment parameters, Tier 1 sampling stations are distinguished from Tier 2 sampling stations based on the magnitude of a sediment chemistry measure or the degree of corroboration among the different types of sediment quality measures.

The remainder of this chapter presents a short history of how EPA developed the NSI, a brief description of the NSI data, and an explanation of the NSI data evaluation approach.

Background

EPA initiated work several years ago on the development of the NSI through pilot inventories in EPA Regions 4 and 5 and the Gulf of Mexico Program. Based on lessons learned from these three pilot inventories, the Agency developed a document entitled *Framework for the Development of the National Sediment Inventory* (USEPA, 1993a), which describes the general format for compiling sediment-related data and provides a brief summary of sediment quality evaluation techniques. The format and overall approach were then presented, modified slightly, and agreed upon at an interagency workshop held in March 1993 in Washington, DC. Following the workshop, EPA began compiling and evaluating data for the NSI. Data from several national and regional databases were included as part of the effort.

In the spring of 1994, EPA conducted a preliminary evaluation of NSI sediment chemistry data only. The purpose of the assessment was to identify sampling stations throughout the United States where measured values of sediment pollutants exceeded sediment chemistry

levels of concern. The results of that assessment were then distributed to the EPA Regional offices for their review. The Regional offices were asked to review the preliminary evaluation and to:

- Verify sampling stations targeted as areas of concern.
- Identify sampling stations that might be incorrectly targeted as areas of concern.
- Identify potential areas of concern that were not targeted, but should have been.
- Inform EPA Headquarters of additional sediment quality data that should be included in the NSI to make the inventory more accurate and complete.

The EPA Regional offices completed their review of the preliminary evaluation during the winter of 1994-95. Regional comments on the results of the preliminary evaluation were incorporated into the NSI database. EPA will add new data sets identified by the Regions to the NSI and include them in the national assessment for future reports to Congress.

In April 1994, EPA Headquarters held the Second National Sediment Inventory Workshop (USEPA, 1994d). The purpose of this workshop was to bring together experts in the field of sediment quality assessment to recommend an approach for integrating and evaluating the sediment chemistry and biological data contained in the NSI. The final approach recommended by workshop participants provided the basis for the final approach adopted to evaluate NSI data for this report to Congress. Appendix I of this report provides a brief description of the workshop approach and a list of attendees.

Description of NSI Data

The NSI includes data from the following data storage systems and monitoring programs:

- Selected data sets from EPA's Storage and Retrieval System (STORET) (69 percent of sampling stations)
  - U.S. Army Corps of Engineers (USACE)
  - U.S. Geological Survey (USGS)
  - EPA
  - States
- NOAA's Coastal Sediment Inventory (COSED) (5 percent of sampling stations)
- EPA's Ocean Data Evaluation System (ODES) (6 percent of sampling stations)
- EPA Region 4's Sediment Quality Inventory (5 percent of sampling stations)
- Gulf of Mexico Program's Contaminated Sediment Inventory (1 percent of sampling stations)
- EPA Region 10/COE Seattle District's Sediment Inventory (8 percent of sampling stations)
- EPA Region 9's Dredged Material Tracking System (DMATS) (1 percent of sampling stations)
- EPA's Great Lakes Sediment Inventory (less than 1 percent of sampling stations)
- EPA's Environmental Monitoring and Assessment Program (EMAP) (2 percent of sampling stations)
- USGS (Massachusetts Bay) Data (3 percent of sampling stations)

Although EPA elected to evaluate data collected since 1980 (i.e., 1980-93), data from before 1980 are still maintained in the NSI. At a minimum, EPA required that electronically available data include locational information, sampling date, latitude and longitude coordinates, and measured units for inclusion in the NSI. Additional data fields providing details such as sampling method or other quality assurance/quality control information were retained in the NSI if available. Additional information about available data fields and NSI component databases is presented in Appendix A of this report.

The types of data contained in the NSI include the following:

- *Sediment chemistry*: Measurement of the chemical composition of sediment-associated contaminants.
- *Tissue residue*: Measurement of chemical contaminants in the tissues of organisms.
- *Benthic abundance*: Measurement of the number and types of organisms living in or on sediments.

- *Toxicity*: Measurement of the lethal or sublethal effects of contaminants in environmental media on various test organisms.
- *Histopathology*: Observation of abnormalities or diseases in tissue (e.g., tumors).
- *Fish abundance*: Measurement of the number and types of fish found in a water body.

The NSI represents a compilation of environmental monitoring data from a variety of sources. Most of the component databases are maintained under known and documented quality assurance and quality control procedures. However, EPA's STORET database is intended to be a broad-based repository of data. Consequently, the quality of the data in STORET, both in terms of database entry and analytical instrument error, is unknown and probably varies a great deal depending on the quality assurance management associated with specific data submittals.

Inherent in the diversity of data sources are contrasting monitoring objectives and scope. Component sources contain data derived from different spatial sampling plans, sampling methods, and analytical methods. For example, most data from EPA's EMAP program represent sampling stations that lie on a standardized grid over a given geographic area, whereas data in EPA's STORET most likely represent state monitoring data sampled from locations near known discharges or thought to have elevated contaminant levels. In contrast, many of the National Status and Trends Program data in NOAA's COSED database represent sampling stations purposely selected because they are removed from known discharges. However, many other sampling stations in the COSED database were located within highly urbanized bays and estuaries where chemical contamination was expected. These sampling stations include data from regional bioeffects assesments in which NOAA examined sediment quality in several highly urbanized areas. These surveys were region-wide assessments, not point source or end-of-pipe studies.

From an assessment point of view, STORET data might be useful for developing a list of contaminated sediment locations, but might overstate the general extent of contaminated sediment in the Nation by focusing largely on areas most likely to be problematic. On the other hand, analysis of EMAP data might result in a more balanced assessment in terms of the mix of contaminated sampling stations and uncontaminated sampling stations. Approximately two-thirds of sampling stations in the NSI are from the STORET database. Reliance on these data is consistent with the stated objective of this survey: to identify those sediments which are contaminated. However, one cannot accurately make inferences regarding the overall condition of the Nation's sediment, or characterize the "percent contamination," using all the data in the NSI because uncontaminated areas are most likely underrepresented.

NSI data do not evenly represent all geographic regions in the United States, nor do the data represent a consistent set of monitored chemicals. For example, several of the databases are targeted toward marine environments or other geographically focused areas. Table 2-1 presents the number of stations evaluated per state. More than 50 percent of all stations evaluated in the NSI are located in Washington, Florida, Illinois, California, Virginia, Ohio, Massachusetts, and Wisconsin. Each of these states has more than 700 monitoring stations. Other states of similar or larger size (e.g., Georgia, Pennsylvania) have far fewer sampling stations with data for evaluation. Figures 2-1, 2-2, and 2-3 depict the location of monitoring stations with sediment chemistry, tissue residue, and toxicity data, respectively. Individual stations may vary considerably in terms of the number of chemicals monitored. Some stations have data that represent a large number of organic and inorganic contaminants, whereas others have measured values for only a few chemicals. Thus, the inventory cannot be considered comprehensive even for locations with sampling data. The reliance on readily available electronic data has undoubtedly led to exclusions of a vast amount of information available from sources such as local and state governments and published reports. Other limitations, including data quality issues, are discussed in Chapter 5 of this report.

NSI Data Evaluation Approach

The methodology developed for classifying sampling stations according to the probability of adverse effects on aquatic life and human health from sediment contamination relies on measures of sediment chemistry, sediment toxicity, and contaminant residue in tissue. Although the NSI also contains benthic abundance, histopathology, and fish abundance data, these types of data were not used in the evaluation. Benthic and fish abundance cannot be directly associated with sediment contamination based on the statutory definition and currently available assessment tools, and available fish liver histopathology data were very limited.

The approach used to evaluate the NSI data focuses on the protection of benthic organisms from exposure to contaminated sediments and the protection of humans from the consumption of fish that bioaccumulate contaminants from sediment. In addition, potential effects on wildlife from

Table 2-1. Number of Stations Evaluated in the NSI by State

Region 1	Connecticut	98	Region 6	Arkansas	107
	Maine	55		Louisiana	460
	Massachusetts	895		New Mexico	101
	New Hampshire	7		Oklahoma	286
	Rhode Island	42		Texas	662
	Vermont	5			
Region 2	New Jersey	448	Region 7	Iowa	228
	New York	618		Kansas	203
	Puerto Rico	30		Missouri	327
				Nebraska	253
Region 3	Delaware	218	Region 8	Colorado	202
	District of Columbia	4		Montana	38
	Maryland	206		North Dakota	161
	Pennsylvania	311		South Dakota	43
	Virginia	1,051		Utah	47
	West Virginia	120		Wyoming	44
Region 4	Alabama	477	Region 9	Arizona	124
	Florida	1,776		California	1,443
	Georgia	318		Hawaii	36
	Kentucky	249		Nevada	96
	Mississippi	318			
	North Carolina	612			
	South Carolina	563			
	Tennessee	646			
Region 5	Illinois	1,669	Region 10	Alaska	267
	Indiana	108		Idaho	95
	Michigan	402		Oregon	291
	Minnesota	438		Washington	2,225
	Ohio	970			
	Wisconsin	703			

fish consumption were also evaluated. The wildlife results were not included in the overall results of the NSI data evaluation; however, they are presented separately. Table 2-2 presents the classification scheme used in the evaluation of the NSI data. Each component, or evaluation parameter, of the classification scheme is numbered on Table 2-2. Each evaluation parameter is discussed under a section heading cross-referenced to these numbers. Figures 2-4 through 2-8 depict the evaluation parameters and sampling station classifications in flowchart format.

EPA analyzed the NSI data by evaluating each parameter in Table 2-2 on a measurement-by-measurement and sampling station-by-sampling station basis. Each sampling station was associated with a "probability of adverse effects" by combining parameters as shown in Table 2-2 and Figures 2-4 through 2-8. Because each individual measurement was considered independently (except for divalent metals, whose concentrations were summed), a single observation of elevated concentration could place a sampling station into Tier 1, the higher probability category. In general, the methodology was constructed such that a sampling station classified as Tier 1 must be represented by a relatively large set of data or by a highly elevated sediment concentration of a chemical whose effects screening level is well characterized based on multiple assessment techniques. Fewer data were required to classify a sampling station as Tier 2. Any sampling station not meeting the requirements to be classified as Tier 1 or Tier 2 was classified as Tier 3. Sampling stations in this category include those for which substantial data were available without evidence of adverse effects, as well as sampling stations for which limited data were available to determine the potential for adverse effects.

Individual evaluation parameters, applied to various measurements independently, could lead to different site classifications. If one evaluation parameter indicated a higher probability of adverse effects, but other evaluation parameters indicated a lower to intermediate probability or did not indicate adverse effects, a Tier 1 classification was assigned to the sampling station. For example, if a sampling station was categorized as Tier 2 based on all sediment chemistry data, but was categorized as Tier 1 based on toxicity data, the station was placed in Tier 1. This principle also applies to evaluating multiple contaminants within the same evaluation parameter. For example, if the evaluation of sediment chemistry data placed a sampling station in Tier 1 for metals and in Tier 2 for PCBs, the station was placed in Tier 1.

Recognizing the imprecise nature of some assessment parameters used in this report, Tier 1 sampling stations are distinguished from Tier 2 sampling stations based on the magnitude of a contaminant concentration in sediment, or the degree of corroboration among the different types of sediment quality measures. In response to uncertainty in both biological and chemical measures of sediment contamination, environmental managers must balance Type I errors (false positives: sediment classified as posing a threat that does not) with Type II errors (false negatives: sediment that poses a threat but was not classified as such). In screening analyses, the environmentally protective approach is to minimize Type II errors, which leave toxic sediment unidentified. To achieve a balance and to direct attention to

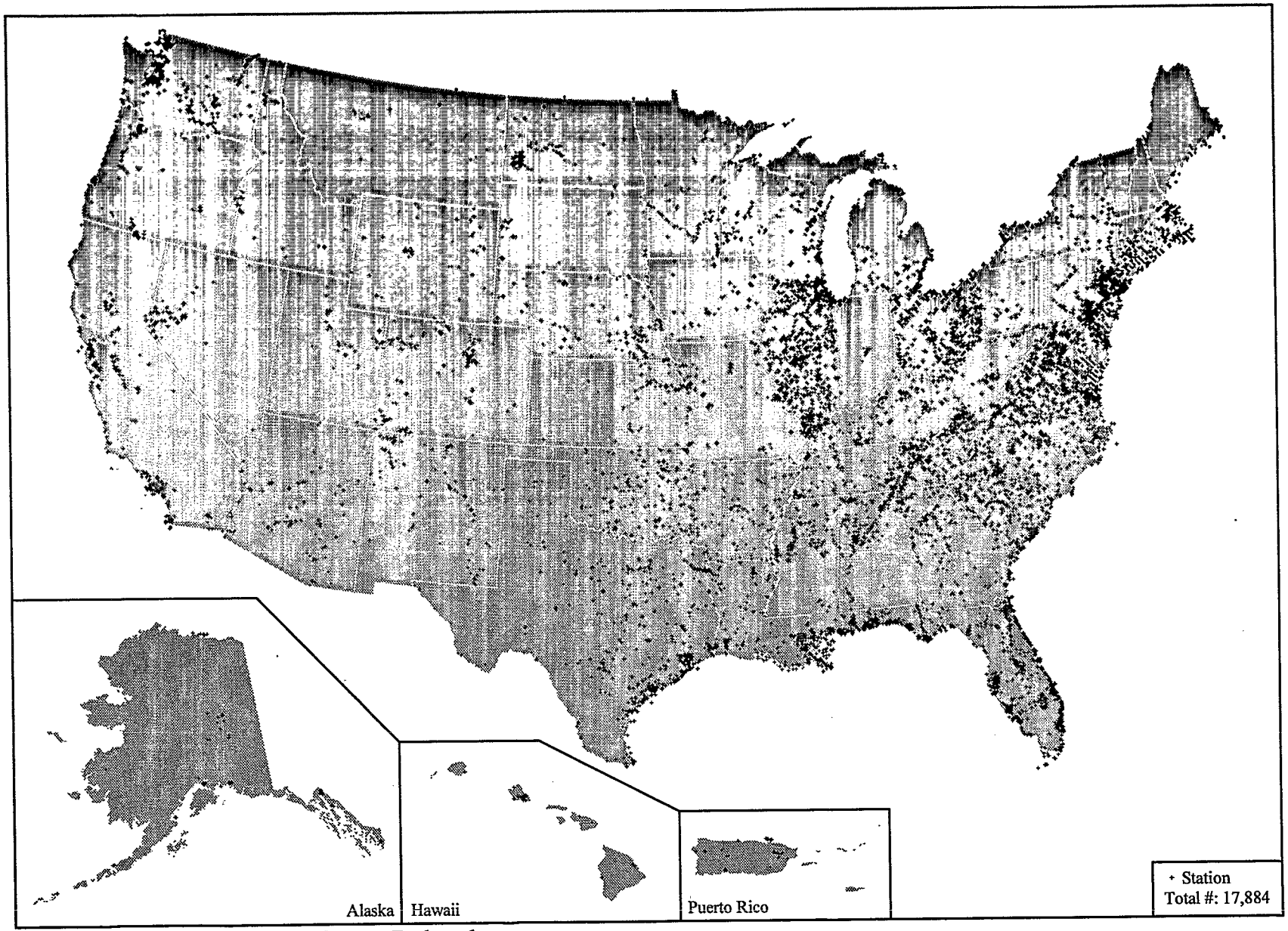


Figure 2-1. NSI Sediment Sampling Stations Evaluated.

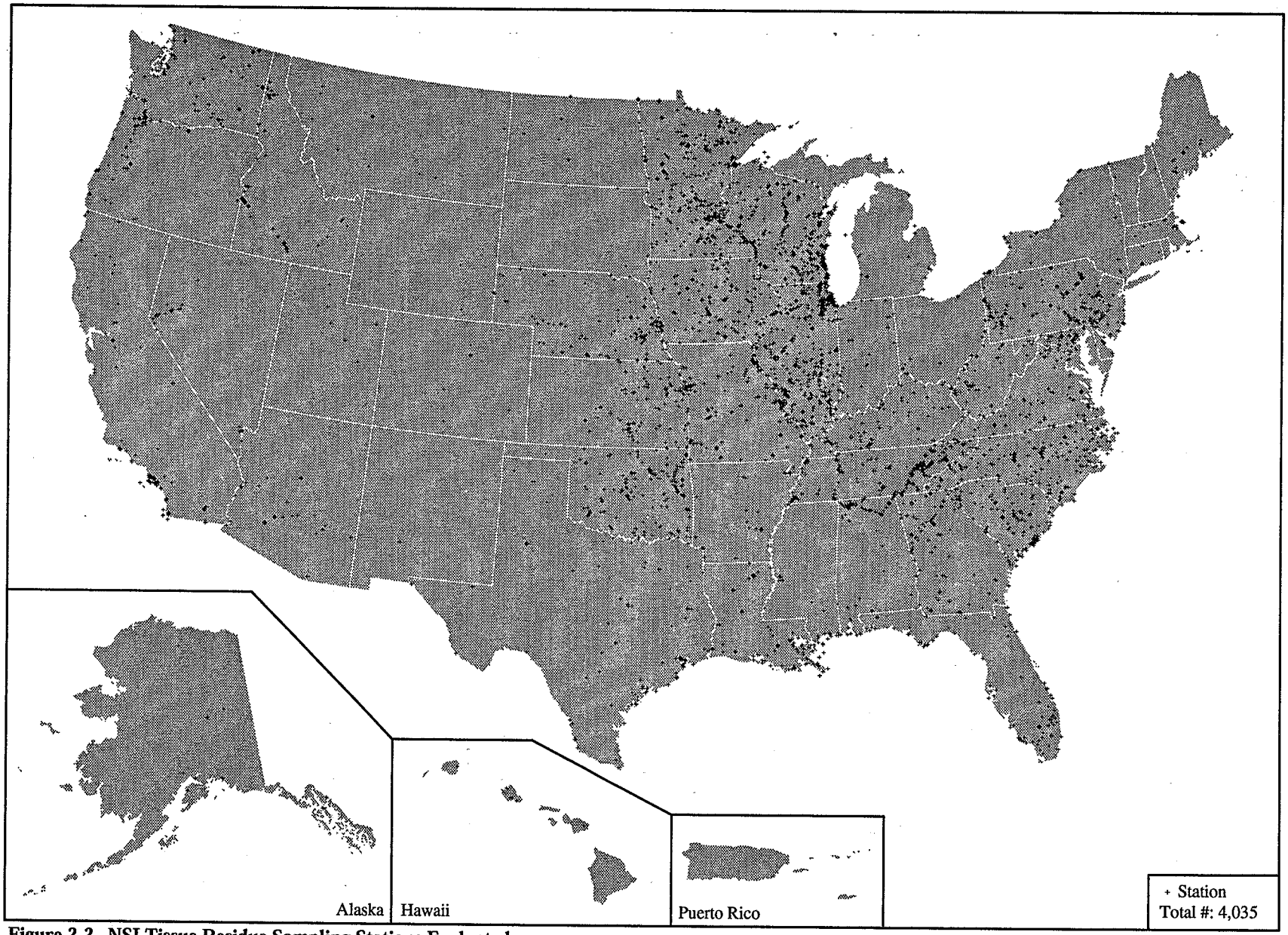


Figure 2-2. NSI Tissue Residue Sampling Stations Evaluated.

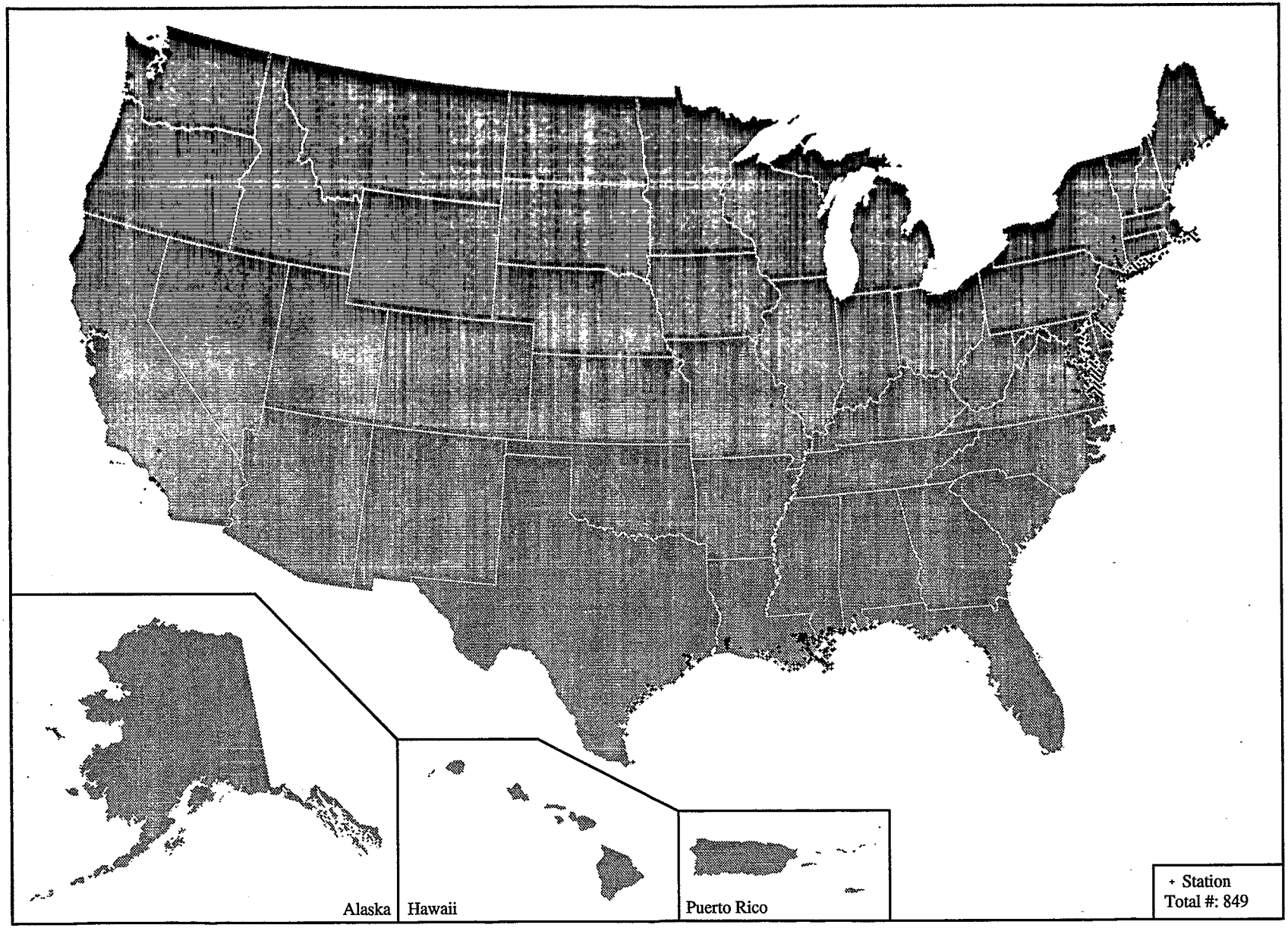


Figure 2-3. NSI Toxicity Test Stations Evaluated.

Table 2-2. NSI Data Evaluation Approach (with numbered parameters)

Category of Sampling Station Classifications	Data Used to Determine Classifications				
	Sediment Chemistry		Tissue Residue		Toxicity
Tier 1: Sediment Contamination Associated With A Higher Probability of Adverse Effects to Aquatic Life or Human Health	Sediment chemistry values exceed draft sediment quality criteria for any one of the five chemicals for which criteria have been developed by EPA (must have measured TOC) 1		Tissue levels of dioxin or PCBs in resident species exceed EPA risk levels 8		Toxicity demonstrated by two or more nonmicrobial acute toxicity tests using two different species (one of which must be a solid-phase test) 11
	OR [SEM]-[AVS]>5 for the sum of molar concentrations of Cd, Cu, Ni, Pb, and Zn[a] 2	OR		OR	
	OR Sediment chemistry values exceed two or more of the relevant upper screening values (ERMs, AETs (high), PELs, SQALs, SQCs) for any one chemical (other than Cd, Cu, Ni, Pb, and Zn) (can use default TOC) 3				
	OR Sediment chemistry TBP exceeds FDA levels or EPA risk levels 4	AND	Tissue levels in resident species exceed FDA levels or EPA risk levels 9	—	———
Tier 2: Sediment Contamination Associated With A Lower to Intermediate Probability of Adverse Effects to Aquatic Life or Human Health	[SEM]-[AVS] = 0 to 5 for the sum of molar concentrations of Cd, Cu, Ni, Pb, and Zn 5		Tissue levels in resident species exceed FDA levels or EPA risk levels 10		Toxicity demonstrated by a single-species nonmicrobial toxicity test 12
	OR Sediment chemistry values exceed any one of the relevant lower screening values (ERLs, AETs (low), TELs, SQALs, SQCs) for any one chemical (can use default TOC) 6	OR		OR	
	OR Sediment chemistry TBP exceeds FDA levels or EPA risk levels 7				
Tier 3: No indication of adverse effects	Any sampling station not categorized as Tier 1 or Tier 2. Available data (which may be very limited or quite extensive) do not indicate a likelihood of adverse effects to aquatic life or human health.				

[a]Metals: Cd = cadmium, Cu = copper, Ni = nickel, Pb = lead, Zn = zinc.

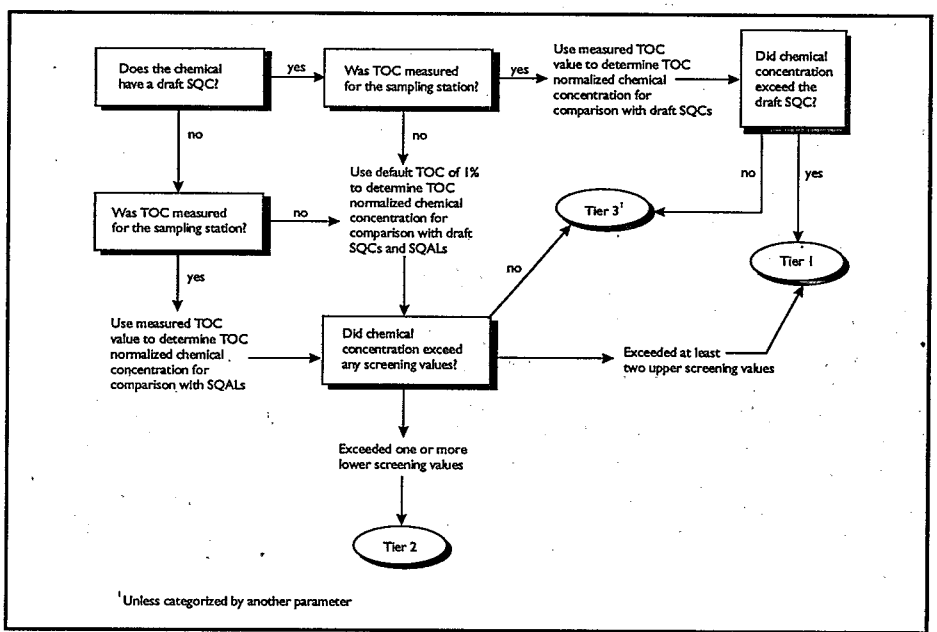


Figure 2-4. Aquatic Life Assessments: Sediment Chemistry Analysis for Organic Chemicals and Metals Not Included in the AVS Analysis.

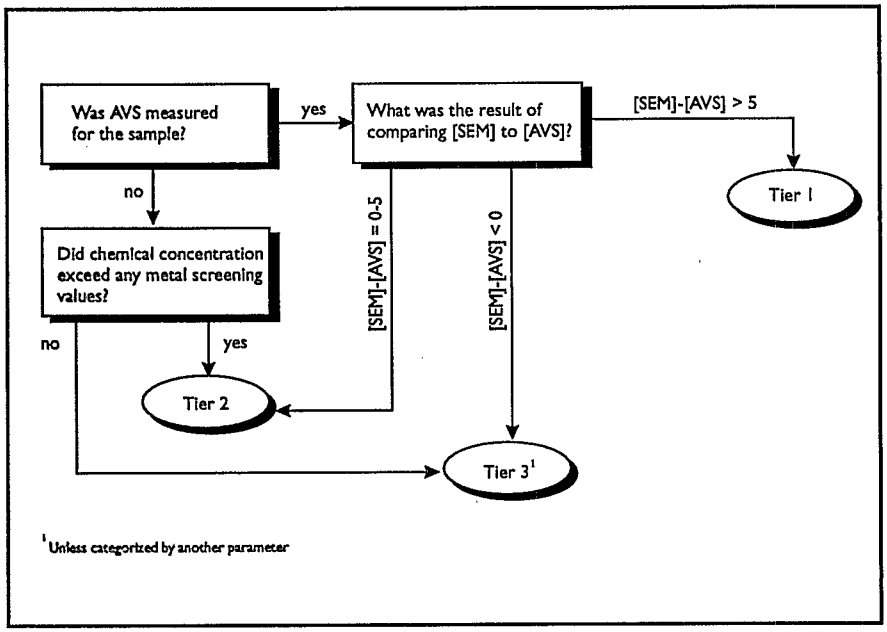


Figure 2-5. Aquatic Life Assessments: Sediment Chemistry Analysis for Divalent Metals.

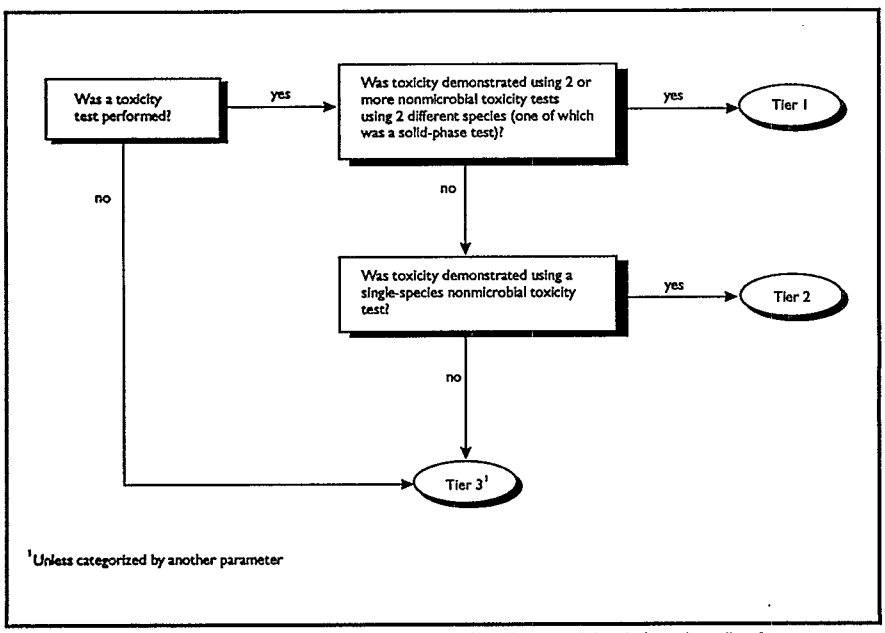


Figure 2-6. Aquatic Life Assessments: Sediment Toxicity Analysis.

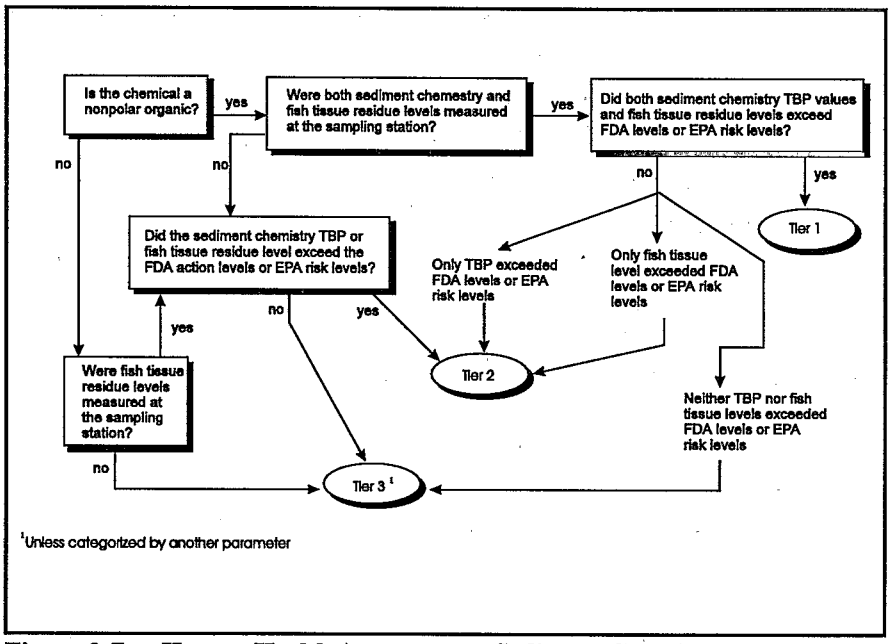


Figure 2-7. Human Health Assessments: Sediment Chemistry and Fish Tissue Residue Analysis (excluding dioxins and PCBs).

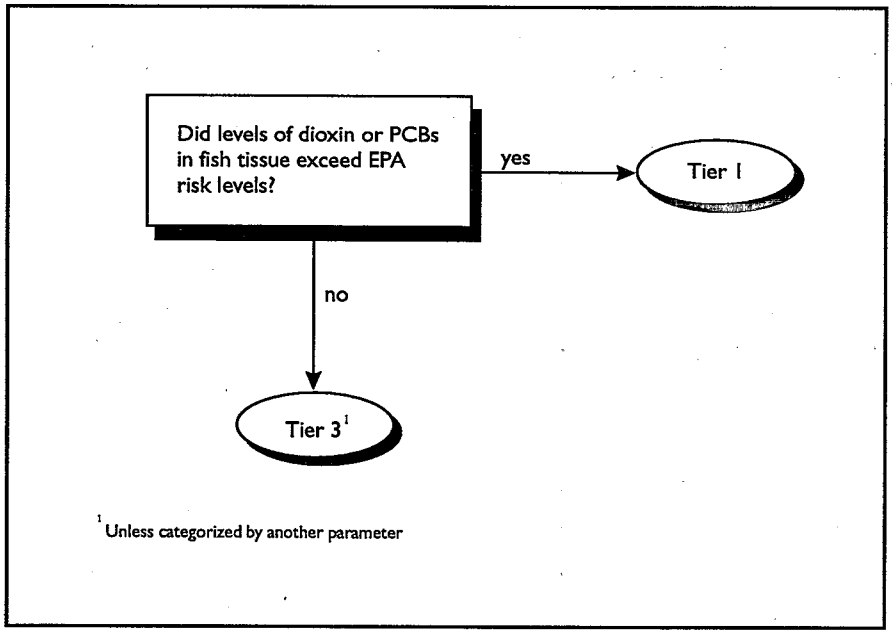


Figure 2-8. Human Health Assessments: PCBs and Dioxin in Fish Tissue Analysis.

areas most likely to be associated with adverse effects, Tier 1 sampling stations are intended to have a high rate of "correct" classification (e.g., sediment definitely posing or definitely not posing a threat) and a balance between Type I and Type II errors. On the other hand, to retain a sufficient degree of environmental conservatism in screening, Tier 2 sampling stations are intended to have a very low number of false negatives in exchange for a large number of false positives.

