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Development Selection and Pilot Demonstration of Preliminary Environmental Indicators for the Clean Water State Revolving Loan Program

Volume 2: Technical Appendices

Table of Contents

Volume I

List of Tables

List of Figures

Volume II

Introduction

Environmental indicators have been under development at the U.S. Environmental Protection Agency (EPA) for more than a decade. EPA conducted a feasibility analysis, developed a methodology, and identified available resources for developing environmental indicators and applying them to the Clean Water State Revolving Fund (CWSRF) program in 1998. EPA's Office of Wastewater Management established a Task Force to propose and oversee the pilot feasibility testing of a series of environmental indicators specific to the CWSRF program. The Task Force included 15 to 20 participants (listed in Appendix A) who have worked on this assignment one or two days per month since January 1999. Members were drawn from states, EPA regions, and EPA headquarters.

States received a generic scope of work (Appendix B), which was intended to help establish consistency among the pilot projects and allow the results to be compared more consistently. The scope of work should be viewed in a historical context as the starting point from which the states began the pilot indicator project.

After states identified the type and scope of projects to evaluate, they focused on data collection. One tool used for managing collected project data was a questionnaire, which was available to states online and in hard copy (Appendix C). The web-based questionnaire was presented in three successive pages entitled Project Information, Indicator Information, and Data Information.

Each state prepared and submitted a written report on its findings. Recommendations about how to best incorporate data requirements and identification of any barriers to using or accessing data were included in the narrative. Appendix D provides a detailed summary of states' projects and the full state reports are presented in Appendix E and F.

The Task Force acknowledged that various types of physical habitat measures, such as the Qualitative Habitat Evaluation Index (QHEI) and Zig-Zag Pebble Count, might be useful with Indicator 4 -- Physical changes to the terrestrial, riparian, or aquatic habitat and hydrology as a result of CWSRF-funded projects. States are encouraged to further investigate the techniques (field surveys, Zig-Zag Pebble Count Method), tools (QHEI, geographic information systems), and units (acres, river miles, degree of embeddedness) used to measure progress under this indicator (See Appendix G and H).

The environmental indicators identified in this report represent the start of an evolutionary process. As the states gain experience in trying to measure environmental progress by using those indicators, additional or revised indicators are likely to surface, and use of geographic information systems to detect progress is expected to be expanded. Because of the diversity among the states, the environmental indicators are presented as a "suite" of indicators to be used at each state's discretion according to its individual needs.

Appendix A. Environmental Indicator Task Force Membership

November 2, 1999

Environmental Indicator Task Force Membership

The Task Force should total from 15 to 20 participants working from 1-2 days per month over about a two-year period. Members will be drawn from states, EPA regions and headquarters. The objective is to develop, select, pilot test, and implement a set of environmental indicators for the CWSRF program. Addresses for EPA Headquarter members is: USEPA Waterside Mall, 401 M Street, S.W., Washington, DC 20460 unless noted by *

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Appendix B. Generic Scope of Work for Pilot Project

CLEAN WATER STATE REVOLVING LOAN FUND ENVIRONMENTAL INDICATOR PILOT PROJECTS

Generic Scope of Work

The purpose of this generic scope of work is to present the major tasks applicable to each state environmental indicator pilot demonstration project. California, Ohio, and Texas have been selected to conduct environmental indicator pilot projects. Each state will review a subset of their projects funded through the use of Clean Water State Revolving Fund (CWSRF) loan funds and apply environmental indicators to measure environmental improvement as a result of the implementation of these projects. The environmental indicators to be pilot tested for the CWSRF program are as follows:

1. Number of pounds of pollutants *removed* from the environment through CWSRF-funded projects. (Point source oriented)
2. Number of pounds of pollutants *prevented* from entering the environment through CWSRF-funded projects.
3. Increase in biophysical benefits or reduction in biophysical stressors by changing land use practices, and resource harvesting and extraction practices through CWSRF-funded projects.
4. Waterbodies, expressed as river and riparian miles, lake acres, estuary square miles, and wetland acres, *previously impaired, now meeting designated uses*, as a result of CWSRF-funded projects.
5. Waterbodies, expressed as river and riparian miles, lake acres, estuary square miles, and wetland acres, *protected, or improved* as a result of CWSRF-funded projects.
6. Benefits of reduced health risks and/or increased recreational use attributable to CWSRF-funded projects.

The objective of this pilot phase is to examine more closely the feasibility of measuring environmental outcomes and making linkages back to the CWSRF program activity with the proposed environmental indicators. These pilots will investigate and report on the availability of data and the mechanisms (systems) to provide that data. Each pilot can be conducted to perform a program-wide analysis, a project-specific analysis, or a watershed- or subwatershed-level analysis. Following this generic scope of work will ensure consistency between each pilot project and will help obtain a level of comparability between pilots and their results. Due to variations between pilots on the type, available data, and number of projects to be evaluated, it is expected that alterations and refinements will be required by each pilot project when developing and conducting their projects.

The following five major tasks are required to conduct an environmental indicator pilot project.

Task 1: Identify Type and Scope of Projects to Evaluate
Under this task, states will determine the type and number of CWSRF projects that will be evaluated. This identification of projects can be selected for program-wide, project-specific, or

watershed or subwatershed level analysis. For example, California is proposing to evaluate a randomly selected number of projects (approximately 20-30) that were completed during the period 1992-1993. Ohio is proposing to identify all projects funded through the CWSRF and then select for evaluation those projects that have collected water quality and other project specific data that can be applied to the six environmental indicators. Texas will employ a subwatershed or stream segment approach and evaluate all projects completed within each subwatershed.

Task 2: Data Collection

Under this task, states will search electronic and manual databases and project files to collect baseline data on each CSWRF project. The purpose of this task is not only to collect the necessary data which will be used to apply each indicator, but also to document the ease or difficultly in collecting the data. Data collected of each selected project will encompass project specific information as well as the environmental data related to the project. Water quality conditions prior to and post project implementation are critical environmental data sets.

The data collected will be documented using data source criteria including:

- Availability/accessibility of data (ease of acquiring information; were data out there?)
- Temporal coverage (period of time, e.g., one year; more or less?)
- Spatial coverage (latitude/longitude; watershed; stream length)
- Technical credibility (quantity, diversity, robustness, etc.; how comfortable are you with the data?)

Task 3: Data Synthesis and Analysis

Under this task, all data collected will be synthesized in tabular or other format for display and analysis. Types of CWSRF-funded projects will be tallied along with water quality and environmental condition data. The analysis of the results will be presented in a brief written description with discussions on validity/accuracy, data comparability, and scope/applicability.

Task 4: Indicator Evaluation

Under this task, an evaluation of each environmental indicator applied in that state will be conducted. A brief narrative discussion will be prepared about the application of each environmental indicator against the following evaluation criteria:

- Data sources
- Data quality/quantity
- Data availability (how available; how long did it take to evaluate and compile?)
- Data accessibility
- Representativeness
- Comparability
- Cost-effectiveness
- Ease of implementation

Recommendations about how to best incorporate data requirements and identification of any barriers to using or accessing data should be included in the narrative. Identify specific ideas about the use, implementation, and/or needed changes to the indicators.

Task 5: Report Findings

Under this task, a written report on the pilot project approach and findings from tasks 1-4 above will be prepared. It is anticipated that this report will consist of 10-20 pages of text and tables. Each report will include a one-page executive summary that could be used at a briefing level.

Appendix C. Pilot Project Data Entry Questionnaire

CWSRF Indicators - Questionnaire for Project Managers

Characterizing Environmental Benefits to Support Indicator Development

Project Information

- Project name and unique identifier (e.g., parent number) ______________________________
  ____

- Project type and comments (listed by Clean Water Needs Survey category)
  - ☐ CAT I Secondary Treatment ______________________
  - ☐ CAT II Advanced Treatment ______________________
  - ☐ CAT IIIA Infiltration/Inflow Correction______________________
  - ☐ CAT IIIB Sewer Replacement/Rehabilitation ______________________
  - ☐ CAT IVA New Collector Sewers ______________________
  - ☐ CAT IVB New Interceptor Sewers ______________________
  - ☐ CAT V Combined Sewer Overflows ______________________
  - ☐ CAT VI Storm Water ______________________
  - ☐ CAT VIIA Nonpoint Source - Agriculture (crop, pasture, and rangelands) __________
  - ☐ CAT VIIB Nonpoint Source - Agriculture (animals) ______________________
  - ☐ CAT VIIC Nonpoint Source - Silviculture ______________________
  - ☐ CAT VIID Nonpoint Source - Urban ______________________
  - ☐ CAT VIIE Nonpoint Source - Ground Water ______________________
  - ☐ CAT VIIF Nonpoint Source - Estuaries ______________________
  - ☐ CAT VIIG Nonpoint Source - Wetlands ______________________

- Project description (detailed engineering and construction aspects) __________________
____
____

- Locational information (lat./long.); include waterbody affected (8 digit CU; plus reach and river mile) ______________________

- Project stated objective/goal ______________________________
  ____

- Project funding information - Total project cost and CWSRF share
  $________________

- Time frame of project and subsequent monitoring or assessment __________________

Indicator Information

- Identify indicators used in this project ______________________________
  Indicator Information (continued)

- Any existing documentation to characterize expected environmental benefit
  Yes ☐ No ☐ Describe________________________________

- Any specifically stated water quality objective to reduce or prevent loading
  - Load reduction point source
    Yes ☐ No ☐ Describe________________________________
  - Load prevented point source
    Yes ☐ No ☐ Describe________________________________
  - Load reduction NPS
    Yes ☐ No ☐ Describe________________________________
  - Load prevention NPS
    Yes ☐ No ☐ Describe________________________________

- Any specifically stated water quality objective to improve resource conditions
  - Existing impairment
    Yes ☐ No ☐ Describe________________________________
  - Expected impairment (threatened)
    Yes ☐ No ☐ Describe________________________________

- Any specifically stated water quality objective to address public health concerns
  - Existing fish advisories
    Yes ☐ No ☐ Describe________________________________
  - Existing recreational impairments
    Yes ☐ No ☐ Describe________________________________
  - Other existing health concerns (bacterial contamination, drinking water threats)
    Yes ☐ No ☐ Describe________________________________
  - Expected public health concerns (threatened)
    Yes ☐ No ☐ Describe________________________________

Data Source Information (summed for each indicator)

- Which indicator? _____

- Describe the data source (fill out once and then reference)
  - system name ______________
  - system type ______________
  - where located ______________
  - owner ______________
  - what program was the system originally designed to support? ______________

- How current are the data? ________________________________

Data Source Information (continued)

- Are there historical trend data available? ______________________________
- What affects the data availability? ______________________________
- What affects the data source accessibility? ______________________________
- Describe accessibility barriers to using data source (provide narrative, if necessary)
  - Administrative (e.g., interagency accessibility) __________
  - Jurisdictional (e.g., data owner issues) __________
  - Resources (e.g., budget of personnel constraints) __________
  - Programmatic (e.g., regulatory authority) __________
- Describe technical barriers to using data source
  - Lack of QA/QC ______________________________
  - Reliability ______________________________
  - Accuracy ______________________________
  - Completeness ______________________________

Space below is provided for additional comments:

Appendix D. Pilot Project Data Summary

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
	California										
1	Pittsburg Conveyance System Improvements	Construction of gravity interceptor sewers to bypass pump stations and increase the pumping capacity at Pittsburg Pump Station.	IVB	None	Overflows caused by under-capacity gravity sewers and unreliable sewage pump stations occurred in February 1993 and have not occurred since.	no	No info	N	qualitative/news-paper articles	2-year project	$10 million total/$4.4 million CWSRF share
2	Nevada County Sanitation Dist. No. 1, Cascade Shores Treatment Plant	Construction/installation of package tertiary plant (20,000 gpd) and replacement/upgrade of collection system. Project replaces zero discharge pond system that was subject to seasonal overflow of partially treated undisinfected wastewater.	II, IIIA	5		no	No info	Y (other concerns: bacterial contamination, drinking water threats)	Discharge self-monitoring and NPDES reports (pH, total coliform violations)	blank/reports Dec 1997-Nov 1998	$2.1 million/ $170,000 CWSRF
3	McKinleyville WWTP Upgrade	Treatment plant upgrade	I	1	Plant performance has improved, with higher BOD and SS removal efficiencies in recent years, as data from 1990-1998 show. The monthly BOD effluent range for June 1997-May 1998 was 22-35 mg/L, while the range of monthly BOD effluent weighted averages from 1990 to 1996 was 26-43 mg/L.	no	Mad River Discharge	N	Project performance report (June 1998); annual reports (from 1996,1997,1998)	Began Aug 1995, active May 1997	$810,628 + 436,673 = 1,247,301

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
4	City of Blythe Wastewater Treatment Plant Expansion and Denitrification	Expansion of secondary treatment capacity of existing plant from 1.5 MGD to 2.4 MGD, including facilities for effluent dentirification. Discharge is to ground water via percolation ponds.	I	2	BOD discharged from the plant in 1992 was 233.7 lb/d, compared to 80.9 lb/d in 1998. For TSS, 201.3 lb/d were discharged in 1992, with 175.8 lb/d in 1998.	no	Discharge to ground water via percolation ponds	N	Post project monitoring report (1998), appendices C&D (1990-92 reports)	13 months construction (START DATE? 1994?), performance certificate one year after construction	$7,128,384/ CWSRF $6,444,447
	Texas										
	Texas approached the indicators according to (1) stream segments impaired in 1983-1987 305(b) and currently not impaired; (2) stream segments not impaired in 1983-1987 305(b) and currently not impaired; and (3) stream segments impaired in 1983-1987 305(b) and currently listed as impaired.										
1	City of Nacogdoches, # 3253-01	The project will upgrade and expand the treatment facility. 10.08 MGD capacity will be increased to 12.88 MGD. These improvements will enable the system to produce an upgraded effluent quality of 10 mg/l BOD, 15 mg/l TSS and 3 mg/l NH3-N with dechlorination.	II	1	WWTP effluent contributing to problems, dissolved oxygen violation, stream segment impaired in 1983-1987 305(b) and currently not impaired.	no	Segment 0611, Angelina River above Sam Rayburn Reservoir	N	1983-1987 305(b) reports, 1999 303(d) reports	Funding granted July 14, 1992	$5,670,000 CWSRF
2	City of Carthage, #2244-01	Construction of wastewater treatment plant and collection system improvements.	II,IIIA,IIIB	1	WWTP effluent contributing to problems, depressed DO, nutrients; stream segment impaired in 1983-1987 305(b) and currently not impaired	no	Segment 0505, Sabine River above Toledo Bend Reservoir	N	1983-1987 305(b) reports, 1999 303(d) reports	Final inspection Jan 30, 1996	$3,715,000 CWSRF

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
3	City of Hallsville, #2644	WWTP improvements to increase plant design capacity from 0.32 MGD to 0.8 MGD and meet more restrictive effluent limits.	I	1	WWTP effluent contributing to problems, depressed DO, nutrients; stream segment impaired in 1983-1987 305(b) and currently not impaired.	no	Segment 0505, Sabine River above Toledo Bend Reservoir	N	1983-1987 305(b) reports, 1999 303(d) reports	Final inspection November 22, 1999	$2,473,326, loan $2,250,000
4	City of Longview, #3089	Collection system improvements, construction of sewer interceptors, improvement of wastewater treatment.	II,IVB	1,2	WWTP effluent contributing to problems, depressed DO, nutrients; stream segment impaired in 1983-1987 305(b) and currently not impaired.	no	Segment 0505, Sabine River above Toledo Bend Reservoir	N	1983-1987 305(b) reports, 1999 303(d) reports	Final inspection May 30, 1996	$11,030,000 CWSRF

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
	New Jersey										
1	Town of Hammonton STP	The project included modifications to the Hammonton STP to improve treatment capabilities.	I	1	Decreasing trend in 5-day BOD concentration (mg/L) from Jan 1990 to April 1997 (STORET) Parameter / % Viol / Trend FC 67% Increase Un-ionized Ammonia 0% NONE NO_3 78% 6%/yr TP 100% -3%/yr DO 55% No trend TSS 0 Not tested %Viol= Violations 1990-1994 Trend = 1975-1994 trend	yes	Hammonton Creek, Mullica River in the Pinelands	Y, nontrout fishing and primary contact recreation	STORET	Date of initiation: June 15, 1994	$5,344,772 CWSRF
2	Delran STP	The project involved the upgrade and expansion of the STP from 1.5 MGD to 2.5 MGD and included the construction of an influent pump station with screen chamber, and a new contact stabilization unit with a capacity of 1.0 MGD.	I	1	No NJDEP sampling stations below discharge point.	yes	Rancocas Creek/ Delaware River; USGS HUC 02040202	Y, nontrout fishing, recreational fishing; and discharge affects Philadelphia Torresdale potable water intake	STORET	Date of initiation: Nov 17, 1994	$10,331,785 CWSRF

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
3	Middlesex County UA STP	The project involved the construction of 4 new final settling tanks and related appurtenances. These facilities will improve the efficiency of the plant and thus the quality of discharge.	I	1	No chemical data available near coastal outfall.	yes	Raritan River/Raritan Bay; USGS HUC: 02030105	Y, discharge affects shellfish and recreational use	STORET	Date of initiation: Sep 23, 1994	$8,236,808 CWSRF
4	City of Millville STP	The project involves the upgrade of the existing secondary level STP to improve biochemical oxygen demand and suspended solids removal. The proposed facilities will include improved biological treatment and the addition of tertiary filters.	I	1	No monitoring station below discharge point.	yes	Maurice River		STORET	Date of initiation: June 6, 1994	:$6,380,458 CWSRF
5	Woodstown STP	The project includes the installation of two counter current aeration basins, two clarifiers, a solids contact tank with phosphorous removal, a chemical fed/filtration/control building, disinfection facilities and aerobic sludge digestion facilities.	I	1	Parameter / % Viol / Trend FC 67% +8%/yr Un-ionized Ammonia 11% NONE NO_3 0 +3%/yr TP 83% +2%/yr DO 0 -0.1mg/L/yr TSS 8% Not tested	yes	Salem Creek		STORET	Date of initiation: Sep 23, 1994	$5,238,167 CWSRF

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
					%Viol= Violations 1990-1994 Trend = 1975-1994 trend						
6	Town of Clinton STP	The project involves the construction of modifications to the existing Town of Clinton STP to provide for upgraded phosphorus, ammonia, and TKN removals.	II	1	Parameter / % Viol / Trend FC 17% NONE Unionized Ammonia ? NONE NO_3 0 +1mg/L/yr TP 27% NONE DO 0 -0.05mg/L/yr TSS 0 Not tested %Viol= Violations 1990-1994 Trend = 1975-1994 trend	yes	South Branch Raritan River	Y, trout fishing is adversely affected	STORET	Date of initiation: Jan 3, 1994	$4,345,144 CWSRF
7	Borough of Hawthorne, Sewer Rehabilitation	The Borough built a pumping station to transport the entire flow by force main to the PVSC interceptor. A new venturi flow meter will be installed.	3B		Closest monitoring point is 4 miles downstream, with several discharges and urban land use in between.		Ground water in Borough		None available	Date of initiation: May 19, 1997	$2,978,508 CWSRF
8	Berkeley Township SA Collection System	The project involved building a collection system in the Riviera Beach area consisting of approx. 8200 linear feet of 8-inch gravity sewer.	4A	2	No ambient data collected nearby.		Barnegat Bay	Y, primary contact recreation uses impacted	None available	Date of initiation: Aug 10, 1994	$2,590,318 CWSRF
9	Town of Phillipsburg	An emergency generator was installed to service the Riverside Way			No change in effluent quality expected.		Not applicable		None available	Date of initiation: Sep 5, 1995	$441,634 CWSRF

Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
	Pumping Station. The Market and Mercer Street pump stations were also rehabilitated or replaced.									
Michigan										
Michigan did not report on specific projects. Michigan's project priority ranking system was provided, however. Every facility seeking CWSRF assistance submits a project plan, and modeling is conducted for pre- and post-project water quality in-stream conditions. The difference between these two simulations is used to award up to 100 points in the categories 1. dissolved oxygen, 2. nutrients(P), 3. toxic substances (un-ionized NH_4, Cl), 4. microorganisms (fecal coliform), and 5. ground water (well contamination).										
Data for indicators 1 and 2 are available from Michigan's Project Priority List (PPL) system (also data from DMR inventory?). Extrapolation from load reduction data might provide information for reduced health risks.										

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
	Utah										
1	St. George City (Utah) Wastewater Project ID#138	Expansion of existing extended aeration treatment plant to add two clarifiers, two oxidation ditches, influent pump station modifications, UV disinfection, sludge dewatering and handling, RAS/WAS pump station, and odor control.	II	2	Over the life of the project (year 2012), the facility will now have the ability to remove from the environment 19,495 lb/d of TSS; 15,950 lb/d of BOD; and 1,630 lb/d of ammonia.	yes	HUC 15010008. The receiving water is the Virgin River, which serves as the habitat of a threatened species, the woundfin minnow. A strict ammonia standard has been established to help protect that habitat.	Y--Existing fish advisories, existing recreational impairments, other existing health concerns (bacterial contamination, drinking water threats), expected public health concerns (threatened)	DMR data	Loan closing: Jul 17, 1997; Notice to Proceed: Dec 1997; Final Inspection: scheduled for Sep 1999	Total project: $27,550,000; CWSRF funding $12,000,000
2	Santaquin City (Utah) Sewer Project ID#109	Construction of a gravity sewage collection system, two lift stations, a 3-cell aerated lagoon system which totals 12.3 acres, a 150-acre-foot winter storage reservoir, and 100 acres of land for land application of the treated effluent.	II	1,3	The immediate load reduction of nitrates and BOD entering the ground water in 1995 was, respectively, 43 lb/d and 482 lb/d. The nitrate loading and BOD loading subsequently prevented from entering the ground water from on-site systems is, respectively, 55 lb/d and 619 lb/d.	yes	HUC 16020202. Santaquin City rests on alluvial material and is in the ground water recharge zone. Unabated proliferation of on-site disposal systems	Y--Existing fish advisories, existing recreational impairments, other existing health concerns (bacterial contamination, drinking water threats), expected public health	Estimation of nitrate and BOD loadings which otherwise would have potentially entered the ground water had on-site disposal system use continued unabated.	Loan closing: Feb 28, 1994; Notice to Proceed: Mar 1994; Final Inspection: Sep 1995	Total project: $6,008,400; CWSRF funding: $1,307,000

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
							would ultimately result in fouling of aquifer.	concerns (threatened)			
3	Orem City (Utah), Wastewater Project ID# 128	Construction of gravity thickener and belt press for better handling of biosolids. Replacement of some old sewer collection lines and some interceptor sewers.	II	1		yes	HUC 16020203			Loan closing: Apr 18, 1994; Notice to Proceed: May 1994; Final inspection: Sep 1995	Total project: $4,000,000; CWSRF funding: $3,500,000
4	Aurora City (Utah) Wastewater Project ID#119	Wastewater will be collected and conveyed to a lagoon treatment system, with no discharge, for treatment and disposal. Complete sewage collection system for community. Interceptor sewers from collection system to treatment system.	I, IVA, IVB	2	Over life of project (year 2012) the facility will have the ability to remove from the environment 199 lb/d BOD; 243 lb/d TSS and 20 lb/d ammonia.	yes	HUC 16030003			Loan closing: Apr 20, 1993; Notice to Proceed: Dec 2, 1993; Final inspection: Aug 20, 1994	Total project: $2,694,000; CWSRF funding: $841,015
5	Cedar City (Utah), Wastewater Project ID#117	Construction of a 4.4-MGD single-stage trickling filter treatment facility and interceptor line. Replaced old city plant and replaced community septic systems of neighboring town of Enoch.	I, IVB	2	Over life of project (year 2014), the facility will now have the ability to remove from the environment 4,016 lb/d BOD; 4,908 lb/d TSS; and 411 lb/d ammonia.	Yes	CU: 16030006		PCS database of discharge monitoring reports (DMRs)	Loan closing: Aug 18, 1994; Notice to Proceed: Oct 3, 1994; Final Inspection: Jun 18, 1997	Total project: $12,410,000; CWSRF funding: $12,010,000
6	Grantsville City (Utah), Wastewater Project #124	Upgrade of existing lagoon treatment system consisting of conversion of facility to a 4-cell, 12.4-acre, partial-mix aerated lagoon with headworks, disinfection,	I	2	Over life of project (year 2015) the facility will now have the ability to remove from the environment 263 lb/d BOD; 321 lb/d TSS and 27 lb/d ammonia.	Yes	CU: 16020304		STORET (#496024) and DMRs	Loan closing: Aug 16, 1995; Notice to Proceed: Aug 23. 1995; Final Inspection: Jul 16, 1996	Total project: $3,378,000; CWSRF funding $3,278,000

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
		standby power, flow measurement, and administration building. Upgrades of 2 existing lift stations, reconfiguration of 15-inch interceptor line, and extension of 8-inch sewer lines totaling approximately 7000 ft.									
7	Jordanelle Special Service District, I.D. #130	21,800 ft of 8-in, 10-in, 12-in, 15-in, 18-in gravity sewers and 5,400 ft of 8-in and 12-in force main. The project services largely undeveloped areas around the Jordanelle Reservoir, a major drinking water source for the Wasatch Front (Salt Lake City and surrounds).		2	Nutrient loading to the Jordanelle Reservoir from on-site disposal systems; at build-out, 1,754 lb/d of nitrate and 2,102 lb/d of BOD;	no	CU: 16020203		1994 Facility Plan	Loan closing: Jun 26, 1995; Notice to Proceed: Jan 14, 1994; Expected completion date: Fall 1999	Total project: $6,490,000; CWSRF $2,736,000

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
8	Mapleton City Sewer Project; ID#116	Construction of a centralized collection system with two pump stations and interceptor lines, which conveys the wastewater to a treatment facility in the neighboring city of Spanish Fork, UT. Removal of approximately 167 lb/d of BOD and 33 lb/d of nitrates.	IVA,IVB	1,2	Elimination of approximately 1,000 on-site disposal systems. At existing flows of 0.429 MGD, 716 lb/d of BOD and 89 lb/d of nitrates will be removed. At build-out in 2013 (flows of 0.649 MGD), an additional 367 lb/d of BOD and 46 lb/d of nitrates will be removed.	yes	CU: 16020202	Potential ground water contamination in a recharge area due to high ground water and hundreds of on-site disposal systems in a relatively small area. This was the largest unsewered community in the state.	Data extrapolated from 1993 Facility Plan	Loan closing: Jun 30, 1995; Notice to Proceed: Jul 17, 1995; Final Inspection: Dec 1997	Total project: $10,322,058; CWSRF: $9,400,000

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
	Maryland										
1	Ballenger Creek	The project was an expansion of the existing wastewater treatment plant from 2.0-MGD secondary treatment facility to a 6-MGD advanced treatment facility with biological nutrient removal (BNR) and an upgrade to the sludge processing system. A major portion of the existing plant was incorporated into this expansion, with major additions of tankage, hydraulic structures, new treatment unit processes, and replacement of the old sludge stabilization system.	II	1, 2	Decreasing trend in Total N concentration from Jan 21, 1991 to Nov 21, 1995 (STORET)	yes	Monocacy River (HUC 02070009)	N	STORET	Construction initiation: Apr 19, 1993 Construction completion: Aug 30, 1995	WQFA-SRF funds: $10,141,237 (47%) State BNR Grant: $1,000,000 (4.7%) Local funds: $10,358,733 (48.3% Total: $21,499,970
2	Birch Branch		VII A, VII B	5, possibly 3		no	Shingles Landing watershed, flows to St. Martin River	N	(blank)	Final project inspection conducted Mar 17, 1995	Unknown, but estimated costs are included in scope of work

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
3	Edesville Sewer Project	The sewage collection system consists of small-diameter gravity sewers with clarifier tanks (similar to septic tanks) installed at each household to provide primary treatment. Clarified sewage effluent is collected by 9800 LF of 3- and 4-in., small-diameter gravity sewers and conveyed by 380 LF of 2-in. force main to a lagoon/land treatment system for final treatment and disposal. After natural aeration by the 2-cell, 3-acre sewage lagoon, the aerated effluent is discharged, via a piped header and valve system, to a 13.5-acre ridge and furrow land treatment area, where the effluent is treated through continued natural aeration, absorption, transpiration, and evaporation. Grassed furrows and treed ridges assist in the transpiration and treatment of the effluent.	I, IV A	6		no	(blank)	Y, sewage disposal	Safe Drinking Water Information Database	Construction initiation: July 1991 Construction completion: Nov 12, 1992	Total: $1,739,663 CWSRF share: $997,663

	Project	Project Description	Clean Water Needs Survey Category	Ind #	Indicator Data	Lat/ Lon?	Waterbody Affected	Public Health Concern?	Data Source for Evaluation	Status/Time Frame	Total Project Cost (CWSRF Share)
4	Little Patuxent	The proposed project consists of the upgrade and expansion of the existing Little Patuxent WWTP. The WWTP upgrade involves the construction of a Biological Nutrient Removal (BNR) facility to achieve nitrogen removal to a level of 8mg/L, while the expansion is to increase the existing WWTP capacity from 15 MGD to 18 MGD to accommodate planned growth in Howard County. The treated wastewater from the Little Patuxent WWTP will be discharged to the Little Patuxent River, a tributary of the Patuxent River/Chesapeake Bay.	II	1, 2	No trend identified for BOD, Suspended sediment, or NH_3+NH_4+N dissolved concentrations, from 1990 to 1993. (STORET data do not extend past 1993 for these stations.)	yes	Little Patuxant River, Chesapeake Bay	N	STORET	Design completion: Dec 1991 Construction initiation: Jun 1992 Construction completion: Nov 30, 1994	Total: $25,000,000 CWSRF share: $15,000,000 (60%)

Note: gpd, gallons per day; MGD, million gallons per day; mg/L, milligrams per liter; BOD, biochemical oxygen demand; TSS, total suspended solids; DO, dissolved oxygen; WWTP, wastewater treatment plant; STP, sewage treatment plant; FC, fecal coliform bacteria; TP, total phosphorus; NO_3, Nitrate-nitrogen; TKN, total Kjeldahl nitrogen; NH_4, Ammonia-nitrogen; Cl, chlorine.

Appendix E. State Reports on Pilot Project Experience

Pilot Projects

This section contains reports written by the pilot states and represents their findings and recommendations in relation to this pilot indicator effort.

California's Pilot Project Experience

California participated in the indicator study as a pilot state and provided data on four previously funded CWSRF projects. The projects were randomly selected from a database of projects constructed in 1995. CWSRF project managers who had experience with the projects were trained by the Indicator study representative on the indicator topics and examples of the types of data that exist. The project managers were directed to investigate the different data sources that pertain to the indicators identified. The project managers and the indicator study representative determined the following from this exercise:

Data Availability
- There are data for Indicators 1 and 2 as long as end-of-pipe data are adequate.
- No data were found for Indicator 3.
- Only qualitative data were found for Indicators 4, 5, and 6, but there is no correlation to CWSRF projects.
- There is no single point of contact for the data; many different entities house information, which is not easily located.

Data Quality
None of the data were specifically developed for the indicators. Data were mainly developed as monitoring data intended to satisfy requirements for discharge permits; therefore, the data are not necessarily a good fit for the indicators.

Ohio's Pilot Project Experience

SUMMARY

This pilot study was undertaken as part of an EPA/state work group effort over the last year to develop and test environmental indicators that could be used to measure environmental improvements resulting from the Clean Water Act State Revolving Loan Fund (CWSRF) program. Ohio chose to assess all the potential indicators developed by the group in order to gauge their individual and combined effectiveness in evaluating funded actions. The following are the six indicators that were evaluated in Ohio's pilot study.

Indicator 1. Number of pounds of pollutants *removed* by point sources from the environment through CWSRF-funded projects.

Indicator 2. Number of pounds of pollutants *prevented* from entering the environment through CWSRF-funded projects.

Indicator 3. Increase in biophysical benefits or reduction in biophysical stressors by changing land use practices and resource harvesting and extraction practices through CWSRF-funded projects.

Indicator 4. Waterbodies, expressed as river and riparian miles, lake acres, estuary square miles, and wetland acres, previously impaired, now meeting designated uses, as a result of CWSRF-funded projects.

Indicator 5. Waterbodies, expressed as river and riparian miles, lake acres, estuary square miles, and wetland acres, *protected, improved, or restored* as a result of CWSRF-funded projects.

Indicator 6. Benefits of reduced health risks and/or increased recreational use attributable to CWSRF-funded projects.

After interpreting and evaluating each indicator for applicability to Ohio's program, the indicators were tested by using them to evaluate 15 of Ohio's State Revolving Loan Fund (Ohio CWSRF) projects. Recommendations regarding use of the indicators, as well as recommended changes to the indicators are based on the results of the pilot testing. The following is a summary of the recommendations.

Indicator 1. Ohio EPA recommends using this indicator in conjunction with biologically based indicators to see whether CWSRF-financed projects have resulted in reductions of pollutants, and whether these reductions are related to improvements in water quality as measured by improved attainment of aquatic life use stream standards. If used alone as a measure of CWSRF project accomplishments, this indicator will not show whether any improvement occurred in the receiving water's aquatic biota or any reduction in public health risks.

Indicator 2. Because of the difficulty of reliably estimating prevention of pollution, further investigation of this indicator is recommended.

Indicator 3. Ohio recommends exploring use of this indicator when the effect of the project is to change land use practices, such as converting farming practices from conventional to conservation tillage, or the restoration of land areas to natural vegetation. This indicator would be especially useful for these types of projects when there is no associated water quality monitoring of the benefitted water resources.

Indicator 4. This is an easily used indicator which measures the desired endpoint of the CWSRF activity, that is, progress toward meeting the Clean Water Act goals. Ohio EPA believes, however, that this indicator is covered by Indicator 5, and hence, should be dropped as a separate indicator.

Indicator 5. This indicator should be used because it measures the desired endpoint of the CWSRF activity, which is progress toward the Clean Water Act goals. To effectively use this indicator, it will be important to ensure that Agency water quality monitoring planning includes monitoring of both projects already funded through the CWSRF program, and projects anticipated to be funded in the future.

Indicator 6. Water quality data as it relates to human health issues needs to be aggregated by the respective agencies and laboratories so that a complete picture of the human health impacts can be viewed quickly and easily. The indicator is important because it monitors a Clean Water Act objective.

Ohio also suggested the inclusion of the two additional indicators below:

Indicator A. **Actions funded by CWSRF programs. (Response by the regulated community)** Ohio recommends using this indicator as an initial indicator of the contribution state CWSRF programs make to achieving Clean Water Act objectives. This indicator would be useful in situations where there is an absence of any other information regarding CWSRF-financed projects.

Indicator B. **Changes in habitat of a waterbody as a result of an CWSRF-funded project. (Changes in ambient habitat)**
This would allow measurement of CWSRF project accomplishments in terms of habitat improvement. This would be particularly useful for those projects (mainly nonpoint source) whose main benefit is to provide habitat restoration. In the absence of biological data, this would be the sole indicator available for these types of projects. We recommend exploring the use of both Qualitative Habitat Evaluation Index (QHEI) and Zig-Zag Pebble Count data for use with this indicator.

The modifications to the indicators recommended above would serve several purposes. First, they would allow all states to measure the accomplishments of their CWSRF programs. This is because the indicators range from purely administrative indicators (types of projects financed) to indicators which rely upon collection of biological data. Second, the proposed modifications would make the CWSRF indicators consistent with other water quality indicators previously developed by U.S. EPA, particularly the 1990 integrated framework (described later in this report), in that the CWSRF indicators would cover all six levels of indicators in the framework.

Taken together, the proposed CWSRF indicators cover the following SRF-related parameters:

- Loadings reductions to the environment
- Loadings prevented from entering the environment
- Project affect on land use
- Project affect on the aquatic life
- Project affect on human health risk
- CWSRF projects funded
- Project effect on habitat

The most effective way of using the indicators to measure progress toward accomplishment of Clean Water Act objectives is by using them in combination. Combining the indicators enables positive links to be made between CWSRF activities and changes to water resources, particularly if biological indicators (see Appendix E) are included as part of the combination. However, in the absence of sufficient data to use the indicators in combination, the individual indicators will still give a view of how states' CWSRF programs are contributing to improving water quality.

THE OHIO EPA WATER QUALITY MONITORING PROGRAM

For 20 years, Ohio EPA has assessed the quality of Ohio's surface waters using chemical, physical, and biological data. The resulting database is one of the most extensive examples in the country for the use of an integrated approach to environmental monitoring and assessment. Some of our recommendations and methods for using the indicators may not be directly applicable to states that do not have the same quantity or quality of water quality data. However, all states should be able to use portions of Ohio's analysis and recommendations to develop their own ways to use the indicators.

A study completed by the Ohio EPA monitoring group in 1997[1] recommended making better use of environmental indicators to establish priorities for enforcement and for awarding grant and loan funds. CWSRF programs should take this a step further and evaluate what types of funded activities, under what conditions, have provided the greatest water quality improvements and human and environmental health benefits. This approach will provide CWSRF programs with

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[1] Demonstrating the Linkages between Ambient Indicators of Surface Water Quality and Indicators of Water Program Performance in Two Ohio Watersheds, Central Scioto River and Ottawa River Basins, Environmental Indicators Pilot Projects: Volume I: Summary and Conclusions, Ohio EPA Technical Bulletin DSW/1977-9-1, September 26, 1997. 347pp.

the information needed to enable states to focus their loan programs on activities that provide the greatest benefit per dollar spent.

DEVELOPMENT OF PREVIOUS ENVIRONMENTAL INDICATORS BY USEPA

It is important to relate the Clean Water SRF Indicators to other water quality indicators that have been developed previously by U.S. EPA, namely: (1) the U.S. EPA (1990)[2] integrated framework, which provides a hierarchy of six levels of environmental indicators; and (2) the U.S. EPA (1991)[3] concept of stressor, exposure, and response indicators, which was also utilized in the 1997 recommendations made by the Ohio EPA monitoring group referenced above.

The U.S. EPA 1990 integrated framework uses the following six levels of indicators:

Level 1 - actions taken by regulatory agencies (e.g., permitting, enforcement, grants);
Level 2 - responses by the regulated community (e.g., construction of treatment works, pollution prevention);
Level 3 - changes in discharged quantities (e.g., pollutant loadings);
Level 4 - changes in ambient conditions (e.g., water quality, habitat);
Level 5 - changes in uptake and /or assimilation (e.g., tissue contamination, biomarkers, assimilative capacity);
Level 6 - changes in health, ecology, or other effects (e.g., ecological condition, pathogenicity)

The U.S. EPA 1991 concept of stressor, exposure, and response indicators relates to four of the six indicators listed above. *Stressor* indicators include activities that have the potential to degrade the aquatic environment, such as pollutant discharges, land use effects, and habitat modifications (Level 3 indicators from the integrated framework). *Exposure* indicators are those that measure the apparent effects of stressors and can include chemical water quality criteria, whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent (Level 4 and 5 indicators from the integrated framework). *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of biological community and population response that are quantified by the biological indices used by Ohio EPA (Level 6). Other response indicators include target assemblages (e.g., rare, threatened, endangered, special status, and declining species), or bacterial levels which serve as surrogates for recreational use designations. All of these indicators provide essential technical elements for watershed-based management approaches.

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[2]U.S. Environmental Protection Agency. 1990. Feasibility Report on Environmental Indicators for Surface Water Programs. U.S. EPA, Office of Water Regulations and Standards, Office of Policy, Planning, and Evaluation, Washington, D.C.

[3]U.S. Environmental Protection Agency. 1991. Environmental Monitoring and Assessment Program. EMAP - surface waters monitoring and research strategy - fiscal year 1991, EPA/600/3-91/022. Office of Research and Development, Environmental Research Laboratory, Corvallis, OR. 184pp.

All of the CWSRF-funded projects can be classified using the Level 1 or 2 indicators because they represent both actions taken by regulatory agencies and the subsequent responses by the regulated community (financing of projects and implementation of projects). These initial actions result in changes in pollutant loadings and ambient water quality (represented by Level 3, 4, and 5 indicators). The changes in pollutant loadings and ambient water quality may also provide measurable environmental "results" which would be within the Level 6 indicator. The Level 6 Indicator is the one indicator that provides feedback on whether the Clean Water Act objective of "restoring the chemical, physical, and biological integrity" of state waters is being met.

Since CWSRF projects usually do not address all sources of impairment in a stream, project success needs to be measured in terms of contribution to meeting the goal of improved water quality. This measurement of progress can then be used to guide future funding decisions and priorities. The purpose of this pilot study was to see if this can be done and under what circumstances.

CLEAN WATER SRF INDICATORS

The six indicators developed by the EPA/state work group, plus the two additional indicators proposed by Ohio EPA are evaluated below regarding ease of use and level of confidence. Recommendations are made, based in part on the use of the indicators to evaluate pilot projects, regarding their use by state CWSRF programs. Reference is also made as to which of the U.S. EPA 1990 indicators each indicator falls within.

Indicator A. Actions funded by the CWSRF program.

U.S. EPA 1991 Indicator Type
This is a Level 1 and/or 2 Indicator: actions taken by regulatory agencies (Level 1) and responses by the regulated community (Level 2).

Ease of Use/Difficulties
This indicator identifies the types of projects that receive CWSRF financing. It also indicates why the financing was requested (e.g. enforcement action, treatment works expansion, maintenance/repair, etc.) This information should be easily obtained from project records.

Confidence in the Indicator
This indicator will provide information about the types of projects that receive CWSRF funding. Information about these projects can be obtained from priority list ranking documentation, facility planning documents, enforcement documents, environmental assessments, detailed plans and specifications and financial records. This information is accurate, complete and readily available to the state CWSRF programs.

Recommendation
Ohio recommends using this indicator as an initial indicator of the contribution state CWSRF programs make to achieving Clean Water Act objectives.

Indicator 1. Number of pounds of pollutants *removed* from the environment through CWSRF-funded projects.

U.S. EPA 1991 Indicator Type
This is a Level 3 Indicator - Changes in Discharge Quantities - and a Stressor Indicator.

Ease of Use/Difficulties

Ohio determined the number of pounds of pollutants removed from the environment through CWSRF-funded projects using data from Ohio EPA's LEAPS (Liquid Effluent Analysis Process System), SWIMS (Surface Water Information Management System), and PCS (Permit Compliance System) databases. STORET and community-generated data were also used along with the other databases to establish influent, effluent, and ambient upstream and downstream conditions for a one year period prior to loan award, and a one-year period commencing in the second year after project completion. With each source of data Ohio encountered different problems.

We presumed that SWIMS, a recently constructed, personal computer-driven database, could provide all the data we would need to evaluate the wastewater treatment plant (WWTP) projects. We soon learned, however, that SWIMS is limited to post-1994 data. This finding led us to greater reliance on the pre-SWIMS programs known as LEAPS and PCS for data on pre-1995 projects.

To obtain pre-1995 sampling information, the LEAPS and PCS databases were combined electronically in DBASE/FOXPRO data files to include specific chemical parameter and station data from the Monthly Operating Reports (MORs) of the 12 wastewater treatment plants evaluated in this pilot study. A major constraint of the LEAPS and PCS databases are that this material can only be accessed through a trained operator and must be transferred into a DBASE/ FOXPRO data file format.

The data were sorted using codes for individual monitoring stations and chemical parameters. In addition, we frequently had to convert the database format files into more easily manipulated (spreadsheet) format files. This conversion then provided the flexibility needed to calculate daily averages for specific parameters on a month-by-month basis. Getting this data in an easily read and organized format required a considerable amount of time and effort.

The SWIMS database was more usable than LEAPS primarily because an electronic link could be established directly to the central computer housing this material. However, a main drawback with the use of this data source is that the calculated averages in SWIMS do not transfer with the raw data, hence requiring the use of another program to recalculate and permanently store the averages in a data file. Further complications involved the non-numerical values used in SWIMS such as "AA" which denotes "below detectable limits." Upon the recommendation of Ohio EPA's Division of Surface Water staff, the "AA" scores were converted to a score of zero, while all other non-numerical values were excluded from calculations of averages because they represented data gaps or other errors in record keeping that could not be resolved for this study.

In conducting our evaluation of MOR data from the 12 selected WWTP projects, data was recorded and analyzed for seven standard parameters: dissolved oxygen, total suspended solids, ammonia-nitrogen, fecal coliform, flow, total residual chlorine, and five-day carbonaceous oxygen demand. We also used all or a number of these parameters to ascertain changes over time in both the in-stream, influent, and effluent conditions and to assure consistency with what we were observing in pollutant removal rates.

One of the more important uses of the total suspended solids, flows, and five-day carbonaceous oxygen demand ($CBOD_5$) data was to determine the pounds of pollutants removed from the waste stream by each WWTP prior to discharge. To calculate these removal rates, the influent and effluent values were entered into spreadsheets and the flow data were used to transform the chemical concentrations for these two parameters into pounds of pollutants using the following equation:

$$\text{Pounds of Pollutant} = \text{Concentration in milligrams per liter (mg/L)} * 8.34 \text{ pounds per mg/L} * \text{Flow in million gallons per day}$$

Simple addition and subtraction were used to calculate net removals. In a few cases, such as Akron and Columbus, the presence of monitored overflows at the WWTPs required greater consideration of the effects of the overflows on the receiving streams. In these two examples, the pounds of pollutants released into the environment during storm events were calculated and added to the other pollutant loadings released following complete treatment. These combined effluent totals for both total suspended solids and 5-day carbonaceous oxygen demand were then compared to the influent values and a percentage removal figure was determined. A similar, but simplified, approach was used when bypasses and overflows are absent from a wastewater treatment system. These summary values are included in this text.

In addition to the LEAPS and SWIMS databases, STORET data and analyses from technical and permit support documents provided background information on water quality conditions. In some cases, the STORET data were not available for the time periods and locations to document the success or failure of CWSRF-funded projects from a chemical pollutant standpoint.

Confidence in the Indicator

This indicator can provide valuable information about the WWTP function before and after CWSRF project completion. In many cases, large increases in one or more of the pollutant(s) removed can be demonstrated. This information, taken along with the WWTP pollutant removal efficiencies, can demonstrate a direct and measurable benefit of a CWSRF-funded project to the receiving water.

It is important, however, to link this information back to the pollutant(s) that impacted the biology of the receiving stream. We do not recommend focusing on any one or two of the chemical parameters as indicators of the others, as the causes of impairments to receiving waters are highly variable and a decrease in one chemical parameter does not always translate to a reduction in the other parameters. As an example, a decrease in ammonia-nitrogen levels does not necessarily translate to a reduction in chlorine or copper levels. If an impairment to the biology of a stream segment was due to toxic exposure to copper, then reductions of other chemical parameters would have no effect on the recovery of this stream segment.

In general, we must not presume that the number of pounds of one or more pollutants removed from the environment can give a direct measure of how a stream is achieving Clean Water Act objectives. Focusing on the reduction of one or several pollutants in a waterbody without consideration of the other potential causes or sources of impairment and pollutant interactions provides only a small amount of information on what is going on in a stream. There are multiple factors in addition to chemical water quality that are responsible for the condition of a surface water resource. Hence, this indicator will provide only one piece of the information needed to evaluate the effectiveness of a CWSRF project. Because the biological integrity of a waterbody is influenced and determined by multiple chemical, physical, and biological factors, a singular strategy emphasizing the control of chemicals alone does not assure the restoration of biological integrity.[4]

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[4]Karr, J.R., K.D. Fausch, P.L. Angermier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters: a method and its rationale. Illinois Natural History Survey Special Publication 5. 28 pp.

The main benefit of this indicator is that it shows whether SRF-financed projects resulted in pollutant reductions.

Recommendation

This indicator provides valuable information when comparing the before and after project pollutant removal amounts, or in looking at the percentage of influent pollution removed by treatment. This indicator is important when a stream segment has the same cause of impairment coming from multiple sources. An example of this would be a stream segment impaired by organic enrichment/low dissolved oxygen. The source could be a WWTP, a CSO, failing on-lot systems, or some combination of these sources. If it can be shown that a wastewater treatment plant has reduced its loadings of oxygen-demanding pollutants to a stream in such a situation, then it can be concluded that this plant has become less of a source of the problem.

The issue of multiple sources of stream impairment is likely to be prominent in highly impaired watersheds. As the agency begins to address these watersheds through the Total Maximum Daily Load (TMDL) process, this type of information will be valuable in identifying the various sources of impairment to a waterbody so links can be made between impairment and pollution sources that need to be remediated to achieve restoration.

Ohio EPA recommends using this indicator in conjunction with biologically based indicators to see whether SRF-financed projects have resulted in reductions of pollutants, and whether these reductions are related to improvements in water quality as measured by improved attainment of aquatic life use stream standards. If used alone as a measure of CWSRF project accomplishments, this indicator will not necessarily show whether any improvement occurred in the receiving water's aquatic biota or any reduction of public health risks occurred.

Indicator 2. Number of pounds of pollutants *prevented* from entering the environment through CWSRF-funded projects.

U.S. EPA 1991 Indicator Type

This is a Level 3 Indicator - Changes in Discharge Quantities - and a Stressor Indicator

Ease of Use/Difficulties

This indicator can be interpreted quite broadly and from a number of perspectives. Ohio EPA excluded most projects serving developing areas because intended environmental benefits (pollutants prevented) may not have resulted in improved surface water quality. For example, funding sewers in a developing area could be considered as preventing pollutants from entering the environment. Alternatively, the project could be viewed as enabling development of the watershed, resulting in a "hardening" of the watershed with a consequent decline in water quality.

In other cases, the CWSRF involvement made a difference in the way an area was being developed by preserving riparian areas, wetlands, woodlands, etc., or by installing environmentally friendly storm water controls, or even going so far as to fund an "environmentally friendly development" (e.g., Hidden Creek project[5]). In those cases, the funded activities could be considered as preventing pollutants from entering the waterbodies. The problem becomes calculating the amount of prevention in a way that will be comparable. We suggest looking at the other indicators to demonstrate that the funded action did protect water quality, aquatic life and associated habitat.

For CWSRF-funded wastewater treatment plant improvement projects, we recommend using this indicator only for those projects that involve maintenance or repair activities necessary for the plant to stay in compliance, and only for WWTP projects **not** under enforcement action. In these cases, pollution is being prevented from entering the environment through forethought and preventative action. The question remains as to how to quantify the resulting pollution reduction.

One method is to record the number and magnitude of 30-day violations during one year before and one year after a project is completed. The difference would provide an estimate of pollution reduction to a waterbody. The information on the Akron WWTP presented later in this report is an example of how this indicator might work (even though Akron was under enforcement action at the time). This indicator was not examined for any other project in the study.

Another method is to compare before and after Annual Maintenance Performance Evaluation Report (AMPER) scores (described below). Since these scores reflect the effectiveness, condition and operation of each WWTP component and procedure, they should be good stressor indicators. This method will only work with communities that participate in the Municipal Compliance Maintenance Program (MCMP).

The MCMP is a *voluntary* program that assists in the protection, maintenance, renewal, expansion or enhancement of the existing wastewater treatment infrastructure in order to meet effluent limitations. This program is designed to assist municipalities in planning for the future. Participants in the MCMP conduct:

- Annual facility performance evaluations that will indicate when planning for new construction must be undertaken to continue to meet effluent limitations and water quality standards;
- Proper maintenance and management of existing facilities that will assist communities in meeting their discharge limitations while deferring capital investments.

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[5]Hidden Creek at the Darby is a housing development in central Ohio that used CWSRF funding to finance storm water management and run-off control measures, as well as vegetation of a wetland. The development was comprehensively planned and designed to prevent any impacts to Little Darby Creek, which runs through the development, and is a designated State and National Scenic River. The project won a National Wetlands award in 1998 from the Environmental Law Institute.

The performance evaluation looks at the following factors and generates an AMPER score on a scale of 0 to 300:

- WWTP Hydraulics (design average flow, current average flow, design peak flow, peak flow exceedances).
- WWTP Influent Loadings (design, actual).
- Biosolids/Sludge Handling (disposal method, level and type of treatment, design capacity, actual volume generated).
- WWTP Effluent Performance (design, actual, violations).
- WWTP Maintenance (equipment failures, availability of back up equipment, failures that affected compliance).
- WWTP Laboratory (QA/QC program in place, process control used).
- Collection System (equipment failures, dry weather overflows, wet weather overflows).
- Administration (budget, staffing, pretreatment, growth and planning).

The MCMP performance evaluation may be a useful indicator, as long as the following criteria are met:

- There is complete performance evaluation data for both before and after the project improvements.
- The project involves some work that changes one or more of the factors evaluated in the performance evaluation.
- There is complete knowledge of other, non-project-related changes in the WWTP and collection system so that any influence from these factors on the performance evaluation score can be separated from the influence of the CWSRF-funded project on the performance evaluation score (this is the indicator value).
- The project was initiated as a result of existing stress factors on the WWTP and not done in response to an anticipated (future) stressor such as a new development.

Columbus Southerly WWTP was the only project in Ohio's pilot study that was not under enforcement action and was also a participant in the MCMP program. However, we did not look at the AMPER scores for this project because it did not satisfy the above criteria.

Confidence in the Indicator

Preventing increases in pollution or other impacts to water resources is an important use of the CWSRF program. As such, it needs to be recognized as a program accomplishment and appropriate measures of environmental accomplishment need to be developed. Using AMPER scores from the MCMP program may provide a means to do this for municipal wastewater treatment systems. A method appropriate for nonpoint sources of pollution needs to be developed.

Recommendation

Because of the difficulty of reliably estimating prevention of pollution, further investigation of this indicator is recommended as outlined above.

Indicator 3. Increase in biophysical benefits or reduction in biophysical stressors by changing land use practices and resource harvesting and extraction practices through CWSRF-funded projects.

U.S. EPA 1991 Indicator Type

This is a Level 2 indicator - Response by the regulated community - and a Stressor Indicator.

Ease of Use/Difficulties

We assume this indicator measures changes in land use (such as a change in agricultural tillage practices or restoration of riparian stream corridor) or other attributes of the physical environment that could affect the aquatic community. This benefit has not been tracked in Ohio, although Ohio has funded such projects.[6] It is conceivable that such documentation could be provided.

Confidence in the Indicator

The 305(b) report and monitoring data include physical causes and sources of impairments such as dredging, hydromodification, habitat alterations, siltation, removal of riparian vegetation, etc. Therefore, the results of changing land use practices are generally covered under Indicators 4 and 5, but not quantified in terms of number of river miles impaired or acres altered. This latter information would be useful to link changes in Indicators 4 and 5 back to the actions measured by this indicator. The current set of pilot projects is not appropriate for testing this indicator, and so no direct testing was possible to establish confidence in the indicator.

Recommendation

We recommend exploring use of this indicator when the effect of the project is to change land use practices, such as converting farming practices from conventional to conservation tillage, or the restoration of land areas to natural vegetation. This indicator would be especially useful for

[6]The Nature Conservancy received CWSRF loans totaling $266,000 to purchase conservation easements and property located immediately adjacent to Ohio Brush Creek, near a Wilderness Preserve. Purchase of this easement will permanently protect this property from future development and will likewise maintain a permanent high-quality riparian corridor along the creek. Thus, the water quality benefits realized from this easement will remain in perpetuity.

these types of projects when there is no associated water quality monitoring of the benefitted water resources.

Indicator 4. Waterbodies, expressed as river and riparian miles, lake acres, estuary square miles, and wetland acres, previously impaired, now meeting designated uses, as a result of CWSRF-funded projects.

U.S. EPA 1991 Indicator Type

This is a Level 6 Indicator, if the designated water resource uses are based on aquatic biota. If the designations are not based upon aquatic biota, then this is a Level 4 Indicator - Changes in Health and Ecology and other Effects. It is also a Response Indicator.