The numbered evaluation parameters used in the NSI data evaluation are briefly described below. A detailed description of the evaluation parameters is presented in Appendix B.

Sediment Chemistry Data

The sediment chemistry screening values used in this report are not regulatory criteria, site-specific cleanup standards, or remediation goals. Sediment chemistry screening values are reference values above which a sediment ecotoxicological assessment might indicate a potential threat to aquatic life. The sediment chemistry screening values used to evaluate the NSI data for potential adverse effects of sediment contamination on aquatic life include both theoretically and empirically based values. The theoretically based values rely on the physical/chemical properties of sediment and chemicals to predict the level of contamination that would not cause an adverse effect on aquatic life. The empirically based, or correlative, screening values rely on paired field and laboratory data to relate incidence of observed biological effects to the dry-weight sediment concentration of a specific chemical.

The theoretically based screening values used as parameters in the evaluation of NSI data include the draft sediment quality criteria, sediment quality advisory levels, and comparison of simultaneously extracted metals to acid-volatile sulfide concentrations. Empirically based, correlative screening values used in the NSI evaluation include the effects range-median/effects range-low values, probable effects levels/threshold effects levels, and apparent effects thresholds. The use of each of these screening values in the evaluation of the NSI data is described below. Another theoretically based evaluation parameter, the theoretical bioaccumulation potential (which was used for human health assessments), is also described below. The limitations associated with the use of these screening values are discussed in Chapter 5.

Sediment Chemistry Values Exceed EPA Draft Sediment Quality Criteria [1]

This evaluation parameter was used to assess the potential effects of sediment contamination on benthic species. EPA has developed draft sediment quality criteria (SQCs) for the following five nonionic organic chemicals:

- Acenaphthene (polynuclear aromatic hydrocarbon, or PAH)
- Dieldrin (pesticide)
- Endrin (pesticide)
- Fluoranthene (PAH)
- Phenanthrene (PAH)

EPA developed these draft criteria using the equilibrium partitioning (EqP) approach (described in detail in Appendix B) for linking bioavailability to toxicity. The EqP approach involves predicting the dry-weight concentration of a contaminant in sediment that is in equilibrium with a pore water concentration that is protective of aquatic life. It combines the water-only effects concentration (the chronic water quality criteria) and the organic carbon partitioning coefficient of the chemical normalized to the organic carbon content of the sediment. The draft criterion is compared to the measured dry-weight sediment concentration of the chemical normalized to sediment organic carbon content. If the organic-carbon-normalized concentration of the contaminant does not exceed the draft sediment quality criterion, adverse effects should not occur to at least 95 percent of benthic organisms. The draft SQCs are based on the highest quality data available, which have been reviewed extensively.

For the NSI data evaluation, sediment chemistry measurements with accompanying measured total organic carbon (TOC) values can place a site in Tier 1 based exclusively on a comparison with a draft SQC. The amount of TOC in sediment is one of the factors that determines the extent to which a nonionic organic chemical is bound to the sediment and, thus, the availability for uptake by organisms (bioavailability). If draft SQCs based on measured TOC were not exceeded, or if none of the five nonpolar organic chemicals that have been assigned draft SQC values were measured, the sampling station was classified as Tier 3 unless otherwise categorized by another parameter. Appendix B discusses the assumptions and limitations associated with the use of draft SQCs. If a sample for any of the five contaminants for which draft SQCs have been developed did not have accompanying TOC data, the measured concentration was compared to the draft SQC based on a default TOC value of 1 percent. In these instances, the draft SQC was treated like other sediment quality screening values described later in this section.

The assumption that the percent TOC for samples without measured TOC is equal to 1 percent is based on a review of values published in the literature. TOC can range from 0.1 percent in sandy sediments to 1 to 4 percent in silty harbor sediments and 10 to 20 percent in navigation channel sediments (Clarke and McFarland, 1991). Long et al. (1995) reported an overall mean TOC concentration of 1.2 percent from data compiled from 350 publications for their biological effects database for marine and estuarine sediments. Ingersoll et al. (1996) reported a mean TOC concentration of 2.7 percent for inland freshwater samples. Based on this review of TOC data, EPA selected a default TOC value of 1 percent for the NSI evaluation. Consistent with the screening level application, this value should not lead to an underestimate of the bioavailability of associated contaminants in most cases.

Comparison of AVS to SEM Molar Concentrations [2, 5]

The use of the total concentration of a trace metal in sediment as a measure of its toxicity and its ability to bioaccumulate is problematic because different sediments exhibit different degrees of bioavailability for the same total quantity of metal (Di Toro et al., 1990; Luoma, 1983). These differences have recently been reconciled by relating organism toxic response (mortality) to the metal concentration in the sediment interstitial water (Adams et al., 1985; Di Toro et al., 1990). Acid-volatile sulfide (AVS) is one of the major chemical components that control the activities and availability of metals in interstitial waters of anoxic (lacking oxygen) sediments (Meyer et al., 1994).

A large reservoir of sulfide exists as iron sulfide in anoxic sediment. Sulfide will react with several divalent transition metal cations (cadmium, copper, mercury, nickel, lead, and zinc) to form highly insoluble compounds that are not bioavailable (Allen et al., 1993). It follows in theory, and with verification (Di Toro et al., 1990), that divalent transition metals will not begin to cause toxicity in anoxic sediment until the reservoir of sulfide is used up (i.e., the molar concentration of metals exceeds the molar concentration of sulfide), typically at relatively high dry-weight metal concentrations. This observation has led to a laboratory measurement technique of calculating the difference between simultaneously extracted metal (SEM) concentration and acid volatile sulfide concentration from field samples to determine potential toxicity.

To evaluate the potential effects of metals on benthic species, the molar concentration of AVS ([AVS]) was compared to the sum of SEM molar concentrations ([SEM]) for five metals: cadmium, copper, nickel, lead, and zinc. Mercury was excluded from AVS comparison because other important factors play a major role in determining the bioaccumulation potential of mercury in sediment. Specifically, under certain conditions mercury binds to an organic methyl group and is readily taken up by living organisms.

Sediment with measured [SEM] in excess of [AVS] does not necessarily exhibit toxicity. This is because other binding phases can tie up metals. However, research indicates that sediment with [AVS] in excess of [SEM] will not be toxic from metals, and the greater the [SEM]-[AVS] difference, the greater the likelihood of toxicity from metals. Analysis of toxicity data for freshwater and saltwater sediment amphipods (crustaceans) from EPA's Environmental Research Laboratory in Narragansett, Rhode Island, revealed that 80 to 90 percent of the sediments were toxic at [SEM]-[AVS] > 5 (Hansen, 1995; see also Hansen et al., 1996). Thus, EPA selected [SEM]-[AVS] = 5 as the demarcation line between Tier 1 and Tier 2. For the purpose of this evaluation, where [SEM]-[AVS] was greater than 5, the sampling station was classified as Tier 1. If [SEM]-[AVS] was between zero and 5, the sampling station was classified as Tier 2. If [SEM]-[AVS] was less than zero, or if AVS or the five AVS metals were not measured at the sampling station, the sampling station was classified as Tier 3 unless otherwise classified by another parameter. Appendix B discusses the assumptions and limitations associated with the [SEM]-[AVS] approach.

Sediment Chemistry Values Exceed Screening Values [3, 6]

Several sets of sediment contaminant screening values, developed using different methodologies, are available to assess potential adverse effects on benthic species. The screening values selected for comparison with measured sediment levels are the draft SQCs using a default TOC of 1 percent (for those samples which do not have accompanying TOC data), sediment quality advisory levels (SQALs) for freshwater aquatic life (developed using the equilibrium partitioning approach discussed previously for the development of draft SQCs), the effects range-median (ERM) and effects range-low (ERL) values developed by Long et al. (1995), the probable effects levels (PELs) and threshold effects levels (TELs) developed for the Florida Department of Environmental Protection (FDEP, 1994), and the apparent effects thresholds (AETs) developed by Barrick et al. (1988). The assumptions and approaches used to develop these screening values are discussed in detail in Appendix B.

The draft SQCs and SQALs were both developed using the same EqP approach. However, the data used to derive SQALs were not compiled from an exhaustive literature search, nor were the toxicity data requirements as extensive as specified for draft SQCs. Toxicity values used for SQAL development include final chronic values from EPA ambient freshwater quality criteria and secondary chronic values derived using EPA's Great Lakes Water Quality Initiative "Tier II" water quality criteria methodology. The data used to develop the latter values were taken primarily from quality-screened studies in published literature. The development of SQALs is discussed in further detail in Appendix B of this report. EPA has also prepared a draft document describing the derivation of the SQALs (USEPA, 1996). The chemicals for which SQALs have been developed are identified in Appendix D of this volume.

The ERLs/ERMs, PELs/TELs, and AETs relate the incidence of adverse biological effects to the sediment concentration of a specific chemical at a specific sampling station using paired field and laboratory data. The developers of the ERLs/ERMs define sediment concentrations below the ERL as being in the "minimal-effects range," values between the ERL and ERM in the "possible-effects range," and values above the ERM in the "probable-effects range." In the FDEP (1994) approach, the lower of the two guidelines for each chemical (the TEL) is assumed to represent the concentration below which toxic effects rarely occur. In the range of concentrations between the TEL and PEL, effects occasionally occur. Toxic effects usually or frequently occur at concentrations above the upper guideline (the PEL).

In independent analyses of the predictive abilities of the ERL/ERMs and TEL/PELs, the precentages of samples indicating high toxicity in laboratory bioassays of amphipod survival were relatively low (10-12 percent) when all chemical concentrations were in the minimal effects range, intermediate (17-19 percent) in the possible effects range, and higher (38-42 percent) in the probable effects range. Furthermore, the percentages of samples indicating high toxicity in any one of a battery of 2-4 tests performed, including more sensitive bioassays with sublethal endpoints, were 5-28 percent, 59-64 percent, and 78-80 percent among samples within the minimal, possible, and probable effects ranges (Long et al., in press).

The AET approach is not based on the probability of incidence of adverse biological effects. The AET is the highest concentration at which statistically significant differences in observed adverse biological effects from reference conditions do not occur, provided that the concentration also is associated with observance of a statisically significant difference in adverse biological effects. Essentially, this identifies the concentration above which an adverse biological effect always occurs for a particular data set. Barrick et al. (1988) list specific AET values for several different species or biological indicators. For the purposes of this assessment, EPA defined the AET-low as the lowest AET among applicable biological indicators, and the AET-high as the highest AET among applicable biological indicators.

For the NSI data evaluation, the upper screening values were considered to be the ERM, PEL, draft SQC (when using default TOC value of 1 percent), SQAL, and AET-high for a given chemical. The lower screening values were considered to be the ERL, TEL, draft SQC (when using default TOC of 1 percent), SQAL, and AET-low for a given chemical. Because they are not based on ranges of effects, the single freshwater aquatic life draft SQC and SQAL values for a given chemical served as both the high and low screening values.

For a sampling station to be classified as Tier 1, a chemical measurement must have exceeded at least two of the upper screening values. If a sediment chemistry measurement exceeded any one of the lower screening values, the sampling station was classified as Tier 2. If sediment concentrations at a sampling station did not exceed any screening values or there were no data for chemicals that have assigned screening values, the sampling station was categorized as Tier 3 unless otherwise categorized by another parameter.

Under this approach, a sampling station could be classified as Tier 1 from elevated concentrations of cadmium, copper, lead, nickel, or zinc based only on a comparison of [SEM] to [AVS]; that is, sampling stations could not be classified as Tier 1 based on an exceedance of two upper screening values for any of the five metals. However, sampling stations were classified as Tier 2 for these five metals based on an exceedance of one of the lower screening values if AVS data were not available.

Sediment Chemistry TBPs Exceed Screening Criteria [4, 7]

This evaluation parameter addresses the risk to human consumers of organisms exposed to sediment contaminants. The theoretical bioaccumulation potential (TBP) is an estimate of the equilibrium concentration (concentration that does not change with time) of a contaminant in tissues if the sediment in question were the only source of contamination to the organism. At present,

the TBP calculation can be performed only for nonpolar organic chemicals. The TBP is estimated from the concentration of contaminant in the sediment, the organic carbon content of the sediment, the lipid content of the organism, and the relative affinity of the chemical for sediment organic carbon and animal lipid content. This relative affinity is measured in the field and is called a biota-sediment accumulation factor (BSAF, as discussed in detail in Appendix C).

In the evaluation of NSI data, if a calculated sediment chemistry TBP value exceeded a screening value derived using standard EPA risk assessment methodology or the Food and Drug Administration (FDA) tolerance/action or guidance level, and if a corresponding tissue residue level for the same chemical for a resident species at the same sampling station also exceeded one of those screening values, the station was classified as Tier 1. Individual chemical risk levels were considered separately; that is, risks from multiple contaminants were not added. Both sediment chemistry and tissue residue samples must have been taken from the same sampling station. If tissue residue levels for the same chemical for a resident species at the same sampling station did not exceed EPA risk levels or FDA levels or there were no corresponding tissue data, the sampling station was classified as Tier 2. If neither TBP values nor fish tissue residue levels exceeded EPA risk levels or FDA levels, or if no chemicals with TBP values, EPA risk levels, or FDA levels were measured, the sampling station was classified as Tier 3 unless otherwise classified by another parameter. A detailed description of the methods used to develop TBP values and to determine the EPA risk levels used in this comparison is presented in Appendix B.

Tissue Residue Data [8, 9, 10]

Tissue residue data were used to assess potential adverse effects on humans from the consumption of fish that become contaminated through exposure to contaminated sediment. Only those species considered benthic, non-migratory (resident), and edible by human populations were included in human health assessments. A list of species included in the NSI and their characteristics is presented in Appendix F.

Sampling stations at which human health screening values for dioxin and PCBs were exceeded in fish tissues were classified as Tier 1. For these chemicals, corroborating sediment chemistry data were not required. If human health screening values for dioxin or PCBs in fish tissue were not exceeded or if neither chemical was measured, the sampling station was classified as Tier 3 unless otherwise classified by another parameter.

For other chemicals, both a tissue residue level exceeding an FDA tolerance/action or guidance level or EPA risk level and a sediment chemistry TBP value exceeding that level for the same chemical were required to classify a sampling station as Tier 1. If tissue residue levels exceeded FDA levels or EPA risk levels but corresponding TBP values were not exceeded at the same station (or there were no sediment chemistry data from that station), the sampling station was classified as Tier 2. If neither fish tissue levels nor TBP values exceeded EPA risk levels or FDA levels, or if no chemicals with TBP values, EPA risk levels, or FDA levels were measured, the sampling station was classified as Tier 3 unless otherwise classified by another parameter.

Toxicity Data [11, 12]

Toxicity data were used to classify sediment sites based on their demonstrated adverse effects on aquatic life. Nonmicrobial sediment toxicity tests with a mortality endpoint were evaluated. Toxicity test results that lacked control data, or had control data that indicated greater than 20 percent mortality (less than 80 percent survival), were excluded from further consideration. The EPA has standardized testing protocols for marine and freshwater toxicity tests. A review of several protocols for sediment toxicity tests suggests that mortality in controls may range from 10 to 30 percent, depending on the species, to be considered an acceptable test result (API, 1994). Current amphipod test requirements indicate that controls should have less than 10 percent mortality (API, 1994; USEPA, 1994b).

For the NSI data evaluation, EPA considered significant toxicity as a 20 percent difference in survival from control survival. For example, significant toxicity occurred if control survival was 80 percent and experimental survival was 60 percent or less.

For this evaluation parameter, corroboration of multiple tests was considered more indicative of a higher probability of adverse effects than the magnitude of the effect in a single test. Toxicity demonstrated by two or more single-species tests using two different test species (at least one of which had to be a solid-phase test) placed a sampling station in Tier 1. A sampling station was classified as Tier 2 if toxicity was demonstrated by one single-species nonmicrobial toxicity test. If toxicity was not demonstrated by a nonmicrobial toxicity test, or if toxicity test data were not available, the sampling station was classified as Tier 3 unless otherwise classified by another parameter.

Incorporation of Regional Comments on the Preliminary Evaluation of Sediment Chemistry Data

Several reviewers from different EPA Regions and states provided comments on the May 16, 1994, preliminary evaluation of sediment chemistry data. The comments included more than 150 specific comments identifying additional locations with contaminated sediment that had not been identified in the preliminary evaluation. Since the preliminary evaluation, the final NSI methodology has been developed and implemented. The updated methodology has been refined significantly to include tissue residue and toxicity data as well as revised screening values. Data corresponding to any additional comments that required further review were divided into two categories: (1) data that incorrectly identified contaminated sediment and (2) additional water bodies that contain areas of sediment contamination. The first category primarily addressed sampling stations identified in the preliminary assessment as exceeding sediment chemistry screening values for specific contaminants that reviewers stated were located in water bodies that are not contaminated from the chemical(s) in question.

EPA examined all NSI sampling stations that had been identified in the preliminary evaluation as exceeding a sediment quality screening value, but were located in water bodies that reviewers of the preliminary evaluation identified as not being contaminated by that specific contaminant or contaminants. If the sampling station in question was classified in this final evaluation as Tier 1 based only on the specific contaminant(s) identified by the reviewer as not being a problem, the sampling station was removed from the Tier 1 category and placed in the Tier 3 category. Only a few sampling stations were moved from the Tier 1 category to the Tier 3 category as a result of this procedure. Stations identified in the NSI evaluation as Tier 1 based on other chemicals not identified by the reviewer or because of toxicity data were not removed from Tier 1.

Additional water bodies that reviewers identified as potential areas of significant contamination were evaluated to determine whether sampling stations along those water bodies were classified as Tier 1 based on the final NSI data evaluation. Locations or water bodies identified by reviewers as potential areas of significant contamination are discussed separately in the results (Chapter 3).

Evaluation Using EPA Wildlife Criteria

In addition to the evaluation parameters described above and presented in Table 2-2, EPA conducted an assessment of NSI data based on a comparison of sediment chemistry TBP values and fish tissue values to EPA wildlife criteria developed for the Great Lakes. This evaluation, however, was not included with the results of evaluating the NSI data based on the other parameters. The results of evaluating NSI data based on wildlife criteria are presented in a separate section of Chapter 3. Wildlife criteria based solely on fish tissue concentrations were derived for EPA wildlife criteria for water that are presented in the *Great Lakes Water Quality Initiative Criteria Documents for the Protection of Wildlife* (USEPA, 1995a). EPA has developed wildlife criteria for four contaminants: DDT, mercury, 2,3,7,8-TCDD, and PCBs. The method to adjust these wildlife criteria for the NSI data evaluation is explained in detail in Appendix B.

Appendix E

Example of Basin-Level Assessment Information: Arizona

Middle Gila River Basin

The Middle Gila River Basin (**Map 18**) encompasses 12,150 square miles, and includes the Phoenix metropolitan area. Almost two-thirds of the State's population resides in this basin. The historical land use in the Middle Gila Basin was agricultural; however, in the metropolitan area agriculture has been displaced by 30 years of almost exponential population growth. Surface water diversions in the Gila River and the Salt River for agricultural and urban uses have left the streambeds in the Phoenix area dry. The basin also includes two Indian Reservations, portions of two National Forests, and 11 designated Wilderness Areas. The basin receives limited rainfall; therefore, surface water flow in this basin is primarily attributable to releases from upstream impoundments, effluent from wastewater treatment plants, and/or agricultural return flows.

The Arizona Department of Health Services released a human health risk report in 1991 entitled "Risk Assessment for Recreational Usage of the Painted Rocks Borrow Pit Lake at Gila Bend, Arizona". This report indicated that a greater than acceptable lifetime cancer risk could result from long-term consumption of fish from this impoundment and upstream along Gila River. Specifically, ADHS found that there would be a greater than a one-in-a-million lifetime (70-year) risk of cancer associated with DDT metabolite ingestion by eating (8 ounce portions) 3.5 meals per month, and methylmercury toxicity would be expected to occur at a consumption level approaching eight meals per month. As a result, a fish consumption advisory was issued on October 3, 1991, warning people not to eat fish, turtles, crayfish or other aquatic organisms from portions of the Salt, Hassayampa, and Gila rivers (the Gila River between the confluence with the Salt River to Painted Rocks Lake, the Hassayampa River near its mouth, and the Salt River below the 23rd Ave in Phoenix). Camping, boating, fishing, other recreational uses and public access have been prohibited since the Painted Rocks Lake State Park was closed in January, 1989. Management of the area has reverted back to the U.S. Army Corps of Engineers and the Bureau of Land Management through actions by the State Parks Board. These two federal agencies are considering proposals to reopen the lake facilities to the public.

Sediment borings from the Gila River were tested for organochlorine pesticides and heavy metals as part of a Painted Rocks Lake diagnostic/feasibility study by the Clean Lakes Program (The Earth Technology Corporation, 1993). Results indicted that the continued loading of DDT metabolites, toxaphene, and mercury can be expected from the watershed. A disparity between high biota contaminant concentrations and low sediment concentrations suggests that the food web acts as a filtering mechanism for the removal and concentration of toxic lipidophilic contaminants (DDT metabolites, toxaphene, and mercury). Extensive agricultural area in the watershed is the assumed source for the DDT metabolites and toxaphene, while the potential sources of mercury contamination include the watershed's natural geology, mining activities (historic use of mercury to leach precious metals), landfills, and treated sewage effluent. Several restoration techniques were proposed to mitigate the eutrophic conditions at the lake; however, these proposals were costly and would not resolve the on-going pesticide loading from the watershed.

The USFWS has begun collecting fish and predatory birds along the lower Salt and Gila Rivers (from 59th Avenue in Phoenix to the Colorado River) and will be testing their tissues for organochlorine pesticides and heavy metals. This is a follow up to the extensive monitoring completed by the USFWS in this area in 1985-1986. In the present study sediment samples will not be collected because they were not a reliable indicator of the level of contamination in resident wildlife. USFWS is also attempting to collect soft-shelled turtles for comparison to previous collections, but has so far been unsuccessful.

Two projects provided information concerning the existing level of contamination by organochlorine pesticides in agricultural fields, a source of aquatic contamination in this watershed. In one project samples were collected along the edge of cultivated fields, adjacent to roadway shoulders (SCS Engineers, 1991). Any residues of organochlorine pesticides in these locations would represent the results of overspray, rather than direct application. Varying degrees of soil disturbance due to road grading and field plowing were observed, and areas where disturbed soils appeared to have originated from road grading activities were avoided. Also areas where significant runoff or irrigation water accumulated were avoided. Soil samples collected at approximately 6 inches below ground surface indicated extensive residual pesticide contamination in these areas, and that human consumption of the soil is probably not advisable. A summary of these soil sample results and the USFWS sediment sample results are indicated in the following table:

PESTICIDE	RANGE IN SOIL* (mg/kg)	HBGL* (mg/kg)	RANGE IN STREAM SEDIMENTS* (mg/kg)
DDT METABOLITES	0.07-5.13	4.0	<detection level-0.44
TOXAPHENE	<detection level-18.0	1.2	<detection level
TOTAL PESTICIDES	0.38-23.86	--	--

* Soil sediments collected by SCS Engineers (1991).
HBGL = Health Based Guidance Level established by the Arizona Department of Health Services for human consumption of soil.
Stream sediment samples collected by the USFWS in 1985-87 in the Painted Rocks Lake study area.

A second study of organochlorine pesticide levels associated with historic agricultural areas in the Middle Gila River Basin was completed by ADEQ and published as a masters thesis (Brown, 1993). Soil samples were collected at two depths in fields which had been fallow for at least 5 years, and sediment samples were collected in drainage areas associated with these fields. Only DDT metabolites and toxaphene were detected in the ranges that are indicated in the table at the bottom of this page.

Another pesticide study was conducted in the Maryvale area of Phoenix (ADEQ, 1992d). A study of residual pesticide levels was initiated because of a childhood leukemia cluster in the Maryvale area of Phoenix, and the area of concern had been previously in agricultural fields. Soil samples were collected around 10 sites (residents, parks, schools, and agricultural sites) in 1989-1990. DDT metabolites, toxaphene, heptachlor, and aldrin were detected at levels higher than the Health Based Guidance Level established by ADHS for human ingestion of these pesticides in soil. Ziram, a fungicide and seed treatment, was also detected, but no guidance level has been established. Toxaphene was the only pesticide detected over the guidance level at an athletic field or public level, the other exceedances were confined to samples taken around structural foundations. This suggests that these residues resulted from application to the foundations as structural pest control. There is also DDT and toxaphene residue that appears to be correlated with agricultural activity. This study did not answer questions about health risk, if any, that these residuals may pose to the population. The study had three recommendations:

- Further soil testing to characterize the nature and distribution of DDT and toxaphene in Phoenix area.
- The guidance levels for DDT and toxaphene should be expanded to consider risks from inhalation exposures.
- A human health risk assessment should be conducted by ADHS of the total DDT and toxaphene levels found in Phoenix area.

During the winter floods of 1992 and 1993, the Salt River flooded and inundated a portion of the Tri-City Landfill on the Salt River Indian Reservation that served several cities and institutions in the Phoenix metropolitan area. Although only a minor portion of the landfill was carried

PESTICIDE	SOIL AT 0-15 cm (mg/kg)	SOIL AT 15-30 cm (mg/kg)	CHANNEL SEDIMENT (mg/kg)
DDT METABOLITES	0.014-0.93	0.02-0.59	0.02-0.195
TOXAPHENE	<detection level-0.60	0.02-0.195	0.03-1.20

* Soil and sediment samples collected by ADEQ Pesticide Unit (Brown, 1993).

away, thousands of tons of debris being swept into the floodwaters, to be deposited along the Salt and Gila rivers shorelines for more than 100 miles. EPA and the Army Corps of Engineers have been working with the Tribal government to mitigate these problems (the State lacks jurisdiction). Currently, a portion of the landfill is being moved out of the floodplain. The part that will remain must be protected from future floods and natural shifts in the river channel.

During the January 1993 record breaking floods, ASARCO Hayden Tailings discharged approximately 220,000 cubic yards of tailings into the Gila River. Tailing deposits along the banks were documented, and voluntary actions to remediate were initiated, however, the tailings have now spread out to such an extent that remediation may not be possible. Also during this flood, Black Canyon City Auto Parts discovered that keeping salvage cars in the Squaw Creek floodplain can lead to an annoying "distribution of assets", as the vehicles were swept down into the Agua Fria River. The owner has removed them from the streambed, but deposited them on State Land without permission. Further enforcement action is still pending.

Portions of the federal Superfund site located at Phoenix's 19th Avenue Landfill are located within the 100-year floodplain of the Salt River. Flooding in 1979 raised the water table, filled several disposal pits, breached several dikes, and washed refuse into the river. Refuse in the landfill contains volatile organic compounds (VOCs) and pesticides; the soil contains VOCs, polychlorinated biphenyls (PCBs), and pesticides; the groundwater contains VOCs, heavy metals, and beta radiation; and excessive methane gas is being produced. Earthen berms have been constructed to mitigate further surface water contamination. Cleanup of this site is to begin as soon as the design phase is completed (EPA, Sept. 1990a).

The U.S. Army Corps of Engineers initiated a feasibility study, known as Tres Rios, for seven miles of the Salt and Gila rivers below the 91st Avenue Wastewater Treatment Plant. The project would create an artificial wetland to provide additional treatment of secondary treated effluent from the plant.

Surface water (McKellips Lake) within the Indian Bend Wash federal Superfund site is contaminated by VOCs. In this 12 square mile Superfund site, VOCs, cyanide, acids, and heavy metals from several industrial facilities have contaminated the soils. Groundwater is contaminated with VOCs, boron, methane, chloroform, lead and zinc. Further studies are taking place and cleanup activities are planned (EPA, 1990a).

Results from a cooperative monitoring station on the Gila River within the Gila River Indian Community is indicated in the basin discussion for information purposes. This section of the Gila River was not assessed. Total dissolved solids exceed 1000 mg/l on the Gila River below San Carlos Reservoir. At a downstream monitoring station, near the Gila River Indian Community, TDS ranged between 7160-9090 mg/l in 1990. Elevated salts and high boron are attributed to the agricultural return flows from Broadacres Farm on the Gila Indian Reservation. Broadacres Farm utilizes City of Chandler effluent and shallow saline groundwater to irrigate saline soils. The high levels of TDS did not affect the assessment of this reach, because it is not protected for Agricultural Irrigation or Domestic Water Source uses; nonetheless, this contamination may contribute to downstream irrigation limitations.

The Gibson Mine, which is located on a ridge near Globe, Arizona, has documented surface water violations in two watersheds: Salt River Basin and Middle Gila River Basin. The mine produced high grade copper ore between 1906-1918, until the underground workings apparently collapsed. Since then the mine has been operated sporadically to produce copper from the ore dumps. In response to a complaint in 1990, samples taken along Mineral Creek and its tributary revealed that designated uses were impaired by cadmium, copper, zinc, manganese and low pH. (See also the Gibson Mine discussion in the Salt River Basin.) In 1993, the Attorney General entered into a consent decree with the chief lessee, requiring engineering studies in preparation for remediation actions. Engineering studies have been completed, reviewed, and approved. However, subsequently the operation was discontinued, and there have been insufficient funds to initiate remediation actions as approved. Owners were also found to be responsible for certain discharges and the Attorney General's Office has given the owners a Notice of Violation. Negotiations are in progress with the owners.

The Ray Mine is also located on Mineral Creek, and has numerous documented water quality violations below the mine. The U.S. Department of Justice is reviewing an enforcement order by EPA through its NPDES permit.

Complaints of a green stream in Queen Creek revealed that a culvert had become plugged, backing water up behind a railroad embankment that contained copper ore. Magma Copper quickly resolved this problem upon notification, investigated further, and corrected similar situations at other locations along the creek.

At the McCabe-Gladstone Mine a seeping tailings pond was discovered to be contaminating groundwater and surface water with cyanide. A notification of ownership change stimulated an investigation of the operation through the Aquifer Protection Permit Program. This mine is located in the Agua Fria drainage on an unnamed tributary to Galena Gulch. As a condition of sale to Magma Gold in 1992, Magma has completed a hydrogeologic study below the tailings pond, and is to remediate the existing water quality problems. Meanwhile, Magma restarted the mining operations without using additional cyanide. Enforcement action is pending, based on remediation actions taken by Magma.

The Vulture Mill site near the Hassayampa River in Wickenburg was investigated by ADEQ in 1992 and 1993, following the death of one colt. Although toxic poisoning of the colt could not be proven, surface water ponding at the site was heavily contaminated with heavy metals. Subsequently, hogs have been removed from contact with tailings. Water drainage has been captured and the animal waste lagoon, which had contained excessive levels of mercury, lead and other heavy metals, has dried up. Currently, only low level groundwater contamination is detected on site. The owner has initiated arrangements to have the tailings processed if they contain sufficient amounts of gold.

Investigations in 1990 at Zonia Mine, near the headwaters to the Hassayampa River, revealed contamination of surface water with cadmium, copper, manganese, mercury, zinc, and TDS, and a low pH. EPA issued a Findings in Violation order against the owner in 1991. The owner has leased the mine to Arimetco Mining Co, which has completed substantial remediation activities to eliminate leaks at the leach basins. A hydrogeological study of the area was completed in 1993, which is currently under review by EPA and ADEQ. Arimetco plans to restart the mining operations under an Aquifer Protection Permit. Enforcement action against the owner has been halted by EPA as remediation actions continue.

Abandoned mines have contaminated groundwater, surface water and stream sediments at several other sites in this watershed. For example:

- The abandoned Maricopa Mine along Cave Creek has discharged ore and tailings into this ephemeral wash, as evidenced by elevated chromium and lead in sediment samples.
- Surface water monitoring along Turkey Creek (a tributary of the Agua Fria River) at Golden Belt Mine exhibited contamination by arsenic, cadmium, copper, cyanide, lead and mercury.
- In the Agua Fria River headwaters: copper and mercury violations occur near Arizona Victory Mine, copper and zinc violations occur at Walker Mine, mercury violations occur at Knapp Gulch, copper violations occur at Transcendent Mine.
- Below the Holiday Girl Mine (Hassayampa River headwaters) mercury exceeds standards and dissolved oxygen is below required levels.
- Monitoring below the Senator and Cash mines in the Hassayampa River Basin indicate violations of cadmium, copper, zinc, and low pH values.
- Turbidity violations occur below Wagoner Mine.

Prior reports of groundwater and soil contamination with VOCs at Luke Air Force Base (near the Agua Fria River) have been extensively investigated. In 1993, a "record of decision" indicated that all eight soil sites had levels of contamination above the detection level but below "action levels" for remediation. The Air Force Base has decided to bio-remediate one site to eliminate any potential that contamination could spread onto adjacent private land. The investigation of groundwater contamination continues, but preliminary data indicate that contamination may be below "action levels" for remediation. A record of decision concerning groundwater contamination is to be completed in 1996.

Luke Air Force Base has also been in non-compliance with the NPDES permit for many years. In the summer of 1994 Luke will complete the construction of a six million dollar tertiary wastewater treatment plant. Initial testing indicates that the effluent will be better than surface water standards and permit requirements.

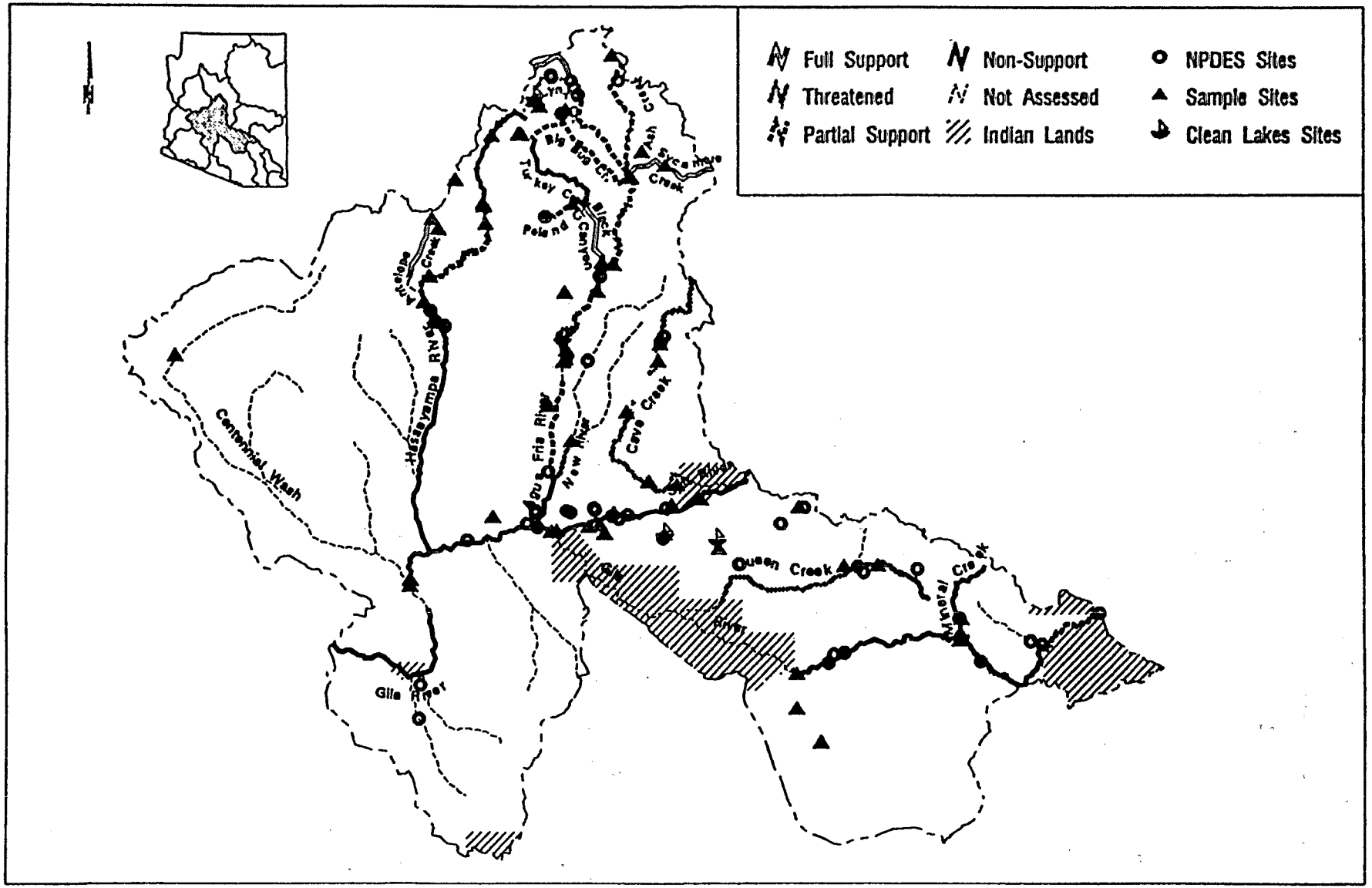
There have been documented violations of surface water quality from National Metals in Phoenix due to precipitation runoff. The runoff flows to a ditch, which discharges to the Salt River at about 31st Avenue in Phoenix. Enforcement and mitigation actions are in progress.