Ease of Use/Difficulties

This indicator was easy to use because this information is reported in Ohio's 305(b) database and in electronic database (Foxpro) format. It took some time to locate the "Waterbody Identification Numbers" (WBID) for the impacted stream segments because, prior to 1998, this was not routinely done for CWSRF projects. WBIDs are a necessary reference number for our Integrated Priority System[7] ranking procedure and are routinely assigned now. Therefore, this problem will be moot for analyses of projects funded after 1997.

Difficulties were encountered in locating and linking appropriate 305(b) databases. The Ohio EPA has not devoted personnel or resources to making this information easily accessible to external users. The database was not designed for extensive use outside of this group and recent staff reductions have made communications and technical assistance from the group difficult because the remaining staff members have multiple commitments and tasks.

Ambient chemical data taken in conjunction with the biological monitoring are not in a database, but housed with the individuals writing the Technical Support Documents or contained within the completed documents. We had originally thought that we could obtain this information from STORET retrievals. However, with the information spread out among the monitoring staff, in hard copy or electronic copies of reports, it was time-consuming and difficult to obtain and manipulate the data.

Confidence in the Indicator

Water quality improvement in a stream segment is sometimes very hard to attribute solely to an SRF- funded project. However, overall trends, along with identification of the funded activities, the 305(b) monitoring comments, and information from Indicator 1 (for point source projects) do

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[7]The Integrated Priority System was developed in 1998 by the Ohio EPA to rank projects, activities, or actions addressing both point and nonpoint sources of impacts on water resources. Development of the Integrated Priority System was partially funded through a Funding Framework grant from U.S. EPA., and the system is currently used to prioritize all CWSRF projects.

give enough information to draw conclusions as to the effect a CWSRF project has had on its receiving stream segment.

Recommendation

This is an easily used indicator which measures the desired endpoint of the CWSRF activity, that is, progress toward meeting the Clean Water Act goals. Ohio EPA believes, however, that this indicator is covered by Indicator 5, and hence, it should be dropped as a separate indicator.

Indicator 5. Waterbodies, expressed as river and riparian miles, lake acres, estuary square miles, and wetland acres, *protected, improved, or restored* as a result of CWSRF-funded projects.

This is a Level 6 Indicator - Changes in Health and Ecology and other Effects - provided it refers to protecting, improving or restoring a designated use that was based upon the biology of the stream. Otherwise, this is a Level 4 Indicator - changes in ambient conditions. It is also a Response Indicator.

Ease of Use/Difficulties

Improvements in a waterbody segment are easy to determine by looking at the 305(b) data before and after an CWSRF-funded project.

Confidence in the Indicator

To evaluate this indicator, we relied upon the 305(b) cause/source data for the appropriate, impacted waterbody that was reported before project funding and one year following the construction completion date for the project. For this pilot study, we included only CWSRF projects that affected waterbodies with both before and after data. Because there were not many projects with data that met this criterion, we ended up choosing some projects that had very old pre-project data and a few projects where the post-project monitoring data was collected not quite a full year after the end of construction.

Data prior to 1988 were not reported in the same format and manner as the more recent 305(b) data. These old data sets were converted into the new format by the 305(b) coordinator some years ago. The data can be easily compared, but the older data were not collected with this type of reporting in mind and therefore are unlikely to carry the same degree of precision and resolution as the newer data sets. However, the data quality was good enough to permit use of the data in this study.

As was discussed above under Indicator 1, it can sometimes be difficult to see the effect of an CWSRF-funded project on stream segments impaired by multiple sources. Sources other than those addressed by CWSRF financing can contribute to the same cause of degradation, making the SRF-financed improvements appear somewhat insignificant in restoring a stream segment.

Over time, however, the SRF-financed improvements can be important as a part of continued improvements in degraded stream segments, eventually leading to recovery of those segments.

Recommendation

This indicator should be used because it measures the desired endpoint of the CWSRF activity, which is progress toward the Clean Water Act goals.

To effectively use this indicator, it will be important to ensure that Agency water quality monitoring planning includes monitoring of both projects already funded through the CWSRF program, and projects anticipated to be funded in the future. Ohio's CWSRF program staff is working with Ohio EPA monitoring staff to ensure that this will now occur annually, as a part of the Agency's 5-year basin monitoring strategy.

Indicator 6. Benefits of reduced health risks and/or increased recreational use attributable to CWSRF-funded projects.

U.S. EPA 1991 Indicator Type

This is a Level 6 Indicator - Changes in Health and Ecology and other Effects. It is also a Response Indicator.

Ease of Use/Difficulties

Human health information is not readily accessible in a single database, but is in many different forms and locations. The available information appears to not be consistently or systematically gathered or reported.

Confidence in the Indicator

For some projects, these data are insufficient for drawing conclusions. The data that have been collected were subjected to quality assurance and quality control (QA/QC) criteria, and should be accurate and reliable. Adequate sampling to draw conclusions for the various projects is often lacking because samples need to be taken during various seasonal flows and at strategic locations. Although sampling upstream and downstream of a WWTP effluent can provide information regarding the plant operation, it may be more appropriate for some CWSRF projects to have a record of bacteriological violations in pools, ditches, water wells, etc. to document effects of failing on-lot systems. Such locations may not be considered an official waterway/body, but would nonetheless pose a threat to human health and warrant attention. These data are not in any known database or report, but are often gathered on an individual project basis from local health departments.

Recommendation

The human health data needs to be aggregated by the respective agencies and laboratories so that a complete picture of the human health impacts can be viewed quickly and easily. The indicator is an important one because it monitors a Clean Water Act objective.

Indicator B. Changes in the habitat of a waterbody as a result of a CWSRF project.

U.S. EPA 1991 Indicator Type

This is a Level 4 Indicator - changes in ambient conditions (e.g., water quality, habitat). It is also a Response Indicator.

Ease of Use/Difficulties

The 1998 305(b) Report states that habitat destruction is now the leading cause of aquatic life impairment in Ohio streams and rivers, overtaking organic enrichment and dissolved oxygen impacts. Hydromodification has overtaken point sources as the chief source of impairment to streams and rivers. As SRFs fund a wide variety of nonpoint source, restoration and preservation projects, this indicator will provide an appropriate measure when coupled with the biological information in Indicators 4 and 5. Another method of assessing impacts of land use (nonpoint sources) on the physical stream habitat may be to look at trends in the Qualitative Habitat Evaluation Index (QHEI) of a location over time. Ohio EPA uses the QHEI to evaluate the characteristics of a stream segment based on the overall importance of a number of metrics related to the maintenance of viable, diverse, and functional aquatic faunas. The types and quality of substrates; amount and quality of in-stream cover; channel morphology; extent and quality of riparian vegetation; pool, run, and riffle development and quality; and gradient are some of the metrics used to determine the QHEI score; which generally ranges from 20 to 100. Since the QHEI factors in a large amount of diverse information, the monitoring group has recommended looking at the trends of just one component of the QHEI, bottom substrate characterization. The composition of stream bottom substrates can be used to measure nonpoint source stressors like fine sediment.

The median particle size in an unimpacted stream in Ohio is typically coarse (gravel, cobble, sometimes boulders). These sizes of bottom sediment are typically associated with high-quality biota and stream habitats. As erosion increases in a watershed, either from surface runoff and/or bank erosion, the percent of fine materials in the stream bottom can increase, fill pools, and embed the larger-diameter substrates. Our data show that increased substrate embeddedness is associated with lower Index of Biotic Integrity (IBI) scores (lower ecological condition of the stream).

An easy procedure that can be used to evaluate substrate condition of rivers and streams is called the Zig-Zag Pebble Count Method, explained in Ohio EPA draft Fact Sheet 3: Field-1-MAS-99 (see Appendix F). The procedure involves starting at the downstream end of the sampling zone and picking a point up and across the stream (e.g., tree) at an acute angle. The data collector then starts walking and on every third pace or so, bends down and without looking picks up the first particle that he/she touches. The items are recorded and the procedure is repeated so that a little more than 100 pieces are collected within the zone. The results are classified into 16 possible categories ranging from silt < 2mm to artificial (concrete or riprap) >1024mm. Such tools could be used to establish targets and measure incremental progress after the establishment of best management practices or to detect deviation from reference conditions of streams in rapidly developing areas.

One project (West Milton WWTP improvement project) in this report will demonstrate the use of the QHEI (in absence of the pebble count data) for this indicator. Funded projects that focus on nonpoint source issues lacked sufficient data to make a valid before-versus-after project comparison.

Confidence in the Indicator

Changes in land use practices, or channel modifications will be reflected in some degree in Indicators 4 and 5. Tracking Zig-Zag Pebble Counts for stream segments where either nonpoint source projects or WWTP projects to eliminate solids discharges are implemented should provide insight into the effectiveness of various types of activities/best management practices.

Recommendation

We recommend using this factor to capture those projects providing ambient habitat restoration. Also, further investigation should be done regarding the use of both QHEI and Zig-Zag Pebble Count data from appropriate project locations.

Overall Recommendations and Conclusions

The following are our recommendations regarding development and use of CWSRF indicators, based on our analysis of the six draft indicators, and our experience using the indicators to evaluate a select group of CWSRF-financed projects.

We recommend that Indicator 4 be eliminated, because it is covered by Indicator 5, and that the two new indicators be added to the list of CWSRF indicators. This will provide a robust set of indicators that will provide states with a wide range of choices for measuring the results obtained from their CWSRF programs. However, to provide the best picture of the effect of CWSRF-financed projects on water quality, Indicators 1-3 and the two new recommended indicators should be combined with Indicators 5 and/or 6. This will allow causal connections to be made between CWSRF-financed projects and changes seen in the environment.

The indicator study performed by Ohio EPA's biological monitoring group shows that linking management actions to real environmental results is most successful when direct measures (as opposed to surrogates) are used. In evaluating the individual indicators for the CWSRF program, it is important to keep in mind the nature and type of information that each environmental indicator provides, and to be careful not to use stressor and exposure indicators as substitutes for response indicators. States lacking well-developed biological indicators still must report on the status of their waters to U.S. EPA. Unfortunately, the most readily available information usually consists of stressor or exposure indicators, which necessarily leads to their use as surrogates for biological indicators. Response (biological) indicators are inherently better at evaluating attainment of designated uses, which are the basis of state water quality standards. More accurately portraying the condition of the nation's aquatic resources depends on the wider development and use of response indicators. These are important concepts to keep in mind in evaluating the nature of the information that each CWSRF indicator requires, and the resulting conclusions that can be drawn about the effectiveness of CWSRF projects in meeting Clean Water Act objectives.

Preparation of this report has pointed out the importance of having monitoring data accessible and in an easy, usable format. Ohio has information on the various permits, projects, chemical data, biological data, bacteriological data, etc. stored in different databases or paper files, making the information time-consuming and difficult to access. We recommend that agencies in Ohio that are doing water quality monitoring and assessment consolidate the body of information on state water resources into one, or a very few, user-friendly, electronically accessible databases to allow for a more complete picture of our water resources and a wider use of the data.

This study has also pointed out the need to include CWSRF programs in state monitoring strategies so that data collected can be used to give CWSRF programs needed information to evaluate the impacts of funded projects on the influenced waterbodies. Some such benefitted waterbodies may not be monitored otherwise. This is especially the case for nonpoint source projects, wastewater treatment plant elimination projects, or riparian protection projects where a permit (or likely enforcement action) is not involved. To get an idea of the effectiveness of these various types of projects, monitoring data on such projects needs to be collected and evaluated.

Finally, CWSRF programs should get involved in the Total Maximum Daily Load (TMDL) efforts. In order to be most effective in this process, the CWSRF program will need to be able to predict what types of projects, under what conditions, will provide the greatest benefit to aquatic life and human health in a watershed. The CWSRF program may play a prominent role in TMDL implementation as watershed groups look for financing to support water quality improvement activities.

Texas's Pilot Project Experience

EPA proposed the following indicators as a means to measure the benefit derived from CWSRF funding on the environment. Texas was selected as a pilot state to help evaluate these proposed indicators.

The following comments represent initial feedback to EPA regarding the efficacy of the proposed indicators.

> *Indicator 1* - Number of pounds of pollutants *removed* from the environment through CWSRF-funded projects. (Point source oriented)
>
> *Indicator 2* – Number of pounds of pollutants *prevented* from entering the environment through CWSRF funded projects. (Nonpoint source and no discharge)
>
> *Indicator 3* – Increase in biophysical benefits or reduction in biophysical stressors by changing land use practices, and resource harvesting and extraction practices through CWSRF-funded projects.
>
> *Indicator 4* – Waterbodies, expressed as river and riparian miles, lake acres, estuary square miles, and wetland acres, *previously impaired, <u>now</u> meeting designated uses*, as a result of CWSRF-funded projects.
>
> *Indicator 5* – Waterbodies, expressed as river and riparian miles, lake acres, estuary square miles, and wetland acres, *protected, improved, or restored* as a result of CWSRF-funded projects.
>
> *Indicator 6* – Benefits of reduced health risks or increased recreational use attributable to CWSRF-funded projects.

Of the six proposed indicators, the first two indicators appear to be the most developed and, therefore, most useful for measuring the performance of specific Clean Water State Revolving Fund (CWSRF) projects. Texas continues to have a large funding demand for Section 212 projects (i.e., wastewater). Indicators 1 and 2 seem best suited to measuring 212 projects. Regarding Indicator 3, Texas has no experience in funding projects through the CWSRF for protective zoning, watershed management planning, stream restoration, changes in agricultural practices, riparian buffers, and other BMPs that could have biophysical benefits. Since Indicator 3 is intended to measure this type of activity, Texas cannot comment on the adequacy of Indicator 3 at this time. Indicators 4 and 5 appear to be measures of stream conditions against set ambient standards. Indicator 4 would be a comparison to the 303(d) list while Indicator 5 would be a "more comprehensive" measure of ambient water quality against a standard which, heretofore, has not been established. It appears that Indicator 5 is particularly undeveloped. Because of this, Texas has no comments regarding Indicator 5 at this time. Indicator 4, however, appears to be in keeping with the approach that Texas has chosen to pursue. That is, for the purposes of the pilot study, Texas has attempted to select specific CWSRF projects which best correlate to the stream conditions as monitored through 305(b) reports and listed in the 303(d) list. Finally, Indicator 6 appears to be very undeveloped as well.

Evaluation of Indicators 1, 2, and 4

As indicated above, Indicators 3, 5, and 6 were not evaluated. These indicators need to be developed further in order to provide a framework for an evaluation. Indicators 1, 2, and 4 were considered to be the most viable of the six. Indicators 1 and 2 lend themselves to a loading analysis and Indicator 4 relates well to the approach that Texas has elected to take to correlate CWSRF projects with existing 305(b) and 303(d) reports.

Texas first identified six stream segments that represent the following before and after stream conditions:

Two IMPAIRED segments in 1983-1987 that are now NOT IMPAIRED.
Two NOT IMPAIRED segments in 1983-1987 that are now NOT IMPAIRED.
Two IMPAIRED segments in 1983-1987 that are now IMPAIRED.

Stream impairment for the before and after conditions were determined by evaluating 305(b) reports prepared between 1983 and 1987 and the current 303(d) list of impaired streams. Once the six stream segments were identified, then specific CWSRF projects in these stream segments were identified for analysis. The intent was to get as close as possible to a cause and effect relationship between individual CWSRF projects and their specific impact on the stream. The following projects were selected for evaluation:

Table A-1. CWSRF Projects/stream segments selected for evaluation.

SEGMENT	*CWSRF PROJECT*	*1983-1987 305(b) REPORT*	*CURRENT 303(d) LIST*
0505 Sabine River above Toledo Bend Reservoir	Carthage Hallsville Longview Marshall	Depressed DO, nutrients, WWTP effluent contribution problems IMPAIRED	Selenium, Pb No mention of municipal waste related problems NOT IMPAIRED
0611 Angelina River above Sam Rayburn Reservoir	Canada St. (Jacksonville) Double Creek (Jacksonville) Nacagdoches Whitehouse	DO violation Problems have been due to the assimilation of wastewater effluent. 1985 waste load evaluation recommended Nacagdoches #2a and Tyler Southside WWTPs attain advanced Treatment levels in order to achieve DO standards IMPAIRED	Not Listed NOT IMPAIRED
1202 Brazos River below Navasota	Sugarland Regional (BRA) Richmond North Second Street Richmond Regional	No significant water quality problems Effluent Limited NOT IMPAIRED	Not Listed NOT IMPAIRED

SEGMENT	*CWSRF PROJECT*	*1983-1987 305(b) REPORT*	*CURRENT 303(d) LIST*
1217 Lampasas River above Stillhouse Hollow Lake	Copperas Cove South Lampasas Henderson	No significant water quality problems Effluent Limited NOT IMPAIRED	Not Listed NOT IMPAIRED
0810 West Fork Trinity River below Bridgeport Reservoir	Alvord Bowie Bridgeport Sunset	Coliform exceeds contact recreation standards Water Quality Limited IMPAIRED	Lower 25 miles, bacteria levels exceed contact recreation standards IMPAIRED
2202 Arroyo Colorado above tidal	Donna McAllen Mission Pharr Weslaco	Low DO levels below 4 mg/L downstream major municipal discharges Bacteria levels exceed contact recreation levels in portions of the segment IMPAIRED	Chlordane, Toxaphene, DDE Bacteria levels exceed contact recreation levels in lower 40 miles IMPAIRED

The projects listed involved plant expansions, plant upgrades, major sewer rehabilitation, point repairs, removal and replacement of lines, and the construction of new interceptors and collectors. The project categories used by Texas are as follows:

A. Wastewater Treatment Plant Expansion - The capacity of a Waste Water Treatment Plant (WWTP) is being expanded or additional facilities are needed for more stringent effluent limits.

B. Bio-solids Treatment Capacity Expansion - The project is primarily to expand the solids treatment and handling portion of a treatment facility.

C. Facilities Rehab - The project is primarily to rehabilitate (not expand) equipment at an existing wastewater treatment facility, both wet and dry processes, or rehab/replace (not expand) an existing lift station.

D. Collection System Rehab/Overflow Control - The project is primarily to manage excessive I/I flows or exfiltration and includes any of the following: collection system rehabilitation, relief lines, expansion of lift stations or construction of new lift stations, and expansion of the hydraulic capacity at a WWTP.

E. Unserved Areas - Projects that involve extending service to populated areas of an existing developed community that are not served by a centralized collection system. Project is primarily collector sewers as opposed to trunk sewers.

(1) For an **isolated community** that has no centralized system, the principal project may include the cost of the collection system, transmission lines, and construction of a wastewater treatment plant.

(2) For an **area adjacent to an existing community** with centralized wastewater collection and treatment service the principal project may include the cost of construction of the collection system and the transmission lines required to convey flow to treatment.

F. Trunk Sewer, Diversion - Projects where all or a portion of flow is diverted from an existing facility to an existing or new WWTP. The project could include diversion sewers, lift stations and expansions or construction of **new WWTP**. In these cases the project will be scored on the basis of the WWTP that is being removed or relieved of flow.

G. Trunk Sewer, Developing Area - Project primarily involves extension of trunk lines and lift stations to areas of a community that are developing.

H. Reuse - Projects to construct facilities to reuse wastewater for irrigation or other purposes.

I. Nonpoint Source Pollution Project - A project for managing nonpoint source pollution that is in accordance with the State of Texas 319 plan or the State of Texas 320 plan (Estuary Management Plan). Items 3-8 on the SRF-6 form need not be completed for a nonpoint project. These projects are not rated.

Indicator 1- Pounds of pollutants *removed*

Indicator 1 was conceptualized to apply to point discharge projects. As such, it appears that this indicator can easily be applied to plant expansion projects. Plant expansion projects include the construction of new treatment plants, expansion of existing plants to accommodate additional flows, and plant improvements to enable more stringent discharge limits. All of these scenarios involve the development of facilities for the "removal" of pollutants. Pollutants removed can be estimated by comparing plant loadings to discharge parameters. For example, if the influent strength is 200 mg/L BOD at 5 MGD and the discharge limits are 10 mg/L BOD at 5 MGD, then the pounds removed would be the difference at 7,923 lb BOD/day. This calculation can easily be made by using theoretical numbers or actual measured numbers at the influent and the effluent once the plant is in operation. Discharge information is reported to the state for each wastewater treatment permit. This information is maintained by the state and is easily accessed. However, it is currently not mandatory for plants to measure influent loadings at each plant. This would need to be made mandatory in order to get the accurate before and after information needed if calculations are to be made on real, not estimated, data. This could present a barrier to applying the Indicator. But, we consider a measure of discharge information against design influent (estimated) information an easy, consistent, and credible method of determining pounds of pollutants removed from the stream for plant expansion projects.

Plant upgrades include improvements that are not directly related to the treatment train and hydraulic discharge. Items of this type would include such things as plant buildings, plant site improvements, electrical improvements, equipment repair and replacement, and treatment facilities that don't contribute to liquid treatment such as sludge facilities and methane recovery facilities. The CWSRF might fund these types of improvements without yielding a change in pounds loading to the stream. As a result, Indicator 1 would not be able to measure these types of improvements. Indicator 1, therefore, cannot measure *all* projects funded for treatment plant work. Another indicator should probably be developed to measure plant upgrades.

Improvements to the collection system made through major sewer rehabilitation, point repairs, removal and replacement of lines, and lift station rehabilitation and construction are designed to reduce infiltration/inflow (I/I), to eliminate overflows and bypasses, and to increase collection system capacity. A direct measure of pounds removed in Indicator 1 does not seem feasible for these types of improvements. Likewise, the construction of new collectors and interceptors do not appear to be measurable through Indicator 1.

Indicator 2 – Pounds of pollutants *prevented*

Indicator 2 was conceptualized to apply to nonpoint source projects. Although they are not necessarily directly related to nonpoint source pollution, improvements to the collection system appear to be better measured through Indicator 2. It is possible to estimate pounds "prevented" in cases where I/I is being reduced, and where overflows and bypasses are being eliminated. Estimates developed in documents such as I/I analyses or Sewer System Evaluation Surveys (SSES) could be used as "measures" of pounds prevented. However, the vast majority of collection system improvement projects funded in Texas are for major sewer rehabilitation and replacement. Formal I/I analyses or SSES are not required. In addition to the fact that this method is not a direct measure of pounds prevented, another drawback is that it would represent an extra requirement that we would need to impose upon our applicants.

The proper collection/transportation of sewer flows does represent a significant means of "preventing" pollution. Collectors, interceptors, and lift stations are used to transport and transfer flows in a sewer system to prevent pollution. As such, the construction of these types of improvements appears to be best measured under Indicator 2. Design calculations identifying line capacity and lift station capacity can be used as estimates of the pounds prevented for these systems. This information is easily obtained and is part of the information that we currently gather routinely from our applicants. Again, this method does not provide a direct measure. We consider this method of estimating pounds prevented to be consistent and credible for these types of improvements. As a final note, the extension of collectors and interceptors into unsewered areas often involves taking septic systems out of service. This can be viewed as a nonpoint source project. The pounds of pollutants prevented from entering the environment for this type of project would, likewise, be estimated by the applicant through design calculations.

Indicator 4 – Waterbodies *previously impaired, now meeting designated uses*

Indicator 4 is intended to enable a comparison of waterbodies to a set standard. The standard which seems to be the most logical and convenient to use would be the 303(d) list since the list and the procedures for its development are already in place. In our evaluation, we attempted to determine a cause and effect relationship between CWSRF improvements and the stream conditions listed in the 305(b) report and the 303(d) list. The 305(b) and 303(d) information was easily obtained through printed reports provided to us by our sister agency, the Texas Natural Resource Conservation Commission (TNRCC). We were able to make conclusions about the before and after conditions of select stream segments. For example, (Table A-1) for the Sabine River above Toledo Bend Reservoir (Segment 0505), the 305(b) report stated that there was depressed dissolved oxygen (DO) and nutrients in the stream. It specifically stated that wastewater effluent contributed to problems. The 303(d) list made no mention of municipal waste problems. By virtue of this omission and for wastewater purposes, we concluded that the segment was previously impaired and now is not impaired.

We then identified four communities in Segment 0505 that received funding from the CWSRF. It appeared that we could infer that the wastewater improvements in these four communities remedied the stream deficiencies listed in the 305(b) report. However, it became immediately obvious that we could not determine a clear cause and effect relationship. First, we identified only the projects that we funded. We, by no means, fund all of the wastewater improvements statewide. This means that we are not aware of all of the improvements that were made in facilities that might impact any one segment. Hence, we could never conclude that it was the CWSRF improvements that remedied the problem.

When comparing to a set standard as is proposed by Indicator 4, a means of collecting *comprehensive* information regarding what was built and when, including any nonpoint source projects, would be necessary to enable us to give credit where credit is due. Second, once the stream achieves the set ambient standards, a method of measuring the beneficial impact of subsequent wastewater projects would need to be developed. The method that we attempted was limited because once a segment is removed from the 303(d) list, there would be no way to determine the impact of subsequent improvements on the stream since the stream was already meeting standards.

Texas currently has a basic statewide ambient water quality monitoring system. The question, however, is whether it is fined tuned enough to determine whether a single CWSRF project can make a difference in the stream. The system as it is designed now measures stream segment conditions and is not targeted toward monitoring the impact of specific CWSRF projects. To obtain information on the impact of specific plants, the monitoring system would need to be modified to include monitoring stations around specific wastewater treatment plant discharge points. Care would need to be taken to avoid the placement of these new stations in mixing zones to avoid false readings of the stream itself. Maintenance monitoring of this type would be necessary for every wastewater project that is funded by the CWSRF in order to draw a direct relationship between the funding and the stream conditions. In addition, the monitoring system would need to be modified to correlate the stream conditions to specific nonpoint source projects. The placement of additional monitoring stations would, of course, demand a corresponding increase in resources.

Data Availability

For Indicators 1 and 2, data appears to be readily available from project information collected from applicants as we process applications. This information would be maintained in our fileroom. However, in the case of Indicator 2, a drawback is found in that we would need to impose an extra requirement on applicants to get the necessary information. This would be considered burdensome and undesirable.

Databases containing relevant information are maintained by our agency (the Texas Water Development Board) and the TNRCC. Sharing of this information would be necessary and easy to do. The TNRCC TRACS database maintains 305(b) and 303(d) information. We maintain the FNMIS for facility needs and project information purposes.

Michigan's Pilot Project Experience

Michigan's participation in EPA's Environmental Indicator Task Force has been an interesting experience, but has reaffirmed that the state has very limited hard data to support an indicator effort. Coupled with a need to aggregate data nationally from states with differing philosophies, resources and funding priorities, the Task Force has been left with a very difficult charge. Before discussing the various indicators and Michigan's experience attempting to implement them, it would be appropriate to briefly describe a number of issues that directly bear on the state's efforts:

(1) Historically, Michigan maintained an extensive ambient monitoring network on its lakes and streams. Over the last 15 years, however, nearly all of these ambient monitoring efforts have been abandoned as budgets have been cut. Although there has been a flurry of discussion regarding the planned expenditure of the newly approved Clean Michigan Initiative funds for water quality monitoring, efforts have not yet gotten off the ground.

(2) Michigan does maintain the PCS system, collecting and storing discharge data filed by dischargers on monthly Discharge Monitoring Reports (DMRs). These reports are filed by NPDES permit holders and cover primarily treatment facilities with continuous or seasonal discharges.

(3) Nearly one-half of Michigan's CWSRF funds to date have been utilized for the control or elimination of combined sewer overflows. Although the overflows in most cases are permitted discharges, due to the difficulty of sampling intermittent events and the absence of firm monitoring requirements in CSO discharge permits, there is little or no reliable discharge quantity/quality information available.

(4) Michigan has not provided any CWSRF assistance to date to nonpoint source projects.