ADEQ's annual water compliance report has indicated that several NPDES permits in this basin have chronically been in non-compliance (see **Appendix C** for current compliance). Toxic monitoring in the Salt River by the City of Phoenix (April 1987-1989) indicated several toxics that exceeded water quality standards. However, since completion of this monitoring, a progressive pretreatment program has been established that should mitigate toxic

discharges. Therefore, this monitoring data was not used in this assessment.

The USDA is coordinating two projects: one in West Maricopa Hydrologic Unit Area and the other in the Casa Grande-Coolidge area. The purpose is to evaluate the impact of agricultural practices on groundwater quality and to assist local agricultural clientele with implementation of Best Management Practices to minimize potential for groundwater degradation. These projects are a cooperative effort between the Soil Conservation Service, Agricultural Stabilization and Conservation Service, Cooperative Extension Service, Arizona Department of Water Resources, Natural Resource Conservation Districts, and local producers.

In the Queen Creek and Eloy areas (New Magma and Central Arizona Irrigation and Drainage Districts), the Soil Conservation Service is providing accelerated technical and financial assistance to improve on-farm chemical handling facilities and irrigation systems which reduce deep percolation and runoff. The Soil Conservation Service is cooperating on this project with Natural Resource Conservation Districts, local Irrigation and Drainage Districts, and ADWR in implementing land treatment projects to address water quality and quantity concerns. A similar land treatment project is in the planning stage for the Hohokam Irrigation District.



Map 18. Middle Gila River Basin

ADEQ - 1994 (Scale 1 inch = 25 miles)

Table 22. Middle Gila River Basin 1994 Assessment Statistics

STREAMS		LAKES	
Total Miles Assessed (72 reaches)	1,006	Total Acres Assessed (7 lakes)	1,841
Full Support	171	Full Support	14
Threatened	189	Threatened	62
Partial Support	260	Partial Support	1,565
Non-support	386	Non-support	200
Top Stressors/Causes	(miles impacted)	Top Stressors/Causes	(acres impacted)
Metals	465	Metals	1,541
Salinity/TDS	214	Pesticides	200
Turbidity	212	Salinity/TDS	200
Suspended solids	165	Dissolved oxygen	200
Pathogens	135	Other habitat alterations	200
Dissolved oxygen	126		
Pesticides	118		
Top Sources	(miles impacted)	Top Sources	(acres impacted)
Agricultural activities	430	Agricultural activities	1,740
Natural	300	Natural	1,541
Hydromodification	272	Hydromodification	255
Major/Minor municipal	237	Major/Minor industrial	200
Landfills	124	Major/Minor municipal	200
Urban runoff	112	Landfills	200
Resource extraction	92		
Major/Minor industrial	99		
Stream Miles in Basin	Total: 14,164	Lake Acres in Basin	Total: 63,253
Perennial	206	Perennial	60,203
Non-perennial	13,958	Non-perennial	3,050
On Indian Lands	911	On Indian Lands	725
Not Indian Lands	13,253	Not Indian Lands	62,528

Miles and acres have been rounded to nearest whole number.
TDS = total dissolved solids.

Table 23. Middle Gila River Basin Assessments

WATERBODY ID, NAME, LOCATION	MILES OR ACRES*	EVALUATED OR MONITORED	WATER QUALITY LIMITED	TROPHIC STATUS	USE SUPPORT	BASIS OF ASSESSMENT
AZ15050100-010 Gila River, San Carlos Res.-Dripping	16	E	N		Partial	Evaluation based on upstream and downstream monitoring (AZ15050100-008) and (AZ15040005-011). NPDES permit at Coolidge dam: full compliance.
AZ15050100-009 Gila River, Dripping Spr-San Pedro	11	E	N		Non	Evaluation based on upstream and downstream monitoring (AZ15050100-008) and (AZ15040005-011 in Upper Gila River Basin). NPDES permit for AZ Dept of Correction Eyman facility: non-support due to ammonia, nitrogen, mercury, copper, silver, cadmium, and lead.
AZ15050100-008 Gila River, San Pedro-Mineral Cr	18	E	Y		Non	ADEQ Ray Mine Investigation 1990, 3 sites: non-support A&Ww, FBC due to copper, and turbidity; partial support AgI, FC due to arsenic and TDS. USGS station 1989,1 sample: partial support A&Ww, FBC, due to turbidity. 2 NPDES permits: 1) Winkleman POTW: non-support A&Ww due to phosphate, 2) Kearny POTW: full support.
AZ15050100-007 Gila River, Mineral Cr-Donnelly W	14	E	Y		Non	ADEQ (Ray Mine Inv.) 1990, 4 samples: non-support A&Ww, FBC, and AgL due to copper and turbidity, partial support FC, A&Ww, and AgI due to TDS, arsenic, and copper. Evaluation of persistence based on upstream monitoring (AZ15050100-008).
AZ15050100-005 Gila River, Donnelly W-Box O Wash	2	E	N		Non	Evaluation based on upstream monitoring (AZ15050100-007) and (AZ15050100-008).
AZ15050100-003 Gila River, Box O Wash-Queen Creek	50	E	N		90% Part 10% Non	ADEQ (Ray Mine Inv.) 1990, 1 sample: partial support FC due to arsenic. 2 NPDES permits: AZ Sierra WTP and Florence POTW: non-support due to ammonia, chlorine, mercury, and sulfide. Reach has 4 sets of designated uses: Box-O Wash to Ashurst-Hayden Dam (2.3 miles A&Ww, FBC, FC, AgI, AgL); Ashurst-Hayden Dam to Florence POTW (2.4 miles-drop AgI); Florence POTW to Feliz Rd (approx 5 miles A&Wedw, PBC, AgL); below EDW to Queen Creek (44.8 miles A&Ww, PBC, AgL). Evaluation of turbidity and sedimentation problems based on upstream sampling (AZ15050100-007).
AZ15050100-001 Gila River, Santa Cruz Wash-Salt	13				N.A.	Indian Lands: not assessed. ADEQ (upstream of Salt), 11 samples: would be non-support due to DO, turbidity. (Boron 1460-1860 mg/l, Se, SO3, and TDS high.) See AZ15070101-003.
AZ15070101-015 Gila River, Salt River-Aqua Fria River	4	M	Y		Non	ADEQ fixed station 1990-91, 14 samples: partial support FC due to mercury. Threat of FC due to arsenic and beryllium exceeding standards once (in other samples lab detection level too high). FWS/ADEQ monitoring 1980-1990 indicated fish and turtle contamination by DDT metabolites and toxaphene; sediment contamination by DDT metabolites. 1992 and 1993 spring flood erosion of the Tri-City Landfill resulted in debris in water and along stream banks (narrative violations).

Table 23. continued (Middle Gila River Basin)

WATERBODY ID, NAME, LOCATION	MILES OR ACRES*	EVALUATED OR MONITORED	WATER QUALITY LIMITED	TROPHIC STATUS	USE SUPPORT	BASIS OF ASSESSMENT
AZ15070101-014 Gila River, Agua Fria-Waterman	12	E	Y		Non	Evaluation based on upstream and downstream monitoring (AZ15070101-007) and (AZ15070101-015). Erosion of the Tri-City Landfill resulted in debris in water and deposited on stream bank. (Still cleaning up)
AZ15070101-010 Gila River, Waterman W-Hassayampa	12	E	Y		Non	Evaluation based on upstream and downstream monitoring (AZ15070101-007) and (AZ15070101-015). ADEQ Clean Lakes Program 1992, 1 deep sediment boring indicated sediment contamination with DDT metabolite below detection limit. Buckeye POTW: non-support due to boron, arsenic, mercury, copper and silver.
AZ15070101-009 Gila River, Hassayampa-15070101-016	1	E	Y		Non	Evaluation based on upstream and downstream monitoring (AZ15070101-007) and (AZ15070101-015). ADEQ Clean Lakes Program 1992, deep sediment borings did not indicate sediment contamination.
AZ15070101-008 Gila River, 15070101-016-Centennial W	10	E	Y		Non	ADEQ Clean Lakes Program 1 sediment deep boring detected DDT metabolites contamination. Evaluation based on fish and turtle contamination and downstream water monitoring (AZ15070101-007). Erosion of Tri-City Landfill resulted in floating material and debris deposits on stream bank.
AZ15070101-007 Gila River, Centennial -15070101-006	6	M	Y		Non	USGS station at Gillespie Dam 1989-93, 60 samples: Non-support A&Wedw due to Fecal coliform. Partial support FC, AgI, A&Wedw, AgI due to arsenic, boron, TDS, and turbidity. FWS/ADEQ monitoring water, fish, and sediment 1980-1990 revealed fish & turtle contamination by DDT metabolites and toxaphene in the Gila River between the Salt River and Painted Rocks Lake (Borrow Pit). DDT metabolites were also detected in the sediment. ADEQ Clean Lakes program sediment borings in 1992 indicated DDT metabolites contamination. Fish advisory in place since 1991 ADHS risk assessment. Erosion of Tri-City Landfill (located in Salt River floodplain) debris coated banks and filled stream with debris during 1993 floods.
Z15070101-005 ila River, 5070101-006)-Sand Tank	14	E			Non	ADEQ Clean Lakes Program sediment deep borings did not detect contamination of pesticides or metals. Evaluation based on fish and turtle contamination and upstream water monitoring (AZ15070101-007). NPDES for Luke Air Force Base in Gila Bend: full support.
Z15070101-003 la River, nd Tank Wash-Sau a Wash	5	E			Non	Evaluation based on upstream and downstream monitoring (AZ15070101-001) and (AZ15070101-007). Gila Bend POTW was several feet under water when Painted Rock Reservoir backed up during the 1993 floods. Gila Bend POTW: threat to A&Ww due to excess suspended solids.

Table 23. continued (Middle Gila River Basin)

WATERBODY ID, NAME, LOCATION	MILES OR ACRES*	EVALUATED OR MONITORED	WATER QUALITY LIMITED	TROPHIC STATUS	USE SUPPORT	BASIS OF ASSESSMENT
AZ15070101-001 Gila River, Sauceda Wash-Painted Rock	19	M	Y		Non	FWS/ADEQ monitoring water, fish, and sediment 1980-1990 revealed fish & turtle contamination by DDT metabolites and toxaphene in the Gila River between the Salt River and Painted Rocks Lake (Borrow Pit). DDT metabolites were also detected in the sediment. ADEQ Clean Lakes program sediment borings in 1992 indicated DDT metabolites contamination at or below detection limit. Upstream water monitoring revealed impairment (see AZ 15070101-007). Fish ban in place since 1991 ADHS risk assessment due to DDT metabolites, toxaphene, chlordane, dieldrin, and mercury. The 1993 inundation of Tri-City Landfill with flood waters left debris coating banks and filled stream with debris (much debris still present). Evaluation also based on upstream monitoring at Gillespie Dam (AZ15070101-007).
AZ15050100-012 Mineral Creek, hdwt-Gila River	17	M	Y		Non	ADEQ complaint investigation (WQMS 212.251) 1992, 9 sites water samples and 1 sediment: non-support of A&Ww due to copper and sulfide. ADEQ investigations of 2 mines (Ray Mine and Gibson Mine) 1990-1992: non-support A&Ww, FBC, AgL due to copper, zinc, and pH (low); threat support of FC due to arsenic and beryllium. ADEQ fixed station 1993, 11 samples: non-support A&Ww due to copper. EPA sample (Copper Mines Initiative) on tributary in 1992: partial support FC and FBC due to beryllium. ADEQ priority pollutant monitoring of fish and sediment: arsenic and beryllium above Health Based Guidance Levels (ADHS, 1992) for human ingestion of sediment.
AZ15050100-011 Dripping Spring Wash, hdwt-Gila River	17		N		N.A.	Insufficient data to assess stream. NPDES permit Cyprus/Miami Mine at Christmas: full compliance.
AZ15050100-010OFF9 Mescal Creek	9	E	N		Partial	BLM monitoring 1990-93, 3 samples: partial support of FBC, A&Ww, AgI, AgL due to fecal coliform.
AZ15050100-014 Queen Creek, hdwt-Witlow Canyon	17	E	N		Non	3 NPDES permits. Magma Superior and Superior Sanitary Dist: full compliance. Queen Valley Sanitary Dist.: non-support due to chlorine, fecal coliform, suspended solids, and settlable solids.
AZ15050100-013 Queen Creek, Witlow Canyon-Gila R	43	E	N		Threat	ADEQ investigation 1993, 2 sites: full support. 3 NPDES permits: Mining Camp Restaurant and Roadhaven R.V. Park in full compliance; Williams Air Force Base on tributary non-support due to zinc, mercury and bioassay.
AZ15050100-000 Weekes Wash	12	E	N		Full	ADEQ priority pollutant monitoring 1992 fish and sediment: no exceedance of Health Based Guidance Level (ADHS, 1992) or EPA fish criteria.

Table 23. continued (Middle Gila River Basin)

WATERBODY ID, NAME, LOCATION	MILES OR ACRES*	EVALUATED OR MONITORED	WATER QUALITY LIMITED	TROPHIC STATUS	USE SUPPORT	BASIS OF ASSESSMENT
AZ15060106-001 Salt River, Granite Reef-Gila River	42	M	Y		Non	This reach flows through the Phoenix metro area. ADEQ monitoring station 1990-91, 14 samples: non-support A&Wedw due to mercury, partial support A&Wedw, PBC, AgL due to pH. Tri-City Landfill eroded into Salt River in two episodes: non-support of all uses (narrative standards). NPDES permits in compliance: Phoenix 23rd Ave, Tempe POTW's, and W. Cotton Service Co. NPDES permits impairing water: AMERON Inc (settlable solids), Phoenix 91st Ave (chlorine, fecal coliform, suspended solids), Tolleson (chlorine, suspended solids, BOD), and Union Rock and Material (dichloroethene). USFWS fish, turtle, and sediment monitoring (1980-1990) indicates serious contamination by DDT metabolites and toxaphene. Fish advisory/ban below 59th Ave due to DDT, toxaphene, chlordane, dieldrin, and mercury.
AZ15060106-001OFF42 Arizona Canal, Granite Reef Dam-Skunk	40	E	N		Threat	SRP monitoring 1990-92, 20 samples: TDS threat to DWS. ADEQ priority pollutant monitoring 1992 (fish and sediment): no criteria were exceeded.
AZ15060106-001OFF Grand Canal, Crosscut Cnl-New River	24	E	N		Full	SRP monitoring at lateral 23: full support.
AZ15060106-001OFF Southern Canal, Granite Reef Dam-Consolidated	7	E	N		Partial	SRP monitoring 1990-92, 20 samples: mean of TDS exceeds secondary drinking water standard - partial support DWS.
AZ15060106-0010FF Consolidated Canal, Southern-Superstition	22	E	N		Partial	SRP monitoring 1990-91, 8 samples (few parameters): DWS partial support due to chloride and TDS exceeding secondary drinking water standards.
AZ15060106-001OFF Tempe Canal, Consolidated-Western	9	E	N		Partial	ADEQ 1993 priority pollutant monitoring of fish and sediment: beryllium contamination of sediment over Health Based Guidance Level (ADHS, 1992). SRP monitoring 1990 92, 16 samples: TDS exceeds secondary drinking water standards.
AZ15060106-001OFF Western Canal, Tempe Canal-43rd Ave, Phx	14	E	N		Full	SRP monitoring 1990-92, 20 samples: full support.
AZ15060106-001OFF Eastern Canal, Southern Cnl-Superstition	20	M	N		Full	SRP monitoring 1990-92, 20 samples: full support.

Table 23. continued (Middle Gila River Basin)

WATERBODY ID, NAME, LOCATION	MILES OR ACRES*	EVALUATED OR MONITORED	WATER QUALITY LIMITED	TROPHIC STATUS	USE SUPPORT	BASIS OF ASSESSMENT
AZ15060106-001TD Tempe Drain, hdwt-Salt River	3	E	N		Full	ADEQ priority pollutant monitoring 1993 (fish and sediment): beryllium over Health Based Guidance Level (ADHS, 1992) in sediment. ADEQ complaint investigation 1989: mercury would exceed FC level (not a protected use in drain, but sample taken as it entered Salt River).
AZ15060106-026 Cave Creek, hdwt-Arizona Canal	70	E	N		Threat	ADEQ fixed station 1992-93, 6 samples: full support. USFS/ADEQ cooperative monitoring 1991, 3 samples: full support. ADEQ/Kleinfelder 304(l) investigation @ Maricopa Mine: sediment contamination by lead and zinc. This contamination threatens A&Ww, AgI, AgL uses. Spur Cross Ranch NPDES permit: full compliance.
AZ15070102-032 Agua Fria River, hdwt-Lynx Creek	13	E	N		Full	Evaluation based on downstream monitoring (AZ15070102-023).
AZ15070102-031 Agua Fria River, Lynx Creek-Yarber Wash	16	E	N		Partial	Evaluation based on upstream and downstream monitoring. NPDES permits in full compliance: Soft Winds Mobile Home Park & Magma Copper McCabe Mine.
AZ15070102-029 Agua Fria River, Yarber Wash-Ash Creek	5	E	N		Partial	Evaluation based on downstream monitoring (AZ15070102-19) and (AZ15070101-023) and upstream on Lynx Creek (AZ15070102-033).
AZ15070102-025 Agua Fria River, Ash Creek-Sycamore Cr	1	E	N		Partial	Evaluation based on downstream monitoring (AZ15070102-023) and upstream (AZ15070102-033).
AZ15070102-023 Agua Fria River, Sycamore Creek-Big Bug Creek	10	E	N		Partial	BLM monitoring 1993, 1 sample: partial support FBC, A&Ww, DWS, AgI, AgL due to fecal coliform source probably open range grazing. ADEQ biocriteria site (phys/chem monitoring) 1 sample: full support. Evaluation of partial support FC due to arsenic based on upstream and downstream monitoring (lab detection levels at these sites 3 times the standard).
AZ15070102-022 Agua Fria River, Big Bug Creek-Squaw Cr	11	E	N		Partial	Evaluation based on upstream monitoring (AZ15070101-023) and in tributaries.
AZ15070102-020 Agua Fria River, Squaw Ck.-Black Canyon	3	M	N		Partial	Evaluation based on downstream monitoring (AZ15070102-019).

Table 23. continued (...iddle Gila River Basin)

WATERBODY ID, NAME, LOCATION	MILES OR ACRES*	EVALUATED OR MONITORED	WATER QUALITY LIMITED	TROPHIC STATUS	USE SUPPORT	BASIS OF ASSESSMENT
AZ15070102-019 Agua Fria River, Blk Cyn.Ck.-Little Squaw	4	M	Y		Partial	USGS station at Rock Springs 1989-92, 48 samples: Partial support FC and A&Ww due to arsenic and low DO; threats to FBC and A&Ww due to fecal coliform and turbidity (violations occur consistently in August during monsoon rain flows). ADEQ special investigations in 1990 indicate partial support FC due to arsenic. BLM monitoring 1993, 1 sample: partial support FBC, A&Ww, AgI, AgL due to fecal coliform.
AZ15070102-017 Agua Fria River, Ld Squaw Ck-Cottonwood	6	E	N		Partial	Evaluation based on upstream and downstream monitoring (AZ15070101-007) and (AZ15070102-019).
AZ15070102-016 Agua Fria River, Cottonwood Ck-Humbug	6	E	N		Partial	Evaluation based on upstream and downstream monitoring (AZ15070101-007) and (AZ15070102-019).
AZ15070102-015 Agua Fria River, Lake Pleasant-Humbug Cr	1	E	N		Partial	Evaluation based on upstream and downstream monitoring (AZ15070101-007) and (AZ15070102-019).
AZ15070102-014 Agua Fria River, Humbug Cr-Lake Pleasant	1	E	N		Partial	Evaluation based on upstream and downstream monitoring (AZ15070102-019) and (AZ15070102-008).
AZ15070102-008 Aqua Fria River, Lake Pleasant-Beardsly Canal	5	M	Y		Threat	USGS station 1989-92, 15 samples: partial support FC due to arsenic. USBR New Wadell Dam NPDES permit: full compliance.
AZ15070102-007 Aqua Fria River, Beardsly Canal-New River	20	E	N		Partial	Evaluation based on upstream monitoring (AZ15070102-008). Luke Air Force Base NPDES discharge on unnamed tributary: threat to this reach due to ammonia, chlorine, mercury, boron sulfide, selenium and zinc exceedances of permit levels. ADEQ priority pollutant monitoring of fish and sediments: arsenic and beryllium exceeded HBGLs for human ingestion of sediment.
AZ15070102-001 Agua Fria River, New River-Gila River	8	E	N		Non	Evaluation based on upstream monitoring (AZ15070102-008). Avondale POTW: nonsupport due to nitrogen and several phenols. Loral Corporation (on Buckeye Canal): nonsupport due to bromoform, tetrachloroethene, dichloroethan, trichloroethane, grease/oil, and copper. Goodyear POTW: partial support due to settable solids and fecal coliform.
AZ15070102-034 Big Bug Creek, hdwt-Aqua Fria River	27	E	N		Partial	BLM monitoring 1993, 1 bacteria sample: partial support FBC, A&Ww, AgI, AgL (open range grazing believed the source).

Table 23. continued (Middle Gila River Basin)

WATERBODY ID, NAME, LOCATION	MILES OR ACRES*	EVALUATED OR MONITORED	WATER QUALITY LIMITED	TROPHIC STATUS	USE SUPPORT	BASIS OF ASSESSMENT
AZ15070102-033 Lynx Creek, hdwt-Agua Fria River	15	E	N		Threat	ADEQ priority pollutant monitoring (fish and sediment): sediment contamination with arsenic, lead, and beryllium exceeding HBGLs (ADHS, 1992). USFS/ADEQ monitoring 1991, 2 samples: full support. Prescott Natl. Forest abandoned mine survey 1990, 5 sites: full support. ADEQ complaint investigation (water and soil): full compliance (arsenic would be high for fish consumption). 3 of 4 NPDES permits in full compliance. Only Villages at Lynx Creek in non-support A&Ww due to excess chlorine.
AZ15070102-033OFF Knapp Gulch, hdwt-Lynx Creek	2	E	N		Threat	Prescott National Forest abandoned mines survey 1990: full support.
AZ15070102-031OFF Galena Gulch, hdwt-Agua Fria River	6	M	Y		Non	Magma Copper Co monitoring (Hargis & Assoc) 1990-93: sediments contaminated with chromium, lead and zinc (lead exceeds ADHS's Health Based Guidance Level for consumption). Water samples in cistern and below tailings ponds indicate non-support of A&Ww and AgL due to lead and cyanide.
AZ15070102-028 Ash Creek, hdwt-Yellow Jacket	25	E	N		Partial	ADEQ biocriteria site (phys/chem monitoring) 1992, 1 sample: full support. BLM monitoring 1993, 1 sample 1993: partial support FBC due to fecal coliform believed caused by open range grazing.
AZ15070102-026OFF Little Ash Creek, hdwt-Ash Creek	15	E	N		Partial	ADEQ biocriteria site (phys/chem monitoring) 1992-93, 2 samples: partial support A&Ww due to low dissolved oxygen.
AZ15070102-024 Sycamore Creek, hdwt-Agua Fria River	16	E	N		Full	ADEQ biocriteria site (phys/chem monitoring) 1992-93, 2 samples: full support.
AZ15070102-022OFF Lousy Canyon, hdwt-Agua Fria	5	E	N		Partial	BLM monitoring 1993, 1 sample: partial support FBC due to fecal coliform (probable source: open range grazing).
AZ15070102-022OFF Silver Creek, hdwt-Agua Fria	14	E	N		Full	BLM monitoring 1993, 1 sample: full support.
AZ15070102-022OFF Indian Creek, hdwt-Agua Fria	12	E	N		Partial	BLM monitoring 1993, 2 samples: partial support A&Ww, FBC, AgI, AgL and DWS due to fecal coliform (probable source: open range grazing).
AZ15070102-035 Black Canyon Ck., hdwt-Aqua Fria River	15	E	N		Full	ADEQ station BCC1 1993, 2 samples: full support. BLM monitoring 1993, 1 sample (bacteria only): no exceedance.

Table 23. continued (Middle Gila River Basin)

WATERBODY ID, NAME, LOCATION	MILES OR ACRES*	EVALUATED OR MONITORED	WATER QUALITY LIMITED	TROPHIC STATUS	USE SUPPORT	BASIS OF ASSESSMENT
AZ15070102-035OFF Dripping Spring, hdwt-Black Canyon	3	E	N		Full	BLM monitoring 1993, 1 sample: full support.
AZ15070102-035OFF Rock Springs Creek, hdwt-Black Canyon	3	E	N		Partial	ADEQ complaint investigation (WQMS 212.283) 1993, 2 samples: partial support of PBC and AgL due to arsenic (FC not a use here).
AZ15070102-037 Poland Creek, hdwt-Black Canyon	8	E	N		Partial	ADEQ biocriteria site (phys/chem monitoring) 1992, 1 sample: full support. USFS/ADEQ cooperative monitoring 1991, 2 samples: full support. USFS Crown King facility in Prescott Natl Forest: partial support due to chlorine (facility closed due to continued violations during this period).
AZ15070102-036 Turkey Creek, hdwt-Poland Creek	18	E	Y		Non	Prescott National Forest/Labat-Anderson 1990 monitoring 3 sites (total of 7 samples): non-support FBC, AgI, AgL, and A&Ww due to arsenic, cadmium, copper, cyanide, lead and zinc; partial support of FBC due to antimony. USFS/ADEQ monitoring 1991, 3 samples: full support.
AZ15070102-016OFF Tule Creek, hdwt-Agua Fria	8	E	N		Full	BLM monitoring 1993, 1 sample: full support. ADEQ biocriteria site (phys/chem monitoring) 1 sample: partial support FC due to arsenic.
AZ15070102-042OFF Ad Wash, hdwt-Castle Creek	2	E	N		Full	BLM monitoring 1993, 1 sample: full support.
AZ15070102-006 New River, hdwt-Deadman Wash	34				N.A.	Not enough information to assess. USBR New River Dam NPDES permit: full compliance.
AZ15070102-002 New River, Skunk Wash-Aqua Fria	12	E	N		Threat	ADEQ hazardous materials investigation in 1991 of auto shredder materials: soil contamination with cadmium and lead.

Table 23. continued (Middle Gila River Basin)

WATERBODY ID, NAME, LOCATION	MILES OR ACRES*	EVALUATED OR MONITORED	WATER QUALITY LIMITED	TROPHIC STATUS	USE SUPPORT	BASIS OF ASSESSMENT
AZ15070103-007 Hassayampa River, hdwt-Blind Indian Ck.	25	E	Y		Non	ADEQ fixed stations above and below Senator Mine: full support above (although threatened by metals and turbidity) and non-support of uses below due to cadmium, copper pH, zinc, and turbidity; partial support due to lead. ADEQ biocriteria site (phys/chem monitoring) and USFS site, 5 samples: full support. ADEQ priority pollutant sediment sample: arsenic, antimony, beryllium, cadmium, lead, and zinc exceed HBGL for human ingestion of sediments below Senator Mine. ADEQ monitoring in 1990 on unnamed wash to McCleur Mine also indicates non-support due to heavy metals, low DO, and low pH. ADEQ investigation Senator Mine 1993, 2 sites sampled twice: non-support of most uses due to pH, Zinc, Copper and cadmium; sediment samples: lead and aluminum exceed Health Based Guidance Levels (ADHS, 1992). ADEQ investigation of Cash Mine on unnamed tributary 1990-1993, 3 samples: non-support AgL, A&Ww, FBC due to cadmium, copper, pH, and zinc.
AZ15070103-005 Hassayampa River, Blind Indian-Cottonwood	1	E	N		Threat	Evaluation based on upstream monitoring (AZ15070103-007).
AZ15070103-004 Hassayampa River, Cottonwood Cr-Martinez	26	M	Y		Partial	ADEQ station 1990-93, 23 samples: partial support FBC and A&Ww due to turbidity (suspended solids). ADEQ WQARF investigation of Wickenburg Mill 1991 set of 2 samples: full support.
AZ15070103-003 Hassayampa River, Martinez Wash-Sols Wash	1	E	Y		Non	ADEQ investigation of Vulture Mill (WQMS 212.236) 1992, 6 sites: non-support A&Ww, FBC, AgI, AgI due to ammonia, boron, cadmium, copper, lead, manganese, mercury, pH (high), selenium; partial support due to turbidity.
AZ15070103-002 Hassayampa River, Sols Wash-Jackrabbit	40	M	Y		Non	ADEQ station 1990-91, 10 samples: A&Ww non-support due to low dissolved oxygen; threat to FBC & A&Ww due to turbidity. ADEQ biocriteria site (phys/chem monitoring) 1992-93, 2 samples: full support. ADEQ priority pollutants fish and sediment: ok. 2 NPDES permits, both full compliance.
AZ15070103-001 Hassayampa River, Jackrabbit-Gila River	15	E	Y		Non	ADEQ Clean Lakes 1992 deep sediment borings: DDT metabolites present. Monitoring of fish and sediments 1980-1990 by FWS (and others) indicated fish and soft shelled turtles contaminated by DDT and toxaphene (at levels that should interfere with reproduction in some species), sediment contaminated by DDT metabolites. Fish ban since 1991 due to chlordane, dieldrin, ddt metabolites, toxaphene, and mercury.
AZ15070103-010 Antelope Creek, Dd-Martinez Creek	17	E	N		Full	ADEQ biocriteria site (phys/chem monitoring) 1992-93, 2 samples: full support.

Table 23. continued (Middle Gila River Basin)

WATERBODY ID, NAME, LOCATION	MILES OR ACRES*	EVALUATED OR MONITORED	WATER QUALITY LIMITED	TROPHIC STATUS	USE SUPPORT	BASIS OF ASSESSMENT
AZ15070103-007OFF French Gulch, hdwt-Hassayampa	9	M	Y		Non	ADEQ Zonia Mine investigations (WQMS 212.068) monitoring 1989-93, 22 samples: non-support all uses due to beryllium, cadmium, copper, manganese, mercury, low pH, zinc, and TDS. ADEQ priority pollutant program 1993 sediment sample: arsenic and beryllium exceeded HBGLs for human ingestion of sediment.
AZL15060106-0050 Alvord Park Lake	25	E	N	E	Partial	Priority pollutant sediment monitoring 1992: arsenic and beryllium exceeded HBGLs for sediment consumption. AGFD monitoring 1988-92, 3 samples: A&Ww partial support due to turbidity.
AZL15060106-0300 Chaparral Park Lake	11		N		N.A.	Not assessed for water chemistry. ADEQ priority pollutant monitoring 1992 fish and sediment: arsenic and beryllium exceeded HBGL for sediment ingestion.
AZL15070103-3160 Hassayampa Lake	1	E	N		Threat	ADEQ Priority Pollutant monitoring 1993 fish and sediment: arsenic, beryllium, and lead exceeding HBGL (ADHS) for sediment ingestion by humans.
AZL15060106-0740 Kiwanis Park Lake	14	E	N	M	Full	ADEQ priority pollutant program 1992 fish and sediment: arsenic exceeded HBGL for sediment consumption. AGFD (limited data) 1989-91: full support.
AZL15070102-0860 Lynx Lake	55	E	N	M	Threat	ADEQ Clean Lakes Program 1992, 6 samples: full support. ADEQ Priority Pollutant Program 1992 sediment and 1993 sediment & fish: arsenic, lead, and beryllium above Health Based Guidance Levels (ADHS, 1992) for ingestion of soil.
AZL15060106-0920 McKellips Park Lake	6	E	N		Threat	McKellips Park Lake. ADEQ Priority Pollutant Program 1992 sediment samples: arsenic and beryllium exceeded HBGLs (ADHS, 1992) for human ingestion of sediment. AGFD monitoring 1992 (limited parameters): full support.

Table 23. continued (Middle Gila River Basin)

WATERBODY ID, NAME, LOCATION	MILES OR ACRES*	EVALUATED OR MONITORED	WATER QUALITY LIMITED	TROPHIC STATUS	USE SUPPORT	BASIS OF ASSESSMENT
AZL15070101-1020 Painted Rock Reservoir	200	M	Y		Non	ADEQ Clean Lakes Diagnostic/Feasibility Study 1993 concluded that reservoir sediments contain low levels of DDE and metals when compared to Health Based Guidance Levels for ingestion of sediments. But prior fish and turtle tissue analysis (FWS studies in 1980s) indicated bioconcentration of DDE and toxaphene at levels of concern for wildlife. ADHS Health Risk Assessment for Painted Rocks and Gila River 1991 resulted in a fish ban and a warning that there was a cancer risk associated with fish consumption. Monitoring by Corps of Engineers and USFWS 1992-93 18 samples: partial support A&Ww due to low DO (no metals or organics tested). Evaluation of water quality based on upstream and downstream monitoring (AZ15070201-1010) and (AZ15070101-007). Erosion of Tri-City Landfill in January 1992 and 1993 floods resulted in non-support due to narrative violations (debris in water and accumulating on stream banks).
AZL15070102-1100 Pleasant, Lake	1540	E	N	M	Partial	ADEQ Clean Lakes Program 1992, 2 samples: FC partial support due to arsenic. USFWS Bald Eagle Prey Study (King et al., 1993): fish contaminated above EPA levels of concern for mercury. ADEQ Priority Pollutant Program 1992 fish and sediment: no exceedance of criteria. USGS station at Lake Pleasant 1991, 1 sample: partial support FC due to arsenic.

Notes: Water Quality Limited Waterbodies are included on the Clean Water Act 303(d) list and prioritized for completion of Total Maximum Daily Load analyses.
Trophic status of lakes include: Oligotrophic (O) = nutrient poor, biologically unproductive; Mesotrophic (M) = intermediate nutrient availability and biological productivity; and Eutrophic (E) = nutrient rich, highly productive; Hypereutrophic (H) = pea-soup conditions, the extreme end of the eutrophic stage.
Miles and acres rounded to nearest full number.
Monitored or Evaluated = type of assessment based on amount of data available.