(5) Michigan does maintain a project priority ranking process that attempts to "estimate" the amount of in-stream water quality improvement that would result from a CWSRF project. Using a modified Streeter-Phelps equation and mass balance computations, the system awards points in five categories: dissolved oxygen, nutrients (phosphorus), toxic substances (un-ionized ammonia and residual chlorine), microorganisms, and groundwater improvement (contaminated wells). The process relies only partially on hard data from the DMRs while using a series of default values and estimates to complete assessments of the in-stream improvements that could be expected from a CWSRF investment.

These realities made it nearly impossible for Michigan to complete indicator questionnaires on any meaningful cross section of CWSRF projects in the state. In most cases reliable pre and post project data simply does not exist. As Michigan evaluated each indicator against the 165 projects funded to date in the CWSRF we found the following:

1. Number of pounds of pollutants removed from the environment through SRF-funded projects. (Point source oriented)

- For existing treatment facilities DMR data could provide accurate pre-project load data, while post-project load data could be derived from basis of design information. Unfortunately, a significant number of our CWSRF funded treatment plants were primarily for expansion rather than upgrade, rendering the post-project load larger than the pre- project load.
- For CSO projects, since actual discharge data is not available, pre-project loads would have to be estimated from default data used in our priority ranking system. Post-project loads would have to come from basis of design data for treatment facilities and post-project assumptions for residual storm water in separation projects.
- Collection sewer projects would have to be assessed using estimated data on loading to the groundwater in most cases.

2. Number of pounds of pollutants prevented from entering the environment through SRF-funded projects. (NPS or non discharge oriented)

- This indicator was difficult to use in Michigan because it seems to "assume" that when a facility is expanded the additional load it is capable of removing would have gone to the environment without the expansion. Here Michigan would have to use some assigned "per capita" load and credit the project for loading prevention based on the new population to be served.
- Since we have not funded any nonpoint projects to date we were unable to fully test this indicator.

3. Increase in biophysical benefits or reduction in biophysical stressors by changing land use practices, and resource harvesting and extraction practices through SRF-funded projects.

- Michigan found it was unable to properly assess this indicator without having nonpoint source projects funded.

4. Waterbodies, expressed as river and riparian miles, lake acres, estuary square miles, and wetland acres, previously impaired, now meeting designated uses, as a result of SRF-funded projects.

- This indicator proved very difficult to utilize even though Michigan maintains an extensive involvement in the 303(d) process and is well on its way to completing TMDLs. The fact that the vast majority of our impaired waters result from numerous influences will make it difficult to assign the improvement, or a specific share of the improvement, to any CWSRF project. Work outside the CWSRF program, contaminated sediment removal, storm water control and nonpoint source reductions in many areas "overlap" the zone of influence of CWSRF work.

- Any assessment of designated uses would necessitate having in-stream water quality data available, which would be problematic in Michigan.

5. Waterbodies, expressed as river and riparian miles, lake acres, estuary square miles, and wetland acres, protected, improved or restored as a result of SRF-funded projects.

- Conceptually this indicator seems to get at the kind of "cross program" improvements that might be realized by the CWSRF and the other federal programs striving to the same "fishable and swimmable" goal. This broadness, however, also reveals the weakness that will inherently exist with data availability and consistency. When evaluating this indicator Michigan ran into much of the same problem encountered in No. 4 above.

6. Benefits of reduced health risks or increased recreational use attributable to SRF-funded projects.

- Clearly much of Michigan's CWSRF investment (particularly in CSO elimination) is being driven by the public health concerns of untreated overflows. With that said, however, it is nearly impossible to directly link CWSRF projects to the elimination of any disease outbreaks. Many county health departments in Michigan are diligently issuing health advisories following rain-induced overflows from CSOs, and this could be used as an approximate reflection of reduced risks assuming advisories become less frequent after project completion.

- The only recreational use attainment indicator available would be the designated use for partial/full body contact recreation (fecal coliform concentrations), but this again would necessitate the availability of in-stream data, which is not consistently available in Michigan.

In summary, Michigan found that with the exception of modifying our project priority ranking process to accommodate Indicator No. 1, we would be hard pressed to provide accurate, reproducible data for the other suggested indicators, primarily due to a lack of the necessary in stream water quality information.

New Jersey's Pilot Project Experience

Results Summary: The information obtained from these indicators could be beneficial to Clean Water Act program management. However, New Jersey currently collects data that directly supports only one of the six pilot indicators. In addition, indicator development guidelines are needed to facilitate consistent state reporting for national indicators and state or regional comparisons. Additional effort would also be needed to integrate the pilot indicators into New Jersey's goal and indicators system.

Due to the integrated nature of water programs, NJDEP has attributed improvements in water quality to the combined efforts of permitting, enforcement and finance programs which have acted in concert to address point sources and now are being used to address nonpoint sources. Clearly attributing improvements in water quality specifically to the CWSRF, as suggested by the pilot indicators, may overemphasize one aspect of an integrated approach.

As states analyze the environmental effect of the treatment upgrades, project-specific information may not be readily comparable. Project sponsors come in for financing in order to do upgrades for a variety of reasons. The facility may provide only primary treatment (note that none are left in NJ), marginally secondary treatment, secondary with compliance issues, or upgrade to advanced levels. New Jersey's compliance indicator shows a downward trend in permit violations, and there are significant penalties for permit violations under New Jersey's Clean Water Enforcement Act. Thus, actual or potential compliance issues are an important impetus for upgrades.

In general, the cost of upgrading increases as higher treatment levels are required. Required treatment levels are also influenced by the size and variability of the receiving waterbody. Thus, the unit cost per pound of pollutant removed may vary significantly. Based upon this, we do not believe that it is appropriate to establish national priorities for the use of CWSRF funds (i.e., projects that reduce BOD are a higher priority than projects that reduce SS, for example), or to make generalizations regarding the most cost-effective use of CWSRF dollars. Project priority decisions, as is the current precedent of the CWA, are intended to be made by the states. While the intent of the environmental indicator effort to attempt to quantify environmental benefits achieved through the expenditure of CWSRF funds is appropriate, the use of such information to set federal priorities for the use of these funds is not.

Background: New Jersey is the seventh smallest state in the United States (7,600 square miles) and one of the most densely populated (7.9 million people in 1990). Population, industrial and shipping centers occur in the northeast and southwest portions of the state and most other areas are becoming suburbanized. The Pinelands in the southeast and Highlands in the northwest are relatively less developed. Surface waters in New Jersey are intensely used for potable and industrial supplies, recreation and wastewater disposal. The 300 publicly owned treatment works treat domestic waste and 90% of the state's industrial waste. There are also 1200 industrial treatment plants and 300 CSOs. Stream headwaters are typically forested; larger watersheds typically receive stormwater and runoff from residential, commercial, industrial and agricultural land and direct discharges of domestic and industrial effluents.

Indicator 1: Number of pounds of pollutants removed from the environment through CWSRF-funded projects.

Discharge Monitoring Reports (DMR) data include specific pollutants that are routinely monitored nationally (i.e., BOD, Suspended Solids) could be used for CWSRF POTW projects to calculate the pounds of each pollutant removed at the POTW. This approach appears to be workable; however, testing identified questions about the validity of the numbers generated, as explained below.

In New Jersey, no new POTWs have been funded from CWSRF dollars. All of the POTW projects in NJ have involved upgrades, expansions, improvements to maintain current operational reliability or combinations of these items. Therefore, since the existing facilities were already removing a certain number of pounds of pollutants, and upgrades are usually done in combination with expansions together with tying in new flows, it is difficult to identify the additional pounds of pollutants removed due to CWSRF funding.

For example, improvements to one POTW were funded to construct four new final clarifiers to improve operational reliability. Several approaches could be taken to calculate the indicator which yield very different results. One approach would be to calculate the removal capabilities of the new units financed with CWSRF funds by comparing DMR loadings data before and after addition of the new clarifiers. However, gains in treatment may be offset by additional influent flows. Another approach would be to use current influent and effluent data to calculate the total pounds of pollutants removed by the POTW. This approach gives the CWSRF credit for all pollutant removal at the POTW.

DMR data to calculate this indicator are readily available through the PCS system. This indicator could provide useful data regarding pollutant load reductions from regulated facilities. New Jersey has reported statewide BOD loadings between 1985 and 1998, which show a statewide decreasing trend despite increases in population served by sewers. As discussed above, this trend was attributed to the combined efforts of permitting, enforcement and finance. This pilot indicator is currently limited by a need for clear guidelines for indicator calculations that address the variety of POTW projects financed by states so that information is comparable between states.

Indicator 2: Number of pounds of pollutants prevented from entering the environment through CWSRF funded projects.

This indicator is designed to address NPS and no-discharge oriented projects. In New Jersey, the number of these projects is quite substantial and includes sewer rehabilitation, inflow/infiltration correction, drinking water sludge management, wastewater sludge management, treatment plant expansions, lakes management projects and others. Typically, there are no "before" or "after" data. Thus, to develop this pilot indicator, substantial modeling for each individual project type that the states have financed with CWSRF funds would need to be developed; a very costly, controversial and time consuming endeavor. Alternatively, nationally accepted estimates may suffice, but this needs to be further evaluated.

Indicator 3: Increase in biophysical benefits or reduction in biophysical stressors by changing land use practices, resource harvesting and extraction practices through CWSRF funded projects.

The specific types of projects associated with this indicator are unclear. For example, would land acquisition and conservation be included under this indicator. While "riparian buffers" buffers are listed, what is meant? Thus we cannot ascertain whether this indicator is likely to be associated with a substantial number of projects in New Jersey. The national applicability of this indicator should be reconfirmed. The units to measure biophysical benefits and stress reduction for this indicator are also unclear.

Indicator 4: Waterbodies previously impaired and now meeting designated uses as a result of CWSRF projects.

In order to evaluate this indicator, ambient stream monitoring stations downstream of CWSRF projects were evaluated for water quality improvements subsequent to CWSRF project implementation. Stream monitoring network stations are typically selected for a variety of reasons and are often not in close proximity to a specific discharge. As discussed above in the background section, a variety of land uses and point sources often contributed pollutant load between the upgraded facility and the monitoring point. Although improvements in water quality were observed (i.e., increasing DO, decreasing total phosphorus), it was not possible to attribute these improvements to one or more specific CWSRF projects.

Data are not readily available in New Jersey for this indicator at this time. However, through several efforts, data to support this indicator may become available in the future. Development of watershed-based TMDLs is expected to lead to issuance of permits for all facilities in a watershed. CWSRF assistance to implement these watershed-based permits could be measured in terms of pollutant load reductions to watersheds (Indicator 1) and improvements to designated use attainment (Indicator 4). Again, concerns regarding specifically attributing CWSRF with improvements associated with permitting, enforcement, and finance should be noted.

Additional data collection to support TMDL development and implementation as well as the recently redesigned Ambient Stream Monitoring Network could provide data needed to support this indicator. In addition, NJDEP's CWSRF program and Water Assessment Team are working to exchange data regarding CWSRF projects and ambient water quality. This data exchange is the first step to evaluating CWSRF contributions to improved designated use attainment.

Indicator 5: Waterbodies protected or improved as a result of CWSRF funded projects.

In NJ, land acquisition projects would be reflected in this indicator. New Jersey is extending eligibility to land acquisition projects in FY 2001. In addition, New Jersey's land acquisition programs utilize several funding sources confounding specific identification of protection or improvements related to CWSRF. The data concerns identified above for Indicator 4 also apply to this indicator.

As noted above, TMDL development, improvements in data collection and exchange may provide information to support this indicator in the future. In addition, watershed management efforts focused on land acquisition and pollution prevention may provide data in the future.

Indicator 6: Benefits of reduced health risks and/ or increased recreational use attributable to CWSRF funded projects.

Links between CWSRF funding and specific reduced health risk, as measured by disease outbreaks prevented, would be difficult, if not impossible, to confirm. CWSRF projects were conceptually reviewed and clear links to projects for which reductions in disease outbreaks could not be made. Recent disease outbreaks in bathing areas were associated with wildlife. Recent studies of *cryptosporidium* and *giardia* in water supplies indicate that NJ supplies are not significantly affected by these pathogens, given limitations of the study design and test methods.

A review of enforcement data showed that facilities rarely exceed permit limits for fecal coliform. Pathogen contamination, as indicated by fecal coliform pollution, has been attributed primarily to CSOs, storm water and runoff in New Jersey. Pollution from storm water and municipal runoff contributes to beach closings and shellfish harvest restrictions. However, given the intensity of development, it is difficult to identify specific pipes. For example, over 7000 municipal storm water pipes discharge to Barnegat Bay. Through watershed management, CWSRF needs associated with management of these sources are expected to be identified and addressed in the future.

In New Jersey, CSO discharges occur primarily in urban areas away from shellfish beds and bathing beaches. (Note that significant sums were provided under the construction grants program to accomplish this.) Management of pathogens from CSO sources will be very difficult to accomplish and designated use improvements may be confounded by other pollution sources, including storm water and runoff. Additional issues associated with the use of the fecal coliform indicator need to be addressed on a national level. As above, a survey of the other states should be made to see if information on more than just a handful of situations can be confirmed.

New Jersey's Goal and Indicator System

New Jersey was one of six states to pilot the National Environmental Performance Partnership System (NEPPS) in 1995. Under NEPPS, water program representatives and external advisory groups developed the Goal and Indicator System. New Jersey's water goal reflects the Clean Water Act goal. Milestones (measurable targets) that reflect designated uses were developed if sufficient data were available (e.g., By 2005, 50 percent of assessed, nontidal river miles will support healthy aquatic life.). If sufficient data were not available, objectives were developed (e.g., Maintain and enhance aquatic life in assessed tidal waters).

Environmental indicators are being used to measure progress toward each milestone and objective using three types of indicators in a feedback model. Cause indicators show pollutant loads from point and nonpoint sources and other environmental stressors (e.g., BOD loads). Condition indicators show ambient environmental conditions (e.g., stream water quality). Response indicators show management measures implemented by NJDEP, regulated entities and watershed partners (e.g., CWSRF investment, permit compliance, BMP implementation).

New Jersey reported "Infrastructure Investment By County" (state and CWSRF funds) as one of several response indicators measuring progress toward the aquatic life milestone (see following section from "Environmental Indicators Technical Report," NJDEP, June 1998). To reflect the integrated nature of water programs, permit compliance and industrial storm water pollution prevention plan implementation were also reported.

Milestone: By 2005, 50% of assessed river miles will support healthy sustainable biological communities.

Indicator: Infrastructure investment to improve water quality

Type of Indicator: Response

From 1987 (the first year of the loan program) through 1995, approximately $1.2 billion has been awarded in the state for various types of wastewater projects.

What does this indicator tell us?

This indicator conveys the total amount of funding awarded through the Wastewater Treatment Financing Program in the state. "Loan awards" has been selected as an indirect indicator of potential water quality improvement. Water quality improvements specifically related to infrastructure investment are difficult to identify, particularly on a project-specific basis, because water quality is subject to significant other point and nonpoint source impacts at the same time. Notwithstanding, surface water quality improvements in specific areas of the state have been noted and are coincident with areas in which substantial loan funding has been provided.

From 1987 (the first year of the loan program) through 1995, approximately $1.2 billion has been awarded in the state for various types of wastewater projects. This includes upgrade of sewage treatment facilities, abatement of combined sewer overflows, repair or replacement of overflowing and overloaded sewer systems, construction of sludge management facilities, and provision of collection systems in areas experiencing on-site system failures.

Data Characteristics

Information on loan awards in the state is maintained by NJDEP within EPA's Grants Information and Control System (GICS). In addition, detailed annual reports on loan awards in accordance with the New Jersey Wastewater Treatment Trust's authorizing legislation are prepared by the NJDEP and the Trust, which are jointly submitted to the Legislature. NJDEP and the Trust also prepare and submit to EPA annual reports which summarize the use of State Revolving Fund (CWSRF) monies in accordance with the requirements of the Federal Clean Water Act. These reports are available to the public upon request. Requests may be made by calling the Municipal Finance and Construction Element in the Division of Water Quality, NJDEP, at (609) 292-8961.

Data Strengths and Limitations

Loans are awarded through the Wastewater Treatment Financing Program on an annual basis. Project priorities are established based upon a combination of project type, water quality/water use, State Development and Redevelopment Plan aspects and population served by the project. In addition, a new provision of the ranking methodology provides additional points for projects within an area in which watershed management planning has been completed, intended to serve as an incentive to complete needed planning activities and construction of priority projects within the watershed.

The loan amounts are fixed at the time of loan execution in November of the fiscal year. NJDEP's zero-interest loan represents approximately half the principal amount needed, based on engineering estimates, to construct the project, as well as an allowance to cover costs for planning and design; the Trust's loan covers the remaining allowable costs for the project and may be somewhat higher, based upon the interest rate of the bonds sold by the Trust to finance the project as well as the financing terms desired by the project sponsor. Subsequent loan adjustments, including the award of supplemental loans, are made if actual construction costs are higher (or lower) than as included in the initial loan awards.

As indicated above, "loan awards" represent an indirect indicator of potential water quality improvement. The award of loans does not quantify the specific water quality benefits realized. Each of the different types of projects have widely variable water quality benefits that would be associated, which are further influenced by the specific project conditions involved. Treatment plant upgrades and combined sewer overflow projects will impact receiving water quality. Collection system upgrades and/or elimination of failing septic systems will affect ground water quality and quantity, and surface water effects may also be involved. Sludge management systems are important to assure environmentally acceptable treatment and disposal practices, thus avoiding impacts as a result of inadequate systems or disposal practices.

Significant water quality improvements are not typically apparent as a result of construction of a single project. Improvements are more likely to be apparent through the cumulative improvements as a result of construction of a number of point and nonpoint source management projects.

The loan awards information presented below represents a portion of the total wastewater infrastructure investments made in the state. Not included in this summary are construction grant awards made in the state (the financing program administered by the state prior to implementation of the Wastewater Treatment Financing (loan) Program); municipal projects financed at the local level; and water quality improvement projects undertaken by the industrial sector (which are not eligible under the financing program).

Discussion

Historically, municipalities have been hesitant to construct needed wastewater treatment facilities because of the significant costs involved. The 1996 National Needs Survey indicates that $4.75 billion is needed in order to address the wastewater needs that currently exist in the State. Notwithstanding, external forces, such as permitting and enforcement activities, or concerns with the structural integrity of sewers (i.e., fear of pipe collapse and related water quality concerns), are frequently involved in providing the impetus for a municipality to pursue a project. By providing low interest financing through the program, the state administers a program to provide municipalities with the financial means to address their water quality infrastructure needs.

The breakdown of loan awards provided through the Wastewater Treatment Financing Program, jointly administered by the Municipal Wastewater Assistance program in the NJDEP and by the New Jersey Wastewater Treatment Trust, to finance types of wastewater treatment facilities throughout the state included the following:

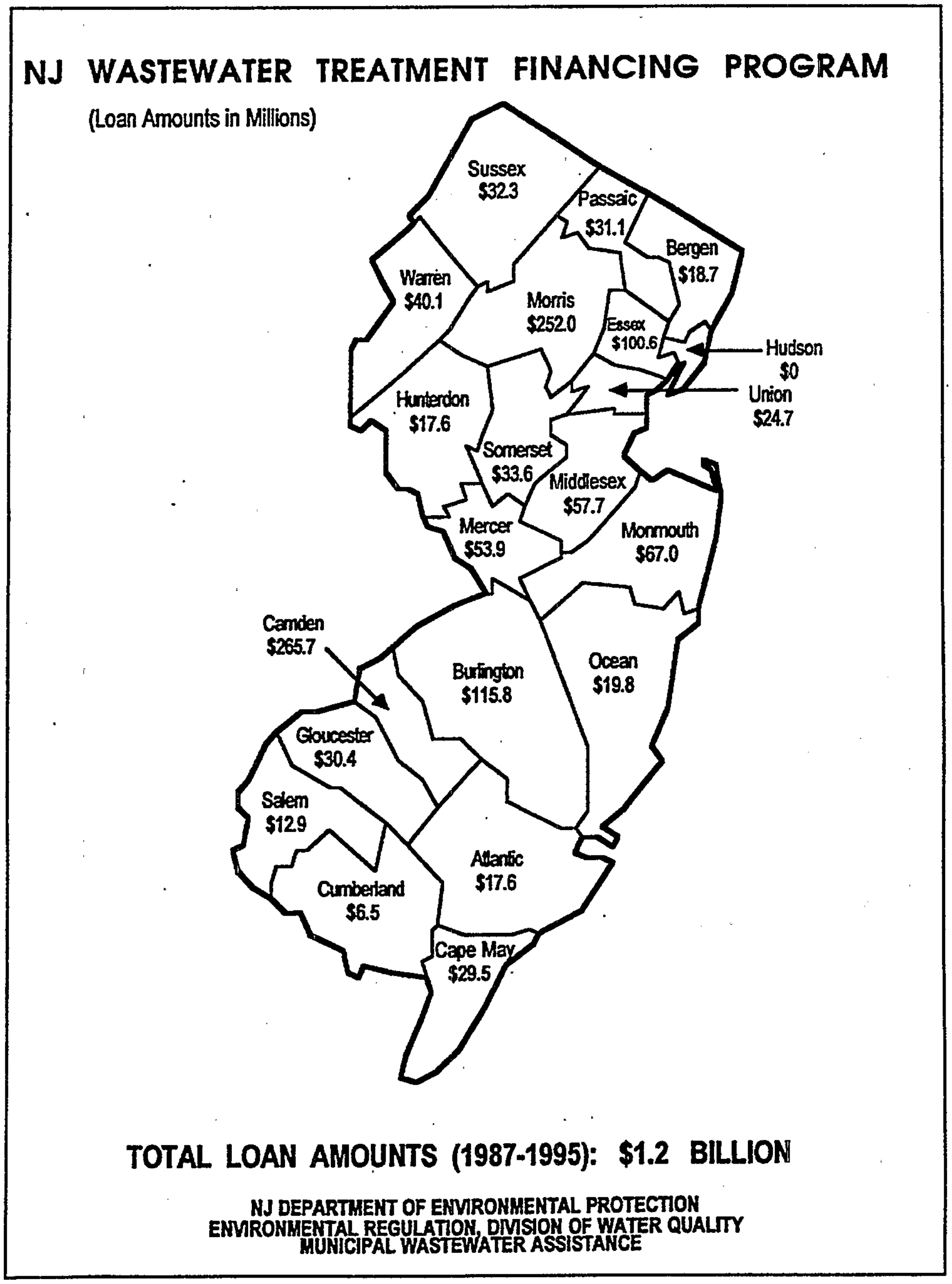
Loan Awards by Type (1987-1995)

Type of Improvement	Investment Amount
Sewage treatment plant upgrades	**$659.1 million**
Sewage treatment plant tie-ins (to abandon inadequate treatment facilities)	**$111.6 million**
Sludge management facilities	**$199.0 million**
Collection system construction and rehabilitation	**$180.6 million**
Combined sewer overflow abatement	**$ 49.7 million**
Total	**$ 1.2 billion**

The map below summarizes cumulative loan awards made by the Wastewater Treatment Financing Program on a county basis. (Note that the cumulative loan awards represent the location of the project sponsor, although in some cases, the service area may involve municipalities beyond the county boundaries.) This map demonstrates that a number of areas in the state have received significant amounts through the Financing Program. This includes, in particular, the counties of Morris, Camden and Burlington.

The Water Quality chapter of the Self-Assessment cites a number of areas in the state in which water quality improvements have been noted, including the Whippany Watershed in Morris County and in the Big Timber Creek Watershed in Camden County. The significant wastewater treatment system upgrades financed by the state are, in large part, responsible for these noted water quality improvements. As cited in Water Quality section of the Self-Assessment document, these improvements represent the combined efforts of planning, permitting and enforcement programs, in addition to that of the financing program. Significant financing has also been awarded in Burlington County, both for wastewater treatment system upgrades at a number of treatment plants and for a regional sludge composting facility to accommodate the sludge generated within the county.

It should be noted that the recent inclusion of eligibility for storm water/nonpoint source projects under the Financing Program, as well as regional watershed management planning efforts (for which projects will receive additional project ranking points as previously discussed), will be a major tool for implementation of water quality improvements, to address both point and nonpoint source priorities in the state, on a watershed basis.


NJ WASTEWATER TREATMENT FINANCING PROGRAM
(Loan Amounts in Millions)
Sussex $32.3
Passaic $31.1
Bergen $18.7
Warren $40.1
Morris $252.0
Essex $100.6
Hudson $0
Union $24.7
Hunterdon $17.6
Somerset $33.6
Middlesex $57.7
Mercer $53.9
Monmouth $67.0
Camden $265.7
Burlington $115.8
Ocean $19.8
Gloucester $30.4
Salem $12.9
Atlantic $17.6
Cumberland $6.5
Cape May $29.5
TOTAL LOAN AMOUNTS (1987-1995): $1.2 BILLION
NJ DEPARTMENT OF ENVIRONMENTAL PROTECTION
ENVIRONMENTAL REGULATION, DIVISION OF WATER QUALITY
MUNICIPAL WASTEWATER ASSISTANCE

Utah's Pilot Project Experience

A brief narrative on the nature of the wastewater treatment facilities in Utah will help explain the difficulty we had in applying many of the environmental indicators. There are 93 publicly-owned treatment facilities in Utah of which only 26 are mechanical plants. Most of the mechanical plants lie along the more densely populated Wasatch Front range. The remaining treatment facilities are lagoon systems, either facultative or aerobic. Generally, the lagoon systems serve smaller, more rural communities where sufficient and lower cost land is available for wastewater treatment and disposal. Most of the lagoon systems are either total containment facilities or employ land application of the effluent. In either of these cases the facilities are not issued an NPDES permit. Additionally, approximately 15% of the state's residents, generally those residing in unincorporated areas, are served by individual on-site disposal systems.

For our study we selected eight CWSRF projects based largely on their varied nature. Utah has funded only traditional Section 212 projects. The projects we selected are as follows:

Project	Description	Total Cost	CWSRF
Aurora Town	New collection system and total containment lagoon	$2.694 M	$0.841 M
Orem City	Interceptor sewer, Gravity thickener and belt filter press	$4.0 M	$3.5 M
Mapleton City	New collection system and interceptor sewer	$10.3 M	$9.4 M
Jordanelle SSD	New interceptor sewer, lift stations, force main	$6.49 M	$2.74 M
St. George City	7.5 mgd WWTP expansion	$27.5 M	$12.0 M
Cedar City	New WWTP with land application of effluent	$12.4 M	$12.0 M
Grantsville City	Upgrade and expand existing lagoon facility, new interceptor, lift stations	$3.4 M	$3.3 M
Santaquin City	New collection system, aerated lagoon with land application of effluent, lift stations	$5.98 M	$1.307 M

All eight projects studied were for the initiation or expansion of treatment service. None were simply for upgrading existing services. Of the eight projects we studied, only four of the projects (Orem, St. George City, Cedar City, and Grantsville) were at facilities where NPDES permits are required. However, the Cedar City WWTP land applies its effluent without discharging to a receiving stream. Of the other three NPDES-permitted facilities, only the St. George and Grantsville projects involved construction of treatment train processes. Orem's project was for solids dewatering/handling. The remaining four projects evaluated were either at a facility with no effluent discharge (Aurora); or a facility that land applies effluent (Santaquin); or with communities which contract for treatment services at a regionalized treatment facility (Jordanelle and Mapleton).

Our experience applying the environmental indicators to these eight projects follows.

Indicator 1 - Actions funded by CWSRF programs.

We feel this is a viable indicator which states are tracking already. The premise is that all CWSRF projects provide to varying degrees a needed environmental benefit and serve a worthwhile public purpose. This indicator, which does not rely on empirical data for its support, is one which is readily available and can easily be applied. This indicator will particularly be important for those states which have limited water quality data to substantiate environmental improvements but wish to nevertheless claim "credit" for what has been accomplished through the CWSRF. This indicator also has general application to all CWSRF projects, whereas the environmental benefits of some CWSRF-funded projects, e.g., pump stations, bio-solids thickening, and replacement projects, may not be quantifiable.

Data availability: High. Utah has a current data base which allows ready access to the data, including the number of projects funded, the amount of CWSRF loans, funds leveraged, etc.

Data accessibility: High

Data applicability: Questionable. Application of this indicator assumes that all CWSRF projects are created equal and that none provides any more of an environmental benefit than another except that those projects receiving higher amounts of funds presumably provide a greater environmental improvement.

Recommendation: Let this indicator stand as is.

Indicator 2 - Number of pounds of pollutants *removed* from the environment through SRF-funded projects.

We considered this indicator to apply to generally point source discharges where, as a result of a CWSRF project, the pollutant load to the receiving stream was removed or reduced. For most point source projects the application of this indicator is probably limited, unless the project is simply for the upgrade of the treatment facility to enhance the level of treatment. For projects which increase the capacity of a treatment facility this indicator would likely not apply because the loading to the receiving stream would also be expected to increase. Although none of the projects we evaluated were strictly "upgrades", to which Indicator 2 would not necessarily apply, we nevertheless evaluated this indicator.]

Data availability: High for point source projects. DMR data is available from all NPDES-permitted facilities. For improvements associated with NPS CWSRF projects, data may be limited or nonextant. To demonstrate improvements associated with NPS CWSRF projects, before-project and after-project sampling would be needed. Absent project-specific sampling data there would need to be reliance on ambient water quality monitoring data both upstream and downstream of the project in order to demonstrate improvement.

Data accessibility: High for point source projects. The PCS data base allows ready access to the data. For NPS projects, if data were generated or already available, it could be accessed in our surface water database.

Data applicability: For point source projects the data would most certainly apply. For NPS projects the applicability is questionable. For NPS projects it may be difficult to confidently ascribe improvements in the receiving stream completely or even partially to the CWSRF project. There may be too many variables affecting the receiving stream to show improvements directly attributable to a project.

Indicator 3 - Number of pounds of pollutants *prevented* from entering the environment through CWSRF-funded projects.

We considered this indicator to apply to the following types of projects: 1) point source projects where either the hydraulic or organic capacity of a facility to treat wastewater is increased; 2) point source projects where on-site disposal systems (septic tank systems) are abandoned and wastewater is instead diverted to a centralized wastewater treatment facility; and 3) NPS projects where pollutants are prevented from entering into a receiving stream.

We reasoned that there is an environmental benefit derived from removing more pollutants from the waste stream at a treatment facility even though effluent loadings to the receiving stream may actually increase due to higher flows resulting from growth. Pollutant removal can be easily calculated utilizing effluent information (i.e., flow, BOD, TSS, ammonia, phosphorous) gathered from DMRs and either actual influent information on the same parameters or estimates which can be made based on text book values.

Since 1992 Utah has operated a voluntary program called the Municipal Wastewater Planning Program (MWPP). The purpose of this program is to provide a mechanism for communities to perform a self-assessment of their wastewater collection and treatment infrastructure to determine the "health" of these facilities. Areas evaluated include: influent/effluent flows and quality; facility capacity; operator certification; bypasses; maintenance; facility age; solids handling; anticipated capital improvements; user charge system; debt coverage; viability of the enterprise fund; and a subjective evaluation. On average approximately 65% of Utah communities participate in the annual evaluations. All past recipients of CWSRF loans are required to participate as a condition of receiving funding. Over the last five years 92% of all POTWs in the state have participated in the MWPP at least once.

Data availability: High. DMR data is available for all facilities which have an NPDES permit. Monthly operating reports (MORs) are available from all non-NPDES facilities in the state. MWPP reports generally provide influent and effluent flow and water quality information for both discharging and non-discharging facilities.

Since Utah has not funded any NPS projects, we didn't extensively pursue an assessment of data which may be available for them. We feel it will be much more difficult estimating correctly the pollution prevented from entering the environment as a result of a NPS project. Either monitoring of the completed NPS project would need to occur or a method of estimating the pollutants devised.

Data accessibility: High. While no data base exists for MORs, the five most recent year's worth of data is kept in hard copy form and is readily accessible. MWPP reports are also available in hard copy. DMR data is readily accessible from PCS.

Data applicability: For point source projects which expand the capacity of a POTW or for NPS projects which prevent pollution from occurring, this indicator is applicable. For CWSRF projects which are for the abandonment of on-site disposal systems, the indicator would still seem applicable, but more questionable. It may not be correct to receive "credit" for a CWSRF project which results in loadings formerly being treated in on-site disposal systems but now being diverted to a POTW. To do so would presume that there is no remaining ability of the on-site disposal systems to continue to adequately treat wastewater. This may not be the case unless the on-site systems were at the point of failure or the density of additional systems would have exceeded the ability of the soils to assimilate more pollutants.

Recommendation: Let this indicator stand with the understanding that the estimation of pollutants removed may be based on modeling or engineering estimates rather than empirical data. Also, clarification should be made as to what kinds of projects this indicator applies to and how the application is different than that of Indicator 2.

Indicator 4 - Physical changes to the terrestrial, riparian, or aquatic habitat and hydrology resulting from CWSRF-funded projects.

We feel this indicator generally has application to only NPS projects. We have not yet utilized the CWSRF to fund NPS projects although we recently received legislative authority to do so. Therefore, this indicator was not tested. Had this indicator been tested we feel some tools are available to help measure improvement to water quality and habitat. On a limited basis, Utah does perform an inventory of macroinvertebrates in certain streams. Using a Winget-Modified Surber Net, samples are collected, counted, weighed, and the species diversity recorded. Together with an evaluation of the physical habitat and water quality the presence and diversity of macroinvertebrates help identify the ecosystem integrity and health. Following the assay, the Biotic Condition Index (BCI), developed by the USDA Forest Service, is used to evaluate the conditions in the aquatic ecosystem.

The BCI system:

- measures a stream against its own potential, not that of another stream;
- is sensitive to most forms of environmental stress;
- is applicable to various types and sizes of streams;
- provides a basis for assessment of unstressed to stressed conditions;
- is independent of sample size, if the samples are representative;
- is based on easily acquired data;
- meshes with and supports stream habitat and water quality data;
- provides an easily understood "score";
- is particularly useful for monitoring trends;
- is based mainly upon tolerance levels of the invertebrates

Several other indices are also used to assess diversity and richness.

For a few streams where Section 319 watershed restoration projects have been implemented, a multi-agency work group has complimented Utah DEQ's chemical water quality data by monitoring for channel morphology, riparian vegetation recovery, fish population/productivity, and habit quality. Tools have included: pebble counts; assessments of riparian shade and temperature; riparian vegetation surveys; fish population surveys; channel geomorphology surveys; and a habitat quality index.

When CWSRF non-point source projects are undertaken in Utah, an effort will be made to incorporate selected quantitative assessment measures into the project budget so that water quality and habitat improvements can be identified.

We feel Indicator 4 will be a useful tool and should remain as is. It is unclear to us how these "physical changes" will be meaningfully report.

Indicator 5 - Waterbodies, expressed as river and riparian miles, lake acres, estuary square miles, and wetland acres, ***previously impaired, now improved or meeting designated uses*****, as a result of CWSRF-funded projects.**

Only a mild attempt was made to apply this indicator to the projects which we studied. Four of the eight projects evaluated are facilities which have NPDES permits but only one of these (St. George City) discharges to an impaired stream which appears on the FY2000 303(d) list. In this case the impaired receiving stream (the Virgin River) is so designated due to a total dissolved solids (TDS) loading which is not a standard which is traditionally governed by an NPDES permit. The same receiving stream appeared on the FY1986 303(d) list (pre-SRF) for TDS and total phosphorus.

POTWs in Utah have no TDS standard in their NPDES permits and currently only one POTW has a phosphorus standard. This standard was imposed because the facility caused a phosphorus loading to a receiving stream which was impaired largely due to that loading. Until TMDL work is completed on all discharging POTWs, no discharge standards beyond the conventional ones (TSS, BOD, pH, coliform bacteria and DO) and the toxic ones (ammonia and chlorine) will be imposed in NPDES permits. Without the TMDLs it would be difficult to quantify the impaired streams or waterbodies which have been improved as a result of CWSRF-funded projects. Even when the TMDLs are completed, it may still be difficult for stream segments to be "de-listed" or show measurable water quality improvement as a result of an CWSRF-funded project because of the impacts of other contributing sources of pollutants.

We feel this indicator should remain as is, but we recognize there likely will be difficulty in applying it to CWSRF projects.

Indicator 6 - Waterbodies expressed as river and riparian miles, lake acres, estuary square miles, and wetland acres, ***protected*** **as a result of CWSRF-funded projects.**

This indicator focuses on the protection of unimpaired resources. We firmly believe that the Construction Grants and CWSRF programs have "protected" many of our water resources from being listed on the 303(d) list of impaired waters. We were unable to apply this indicator to our CWSRF projects to validate that theory because of the level of modeling and TMDL work which would be necessary. We feel Indicator 6 can be a useful indicator which can be tested using the monitoring data which is used to compile the 305(b) report. The difficulty will be for an CWSRF-funded project to assume full credit for "protecting" a water resource when there may be several other contributors to the stream or lake not being listed on the 303(d) list.

We feel this indicator should remain as is, but we recognize there likely will be difficulty in applying it to CWSRF projects.

Indicator 7 - Benefits of reduced health risks and/or increased recreational use attributable to CWSRF-funded projects.

This indicator did not apply to the CWSRF-funded projects we studied. We feel it can be a useful indicator but one which may be the most difficult of all to apply to projects. Utah's Project Priority List accords the highest priority to projects which will eliminate a substantial health hazard including those caused by the discharge of inadequately treated wastewater to an area of immediate public occupancy or those which remedy the failure of subsurface disposal systems which result in surfacing sewage. Water samples which identify the presence of pathogenic organisms or "indicators" such as coliform organisms are used to help validate the health hazard designation. This designation has never been applied to treatment facilities but only to areas which demonstrate extensive failures of on-site disposal systems. The designation is rarely accorded because of the strict documentation which is necessary. Without obtaining significant water samples and performing the necessary lab work it is nearly impossible to substantiate health risks caused by inadequately treated or non-treated sewage on the basis of influenza-like symptoms. How the measurement of this indicator would be quantified is also a question we have.

We feel this indicator should remain as is, but we recognize there likely will be difficulty in applying it to CWSRF projects.

Appendix F. Ohio Pilot Project Specific Examples

OHIO'S PILOT STUDY–SPECIFIC EXAMPLES

The following section summarizes our pilot study results and details the basis for our recommendations and conclusions. In general, the projects reflect a reduction of one or more chemical or bacteriological pollutants to the receiving streams and a corresponding response in the biological communities. In some cases, however, the magnitude of the response did not always result in full attainment of the Aquatic Life Use designation. In other cases, the CWSRF project did not go far enough to see an adequate reduction of pollutants to the receiving stream, and consequently, there was no positive change in the biological community.

The information compiled below has been taken from Ohio's Water Quality Inventories, technical and permit support documents, Water Pollution Control Loan Fund (Ohio's CWSRF) environmental assessments and project records, Water Quality Standards and field notes from the monitoring staff. The rigorous methods and formulas behind the results listed below are not described in this document, but can be provided.

Each project is described, along with information about the waterbody that is influenced by the CWSRF-funded entity. The aquatic life use attainment status in river miles are given for periods both before and after construction of SRF-financed improvements.

Use attainment is a term which describes the degree to which environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (WQS, Ohio Administrative Code 3745-1). Assessing use attainment status for aquatic life use involves a primary reliance on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-17). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on multi-metric biological indices which include the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), which indicate the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Numerical endpoints are stratified by ecoregion, use designation, and stream or river size.

Four attainment status results are possible in each monitored stream segment - full, threatened, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Threatened attainment means that the indices are meeting the biocriteria, but are close to falling below the line of acceptance. Partial attainment means that one or more of the applicable indices fail to meet the biocriteria. Non-attainment means that none of the applicable indices meet the biocriteria or one of the organism groups reflects poor or very poor performance. It is also possible that some river miles in a segment were not assessed and therefore are not categorized.

Information and descriptions of the causes and sources associated with observed impairments rely on interpretation of multiple lines of evidence including the water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus, the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. This information was taken from Ohio's Water Quality Inventory (305(b)) database or reports.

1. FAIRBORN WWTP (Completion Date June 18, 1994)
Location: Greene County, latitude 39`50' 45" N, longitude 84`03' 15" W

The Fairborn Wastewater Treatment Plant (WWTP) outfall is located on the Mad River at river mile 9.62. The Mad River is in the Great Miami River Basin and is identified by USEPA River Reach number 05080001-001.

The facility was constructed in 1958 with improvements made in 1974, 1986 and again in 1992-1993 (with CWSRF funds). It is an advanced treatment plant with an average design flow of 5.5 million gallons per day (MGD). Wet stream processes include screening, grit removal, oxidation ditches, secondary settling, and ultraviolet (UV) disinfection. Solids stream processes include sludge stabilization using aerobic digestion, sludge thickening, dewatering by filter press, and sludge disposal by land application. The collection system is 100% separated and nearly all of the service area is sewered.

Indicator A
Fairborn WWTP had been unable to comply with its NPDES permit limitations during peak flow events for three years prior to this project. The result was the discharge of inadequately treated wastewater to the Mad River.

The solution was to do the following improvements: a) install two new clarifiers; b) install ultra-violet disinfection; c) construct a new sampling building; d) relocate and redesign grit removal equipment; and e) excavate and dispose of buried sludge. Cost for Phase I was $2,519,600 and funded entirely through CWSRF funds.

Indicator 1
Pounds of pollutants removed increased by 2,321 pounds for TSS and by 1897 pounds for $CBOD_5$ while the WWTP percent removal efficiency increased by 1% for TSS and remained static for $CBOD_5$.

POLLUTANTS REMOVED AT FAIRBORN WWTP				
SAMPLING PERIOD (1 YEAR)	POUNDS OF $CBOD_5$ REMOVED (daily average)	% $CBOD_5$ REMOVED	POUNDS OF TSS REMOVED (daily average)	% TSS REMOVED
PRE-PROJECT (beginning 4/91)	3915	97	5,445	95
POST-PROJECT (beginning 7/95)	5812	97	7,766	96
CHANGE	1,897	0	2,321	1

According to Ohio EPA's 1996 water quality permit support document, the Fairborn WWTP contributed approximately 16% of the total wastewater volume annually discharged by the four major Mad River mainstem WWTPs in 1994. Based on an annual mean flow of 3.8 MGD in 1994, the plant operated at approximately 69 percent of the 5.5 MGD design capacity. Annual mean flows from 1976 through 1994 ranged from 2.7 MGD in 1988 to 4.7 MGD in 1990. Annual 50th and 95th percentile flows ranged from lows in 1988 of 2.8 MGD and 3.4 MGD, respectively, to highs of 4.4 MGD and 7.6 MGD in 1990. Third quarter 50th percentile values ranged from 2.8 MGD in 1976 to 5.2 MGD in 1980 while 95th percentile values ranged from 3.6 MGD in 1977 to 7.6 MGD in 1990.

Ammonia-N loadings have been significantly reduced in recent years, particularly so after 1991. Annual and third quarter 50th and 95th percentile values recorded since 1991 have generally remained well below 10 kg/day. In comparison, 50th and 95th percentile loadings prior to 1988 were rarely below 150 and 200 kg/day, respectively. Median loadings declined markedly after 1988, but 95th percentile values exceeded 75 kg/day through 1991. Nitrate-N loadings increased significantly in 1991 (due to increased nitrification) with median levels reaching 88 kg/day, a nearly 400% increase above 1990. Nitrate-N loadings increased to even higher levels in 1992 to over 200 kg/day and remained at these levels through 1994.

Ambient water quality sampling in 1994, after completion of the SRF-financed improvements, downstream from the Fairborn WWTP revealed no indications of problems with parameters commonly associated with WWTPs. D.O. concentrations were well above levels considered compatible with Warmwater Habitat (WWH) aquatic communities. Mean total phosphorus values were similar upstream and downstream from the discharge, well below the water quality guideline of 1.0 mg/L. Ammonia-N levels were at or below the minimum detection limit of 0.05 mg/L, both upstream and downstream of the discharge. One organochlorine pesticide (dieldrin) in exceedence of the 30-day average human health criterion was detected downstream from the discharge and was likely a residual of past usage in the basin. We would expect the reductions of pollutant concentrations to be reflected by an improvement in the biological condition of the receiving water.

Indicators 4& 5

FAIRBORN WWTP IMPROVEMENTS, RM 9.62			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
MAD RIVER OH58 1	WARMWATER HABTAT	HIGH	EASTERN CORN BELT PLAIN

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1984	0.40	0.00	9.00	0.67	0.00
1992	5.00	0.00	4.00	1.00	0.07
1994	7.55	0.00	2.52	0.00	0.00

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as **H**igh, **M**oderate, **S**light, or **T**hreats)

	Magnitude				Magnitude		
Source	**1984**	**1992**	**1994**	**Cause**	**1984**	**1992**	**1994**
Municipal Point Sources	H	H	-	Organic enrichment/DO	H	S	-
Urban Runoff/Storm Sewers(NPS)	S	S	-	Unionized Ammonia	M	S	-
Channelization	M	H	-	Other habitat alterations	M	H	-
Source Unknown	-	-	H	Cause Unknown	-	-	H

Monitoring comments identified the Fairborn WWTP as being a major source of impairment in 1984 and in 1992. After CWSRF project completion, "Municipal Point Sources" are no longer listed as a source of impairment. Comments also indicate that the channelization was beginning to return to a more natural form in 1992. The improvement in habitat and the improved WWTP effluent resulted in more river miles fully attaining the aquatic life use and a reduction of the causes and sources of impairment in this segment. We can conclude that the CWSRF project had a positive effect on the aquatic biota.

Indicator 6
Mad River has a Primary Contact Recreation designation. The standard for fecal coliform content is not to exceed 1,000 per 100 milliliters(ML) on no less than 5 samples in a 30 day period, or 2,000 per 100 ML in more than 10% of samples per month.

MAD RIVER ANNUAL AVERAGE FECAL COLIFORM COUNTS			
SAMPLING PERIOD (1 YEAR)	UPSTREAM (#/100ML)	EFFLUENT (#/100ML)	DOWNSTREAM (#/100ML)
PRE-PROJECT (beginning 4/91)	291	113	225
POST-PROJECT (beginning 7/95)	701	203	739

Monthly data was looked at over the pre- and post-project periods and there does not seem to be a problem with fecal coliform that relates to this project. The WWTP is in compliance.

2. BEALLSVILLE WWTP (completion date 8/3/95)
location: Monroe County, latitude 39`50' 40" N, longitude 81`02' 20" W

The Beallsville WWTP is situated on Mulat Run which empties into the East Fork, Piney Fork at river mile 4.72. These streams are located in the Sunfish Creek Basin and this section is identified by USEPA River Reach number 05030201-096.

Indicator A
Prior to the CWSRF project, the Beallsville WWTP was hydraulically overloaded during periods of rainfall; large quantities of wastewater received inadequate treatment before being discharged to Mulat Run. The existing WWTP was aging and the collection system had infiltration and inflow problems. The Village was under a consent decree for failing to meet its NPDES permit limitations.

The Village constructed a new WWTP with an equalization basin at the head of the treatment process. The plant included two aeration tanks, two clarifiers, two sludge holding chambers, chlorination, and synthetic media filter bed system. Total cost of the project was approximately $594,000. Funding in the amount of $338,450 was obtained from the Ohio CWSRF with the remainder coming from the Ohio Public Works Commission.

Indicator 1

POLLUTANTS REMOVED AT BEALLSVILLE WWTP				
SAMPLING PERIOD (1 YEAR)	POUNDS OF $CBOD_5$ REMOVED (daily average)	% $CBOD_5$ REMOVED	POUNDS OF TSS REMOVED (daily average)	% TSS REMOVED
PRE-PROJECT (1993)	35	94	36	89
POST-PROJECT (beginning 9/96)	50	95	39	84
CHANGE	15	1	3	-5%

Although the pounds of TSS removed increased by 3 pounds per day following the improvement project, the plant efficiency dropped by 5% for TSS removal. The $CBOD_5$ removal increased 15 pounds per day and the plant efficiency increased by 1% for $CBOD_5$ removal per day on average. Changes in the biological community cannot be predicted on the basis of these parameters alone.

Dissolved oxygen and ammonia-N concentrations in the effluent went from average monthly concentrations of 5.7mg/L and 1.31 mg/L, pre-project to 8.8 mg/L and 0.2 mg/L, post-project, respectively. These parameters show considerable improvement which we would expect to be reflected in the biological community.

There are no technical or permit support documents for this location.

Indicators 4& 5

BEALLSVILLE WWTP IMPROVEMENTS, RM 4.72			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
EAST FORK PINEY FORK, OH 7 7	WARMWATER HABITAT	HIGH-VERY HIGH	WESTERN ALLEGHENY PLATEAU

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1983	0.00	0.00	0.00	4.40	0.40
1996	4.00	0.80	0.00	0.00	0.00

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as **H**igh, **M**oderate, **S**light, or **T**hreats)

Source	**Magnitude 1983**	**Magnitude 1996**	**Cause**	**Magnitude 1983**	**Magnitude 1996**
Municipal Point Sources	H	T	Organic enrichment/DO	H	T
Natural	M	-	Other habitat alterations	M	-

Monitoring comments from 1983 indicate that Beallsville WWTP discharges to this segment and municipal point sources are listed as a high source of impairment. Monitoring after completion of the new Beallsville WWTP indicated that the new plant operates very well. The municipal point source of pollution dropped from being a high cause of impairment to being a threat to full attainment. We can conclude that the CWSRF project made a positive difference. Steam restorability is high-very high.

Indicator 6
East Fork Piney Fork has a Secondary Contact Recreational use designation. The standard for fecal coliform content is not to exceed 5,000 per 100ML in no more than 10% of the samples taken in a 30 day period.

EAST FORK PINEY FORK ANNUAL AVERAGE FECAL COLIFORM COUNTS			
SAMPLING PERIOD (1 YEAR)	UPSTREAM (#/100ML)	EFFLUENT (#/100ML)	DOWNSTREAM (#/100ML)
PRE-PROJECT (1993)	no data	no data	930
POST-PROJECT	3314.3	256	869

The recreational use standard is being met in this stream and the WWTP effluent seems to be diluting the background fecal coliform concentrations. The plant appears to be performing well in this regard.

3. AKRON WWTP IMPROVEMENTS (completion date 5/22/96)
location: Summit County, latitude 41`09' 00" N, longitude 81`33' 45" W

The Akron WWTP discharges to the Cuyahoga River mainstem (Cuyahoga River Basin)at RM 37.45 via outfall 001. This section is identified by USEPA River Reach number 04110002-001.

Indicator A
The City of Akron was the subject of a federal enforcement action requiring a series of wastewater treatment improvements at the city's existing WWTP plant. This project dealt with one component of the required improvements called the Distributive Control System which involved the installation of automated controls at the WWTP. The project included the installation of all necessary conduits (optical cables), the design, manufacture, and installation of the computer system, related control panels, and minor rehabilitation of some building interiors to house the computer system. In addition, the city also constructed a new generator building and new flow metering chamber.

With the installation of the Distributive Control System, data from monitoring instruments can be transferred directly to computers where they are stored and made instantly available to the operators. The system can be programmed to control major processes, responding immediately to changes in the flow and equipment problems as they develop. The system improved plant operations and monitoring capabilities by replacing manual data gathering and entering. The installation of these automated controls at the plant should have resulted in more reliable plant operations and allowed the city to more effectively use its plant staff.

This project was completed on 5/22/95 and was fully operational a year later. The total project cost was $15,328,600. Ohio's CWSRF was the sole lender.

Indicator 1
Comparisons between the 1994-96 historical loadings are difficult due to past differences in permit reporting requirements for the various outfalls and bypasses. A study done by the Ohio EPA Monitoring Group in 1991 showed that drastic reductions in raw bypasses and secondary bypasses (not chlorinated) occurred through the 1980s. However, chlorinated secondary bypasses were not specifically monitored until after the 1994 permit modifications. For this reason, the most recent data are probably closest in estimating the BOD and TSS load discharged to the Cuyahoga River mainstem.

POLLUTANTS REMOVED AT AKRON WWTP				
SAMPLING PERIOD (1 YEAR)	POUNDS OF $CBOD_5$ REMOVED (daily average)	% $CBOD_5$ REMOVED	POUNDS OF TSS REMOVED (daily average)	% TSS REMOVED
PRE-PROJECT (1994)	51,683	92	75,509	89
POST-PROJECT (beginning 6/97)	52,419	95	89,948	93
CHANGE	10,736	3	13,439	4

When available, the figures above reflect the occurrences of bypasses at Akron's WWTP. In 1994, only four months of data are available which fully document the effect of the by-passes effluent quality. By contrast, the June 1997 to June 1998 data includes material on bypasses from a full twelve months. Thus, the latter data set appears to more fully represent the situation at this facility. Keeping this in mind, the removal of TSS increased by 13,439 pounds, a 4 % increase in WWTP efficiency, and 10,736 pounds of $CBOD_5$, a 3% increase in WWTP efficiency.

According to Ohio EPA's Cuyahoga River Technical Support Document (MAS/1997-12-4, 1999), one hundred and eighteen bypass events were recorded during 1996, an average of nearly one every three days. Despite much lower mean annual flows, the bypass contributed a higher loading of BOD and TSS than the outfall during each reporting year.

The yearly average of daily values for dissolved oxygen and ammonia-nitrogen downstream from the effluent are 8.5 and 0.34, pre-project, and 8.8 and 0.15, post-project. Both of these parameters improved.

The 1996 monitoring survey also indicated that nutrient enrichment in the form of phosphorus and nitrate nitrogen may be a significant cause of non-attainment of the fish community between the Akron and NEORSD Southerly WWTPs. Predicting the response in the biological condition of the stream due to improvements at the WWTP is complicated by the bypass events and other pollution sources, and is not reliably based on chemical information alone.

Indicator 2
The method used to determine the effectiveness of the Distributive Control System project with assisting the Akron WWTP in preventing pollutants from entering the aquatic environment was simply a comparison of the pre- and post-project monthly operating report effluent data for violations of NPDES permit limits. The results indicate that there were 55 violations of NPDES discharge limits in 1995 (the pre-project time period), 4 violations in 1997, and 2 violations in 1998 (the latter two years corresponding, in part, to the post-project time period). Overall, the frequency of permit violations declined by 96.3% from 1995 to 1998. Most significantly, daily dissolved oxygen violations decreased from 31 in 1995 to 0 in 1997-1998. Daily chlorine residual violations also declined significantly from 21 in 1995 to 3 in 1997-1998. Monthly fecal coliform violations continued to occur with 3 in 1995, 1 in 1997, and 2 in 1998. On this basis, the data suggests that there were significant and positive effects resulting from the construction of the WPCLF funded improvements at Akron's WWTP.

From these comparisons, it appears that installation of these automated controls at the plant contributed to more reliable plant operations and reducing the number of violations. Without knowledge of other operational factors that may have also change at the WWTP over the study period, it is impossible to definitively attribute the reduction in violations solely to the Distributive Control System project. However, without the additional flexibility that the new automated controls provided to the WWTP operators, it is likely that frequent violations would have continued and worsened, especially if no changes were implemented at the WWTP.