Appendix F

305(b) Reporting for Indian Tribes

APPENDIX F

305(b) REPORTING FOR INDIAN TRIBES

EPA encourages Tribes and Tribal groups with monitoring and assessment programs to submit 305(b) reports. Benefits of participating in the 305(b) process include

- The Tribe assesses its monitoring data in a way that is meaningful to decisionmakers.
- The 305(b) report is a public information tool documenting Tribal actions to protect waterbodies.
- The report calls national attention to special issues such as fish tissue contamination from toxic chemicals and ground water contamination.
- The process offers an opportunity for Tribal and State technical staff to coordinate assessments.
- The 305(b) report is a good vehicle for recommending actions to EPA to achieve the objectives of the Clean Water Act and protect Tribal waterbodies.

This appendix describes a level of reporting that may be appropriate for a Tribe's first-time 305(b) report. For details about the various topics, see the main body of this *Guidelines* document. **In addition, EPA has prepared a booklet about Tribal 305(b) reporting -- *Knowing Our Waters: Tribal Reporting Under Section 305(b)* (EPA, 1995). The booklet is available from the EPA Regional 305(b) Coordinators listed inside the front cover of these *Guidelines*.**

If all topics cannot be covered in a Tribal 305(b) report, EPA encourages Tribes to present available information in whatever form is appropriate -- tabular, narrative, or graphical (map) format. EPA also encourages Tribes to coordinate with State and Federal water quality agencies including the EPA Regions on topics such as assessment methods, data sharing, and common boundary waters. Each State and EPA Region has a 305(b) Coordinator. State, Territory, and Tribal 305(b) Coordinators are listed inside the back cover of these *Guidelines*.

It may be mutually beneficial for Tribes and States to collaborate on assessments and reporting. For example, common assessments would be appropriate for shared water resources. Opportunities for collaboration would need to be evaluated by each Tribe on a case-by-case basis.

Following are the major sections and contents of a Tribal 305(b) report. If the terms are not familiar to you, please refer to Sections 3 through 5 of the main body of these *Guidelines* and to *Knowing Our Waters: Tribal Reporting under Section 305(b)* (EPA, 1995).

EXECUTIVE SUMMARY/OVERVIEW

Provide a brief narrative overview of surface and ground water quality on Tribal lands, including:

- Summary of degree of designated use support
- Causes (pollutants/stressors) and sources of water quality impairments
- Programs to correct impairments
- Monitoring programs, issues of special concern, and Tribal initiatives
- A map showing reservation boundaries, waterbodies, monitoring sites

BACKGROUND

Complete as much of the Atlas table (Table F-1) as possible.

SURFACE WATER ASSESSMENT

Surface Water Monitoring Program

- Brief description of the program including:
  - Monitoring design used by the Tribe (e.g., fixed stations; toxics monitoring; biological monitoring)
  - Parameters (e.g., pollutants) and sampling frequency for each type of monitoring
  - References for written protocols (field, lab, assessment)
  - Description of quality assurance/quality control (QA/QC) program
  - Data management
  - Changes in program since last assessment
  - Reporting other than 305(b)

- Cooperative efforts with State and Federal agencies
- Training received and given
- Volunteer monitoring

Assessment Methodology and Water Quality Standards

- Description of methods to assess water quality data for use support (fully, partially, not supporting); use of a detailed flow chart is encouraged. See Sections 3 - 5 of these *Guidelines* for recommended approaches.
- Description of water quality standards used for assessments, including Tribal standards

Water Quality Assessment Summary

- For streams and rivers, complete Tables F-2, F-3, and F-4 for all appropriate designated uses, causes, and sources of impairment. If mileage cannot be quantified, describe causes and sources in narrative form. (See *Knowing Our Waters* for examples; see Section 3 of these *Guidelines* for details).
- For lakes, prepare tables similar to Tables F-2, F-3, and F-4 for all appropriate designated uses, causes, and sources of impairment. Use units of acres; if acreage cannot be quantified, describe causes and sources in narrative form.
- Provide map/maps color coded or shaded to show degree of use support (full, partial, threatened, not supporting) for waterbodies on Tribal lands. Show designated uses of importance to the Tribe for which data are available (e.g., aquatic life, fish consumption, swimming)
- For other waterbody types such as estuaries or coastlines for which assessments are available, report in narrative form or in tables similar to Tables F-2, F-3, or F-4.
- If information is available on wetlands (extent, degree of use support, or impairment), report using tables from Section 7 (Part III Chapter 6) of the *Guidelines* or in narrative form; report on any wetland protection activities in narrative form

Public Health/Aquatic Life Concerns

To the extent possible, provide information on the public health and aquatic life impacts of toxicants and non-toxic contamination including:

- Significant impairments from point and nonpoint sources
- Areas of special concern due to toxics in fish tissue
- Pollution-caused fish kills/abnormalities
- Sites of known sediment contamination
- Restrictions on surface drinking water supplies
- Incidents of waterborne disease during this reporting cycle
- Other aquatic life impacts of pollutants and stressors (e.g., reproductive interference, threatened or endangered species impacts)

Tribes may present this information in narrative or tabular form (see Section 7, Part III/Chapter 7). Tribes are encouraged to discuss the nature and limits of the monitoring effort from which these data were derived, and to place these impacts in perspective as compared to other water quality problems.

Water Quality Inventory

Either in this section or in an appendix, provide a listing or inventory of Tribal waterbodies, including waterbody name, identification number, size, degree of use support, causes, sources, and needed control measures. Table F-5 shows the requested information with examples of waterbody-specific data. Tribes may use EPA's PC Waterbody System (WBS) to track this information and other data for management purposes. Contacts for WBS are the EPA Regional 305(b) Coordinators and John Clifford, EPA National Waterbody System Coordinator, (202) 260-3667.

GROUND WATER ASSESSMENT

Provide narrative or tabular description of ground water aquifers under Tribal lands, including:

- Major uses of ground water from each aquifer (e.g., Tribal- or State-designated uses, if any)
- Numeric ground water standards, if any

- Population using the aquifer
- Summary results of ground water monitoring, by parameter

Tribes should also describe the type and extent of ground water monitoring on tribal lands, including maps if possible. Section 8 of these *Guidelines* describes recommended indicators for different types of ground water monitoring.

WATER POLLUTION CONTROL PROGRAMS

Provide a narrative overview of point and nonpoint source control programs in whatever level of detail the Tribe chooses. If this information is supplied to EPA elsewhere, briefly summarize those documents. Also, discuss special Tribal concerns and any strategies planned or implemented for addressing these concerns. Give site-specific examples where possible. Finally, provide recommendations to EPA regarding additional actions needed to achieve the objectives of the Clean Water Act and protect tribal waterbodies. Examples include additional monitoring, training in assessment or data management, and improved methods for fish consumption advisories.

Table F-1. Atlas of Tribal Resources (complete to the extent possible)

Topic	Value
Surface area of Tribal lands[a]	
Tribal population residing on these lands	
Total miles of rivers and streams on Tribal lands - Miles of perennial rivers/streams (subset) - Miles of intermittent (non-perennial) streams (subset) - Miles of ditches and canals (subset) - Border miles of shared rivers/streams (subset)	
Number of lakes/reservoirs/ponds on Tribal lands[b]	
Acres of lakes/reservoirs/ponds on Tribal lands[b]	
Acres of freshwater wetlands on Tribal lands	
Acres of tidal wetlands on Tribal lands	
Square miles of estuaries/harbors/bays	
Miles of ocean coast	
Miles of Great Lakes shore	

[a] Please define the boundaries of the land and waters under Tribal jurisdiction and included in this report; use a map and/or text descriptions.

[b] Impoundments should be classified according to their hydrologic behavior, either as stream channel miles under rivers, or as total surface acreage under lakes/ponds, but not under both categories. In general, impoundments should be reported as lakes/reservoirs/ ponds unless they are run-of-river impoundments with very short retention times

Table F-2. Individual Use Support Summary[a]

Type of Waterbody: Rivers and Streams[b]

Use	Size Supporting	Size Supporting but Threatened[c]	Size Partially Supporting	Size Not Supporting	Size Not Attainable	Size Unassessed
Fish Consumption						
Shellfishing						
Aquatic Life Support						
Swimming						
Secondary Contact						
Drinking Water Supply						
Cultural/Ceremonial Uses						
Agriculture						
Tribe Defined: 1 2 3 4 5 6						

[a] Prepare one table for rivers and streams, a separate table for lakes, and others for estuaries, coastline and wetlands, as appropriate.

[b] Reported in miles; in the other tables use acres for lakes, square miles for estuaries, miles for coastal waters, and acres for wetlands.

[c] Size threatened is a distinct category of waters and is not a subset of the size fully supporting uses. See Section 3.2.

Note: Tribe defined codes should be established for any important uses that are not included above. Examples of such uses could include Outstanding Resource Waters, Aesthetics, and Industry. To the extent possible, attempt to group waters into the eight general categories of use. Where waterbodies have multiple uses, the appropriate waterbody length/area should be entered in each applicable category.

Table F-3. Total Sizes of Impaired Waters, by Cause Category[a]

Type of waterbody: Rivers and Streams[a]

Cause Category	Size of Waters Impaired[b]
Cause unknown	
Unknown toxicity	
Pesticides	
Priority organics	
Nonpriority organics	
Metals	
Ammonia	
Chlorine	
Other inorganics	
Nutrients	
pH	
Siltation	
Organic enrichment/low DO	
Salinity/TDS/chlorides	
Thermal modifications	
Flow alterations	
Other habitat alterations	
Pathogen indicators	
Radiation	
Oil and grease	
Taste and odor	
Suspended solids	
Noxious aquatic plants	
Filling and draining	
Total toxics	
Turbidity	
Filling and draining	
Exotic species	
Other (specify)	

[a] Prepare one table for rivers and streams, a separate table for lakes, and others for estuaries, coastlines, and wetlands as appropriate.

[b] Reported in miles for rivers and streams. When preparing similar tables for other waterbody types, use the following units: lakes, acres; estuaries, square miles; coastal waters and Great Lakes, shore miles; wetlands, acres.

Table F-4. Total Sizes of Impaired Waters Affected by Various Source Categories[a]

Type of Waterbody: (Rivers and Streams)

Source Category	Size of Waters Impaired [b]
Point Sources	
Industrial Point Sources	
Municipal Point Sources	
Agricultural Point Sources (e.g., feedlots)	
Combined Sewer Overflows	
Nonpoint Sources	
Agriculture	
Silviculture	
Construction	
Urban Runoff/Storm Sewers	
Resource Extraction	
Land Disposal	
Hydromodification/Habitat Modification	
Contaminated Sediments [c]	
Atmospheric Deposition	
Unknown Source	
Natural Sources[d]	
Other (specify) [e]	

[a] Prepare one table for rivers and streams, a separate table for lakes, and others for estuaries, coastlines, and wetlands as appropriate.

[b] Reported in miles for rivers and streams. When preparing this table for other waterbody types, use the following units: lakes, acres; estuaries, square miles; coastal waters and Great Lakes, shore miles; wetlands, acres.

[c] Bottom sediments contaminated with toxic or nontoxic pollutants; includes historical contamination from sources that are no longer actively discharging. Examples of contaminants are PCBs, metals, nutrients (common in lakes with phosphorus recycling problems), sludge deposits.

[d] Sources not due to human influence; e.g., naturally-occurring low flow or drought, natural deposits resulting in high metals or salinity. See Section 3 of *Guidelines*.

[e] List additional sources known to cause impairment.

Note: See Sections 3 and 7 of the full 305(b) *Guidelines* for more information.

Table F-5. Examples of Waterbody-Specific Assessment Data for Tribal 305(b) Reporting

Waterbody Name	Water-body ID	Description	Total Size*	Size Impaired	Designated Use	Degree of Use Support	Causes	Sources	Type of Assessment	Comments
Mill Creek	TT-001	Source to mouth	10 mi	6 mi	Aquat. Life Ceremonial	Nonsupport Nonsupport	DO, pH, nutrients, sediment	Agric., Munic. WWTP	Fixed-station chemical monitoring	Need WWTP upgrade
Sky Lake	TT-002	Entire lake	50 ac	0 ac	Aquat. Life Drink.Water	Full Support Full Support			Creel survey; drinking water data	
Back River	TT-003	Downstream of Giant Mine	50 mi	25 mi	Aquat. Life Fish Consump.	Partial Sup. Nonsupport	Metals, pesticides	Mine tailings, agric.	Fish tissue data; biosurvey	Fish consump. advisory for mercury, lead
Spring Branch	TT-004	Source to mouth	15 mi	15 mi	Aquat. Life Swimming	Nonsupport Full Support	Sediment, nutrients	Agric., streambank modification	Biosurvey; bacteria sampling	Streambank stabilization needed

*Use miles for rivers, streams, and coastline; acres for lakes; square miles for estuaries;
WWTP = wastewater treatment plant

Appendix G

Definitions of Selected Source Categories

Selected Definitions of Source Categories

The following is a selection of Source Category definitions (from the list presented in Table 1-3 of the Guidelines Supplement).

0212, 0222 Dry Weather Discharges (Municipal Point Sources): All municipal point source discharges except wet weather discharges.

0214, 0224 Wet Weather Discharges (Municipal Point Sources): Municipal point source discharges that occur during wet weather, caused by infiltration and inflow, operation and maintenance problems, etc.

0500 Collection System Failure: Overflow from non-combined sewer systems, caused by infrastructure problems, heavy loads during wet weather, etc.

1050 Crop-related Sources* (Agriculture): Land used for the production of adapted crops for harvest, including row crops, small-grain crops, hay crops, nursery crops, orchard crops, and other specialty crops. The land may be used continuously for these crops or they may be grown in rotation with grasses and legumes.

1350 Grazing-related Sources (Agriculture):

***1400 Pasture Grazing*:** Land used primarily for production of introduced or native forage plants for livestock grazing. Management usually consists of cultural treatments — fertilization, weed control, reseeding, or renovation — and control of grazing.

***1500 Range Grazing*:** Land on which the climax or potential plant cover is composed principally of native grasses, grass-like plants, forbs, or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. This would include areas where introduced hardy and persistent grasses such as crested wheat grass are planted and practices such as deferred grazing, burning, chaining, and rotational grazing are used with little or no chemicals or fertilizers being applied.

1600 Intensive Animal Feeding Operations (Agriculture):

***1620 Concentrated Animal Feeding Operations (CAFOs; permitted point source)*:** A lot, yard, corral, building, or other area in which animals are confined, fed, and maintained for some duration throughout the year where discharges are regulated through the National Pollutant Discharge Elimination System.

***1640 Confined Animal Feeding Operations (nonpoint source)*:** A lot, yard, corral, building, or other area in which animals are confined, fed, and maintained for some duration throughout the year that is considered a nondischarge system according to the Clean Water Act.

5900 Abandoned Mining (Resource Extraction): Abandoned mining sites that persist as sources of pollution, where the mines are no longer in use and no responsible party has been identified.

5950 Inactive Mining (Resource Extraction): Inactive mining sites that persist as a source of pollution, where a responsible party has been identified.

6350 Inappropriate Waste Disposal/Wildcat Dumping (Land Disposal): Dumping or other disposal of liquid or solid waste that runs off into waters.

7000 Hydromodification: Alteration of the hydrologic characteristics of coastal and noncoastal waters, which in turn could cause degradation of water resources.

7550 Habitat Modification (other than Hydromodification): Changes in a habitat that make it less suitable for the organisms inhabiting it, create conditions favorable to invasion by species not present prior to the changes, or limits its ecosystem function.

8050 Erosion from Derelict Land: Erosion from land formerly used for another purpose, such as cropland, pastureland, rangeland, etc.

8520 Debris and Bottom Deposits: Bottom debris deposited in waters by unknown parties (i.e., construction debris, car bodies, mattresses, grocery carts, etc.)

8530 Internal Nutrient Cycling (Primarily Lakes): The process by which historically deposited nutrients are released into surface waters, causing periodic algal blooms or other water quality impairment. The source of the nutrients has not been identified or no longer exists.

8540 Sediment Resuspension: The process by which historically deposited sediments periodically re-enter the water column.

8600 Natural Sources: Those sources of pollution *not* due to past or present human activity. Such sources include: natural mineral salt deposits; naturally occurring metal deposits; naturally occurring poor aeration or natural organic materials; glacial till or glacial flour; catastrophic floods that are excluded from water quality standards or other regulations; and catastrophic droughts with flows less than design flows in water quality standards. The natural sources category does not include, for example, water diversions; drainage from abandoned mines; stormwater runoff; and other impacts where human-induced conditions are a factor.

9050 Sources Outside State Jurisdiction or Borders: Sources of pollution originating across State lines or outside of a State's jurisdiction (i.e., BLM lands, USDA National Forests, Native American reservations, etc.).

* Definitions adapted from the *Instructions for Collecting 1992 Natural Resources Inventory Sample Data*

Appendix H

Data Sources for 305(b) Assessments

APPENDIX H

DATA SOURCES FOR 305(b) ASSESSMENTS

The main purpose of this appendix is to identify data sources that may be useful for assessing use support in State waterbodies, including sources that may not be commonly used by State water quality agencies.

The sources discussed below are Federal and nongovernmental data sources; States will find additional data available from such State agencies as fish and wildlife agencies, State planning offices, departments of health, and others.

H.1 EPA Databases

Table H-1 lists EPA databases that may prove useful for assessing use support in State waterbodies. Each of these systems can be accessed through EPA's National Computer Center mainframe computer. The national data systems in Table H-1 vary in data completeness and data quality; such characteristics should be evaluated for a given State before a system is used for assessing use support. The most complete and reliable national data systems tend to be those in which the State regularly updates information (e.g., STORET, the WBS, and the Permit Compliance System (PCS) in many States), and for which rigorous quality assurance features have been incorporated (e.g., the Reach File and ODES). Most of the information in Table H-1 is taken from the *Office of Water Environmental and Program Information Compendium* FY92, EPA 800-B92-001.

EPA's Assessment and Watershed Protection Division is distributing WBS96 shortly after distribution of these *Guidelines*. EPA specifically designed the WBS to store use support assessments for individual waterbodies and generate summary information requested in this guidance. The WBS differs from other databases in that the WBS does not contain raw data. Instead, the WBS contains use support assessment information resulting from analysis of the raw monitoring data from the States.

H.2 Other Data Sources

Table H-2 lists sources of information available from agencies and organizations other than EPA. Many of these sources are readily available but may not be used by State water quality programs. Many State water

quality agencies rely on a combination of EPA data systems and their own systems for acquiring water quality data. Reliable data on rural sources are especially difficult to obtain in many States. The best information often comes from State departments of agriculture, which compile county statistics annually and make them available relatively quickly (e.g., data on crop and livestock production). Data on crop cover, agricultural BMPs, and animal units are typically available only as county summaries, although hard copy files and maps showing exact locations may be available at the Soil and Water Conservation District level.

Databases maintained by the U.S. Department of Interior (DOI) may be of special interest to State water quality agencies; several are listed in Table H-2. The U.S. Geological Survey (USGS) Water Resources Division coordinates USGS databases through its National Water Data Exchange (NAWDEX) Program Office. For more information, States may contact the local NAWDEX Assistance Center in their USGS Water Resources District Office, or call the national NAWDEX Program Office at (703) 648-5684.

The DOI's Fish and Wildlife Service has many relevant monitoring and assessment programs including the National Wetlands Inventory and the National Contaminant Biomonitoring Program. Table H-2 gives brief descriptions and contacts for these and other programs.

The National Oceanic and Atmospheric Administration, through its National Status and Trends Program, assesses the levels of 70 organic chemicals and trace elements in bottom-dwelling fish, sediments and mollusks at more than 300 sites throughout the United States. Table H-2 presents some major components of the Program and contacts.

Table H-1. EPA Data Systems Containing Water Information

Data System	Description	Primary Function	Contact
Waterbody System (WBS) EPA, Office of Wetlands, Oceans, and Watersheds (OWOW)	Database of assessment information drawn from CWA 305(b) activities	Provides waterbody-specific information on pollution causes and sources, use impairments, and status of TMDL development	Barry Burgan, OWOW (202) 260-7060
Reach File EPA, OWOW	Hydrologic georeferencing and routing system based on USGS digital line graph traces	Integrates many databases having locational information on water quality conditions or pollutant causes	Tommy Dewald, OWOW (202) 260-2488
STORET Water Quality File EPA, OWOW	Data analysis tool for chemical monitoring data from surface and groundwater sites. Also capabilities to store sediment and fish tissue data	Major source of raw ambient data for water quality assessments	Robert King, OWOW (202) 260-7028
STORET Biological System (BIOS) EPA, OWOW	A special component of STORET for storing information on biological assessments	Simplifies storage and analysis of biological data or metrics, with links to other EPA data files	Robert King, OWOW (202) 260-7028
Ocean Data Evaluation System (ODES) EPA, OWOW	Database and analysis system for marine and near coastal monitoring information	Permit tracking system for NPDES discharges to oceans and estuaries and ocean dumping programs	Robert King, OWOW (202) 260-7028
North American Listing of Fish and Wildlife Advisories EPA, Office of Science and Technology (OST)	National database of fish/wildlife consumption advisories and bans from States	Identifies waterbodies, species affected by advisories and bans and the problem pollutants	Jeffrey Bigler, OST (202) 260-1305
Index of Watershed Indicators EPA, OWOW	Web site describing water quality in the US and progress toward national goals and objectives	Public access to the 18 national water quality indicators	Sarah Lehmann, OWOW (202) 260-7021 http://www.epa.gov/surf

Table H-1. EPA Data Systems Containing Water Information

Data System	Description	Primary Function	Contact
Surf Your Watershed EPA, OWOW	Web site of watershed-level water quality information	Public access to data for various water quality indicators	Sarah Lehmann, OWOW (202) 260-7021 http://www.epa.gov/surf
Permit Compliance System (PCS) EPA, Office of Wastewater Management (OWM)	Locations and discharge characteristics for thousands of major and minor NPDES facilities	Compliance status tracking system for major dischargers	Carol Galloway OWM (202) 564-2375
Industrial Facilities Discharge File (IFD) EPA, Office of Water	Information for about 120,000 NPDES dischargers; also Superfund sites	Locations, flows and receiving waterbodies, for industrial discharges and POTWs	Robert King, OWOW (202) 260-7028
Toxic Chemical Release Inventory System (TRIS) EPA, Office of Prevention, Pesticides and Toxic Substances	Database of estimated and measured releases by industries of about 300 toxic chemicals to all environmental media	Inventory of toxic chemical releases with references to receiving waters and methods of waste treatment	Janette Petersen, OPTS (202) 260-1558
Drinking Water Supply File EPA, OWOW	Information on public and community surface water supplies	Data on waterbody, flow, and locations of mainly surface water intakes	Robert King, OWOW (202) 260-7028
Safe Drinking Water Information System (SDWIS) EPA, Office of Ground Water and Drinking Water (OGWDW)	Information about public supplies	Detailed data on compliance with Safe Drinking Water Act requirements including monitoring	Abe Siegel, OGWDW (202) 260-2804
Gage File EPA, OWOW	Information on some 36,000 stream gage locations	Summaries of mean annual and critical low flows and other data collected. Sites indexed to Reach File	Robert King, OWOW (202) 260-7028

Table H-1. EPA Data Systems Containing Water Information

Data System	Description	Primary Function	Contact
City and County Files EPA, OWOW	Location information and census data for 53,000 municipalities and all counties	Background data with lists of streams for each city, census population, county land/water area (coastal counties)	Robert King, OWOW (202) 260-7028
Dam File EPA, OWOW	Information on locations of 68,000 dam sites and associated reservoirs	Information on ownership, uses of reservoir, size, and stream reach	Robert King, OWOW (202) 260-7028

Table H-2. Other Useful Data Sources

Data System	Description	Primary Functions	Contacts
Water Data Storage and Retrieval System (WATSTORE) DOI, USGS, Water Resources Division	Database of water quality data collected at thousands of peak flow and daily flow data stations.	Store data collected by USGS, as well as cooperating agencies in DOI and the Corps of Engineers; good source of ground water data.	Dr. James S. Burton, Chief USGS, Water Resources Division, NAWDEX Program Office (703) 648-5684
National Wetlands Inventory, DOI, Fish and Wildlife Service	Computerized mapping scheme for entire United States.	Shows locations of vegetative community types using a FWS classification scheme.	David Dall, DOI, Fish and Wildlife Service (703) 358-2201
National Irrigation Water Quality Program, DOI, Fish and Wildlife Service	Physical, chemical and biological data collected at about 200 areas consisting of about 600 projects.	To identify and address irrigation-induced contamination on DOI irrigation and drainage facilities, National Wildlife Refuges, and other wildlife management areas.	Tim Hall, DOI, Fish and Wildlife Service, Division of Environmental Contaminants (703) 358-2148
Biomonitoring of Environmental Status and Trends (BEST) Program, DOI, Fish and Wildlife Service	Data collection to address effects on migratory birds, endangered species, anadromous fish, certain marine mammals, and habitats.	Monitor and assess environmental contamination effects to fish and wildlife and their habitats, on and off National Wildlife Refuges.	Tim Hall, DOI, Fish and Wildlife Service, Division of Environmental Contaminants (703) 358-2148
National Shellfish Register, NOAA, Strategic Environmental Assessment Division	Tracks status of shellfish harvesting areas by State at 5-year intervals (most recent data is from 1995).	Detect trends in shellfish growing waters and the abundance of shellfish resources.	Dan Farrow, NOAA, National Ocean Service (301) 713-3000, ext.156

Table H-2. Other Useful Data Sources

Data System	Description	Primary Functions	Contacts
Multi-State Fish and Wildlife Information Systems Project, DOI, Fish and Wildlife Service	Database of life history, habitat needs, and environmental tolerances for inland and marine fish and wildlife.	Central database to facilitate review of permits, regulatory requirements, and ecological preservation or restoration programs.	DOI, Fish and Wildlife Service (703) 358-1718
American Rivers Outstanding Rivers List	Database on 15,000 river segments possessing outstanding scenic, recreational and ecological attributes.	Assembles information from National Park Service river surveys, Northwest Power Planning Council's Protected Areas Program, Nature Conservancy Priority Aquatic Sites and other major sources.	Carrie Collins, American Rivers (202) 547-6900 ext. 3013
Recreation Information Management System, USDA, Forest Service	Database of recreational facilities and areas in National Forest System.	Contains data on types of recreation, visitor days, and participation by activity.	USDA, Forest Service (202) 205-1706
Biological and Conservation Data System, The Nature Conservancy	Listing by States of rare species and key habitat areas.	For identifying waters important for rare plant and animal species protection.	Shara Howie, The Nature Conservancy (703) 841-4886
National Water Quality Technology Development Staff (NWQTDS), USDA	Four regional centers provide database, modeling, and GIS technology assistance to promote the President's Water Quality Initiative, the Farm Bill, and other programs.	Will provide convenient access to soil survey data and a variety of models (e.g., AGNPS) for use with GIS systems to support USDA HUA projects and similar initiatives.	Jackie Diggs USDA, Natural Resources Conservation Service (202) 720-0136

Table H-2. Other Useful Data Sources

Data System	Description	Primary Functions	Contacts
Benthic Surveillance Project, National Status and Trends Program, Department of Commerce, NOAA	Sampling at 79 estuarine sites for PCBs, PAHs, chlorinated pesticides, butyltins, sewage tracers, and trace elements.	Determine concentrations of toxic chemicals in sediments and bottom-dwelling fish.	NS&T Program National Ocean Service, NOAA (301) 713-3028
Mussel Watch Project, National Status and Trends Program, NOAA	Mussels and oysters collected annually at about 240 sites and analyzed for same parameters as the Benthic Surveillance Project.	To determine concentrations of toxic chemicals in mussels and similar bivalve mollusks as "sentinel organisms" in environmental monitoring.	NS&T Program National Ocean Service, NOAA (301) 713-3028
Coastal Contamination Assessments, National Status and Trends Program, NOAA	Quick-reference reports for Long Island Sound, Gulf of Maine, Hudson-Raritan area, Narragansett Bay, and Buzzards Bay done or underway.	To identify potential toxicant problems and compare local levels of contamination with national-scale results.	NS&T Program National Ocean Service, NOAA (301) 713-3028
National Estuarine Inventory and Strategic Assessment Program	Source of demographic, economic, and natural resource information for 102 Estuarine Drainage Areas	Provide data to support NOAA initiatives related to the Sea Grant and Coastal Zone Management Programs.	John Klein National Ocean Service, NOAA (301) 713-3000 ext. 160

Appendix I

305(b) Monitoring and Assessment Design Focus Group Handouts

Section 1. Selected Features of Monitoring Designs

Section 2. Types of Questions That Different Monitoring Designs Can Address

Section 3. Selected Definitions

Section 4. Answers to Frequently Asked Questions Regarding Probability Design

APPENDIX I

Section 1.
Selected Features of Monitoring Designs

FEATURE	Type of Monitoring Design			
	Sample Survey			
Comprehensive Assessment	Probability-Based Design	Judgmental Design	Conventional or Targeted Design	Combination of Sample Survey and Targeted
Geographic Extent and Spatial Considerations	Type, category, and scale of water resource (or class) being assessed determine spatial coverage; sample results can be extrapolated (with known statistical confidence) to broader geographic area.	Results will be used to make statements at regional scales, primarily using the ecoregional framework but also appropriate at the watershed scale.	Some states seek to monitor a high % of their waters by sampling a large number of targeted sites (e. g., OH's stream network and SC's rotating basin surveys). Some states sample 50-100 sites annually. Extrapolation to a broader geographic area may be problematic.	The probability network would generate data and results useful for area- or resource-wide assessments; the targeted network would cover specific sites for which information is necessary.
Advantages	Unbiased estimates of status and trends at ecoregion, basin, and State levels. Large-scale assessments can evaluate effectiveness of management decisions in watersheds, basins or States over time. Greater use of this design approach will enhance ability to discover previously unknown pollution sources, particularly for nonpoint. May identify statewide issues such as habitat quality.	Would retain many long-term monitoring sites with their rich data records. Spatial trends could be determined almost immediately instead of waiting 5 to 20 years Staff already know sites and procedures. Easier to convince management since does not involve radical change in monitoring program.	Can determine sources of impairment. Identifies temporal trends at individual sites. Can assess WQ improvements due to management actions or controls in a waterbody or watershed. Information for political priorities and fire drills is readily available. Contributes to understanding of biological response to stressors.	Could incorporate benefits of both probabilistic and targeted designs. E.g., rotating basin surveys could include both prob.-based sites and targeted sites. A certain % of the prob. sites could be retained as targeted sites during the next basin cycle.

FEATURE	Type of Monitoring Design			
	Sample Survey			
Comprehensive Assessment	Probability-Based Design	Judgmental Design	Conventional or Targeted Design	Combination of Sample Survey and Targeted
Advantages (cont'd)	Statistical design lends itself to a structured process such as data quality objectives (DQO) process. A structured process with statistical rigor might convince potential plaintiffs and judges that the State is making progress addressing 303(d). 305(b) would no longer be criticized by environmental and business groups as not being scientifically based; EPA and States might have stronger basis for CWA reauthorization changes and funding request.			
Disadvantages and concerns	Will not identify new problem sites unless they happen to be selected randomly.	May not result in statistically-valid statements about spatial trends.	States and EPA cannot tell the public with certainty what % of waters meet aquatic life uses.	Could be more costly to operate both prob.-based and target networks; costs unknown at this time.

FEATURE	Type of Monitoring Design			
Comprehensive Assessment	Sample Survey		Conventional or Targeted Design	Combination of Sample Survey and Targeted
	Probability-Based Design	Judgmental Design		
Disadvantages and concerns (cont'd)	Will not determine temporal trends at priority sites. Not designed to assess improvements in specific waterbodies or watersheds due to controls, enforcement, or restoration. Responds poorly to political priorities and fire drill. If all 305(b) assessments were based on changing probabilistic sites, States would no longer track specific waterbodies and mapping and spatial analysis would be curtailed (no particular miles, acres, would be associated with each site). Requires significant up-front effort for proper design and long-term adherence to the study plan.	State does not plan to track assessments by waterbody anymore; no miles, acres, etc. will be associated with each site. If State wants to quantify a level of certainty in assessment results, will require comparison studies versus a true probabilistic network.	Difficult to convince Congress and industry that expensive controls are needed when we cannot state with certainty the extent of a problem.	Requires significant upfront effort for proper design and long-term adherence to the study plan. The pro-based component would be subject to many of the same concerns in column 2. State might have to drop some existing sites with many years of data. Determining sources of impairment may be beyond program's capability. Sampling away from easy access points would be difficult and expensive.

FEATURE	Type of Monitoring Design			
	Sample Survey			
Comprehensive Assessment	Probability-Based Design	Judgmental Design	Conventional or Targeted Design	Combination of Sample Survey and Targeted
Disadvantages and concerns (cont'd)	State could lose the benefits of existing sites with many years of data. Determining sources of impairment may be beyond program's capability. If the design does not allow sampling at access points like bridges, sampling elsewhere will be difficult and expensive. Concern over no. of years required to determine spatial or temporal trends in a basin or State. Concerns over the expense of sampling sufficient sites for statistical rigor and also availability of technical support for States.			

FEATURE	Type of Monitoring Design			
Comprehensive Assessment	Sample Survey		Conventional or Targeted Design	Combination of Sample Survey and Targeted
	Probability-Based Design	Judgmental Design		
Barriers to State Implementation	Lack of management support because probabilistic networks reduce manager's flexibility to direct monitoring efforts to specific locations. Approach may not answer manager's questions (statistical significance not a driving concern). Cost of converting to new design; staff resistance.		Targeting monitoring programs already implemented in all States.	Same barriers as for probabilistic (see column 2) only perhaps to a lesser extent.
Cost effectiveness; benefits to agency and public	Need cost estimates. Construct scenarios and develop cost estimates; e.g., costs if SC or another State were to switch to prob-based rotating basins.		Agency does not have incur costs for changing programs. Agency can respond to large no. of questions about priority waters.	Costs unknown. Agency gets benefits of each approach.
Cost effectiveness; benefits to agency and public	At one point MN made a rough estimate that switching would cost approx. $200K for streams and similar amount for lakes. Basis for these costs not known. States and EPA would be able to say with known level of certainty what % of waters meet aquatic life uses.			

FEATURE	Type of Monitoring Design			
	Sample Survey			
Comprehensive Assessment	Probability-Based Design	Judgmental Design	Conventional or Targeted Design	Combination of Sample Survey and Targeted
Where being used currently (possible case studies)	Maryland–biological stream survey and previous acid deposition impacts network; Delaware–macroinvertebrate and habitat network; Prince George's County, MD; Manatee County and Tampa Bay, FL.	State of Washington is considering this approach.	Every State; no case studies needed.	State of MD uses both approaches. Is this a candidate case study–both monitoring networks designed for optimum compatibility? Others?

APPENDIX I

Section 2.
Types of Questions that Different Monitoring Designs Can Address

FEATURE	ITFM Purposes*					TYPE OF MONITORING DESIGN			
						Sample Survey			
Comprehensive Assessment	1	2	3	4	5	Probability-Based Design	Judgmental Design	Conventional or Targeted Design	Combination of Sample Survey (Probability) and Targeted
Assess Status of Resource									
a) Site-Specific	√	√				----	X	X	X
i. What is the level of aquatic life use support in Joe's Creek?									
ii. What is the bacteriological quality of the 10 most widely used lakes in a basin for swimming?									
iii. What is the quality of streams with large point sources?									
iv. What is the location of the impaired waters?									
b) Regional	√	√				X	X	----	X
i. How many miles (with known confidence) of first- through third-order streams in the basin- or ecoregion or State — are supporting their aquatic life uses?									