Indicators 4& 5

AKRON WWTP IMPROVEMENTS, RM 37.45			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
CUYAHOGA RIVER OH89 27	WARMWATER HABITAT	MODERATE-HIGH	ERIE-ONTARIO LAKE PLAIN

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1988	0.00	0.00	0.00	5.10	0.00
1992	0.00	0.00	0.00	5.10	0.00
1996	0.00	0.00	0.00	5.10	0.00

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as **H**igh, **M**oderate, **S**light, or **T**hreats)

	Magnitude		
Source	**1988**	**1992**	**1996**
Municipal Point Sources	-	H	H
Urban Runoff/Storm Sewers(NPS)	M	S	M
Combined Sewer Overflow	H	H	H
Non-industrial Permitted	M	-	H
Spills	-	S	M
Other			M

	Magnitude		
Cause	**1988**	**1992**	**1996**
Organic enrichment/DO	H	H	H
Unknown Toxicity	M	S	H
Priority Organics	-	S	S
Zinc	-	-	M

The Akron WWTP has been named as a high source of impairment in this segment for years. No real significant change in the aquatic life use attainment has been noted as a result of this project. The Cuyahoga River has shown considerable improvement in recent decades, but stresses from multiple pollution sources (beginning well upstream of the Akron area) continue to impact fish communities downstream to Cleveland. The chronic impairment of the fish community and elevated high background nutrient levels suggest chronic toxic influences and an exceedence of the assimilative capacity of the stream. Surveys in the 1990s detected incremental improvements in biological community health and a lessening of the severely toxic conditions encountered during the 1980s. However, there has been little change, positive or negative, downstream from Akron since 1991. The magnitude of impairment to this stream segment due to municipal point sources is still high, indicating that the WWTP problems have not been completely addressed by this project. Additional WWTP improvements/bypass elimination may be necessary for attainment of the aquatic life use designation, along with elimination of the CSOs, and minimization of pollutants from other permitted non-industrial and nonpoint sources.

Area of Degradation Values (ADVs) are available for this stream segment for three sampling periods and are shown in the table below. Descriptions of the various indices can be found in Appendix A.

Area of Degradation Values (ADV) statistics for the lower Cuyahoga River. Values were calculated using Erie Ontario Lake Plain WWH biocriteria as the baseline for community performance.											
Stream (Year)			Biological Index Values		ADV Statistics				Attainment Status		
	Reach				Positive		Negative		miles		
Index	Upper RM	Lower RM	Mini-mum	Maxi-mum	ADV	**ADV/ Mile**	ADV	**ADV/ Mile**	Full	Partial	Non
Lower Cuyahoga River (1996)											
IBI	42.9	7.0	13	38	11	**0.3**	5931	**165.2**	0.2	3.3	32.4
MIwb			3.9	7.4	0	**0.0**	4796	**133.5**			
ICI			24	46	2581	**71.9**	262	**7.3**			
Lower Cuyahoga River (1991)											
IBI	42.9	7.0	17	33	0	**0.0**	4682	**130.4**	0.0	2.9	33.0
MIwb			5.8	8.1	2	**0.0**	2350	**65.4**			
ICI			26	42	2114	**58.9**	78	**2.1**			
Lower Cuyahoga River (1984)											
IBI	42.9	7.0	12	27	0	**0.0**	7707	**214.7**	0.0	0.8	35.1
MIwb			0.1	7.4	0	**0.0**	8985	**250.2**			
ICI			10	32	10	**0.2**	4863	**135.4**			

Although the segment is still in a state of non-attainment, a major improvement can be seen from the 1984 values in each of the indices that Ohio EPA utilized to assess the condition of the aquatic biota.

Indicator 6

The Cuyahoga River has a Primary Contact Recreation Designation. The standard for fecal coliform content is not to exceed 1,000 colonies per 100ML in no less than 5 samples in a 30 day period, or 2,000 colonies per 100ML in more than 10% of samples per month.

CUYAHOGA RIVER ANNUAL AVERAGE FECAL COLIFORM COUNTS			
SAMPLING PERIOD (1 YEAR)	UPSTREAM (#/100ML)	EFFLUENT (#/100ML)	DOWNSTREAM (#/100ML)
PRE-PROJECT (1994)	4,691.67	No data	3,692.75
POST-PROJECT (beginning 6/97)	4,621	2,352	3,556

Fecal coliform concentrations in this stream segment do not appear to have changed significantly in pre- versus post-project periods. Colony numbers continue to exceed the 1000/100 ML Primary Contact Recreation criterion. The most significant sources of fecal coliform are likely from the bypass at the WWTP, urban runoff/storm sewers and CSOs.

4. PIQUA WWTP (completion date 12/23/93)
location: Miami County, latitude 40°07'49" N, longitude 84°14' 06" W

The Piqua WWTP discharges to the Great Miami River. This segment is identified by USEPA River Reach number 05080001-027. The Piqua WWTP is a secondary treatment facility consisting of primary settling, activated sludge, secondary settling, chlorination, and post aeration. The collection system consists of separate sewers, with 100% of the service area sewered. Significant industrial contributors are Hartzell Fan, Metal Cleaning , and Harzel Prop-Cyanide bath.

Indicator A
The Piqua WWTP had continually exceeded its National Pollutant Discharge Elimination System (NPDES) permit limits for ammonia, and consequently, was issued Findings and Orders by the Environmental Protection Agency (EPA) in 1985. In addition to changes required to meet the NPDES permit requirements, the Piqua WWTP improvement project also included other upgrades to plant processes and equipment to ensure proper treatment

Because the Piqua WWTP pre-dated ammonia-N permit limits, it had no provisions for reduction of ammonia nitrogen because there were no permit requirements for it at that time. When the revised NPDES permit was implemented, the Piqua WWTP could not meet the specified ammonia limits, resulting in constant violations of the NPDES permit.

Before completion of the Piqua WWTP improvement project, operational problems existed in at least five locations throughout the plant. Operational problems at the secondary settling tanks, due to the original orientation of the influent piping and sludge draw-off, resulted in excessive mixing, poor sludge concentration, and loss of solids over the effluent weir.

The Piqua WWTP improvement project began in the late 1980s and was completed in December 1992. An anoxic MASS system was installed for ammonia nitrogen removal at the Piqua WWTP. Modification of the existing aeration tanks and construction of four new aeration tanks was required to implement the anoxic MASS system. All other work completed during the Piqua WWTP improvement project involved those items identified necessary to optimize use of original equipment at the Piqua WWTP.

Replacement of some original units has increased plant efficiency, reduced energy use and associated operating costs, and provided for a higher level of treatment. Back up electrical support, better sludge handling and flood controls were also installed.

Indicator 1
Median effluent flows fluctuated between 2.4 MGD and 44.3 MGD with 95th percentile values exceeding the 4.5 MGD design flow several times during the period 1976-1994. No obvious trends are evident for this time period. The Piqua WWTP contributed approximately 13% (2.62 MGD) of the total wastewater volume discharged by five major WWTPs to the Upper Great Miami River mainstem in 1994.

A dramatic decline occurred for the median and 95th percentile ammonia-nitrogen loadings in 1989. Median values which consistently exceeded 150-200 kg/day prior to 1989 declined to less that 5-10 kg/day afterwards. Ninety-fifth percentile values showed a similar decline to less than 20-30 kg/day during 1992-94. The Piqua WWTP contributed 11% (9.73 kg/day) of the ammonia-nitrogen loading discharged by five major WWTPs to the Upper Great Miami River mainstem in 1994.

The BOD data available through the period of record is comprised of two parameters, BOD_5(1976 through 1985) and $CBOD_5$(1986 through 1994). Median and 95 percentile loadings of BOD during the 1976-1994 period showed some fluctuations, but demonstrated an overall decline through the period . Annual TSS loads displayed a similar trend as that of BOD.

Eighty-nine violations were reported during 1989-94. Heavy metals dominated the NPDES violations from 1989-93. After the CWSRF-funded WWTP upgrade in 1994, the reported number of permit violations were significantly reduced, and appeared more typical of the constituents of treated domestic wastewater (e.g. TSS, residual chlorine, and fecal coliform).

POLLUTANTS REMOVED AT PIQUA WWTP				
SAMPLING PERIOD (1 YEAR)	POUNDS OF $CBOD_5$ REMOVED (daily average)	% $CBOD_5$ REMOVED	POUNDS OF TSS REMOVED (daily average)	% TSS REMOVED
PRE-PROJECT (1988)	3,695	93	2,543	91
POST-PROJECT (1995)	2,985	96	2,574	95
CHANGE	710	3	31	4

Pounds of pollutants removed increased by 710 pounds for $CBOD_5$ and 31 pounds for TSS. The WWTP efficiency increased by 3% for $CBOD_5$ and by 4% for TSS.

Indicators 4& 5

PIQUA WWTP IMPROVEMENTS, RM 114.05 & 114.13			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
GREAT MIAMI RIVER OH56 12	WARMWATER HABITAT (before 1997) EXCEPTIONAL WARMWATER HABITAT(after 1997)	HIGH-VERY HIGH	EASTERN CORN BELT PLAIN

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1982	6.30	0.00	3.21	1.10	0.00
1994	9.90	0.00	0.70	0.00	0.01

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as **H**igh, **M**oderate, **S**light, or **T**hreats)

Source	**Magnitude 1982**	**Magnitude 1994**
Municipal Point Sources	H	-
Dam construction	S	-
Industrial Point Sources	H	-
Other Urban Runoff	M	-
Urban Runoff/Storm Sewers(nps)	M	
Flow regulation/modification	-	H
Upstream Impoundment	-	H

Cause	**Magnitude 1982**	**Magnitude 1994**
Organic enrichment/DO	H	-
Other habitat alterations	S	-
Unionized ammonia	H	-
Metals	H	-

Monitoring comments from 1982 indicate that there was a large fish kill in 1986 from the Piqua WWTP.

Monitoring comments from 1994 attribute impairments to sources other than the Piqua WWTP. Partial attainment of a portion of this stream segment is due to habitat alteration from a dam.

Municipal Point Sources went from a high source of impairment in 1992 to **not** being a source of impairment in 1994. The cause data reflect the disappearence of metals and unionized ammonia as impairments. We can conclude that the CWSRF project made a significant positive contribution to water quality and aquatic life improvement in this stream segment. This portion of the Great Miami River recovered to such an extent that the aquatic life use designation was upgraded from Warmwater Habitat to Exceptional Warmwater Habitat.

Indicator 6
Great Miami River has a Primary Contact Recreation designation. The standard for fecal coliform content in no less than 5 samples in a 30 day period is not to exceed 1,000 per 100ML or 2,000 per 100 ML in more than 10% of samples per month.

GREAT MIAMI RIVER ANNUAL AVERAGE FECAL COLIFORM COUNTS			
SAMPLING PERIOD (1 YEAR)	UPSTREAM (#/100ML)	EFFLUENT (#/100ML)	DOWNSTREAM (#/100ML)
PRE-PROJECT (1988)	no data	20	346
POST-PROJECT (1995)	503	385	618

It does not appear that fecal coliform was a major problem even in the pre-project phase.

5. URBANA WWTP (completion date 12/23/93)
location: Champaign County, latitude 40`05'46" N, longitude 83`47'50" W

The Urbana WWTP discharges to the Mad River, just south of Dugan Run. This segment is identified by USEPA River Reach number 05080001-009. The Ohio EPA has identified the Mad River, from its headwaters to Buck Creek (located at Springfield, Ohio), as a State Resource Water and has given it a Cold Water Aquatic Life Habitat use designation. According to the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, populations of the Tonguetied Minnow (Exoglossum laurae), a state endangered species, have been identified within the Mad River upstream and downstream of Dugan Run. The Mad River is used extensively for recreation(e.g., trout fishing). Much of Champaign County, including land in proximity to the Urbana WWTP, is underlain by the Great Miami/Little Miami Buried Valley Aquifer System. The Great Miami/Little Miami Buried Valley Aquifer System was designated a "Sole Source Aquifer" by U.S. EPA in April 1988. The Mad River is significantly fed by groundwater, leading to the Cold Water Habitat designation.

Indicator A
The Urbana WWTP began to experience operational problems in the late-1980's, resulting in violations of the plant's NPDES permit. Consequently, a series of upgrades were made to the plant in order to maintain compliance. Construction activities for the first WWTP upgrades began in the Spring of 1991 and were completed by the Spring of 1992.

Major elements of the 1991-92 WWTP upgrade included replacement of aging and worn components, installation of a belt filter press to dewater sludge, construction of a maintenance garage, and WWTP laboratory improvements. Upon project completion, the Urbana WWTP continued to have difficulty meeting NPDES discharge permit limits. In 1993, the city of Urbana undertook a Comprehensive Performance Evaluation (CPE) of the WWTP as the first step in a Composite Correction Program (CCP) designed at bringing the plant into compliance. This led to phase 2 improvements in 1995.

The 1995 upgrade included installation of chlorination, dechlorination, and post aeration tanks and equipment to ensure compliance with final effluent chlorine residual and dissolved oxygen limits; installation of a trickling filter bypass pump station; replacement of trickling filter media and distributors, providing forced air ventilation in trickling filters; replacement of withdrawal draft tubes and other secondary clarifier improvements; and conversion of anaerobic digesters to aerobic digesters for the stabilization of primary sludge.

The loan amount for phase 1 was $2,600,000. In 1995, phase 2 also received partial CWSRF funding, but these improvements were **not** captured by the available data.

Indicator 1

POLLUTANTS REMOVED AT URBANA WWTP				
SAMPLING PERIOD (1 YEAR)	POUNDS OF $CBOD_5$ REMOVED (daily average)	% $CBOD_5$ REMOVED	POUNDS OF TSS REMOVED (daily average)	% TSS REMOVED
PRE-PROJECT (1990)	5,739	97	4,745	96
POST-PROJECT (beginning 8/93) *based upon 11 months of flow data	5,025*	96	4,515*	94
CHANGE	-714	-1	-230	-2

The loadings of these two parameters and WWTP removal efficiencies did not improve with the first phase of improvements.

Indicators 4& 5

URBANA WWTP IMPROVEMENTS, RM 39.15			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
MAD RIVER OH58 43	COLDWATER HABITAT	VERY HIGH	EASTERN CORN BELT PLAIN

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1986	0.00	6.64	0.00	0.00	0.00
1994	0.00	0.00	6.64	0.00	0.00

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as High, Moderate, Slight, or Threats)

Source	**Magnitude 1986**	**Magnitude 1994**	**Cause**	**Magnitude 1986**	**Magnitude 1994**
Removal of riparian vegetation	T	-	Other habitat alterations	T	H
Channelization	T	H	Nutrients	-	M
Agriculture	-	M	Noxious aquatic plants	-	M

Monitoring comments indicate that in 1986, the Mad River was attaining Cold Water Habitat, but the fish indices were low due to channel modification. The 1986 comments also indicate a potential destruction or alteration of riparian buffer or channel due to agricultural practices.

The Mad River showed only partial attainment in 1994 due to channelization and agriculture, and one out of three fish tissue samples with elevated mercury levels. The Urbana WWTP is not listed as a source of impairment either before or after the CWSRF WWTP improvements. As Indicator 1 has demonstrated, WWTP effluent quality did not improve after the Phase 1 improvements.

If phase 2 was successful in bringing the WWTP into compliance, then that project prevented potential degradation of the Mad River due to organic enrichment.

Indicator 6
The Mad River has a Primary Contact Recreation designation. The standard for fecal coliform content in no less than 5 samples in a 30 day period is not to exceed 1,000 per 100 ML or 2,000 per 100ML in more than 10% of samples per month.

MAD RIVER ANNUAL AVERAGE FECAL COLIFORM COUNTS			
SAMPLING PERIOD (1 YEAR)	UPSTREAM (#/100ML)	EFFLUENT (#/100ML)	DOWNSTREAM (#/100ML)
PRE-PROJECT (1990)	159	106	140
POST-PROJECT (beginning 8/93)	233.53	no data	328.52

Fecal coliform counts are not an issue with this project as the counts are well within the water quality standards for the stream.

6. STONELICK WWTP (completion date 10/29/93)
location: Clermont County, latitude 39`13' 13" N, longitude 84`03' 58" W

Indicator A
This regionalization project funded an interceptor to collect wastewater from the Stonelick area and send it to the Middle East Fork WWTP for treatment. Consequently the Stonelick WWTP and its discharge to Stonelick Creek were eliminated. The Middle East Fork WWTP was expanded and upgraded to accommodate a number of regional projects. This example focuses on the former receiving stream of the Stonelick WWTP (identified by USEPA River Reach number 0509202-010). CWSRF funding for this project totaled $2,422,200.

Indicator 1
We do not have information for this project. We can assume that all previous inputs from the WWTP have been eliminated.

Indicators 4& 5

STONELICK WWTP IMPROVEMENTS			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
STONELICK CREEK OH53 8	WARMWATER HABITAT	VERY HIGH	INTERIOR PLATEAU

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1987	3.60	0.00	0.00	3.10	16.20
1993	3.10	0.00	3.30	0.00	16.50

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as **H**igh, **M**oderate, **S**light, or **T**hreats)

Source	Magnitude 1987	Magnitude 1993
Municipal Point Sources	H	-
Other	S	-
Agriculture	-	M
Nonirrigated crop production	-	H
Source unknown	-	H
Dam construction	-	H

Cause	Magnitude 1987	Magnitude 1993
Other habitat alterations	-	H
Cause unknown	-	H
Organic enrichment/DO	M	-
Flow alteration	S	-

Early monitoring comments indicate that Stonelick WWTP had a major impact on the watershed along with potential impacts from agriculture and on-site systems. The upper sections of this creek are intermittent so the effluent had little dilution.

As expected, post-project monitoring did not indicate any degree of degradation due to municipal sources. Although the total number of fully attaining river miles has dropped slightly, there is a large increase in river miles that previously did not support the use designation, but now show partial attainment. Comments do indicate that the upper watershed is impacted by nonpoint sources and habitat alterations (Stonelick Lake). We can conclude from this information that elimination of the wastewater treatment plant had a positive impact on the receiving stream.

Indicator 6
We do not have information for this project.

7. WELLSTON WWTP (completion date 9/15/94)
location: Jackson County, latitude 39`06' 46" N, longitude 82`31' 31" W

The Wellston WWTP effluent is located on Meadow Run at river mile 1.17. Meadow Run is in the Little Raccoon Creek Basin and is identified by USEPA River Reach number 05090101-079.

Indicator A
In 1991, Findings and Orders (F&Os) were issued to the Wellston WWTP for not providing the treatment necessary to meet the final effluent limitations of the NPDES permit, and for not having adequate capacity to treat the wet-weather flows to the WWTP. The plant was also experiencing problems with sludge management. To satisfy the F&Os, the improvements to the WWTP were required to be completed prior to separating the combined sewer system.

This plant, formerly known as the North Plant, discharged to Meadow Run at river mile (RM) 1.20. When improvements were made to the Wellston WWTP in 1992, the discharge location was moved to RM 1.17. The Pillsbury (formerly Jenos) discharge was located at RM 1.19 during the 1995 survey. The 1992 WWTP upgrade involved the following improvements to the wastewater treatment process: 1) improvements in pre-screening at the headworks; 2) new pumps to handle the flow variations and the elimination of the bypass from the headworks; 3) grit removal facilities; 4) a new biological treatment unit; 5) new secondary settling tanks; 6) ultraviolet disinfection; and 7) improved sludge handling and treatment facilities, including a belt filter press and aerated sludge holding facilities. Sanitary sewer service was extended to the south Wellston area which has a concentration of failing septic systems. This action significantly reduced the discharge of inadequately treated sewage to a segment of Meadow Run.

The total cost of the WWTP improvements, a portion of which was paid for with grant assistance from the Ohio Public Works Commission, was $3,517,000. The city received a 2.2% interest refinancing loan from Ohio's CWSRF to pay off a short-term note in the amount of $900,000, the city's portion of debt on the WWTP improvement project. Operating reports show that the WWTP has been functioning as designed, and is now able to consistently meet NPDES permit limits.

The city had a combined sewer system in which stormwater and wastewater flows are contained in the same pipe. During heavy rainfall events, the city's system was, at times, overloaded with up to 100 times the dry weather flow. This resulted in discharges and overflows of raw sewage and storm flow from sewer manholes which posed a potential human health threat in addition to aesthetic problems and further water quality degradation. Beginning in early 1996, the city initiated phased separation of the combined sewer system with additional CWSRF funds to eliminate the discharge and overflow of raw sewage during these heavy rainfall events. The monitoring data below do not capture these subsequent improvements to water quality.

Indicator 1

POLLUTANTS REMOVED AT WELLSTON WWTP				
SAMPLING PERIOD (1 YEAR)	POUNDS OF $CBOD_5$ REMOVED (daily average)	% $CBOD_5$ REMOVED	POUNDS OF TSS REMOVED (daily average)	% TSS REMOVED
PRE-PROJECT (1991)	569	83	439	77
POST-PROJECT (beginning 10/94)	905	97	807	97
CHANGE	336	14	368	20

After the CWSRF-funded improvements, pounds of TSS and $CBOD_5$ removed by the Wellston WWTP increased as did the efficiency of the WWTP in removing these two parameters. Other information gathered from the permit support document (summarized below) indicate that the plant still has problems with pollutants other than TSS and $CBOD_5$. This is a good example of how these two parameters alone are not sufficient to give a complete picture of what is going on in the WWTP.

Monthly operating report data since the 1992 plant upgrade (1993-1995) indicate NPDES permit violations (numbers) for ammonia-nitrogen (20), cadmium (9), copper (5), dissolved oxygen (6), fecal coliform (1), lead (6), mercury (10), and oil and grease (1). While many violations continue to occur, the data show a decline in pollutant loadings through 1993, followed by slight increases in 1994 and 1995. Sampling of the Wellston WWTP 001 outfall during the 1995 survey showed high ammonia-N concentrations (5.50 mg/L, average). Wellston has reduced ammonia-N levels to <0.5 mg/L by adjusting the amount of air in the oxidation ditch.

Ambient water chemistry data from 1995 showed higher levels of ammonia-N, BOD_5, COD, chlorine, conductivity, nitrate+nitrite-N, oil and grease, phosphorus, total dissolved solids, total Kjedahl nitrogen, and total suspended solids in Meadow Run downstream (RM 0.72) from the Pillsbury and Wellston WWTP outfalls compared to upstream (RM 1.42). Dissolved oxygen (D.O.) was lower at the downstream site. The increases in average ammonia-N (0.09 to 6.2 mg/L) and BOD_5 (2.1 to 12 mg/L) concentrations and decrease in the average D.O. (6.1 to 2.9 mg/L) concentration from upstream to downstream during the 1995 survey was very similar to the chemical results from the 1984 survey. Direct comparisons of the 1990 survey data was compounded because the sampling locations were not the same as in 1995 and the Pillsbury 001 outfall was located further upstream at RM 3.00 in 1990. (Details taken from Permit Support Document, April 1997, Division of Surface Water, OEPA.)

Indicators 4& 5

WELLSTON WWTP IMPROVEMENTS, RM 1.17			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
MEADOW RUN OH30 16	LIMITED RESOURCE WATER (PRIOR '95) WARMWATER HABITAT (AFTER'95)	MODERATE-HIGH	WESTERN ALLEGHENY PLATEAU

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1990	0.00	1.10	0.00	2.10	1.90
1995	0.00	0.00	0.00	5.10	0.00

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as **H**igh, **M**oderate, **S**light, or **T**hreats)

Source	**Magnitude 1990**	**Magnitude 1995**	**Cause**	**Magnitude 1990**	**Magnitude 1995**
Industrial Point Sources	H,M,T	H	Metals	H,T	H
Mining	T,M	H	Unionized Ammonia	M,M	-
Municipal Point Sources	H	H	Priority organics	-	H
Subsurface mining	M,T	-	pH	M,T	-
Acid Mine Drainage	-	H	Organic enrichment/DO	H	H

The upper portions of this segment are impacted by acid mine drainage. The 1995 biological sampling results in Meadow Run upstream from Wellston suggested that the aquatic life use designation at the time, Limited Resource Waters (LRW), should be upgraded to Warmwater Habitat (WWH). Significant improvements in biological community performance indicated a lessening of the mine drainage problems that resulted in the original LRW designation based on the 1984 survey results. Note that attainment of the aquatic life use in 1990 reflected the Limited Resource Water use designation while the aquatic life use was upgraded to Warmwater Habitat Aquatic Life Use designation in 1995. The WWH use designation is more difficult to attain.

The lower 1.2 miles (near the Wellston WWTP and the Pillsbury Co. outfalls) are heavily impacted by organic wastes and low dissolved oxygen. The effects of the industrial and municipal point sources are indistinguishable. While improvements have been made in terms of treatment process upgrades and overall loadings reductions, frequent permit limit violations, significant effluent toxicity, and instream water quality criteria exceedences indicate that more consistent compliance with permit terms and conditions is still needed. Unfortunately, some of these problems were only recently addressed following the 1995 survey, thus validation of their effectiveness with instream indicators was not possible.

The facility planning information and environmental assessment indicate that the CSOs/storm sewers adversely impacted water quality in the area. This and other high sources of impairment were not addressed by the time this monitoring took place, so it is really no surprise that this stream segment has become more degraded even with the CWSRF funded WWTP improvements. With so many sources of impairment, improvement of the municipal point source may not have much of an influence on the total water quality. It will be interesting to see future monitoring results now that the CSO problems have been addressed with CWSRF funding.

Indicator 6
Meadow Run has a Primary Contact Recreation designation. The standard for fecal coliform content in no less than 5 samples in a 30 day period is not to exceed 1,000 per 100ML or 2,000 per 100ML in more than 10% of samples per month.

MEADOW RUN ANNUAL AVERAGE FECAL COLIFORM COUNTS			
SAMPLING PERIOD (1 YEAR)	UPSTREAM (#/100ML)	EFFLUENT (#/100ML)	DOWNSTREAM (#/100ML)
PRE-PROJECT(1991)	824	264	5452
POST-PROJECT (beginning 10/94)	744	212	426

As noted earlier, prior to the CWSRF funded project, the Wellston WWTP was experiencing fecal coliform violations. Very high levels downstream from the WWTP plant prior to the improvement project are evident in the above table. CSOs and violations from a food industry plant may have also contributed to the high fecal levels. There has been a dramatic improvement and the stream is now in attainment with the recreation standard and represents a reduced risk to human health.

8. SEBRING WWTP (completion date 10/03/91)
location: Mahoning County, latitude 40`55' 54" N, longitude 81`1' 38" W

The Sebring WWTP discharges to Sulphur Creek Ditch at river mile 0.48. Sulphur Creek Ditch flows into Fish Creek which flows into the Mahoning River. This portion of Fish Creek has the USEPA River Reach number of 05030103-010.

Indicator A
The City of Sebring WWTP dated to the early 1900s with trickling filters and Imhoff tank/sludge drying beds. Based on influent sampling, metal concentrations were high enough to be potentially toxic to the biological treatment system. The high heavy metal concentrations made the sludge unacceptable for land application. Due to organic and hydraulic overloading, inadequate pretreatment of industrial flows, and the inability of the existing WWTP to comply with the advanced treatment limits contained in its NPDES permit, the effluent was causing water quality degradation and standards violations in Sulphur Ditch and Fish Creek. There were also five overflows in the Sebring collection system.

The CWSRF funded a new 1.5 MGD oxidation ditch WWTP and converted the existing on-site facility to an equalization tank for temporary wet weather flow storage. Before and after monitoring data do not exist for Sulphur Ditch and Fish Creek, so we used data from the next downstream segment of the Mahoning River.

Indicator 1
Ohio EPA conducted (pre-project) chemical sampling of Sulphur Ditch and Fish Creek in 1986. Ohio EPA Technical Report MAS/1995-12-14, 1996 reported elevated levels of ammonia-nitrogen and copper in the effluent and violations of the same parameters in Sulphur Creek at two locations downstream of the outfall.

The Sebring WWTP has also significantly degraded the dissolved oxygen concentrations in Fish Creek, and high nutrient loadings have resulted in the excessive growth of aquatic plants. In addition, the WWTP receives significant industrial wastewater and was discharging slightly elevated heavy metals; namely, cadmium, copper, chromium, mercury, zinc, lead, and nickel.

The pollutant removal comparisons for $CBOD_5$ and TSS are shown in the Table below.

POLLUTANTS REMOVED AT SEBRING WWTP				
SAMPLING PERIOD (1 YEAR)	POUNDS OF $CBOD_5$ REMOVED (daily average)	% $CBOD_5$ REMOVED	POUNDS OF TSS REMOVED (daily average)	% TSS REMOVED
PRE-PROJECT (beginning 8/89)	490	74	471	73
POST-PROJECT (beginning 11/92)	726	97	869	96
CHANGE	236	23	398	23

There is a large increase in the pounds of $CBOD_5$ and TSS removed in the plant and the WWTP efficiency at removing these pollutants from the influent.