* *Uses/Purposes of Monitoring Data and Results (ITFM 1995)* [1 Describing Status and Trends, 2 Describing and Rank Existing and Emerging Problems; 3 Designing Management and Regulatory Programs; 4 Evaluating Program Effectiveness; 5 Responding to Emergencies]

FEATURE	ITFM Purposes*					TYPE OF MONITORING DESIGN			
						Sample Survey			
Comprehensive Assessment	1	2	3	4	5	Probability-Based Design	Judgmental Design	Conventional or Targeted Design	Combination of Sample Survey (Probability) and Targeted
ii. What percentage (with known confidence) of stream miles in State or ecoregion have poor habitat quality? (also included under "stressors")									
iii. How many lake acres are impaired due to nutrients? ...due to sedimentation? (also included under "stressors")									
iv. What is the status/condition of the target resource of interest relative to particular values/endpoints? What proportion of the target resource is in good or poor condition?									
v. What proportion (or how many miles) of the streams in South Carolina fail to meet their designated aquatic life uses?									
vi. How many lakes are classified as eutrophic in EPA Regions 1 and 2?									
vii. How many miles of streams contain fish with elevated levels of tissue mercury in Florida?									

* *Uses/Purposes of Monitoring Data and Results (ITFM 1995)* [1 Describing Status and Trends, 2 Describing and Rank Existing and Emerging Problems; 3 Designing Management and Regulatory Programs; 4 Evaluating Program Effectiveness; 5 Responding to Emergencies]

FEATURE	ITFM Purposes*					TYPE OF MONITORING DESIGN			
						Sample Survey			
Comprehensive Assessment	1	2	3	4	5	Probability-Based Design	Judgmental Design	Conventional or Targeted Design	Combination of Sample Survey (Probability) and Targeted
viii. What proportion (or how many miles) of streams in Delaware is classified as priority or problem waters? Are or should they be 303d listed?									
ix. What is the location of the impaired waters?									
Assess Temporal Trend of Resource									
a) Site-Specific	√	√				----	X	X	X
i. What is the trend in biointegrity in Joe's Creek? Is it changing, and if so, how?									
ii. Did agricultural BMPs or ecological restoration in the Oxford Creek drainage area improve biological conditions? (also included under "Measure Effectiveness...")									
b) Regional	√	√				X	X	----	X
i. What percentage (with known confidence) of impaired streams in the basin have improved since the last 5-year rotating basin cycle?									

* *Uses/Purposes of Monitoring Data and Results (ITFM 1995)* [1 Describing Status and Trends, 2 Describing and Rank Existing and Emerging Problems; 3 Designing Management and Regulatory Programs; 4 Evaluating Program Effectiveness; 5 Responding to Emergencies]

FEATURE	ITFM Purposes*					TYPE OF MONITORING DESIGN			
						Sample Survey			
Comprehensive Assessment	1	2	3	4	5	Probability-Based Design	Judgmental Design	Conventional or Targeted Design	Combination of Sample Survey (Probability) and Targeted
ii. What are the temporal trends in the proportion of the resource that is classified in poor condition? Is the proportion in poor condition increasing or decreasing?									
iii. What are the temporal trends in the proportion of the resource that is classified in poor condition? Is the proportion in poor condition increasing or decreasing?									
Determine Presence, Causes, and Sources of Stressors									
a) Site-Specific	√	√			√	X	X	X	X
i. What are the predominant sources of impairment in Joe's Lake?									
ii. What is the primary source of mercury input to Joe's Lake?									
iii. What is causing excessive sediment loading to Reservoir X?									
b) Regional	√	√	√	√		X	X		X
i. How many lakes are impaired due to nutrients? Due to sedimentation, etc.?									

* *Uses/Purposes of Monitoring Data and Results (ITFM 1995)* [1 Describing Status and Trends, 2 Describing and Rank Existing and Emerging Problems; 3 Designing Management and Regulatory Programs; 4 Evaluating Program Effectiveness; 5 Responding to Emergencies]

FEATURE	ITFM Purposes*					TYPE OF MONITORING DESIGN			
						Sample Survey			
Comprehensive Assessment	1	2	3	4	5	Probability-Based Design	Judgmental Design	Conventional or Targeted Design	Combination of Sample Survey (Probability) and Targeted
ii. What percentage (with known confidence) of stream miles in the State or ecoregion have poor habitat quality?									
iii. What is the identity and relative magnitude of the different causes of poor condition?									
iv. What proportion of the stream miles in SC fails to meet designated uses due to toxics? due to elevated nutrients? due to dissolved oxygen depletion? due to physical habitat degradation?									
v. What proportion of the lakes in Regions 1 and 2 is classified as eutrophic, due to elevated phosphorus loadings? due to elevated nitrogen loadings?									
vi. What are the principle sources of the causes of impairment in the Great Lakes Basin?									
vii. What are the sources of toxics? elevated nutrients? dissolved oxygen depletion? physical habitat degradation?									

* *Uses/Purposes of Monitoring Data and Results (ITFM 1995)* [1 Describing Status and Trends, 2 Describing and Rank Existing and Emerging Problems; 3 Designing Management and Regulatory Programs; 4 Evaluating Program Effectiveness; 5 Responding to Emergencies]

FEATURE	ITFM Purposes*					TYPE OF MONITORING DESIGN			
						Sample Survey			
Comprehensive Assessment	1	2	3	4	5	Probability-Based Design	Judgmental Design	Conventional or Targeted Design	Combination of Sample Survey (Probability) and Targeted
viii. What proportion of the phosphorus loadings comes from point vs. nonpoint sources? What are the specific non-point sources of phosphorus?									
ix. Where is the mercury contamination coming from?									
x. What is the source of toxics to Delaware's streams? Elevated ammonia?									
Measure Effectiveness of Individual Controls (BMPs or Chemical Treatments)									
a) Site Specific	√	√	√			—		X	X
b) Regional									
Enforce Permits/Controls		√			√	X		X	X
a) Site-Specific									
b) Regional									
Respond to Emergencies					√	—		X	X
a) Site-Specific								X	X
b) Regional									

* *Uses/Purposes of Monitoring Data and Results (ITFM 1995)* [1 Describing Status and Trends, 2 Describing and Rank Existing and Emerging Problems; 3 Designing Management and Regulatory Programs; 4 Evaluating Program Effectiveness; 5 Responding to Emergencies]

APPENDIX I

Section 3.
Selected Definitions

Combined Probability and Targeted Design: A monitoring design that allows incorporation of site specific assessment of known, targeted environmental problems with watershed-, region-, or area-wide resource assessments based on probability design.

Comprehensive Assessment: An evaluation of resources that provides complete spatial and/or demographic coverage of the geographic area or resource being studied; it provides information on assessment value (condition of the resource), spatial and temporal trends in resource condition, causes and sources of pollution, and locational information.

Conventional or Targeted Design: Targeted site selection is used to answer specific questions regarding the condition of a site or set of sites with known stressors or sources.

Geographic Scale: Spatial breadth or size; can be based on political unit (e. g., state, county, or municipality), watershed (e. g., the Potomac River Watershed, the San Francisco Bay Watershed, the Columbia River Basin), region (e. g., the Huron-Erie Lake Plain ecoregion, the Pacific Coastal Mountain ecoregion), or resource (e. g., the Okefenokee Swamp, the Everglades).

Judgmental (Sample Survey) Design: Nonrandom selection of sampling sites with the intent of using assessment results for drawing inferences on a population as a whole.

Monitoring: The periodic or continual collection of data (measured parameters) using consistent methods to determine the status of a waterbody (the condition of the ecological resources) and the changes in those parameters over time.

Probability-Based (Sample Survey) Design: A sampling design based on selection of sites or sample locations using some aspect of randomization; allows statistically-valid assessments inferences to be drawn on a population as a whole.

Resource Status: The condition of a specified natural resource at a particular point in time.

Sample Survey: An approach for site selection, also known as population sampling, that deals with the selection and observation of a part of the population in order to infer the condition or status of the population as a whole.

Spatial Pattern: Variations observed in measured parameters that correspond to some distribution of large or small-scale geographic features.

Target Population (Stratum): A group of potential sampling locations (or assessment units) that is some subset of the total population of sampling units.

Temporal Trend: Variations in a measured parameter over time.

APPENDIX I

Section 4.
Answers to Frequently Asked Questions Regarding Probability Design

A GENERAL DESCRIPTION OF PROBABILITY BASED SURVEY SAMPLING AND ANSWERS TO FREQUENTLY ASKED QUESTIONS

INTRODUCTION

Much of the material contained here was written by Jon H. Voistad, Steve Weisberg (Versar, Inc., Columbia, MD 21045), Douglas Heimbuch, Harold Wilson, and John Seibel (Coastal Environmental Services, Inc, Linthicum, MD) in the preparation of a document: **Answers to commonly asked questions about R-EMAP sampling designs and data analyses**, under the guidance of Victor Serviess, U.S. EPA). Changes and additions have been made to their document. Contact Steve Paulsen or Phil Larsen (NHEERL, U.S. EPA, Corvallis, OR) for further information.

The Environmental Monitoring and Assessment Program (EMAP) is an innovative, long-term research, and monitoring program designed to measure the current and changing conditions of the nation's ecological resources. EMAP achieves this goal by using statistical survey methods that allow scientists to assess the condition of large areas based on data collected from a representative sample of locations. Statistical survey methods are very efficient because they require sampling relatively few locations to make valid scientific statements about the condition of large areas (e.g., all wadable streams within an EPA Region).

Regional-EMAP (R-EMAP) is a partnership between EMAP, EPA Regional offices, states, and other federal agencies to adapt EMAP's broad-scale approach to produce ecological assessments at regional, state, and local levels (including watershed and county levels). R-EMAP is based on the same statistical survey techniques used in EMAP, which have proven successful in many disciplines of science. Applying these techniques effectively requires recognizing several key principles of survey sampling and using specialized, although not difficult, data analysis methods.

This document provides a nontechnical overview of the survey sampling and data analysis concepts underlying these types of sample survey projects. It is intended for

regional resource managers who have had little statistical training, but who feel they would benefit from a better understanding of the statistical and scientific underpinnings survey sampling. Familiarity with these concepts is helpful for understanding the kinds of information survey sampling can provide.

This document is organized in two sections. The first section explains the general principles of survey sampling and its application to determining ecological condition. Terms such as target population, sampling frame, and random sampling are defined. The second section addresses questions frequently asked about survey sampling design and data analysis methods. Throughout the document, the concepts of survey design are illustrated first with examples from everyday life, and then with examples illustrating applications to water resource questions. The examples involve a stream study; however, the concepts are equally applicable to assessing the condition of other resources such as lakes, estuaries, wetlands, or forests.

PRINCIPLES OF SURVEY DESIGN

There are two generally accepted data collection schemes for studying the characteristics of a population. The first is a census, which entails examining every unit in the population of interest. For most ecological studies, however, a census is impractical. For example, measuring fish assemblages everywhere to assess conditions within a watershed that has 1000 kilometers of stream would be prohibitively expensive.

A more practical approach for studying an extensive resource, such as a watershed, is to examine parts of it through probability (or random) sampling. Studies based on statistical samples rather than complete coverage (or enumeration) are referred to as sample surveys. Sample surveys are highly cost-effective, and the principles underlying such surveys are well developed and documented. The principles of survey design provide the basis for (a) selecting a subset of sampling units from which to collect data, and (b) choosing methods for analyzing the data.

One example of a sample survey is an opinion poll to estimate the percentage of eligible voters who plan to vote Democratic in a presidential election. Such opinion polls are based on interviews with only a small fraction of all eligible voters. Nevertheless, by using statistically sound survey methods, highly accurate estimates can be obtained by interviewing a representative sample of only around 1200 voters. If 700 of the polled voters plan to vote Democratic, then the fraction 700/1200, or 58 percent, is a reliable estimate of the percent of all voters who plan to vote Democratic.

The approach used in conducting a stream sample survey is basically the same as in an opinion poll. Instead of collecting the opinions of a sample of people, a watershed or ecoregion project might collect data about fish assemblages from a representative sample of point locations along the stream length of in the watershed or ecoregion to determine the percent of kilometers of streams in which ecological conditions are degraded. If data are collected from plots of, say, 40 times the stream width in length at each of 40 randomly selected sites, and 16 of the 40 sites exhibit degraded

conditions, then the estimated proportion of degraded stream kilometers in the watershed or ecoregion would be 40% (i.e., 16/40).

STEPS FOR IMPLEMENTING A SAMPLE SURVEY

The *survey design* is a plan for selecting the sample appropriately so that it provides valid data for developing accurate estimates for the entire population or area of interest. Planning and executing a sample survey involves three primary steps: (1) creating a list of all units of the target population from which to select the sample, (2) selecting a random sample of units from this list, and (3) collecting data from the selected units. The same kinds of techniques used to select the sample of people to interview in an opinion poll are used to select the sample of sites from which to collect field data.

Developing a Sampling Frame

Before the sample survey can be conducted, a clear, concise description of the *target population* is needed. In statistical terminology the target population (often shortened to "population") does not necessarily refer to a population of people. It could be a population of schools, area units of farm land, freshwater lakes, or the network of streams.

The list or map that identifies every unit within the population of interest is the *sampling frame.* Such a list is needed so that every individual member of the population can be identified unambiguously. The individual members of the target population whose characteristics are to be measured are the sampling units.

For example, if we were conducting a sample survey to estimate the percentage of students at a university who participate in intramural sports, the target population would consist of all the enrolled students. The individual students would be the sampling units, and the registrar's office could provide a list of students to serve as the sampling frame. We could draw a representative (random) sample of students from this list and interview them about their participation in sports. Their responses would be "yes or no." The percentage of interviewed students who participate in intramural sports would yield an estimate of the "true" percentage for all students.

For a stream survey, the target population might be all perennial, wadable streams in a watershed. The sampling unit is a point along the stream length, and an associated plot, e.g. 40 times the stream width in length. The response variable might be "degraded" or "non-degraded" based on measures of water quality. Conceptually, the collection of all possible point locations along these streams serve as a sampling frame, similar to the list of students in the previous example. The sampling frame for streams typically would be established by using the U.S. River Reach reach files through a geographic information system (GIS).

Selecting a Representative Sample

Survey sampling is intended to characterize the entire population of interest; therefore, all members of the target population must have a known chance of being included in the sample. Conducting an election poll by asking only your neighbors' opinions probably would not enable you to predict the outcome of a national election accurately.

Simple random selection ensures that the sample is representative because all members of the population have an equal chance of being selected. Random selection can be thought of as a kind of lottery drawing to determine which stream reaches, for example, are included in the sample. The selection is non-preferential towards any particular reach or group of reaches. One way to make a random selection would be to place uniquely numbered ping-pong balls (one for each sampling unit) into a drum, blindly mix the drum, and then blindly pick one ball corresponding to each stream reach (i.e., sampling unit) from which data are to be collected. In practice, computers are used to make the random selections. Either way, the result is a subset of sampling units randomly selected from the sampling frame.

FREQUENTLY ASKED QUESTIONS

Upon thoughtful consideration of the sample survey approach, several questions may come to mind. This section answers several commonly asked questions. Some of them concern survey sampling, and some of them concern data analysis. These questions are addressed in fairly general terms. As noted in the introduction, additional technical detail is in a series of methods manuals.

Why is it so important to select sampling sites randomly?

The way we select the sample (i.e., choose the units from which to collect data) is crucial for obtaining accurate estimates of population parameters. We clearly would not get a good estimate of the percentage of all students at a university who participate in intramural sports if we polled students at the entrance to the gymnasium. This preferential sample would, most likely, include a much higher proportion of athletes than the general population of students.

Similarly in a stream study, preferential sampling occurs if the sample includes only sites downstream of sewage outfalls in a watershed where sewage outfalls affect only a small percentage of total stream length. This kind of sampling program may provide useful information about conditions downstream of sewage outfalls, but it will not produce estimates that accurately represent the condition of the whole watershed.

Preferential selection can be avoided by taking random samples. Simple random sampling ensures that no particular portion of the sampling frame (i.e., groups of students or kinds of river reaches) is favored. Within streams, the chance of selecting a sampling unit that has degraded ecological conditions would be proportional to the number of sampling units within the target population that have degraded

conditions. For example, if 30% of the target population has degraded conditions, then on average 30% of the (randomly selected) units in the sample will exhibit degraded conditions. This property of random sampling allows estimates (based only on the sample) to be used to draw conclusions about the target population as a whole.

For 305b reports, I need to estimate the total number of stream miles in my EPA Region that are degraded. Can I do this from sample survey data?

The number of degraded stream miles can be calculated in two steps. First, the proportion of stream miles that are degraded is calculated as illustrated earlier. Then, that fraction is multiplied by the total number of stream miles in the population. The total number of stream miles is available from the sampling frame (for example from EPA's River Reach File, Version 3), which delineates all members of the target population.

Defining "degraded" is an important part of the calculation, regardless of whether it is for percent or absolute number of stream miles. "Degraded" can be defined if a *threshold value* or goal for each measurement variable can be established. Most of the variables measured in stream surveys, such as an Index of Biotic Integrity (IBI), have continuous ranges of response. Calculating the proportion of stream miles that are degraded requires converting this continuous data into binary, or yes/no (e.g., degraded or not degraded) form. The question of how many stream miles are degraded, therefore, must be rephrased to include a threshold value for the relevant measurement variable. For an IBI, the question might be rephrased as "What are the total number of stream miles in my Region with IBI below a score of 45?"

I am accustomed to seeing estimates of average condition instead of estimates of proportion. Can sample survey data be used to estimate average condition?

Yes, estimates of average condition, such as the average IBI in a watershed, provide valuable information and can be calculated with sample survey data as a simple mean. The principles of survey sampling, particularly the emphasis on selecting a representative sample, also apply to estimating a population mean. Just as an estimate of the percent of stream miles in a Region in which IBI is below 40 is biased if data are collected only from sites downstream of sewage outfalls, so is the estimate of mean IBI. Furthermore, estimates of various other properties can be made from the sample survey results, such as median scores, various percentiles, or frequency distributions and their shapes.

EMAP emphasizes estimating spatial extent (e.g., percent of river miles) because it has several advantages over estimating the mean alone. For instance, a Region with an average stream IBI of 45 might be composed entirely of streams with an IBI of 45; however, the same average would occur if half the streams have an IBI of 55 and the other half an IbI of 35. Estimating the spatial extent of the resource that fails to meet some standard (e.g., IBI of at least 45) provides more information about the condition of the resource and is consistent with EPA initiatives to establish environmental goals and measure progress toward meeting them.

EMAP documents suggest that the sampling design is "flexible to enhancement." What does this mean?

One goal of a sample survey may be to compare two parts of a target population (these could be described as sub-populations), or a part of the population to the whole population. For instance, an opinion poll might be used to determine if a higher percentage of the people living in Rhode Island is likely to vote Democratic than in the nation as a whole. Given its small size, Rhode Island probably would receive very little attention in a national poll if samples are allocated by a simple random process. One way to achieve a sample of people in Rhode Island that is sufficient to make this comparison is to increase sampling effort for the nation as a whole until enough people from Rhode Island are included in the randomly selected national sample. This option is not very cost-effective because it requires considerable, unnecessary sampling effort in other areas to achieve a desired sample size in one small area.

Another, preferable, alternative would be to divide the entire target population into two subpopulations,. Voters in the United States could be divided into (1) those living in Rhode Island, and (2) those living elsewhere. A simple random sample of desired size could then be selected from each of these groups.

Stratified sampling could be used in a stream survey to enhance sampling effort in a watershed of special interest so that its condition could be compared with that of a larger area. In a study area with 1000 kilometers of streams, for example, an area of special interest may contain 200 kilometers of streams. If budget constraints limit the size of the total sample to 60 sampling units, 30 could be randomly selected from the special interest area, and 30 from the rest of the sampling frame. If simple random sampling is used, the area of special interest, which represents 20% of the area, will contain only about 12 of the 60 selected sampling units. A sample of 12 would be insufficient to estimate the condition of the special interest area reliably.

Doesn't enhancing the sampling intensity for an area of special interest bias the overall estimate?

No. Sampling units inside an area of special interest usually have a higher chance of being selected than sampling units outside the special interest area. Within each stratum, however, the chance of selecting any location is equal; therefore, a separate (unbiased) estimate can be computed for each stratum, as well as for the entire resource.

With stratified random sampling, estimates are generated first for individual strata, then the stratum-specific estimates are combined into an overall estimate for the whole target population. Stratum-specific estimates are combined by weighting each one by the fraction of all sampling units that are within the stratum. For the simple two-stratum example given above, the weights would be 200/1000 for stratum 1 and 800/1000 for stratum 2. So, if the stratum-specific estimates are 0.5 for stratum 1 and 0.25 for stratum 2, the overall estimate is 0.30 [(0.5 x 2/10) + (0.25 x 8/10)]. This

approach ensures that the overall estimate is corrected for the intentional selection emphasis within a particular subpopulation.

EMAP's objectives state that estimates are made with known confidence. What is "known confidence"?

An estimate of a population parameter is of limited value without some indication of how confident one should be in it. Scientists typically describe the appropriate level of confidence in an estimate derived from a sample survey by defining *confidence limits* or *margins of error.* This description of statistical confidence is used frequently in reporting the results of opinion polls using statements such as "this poll has a margin of error of ± 4%". Provided random sampling is used, similar statements can be made about estimates from biological sample surveys.

Sample surveys provide estimates that are used to make inferences about parameters for the population as a whole. Two types of estimates are commonly provided: the point estimate and the interval estimate. For example, the estimated proportion of voters that support a party is a point estimate. It is important to know how likely it is that such a point estimate deviates from the true population parameter by no more then a given amount. An interval estimate for a parameter is defined by upper and lower limits estimated from the sample values. A confidence interval is constructed so that the probability of the interval containing the parameter of interest can be specified. We do not know with certainty whether an individual interval, specified as a sample estimate plus/minus a margin of error, includes the true population parameter. For repeated sampling, however, the estimated 95% confidence intervals would include the true parameter 95% of the times. The length of the confidence intervals is a measure of how precise the parameter is being estimated: a narrow interval signifies high precision. The margin of error is often used for defining the upper and lower limits of the confidence interval; it is half the width of the confidence interval. Thus, if a poll estimates that 55% of the population will vote Democratic and the margin of error is ± 4%, then the estimated 95% confidence interval ranges from 51% to 59%.

A great advantage of using a random sampling design is that statisticians have developed procedures for calculating confidence intervals for the estimates. For most sample surveys, in which the goal is to estimate the proportion of the resource that is degraded, a standard probability distribution known as the binomial distribution can be used as an estimate of the upper and lower bounds of confidence intervals.

What are the most important factors affecting the size of the confidence interval?

The sample size (# of sampling units collected) and the proportion of yes answers are the primary factors affecting the size of the confidence interval with binary (yes/no) data. The effect of sample size can be illustrated with a pre-election poll of voters. If only 30 people are sampled, and 14 indicate that they will vote Democratic, it would be unwise to predict the winner. With such a small sample size, the margin of error would be about ± 18% for a 95% confidence interval. The degree of confidence would be higher if 140 people out of a sample of 300 say they will vote Democratic (47% ±

6%), and higher still if 1400 people out of a sample of 3000 say they will vote Democratic (47% ± 2%). In this example, the estimated proportion of sampled voters who will vote Democratic stays the same (p = 47%), but the width of the confidence interval decreases with increasing sample size.

Confidence intervals for estimated percentages (p) are affected to a lesser degree by the proportion of yes answers (P) in the population. The widest confidence interval occurs for P equal to 50%. For values of P ranging from 20% to 80%, the margin of error will not vary much with P; it will be determined mainly by the sample size. The fact that there is a maximum margin of error for binomial estimates of proportions is very useful for planning a survey. If we plan for the worst case (i.e., when half of the population is in the yes category) we can select a sample size that ensures that the confidence interval for P will be smaller than a specified limit.

Doesn't the size of the target population affect confidence in the estimates?

The size of the target population theoretically affects the precision of the estimates. For most sample surveys, however, the effect is negligible because the sampled fraction of the target population is so small. When the sampled fraction is small, the size of the sample rather than the size of the target population determines the precision of the estimate. Polling 1000 people in the state of Rhode Island, for example, would yield as precise an estimate as polling 1000 people in the state of Texas, or the nation as a whole. In these cases, a very small proportion of the total population is polled.

If the sample includes a large proportion of the population, in contrast, the accuracy of the estimate is improved. For instance, if a local town has a population of 1400 people, then a sample of 1200 people would produce a substantially more accurate estimate than a sample of 1200 people from a population of 100 million. As the size of the sample approaches the size of the population, statisticians adjust the confidence interval using the *finite population correction factor.* In practice, however, most sampling efforts don't sample a large enough fraction of the population for this correction factor to become important. That is why pollsters interview approximately the same number of people for a local election as for a presidential election.

For sample survey projects, the fraction of the population that is sampled is generally very small. Fish assemblages, for example, are generally sampled from short segments (100 - 400 meters). If 50 such samples are collected from a Region with 1000 kilometers of streams, the sampled fraction is 0.0001 - 0.0004.

States are required to identify or list waterbodies that are impaired, for example, by the 303(d) listing process. How useful are sample surveys for identifying those waterbodies?

Because survey sampling is intended to characterize the status of the resource as a whole, it is generally not useful for enumerating a list of a specific type, for example,

a list of all the impaired waterbodes. However, an important aspect of sample surveys is that they can provide a check on the completeness of the list. Suppose that a state agency had submitted a list of impaired waterbodies it had gathered from ongoing moinitoring programs, and from reports from other agencies. This list would presumably be a census of the impaired waterbodies. The state agency could then compare the amount of the resource impaired against the magnitude of the total resource to derive a percent of the resource impaired. The state agency could check this proportion by conducting a sample survey and classifying the sample sites into impaired/not impaired. It could then check the proportion impaired based on the sample survey with the proportion calculated from the inventory. Consistency between the two estimates would indicate that the census of the impaired sites is reasonably complete (within the uncertainty of the sample survey); inconsistency between the two estimates would provide information on how good the impairment census was (again within the confidence limits of the sample survey).

States conduct targeted monitoring for many purposes; the locations were selected for various reasons. How can the data from these monitoring programs be integrated with probability sample survey data?

To characterize the status of aquatic resources in a watershed, ecoregion, or state, an unbiased site selection process is important so that valid inferences about the resource can be made. Sites selected for targeted monitoring are usually selected with a good purpose in mind, often to answer very site specific questions. Consequently, they might be very biased relative to the resource as a whole. In general, we do not know what the bias might be in using targeted monitoring sites to make population estimates.

One path toward resolving this issue is to divide the population of interest into two parts. One part is the set of sites (or proportion of the resource) that has been censused through the targeted monitoring. The other part is the portion of the population that is uncensused and can be surveyed though a sample survey. Combining the results of the two parts produces an estimate of the condition of the entire resource. The extent to which targeted monitoring will influence the outcome of the picture of the resource as a whole will depend on the proportion of the resource that is censused through targeted monitoring. In general, this is a relatively small part of the entire resource, consequently the results of targeted monitoring won't influence the overall description of the resource.

Many states are moving toward a rotating basin design for conducting their waterbody assessments and water resource planning. How can sample surveys be incorporated into this approach?

One aspect of a rotating basin design is to describe the condition of the basin as a whole. Unless the basin will be censused, a sample survey can be used to characterize the overall status of the basin. A combination of a sample survey and targeted monitoring as outlined above can be used to produce an overall description of the basin. In addition, the rotating basin design could be embedded in a state wide sample survey by intensifying the sampling on the particular basin or set of basins for the year(s) that basin or set of basins was under study. A routine ongoing

statewide survey could be conducted at some baseline level of intensity, along with intensified sampling in the targeted basins. In this way, a state could track statewide progress as well as progress in individual basins as they are revisited, and determine the condition of the basin relative to the condition of the state as a whole.

CLOSING COMMENTS

The approaches and concepts described in this overview document are generally applicable to a variety of sample surveys. They are appropriate whether the purpose of sampling is to estimate the proportion of the number of resource units (e.g., numbers of lakes), the proportion of total length of a resource (e.g., miles of streams), the proportion of area of a resource (e.g., square miles of an estuary), or the proportion of volume of a resource (e.g., cubic meters of one of the Great Lakes). The approaches and concepts can be applied without modification to each of these situations.

This overview document purposefully was written nontechnically; it does not contain enough detail to help someone analyze data. A companion document (EMAP Statistical Methods Manual by Diaz-Ramos, Stevens, and Olsen -- EPA/620/R-96XXX Revision 0, May 1996) describes some of the technical detail. The manual is intended for scientists with some statistical training. Technical documentation targeted for statisticians is also available from the EMAP Statistics and Design Team in Corvallis, Oregon.

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Appendix J

Example Description of State Assessment Methods: Illinois

project. In the future, data collected by these volunteers will be used for the educational purposes of school age groups as well as adult volunteer organizations and to assist the IEPA in updating stream use assessments for the Illinois Water Quality Report. For the current 305(b) reporting cycle, IEPA reviewed water chemistry data from rivers and streams collected by high schools throughout the state to assist in use support determinations.

B. ASSESSMENT METHODOLOGY

Traditionally, designated use support assessments for rivers and streams in Illinois have focused on attainment of aquatic life use. In this report for the 1992 reporting cycle, multiple uses based on current water quality standards have been assessed (See Tables 4 and 5). These standards protect various uses including aquatic life, fish consumption, swimming, drinking water supply and secondary contact where applicable. Specific criteria for determining attainment of these individual uses are described in detail below. Minor revisions to the assessment methodology for aquatic life use attainment have been incorporated in accordance with the Federal guidance (U.S. EPA, 1991). These assessments, however, are comparable to those in previous reporting cycles. An overall use support summary for rivers and streams is also provided. The degree of use support attainment is described as: Full, Full/Threatened, Partial/Minor impairment, Partial/Moderate impairment, and Nonsupport.

Aquatic Life

Aquatic life use assessments were based on a combination of biotic and abiotic data generated from IEPA monitoring programs (See Section A). Biotic data consist of fishery and macroinvertebrate information which were evaluated using the Index of Biotic Integrity (IBI) and the IEPA Macroinvertebrate Biotic Index (MBI), respectively. Types of abiotic data utilized in Aquatic Life Use attainment assessments included water chemistry, fish tissue analysis, sediment chemistry and physical habitat. Stream habitat included metrics such as depth, velocity, substrate and instream cover. Habitat data were used to estimate biotic potential in the form of a Predicted Index of Biotic Integrity value (PIBI) generated from a multiple regression equation. Water chemistry data were evaluated by categories identified as conventionals (dissolved oxygen, pH, temperature) and toxicants (priority pollutants, chlorine, ammonia). Fish tissue and sediment chemistry were based largely on the presence of heavy metals and/or organochlorine compounds.

A few waterbodies were assessed for aquatic life use based only on abiotic data (water or sediment chemistry). In the case of water chemistry only data, a toxicity based criteria for acute and chronic water quality standards were applied (Table 6). For waterbodies where only sediment chemistry data were available, aquatic life use assessments were made utilizing general criteria provided in Table 7. Where appropriate, documented impairments, such as habitat degradation, were also factored into these assessments.

A summary of abiotic and Aquatic Life Use Assessment Criteria, as well as general descriptors of water quality conditions are depicted in Table 8. Also included in Table

TABLE 6. CRITERIA FOR WATER CHEMISTRY USED FOR ASSESSING AQUATIC LIFE USE IN RIVERS AND STREAMS.

Degree of Aquatic Life Use Support	Criteria
Full	0 or 1 violation per parameter of acute standard within 5 year period or no more than 10% of the total individual samples may exceed chronic standard.
Partial/Minor	2 violations per parameter of acute standard within 5 year period or > 10% to 18% of the total individual samples may exceed chronic standard.
Partial/Moderate	2 violations per parameter of acute standard within 3 consecutive year period or 18% to 25% of the total individual samples may exceed chronic standard.
Nonsupport	3 or more violations per parameter of acute standards within 5 year period or > 25% of the total individual samples exceed the chronic standard.

TABLE 7. CRITERIA FOR SEDIMENT CHEMISTRY USED FOR ASSESSING AQUATIC LIFE USE IN ILLINOIS RIVERS AND STREAMS.

Degree of Aquatic Life Use Support	Sediment Chemistry
Full	Metals and organochlorine compounds generally found at nonelevated levels, although some metal or organochlorine compounds may be present at slightly elevated concentrations.
Partial/Minor	Organochlorine compounds or metals occur in stream sediments at elevated levels.
Partial/Moderate	Organochlorine compounds or metals present in stream sediment at highly elevated levels.
Nonsupport	Organochlorine compounds or metals consistently found at extreme concentrations.

TABLE 8. SUMMARY OF USE SUPPORT ASSESSMENT CRITERIA FOR ILLINOIS STREAMS.

U.S. EPA	FULL SUPPORT		PARTIAL SUPPORT MINOR	PARTIAL SUPPORT MODERATE	NON-SUPPORT
GENERAL DESCRIPTION	Good	Good	Fair	Fair	Poor
IEPA/IDOC BIOLOGICAL Stream Characterization (BSC)	Unique Aquatic Resource	Highly Valued Resource	Moderate Aquatic Resource	Limited Aquatic Resource	Restricted Aquatic Resource
FISH/Index of Biotic Integrity (IBI/AIBI)	51-60	41-50	31-40	21-30	< 20
BENTHOS/Macroinvertebrate Biotic Index (MBI)	< 5.0	5.0-5.9	6.0-7.5	7.6-8.9	> 8.9
STREAM Potential Index of HABITAT/Biotic Integrity (PIBI)	51-60	41-50	31-40	< 31	
STREAM IEPA Stream Sediment SEDIMENT/Classification	Nonelevated	Nonelevated -Slightly Elevated	Slightly Elevated	Elevated -Highly Elevated	Extreme

8 are descriptors for Illinois' stream classification process or Biological Stream Characterization (BSC). The overall assessment process for Aquatic Life Use attainment is presented in Figure 3. Field observations were selectively factored into the aquatic life use assessment process through a review of comments and observations of pollution sources and causes of impairment recorded on stream survey field forms. When available, volunteer stream monitoring data was reviewed and incorporated into the assessment process. Professional judgement and knowledge of the study area were required for assessments where various index values appeared to be based upon unrepresentative samples or when conflicts in data needed to be resolved.

"Threatened waters" refers to those waters that fully support their designated use but may not fully support uses in the future (unless pollution control action taken) because of anticipated sources or adverse pollution trends (U.S. EPA 1993). For the 1992-1993 Illinois Water Quality Report the threatened determination was made with the use of available chemical, physical, and biological date and/or information on land use activities. Stream reaches previously assigned full aquatic life use ratings were considered to be threatened when:

- compared to previous monitoring data, current chemical, biological, or physical indicators for exceptional waters exhibited a slight decline in stream quality;
- compared to previous monitoring data, current chemical, biological, or physical indicators exhibited a notable reduction in stream quality, which if continued, might result in a decline of the rating from full to partial support or lower; or
- current activities in the watershed or adjacent to the stream reach might result in impairments and a reduction of the full use designation.