Yearly average nitrogen ammonia levels in the WWTP effluent were 24.02 mg/L before the project compared to 0.56 mg/L post project. Dissolved oxygen concentrations at a downstream sampling site before the CWSRF project had an annual average of 4.7 mg/L compared to 8.6 mg/L post project. The new WWTP appears to be functioning much better than the old WWTP.

More recent data indicate noncompliance of copper, zinc and fecal coliform parameters in the effluent and the occurrence of WWTP bypass events. More recent monitoring information indicates highly elevated levels of Cr, Pb, Zn, and PCB's, and PAHs in the sediment downstream from the effluent, and Sebring WWTP was listed as a possible source of this contamination.

Indicators 4& 5

SEBRING WWTP IMPROVEMENTS			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
MAHONING RIVER OH 1 30	WARMWATER HABITAT	HIGH	ERIE-ONTARIO LAKE PLAIN

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1984	10.20	0.00	0.00	0.00	17.80
1994	17.30	0.00	0.00	9.00	1.70

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as **H**igh, **M**oderate, **S**light, or **T**hreats)

Source	**Magnitude** 1984	**Magnitude** 1994
Agriculture	-	M
Priority organics	-	M
Pasture land	-	M
Minor Industrial Point Source	-	H
Spills	-	H
Source Unknown	-	H
Minor Municipal Point Source	-	H
Contaminated Sediments	-	H

Cause	**Magnitude** 1984	**Magnitude** 1994
Cause unknown	-	H
Metals	-	H
Nutrients	-	S
Siltation	-	M
Pathogens	-	S

The Sebring WWTP discharges to Sulfur Ditch which flows into Fish Creek which joins the Mahoning River in this segment. In 1984, no detrimental effects from the Sebring WWTP were noted in the Mahoning River downstream of Fish Creek and the segment was in full attainment. The 1984 data are very old, and the technical support document indicates that only a portion of the segment was monitored and sampling was not part of an intensive survey. There are pre-project data from Fish Creek which indicates that Sebring WWTP (and Beloit WWTP) do severely impact Fish Creek due to unionized ammonia, low dissolved oxygen and organic enrichment. There is no post-project data for Fish Creek or Sulphur Ditch.

Post-SRF project monitoring in 1994 showed sediment contamination in the the Mahoning River downstream from Beloit, Sebring and Alliance WWTPs. These WWTPs are listed as possible sources of the elevated levels of Cr, Pb, Zn, PCBs and PAHs in the sediment. Sebring WWTP is indicated as the source of high nitrate levels taken downstream of Fish Creek. No changes in the fish community were evident.

Indicator 6
Sulphur Ditch is not listed in Ohio's Water Quality Standards, but the following data are given for relative value.

SULPHUR DITCH ANNUAL AVERAGE FECAL COLIFORM COUNTS			
SAMPLING PERIOD (1 YEAR)	UPSTREAM (#/100ML)	EFFLUENT (#/100ML)	DOWNSTREAM (#/100ML)
PRE-PROJECT (beginning 8/89)	3,454.9	185,126	268,395
POST-PROJECT (beginning 11/92)	4,668	No data	2,927

Since completion of the CWSRF project, there has been major reduction in fecal coliform counts downstream from the Sebring WWTP. This represents a reduced risk to human health which can be attributed to the SRF-financed improvements.

9. WEST MILTON WWTP (completion date 4/30/94)
location: Miami County, approximately latitude 39`57'34" N, longitude 84`19'26" W

The West Milton WWTP discharges to the Stillwater River in the Stillwater River Basin at rivermile 16.57. This stream segment is referred to as USEPA river reach number 05080001-.

Indicator A
The West Milton WWTP required expansion and upgrading to meet its NPDES permit limits. Excessive I/I, and sewer lines of inadequate capacity, are directly responsible for sewer overflows and backups of wastewater in several areas in the village, and for the operational difficulties at the WWTP which resulted in NPDES permit violations.

The sewage collection system for West Milton has separate sewers and storm sewers and no bypasses of raw sewage. There are no other WWTPs that discharge to this stream segment.

Improvements to the West Milton WWTP consisted of constructing a new primary clarifier/digester, two nitrification towers, a secondary clarifier, an equalization basin, a laboratory/control building, rehabilitating the existing trickling filter, final clarifiers, a primary clarifier/digester, and replacing the existing comminutor.

The expanded WWTP was designed to have an average daily design flow of 1.2 million gallons per day (MGD), and be capable of meeting effluent limits of 15 mg/L $CBOD_5$, 30 mg/L suspended solids, and 4 mg/L ammonia-nitrogen.

Upgrading the collection system involved constructing a relief sewer to accommodate the portion of the I/I not cost-effective to remove. The CWSRF loan was for $2,822,120.

Indicator I

POLLUTANTS REMOVED AT WWTP				
SAMPLING PERIOD (1 YEAR)	POUNDS OF $CBOD_5$ REMOVED (daily average)	% $CBOD_5$ REMOVED	POUNDS OF TSS REMOVED (daily average)	% TSS REMOVED
PRE-PROJECT (beginning 8/90)	no data	no data	670	76
POST-PROJECT (beginning 5/95)	457	82	684	83
CHANGE	not applicable	not applicable	17	7

From August 1990 through July 1991, the West Milton WWTP removed 670 lbs (76%) of TSS per day. Reporting for $CBOD_5$ started in November 1992. After the CWSRF project was completed, the WWTP removed 684 lbs of TSS (83%) and 457 lbs of $CBOD_5$ (82%). TSS removal efficiency increased by 17 pounds per day, or 7%.

The 1995 technical support document for Stillwater River (DSW/MAS 1995-8-8) indicates a marked decrease in ammonia and $CBOD_5$ following completion of the plant upgrade. Fiftieth percentile effluent loadings of ammonia-nitrogen from 1982 to 1992 ranged between 11.2 and 37.1 kg/day; during 1993 and 1994, these decreased to 1.1 and 2.2 kg/day, respectively. The fiftieth percentile effluent loadings of $CBOD_5$ from 1986 to 1992 ranged between 15.0 and 84.2 kg/day; during 1993 and 1994, loadings were 12.6 and 6.5 kg/day, respectively.

Indicator B
The following is an example of how the proposed Indicator B could be used. Please refer to the Clean Water CWSRF Indicator Section in the front of the report for explanation, definitions and purpose.

Mean QHEI values greater than 60 from rivers or large river segments, generally indicate a level of macrohabitat quality sufficient to support an assemblage of aquatic organisms fully consistent with the WWH aquatic life use designations. Average reach values greater than 75 are generally considered adequate to support fully exceptional (EWH) aquatic communities.

QHEI values before and after project completion for several locations downstream from West Milton WWTP are available. The results are presented below.

QHEI VALUES FOR THE STILLWATER RIVER			
RIVER MILE	1982	1990	1994
16.0	71.5	85	-
15.7	-	-	82
14.7	-	-	80.5
14.4	80.5	-	-
12.1	63	-	81.5
11.5	-	82	-

The QHEI factors in a number of parameters, and captures information such as substrate embeddedness, which can be influenced by WWTPs and nonpoint sources. QHEI scores improved from 1982 into the range adequate to support exceptional biological communities.

Indicators 4& 5

WEST MILTON WWTP IMPROVEMENTS, RM 16.57			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
STILLWATER RIVER OH57 5	EXCEPTIONAL WARMWATER HABITAT	VERY HIGH	EASTERN CORN BELT PLAIN

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1982	3.60	0.00	3.00	0.20	0.00
1994	6.80	0.00	0.00	0.00	0.00

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as **H**igh, **M**oderate, **S**light, or **T**hreats)

Source	**Magnitude 1982**	**Magnitude 1994**	**Cause**	**Magnitude 1982**	**Magnitude 1994**
Municipal Point Sources	H	-	Unionized Ammonia	M	-
			Organic enrichment/DO	H	-

Municipal Point Sources (West Milton WWTP) were listed as the sole high source of impairment to this stream segment in 1982; in 1995, no municipal point sources caused impairment. The improvement in the fish communities during 1994 appears to be associated with reduced effluent loadings of ammonia-N and oxygen-demanding material from the West Milton WWTP. The reduced loadings (detailed under Indicator 1) are a result of the CWSRF funded WWTP improvements completed in 1992.

Indicator 6
Stillwater River has a Primary Contact Recreation designation. The standard for fecal coliform content in no less than 5 samples in a 30 day period is not to exceed 1,000 per 100ML or 2,000 per 100ML in more than 10% of samples per month.

STILLWATER RIVER ANNUAL AVERAGE FECAL COLIFORM COUNTS			
SAMPLING PERIOD (1 YEAR)	UPSTREAM (#/100ML)	EFFLUENT (#/100 ML)	DOWNSTREAM (#/100ML)
PRE-PROJECT (beginning 8/90)	no data	no data	145
POST-PROJECT (beginning 5/95)	541	1806	597

The in-stream bacteriological levels do not violate primary contact standards. High post project effluent fecal coliform levels may indicate a potential disinfection problem.

10. COLUMBUS SOUTHERLY WWTP (completion date 5/3/94)
location: Franklin County, latitude 39`48' 48" N, longitude 83`00' 53" W

The Columbus Southerly WWTP is one of two treatment facilities serving the Columbus metropolitan area. Wastewater from the eastern part of the metropolitan area, Grove City, and excess flows from the Jackson Pike WWTP are treated at the Southerly WWTP which discharges to the middle portion of the Scioto River, USEPA river reach number 05060001-027. The plant was constructed in 1967 and became an advanced treatment facility in September 1987.

The treatment process is comprised of screening, aerated grit removal, pre-aeration, primary settling, activated sludge aeration, secondary clarification, chlorination, dechlorination using sulfur dioxide, and post-aeration. Discharge occurs directly to the Scioto River at RM 118.4.

Indicator A.
The CWSRF funded the construction of additional clarifier capacity at the Southerly WWTP. The project was initiated as a result of the Anheuser-Bush, Inc. interest in expanding production at its Columbus brewery, thereby increasing wastewater flows. Further planning and value engineering determined that two additional final clarifiers needed to be constructed at the Southerly WWTP to provide additional solids/liquid separation for the aeration unit process at average daily flows and loads, and the current peak flow of 150 million gallons per day (MGD), expandable to 198 MGD for future wet weather flows. Construction of this project began Spring 1991 and both clarifiers were in operation in Spring 1993. The amount financed for this project and some sewer rehabilitation work was $34,752,787 ($12,788,420-secondary treatment; $24,995,547-advanced treatment; $968,820-major rehabilitation).

Indicator 1

POLLUTANTS REMOVED AT COLUMBUS SOUTHERLY WWTP				
SAMPLING PERIOD (1 YEAR)	POUNDS OF $CBOD_5$ REMOVED (daily average)	% $CBOD_5$ REMOVED	POUNDS OF TSS REMOVED (daily average)	% TSS REMOVED
PRE-PROJECT (beginning 10/92)	125,090	99	121,577	95
POST-PROJECT (beginning 6/95)	116,969	93	94,635	76
CHANGE	-8,121	-6	-26,942	-19

Data suggest a decreased ability of the WWTP to remove TSS and $CBOD_5$. This information must be carefully considered since the effect of overflows at the WWTP is not readily apparent. For example, the data suggests that 1993 may not have had as many overflows as 1995-1996 did. In fact, there are six months of missing overflow data for $CBOD_5$ during 1993, but 1995-1996 has a complete record of overflows, suggesting that even with overflow events the WWTP overall had a removal efficiency of 93% for $CBOD_5$. In that same regard, the complete record for TSS in 1992-93 and 1995-96 suggests more clearly the effects of the plant overflow on removal efficiencies. Removal efficiencies varied with the number, frequency, and duration of storm events leading to overflows at this facility.

Only three violations for ammonia and pH were noted during September 1996 and continue to remain low while flow increased after 1988. Total suspended solids loadings have remained consistent through time. A dramatic decrease in the ambient ammonia concentration occurred in 1988 downstream from both the Jackson Pike WWTP and Columbus Southerly WWTP. According to the 1996 Middle Scioto River Technical Support Document, this decrease was a direct result of plant improvements and upgrades to both facilities.

The dissolved oxygen concentration has increased over time from an annual daily average of 7.43 mg/L in 1992-93 to 9.2 mg/L in 1995-96 downstream of the WWTP. Average concentrations have been significantly above the exceptional warmwater criterion since 1980.

Total phosphorus concentrations have declined throughout the study area. In 1996, average phosphorus concentrations were found to be below the Ohio EPA guideline (1 mg/L) for the prevention of nuisance algal growths at all sample sites.

The level of nitrate has increased along the entire stream segment. This coincides with the decrease in ammonia due to the nitrification processes installed at the Columbus WWTPs.

Indicators 4& 5

COLUMBUS SOUTHERLY WWTP IMPROVEMENTS, RM 118.40 (BYPASS EFFLUENT RM 118.40)			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
SCIOTO RIVER OH37 1	WARMWATER HABITAT	HIGH -VERY HIGH	EASTERN CORN BELT PLAIN

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1991	5.65	0.00	1.50	0.10	0.00
1996	1.85	4.50	0.90	0.00	0.00

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as **H**igh, **M**oderate, **S**light, or **T**hreats)

	Magnitude			Magnitude	
Source	**1991**	**1996**	**Cause**	**1991**	**1996**
Municipal Point Sources	H	M,T	Unionized Ammonia	H	T
Combined Sewer Overflow	H	H	Organic enrichment/DO	H	H,T
Urban Runoff/Storm Sewers (NPS)	-	T			

The 1991 monitoring comments indicated that Columbus Southerly WWTP is the most significant point source of impairment in the area. Non- and Partial attainment that year were due to lingering impacts from Columbus CSOs and WWTPs, although extensive improvements downstream from Columbus Southerly have been documented over the past 10 years. The 1996 monitoring indicated significant improvement in this segment due to reduced pollutant loads from the two WWTPs in Columbus and combined sewer overflows. Biological communities indicated full attainment of WWH criteria but DELT[8] anomalies in fish were markedly elevated within this reach indicating likely toxic and/or bacteriological stressors.

Indicator 6
This stretch of the Scioto River has a Primary Contact Recreation designation. The standard for fecal coliform content in no less than 5 samples in a 30 day period is not to exceed 1,000 per 100 ML or 2,000 per 100 ML in more than 10% of samples per month.

[8] Deformities, eroded fins, lesions, and tumors

SCIOTO RIVER ANNUAL AVERAGE FECAL COLIFORM COUNTS			
SAMPLING PERIOD	UPSTREAM (#/100ML)	EFFLUENT (#/100ML)	DOWNSTREAM (#/100ML)
PRE-PROJECT (beginning 10/92)	2186	no data	1770
POST-PROJECT (beginning 6/95)	5905	222.3	4693.6

Monitoring indicates a gradual decrease in the number of fecal coliform bacteria per sample occurring throughout most of the study area both upstream and downstream from Columbus WWTPs. The WWTP effluent seems to have a diluting effect on the fecal coliform concentrations in the stream. Mean concentrations are still above Ohio water quality standards criteria and are most likely due to CSOs, WWTP bypasses and other diffuse inputs. This information points out further work that the city needs to do in order to minimize the potential for human health problems. It also points out an area for potential CWSRF assistance.

11. OAK HILL WWTP (completion date 10/01/95)
location: Jackson County, latitude 38`52'55" N, longitude 82`34'36" W

The Oak Hill WWTP discharges to Huntingcamp Creek in the Symmes Creek Basin. This stream segment can be referenced by USEPA river reach number 05090101-.

Indicator A
Oak Hill WWTP was hydraulically overloaded and in need of expansion and upgrading to meet its National Pollution Discharge Elimination System (NPDES) permit limits. Excessive I/I in the collection system was identified as contributing to the WWTP problems.

The WWTP improvements consisted of a grit chamber, a comminutor, two aeration tanks, two final clarifiers, a new chlorine contact tank along with dechlorination, conversion of the existing final clarifiers to aerobic digesters and replacement of the existing sand drying beds with plastic filter media for sludge drying, and an earthen dike to provide flood protection to the 100-year flood elevation.

Sewer system improvements eliminated the excessive amount of I/I from the collection system.

These upgrades were funded through a grant from Farmers' Home Administration, a grant from the Ohio Public Works' Commission-Issue 2 Program and a low interest loan (at a hardship rate) from Ohio's CWSRF program in the amount of $937,651.

Indicator 1
From May 1992 through April 1993, the Oak Hill WWTP removed an average of 117 pounds of TSS per day (65%) and an average of 224 pounds of $CBOD_5$ per day (76%). After completion of the CWSRF project in October 1997, the WWTP removed an average of 305 pounds of TSS (96%) per day and an average of 378 pounds of $CBOD_5$ (97%) per day.

POLLUTANTS REMOVED AT OAK HILL WWTP				
SAMPLING PERIOD (1 YEAR)	POUNDS OF $CBOD_5$ REMOVED (daily average)	% $CBOD_5$ REMOVED	POUNDS OF TSS REMOVED (daily average)	% TSS REMOVED
PRE-PROJECT (beginning 5/92)	224	76	117	65
POST-PROJECT (beginning 10/97)	378	97	305	96
CHANGE	183	21	204	31

Pounds removed increased by 204 for TSS and 183 for $CBOD_5$ as did the WWTP removal efficiencies for both parameters. The efficiencies increased by 31% for TSS and by 21% for $CBOD_5$.

Indicators 4& 5

OAK HILL WWTP IMPROVEMENTS, RM 1.7			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
HUNTINGCAMP CREEK OH32 40	WARMWATER HABITAT	MODERATE	WESTERN ALLEGHENY PLATEAU

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1987	0.00	0.00	0.00	3.40	0.00
1995	0.00	0.00	0.00	3.40	0.00

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as **H**igh, **M**oderate, **S**light, or **T**hreats)

Source	Magnitude 1987	Magnitude 1995
Municipal Point Sources	H	H
Channelization	M	-
Sludge	-	H
Onsite wastewater systems (septic tanks)		H
Urban runoff/storm sewers (nps)	-	H

Cause	Magnitude 1987	Magnitude 1995
Other Habitat alterations	M	-
Nutrients	-	H
Oil and Grease	-	M
Organic enrichment/DO	H	H

The early monitoring indicated that upstream of Oak Hill WWTP the stream is ditch-like with degraded habitat. Oak Hill WWTP is specifically noted as a source of impact. Later monitoring named Oak Hill WWTP as a source of degradation with sludge deposits present in significant amounts in the stream channel. Oil and grease from a junk yard upstream and other nonpoint sources of impairment add to the water quality impairments in 1995. Indicator 1 demonstrates that the CWSRF project resulted in a big improvement in pollutant removals at the WWTP, but this is not demonstrated by the aquatic community. Huntingcamp Creek is only moderately restorable and more time may be required before any improvement can be seen in the segment due to the WWTP improvements. If the nonpoint sources of impairment are severe enough, the aquatic community may not recover even if the WWTP problems are eliminated.

Indicator 6
Huntingcamp Creek has a Primary Contact Recreation designation. The standard for fecal coliform content in no less than 5 samples in a 30 day period is not to exceed 1,000 per 100ML or 2,000 per 100ML in more than 10% of samples per month.

HUNTINGCAMP CREEK ANNUAL AVERAGE FECAL COLIFORM COUNTS			
SAMPLING PERIOD (1 year)	UPSTREAM (#/100ML)	EFFLUENT (#/100ML)	DOWNSTREAM (#/100ML)
PRE-PROJECT (beginning 5/92)	3,300	no data	60,000
POST-PROJECT (beginning 10/97)	5,192	140	3,758

Violations of fecal coliform concentrations are clearly a source of impairment to this stream segment as well as a potential human health threat. Prior to the CWSRF-funded project, the WWTP added significantly to the problem, but following the WWTP improvements, the downstream fecal coliform concentrations are lower than the upstream concentrations. The WWTP effluent seems to be diluting the already high fecal coliform concentrations. Many of the sources of impairment noted above could be contributing to this problem.

12. RAVENNA WWTP (completion date 10/9/93)
location: Portage County, latitude 41`08' 58" N, longitude 81`15' 42" W

Two municipal wastewater treatment plants discharge to Breakneck Creek, the Franklin Hills WWTP on Breakneck Creek, and the Ravenna WWTP which discharges to Hommon Ditch, a tributary of Wahoo Ditch which flows into Breakneck Creek which is located in the Cuyahoga River Basin. This segment is identified by USEPA River Reach number number 04110002-005.

The Ravenna WWTP is equipped with primary and secondary settling tanks, aeration tanks, microscreens, a chlorine contact tank, sludge concentrator, aerobic and anaerobic digesters, and sludge drying beds.

Indicator A
The CWSRF was used to fund two project phases. Phase 1 included: a siphon control chamber, screen building, flow equalization basins, roughing filter, effluent pump station and post aeration, and a pump station and various other minor improvements. Phase 2 improvements included: aerobic digester piping modifications, expansion of the sludge concentrator building and removal of the existing sludge concentrator, a sieve drum concentrator, a belt filter press, renovation of sludge drying beds, sewer system rehabilitation, and clean-up of a temporary sludge landfill.

The Ravenna WWTP was unable to meet its NPDES permit limits and was under enforcement action to expand and upgrade its plant in order to comply with its permitted effluent limits.

Indicator 1
Prior to the WWTP improvements, the Ravenna WWTP could not meet its final ammonia-nitrogen limit and although TSS and BOD limits were being met consistently, it was becoming more difficult to do so as

the WWTP approached its design capacity.

POLLUTANTS REMOVED AT RAVENNA WWTP				
SAMPLING PERIOD (1 YEAR)	POUNDS OF $CBOD_5$ REMOVED (daily average)	% $CBOD_5$ REMOVED	POUNDS OF TSS REMOVED (daily average)	% TSS REMOVED
PRE-PROJECT (beginning 11/89)	2,198	98	2,564	94
POST-PROJECT (beginning 11/94)	2,569	98	3,279	95
CHANGE	371	0	715	1

Pounds of pollutants removed increased by 715 pounds for TSS and by 371pounds for $CBOD_5$ while the WWTP percent removal efficiency increased by 1% for TSS and remained static for $CBOD_5$.

The Cuyahoga River Technical Support Document (MAS/1997-12-4, 1999) indicated that under normal operation, ammonia nitrogen and total Kjeldahl nitrogen loads have decreased, especially since 1988. However, 95th percentile loadings have increased, demonstrating wider and wider separation between normal and extreme treatment performance. Ravenna has a history of wet weather bypasses from the WWTP. The loadings trends show that the plant operates well during dry weather, but is increasingly unable to handle peak flows. Further expansion and upgrade of their treatment system, if approved, should result in improved plant performance and eliminate treatment bypasses.

All Breakneck Creek samples from RM 14.6 to the mouth were in compliance with chemical WQS criteria. While the standards were not exceeded, the Ravenna and Franklin Hills WWTPs had discernable impacts on Breakneck Creek. Median nitrate-nitrite nitrogen concentrations increased an order of magnitude downstream from the Ravenna WWTP via Wahoo Ditch (from 0.2 mg/L to 2.0 mg/L), and peaked downstream from the Franklin Hills WWTP. Phosphorus and ammonia-nitrogen concentrations were high in Wahoo Ditch with peak concentrations of 0.65 mg/L and 2.5 mg/L, respectively. However, only ammonia-nitrogen concentrations were detectably higher in Breakneck Creek downstream from Wahoo Ditch, suggesting that the phosphorus was readily assimilated, but the nitrogen was not. The high-ammonia nitrogen concentrations found in Wahoo Ditch correspond to the high 95th percentile.

Indicators 4& 5

RAVENNA WWTP IMPROVEMENTS, RM 0.85			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
BREAKNECK CREEK OH88 8	WARMWATER HABITAT	HIGH	ERIE-ONTARIO LAKE PLAIN

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1987	2.00	0.00	15.80	0.70	0.00
1996	9.50	0.00	2.00	3.80	3.20

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as **H**igh, **M**oderate, **S**light, or **T**hreats)

Source	**Magnitude 1987**	**Magnitude 1996**
Municipal Point Sources	M	-
Major	-	H
Minor	-	H
Natural	H	H
Landfills	S	-

Cause	**Magnitude 1987**	**Magnitude 1996**
Flow Alteration	M	H
Organic enrichment/DO	H	H
Unknown toxicity	-	H

The old monitoring comments do not specifically discuss the Ravenna WWTP, but generally list municipal point sources as being a moderate source of impairment. The 1996 comments indicate that the fish communities showed impacts from the Ravenna WWTP with further declines noted downstream from the Franklin Hills WWTP. This was further evidenced by the presence of an increased percentage of tolerant fishes at RM 3.1 relative to RM 5.2 and a low Modified Index of Well Being scrore. This index score continues to decline downstream from Franklin Hills before recovering at the mouth. The results suggest intermittently toxic conditions downstream from Ravenna which are increased as a result of the discharge from the Franklin Hills WWTP.

The CWSRF funded project appears to have improved the functioning of the Ravenna WWTP. Breakneck Creek is in better shape than it was in 1987 as far as total miles fully attaining the aquatic life use designation, but it is clear that further improvement could occur. Municipal point sources are now listed as high sources of impairment as compared to moderate sources in 1987. This may reflect improvement in Ohio EPA's ability to discern causes and sources as monitoring procedures and reporting improved since 1987.

Indicator 6
Breakneck Creek has a Primary Contact Recreation designation. The standard for fecal coliform content in no less than 5 samples in a 30 day period is not to exceed 1,000 per 100ML or 2,000 per 100ML in more than 10% of samples per month.

BREAKNECK CREEK ANNUAL AVERAGE FECAL COLIFORM COUNTS			
SAMPLING PERIOD (1 year)	UPSTREAM (#/100ML)	EFFLUENT (#/100ML)	DOWNSTREAM (#/100ML)
PRE-PROJECT (beginning 11/89)	no data	100	481
POST-PROJECT (beginning 11/94)	2,364	104	439

The fecal coliform data indicates high background levels that drop to a more acceptable level downstream of the WWTP effluent. Effluent levels have very low fecal counts. The high background conditions do not appear to be related to the WWTP operations.

13. VILLAGE OF CONNEAUT (improvements implemented 1987 through 1992 refinanced through WPCLF in 1993), location: Ashtabula County, latitude 41`58' 08" N, longitude 80`32' 57" W

Conneaut Creek is designated Cold Water Habitat, and Seasonal Salmonid Habitat. This creek harbors a number of sensitive species with declining populations in the state. The Conneaut WWTP discharges to the mouth of Conneaut Creek as it empties into Lake Erie. The USEPA River Reach number for this location is 04120101-012.

Indicator A

Conneaut's wastewater treatment plant (WWTP) was under Findings and Orders issued Oct 4, 1985. This enforcement action resulted from the failure of the WWTP to meet the NPDES permit limits, resulting in degradation of Conneaut Creek. After evaluating a variety of alternatives, the city upgraded the WWTP. eliminated a combined sewer overflow (CSO), and rehabilitated existing sanitary sewers. Improvements to the WWTP and portions of the collection system were made between 1987 and 1992. The loan amount was $2,580,000, combined with a Community Development Block Grant in the amount of $93,000.

The Conneaut WWTP was constructed in 1954 with a design capacity of 2.5 million gallons per day (MGD). It was expanded in 1973 and upgraded in 1987-88 to meet NPDES permit requirements. The WWTP improvements required to comply with the permit limitations were a new 300,000 gallon equalization basin; a new 20,000 cubic foot sludge holding tank; two (2) primary settling tank mechanisms; one (1) communicator; one (1) grit tank mechanism; and modifications to the headworks digester control building, and the service building. The current plant is an activated sludge treatment facility with an average daily flow (ADF) capacity of 5.0 MGD. The WWTP discharges to the mouth of Conneaut Creek at RM 0.30. However, the WWTP is considered to be a Lake Erie discharge.

Gravity sewers and force mains were installed in the previously unsewered areas of East Conneaut, Gateway Avenue, and West Main Road over the past ten years. Runoff from this area flows into Conneaut Creek. The final phase of East Conneaut sewer installation is slated to begin in early 2000.