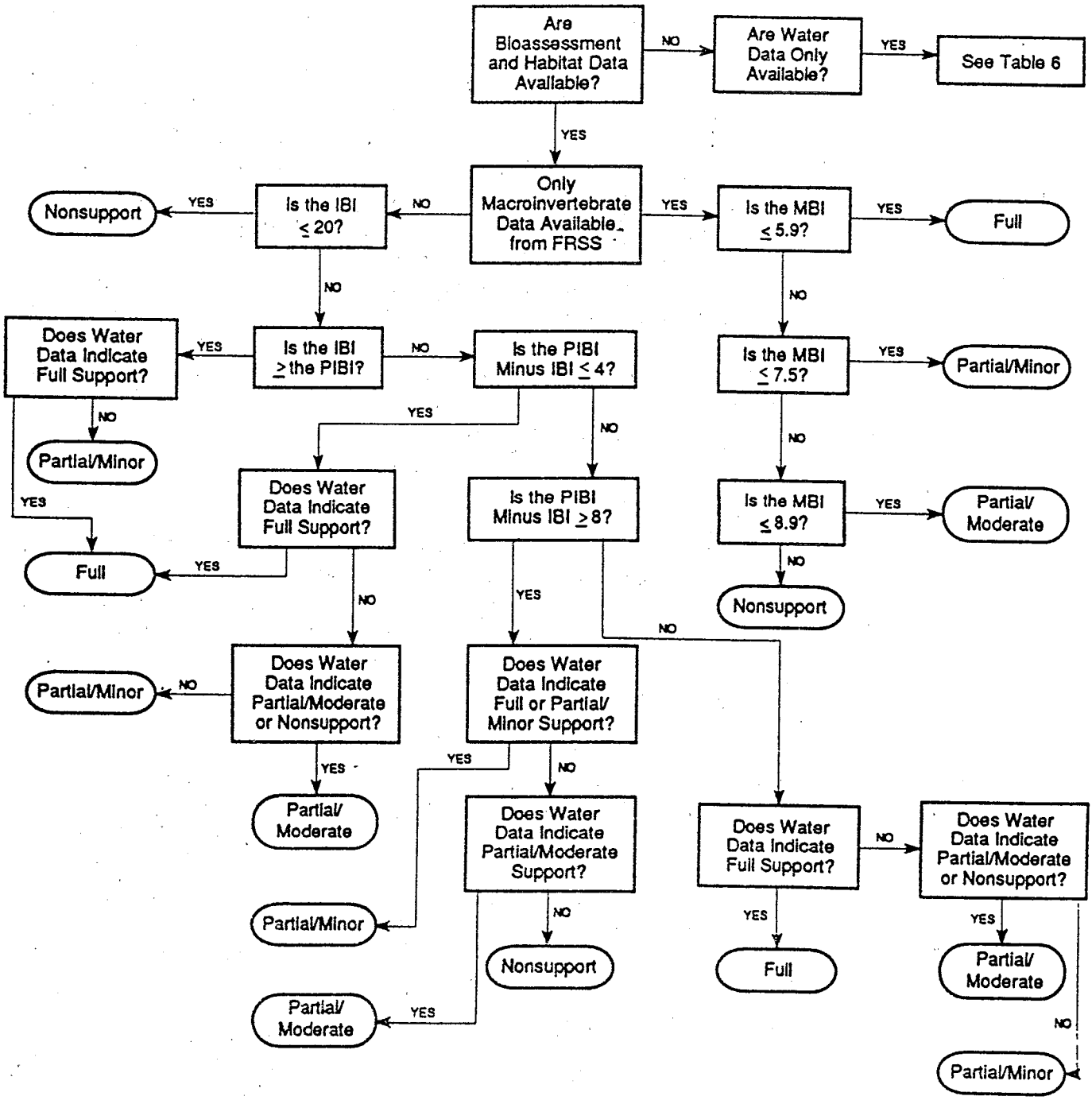
Fish Consumption

The assessment of fish consumption use was based on fish tissue data and resulting sport fish advisories generated by the Fish Contaminant Monitoring Program (See Public Health Chapter). The degree of use attainment for fish consumption was assessed utilizing the criteria depicted in Table 9. All rivers and streams in Illinois, including secondary contact waters, are considered to be attainable for fish consumption use.

Swimming

The assessment of swimming use for primary contact recreation was based on fecal coliform bacteria and water chemistry data from the AWQMN (See Section A). The current Illinois Pollution Control Board (IPCB) bacterial water quality standard specifies that fecal coliform levels below 200/100 ml of water, sampled during the months of May through October should be adequate to protect the State's water for general use and primary contact. Seasonal fecal coliform data and water chemistry data for a period of the last five years from AWQMN stations were analyzed. Geometric means for fecal coliform results were calculated using only those samples collected during warm weather months when recreation in or on the water is likely. Fecal coliform geometric means and individual sample values were compared to the criteria in Table 10. Individual sample values were considered in violation of the standard only if the corresponding total suspended solids value was less than or equal to the fiftieth percentile total suspended solids value for that

Figure 3. Aquatic Life Use Support Assessment Flow Chart for Fish, Habitat and Water Quality Data



station. These criteria provide only an indication of whether or not swimming use attainment can be expected. IT SHOULD BE NOTED THAT THESE CRITERIA ARE ONLY USED AS INDICATORS. TO ASCERTAIN SPECIFIC PUBLIC HEALTH IMPLICATIONS, MORE FREQUENT BACTERIOLOGICAL DATA WOULD BE REQUIRED. Stream miles assessed for swimming included those reaches represented by AWQMN stations. Rivers and streams not considered to be attainable included those designated as secondary contact and indigenous aquatic life use (See Figure 2) as well as those where disinfection exemptions have been approved.

Drinking Water Supply

Drinking Water Supply use assessments for rivers and streams were determined on the basis of water supply closures or advisories obtained from the IEPA's Public Water Supply programs. Rivers and streams utilized as primary source for drinking water supplies were identified. Assessments were based solely on water quality conditions and not on physical closures or relocations due to flooding. The degree of use attainment utilized the criteria identified in Table 11.

Secondary Contact

The assessment of secondary contact use was based on water chemistry data generated from IEPA's monitoring programs (See Section A), primarily the AWQMN. Secondary contact use is the most limited designated use with Illinois State Standards and applies only to certain streams and canals in the Chicago area (Figure 2). These few waters are not, therefore, required to attain primary contact recreational uses such as swimming. All available water chemistry data for the last five-year time period was compared to Secondary Contact Standards (Table 4). Determination of the degree of uses support was based on the assessment criteria in Table 12.

TABLE 9. CRITERIA FOR ASSESSING FISH CONSUMPTION USE IN ILLINOIS RIVERS AND STREAMS.

Degree of Use Support	Criteria
Full	No fish advisories or bans are in effect.
Partial/Moderate	"Restricted Consumption" fish advisory or ban in effect for general population or a subpopulation that could be at potentially greater risk (e.g. pregnant women, children). Restricted consumption is defined as limits on the number of meals or size of meals consumed per unit time for one or more fish species. In Illinois, this is equivalent to a Group II advisory.
Nonsupport	"No consumption" fish advisory or ban in effect for general population for one or more fish species; commercial fishing ban in effect. In Illinois, this is equivalent to a Group III advisory.

TABLE 10. CRITERIA FOR ASSESSING SWIMMING USE IN ILLINOIS RIVERS AND STREAMS.

Degree of Use Support	Criteria
Full	Geometric mean of samples comply with standard or standard exceeded in ≤ 10% of samples.
Partial/Minor	Geometric mean and > 10% but ≤ 18% of samples exceed standard.
Partial/Moderate	Geometric mean and > 18% but ≤ 25% of samples exceed standard.
Nonsupport	Geometric mean and > 25% of samples exceed standard.

TABLE 11. CRITERIA FOR ASSESSING DRINKING WATER SUPPLY USE IN ILLINOIS RIVERS AND STREAMS.

Degree of Use Support	Criteria
Full	No drinking water supply closures or advisories in effect during reporting period; no treatment necessary beyond "reasonable levels".
Partial/Minor	One or more drinking water supply advisory lasting 30 days or less; or problems not requiring closures or advisories but adversely affecting treatment costs and the quality of polished water, such as taste and odor problems, color, excessive turbidity, high dissolved solids, pollutants requiring activated charcoal filters, etc.
Partial/Moderate	One or more drinking water supply advisories lasting more than 30 days per year.
Nonsupport	One or more drinking water supply closures per year.

TABLE 12. CRITERIA FOR ASSESSING SECONDARY CONTACT USE IN ILLINOIS RIVERS AND STREAMS.

Degree of Use Support	Criteria
Full	≤ 10% violations in secondary contact standards.
Partial/Minor	> 10% - 18% violations in secondary contact standards.
Partial/Moderate	> 18% - 25% violations in secondary contact standards.
Nonsupport	> 25% violations in secondary contact standards.

Overall Use

The overall use support of rivers and streams was also assessed. In reviewing the individual use assessments, aquatic life use was considered the best single indicator of overall stream conditions. The overall use support was reported at two assessment levels; monitored and evaluated.

Evaluated waters were those waterbodies for which the overall use support decision was based on information other than current site-specific monitoring data. The assessment basis included a combination of land use information and location of sources, monitoring data more than five-years old, volunteer data, and/or best professional judgement.

Monitored waters were those waterbodies for which the overall use support decision was principally based on current site-specific monitoring data believed to accurately portray water quality conditions. Waterbodies with chemical, physical or biological monitoring data were used to make monitored assessments. Monitored assessments were completed for each site sampled in conjunction with IEPA monitoring (See Section A) conducted in the past five years (1989-1993); however, in certain instances, intensive survey data prior to 1988 was considered representative and used in the assessment process.

C. STATEWIDE WATER QUALITY SUMMARY

For purposes of this report required by Section 305(b) of the Federal Clean Water Act, the estimated number of navigable river and stream miles in and bordering Illinois include a total of 32,190 miles (31,280 interior river miles; 910 border river miles). Data results from over 1,500 river and stream monitoring stations were used in the statewide assessment of overall and individual use supports. These stations are part of ongoing monitoring programs which include the Ambient Water Quality Monitoring Network (AWQMN), Intensive River Basin Surveys, Facility-Related Stream Surveys, and Special Surveys (see Section A).

Overall Use Support

A total of 14,159 of the 32,190 stream miles (44.0%) in Illinois were assessed for the degree of overall use support (Table 13). Statewide assessments were based on both evaluated (4,855.2 stream miles or 34.3%) and monitored (9,303.7 stream miles or 65.7%) levels of assessment. Since overall use support assessments were based on aquatic life use, the results are discussed collectively. Overall use (aquatic life use) was rated as full support on 6,650.3 stream miles (47.0%); 251.7 stream miles (1.8%) were rated as threatened. Partial support with minor impairments of overall use were present on 5,847.9 stream miles (41.3%) and 1,232.4 stream miles (8.7%) were rated as partial support with moderate impairments. Statewide, only 176.6 stream miles (1.2%) were rated as not supporting overall uses.

TABLE 13. STATEWIDE SUMMARY OF DEGREE OF OVERALL USE SUPPORT FOR ILLINOIS RIVERS AND STREAMS.

Degree of Overall Use Support	Assessment Category: Evaluated Miles	Monitored Miles	Total Assessed
Full	2,551.6	4,098.7	6,650.3
Full/Threatened	53.8	197.9	251.7
Partial/Minor	1,801.3	4,046.6	5,847.9
Partial/Moderate	396.7	835.7	1,232.4
Nonsupport	51.8	124.8	176.6
TOTAL	4,855.2	9,303.7	14,158.9

Individual Use Supports

The fish consumption use was assessed on 2,832.5 stream miles (Table 14). Full use support was present on 2,325.6 stream miles (82.1%). The remaining 506.9 stream miles (17.9%) were rated as not supporting fish consumption. These nonsupport segments were limited to portions of the Des Plaines, Illinois, Sangamon and Mississippi Rivers (see Public Health Chapter). Of the 2,907.1 stream miles assessed for swimming, 787.9 (27.1%) were rated as full use support (Table 14). Partial support with minor impairment of the swimming use occurred on 91.5 stream miles (3.2%) and 462.2 stream miles (15.9%) were rated as partial support with moderate impairment. The remaining 1,565.5 stream miles (46.2%) were not supporting the swimming use. The swimming use was not applicable to 2,354.8 stream miles. This included secondary contact waters and streams where disinfection exemptions were present. The secondary contact use was applicable to 91.6 stream miles in the Des Plaines River basin. Of these, 24.0 stream miles were rated as full use support. No data was available to assess the remaining 67.6 stream miles. The drinking water use (PWS) was assessed on 822.5 stream miles. Of these, 603.3 stream miles (73.4%) were rated as full use support. Partial support with minor impairment was present on 150.8 stream miles (18.3%) and 68.4 stream miles (8.3%) were rated as partial support with moderate impairment. There were no stream miles rated as not supporting the drinking water use (Table 14).

Causes of Less Than Full Support of Designated Uses

Stream miles impacted by specific cause categories statewide are summarized in Table 15. Stream segments were generally impacted by multiple causes. A comparison of individual cause categories weighted by miles of impairment is shown in Figure 4. The primary cause categories which resulted in less than full

Appendix K

Section 106 Monitoring Guidance and Guidance for 303(d) Lists

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

OCT 17 1994

MEMORANDUM

OFFICE OF WATER

SUBJECT: Section 106 Monitoring Guidance

FROM: Geoffrey H. Grubbs, Director
Assessment and Watershed Protection Division (4503F)

TO: Regional Water Quality Branch Chiefs
Regional Field Branch Chiefs
Regional Monitoring Coordinators

Attached is the final Section 106 Guidance for Water Quality Monitoring. This has been a long time in the making, as we wanted to be sure the involved and affected parties had ample chance to work with us to make this both a good product and a consensus document likely to be implemented. We have worked on this guidance with members of the Intergovernmental Task Force on Monitoring Water Quality, whose framework for water quality monitoring programs this incorporates, and also with members of the Association of State and Interstate Water Pollution Control Administrators. We have worked with individual State staff, with our Regional Monitoring Coordinators, Water Quality Branch Chiefs and Field Branch Chiefs, and members of various water programs within the Office of Water. In particular, Chuck Kanetsky of Region III put long hours into working with various drafts, and we owe him heartfelt thanks. I thank you all for your comments and involvement.

This 106 monitoring guidance is a key tool in our extensive efforts to work with our partners to improve the water quality monitoring across the country. We are seeking to specifically identify impaired waters across the country. We are seeking to monitor more of our waters, but do so more cost-effectively by employed monitoring techniques appropriate to the condition of and goals for the water. We are seeking greater comparability in monitoring parameters and methods so we can all share data more easily and aggregate it into various geographic scales, from site-specific through watershed, regional and State/Tribal to national. We are seeking to report water quality using common indicators to measure our progress toward meeting our agreed-upon water quality goals. We are seeking to work more closely and share information more easily with our many public and private monitoring partners, especially in a watershed context. This 106 guidance supports all these efforts, and is a tool we can effectively use as we work with States to revitalize monitoring programs and report core information in a comparable fashion.

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Section 106 and 604(b) Grant Guidance

Water Monitoring

I. 106/604(b) Monitoring Goals

Overall Goal Develop and implement a surface and ground water monitoring strategy to help achieve the goals and objectives of the Clean Water Act (CWA) and other environmental initiatives. In doing so use a mix of approaches that provide for the design, collection, measurement, storage, retrieval, assessment, and presentation of physical, chemical/toxicological,and biological/ecological data necessary to implement this monitoring efficiently and effectively, making best use of multiple agency resources.

An overall monitoring strategy includes monitoring for the purposes of 1) determining status and trends, 2) identifying causes and sources of problems and ranking them in priority order, 3) designing and implementing water management programs, 4) determining compliance and program effectiveness, and 5) responding to emergencies.

Among other management goals, monitoring supports the development and attainment of water quality standards, 303(d) listings and Total Maximum Daily Load (TMDL) development, NPDES permit limitations, nonpoint source controls, geographic initiatives such as watershed and ecosystem protection, and the measurement of chosen environmental indicators.

Monitoring coverage and design goals. Assess all State waters [surface, ground, and coastal water and wetlands] on a periodic basis (4 - 10 years as negotiated between the Region and the State) using a monitoring design targeted to the condition of and goals for the waters, and incorporating various approaches (e.g. fixed station and synoptic survey, intensive and screening-level monitoring, probability sampling and design). For example, some States use a five-year basin-by-basin monitoring cycle.

Data collection and methods goals. Collect chemical/toxicological, physical, biological/ecological, habitat, and land use/land cover data employing comparable methods with other agencies so as to be able to share data. Use multiple water quality assessment techniques (e.g., fish tissue, population and community surveys, habitat assessments, sediment data, soils and geological data analysis, and toxicity testing) as appropriate to meet the goals and objectives of the monitoring program. Include latitude and longitude with all samples following the guidelines established under EPA's Locational Data Policy. (See Attachment A.)

Environmental indicator goals. Identify specific environmental indicators to measure and report on progress towards achieving the identified program goals.

Data and information sharing goals. Store the data in automated systems that enable data to be easily shared, analyzed, and portrayed. Put appropriate data into EPA's STORET and the Waterbody System.

Analysis and reporting goals. Analyze the data and report it in the State 305(b) report supported by the Waterbody System or comparable database and in other reports tailored to the audiences who need to know the information.

Reference condition goals. Establish ecoregional reference stations for biological monitoring programs in order to provide baseline data for water quality assessments and development of biocriteria.

Collaboration goals. Coordinate planned monitoring activities with existing and planned monitoring programs in other public and private organizations to gain maximum benefit from sharing information.

II. DEFINITIONS For the purposes of this guidance:

"State" covers States, Indian Tribes, and Territories in this guidance.

"Water quality" refers to physical, chemical/toxicological, and biological/ecological properties of water resources.

"Water resources" include surface and ground waters, coastal waters, associated aquatic communities and habitats, wetlands, and sediment.

"Monitoring activities" include identification of program objectives; selection of indicators; field data collection; laboratory analysis; quality assurance/quality control (QA/QC); data storage, management and sharing; data analysis; and information reporting.

III. PROGRAM ACTIVITIES:

A. Monitoring Strategy States should provide a multi-year (preferably 5-year) monitoring strategy with the 106 grant application. This will provide the framework for Regional/State agreement on an annual monitoring workplan. For this the State can develop or revise its existing water monitoring strategy in consultation with EPA Regional monitoring staff and other affected State program managers. The strategy should be consistent with related program

goals. To the extent possible, use information already available, such as 305(b) report information.

Ambient and program-specific. The strategy should include both ambient and program-specific monitoring. States should summarize all program-specific monitoring activities such as for nonpoint source, lakes, estuaries, wetlands, groundwater (for which soil and geology characterization is important), and wet weather surveys (CSO/stormwater), NPDES, TMDL, 305(b) and 403(c) and describe how the ambient and program-specific monitoring programs are integrated to provide the total body of information necessary to support water quality management programs.

B. **Monitoring Program Workplan.** States should describe their monitoring program in the context of their multi-year monitoring strategy, or revise the overall strategy as needed each year to specify annual activities. The goal is to integrate information from existing reports (305(b), QAPPs, methods manuals) to avoid and eventually eliminate, duplication. Where possible, the monitoring workplan should include the following elements:

1. Purpose

a. Goals. List the goals of your monitoring program, the specific objectives or questions you are trying to answer, and who needs the information.

b. Data quality objectives. Specify data quality objectives (a statement of the quality of environmental information necessary to support the goals you identify). See Attachment B for list of available EPA guidance on quality assurance plans.

c. Boundary delineation. If other than the entire State, identify the boundaries of geographic areas you target for monitoring, such as watersheds or waterbodies, and the time frames in which you will monitor them.

d. Environmental Indicators. Identify the parameters or suites of physical, chemical, biological and habitat parameters you are measuring to determine if you are achieving your goals. Where possible, include the indicators developed by the Office of Water to measure national water goals.

e. Reference conditions. Establish reference conditions for environmental indicators that can be monitored to provide a baseline water quality assessment.

2. Coordination/Collaboration. Identify other agency programs (e.g., nonpoint source, Clean Lakes, RCRA, EMAP/REMAP etc.) or other separate agencies or groups (such as USGS, NOAA, or the Nature Conservancy) with similar monitoring goals or information you can use to support your management goals, and discuss how you will collect and/or share information with them.

3. Design and Implementation.

   a. Identify existing water quality problems and information gaps.

   b. Develop timelines to accomplish program objectives.

   c. Identify who is to collect, analyze, interpret, and receive the water quality information.

   d. Identify sampling approach (including fixed station, synoptic, event sampling, intensive surveys) for biological/ecological, physical, chemical/toxicological, and habitat indicators.

      Describe the approaches used, including the number of surveys planned to be initiated or completed during the fiscal year and for each:

      1. Stream (or basin) name and study and station locations.
      2. Objective(s) of study;
      3. Parameters monitored (physical, chemical/toxicological, biological/ecological, habitat)
      4. Sampling frequency of parameters
      5. Reference to method of data collection and analysis;
      6. Reference to appropriate quality assurance project plan;
      7. Final report date.

   e. Specify data collection methods.

      1. A Standard Operating Procedures manual should be prepared and submitted to the Regional Quality Assurance Officer to document collection methodologies.

      This manual should identify field methods, including sampling procedures for physical, chemical/toxicological, biological/ecological, and habitat monitoring activities.

Report any modification to collection methods or problems associated with the implementation of the methods to the Regional Quality Assurance Officer.

2. Ensure that all data is accompanied by the latitude and longitude at which it was collected (see Attachment A) to allow better sharing of data and integration into spatial analysis systems such as Geographic Information Systems (GIS).

f. Provide laboratory analytical support.

1. Provide for laboratory analytical support. Employ laboratory analytical methods comparable with the requirements of 40 CFR, Part 136, as revised in October 1991.

2. State Laboratory personnel should continue participation in EPA's Performance Evaluation studies.

g. Prepare quality assurance and quality control plans.

1. Review, revise, and implement the existing Quality Management Plans (QMP) and Quality Assurance Project Plans (QAPP) to reflect the most effective parameters and methods, including those for conventional parameters, toxicity testing, biological surveys, fish tissue analysis, habitat surveys and sediment collection and analytical protocols. State QMP and QAPP must be implemented in a manner consistent with EPA regulations (see Attachment B), Regional Grant conditions and EPA's Guidelines.

For QA management plans, use guidance provided in EPA's "Interim Guidelines for Preparing Quality Assurance Program Plans" QAMS-00480 or its updated version "EPA Requirements for Quality Management Plans," EPA QA/R-2. (Choice of documents currently dependent on the specific EPA Region Policy).

For QA project plans, use guidance provided in EPA's "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," QAMS-005/80 or its updated version "EPA Requirements for Quality Assurance Project

Plans," EPA QA/R-5. (Choice of documents currently dependent on the specific EPA Region Policy). (See the new referenced documents listed in Attachment B).

All QMP and QAPP revisions undertaken during the fiscal year should be submitted to the Regional Office for review and approval. Also, any problems encountered in implementing the approved QMP and QAPP should be reported. States should submit an annual QA report as part of their end-of-year report to include any problems encountered in implementing the approved QMP and QAPPs.

h. Provide for data storage, management and sharing

1. Store quality-assured data in a computerized database that will enable data to be easily accessed and shared. Provide hardcopy of monitoring data within a reasonable time if requested.

2. All monitoring data should be accompanied by appropriate latitude/longitude information according to EPA's Locational Data Policy. (See Attachment A.) This will allow GIS portrayal and analysis.

3. Water quality monitoring data should be entered into STORET within 3 - 6 months after data collection and analysis.

4. Fish tissue data (both freshwater and saltwater) should be entered in Ocean Data Evaluation System (ODES).

5. Toxicity test data should be entered into ODES or comparable database.

i. Provide training and support.

1. Ensure necessary training of staff for field and laboratory activities, data management, and data assessment.

2. Provide support for volunteer monitoring programs. Volunteer monitoring is valuable for two reasons: 1) education and stewardship and 2) provision of useful screening or other data if volunteers are appropriately trained.

Where volunteer data is to be used for government decision-making, a quality assurance plan should be prepared by the volunteer group and reviewed for approval by the appropriate State agency.

4. Interpretation and Communication

   a. Report all assessments of waterbodies for designated use support including causes and sources of impairments in the section 305(b) Waterbody System or upload such information from a compatible State system on an annual basis.

   b. In order to use the section 305(b) assessment information for GIS and other spatial analyses, States should [move towards] georeferencing the waterbodies identified in the Waterbody System. States should reference the waterbodies with reach numbers at the Reach File 3 level. EPA support is available.

   c. Identify waters where water quality is known or suspected of being impaired due to any physical, chemical, or biological stressor and report such information as appropriate in the 1996 305(b) report and its supporting Waterbody System. This report should be consistent with and draw upon the information from reports in accordance with the Clean Lakes (314), Nonpoint Source (319), TMDL (303(d)) and other appropriate assessment programs.

   d. Work with your Region to have accessible annually information on all final and ongoing monitoring reports, site-specific evaluations, biological surveys and special monitoring projects. The information should include the study objective, contact name, location of study, and reference to the associated QA project plan.

5. Program Evaluation

   a. Annually review and update where necessary the State monitoring strategy, workplan, and quality assurance management and project plans.

   b. Provide a brief (no more than two pages) assessment of the effectiveness of the monitoring program in providing data suitable to meet program objectives as set forth in the State monitoring strategy (e.g. what changes are needed

in the monitoring program to evaluate new or emerging problems or meet objectives that were not achieved). Include a list of the other programs and agencies with which you have coordinated to obtain your monitoring information.

CHAPTER 13 - LOCATIONAL DATA

1. PURPOSE. This policy establishes the principles for collecting and documenting latitude/longitude coordinates for facilities, sites and monitoring and observation points regulated or tracked under Federal environmental programs within the jurisdiction of the Environmental Protection Agency (EPA). The intent of this policy is to extend environmental analyses and allow data to be integrated based upon location, thereby promoting the enhanced use of EPA's extensive data resources for cross-media environmental analyses and management decisions. This policy underscores EPA's commitment to establishing the data infrastructure necessary to enable data sharing and secondary data use.

2. SCOPE AND APPLICABILITY. This policy applies to all Environmental Protection Agency (EPA) organizations and personnel of agents (including contractors and grantees) of EPA who design, develop, compile, operate or maintain EPA information collections developed for environmental program support. Certain requirements of this policy apply to existing as well as new data collections.

3. BACKGROUND.

   a. Fulfillment of EPA's mission to protect and improve the environment depends upon improvements in cross-programmatic, multi-media data analyses. A need for available and reliable location identification information is a commonality which all regulatory tracking programs share.

   b. Standard location identification data will provide a return yet unrealized on EPA's sizable investment in environmental data collection by improving the utility of these data for a variety of value-added secondary applications often unanticipated by the original data collectors.

   c. EPA is committed to implementing its locational policy in accordance with the requirements specified by the Federal Interagency Coordinating Committee for Digital Cartography (FICCDC). The FICCDC has identified the collection of latitude/longitude as the most preferred coordinate system for identifying location. Latitude and longitude are coordinate representations that show locations on the surface of the earth using the earth's equator and the prime meridian (Greenwich, England) as the respective latitude and longitude origins.

d. The State/EPA Data Management Program is a successful multi-year initiative linking State environmental regulatory agencies and EPA in cooperative action. The Program's goals include improvements in data quality and data integration based on location identification.

e. Readily available, reliable and consistent location identification data are critical to support the Agencywide development of environmental risk management strategies, methodologies and assessments.

f. OIRM is committed to working with EPA Programs, Regions and Laboratories to apply spatially related tools (e.g., geographic information systems (GIS), remote sensing, automated mapping) and to ensure these tools are supported by adequate and accurate location identification data. Effective use of spatial tools depends on the appropriate collection and use of location identifiers, and on the accompanying data and attributes to be analyzed.

g. OIRM's commitment to effective use of spatial data is also reflected in the Agency's comprehensive GIS Program and OIRM's coordination of the Agency's National Mapping Requirement Program (NMRP) to identify and provide for EPA's current and future spatial data requirements.

4. AUTHORITIES.

a. 15 CFR, Part 6 Subtitle A, Standardization of Data Elements and Representations

b. Geological Survey Circular 878-B, A U.S. Geological Survey Data Standard, Specifications for Representation of Geographic Point Locations for Information Interchange

c. Federal Interagency Coordinating Committee on Digital Cartography (FICCDC)/U.S. Office of Management and Budget, Digital Cartographic Data Standards: An Interim Proposed Standard

d. EPA Regulations 40 CFR 30.503 and 40 CFR 31.45, Quality Assurance Practices under EPA's General Grant Regulations

5. POLICY.

a. It is EPA policy that latitude/longitude ("lat/long") coordinates be collected and documented with environmental and related data. This is in addition to, and not precluding, other critical location identification data that may be needed to satisfy individual program or project needs, such as depth, street address, elevation or altitude.

b. This policy serves as a framework for collecting and documenting location identification data. It includes a goal that a 25 meter level of accuracy be achieved; managers of individual data collection efforts determine the exact levels of precision and accuracy necessary to support their mission within the context of this goal. The use of global positioning systems (GPS) is recommended to obtain lat/longs of the highest possible accuracy.

c. To implement this policy, program data managers must collect and document the following information:

(1) Latitude/longitude coordinates in accordance with Federal Interagency Coordinating Committee for Digital Cartography (FICCDC) recommendations. The coordinates may be present singly or multiple times, to define a point, line, or area, according to the most appropriate data type for the entity being represented.

The format for representing this information is:

+/-DD MM SS.SSSS (latitude)
+/-DDD MM SS.SSSS (longitude)

where:

- Latitude is always presented before longitude
- DD represents degrees of latitude; a two-digit decimal number ranging from 00 through 90
- DDD represents degrees of longitude; a three-digit decimal number ranging from 000 through 180

- **MM** represents minutes of latitude or longitude; a two-digit decimal number ranging from 00 through 60
- **SS.SSSS** represents seconds of latitude or longitude, with a format allowing possible precision to the ten-thousandths of seconds
- **+** specifies latitudes north of the equator and longitudes east of the prime meridian
- **-** specifies latitudes south of the equator and longitudes west of the prime meridian

(2) Specific method used to determine the lat/long coordinates (e.g., remote sensing techniques, map interpolation, cadastral survey)

(3) Textual description of the entity to which the latitude/longitude coordinates refer (e.g., north-east corner of site, entrance to facility, point of discharge, drainage ditch)

(4) Estimate of accuracy in terms of the most precise units of measurement used (e.g., if the coordinates are given to tenths-of-seconds precision, the accuracy estimate should be expressed in terms of the range of tenths-of-seconds within which the true value should fall, such as "+/- 0.5 seconds")

d. Recommended labelling of the above information is as follows:

- "Latitude"
- "Longitude"
- "Method"
- "Description"
- "Accuracy."

e. This policy does not preclude or rescind more stringent regional or program-specific policy and guidance. Such guidance may require, for example, additional elevation measurements to fully characterize the location of environmental observations.

f. Formats, standards, coding conventions or other specifications for the method, description and accuracy information are forthcoming.

6. RESPONSIBILITIES.

a. The Office of Information Resources Management (OIRM) shall:

(1) Be responsible for implementing and supporting this policy

(2) Provide guidance and technical assistance where feasible and appropriate in implementing and improving the requirements of this policy

b. Assistant Administrators, Associate Administrators, Regional Administrators, Laboratory Directors and the General Counsel shall establish procedures within their respective organizations to ensure that information collection and reporting systems under their direction are in compliance with this policy.

While the value of obtaining locational coordinates will vary according to individual program requirements, the method, description and accuracy of the coordinates must always be documented. Such documentation will permit other users to evaluate whether those coordinates can support secondary uses, thus addressing EPA data sharing and integration objectives.

7. WAIVERS. Requests for waivers from specified provisions of the policy may be submitted for review to the Director of the Office of Information Resources Management. Waiver requests must be based clearly on data quality objectives and must be signed by the relevant Senior IRM Official prior to submission to the Director, OIRM.

8. PROCEDURES AND GUIDELINES. The Findings and Recommendations of the Locational Accuracy Task Force supplement this policy. More detailed procedures and guidelines for implementing the policy are issued under separate cover as the Locational Data Policy Implementation Guidelines.

Attachment B

QUALITY ASSURANCE GUIDANCE INFORMATION

The Agency Quality Assurance (QA) Program is based in EPA Order 5360.1 "Policy and Program Requirements to Implement the QA Program" April 17, 1984. This order and quidance documents for preparing QA Project Plans and QA Programs plans have been the principal agency quidance documents for some years. An extensive EPA effort is now underway to update, codify and expand QA quidance including replacement of the Order with an Order and manual containing the new requirements and quidance documents.

The key new EPA QA documents for State use are:

EPA QA/R-2 EPA Requirements for quality Management Plans

QA/R-2 is the policy document containing the requirements for Quality Management. QA/R-2 is the replacement for QAMS-004/80 and the subsequent internal EPA quidance on QA Programs Plans issued in 1987.

EPA QA/R-5 EPA Requirements for Quality Assurance Project Plans.

QA/R-5 is the replacement for QAMS-005/80. This policy document establishes the requirements for QA Project Plans prepared for activities conducted by or funded by EPA.

EPA QA/G-4 Guidance for the Data Quality Objectives Process

QA/G-4 provides non-mandatory quidance to help organizations plan, implement, and evaluate the Data Quality Objectives (DQO) process, with a focus on environmental decision-making for regulatory and enforcement decisions. This quidance assists in the preparation of the DQO section of EPA QA/R-2 and QA/R-5.

ATTACHMENT C

APPLICABLE REGULATIONS

Grant Administration

A. 40 CFR Part 130.11 stipulates the program management aspects of these grant programs and the contents of the State work programs.

Monitoring

A. 40 CFR Part 130.4 requires that States must establish appropriate monitoring methods and procedures necessary to compile and analyze data on the quality of waters of the United States.

B. 40 CFR Part 35.260 limits funding (if any) under Section 106 of the Clean Water Act if a State which fails to monitor, compile, and analyze data, and report water quality as described under Section 106(e)(1).

Reporting

A. 40 CFR Part 35.360(b) does not allow funding under Section 205(j)(1) to a State agency that fails to report annually on the nature, extent and causes of water quality problems in various areas of the State and Interstate region.

B. 40 CFR Part 130.8(d) specifies that in the years that the section 305(b) is not required, States may satisfy the annual Section 205(j) report requirement by certifying that the most recently submitted section 305(b) report is current or by supplying an update of the sections of the most recently submitted section 305(b) report which require updating.

Planning

A. 40 CFR Part 130.6 identifies the need for continuing water quality planning and defines the content of the water quality management plans. Continuing water quality planning shall be based upon the water quality management plans and the problems identified in the latest section 305(b) report. State water quality plans should focus annually on priority issues and geographic areas and on development of water quality controls leading to implementation measures.

Quality Assurance

A. 40 CFR Part 31.45 states that the grantee shall develop and implement quality assurance practices consisting of policies, procedures, specifications, standards, and documentation sufficient to produce data of quality to adequately meet project objectives and to minimize loss of data due to out-of-control conditions or malfunctions.

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

AUG 27 1997

OFFICE OF
WATER

MEMORANDUM

SUBJECT: National Clarifying Guidance For 1998 State and Territory Section 303(d) Listing Decisions

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

TO: Water Division Directors, Regions I-X
Directors, Great Water Body Programs
Water Quality Branch Chiefs, Regions I-X

States and Territories (referred to collectively in this memorandum as "States") have made significant progress in developing their section 303(d) lists since the 1992 revision of the water quality management and planning regulations (at 40 CFR Part 130). The attached guidance clarifies several key policies related to listing of waters under section 303(d) for the 1998 listing cycle. The attached guidance is intended to supplement existing EPA section 303(d) listing guidance; all existing national guidance is also applicable to development of the 1998 lists, except with regard to those issues that are explicitly addressed and clarified in today's guidance.

Today's clarifying guidance applies only to the State section 303(d) lists of waters due on April 1, 1998, as required by 40 CFR section 130.7. EPA has convened an advisory committee under the Federal Advisory Committee Act to recommend long-term changes to the TMDL program. After the Federal advisory committee on TMDLs presents its recommendations to the Administrator in mid-1998, EPA may propose significant changes to current regulations, as well as the policies presented in this guidance and other existing guidance, which would then govern the development and approval of State section 303(d) lists for the year 2000 and beyond.

Today's guidance is one of several interim steps that EPA is taking to strengthen the TMDL program while the Federal advisory committee deliberates. The attached guidance addresses only a limited number of key issues that must be clarified before the 1998 section 303(d) lists are submitted to EPA. Other issues not addressed here will be addressed in future guidance or regulations, after consideration of the advisory committee's recommendations.

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Important Reminders

The increased scrutiny that we all face as we assist States in implementing the TMDL program requires that we do our best to help States develop approvable and defensible section 303(d) lists in 1998. Therefore, in addition to the clarifications set out in the attached guidance, I would like to highlight several issues that we have addressed in past guidance:

- First, I ask that you each work closely with your Regional Counsel's Office and with each of your States to ensure that there is a complete administrative record supporting every list approval and disapproval decision.

- Under 40 CFR section 130.7(b)(5), States must consider all "existing and readily available water quality-related data and information" in compiling section 303(d) lists. EPA regulations provide that such data and information should be actively solicited from various sources, including local, State, or Federal agencies, the public, or academic institutions (40 CFR section 130.7(b)(5)(iii)). In addition, the information contained in EPA's Index of Watershed Indicators is appropriate to consider as part of the listing process, but should not form the only documentation upon which a listing decision is based. In making decisions to approve or disapprove State section 303(d) lists, EPA should evaluate whether States have used all "existing and readily available water quality-related data and information."

- EPA's regulations require a State to include an impaired waterbody on the State's section 303(d) list if pollution controls (including technology-based effluent limitations for point sources and best management practices (BMPs) for nonpoint sources) are not stringent enough to implement any applicable water quality standards (40 CFR section 130.7(b)). EPA's *Guidance for 1994 Section 303(d) Lists* (November 26, 1993) clarifies that, if "BMPs or [Coastal Zone Act Reauthorization Amendments] management measures have been established or implemented and water quality standards have been attained or are expected to be attained in the near future, then the waterbody need not be included on the section 303(d) list." This 1993 guidance also clarifies that "near future" in this context should normally be viewed as prior to the required date for the next section 303(d) list.

- Consistent with EPA regulations (40 CFR section 130.7(b)(4)), States should include on the 1998 section 303(d) lists an identification of the specific pollutant(s) causing or expected to cause exceedances of applicable water quality standards. The 1998 lists should also indicate whether the waterbody is impaired for one or more pollutants.

- Finally, several States have chosen to provide to EPA an annual update to their section 303(d) list. 40 CFR section 130.7(d) requires that States submit section 303(d) lists to EPA "on April 1 of every even numbered year." EPA is therefore not required to take a formal approval or disapproval action on an annual list update. However, I ask that each

Region respond in some way to any such updates, if the update is provided prior to the April 1, 1998 list submission deadline, either by informally advising the State of the adequacy of the update or by advising the State that such an update should be incorporated into the State's 1998 list submittal.

State Assistance

A number of efforts are underway to assist States in implementing the TMDL program. Without your help, many of these efforts would not be possible.

First, the President's FY 1998 Budget requests substantially increased resources directly aimed at helping States succeed in their section 303(d) listing and TMDL activities. EPA technical and program assistance resources supporting section 303(d) activities would be increased by 10 FTE and $8 million in available contract support. State 106 grants would also be increased by $5 million for State section 303(d) responsibilities. EPA technical and program assistance for nonpoint source management would be increased by $5 million in available contract support. These funds have been requested by the President, but will not be available unless appropriated by the Congress.

To provide additional technical assistance to the States, EPA's Office of Science and Technology has begun a series of Regional workshops on BASINS, a tool that will allow States to organize and display geographic information and model pollutant loadings to characterize the overall condition of specific watersheds. In addition, OWOW's Assessment and Watershed Protection Division is working with the Regional TMDL Coordinators and others to complete a series of protocols for developing TMDLs for nutrients, bacteria, clean sediment, and variable flow situations. These TMDL protocols will be peer reviewed in the Fall of 1997, at which time they will be made available to the States in draft form. We will also provide technical and financial assistance to a number of States in FY 1998 to help establish Reach File 3 georeferencing capabilities for waterbodies on 1998 section 303(d) lists.

To help administer the TMDL program, we are currently developing a TMDL tracking system -- a data management system to track and analyze State and EPA activities and commitments related to section 303(d), including the status of State lists, identification of listed waters, TMDL development schedules, and any court ordered obligations. A prototype of the system will be tested during the Fall of 1997.

Thank you for your continued hard work and dedication. If you have any questions, please call me or Geoff Grubbs, Director of the Assessment and Watershed Protection Division, at (202) 260-7040, or ask your staffs to contact your Headquarters TMDL liaison or Don Brady, Chief, Watershed Branch, at (202) 260-1261.

Attachment

cc: Mike Llewelyn, President, ASIWPCA
Alan Hallum, Chair, ASIWPCA Watershed Task Force
All Members, TMDL FACA Committee
TMDL Coordinators, Regions I-X

NATIONAL CLARIFYING GUIDANCE FOR 1998 STATE AND TERRITORY CLEAN WATER ACT SECTION 303(d) LISTING DECISIONS

The following guidance clarifies several key policies related to development of Clean Water Act section 303(d) lists by States and Territories (referred to collectively in this guidance as "States"). It applies only to the State lists of impaired waters[1] due on April 1, 1998, as required by 40 CFR section 130.7. It is very important that States meet this deadline since EPA will be reviewing the State lists in April 1998 and taking appropriate action, consistent with applicable regulations and guidance.

Today's guidance clarifies existing EPA section 303(d) listing guidance documents, i.e., *Guidance for Water Quality-based Decisions: The TMDL Process* (April 1991); *Supplemental Guidance on Section 303(d) Implementation* (August 12, 1992); *Approval of 303(d) Lists, Promulgation Schedules/Procedures, Public Participation* (October 30, 1992); and *Guidance for 1994 Section 303(d) Lists* (November 26, 1993). These national guidance documents remain applicable to the development of the 1998 lists except with regard to those issues that are explicitly addressed and clarified below.

Waterbodies Where Water Quality Standards Are in the Process of Being Revised

State section 303(d) lists and the subsequent development of TMDLs are linked to applicable State water quality standards. 40 CFR section 130.7(b)(1) provides that waterbodies included on State section 303(d) lists are those waterbodies for which pollution controls required by local, State, or Federal authority, including technology-based or more stringent point source effluent limitations or nonpoint source best management practices, are not stringent enough to implement any water quality standard applicable to such waters. 40 CFR section 130.7(b)(3) defines "water quality standard applicable to such waters" as "those water quality standards established under section 303 of the [Clean Water] Act, including numeric criteria, narrative criteria, waterbody uses, and antidegradation requirements."

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[1] EPA's regulations, at 40 CFR section 130.2(j), define "water quality-limited segment" as "any segment where it is known that water quality does not meet applicable water quality standards, *and/or is not expected to meet* applicable water quality standards, even after the application of the technology-based limitations required by sections 301(b) and 306 of the Act" (emphasis added). Therefore, for the 1998 listing cycle, States should consider both impaired and threatened waters for inclusion on their 1998 section 303(d) lists. For ease of reference, the phrase "impaired waters" as used in this guidance refers to both impaired and threatened waters.

States may revise their water quality standards to address changes such as a Use Attainability Analysis (as provided by 40 CFR section 131.10), development of a site-specific criterion, or updated science. Several States have asked whether they may exclude waters from the State section 303(d) lists if a water quality standard is in the process of being revised to be less stringent than the standard that is in effect. They are concerned that once the water quality standard has been revised, a waterbody that was water quality-limited under the old water quality standard may not be water quality-limited under the revised water quality standard.

A decision not to list because a water quality standard is in the process of being revised would be inconsistent with the regulations cited above and the Clean Water Act, which require a State to identify "those waters within its boundaries" where controls "are not stringent enough to implement *any water quality standard applicable to such waters*" (section 303(d)(1)(A) of the Clean Water Act, emphasis added). Therefore, for the 1998 listing cycle, States should include on their section 303(d) lists waters that do not meet an applicable water quality standard at the time of listing, even if the standard is in the process of being revised to be less stringent. If the standard is in fact revised in the future, the water may be removed from the section 303(d) list at that time provided the water no longer meets the listing requirements. States have the discretion, of course, to assign a low priority to those waters where there is a likelihood that they may be removed from the list in the near future.

Standards Exceedances Due to Atmospheric Deposition of Pollutants

In past section 303(d) lists submitted to EPA, some States have included waterbodies that do not meet applicable water quality standards due to pollutants from atmospheric deposition, while other States have not listed such waterbodies. 40 CFR section 130.7(b)(1), which requires State section 303(d) lists to include water quality-limited waterbodies still requiring TMDLs, does not differentiate between exceedances of applicable standards based on the source of pollution.

Although EPA recognizes that controlling pollutants from atmospheric deposition may be difficult, section 303(d) and the implementing regulations at 40 CFR section 130.7 do not allow the decision to include a waterbody on a State section 303(d) list to depend upon the ease with which a source of a pollutant can be controlled. Further, EPA's *Guidance for 1994 Section 303(d) Lists* (November 26, 1993) specifies that "[t]he section 303(d) list provides a comprehensive inventory of waterbodies impaired by *all sources*, including point sources, nonpoint sources, or a combination of both" (emphasis added).

For the 1998 State section 303(d) lists, States should include waterbodies that do not meet an applicable water quality standard due entirely or partially to pollutants from atmospheric deposition. For sources of the airborne pollutant located within State boundaries, States should consider the extent to which existing air pollution control authorities in State Implementation Plans adopted pursuant to the Clean Air Act and local ordinances could be used or enhanced to

further reduce emissions of the air pollutant and abate the associated water quality problem. In those cases where atmospheric deposition is associated with long-range transport of pollutants across State boundaries and sources and effects are not completely understood at this time, EPA Regional Offices should take a leadership role to join the air pollution and water pollution programs of the Region and the involved States, and to create a regional research and abatement strategy.

Waterbodies Impaired by Temperature

Even though State section 303(d) lists provide a comprehensive inventory of waterbodies impaired by all sources, States have not listed waterbodies with temperature problems under section 303(d) in a consistent manner. For the 1998 State section 303(d) lists, waterbodies that do not meet an applicable State water quality criterion for temperature or a designated use due to temperature should be listed. Listing is appropriate because the applicable water quality standard is not met. Heat, the cause of the impairment, is defined as a "pollutant" under section 502(6) of the Clean Water Act and can be allocated. It is immaterial to the listing decision whether the source of the temperature-related impairment is a thermal discharge or solar radiation. Both are sources of heat, and the heat can be allocated through the TMDL process.

Waterbodies Impaired by an Unknown Source or an Unidentified Pollutant

40 CFR section 130.7(b)(1) provides that waterbodies included on State section 303(d) lists are those waterbodies for which pollution controls required by local, State, or Federal authority, including technology-based or more stringent point source effluent limitations or nonpoint source best management practices, are not stringent enough to implement any water quality standard applicable to such waters. In addition, 40 CFR section 130.7(b)(4) requires States to identify, in each section 303(d) list submitted to EPA, the "pollutants causing or expected to cause violations of the applicable water quality standards."

These regulatory provisions apply even if the source of the pollutant cannot be identified at the time of listing. Therefore, for the 1998 listing cycle, waterbodies impaired by an unknown source should be included on 1998 State section 303(d) lists, as long as there is a pollutant associated with the impairment. Listing may be based on pollutant loadings from unknown point and nonpoint sources, and includes situations where a pollutant is found in fish tissue such that there is an exceedance of applicable water quality standards, but the pollutant is not traceable to a particular source.

In addition, 40 CFR section 130.7(b)(4) requires States to include on their lists an identification of the *specific* pollutant(s) causing or expected to cause exceedances of applicable water quality standards. In some situations, however, a *specific* pollutant has not been identified at the time of listing. Therefore, for the 1998 listing cycle, where a water is impaired but a specific pollutant has not been identified, States should, if possible, indicate on the 1998 State

section 303(d) lists the class of pollutants (e.g., metals or nutrients) causing, or believed to be causing, the impairment. Moreover, for the 1998 listing cycle, States should indicate whether the water is impaired for one or more pollutants.

Waterbodies Impaired Solely by Physical Barriers to Fish Migration

If a waterbody is not meeting its designated use, the applicable water quality standard is also not met and the waterbody is therefore impaired. In some situations, a physical barrier to fish migration (e.g., a culvert) can result in an impairment to a waterbody's use as an aquatic fishery. The TMDL process may be used to establish load allocations for pollutants that are preventing the attainment of water quality standards. In the specific case of a physical barrier to fish migration such as a culvert, however, there is no pollutant to allocate and the TMDL process is not appropriate. Therefore, for the 1998 section 303(d) lists, States are not required to list waterbodies where the use impairment results solely from a physical barrier to fish migration.

Waterbodies "Not Expected to Meet" Water Quality Standards

40 CFR section 130.2(j) defines water quality-limited segments as those waterbodies "where it is known that water quality does not meet applicable water quality standards, and/or *is not expected to meet* applicable water quality standards" (emphasis added). 40 CFR section 130.7(b)(4) requires States to identify, in each section 303(d) list submitted to EPA, the "pollutants causing or *expected to cause* violations of the applicable water quality standards" (emphasis added). In addition, 40 CFR section 130.7(b)(5)(1) requires States to consider waters identified in the State's most recent section 305(b) report as "threatened" as part of the "existing and readily available water quality-related data and information" considered when developing the section 303(d) list.

Therefore, States should consider inclusion of both impaired and threatened waters on their 1998 section 303(d) lists. EPA's *Guidance for Water Quality-based Decisions: The TMDL Process* (1991) also recommended that threatened waters be included on State section 303(d) lists. However, EPA has never articulated a time frame for this expectation that water quality standards will be exceeded in the future.

For the 1998 section 303(d) lists, a reasonable time frame is the two-year section 303(d) listing cycle itself. States should therefore include a waterbody on the 1998 section 303(d) lists if the waterbody presently meets an applicable water quality standard, but is expected to exceed that standard before the next list submission deadline, i.e., April 2000.

In making determinations whether waterbodies are expected to continue to meet water quality standards, States should use the definition of "threatened" in the *Guidelines for Preparation of the 1996 State Water Quality Assessments (305(b) Reports)*, issued in May 1995. These guidelines state on page 3-3 that:

> A waterbody is fully supporting but threatened for a particular designated use when it fully supports that use now but may not in the future unless pollution prevention or control action is taken because of anticipated sources or adverse pollution trends . . . States should use this category to describe waters for which actual monitoring or evaluative data indicate an apparent declining water quality trend (i.e., water quality conditions have deteriorated, compared to earlier assessments, but the waters still support uses).

EPA and States are currently in the final stages of revising the section 305(b) guidelines for the 1998 section 305(b) reporting cycle. This definition has not been changed for 1998, and should be used as the basis for determining whether a waterbody is expected to continue to exceed a water quality standard before April 2000.

Removal of Previously Listed Waterbodies from Section 303(d) Lists

EPA's *Guidance for 1994 Section 303(d) Lists* (November 26, 1993) describes two instances when a previously listed waterbody may be removed from a State's section 303(d) list prior to TMDL development: (1) if such waterbody is meeting all applicable water quality standards (including numeric and narrative criteria and designated uses) or is expected to meet these standards in a reasonable timeframe (e.g., two years) as a result of implementation of required pollutant controls; or (2) if, upon re-examination, the original basis for listing is determined to be inaccurate.

EPA's *Guidance for 1994 Section 303(d) Lists* (November 26, 1993) also describes several circumstances under which a previously listed waterbody could be retained on a State's section 303(d) list after a TMDL had been established (and approved by EPA) for that waterbody. 40 CFR section 130.7(b)(1) describes the section 303(d) list as "water quality-limited segments still requiring TMDLs." This regulatory language is best interpreted to mean that, once a TMDL has been established (and approved by EPA) for a waterbody, that waterbody may be removed from the State's next section 303(d) list.

For purposes of the 1998 listing cycle, the State may (but is not required to) remove a previously listed waterbody from its 1998 section 303(d) list if a TMDL has been approved by EPA for that waterbody. However, if a waterbody is listed for more than one pollutant and a TMDL for one of the pollutants has been approved, that waterbody may be removed from the

1998 section 303(d) list *for that pollutant*, but not for the remaining pollutants.

Tracking the implementation of TMDLs is crucial. EPA and States should ensure that mechanisms are in place to track previously listed waterbodies that have been removed from a subsequent section 303(d) list. Such mechanisms may include reporting under section 305(b) and updates to State Water Quality Management Plans under 40 CFR section 130.6.

Waterbodies Impaired by Nonpoint Sources Only

EPA has consistently interpreted section 303(d)(1)(A) to apply to *all* waterbodies that do not meet applicable water quality standards, except for those where certain technology-based or other requirements will achieve standards. Consistent with long-standing EPA policy, regulations, and practice, States should include waterbodies impaired by nonpoint sources alone on 1998 section 303(d)(1)(A) lists, including such waterbodies on Federal lands.

Georeferencing Listed Waterbodies

It is important to accurately identify the location and extent of waterbodies on State section 303(d) lists. EPA's Reach File Version 3.0 (RF3) is a data base that interconnects and uniquely identifies the 3.2 million stream segments or "reaches" that comprise the Nation's surface water drainage system. The process of geographically referencing (georeferencing) involves the assignment of reach addresses to these waterbodies in order to establish their locations relative to one another in a manner similar to street addresses.

To the extent possible, States should use RF3 for georeferencing 1998 State section 303(d) listed waterbodies in a nationally consistent manner. When georeferencing to RF3 is not possible, States should provide the latitude and longitude of the start and end of the listed waterbody; when such waterbody is a lake or reservoir, States should use the latitude and longitude of the center of the waterbody. By georeferencing 1998 State section 303(d) lists to RF3, States and EPA will be able to analyze and track patterns, trends, and progress on local, State, regional, and national scales. Also, States will be able to analyze upstream/downstream relationships, as well as effectively link section 303(d) information to other water quality information, such as industrial dischargers, drinking water supplies, streams affected by fish consumption advisories, wild and scenic rivers, and section 305(b).

While some States have already assigned RF3 addresses to section 303(d) listed waterbodies, others have used a stream addressing system other than RF3 or have not yet georeferenced their section 303(d) lists. In FY 1998, EPA will provide technical and financial assistance to help a number of States who either have been using a stream addressing system

other than RF3 or have not yet georeferenced their section 303(d) lists to assign RF3 addresses to section 303(d) lists.

Indian Tribes

Protection of Tribal treaty rights and historic and accustomed uses can be an important consideration as States develop their section 303(d) lists. Therefore, when identifying State waters needing TMDLs, EPA strongly encourages States to cooperate closely with Tribes to assure that appropriate attention is given to Tribal concerns.

In addition, several States have included waters in Indian country on their section 303(d) lists in previous listing cycles. For the 1998 listing cycle, EPA's approval actions will extend to all the waterbodies on 1998 State section 303(d) lists with the exception of those waters that are within Indian country, as defined at 18 USC section 1151. For 1998, EPA will take no action to approve or disapprove State section 303(d) lists with respect to those waters within Indian country. EPA or eligible Indian Tribes, as appropriate, will retain responsibilities under section 303(d) for those waters. In addition, EPA approval actions of State section 303(d) lists do not constitute a finding of State and/or Tribal jurisdiction over particular waters.

Finally, this guidance does not address other section 303(d) listing requirements for waters in Indian country because circumstances are different from those of most States. However, a long-term approach, including new policies and guidance, is needed for developing section 303(d) lists for waterbodies in Indian country, as well as for developing and implementing TMDLs. The Office of Wetlands, Oceans, and Watersheds is working with EPA's American Indian Environmental Office and others to develop specialized TMDL policies and guidance for these waterbodies.

Appendix L

Information for Determining Sources of Designated Use Impairment

Table L-1. Some Types of Information Useful in Determining Sources of Water Quality Impairment

Source Category	Example Types of Information
Industrial Point Sources	Permit Compliance Records • analysis of DMRs • compliance monitoring or special monitoring in permits • WET or TIE bioassay tests Monitoring/Modeling Studies • upstream/downstream chemical, biological, and habitat monitoring • intensive surveys combined with WLA/TMDL modeling • complaint investigations • data from volunteer monitoring
Municipal Point Sources	Permit compliance records • analysis of routine DMRs • compliance monitoring or special monitoring in permits • WET or TIE toxicity bioassay tests Monitoring/modeling studies • upstream/downstream chemical, biological, or physical monitoring • intensive surveys combined with WLA/TMDL modeling • complaint investigations • data from volunteer monitoring
Combined Sewer Overflows	Permit compliance records • records of nonachievement of targets for frequency of wet weather overflows • implementation of other minimum control and pollution prevention methods (as in EPA CSO Control Policy) Monitoring/modeling studies • upstream/downstream chemical, biological, or physical monitoring comparing wet weather and normal flow conditions • intensive surveys combined with WLA/TMDL modeling • complaint investigations

Source Category	Example Types of Information
Agricultural Point Sources (e.g., CAFOs)	Permit compliance records • Observation of overflows from total retention (non-discharge) facilities • Compliance with provisions for off-site disposal of animal wastes (e.g., land application, composting) Monitoring studies • upstream/downstream chemical, biological, or physical monitoring (especially for nutrients and pathogens) • complaint investigations
Agriculture (NPS)	Information from monitoring and field observations (e.g., to document bad actors) • edge of field monitoring of runoff from animal holding areas, cropped areas, or pastures • monitoring of inputs from irrigation return flows, sub-surface drains, or drainage ditches • proper installation of screens or other measures to avoid fish losses in drainage/irrigation ditches • serious rill or gully erosion in agricultural fields • sedimentation problems in agricultural watersheds • indications of unmanaged livestock in streamside management zones • complaint investigations or data from volunteer monitoring or inventories Records on watershed BMP implementation status • documented low implementation level (e.g., less than a 70% target) of recommended water quality BMPs • documented problems with specific agricultural operators Modeling • Use of such models as AGNPS, SWAT or ANSWERS to estimate pollutant loads and improvement from BMP implementation • intensive surveys combined with WLA/TMDL modeling

Source Category	Example Types of Information
Silviculture (NPS)	Monitoring and field observations documenting instances of high sediment delivery to receiving waters • BMPs not followed on logging road, skid paths, or stream crossings • BMPs not followed to protect streamside management zones • serious sedimentation problems (cobble embeddedness or interstitial D.O. problems) in watersheds that are largely silvicultural Records on watershed BMP/management measure) implementation status • documented low implementation level of recommended water quality-oriented BMPs Results of modeling or cumulative effects analyses • Use of such models as WRENSS to estimate pollutant loads and likely improvement from BMP implementation • Use of water temperature models to help quantify impacts on cold water fisheries • use of landscape analysis techniques (e.g., the RAPID method or Integrated Riparian Area Evaluation method) to document cumulative effects • intensive surveys combined with WLA/ TMDL modeling
Construction	Information from monitoring and field observations (primarily to document problem areas or bad actors) • sedimentation problems documented in watersheds with major construction activity • complaint investigations and volunteer monitoring data Information from sediment control management agencies • records of implementation of sediment control measures

Source Category	Example Types of Information
Urban Runoff & Storm Sewers	Monitoring/modeling studies • upstream/downstream chemical, biological, or habitat monitoring comparing wet weather and normal flow conditions near outfalls • special monitoring for BMP effectiveness-wet ponds, artificial wetlands, grass swales • intensive surveys combined with WLA/ TMDL modeling and catchment models such as SWMM • complaint investigations Information from management agencies • documented low implementation level of recommended/required water quality-oriented BMPs • documented problems with BMP operation and maintenance
Resource Extraction (Petroleum)	Information from monitoring and field observations (primarily to document problem areas or bad actors) • evidence of oil and brine spills affecting sizable areas near receiving waters; elevated TDS, toxicity, oil and grease aesthetic impacts; increased erosion and sedimentation problems • complaint investigations and volunteer monitoring data Information from petroleum management agencies • records of recurrent problems with spills, pipeline breaks, over-berming of reserve pits, waste-hauler dumping
Resource Extraction (mainly surface mining)	Information from monitoring and field observations (primarily to document problem areas or bad actors) • evidence of decreases in pH, toxicity from heavy metals, excessive sedimentation, or stream reaches with iron bacteria in watersheds with active mining • complaint investigations and volunteer monitoring data Information from mining management agencies • records of recurrent permit violations (e.g., over-berming of settling ponds, failure to contain leachates, or failure to revegetate or restore mined areas)

Source Category	Example Types of Information
Land Disposal	Monitoring and field observations (primarily to document problem areas or bad actors) • monitoring indicates leachate migration from disposal area or industrial or domestic leach field failures • complaint investigations and volunteer monitoring Modeling • solute transport or plume models (e.g., PRIZM) indicate high potential for pollutants to reach receiving water
Hydromodification (Dams, flow regulation)	Monitoring and field observations • recurring problems with inadequate instream flows (e.g., dewatering of streams, reduced pollutant assimilation, unnatural water temperatures) • documented interference with fish migration and spawning movements (e.g., for such anadromous fish as salmon or rockfish but also for inland fish that seek spawning habitat outside lakes or large rivers) Modeling • Analysis using PHABSIM or other instream flow models to document adverse impacts • Analysis related to FERC permit renewal and State 401 Certification, habitat recovery plans under the ESA, or TMDL studies (e.g., problems with anoxic or nutrient-laden releases from hydrostructures)
Hydromodification (Channelization, dredging, removal of riparian vegetation, streambank modification, draining/filling of wetlands)	Monitoring (usually over considerable period of time) documenting adverse changes: • severe channel downcutting or widening • elimination of vegetation in streamside management zones • excessive streambank erosion and sloughing • loss of significant wetland area in watershed • failure of wetland mitigation projects Modeling studies • decreases in pollutant assimilation from habitat modification • adverse impacts on hydrology, water temperatures, or habitat

Source Category	Example Types of Information
Natural Sources	Monitoring and field observations of the presence of sources that are clearly not anthropogenic. • Saline water due to natural mineral salt deposits • Low DO or pH caused by poor aeration and natural organic materials • Excessive siltation due to glacial deposits • High temperatures due to low flow conditions or drought Note: the Natural Sources category should be reserved for waterbodies impaired due to naturally occurring conditions.

Appendix M

Section 319 v. Section 314 Funding

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

November 1996

Questions and Answers on the Relationship Between the Sec. 319 Nonpoint Source Program and the Sec. 314 Clean Lakes Program

1. What is the Section 319 Nonpoint Source Program?

Congress amended the Clean Water Act (CWA) in 1987 to establish the section 319 Nonpoint Point Source (NPS) Management Program because it recognized the need for greater federal leadership to help focus state and local NPS control efforts. Under section 319, States, Territories and Indian Tribes (hereinafter referred to as just "States") follow a two-step process to qualify for grant money under section 319(h). First, States must complete a NPS assessment report, identifying NPS water quality problems. Second, States are to develop NPS management programs describing what they are going to do about their nonpoint water quality problems over the next 4 years. As of Nov. 1994, all States, as well as six Tribal governments and six Territories, have completed assessments and management programs.

Since 1990, EPA Regional offices have funded projects under section 319(h) to supplement States' ongoing NPS management programs. As of the end of fiscal year 1996, EPA has awarded about $470 million nationwide in grants to States to implement NPS management programs. These funds support a wide variety of activities including nonregulatory or regulatory programs for enforcement, technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific NPS implementation projects. Notably, a portion of the section 319 grant funds has been used by States to support implementation of NPS controls in lake watersheds and to monitor the effectiveness of such controls.

2. What is the Section 314 Clean Lakes Program?

The Clean Lakes Program is a Federal grant program which was established in 1972 as section 314 of the Federal Water Pollution Control Act (now known as the CWA), to provide financial and technical assistance to States in restoring publicly-owned lakes. The early focus of the program was on research, development of lake restoration techniques, and evaluation of lake conditions (Lake Classification Studies). The Clean Lakes Program regulations (40 CFR 35 Subpart H), promulgated in 1980, redirected program activities to diagnose the current condition of individual lakes and their watersheds, determine the extent and sources of pollution, develop

feasible lake restoration and protection plans (Phase I Diagnostic/Feasibility Studies), and to implement these plans (Phase II Restoration/Protection Implementation Projects).

With the passage of the 1987 Amendments to the CWA, the Agency expanded the program to include Statewide assessments of lake conditions (Lake Water Quality Assessment grants). The Agency has encouraged States to use these assessment funds to also develop the institutional and administrative capabilities to carry-out their lakes programs. The Agency also established Phase III Post Implementation Monitoring studies to evaluate the longevity and effectiveness of various restoration and protection techniques (including watershed best management practices) implemented under Phase II grants.

The Clean Lakes Program has funded a total of approximately $145 million of grant activities since 1976 to address lake problems but there have been no appropriations for the program since 1994. EPA has not requested funds for the Clean Lakes Program in recent years, but rather has encouraged States in its recent section 319 guidance to use section 319 funds to fund "eligible activities that might have been funded in previous years under Section 314."

3. What does the new section 319 nonpoint source guidance say about the use of 319 funds to do work that was previously done under 314?

On May 16, 1995, EPA issued new guidance for implementing effective State NPS management programs under section 319 and for awarding section 319(h) grants to States. Key aspects of the guidance include: States are encouraged to update their NPS management programs; the guidance eliminates the competitive grants process starting in FY 1997; and the guidance allows the use of section 319 funds to update State NPS assessment reports and management programs. The guidance also includes a new section on "Lake Protection and Restoration Activities" which reads as follows:

> "5. Lake Protection and Restoration Activities
>
> Lake protection and restoration activities are eligible for funding under Section 319(h) to the same extent, and subject to the same criteria, as activities to protect and restore other types of waterbodies from nonpoint source pollution. States are encouraged to use Section 319 funding for eligible activities that might have been funded in previous years under Section 314 of the Clean Water Act. However, Section 319 funds should not be used for in-lake work such as aquatic macrophyte harvesting or dredging, unless the sources of pollution have been addressed sufficiently to assure that the pollution being remediated will not recur."

4. Can work which was previously done under the section 314 Clean Lakes Program be funded under section 319 grants?

The May 1996 section 319 grants guidance clearly states that "States are encouraged to use Section 319 funding for eligible activities that might have been funded in previous years under Section 314 of the Clean Water Act." **Thus, Phase I, II, and III projects, and lake water quality assessments which were previously done under the section 314 Clean Lakes Program are eligible for funding under section 319(h) grants.** However, the section 319 guidance further states that "(l)ake protection and restoration activities are eligible for funding under Section 319(h) to the same extent, and subject to the same criteria, as activities to protect and restore other types of waterbodies from nonpoint source pollution." Thus, for example, following are several key criteria that lakes-related work will need to meet in order to be eligible for funding under section 319:

1. Section 319(h) of the CWA provides that section 319(h) grants are to be made "for the purpose of assisting the State in implementing such (NPS) management program." Thus, in order for an activity to be eligible for funding under section 319(h) the activity must be included in a State NPS management program. State lake managers and lake communities will need to ensure that critical lake NPS control needs are included in any updated State NPS management programs so that such activities will be eligible for funding under section 319(h).

2. The May 1996 guidance allows States to use section 319 funds to update State NPS management programs and NPS assessments, including Phase I Clean Lakes Diagnostic-Feasibility Studies and statewide lake water quality assessments, subject to the following limitations. The guidance provides that "States may use up to 20 percent of their section 319(h) funds or $250,000, whichever is less, to update and refine their programs and assessments."

3. The May 1996 guidance continues the national monitoring program to evaluate the effectiveness of watershed implementation projects funded under section 319 projects. In fact, a number of the national monitoring projects include lakes.

5. What about in-lake work such as aquatic macrophyte harvesting and dredging, etc.?

The May 1996 guidance states that "(s)ection 319 funds should not be used for in-lake work, such as aquatic macrophyte harvesting or dredging, unless the sources of pollution have been addressed sufficiently to assure that the pollution remediated will not occur." Restrictions were put on in-lake work such as aquatic macrophyte harvesting and dredging due to concerns that the sources of the pollution need to be addressed first and also due to cost considerations. The May 1996 guidance is consistent with the Clean Lakes Program regulations at 40 CFR Part 35.1650-2

which state that projects may not include:

> "...costs for harvesting aquatic vegetation, or for chemical treatment to alleviate temporarily the symptoms of eutrophication, or for operating and maintaining lake aeration devices, or for providing similar palliative methods and procedures... Palliative approaches can be supported only where pollution in the lake watershed has been controlled to the greatest extent, and where such methods and procedures are a necessary part of a project during the project period..."

6. How can we assure that work that was previously done under section 314 is supported under section 319 in the future?

EPA Regional Clean Lakes Coordinators and EPA Regional Nonpoint Source Coordinators and their counterparts at the State/local level will need to work together to assure that critical lake NPS management needs are addressed through section 319. Key actions include assuring that lake management needs are included in updated State NPS assessment and management programs so that these activities are grant eligible and assuring that high priority lake management activities including Phase I, II, III and statewide lake water quality assessment activities are included in annual work programs for section 319(h) grants.

Appendix N

Examples of 305(b) Wetlands Information

Kewaunee County—Mapped Wetlands Two Acres Or More In Size*

WETLAND TYPE	1978 REPORTED ACREAGE (Second Most Recent Acreage)	MOST RECENT ACREAGE (1989)	ACREAGE** LOSS/GAIN	PERCENT CHANGE
Aquatics	20	0	-20	-100
Emergents	1,261	1,832	571	31
Scrub/Shrub, Deciduous	710	2,599	1,889	72
Scrub/Shrub, Coniferous	22	4	-18	-81
Forested, Deciduous	5,389	20,031	14,642	73
Forested, Conifereous	92	3,240	3,148	97
Open Water	22	49	-27	55
Class Unknown***	24,411	0	-24,411	-100
TOTALS	31,927	27,755	-4, 172	-13

Manitowoc County—Mapped Wetlands Two Acres Or More In Size*

WETLAND TYPE	1978 REPORTED ACREAGE (Second Most Recent Acreage)	MOST RECENT ACREAGE (1989)	ACREAGE** LOSS/GAIN	PERCENT CHANGE
Aquatics	49	0	-49	-100
Emergents	4,853	7,811	2,958	38
Scrub/Shrub, Deciduous	2,937	6,635	3,698	56
Scrub/Shrub, Coniferous	30	25	-5	-17
Forested, Deciduous	21,828	30,072	8,244	27
Forested, Conifereous	502	3,932	3,430	87
Open Water	186	393	207	53
Class Unknown***	24,824	0	-24,824	-100
TOTALS	55,209	48,868	-6,341	-11

* Wetland acreage estimates are based on the 1978 Wisconsin Wetland Inventory Maps and the 1989 map revisions.