Indicator 1

A 1988 permit document indicates that $CBOD_5$ and ammonia-nitrogen in the WWTP effluent were found at low concentrations. Monthly averages for BOD_5, $CBOD_5$, and TSS were always found to be lower than 10 mg/L; ammonia levels were below 4.0 mg/L and heavy metals were found in varying concentrations. The 95th percentile confidence interval values for cadmium, total chromium, lead, nickel, and mercury were all above the levels mandated by their permit.
Comparative pollutant removal levels for TSS and $CBOD_5$ are shown below.

POLLUTANTS REMOVED AT CONNEAUT WWTP				
SAMPLING PERIOD (1 YEAR)	POUNDS OF $CBOD_5$ REMOVED (daily average)	% $CBOD_5$ REMOVED	POUNDS OF TSS REMOVED (daily average)	% TSS REMOVED
PRE-PROJECT (beginning 1/86)	no data	no data	1,421	96
POST-PROJECT (beginning 11/94)	1,266	97	1,362	97
CHANGE	can't determine	can't determine	-59	1

TSS and $CBOD_5$ concentrations were not the causes of NPDES permit violations that triggered the WWTP upgrade. The table above reflects that these parameters were being removed at an acceptable level.

The 1997 Grand and Ashtabula River Basin Technical Support Document indicates that the water quality of Conneaut Creek (RM 23.1) is good with no exceedance of any of Ohio's Water Quality Criteria with the exception of one dissolved oxygen reading (possibly attributable to low follow conditions observed during the sampling period). Nutrient concentrations in Conneaut Creek at this location were very low. This sampling location provides information concerning the unsewered portion of the city, but is too far away from the WWTP effluent to provide information regarding the plant.

Indicators 4& 5

VILLAGE OF CONNEAUT			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
CONNEAUT CREEK OH93 3	CWH	HIGH-VERY HIGH	ERIE-ONTARIO LAKE PLAIN

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1987	0.00	0.00	0.00	6.40	17.43
1989	22.33	1.00	0.00	0.50	0.00
1995	22.53	0.00	0.30	0.00	0.00

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as High, Moderate, Slight, or Threats)

Source	Magnitude 1987	1989	1995
Municipal Point Sources	H	-	-
Urban Runoff/Storm Sewers(NPS)	S	-	-
Landfills	S	-	-
Contaminated Sediments	S	-	H
Spills	-	S,T	-
Dredging	-	-	H
Streambank modification/ destabilization	-	H	H

Cause	Magnitude 1987	1989	1995
Organic enrichment/DO	S	-	-
Metals	H	-	-
Other habitat alterations	-	H,T	H
pH	-	S,T	-

The monitoring comments are sparse for this segment and do not elaborate on the sources of impairment. The chemical data above indicates that high metals concentrations (also reflected in the cause column above) is the component of WWTP effluent causing impairment. There is a correlation between the completion of the CWSRF-funded Conneaut WWTP improvements and the disappearance of the "Municipal Point Source" of impairment. A corresponding improvement in water quality is evident as can be seen in the use attainment table above.

Conneaut continues to receive CWSRF funding for collection system upgrades and repairs, and for construction of sewers in the eastern part of the city where failing on-lot systems create a potential health hazard. It is interesting to note the disappearance of the urban runoff/storm sewers (nonpoint) source of impairment and organic enrichment/low DO cause of impairment as these projects progressed.

Indicator 6
There is insufficient information to look at this indicator. The only ambient stream values available are for 1975-77 where the fecal coliform count was 1,217 per 100ML. The site downstream from the WWTP was not comparable due to the influence of Lake Erie.

According to the Environmental Assessments for the east Conneaut area, the local health department has records of failing on-lot systems and corresponding localized high fecal coliform levels in puddles and ditches in the area.

14. CITY OF PARMA HEIGHTS (completion date 8/1/96)
location: Cuyahoga County, latitude 41`23' 04" N, longitude 81`45' 36" W

Indicator A
This project involved connecting 28 homes with failing on-lot systems to a centralized collection system. The health department in the area determined these systems to be inadequate and undersized. Water quality sampling conducted by the health department indicated water quality violations from area catch basins and storm sewers. The surrounding area is served by a centralized collection system.

The loan amount from the CWSRF was $218,870 with the remainder of the project costs coming from assessments.

Indicators 4& 5

PARMA HEIGHTS COLLECTION SYSTEM			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
BIG CREEK OH89 5	WWH	MODERATE - HIGH	ERIE-ONTARIO LAKE PLAIN

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1984	0.00	0.00	0.00	8.40	3.6
1991	0.00	0.00	0.00	1.00	11.00
1996	0.00	0.00	0.00	8.00	4.00

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as **H**igh, **M**oderate, **S**light, or **T**hreats)

	Magnitude				Magnitude		
Source	**1984**	**1991**	**1996**	**Cause**	**1984**	**1991**	**1996**
Industrial Point Sources	M	-	-	Organic enrichment/DO	H	H	H
Urban Runoff/Storm Sewers(NPS)	H,S	-	M	Metals	M	-	-
Combined Sewer Overflows	H	-	H	Oil and grease	S	S	M
Spills	-	-	S	Flow alteration	-	-	M
Other	-	-	M	Cause Unknown	-	S	S

The monitoring comments indicate that in 1984 there was one fish kill (129 fish) caused by sewage. Extensive sludge deposits were also noted. Subsequent monitoring noted improving conditions in the water quality, but urban runoff and spills continue to be a major problem in the basin. Sanitary sewer overflows had been recorded but many of these were due to breaks or blockages. Oil contamination from a research oil company was also suspected to impact water quality.

The evidence suggests that the CWSRF-funded project helped improve water quality, but such a small project in a stream segment with many sources of impairment did not make a large enough improvement to bring this segment into attainment.

Indicator 6.
There is no information available to evaluate this indicator.

15. HARDIN COUNTY LANDFILL (completion date 11/15/95)
location: Hardin County, latitude 40`39' 00" N, longitude 83`38' 30" W

The Hardin County Sanitary Landfill is a 17 acre landfill on a 200 acre tract owned by Hardin County and located about two miles west of Kenton. The Scioto River forms the southern boundary of the site and is identified by USEPA river reach number 05060001-035. The southern limits of solid waste placement are about 200 feet from the Scioto River's current channel. The western boundary of the site is wooded with an intermittent stream tributary to the Scioto River.

Indicator A
This project involved planning, engineering, and construction for final closure of the Hardin County Sanitary Landfill. Documented groundwater contamination has been noted in the uppermost aquifer since 1989. The landfill is also thought to be a source of stream litter and other nonpoint sources of pollution to the Scioto River.

Under Findings and Orders issued by the Director of the Ohio EPA, Hardin County developed the *Hardin County Sanitary Landfill Closure Plan*. Among other things, the approved closure/post-closure plan provided for:

- construction of a cap over the landfill to prevent storm water infiltration;
- construction of a leachate collection system to remove leachate from the landfill;
- implementation of storm water and erosion control measures to maintain the integrity of the cap system and prevent site run-off from adversely impacting the surrounding environment.

The Scioto River downstream from the landfill, between Panther Creek and the Little Scioto River, was identified in the 1990 Nonpoint Source Assessment as being impaired by nonpoint sources of pollution.

The CWSRF loan amount for this project was $971,500.

Indicator 1
Ambient water quality showed no violations of Ohio Water Quality Standards from Hardin County Landfill in 1984 or 1995. Water quality parameter concentrations were similar to or less than concentrations noted upsteam indicating no impact from the county landfill with the exception of abundant stream litter.

Indicators 4& 5

HARDIN COUNTY LANDFILL, RM 213.90			
AFFECTED WATERBODY(S)	AQUATIC LIFE USE DESIGNATION	RESTORABILITY	ECOREGION
SCIOTO RIVER OH34 24	WARMWATER HABITAT	LOW	EASTERN CORN BELT PLAIN

AQUATIC LIFE USE ATTAINMENT IN RIVER MILES					
SAMPLING YEAR	FULLY ATTAINED	THREATENED	PARTIALLY ATTAINED	NOT SUPPORTING	NOT ASSESSED
1984	0.00	0.00	3.60	8.40	12.93
1995	8.63	0.00	16.30	0.00	0.00

SOURCES AND CAUSES OF IMPAIRMENT
(magnitudes are indicated as High, Moderate, Slight, or Threats)

Source	Magnitude 1984	Magnitude 1995	Cause	Magnitude 1984	Magnitude 1995
Municipal Point Sources	H	-	Organic enrichment/DO	H	-
Channelization	M	H	Other habitat alterations	M	H
Pasture land	S	-	Siltation	-	M
Nonirrigated crop production	S	M			

The monitoring comments do not name Hardin County Landfill as a source of impairment to this segment either in 1984 or in 1995. The 1984 comments mention channelization, row crops, pastures and the McGuffy WWTP as being sources of impairment while the 1995 causes named channelization and nonirrigated crop production. The more recent monitoring describes the surface water quality as good, noting that channelization is a problem for the fish community. Capping this landfill had no immediately apparent water quality improvement based on surface water monitoring results. Nonpoint source pollution from the site may be characterized as siltation which is listed as a moderate cause of impairment. In any case, the project description does describe erosion and runoff prevention activities that almost certainly resulted in some reduced nonpoint source pollution to the surface waters from the landfill site.

Indicator 6.
The goal of this project was to mitigate a known source of groundwater contamination and probable source of surface water pollution. Before the CWSRF-funded project, water ponded on the landfill and percolated through the waste and entered ground water and drainage ditches to the Scioto River. The contamination posed a possible threat to a drinking water and human health. Quarterly groundwater monitoring results at the site have documented groundwater contamination in the uppermost aquifer since at least 1989. The source of the contamination, which appears to be confined to the uppermost aquifer, is believed to be landfill leachate.[9] The limited extent of the groundwater contamination may be due, in part, to the presence of a bottom confining layer and the low density of the observed contaminants (i.e., the contaminants tend to float on the surface of the water table). Capping the landfill decreased the human health risks by reducing the potential for direct exposure to the fill and leachate. It also reduced the amount of potential leachate entering the groundwater. Recent information indicates that more may need to be done at this site to protect groundwater.

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[9]Leachate is liquid that has either come in contact with or been released from solid waste. Leachate formation commonly results from the infiltration and percolation of precipitation through the solid waste mass. Once formed, leachate may emerge at the surface as seeps or springs or continue to percolate downward, posing a threat to groundwater.

Appendix G. Ohio EPA Biological Indicators

Biological Indicators

Biological indicators are features of the aquatic ecosystem that demonstrate the health and vitality of the ecosystem. There are three indices that Ohio EPA uses to assess the health of the biological community and determine <u>aquatic life use designations</u>. These are the index of biological integrity (IBI), the modified index of well being, (MIwb) and the invertebrate community index (ICI). These may be referenced in other sections of the 305(b) or in various monitoring or technical support documents.

* Index of Biological Integrity
* Invertebrate Community Index
* Modified Index of Well Being
* Making Sense of the Indices

Index of Biological Integrity (IBI)

The index of biological integrity is a measure of fish species diversity and species populations. The criteria used to establish the index for each of the five ecoregions reflects the biological performance exhibited by natural or least impacted habitats of each region based on specific reference sites. The index is a number that reflects total native species composition, indicator species composition, pollutant intolerant and tolerant species composition, and fish condition. Combined, the higher the calculation, the healthier the aquatic ecosystem; conversely, the lower the index, the poorer the health of the aquatic ecosystem. The highest score is 60.

Invertebrate Community Index (ICI)

The invertebrate community index is based on measurements of the macroinvertebrate communities living in a stream or river. It is particularly useful in evaluating stream health because: (1) there are a wide variety of macroinvertebrate taxa, which are known to be pollutant intolerant; and (2) there are a number of macroinvertebrate taxa, which are known to be pollutant tolerant. Like the IBI, the ICI scale is 0 to 60 with higher scores representing healthier macroinvertebrate communities and therefore more biologically diverse communities.

Modified Index of Well Being (Miwb)

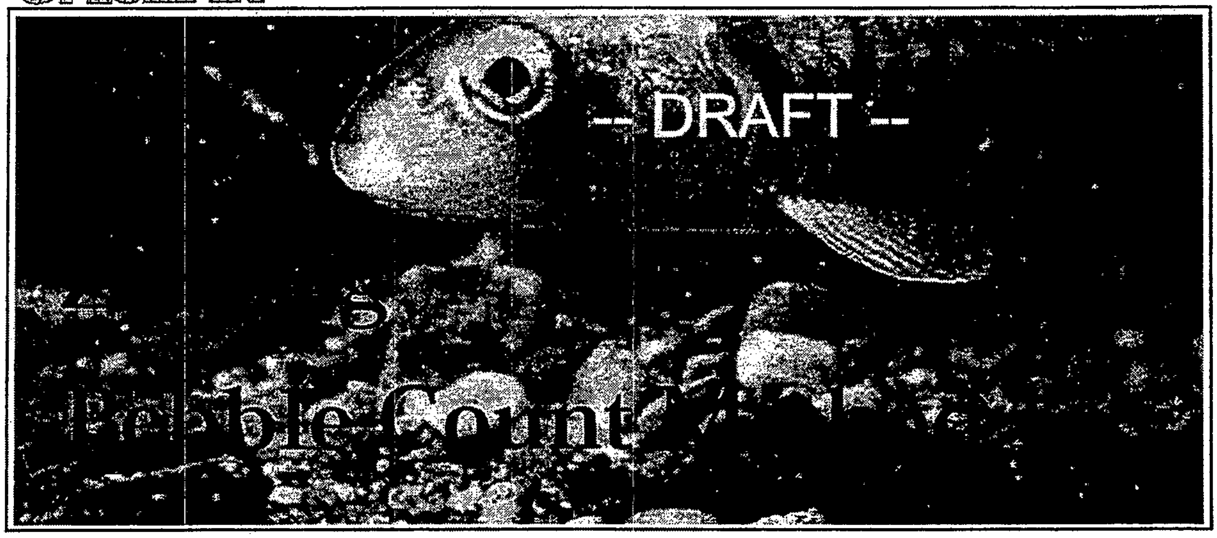
The modified index of well being is based upon the index of well being, which is a calculation of fish mass and density. The *modified* index of well being factors out 13 pollutant tolerant species of fish from certain calculations. This prevents false high readings on polluted streams which have large populations of pollutant tolerant fish.

Making Sense of the Indices

The Ecological Assessment Unit at Ohio EPA uses these indices, in concert with other chemical and physical water quality data to evaluate the use attainment of particular stream segments. When these three biological indices are evaluated together or in pairs, we can lea things about the water quality picture which may not be evident from examining one index alone. For example, if a high IBI is coupled with a low MIwb, it might indicate that while there a variety of species and a good number of individuals of each species (high IBI) individual members of these species are smaller than what is expected. This might indicate that while fi are numerous, they are not maturing fully. In turn, this information could be useful in determining which pollution source is impacting the biological community more than others. F example, thermal increases caused by effluent from wastewater treatment plants could contribute to poor maturation of fish fry. This is just one of many explanations that might be true, depending on other environmental factors.

Appendix H. Ohio EPA Sampling Fact Sheet

OhioEPA

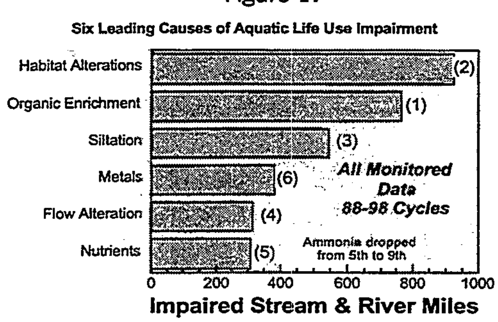


Introduction

Ohio EPA has begun to collect more data related to the effects of sedimentation on aquatic life in streams and rivers. Sedimentation is the third leading cause of impairment to aquatic life in Ohio and is a problem that is prevalent in all areas of the state. Ohio EPA is attempting to increase its focus on innovative ways to remediate these conditions and more sensitive ways to assess stresses on aquatic life from excess fine sediment in streams and rivers.

In geomorphologically stable streams, input of fine materials that naturally erode into the stream is generally balanced by the export of such materials. The median particle size in a unimpacted stream in Ohio is typically coarse (gravel, cobble, sometimes boulders). These sizes are typically associated with high quality biota and stream habitats. As erosion increases in a watershed, either from surface runoff and/or bank erosion, the percent of fine materials in the stream bottom can increase, fill pools and embed the larger diameter substrates. These conditions are frequently reflected in the aquatic biota that inhabitant the stream and by attributes of the QHEI substrate metric. Even at the visual resolution of the QHEI substrate metric and attributes the effects of fine sediments on aquatic life can be substantial (see Figure 2). With an increased need to focus on NPS impairments to meet strategic management goals and to effectively address TMDL issues there is a need for some more sensitive tools to measure NPS stressors like fine sediment. Such tools could be used to establish targets and measure incremental progress after the establishment of BMPs or to detect deviation from reference conditions in streams in rapidly developing area.

Figure 1.



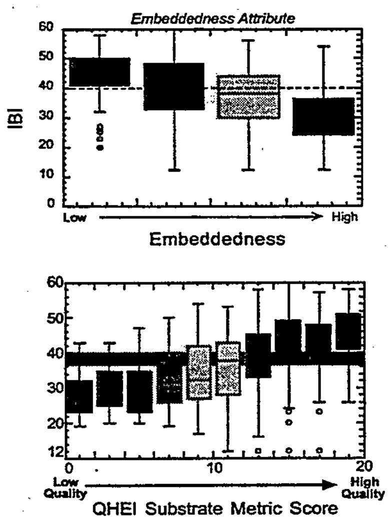


Figure 2. Relationship between IBI and measures of substrate quality as measured by the QHEI.

Pebble Counts

A pebble count is commonly used to sample the surface particle size distribution of gravel-bed rivers. Wolman first developed the method back in the 1950s (Wolman 1954). Our goal here is to accumulate a database of reference site pebble counts (least impacted and habitat impacted) for assessing the utility of these methods for identifying areas with excess erosion.

Methodology.

The pebble count method that we are using is the "Zig-Zag" pebble count (Bevenger and King 1995). The concept is to get an estimate of the distribution of substrates on the surface of the stream bottom by size category. The length of stream we assess is equivalent to the length sampled for a fish sample (i.e., headwater: 150 m, wadeable: 200 m, boat 500 m). Most sites will be in wadeable streams. Start at the downstream end of the sampling zone and pick a point up and across the stream (e.g., tree) at an acute angle. On every third pace or so, bend down and without looking pick the first particle that touches your finger at the tip of your boot. It is important to not look so as not to bias your selection. You also want to pick a specific spot on your finger for situations where your finger touches more than one piece simultaneously. Using the "whole hand" to reach down to initially select a substrate piece can seriously underestimate fines. Care must also be taken that your hand does not "float downstream" where it might touch a larger piece before it hits the stream bottom. Three or more paces (~7 feet) are taken between stones to reduce the potential for autocorrelation. For very small streams this distance can likely be reduced (one long or several short paces).

Pick up that piece and measure its intermediate axis (see Figure 3) in mm Thinking of the piece as a flattened ellipsoid the intermediate axis is not the short, flat axis (b) or the long axis (a), but rather the middle or intermediate axis (c). To be consistent you measure the greatest length of this axis *perpendicular* to the long axis. You want to collect a minimum of 100 pieces within the zone to get a good sample. To do this, start off with a rather acute angle. With experience this can be adjusted so that a little over a 100 pieces are collected with the zone.

Note that the zig-zag pattern is done from bank full stage to bank full stage (i.e., dry and wetted part of stream). This is best done with two people with one recording and one measuring. Frequency of particles are tallied on a data sheet by habitat type (Appendix 1). Presently we are tracking whether the particle was on the dry portion of the channel, from a riffle/run area, or a pool/glide area. For particles that are embedded or too large to

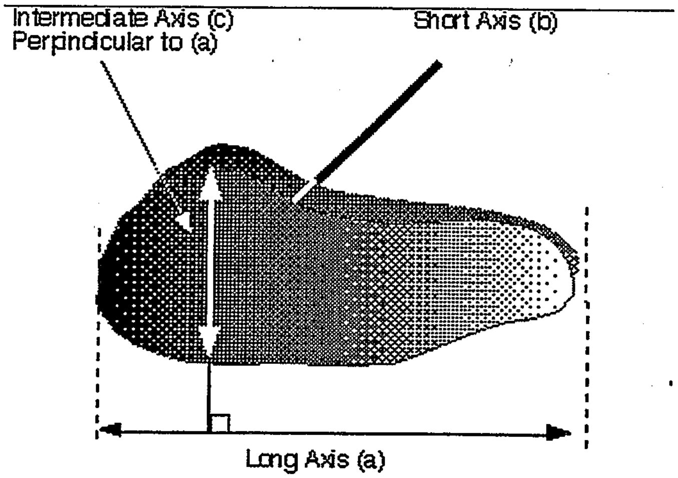


Figure 3: Diagram illustrating the correct way to measure the intermediate axis of a substrate particle. One source of error that has been identified is measuring along a facet of rock rather than along a line perpendicular to the long axis.

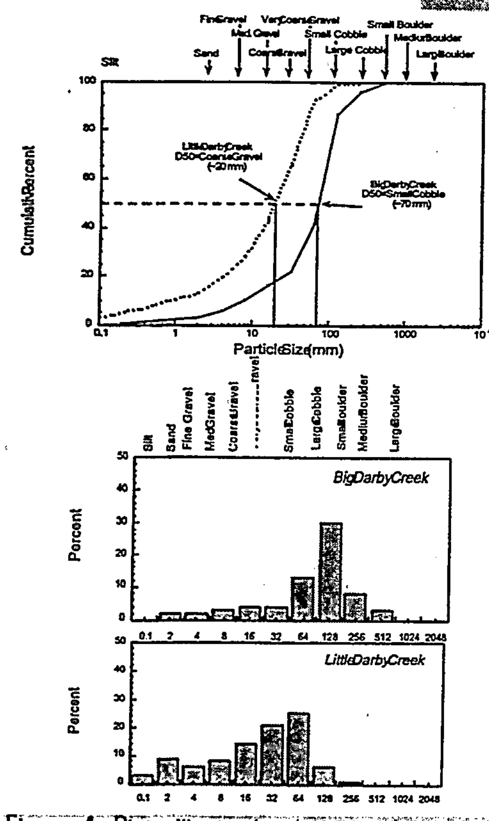


Figure 4. Plots illustrating pebble count results from Big and Little Darby Creeks

lift the intermediate axis is estimated by placing your ruler against the submerged rock or measuring with your fingers and then measuring the span of your fingers. At about 10% of the sites a replicate should be taken to estimate within-site variation.

In addition to the pebble count, the field sheet also has spaces to record data to perform a Rosgen stream classification. At this point, this is not a requirement of the pebble count methodology, but it may be useful for classifying natural streams with natural differences in substrates.

Applications

There will be multiple applications investigated that may use this data. Aggregated at a watershed scale, median particle sizes may be able to identify subwatersheds constributing the most sediment to downstream, impaired or threatened waterbodies. Paired with biological and QHEI data at reference sites, this data may provide more precise predicitive relationships between the biota and substrate conditions. Such relationships have been documented in a number of studies (White and Merritt 1998;) At sites with NPS TMDL targets (e.g., sediment reuction) median particle size or some other statistic of percent fines can be use to test the effectiveness of various BMPs (e.g., bank restoration, establishment of no till plots, etc.,).

Accuracy

Although collection of a pebble count is not resource intensive, like any field technique it takes training and ability improves with experience. Some papers are referenced that should prove useful in improving sampling techniques.

Important Definitions:

Bankfull Stage - "The bankfull stage corresponds to the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphological characteristics of channels (Dunne and Leopold 1978 cited in Rosgen 1995)." The importance for us is that these levels move the most sediment downstream. We measure the "dry" channel within the bank full dimensions to provide a estimate of the material being exported downstream. Some visual indictors of bank full stage (Rosgen 1995) that may prove useful in Ohio include: (1) elevation at the top of the highest depositional features (e.g., point & central bars), (2) a break in the slope of banks or a change in the particle size distribution (finer materials dropping out at overflows), (3) presence of inundation features such as benches, (4) staining of rocks or bridge abutments, (5) roothairs exposted below an intact soil layer, and (6), especially in small wooded streams, lichens. Be careful not to characterize terraces from previous longer term fliods or under different climatic conditions as bankfull. Also some vegetation (e.g., grasses) that can quickly colonize areas can be misleading as bankfull indicators. The bank full is typically about the 1.2 year reccurence interval for Ohio streams.

Intermediate Length - For pebble counts this is not the shortest (c) axis or longest measurement (a axis), but is taken at the middle length (b-axis) that is perpendicular to the longest axis. "Since most streambed particles approximate ellipsoids, the b-dimension is an acceptable predictor of nominal diameter. The nominal diameter is defined as the diameter of a sphere with the same volume and thus corresponds to sieve size. This in turn makes it possible to determine particle size frequency distribution from the b-axis alone."

Size of substrate categories used in the zig-zag pebble count (standard Wentworth sizes classes)

Intermediate Diameter	Class
	Silt
< 2 mm	Sand
2-3.9 mm	Very Fine Gravel
4-7.9 mm	Fine Gravel
8-15 mm	Medium Gravel
16-31 mm	Coarse Gravel
32-63 mm	Very Coarse Gravel
64-127 mm	Small Cobble
128-255 mm	Large Cobble
256-511 mm	Small Boulder
512-1023 mm	Medium Boulder
> 1024 mm	Large Boulder
-	Bedrock
-	Clay Hardpan
-	Detritus/Wood
-	Artificial (Concrete Rip/Rap)

References

Bevenger, G.S. and R.M. King . 1995. A Pebble count Procedure for Assessing Watershed Cumulative Effects. Research Paper RM-RP-319. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Idaho DEQ . 1997. 1997 Beneficial use reconnaissance project workplan. Idaho Dept. of Environmental Quality, Watershed Monitoring & Analysis Bureau, Boise, Idaho

Kondolf, G.M. 1995. Discussion: Use of pebble counts to evaluate fine sediment increase in stream channels. Water Resources Bulletin 31(3): 537-538

Kondolf, G.M. and S. Li. 1992. The pebble count technique for quantifying surface bed material size in instream flow studies. Rivers 3(2): 80-87.

Marcus, W. A., Ladd, S. C., Stoughton, J. A. and J. W. Stock. 1995. Water Resources Research 31(10): 2625-2631.

Rosgen, D. 1996. Applied River Morphology. Wildlands Hydology, Pagosa Springs, CO, USA

White, J. and G. Merritt. 1998. Evaluation of R-EMAP techniques for the measurement of ecological integirty of streams in Washington state's coast range ecoregion. Environmental Monitoring and Assessment 51: 345-355.

Wolman M. G. 1954. A method for sampling coarse river-bed material. Transactions of the American Geophysical Journal 35(6): 951-956.

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River Code:______________ River/Stream:________________________________ RM:_______

Date:______________ Location:____

Investigator:______________________________ Rosgen Channel Type: ______________

Zig/Zag Pebble Count

Particle Size Range (mm)	Total (Dry) Channel	Total (Wetted Channel) Riffle	Run	Pool	Glide	%	Cum%
Silt							
Sand (< 2)							
V Fine Gravel (2-3.9)							
Fine Gravel (4-7.9)							
Medium Gravel (8-15)							
Coarse Gravel (16-31)							
V Coarse Gravel (32-63)							
Small Cobble (64-127)							
Large Cobble (128-255)							
Small Boulder (256-511)							
Medium Boulder (512-1023)							
Large Boulder (> 1024)							
Bedrock							
Clay Hardpan							

Bank Full Width: ________ Bankfull Max Depth: ________ Channel Slope ________

Bank Full Mean Depth ________ Flood Prone Area Width: ________ Valley Slope: ________

Width/Depth Ratio ________ Entrenchment Ratio ________ Sinuosity ________