**Wetland acreage increases are due to improved aerial photography and interpretation techniques and reversion of farmed wetlands back to wetland vegetation. Wetland acreage losses are due to improved aerial photography and interpretation techniques and the draining or filling of areas mapped as wetland in 1978.

***The unknown class represents the acreage of large wetland complexes whose internal boundaries were too detailed to digitize under time and budget contraints imposed on the project.

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Table D-5. Development of State Wetland Water Quality Standards

4/5/95

State	In Place						Under Development						Proposed					
	Use Classification	Narrative Criteria	Numeric Criteria	Narrative Biocriteria	Numeric Biocriteria	Antidegradation	Use Classification	Narrative Criteria	Numeric Criteria	Narrative Biocriteria	Numeric Biocriteria	Antidegradation	Use Classification	Narrative Criteria	Numeric Criteria	Narrative Biocriteria	Numeric Biocriteria	Antidegradation
Alabama																		
Alaska																		
Arizona								X										
Arkansas																		
California																		
Campo Indian Reservation							X			X	X	X						
Colorado																		
Connecticut		X	X			X	X											
Coyote Tribe							X									X		X
Delaware						X	X	X	X									
Delaware River Basin																		
District of Columbia													X					X
Florida	X			X*		X				X	X					X		
Georgia																		
Guam																		
Hawaii							X						X					
Hoopa Tribe							X									X		X
Idaho																		
Illinois																		
Indiana																		
Iowa	X	X	X	X		X												
Kansas	X			X		X											X	
Kentucky																		
Louisiana										X	X	X						
Maine																		
Maryland																		
Massachusetts	X	X	X									X						
Michigan																		
Minnesota	X	X	X			X				X	X							
Mississippi																		
Missouri						X										X	X	
Montana																		
Nebraska	X			X		X					X							
Nevada																		
New Hampshire																		
New Jersey																		
New Mexico																		
New York																		
North Carolina																		
North Dakota							X			X	X	X						
Ohio						X*	X			X							X	
Oklahoma																		
Oregon						X		X										
Pennsylvania																		
Puerto Rico						X												
Rhode Island	X			X		X												
South Carolina																		
South Dakota	X			X		X	X			X	X	X						
Tennessee																		
Texas																		
Utah						X												
Vermont																		
Virginia																		
Virgin Islands																		
Washington																		
West Virginia																		
Wisconsin		X		X		X		X										
Wyoming																		
Totals	8	5	4	7	0	15	9	4	1	7	7	5	2	0	0	4	3	3

Source: 1994 State Section 305(b) Reports.

X - State reported program status.

* In-place but revisions under development. Revisions include expanding coverage.

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Table D-5 (continued)

State	Implementation Process	Page Number
Alabama	Waters in wetlands are waters of the State, but wetlands are not defined for inherent values, e.g. habitat.	75
Alaska		
Arizona	Waters of the State, protected by standards for adjacent waters only.	47
Arkansas	Arkansas does not have a definition of wetlands, standards for wetlands, or legislation to protect them.	38
California		
Campo Indian Reservation		3-26
Colorado	No information.	
Connecticut	Municipal jurisdiction	Comments
Coyote Tribe	Some uses defined, but incomplete. Narrative biocritieria will be developed as funding permits.	III-20
Delaware	Wetlands are waters of the State; now developing criteria and uses for wetlands.	85
Delaware River Basin		
District of Columbia	District does not identify wetlands as waters of the District, but has narrative standards for wetlands?	91-92
Florida	Wetlands are waters of the State, regulated using the same standards as other waterbodies.	148-49
Georgia	Include wetlands as waters of the State.	30
Guam		
Hawaii		III-96
Hoopa Tribe	Some uses defined, but incomplete. Narrative biocritieria will be developed as funding permits.	
Idaho		
Illinois		
Indiana	Wetlands are waters of the state so standards apply to wetlands.	372
Iowa	Section 401, wasteload allocations, specific wetlands identified in State standards.	3-233-235
Kansas	Waters of the State, minimum designations for noncontact recreation and aquatic life support.	36
Kentucky	Wetlands are waters of the State, but standards do not have specific wetlands criteria.	2-4
Louisiana		
Maine	No regs for implementing Section 401.	73
Maryland		
Massachusetts		
Michigan	Will consider specific definition of wetlands as waters of the State in next triennial review.	177
Minnesota		III-22, 26
Mississippi	Wetlands-specific standards under consideration.	
Missouri	Wetlands not defined in State standards.	54
Montana	Standards for lakes and rivers apply to wetlands, but may not be technically appropriate.	32
Nebraska	Specific wetlands standards in 1993, incl designated uses, narrative criteria, numeric toxics criteria.	185
Nevada	No information	
New Hampshire	Wetlands are waters of the State but criteria have not been defined for wetlands.	III-6-5
New Jersey	Wetlands are waters of the State; in the near future, New Jersey will develop standards for wetlands.	V-27
New Mexico	Wetlands are waters of the State, designated for livestock and wildlife use. Specific standards in 1996-97.	175
New York		
North Carolina		
North Dakota		45
Ohio	Developing wetlands specific criteria.	145
Oklahoma	Currently, there are no specific water quality standards for wetlands.	
Oregon	Existing surface water standards apply to wetlands, but may not protect special wetlands functions.	3-54
Pennsylvania	Waters of the Commonwealth, but no specific standards for wetlands until EPA provides guidance.	104
Puerto Rico	No standards or designated uses for wetlands, but antidegradation applies to wetlands.	99
Rhode Island	State Section 401 Wetland Permit	III.F-3
South Carolina	Wetlands assume standards of adjacent waterbodies; SC is considereing wetlands-specific standards.	99
South Dakota	Wetlands are waters of the State, designated for wildlife propagation and stock watering.	
Tennessee		
Texas	Waters of the State; considering wetlands standards and clarifying general criteria applied to wetlands.	168
Utah	Antidegradation applies to wetlands, waters of the State.	142
Vermont		
Virginia	Inlcude wetlands as waters of the State; will consider including wetlands in narrative standards next review	93
Virgin Islands		
Washington		
West Virginia		
Wisconsin	Some criteria in place, some proposed	
Wyoming	Waters in wetlands defined as waters of the State, so wetlands quality is protected but not their existence.	293
Totals		

Source: 1994 State Section 305(b) Reports.

Chapter Six: Wetlands Water Quality Assessment

Background

Minnesota has made several advances in wetland protection and management during 1992 and 1993 including promulgation of two regulatory measures for the protection of wetlands. They include:

1) The administrative rules adopted by the Minnesota BWSR in accordance with the WCA of 1991; and

2) The development of wetland water quality standards, which will be effective in April 1994. Both these measures provide increased protection of wetlands, which are a key component of water resources in Minnesota.

WCA Implementation

The Board of Water and Soil Resources (BWSR) completed Minnesota Rules ch. 8420 which regulate the implementation of the WCA of 1991 by Local Government Units (LGU). Local government units include cities, counties, townships, soil and water conservation districts and watershed management agencies. The rule which took effect January 1, 1994 requires the LGU to regulate drain and fill activities in all wetlands that are not included as *public waters wetlands*. *Public waters wetlands* are the wetlands listed on the Protected Waters Inventory regulated by the MDNR under Minnesota Statute 103G. Under the WCA, certain wetland types, sizes and activities are exempted from regulation by the LGU. Regulations implementing the WCA provide authority to the LGU to grant one or more of 25 exemptions for certain project types. These exemptions principally apply to proposed land use activities on smaller less inundated wetlands. The LGU's are required to confirm to BWSR their acceptance of the responsibilities to administer requirements of the WCA and to indicate their jurisdictional area.

One of the strengths of local government regulation is their relative closeness to the wetland resource and their ability to integrate mandated wetland protection efforts with the local zoning and planning responsibilities. Another anticipated advantage to LGU administration of these wetland protection measures will be effective follow up monitoring and enforcement of conditions included in wetland replacement plans.

A challenge to this newly implemented local regulation will be for BWSR to coordinate the many officials in all cities, townships, counties, SWCDs and watershed management organizations that seek approval to implement this program within their jurisdiction. Training, program interpretation and application and consistency in wetland delineation will also be a major challenge.

Wetland Water Quality Standards and Authorities

Following USEPA guidance the MPCA recently developed narrative water quality standards for wetlands, as part of several revisions to Minnesota Rules ch. 7050. Following solicitation of outside opinion, a 30 day public notice period of the proposed rule, six administrative hearings and two appearances before the MPCA Citizens Board, Minnesota adopted the final rule on January 25, 1994. The following are the amendments pertaining to wetlands that were added to Minnesota Rules ch. 7050 during the 1993 triennial review of water quality standards:

1) Define wetlands in the water quality standards.
2) Assign water use classifications for wetlands.
3) Adopt narrative nondegradation standards to protect wetlands from harmful or otherwise objectionable conditions resulting from human activities.
4) Apply nondegradation standards to wetlands through wetland mitigation sequencing (avoid, minimize and mitigate).

Minnesota Rules ch. 7050 defines wetlands as: "those areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. Constructed wetlands designed for wastewater treatment are not waters of the state. Wetlands must include the following attributes:

1) A predominance of hydric soils.
2) Inundated or saturated by surface water or ground water at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation typically adapted for life in a saturated soil condition.
3) Under normal circumstances support a prevalence of such vegetation."

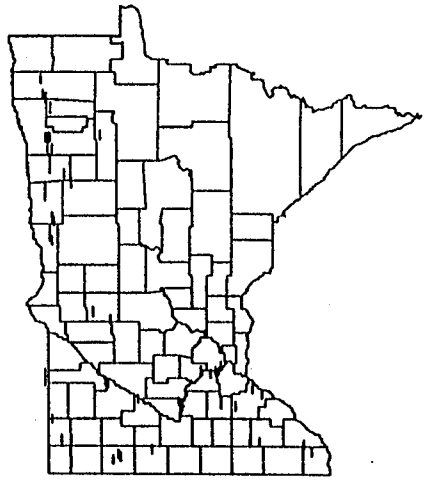
Wetlands have been assigned the following designated uses in the water quality standards: Class 2D wetland waters are protected in support of aquatic life and recreational uses. Dissolved oxygen levels in backgrounds less than 5.0 mg/l daily minimum must be maintained at background, pH and temperature must be maintained at background levels. Class 3D wetland waters are protected in support of industrial uses. Chlorides,

hardness and pH must be maintained at background levels. Class 4C wetland waters are protected for irrigation use and for uses of wildlife, livestock, erosion control, ground water recharge, low flow augmentation, storm water retention and stream sedimentation. In protecting these uses, pH must be maintained at background levels and settleable solids must not accumulate in amounts that result in a loss of use. Class 5 wetland waters are protected in support of aesthetic enjoyment and navigation. For protecting these uses, pH and hydrogen sulfide must both be maintained at background levels.

Through application of these narrative wetland standards, degradation of wetlands from permitted activities will not be allowed. To avoid this degradation associated with permitted activities, these activities are required to be avoided, minimized and in addition any unavoidable physical alterations must be adequately compensated by the replacement of the wetland acreage to satisfy the No-Net Loss Policy of the state. Physical alterations of wetlands would include activities resulting in loss of designated uses associated with filling, draining, excavating or inundating wetlands. Restoration of drained or degraded wetlands would not be considered a physical alteration.

Minnesota recognizes certain significant waters as ORVWs. In some instances wetlands are included in this designation. For example, a wetland is designated as an ORVW when located in a Scientific and Natural Area as designated by the MDNR. In addition, calcareous fens are listed as ORVWs because of their unique floral and faunal communities and their relative sensitivity to impact including hydrologic changes. Calcareous fens are identified and located by the MDNR (see Figure III-8). During each triennial revision of the water quality standards newly identified calcareous fens are considered for listing as ORVWs in state water quality rules.

Figure III-8. Location of 75 Calcareous Fens Listed as Outstanding Resource Value Waters in Minnesota Rules



Prior to this standards revision, state statutes included all waters, including wetlands, as "waters of the state." Therefore, wetland waters were already protected by the water quality standards. The standards developed are more appropriate to the wetlands resource and clarified the application of nondegredation policy to wetlands. The inclusion of a specific definition of wetlands as part of the revised standards was also requested by USEPA.

Another tool used to protect wetlands is Minnesota Executive Order 91-3. This Executive Order mandates that all state agencies protect, enhance and restore Minnesota's wetlands to the fullest extent of their authority. The Executive Order also established a strict policy of No-Net Loss of wetlands in the state that applies to projects under state agency jurisdiction. The revised water quality standards comply with this directive from the Governor and the MPCA continues to operate under that executive directive.

Figure III-9. Water Quality Measurements of 30 Reference Wetlands for Total Suspended Solids (in mg/L) and Turbidity in ntu Units

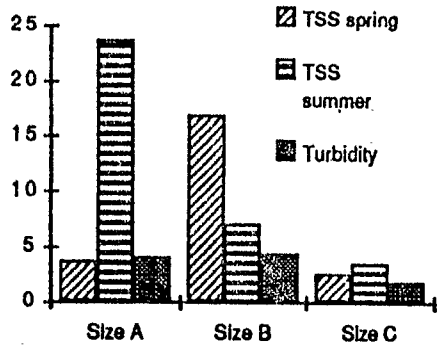
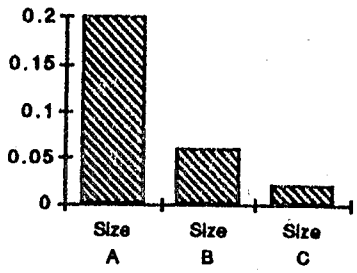


Figure III-10. Summer Values of Orthophosphate (in mg/L) for 30 Reference Wetlands



In Figures II-9 and III-10, 30 reference wetlands are grouped into three size classes:

Size A: 1.8 - 2.0 acres,
Size B: 2.1 - 3.5 acres, and
Size C: 3.6 - 34 acres.

Permit Simplification Activities

In Minnesota there are multiple levels of government involved in regulating activities in wetlands. The LGU administers provisions of the state WCA and the MDNR regulates wetlands designated as Public Waters Wetlands. The USCOE administers provisions of the CWA Section 404 program for all waters of the United States and Section 401 Water Quality Certification is provided by the MPCA.

State agencies including the BWSR, MDNR, MDOT, and MPCA, and federal agencies including the USCOE, USFWS, USEPA (Region 5) and the SCS are working together in an ongoing task force to resolve issues of wetland regulation in Minnesota. These agencies drafted a Memorandum of Understanding (MOU) that states the intent of the agencies to continue cooperation in simplifying wetland permitting activities. As a result of this cooperation the agencies requiring applications for permitting or approval of wetland activities have developed a single joint notification and application form. An applicant may fill out an application document and mail copies to the five agencies listed on the form. This satisfies initial application requirements in a single action. The USCOE has issued a public notice for a General Permit that will provide 404 permit approval for certain activities when they are approved by the LGU under the WCA.

Nationwide Permit Negotiations

Nationwide permits are issued by the USCOE under the CWA Section 404 program. The MPCA certified some of the nationwide permits with conditions, and denied certification for some of the nationwide permits due to water quality concerns. The USCOE and the MPCA negotiated acceptable Regional Conditions and Certification Conditions for the various certified permits. Conditions were applied to nationwide permit number 26, the most commonly used nationwide permit in Minnesota, 1) limiting its application to projects impacting less than three acres of wetland, 2) limiting its application to projects that do not impact ORVW, and 3) requiring notification of the MPCA, the MDNR, the Minnesota Office of Historical Preservation, the USFWS and the USEPA when the proposed project impacts 0.5 acres or more of wetland.

Storm Water Impact to Wetlands

Nonpoint source runoff and point source storm water significantly increase pollutant loadings to surface and ground waters. As these problem sources continue to be studied, different elements of the runoff flow characteristics and pollutant loads associated with them are correlated with the varying landscapes in Minnesota. Agricultural, forested, industrial, commercial areas and urban runoff all pose different challenges to provide either source reduction or BMPs to reduce water quality degradation caused by runoff in these areas. A common water quality BMP in many of these land use situations involves natural wetland basins in the watershed. Natural wetland basins provide water quality benefits to the watershed and the protection and restoration of wetlands for water quality improvement is a frequently used BMP.

Storm water management and the associated impact to wetlands in the urban area are among issues currently being explored by a federal, state and local agency task group. The MPCA promotes construction of storm water retention or treatment ponds in developing areas and the preservation of natural wetland basins as part of wetland protection efforts. Construction of storm water ponds and the preservation of natural wetland basins is sometimes difficult to achieve in developing areas where other incentives may be pushing for maximizing land development. The task group on Urban Storm Water has a mission to develop design criteria and wetland impact policy for storm water management and treatment and offer this information through publication and conferences to the many local, state and federal government agencies that regulate activities involving storm water and wetlands impacts.

Surface water planning is a component of local government, while the permitting for the draining or filling of wetlands associated with the implementation of these plans may involve state and federal authorities. Therefore, development of design criteria for storm water management systems is needed to achieve the desired treatment goals of all interests. Development of a policy for implementation of these design criteria is needed to ensure consistent wetland protection at all levels of government, thereby reducing the potential for government gridlock over projects where responsibilities may overlap.

Representing a predominantly agricultural area of the state, the Minnesota River basin study documented the importance of wetlands with relation to peak flow, sedimentation and chemical pollutants in tributaries and the main river stem. The study should lay a foundation for developing BMPs, wetland protection and wetland restoration techniques to achieve much needed water quality improvements in the watershed.

Comprehensive Wetland Planning

Beginning in July of 1993, Minnesota began a statewide comprehensive wetland conservation planning effort. The MDNR is facilitating this ongoing effort to coordinate existing local, state and federal wetland programs resulting in more effective management of wetland resources. As part of this planning effort, overall statewide wetland goals will be articulated and guidance will be developed for linking these goals with local decision makers. Participants in the planning process include representatives from: state asso-

ciations of cities, counties, watershed districts and SWCDs; state agencies including MDA, BWSR, DNR, MPCA and MDOT; federal agencies including the USCOE, USFWS, SCS, and Federal Highway Administration. The planning process will establish clear objectives for the state's wetland resources for the future, integrating existing regulatory and nonregulatory wetlands programs at all levels of government and identify new programs and strategies required to achieve the plan's objectives.

Basin Planning Initiative

The MPCA is developing a basin planning and management approach and at the same time is moving toward more quantitative and criteria based decision making. In making this shift the MPCA recognizes that there is only minimal existing water quality monitoring information available for wetlands. Therefore, one of the principal needs is to provide consistent monitoring methodologies for wetlands. Efforts are being formulated by the MPCA for initial water quality monitoring of wetlands in priority watersheds of selected basins. One benefit of this effort is to develop a multiple tiered approach for assessing designated uses of the wetland as part of these monitoring efforts. This multiple tiered assessment methodology would include working with local government units and citizens.

The Reference Wetlands Project

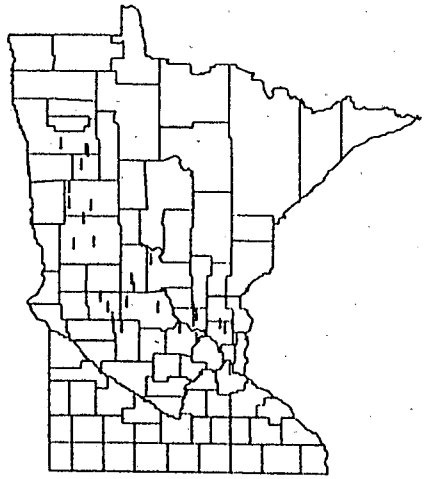
The MPCA has undertaken a reference wetland project to develop the basis for assessing the biological and chemical health of wetlands in Minnesota. The project, originally funded by the Legislative Commission on Minnesota Resources through the Environmental Trust Fund, is currently funded by USEPA through the Office of Research and Development. Biological assessment is important because changes in species composition can reflect pollution or habitat alteration. In addition, biological communities are a key to understanding whether restored wetlands can achieve a condition comparable to natural wetlands. This requires knowledge of reference wetlands that have had minimal disturbance.

Thirty-five isolated or depressional wetlands including three impact sites were selected in seventeen counties in the North Central Hardwood Forest Ecoregion in Minnesota (Figure III-11). These reference wetlands are located largely on public lands managed by Macalester College, the Nature Conservancy, MDNR Heritage Program, MDNR Wildlife, St. John's University, University of Minnesota and the USFWS (WPA's). Invertebrate communities were the main focus of study, but vegetation, amphibians, land cover around the wetlands, water and sediment chemistry were also analyzed.

Wetland water quality is surprisingly high with very clear water, low TSS (Figure III-9) and low orthophosphate (Figure III-10). Turbidity in the reference wetlands is in the range of the clearwater lakes of Northern Minnesota. In summer, water in the smaller sites becomes more chemically concentrated as they dry down. Sites less than two acres had higher TSS and orthophosphate in the summer than in the spring, while larger sites tended to have low TSS and lower phosphate in summer (Figures III-9 and III-10). Where conductivity, a measure of overall ionic concentration, is higher, there are greater numbers of some invertebrates in the wetlands.

Biologically the reference wetlands are very diverse. Invertebrates that act as predators in wetlands include many taxa or kinds of beetles, bugs, dragonflies and damselflies. These feed on a diverse array of herbivorous taxa, like the chironomids or midges, mayflies and caddisflies and crustaceans such as clam-shrimp and scuds. Nesting waterfowl and young ducklings are dependant on the rich invertebrate food source in wetlands. One small reference wetland had over 1,000 clam shrimp per sample, 23 taxa of beetles and five species of young frogs. This productive but temporary wetland was dry by July. A significant relationship exists between the size of the wetlands and the amount of frog reproduction, with smaller sites having more tadpoles per sample than larger wetlands.

Figure III-11. Location of 35 Reference Wetlands in the North Central Hardwood Forest Ecoregion



Present work involves determining 'guilds' or groups of taxa that indicate the condition of the habitat. There are some significant relationships between crustaceans, mayflies and damselflies to some water quality indicators. The diversity of the sedge family may be another useful indicator. A variety of indicators of wetland health including not just invertebrates, but vegetation diversity and the densities of amphibians is being evaluated. This will lead toward the multimetric or several parameter approaches advocated by USEPA for biological criteria.

Wetland Monitoring and Restoration Activities

The MPCA Duluth Regional Office began an effort in 1993 using volunteers to monitor breeding vocalizations of local frog populations in the riverine wetland areas along the St. Louis River. Each of the observation sites was visited three times from April through July. The data presented in Table III-9 shows that frog species vary greatly in their distribution. This difference may be due in part to site conditions and relative sensitivity of the various frog species to pollution related impacts. Similar efforts in other parts of the state including the Twin Cities Metropolitan area will over time provide valuable information about wetland health based on amphibian information. Table III-9 shows the frequency that each species was heard at 50 wetland sites in the first year of the St. Louis River survey. The value reflects the number of sites at which a species' breeding call was heard as a percentage of the 50 sites at which volunteers listened for calls.

Three sites reported hearing what was identified as a pickerel frog. This data is not included in the table because this identification was not confirmed and the sites are out of the normal range of the pickerel frog.

Though there is limited accounting of the status and trends of wetland resource condition in the state, several resource agencies have contributed to the restoration of the wetland resource base in Minnesota. Table III-10 shows approximate totals of restored wetland acres in three regions of Minnesota, as recorded by the USFWS and the SCS during 1992 and 1993. The majority of these restorations involved depressional or riverine wetlands concentrated in the prairie pothole region of the state. It should be noted that these figures of restored wetland acres represent best estimates of projects completed and/or under contract by the respective agencies.

Table III-9. Frequency of Frog Occurrence

Wood Frog	54%	American Toad	30%	Number of samples = 50,
Chorus Frog	40%	Gray Treefrog	44%	Data collected during the
Spring Peeper	80%	Mink Frog	4%	1993 St. Louis River
Leopard Frog	14%	Green Frog	12%	Vocalization Survey

Table III-10. Restored Wetland Acres by Region in Minnesota during 1992 and 1993 (Courtesy of the USFWS and the SCS)

Region	1992 Acres	1993 Acres
Prairie Pothole Region	3,370	3,276
Central Hardwood Forest Transition Region	896	583
Northeast Forest Region	31	15

The BWSR restored 210 wetland acres statewide in 1992 and 349 acres as part of the first of two application cycles in 1993. The MDNR cooperated in many of these restorations and conducted some of their own restoration projects. Many private organizations and interests were involved in restoring these wetland acres, and have conducted wetland restorations without direct assistance from federal agencies. It is extremely difficult to establish the total number of restored wetland acreage in Minnesota because of the large number of agencies and private groups or interests that cooperate in many wetland restoration projects. In the future, it is expected that tracking of wetland restoration projects will improve with the advance of GIS data, technology and techniques.

Minnesota recently completed the digitization of the USFWS National Wetland Inventory. This database is now undergoing field testing. Application databases are currently in development at the MDNR in cooperation with the state Land Management Information Center.

Future Activities and Needs

Minnesota is striving to integrate wetland resource planning activities into the basin planning and management initiative. Key elements to this task include the geographic targeting and prioritizing of wetland resources to manage more effectively priority wetlands on a watershed basis. In the future, wetland monitoring and assessment information will be used to make resource management decisions. It is also recognized that improvements need to be made in linking wetland protection goals to other surface and ground water protection efforts.

Appendix O

National Primary Drinking Water Regulations

National Primary Drinking Water Regulations (October 1996)

Contaminants	MCLG (mg/L)	MCL (mg/L)	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
VOCs				
Benzene	zero	0.005	Cancer	Some foods; gas, drugs, pesticide, paint, plastic industries
Carbon Tetrachloride	zero	0.005	Cancer	Solvents and their degradation products
o-Dichlorobenzene	0.6	0.6	Liver, kidney, blood cell damage	Paints, engine cleaning compounds, dyes, chemical wastes
p-Dichlorobenzene	0.075	0.075	Cancer	Room and water deodorants, "mothballs"
1,2-Dichloroethane	zero	0.005	Cancer	Leaded gas, fumigants, paints
1,1-Dichloroethylene	0.007	0.007	Cancer, liver and kidney effects	Plastics, dyes, perfumes, paints
cis-1,2-Dichloroethylene	0.07	0.07	Liver, kidney, nervous, circulatory	Waste industrial extraction solvents
trans-1,2-Dichloroethylene	0.1	0.1	Liver, kidney, nervous, circulatory	Waste industrial extraction solvents
Dichloromethane	zero	0.005	Cancer	Paint stripper; metal degreaser, propellant, extraction
1,2-Dichloropropane	zero	0.005	Liver, kidney effects, cancer	Soil fumigant, waste industrial solvents
Ethylbenzene	0.7	0.7	Liver, kidney, nervous system	Gasoline; insecticides; chemical manufacturing wastes
Monochlorobenzene	0.1	0.1		
Styrene	0.1	0.1	Liver, nervous system damage	Plastics, rubber, resin, drug industries; leachate from city landfills
Tetrachloroethylene	zero	0.005	Cancer	Improper disposal of dry cleaning and other solvents
Toluene	1	1	Liver, kidney, nervous, circulatory	Gasoline additive; manufacturing and solvent operations
1,2,4-Trichlorobenzene	0.07	0.07	Liver, kidney damage	Herbicide production; dye carrier
1,1,1-Trichloroethane	0.2	0.2	Liver nervous system effects	Adhesives, aerosols, textiles, paints, inks, metal degreasers
1,1,2-Trichloroethane	0.003	0.005		
Trichloroethylene	zero	0.005	Cancer	Textiles, adhesives and metal degreasers
Vinyl Chloride	zero	0.002	Cancer	May leach from PVC pipe; formed by solvent breakdown
Xylenes (total)	10	10	Nervous system effects	Gasoline, metal degreasers, and pesticides

Contaminants	MCLG (mg/L)	MCL (mg/L)	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
SOCs:				
Acrylamide[1]	zero	TT[2]	Cancer, nervous system effects	Polymers used in sewage/wastewater treatment
Alachlor	zero	0.002	Cancer	Runoff from herbicide used on corn, soybeans, peanuts, and other crops
Atrazine	0.003	0.003	Mammary gland tumors	Runoff from use as herbicide on corn and non-cropland
Benzo(a)pyrene (PAHs)	zero	0.0002	Cancer	Coal tar coatings; burning organic matter; volcanoes, fossil fuels
Carbofuran	0.04	0.04	Nervous, reproductive system	Soil fumigant on corn and cotton; restricted in some areas
Chlordane	zero	0.002	Cancer	Leaching from soil treatment for termites
Dalapon	0.2	0.2	Liver, kidney	Herbicide used on orchards, beans, coffee, lawns, road/railways
Dibromochloropropane (DBCP)	zero	0.0002	Cancer	Soil fumigant used on soybeans, cotton, pineapple, orchards
Di(2-ethylhexyl) adipate	0.4	0.4	Decreased body weight; liver and testes damage	Synthetic rubber, food packaging, cosmetics
Di(2-ethylhexyl) phthalate	zero	0.006	Cancer	PVC and other plastics
Dinoseb	0.007	0.007	Thyroid, reproductive organ damage	Runoff of herbicide from crop and non-crop applications
Diquat	0.02	0.02	Liver, kidney, eye effects	Runoff of herbicide on land and aquatic weeds
Ethylene Dibromide (EDB)	zero	0.00005	Cancer	Leaded gas additives; leaching of soil fumigant
Endothall	0.1	0.1	Liver, kidney, gastrointestinal	Herbicide on crops, land/aquatic weeds; rapidly degraded
Endrin	0.002	0.002	Liver, kidney, heart damage	Pesticide on insects, rodents, birds; restricted since 1980
Epichlorohydrin[1]	zero	TT[2]	Cancer	Water treatment chemicals; waste epoxy resins, coatings
Glyphosate	0.7	0.7	Liver, kidney damage	Herbicide used on grasses, weeds, brush
Heptachlor	zero	0.0004	Cancer	Leaching of insecticide for termites, very few crops
Heptachlor epoxide	zero	0.0002	Cancer	Biodegradation of heptachlor
Hexachlorobenzene	zero	0.001	Cancer	Pesticide production waste by-product
Hexachlorocyclopenta-diene	0.05	0.05	Kidney, stomach damage	Pesticide production intermediate
Lindane	0.0002	0.0002	Liver, kidney, nerve, immune, circulatory system	Insecticide used on cattle, lumber, gardens; restricted since 1983

Contaminants	MCLG (mg/L)	MCL (mg/L)	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Methoxychlor	0.04	0.04	Growth, liver, kidney, nerve	Insecticide used on fruits, vegetables, alfalfa, livestock, pets
Oxamyl (Vydate)	0.2	0.2	Kidney damage	Insecticide on apples, potatoes, tomatoes
PCBs	zero	0.0005	Cancer	Coolant oils from electrical transformers; plasticizers
Pentachlorophenol	zero	0.001	Cancer; liver and kidney effects	Wood preservatives, herbicide, cooling tower wastes
Picloram	0.5	0.5	Kidney, liver damage	Herbicide used on broadleaf and woody plants
Simazine	0.004	0.004	Cancer	Herbicide used on grass sod, some crops, aquatic algae
Toxaphene	zero	0.003	Cancer	Insecticide used on cattle, cotton, soybeans; cancelled in 1982
2,4-D	0.07	0.07	Liver and kidney damage	Runoff from herbicide on wheat, corn, rangelands, lawns
2,4,5-TP (Silvex)	0.05	0.05	Liver and kidney damage	Herbicide used on crops, right-of-ways, golf courses; cancelled in 1983
2,3,7,8-TCDD (Dioxin)	zero	0.00000 003	Cancer	Chemical production by-product; impurity in herbicides
Inorganics:				
Antimony	0.006	0.006	Cancer	Fire retardants, ceramics, electronics, fireworks, solder
Arsenic (Interim)	0.05	0.05	Skin, nervous system toxicity	Natural deposits; smelters, glass, electronics wastes; orchards
Asbestos (>10μm)	7 MFL[3]	7 MFL[3]	Cancer	Natural deposits; asbestos cement in water systems
Barium	2	2	Circulatory system effects	Natural deposits; pigments, epoxy sealants, spent coal
Beryllium	0.004	0.004	Bone lung damage	Electrical, aerospace, defense industries
Cadmium	0.005	0.005	Kidney effects	Galvanized pipe corrosion; natural deposits; batteries, paints
Chromium (total)	0.1	0.1	Liver, kidney, circulatory disorders	Natural deposits; mining, electroplating, pigments
Copper[1]	1.3	TT[2]	Gastrointestinal irritation	Natural/industrial deposits; wood preservatives, plumbing
Cyanide	0.2	0.2	Thyroid, nervous system damage	Electroplating, steel, plastics, mining, fertilizer
Fluoride	4.0	4.0	Skeletal and dental fluorosis	Natural deposits; fertilizer, aluminum industries; water additive

Contaminants	MCLG (mg/L)	MCL (mg/L)	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Lead[1]	zero	TT[2]	Kidney, nervous system damage	Natural/industrial deposits; plumbing; solder, brass alloy faucets
Mercury (inorganic)	0.002	0.002	Kidney, nervous system disorders	Crop runoff; natural deposits; batteries, electrical switches
Total Nitrate/Nitrate (as Nitrogen)	10	10	Methemoglobulinemia	Animal waste, fertilizer, natural deposits, septic tanks, sewage
Nitrite	1	1	Methemoglobulinemia	Same as nitrate; rapidly converted to nitrate
Selenium	0.05	0.05	Liver damage	Natural deposits; mining, smelting, coal/oil combustion
Thallium	0.0005	0.002	Kidney, liver, brain, intestinal	Electronics, drugs, alloys, glass
Microbiological and Surface Water Treatment:				
Cryptosporidium	N/A	N/A		
Giardia lamblia	zero	TT[2]	Gastroenteric disease	Human and animal fecal waste
Legionella	zero	TT[2]	Legionnaire's disease	Natural waters; can grow in water heating systems
Standard Plate Count	N/A	TT[2]	Indicates water quality, effectiveness of treatment	N/A
Total Coliform	zero	<5%+	Indicates gastroenteric pathogens	Human and animal fecal waste
Turbidity	N/A	TT[2]	Interferes with disinfection/filtration	Soil runoff
Viruses	zero	TT[2]	Gastroenteric disease	Human and animal fecal waste
Radioactive:				
Beta/photon emitters (Interim and Proposed)	zero	4 mrem/yr	Cancer	Decay of radionuclides in natural and man-made deposits
Alpha emitters (Interim and Proposed)	zero	15 pCi/L	Cancer	Decay of radionuclides in natural deposits
Combined Radium 226/228 (Interim)	zero	5 pCi/L	Bone cancer	Natural deposits
Disinfection Byproducts:				
Total Trihalomethanes[1] (Interim)	zero	0.10	Cancer	Drinking water chlorination byproducts

[1] Contaminants generally created during treatment by the public water system (e.g., during disinfection) or caused by actions in the distribution system (e.g., corrosion byproducts).

[2] Treatment Technique (TT) required. EPA develops a TT for a contaminant when it is not feasible to set a numerical limit (an MCL) for that contaminant. A TT is a procedure or series of procedures that a PWS automatically follows to comply with a drinking water regulation.

[3] Million Fibers per Liter.

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