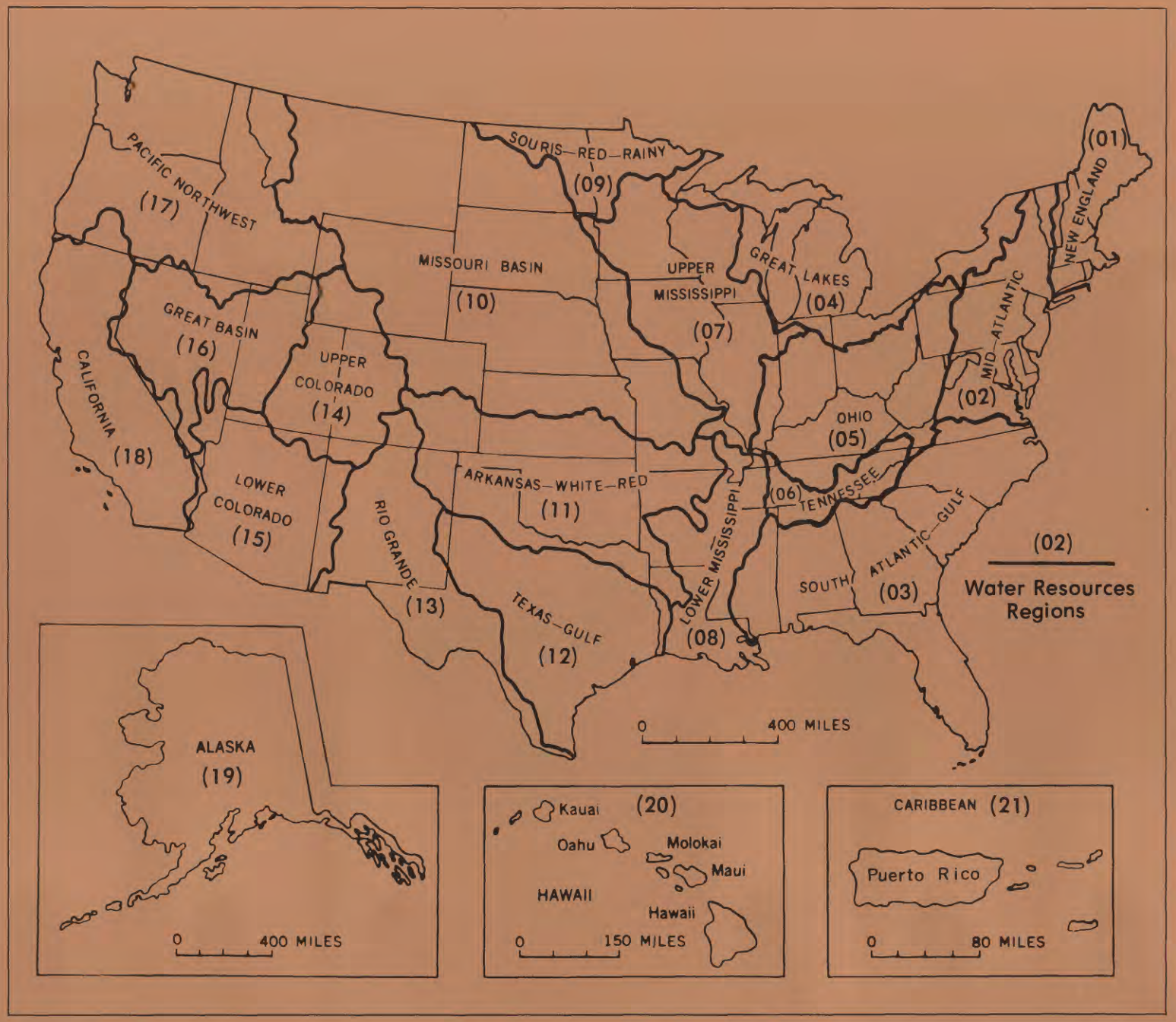
INTERAGENCY ADVISORY COMMITTEE ON WATER DATA

NOTES ON SEDIMENTATION ACTIVITIES CALENDAR YEAR 1985

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division
Office of Water Data Coordination
417 National Center
Reston, Virginia 22092



Water Resources Regions of the United States

NOTES ON SEDIMENTATION ACTIVITIES CALENDAR YEAR 1985

the
Subcommittee on Sedimentation
of the
INTERAGENCY ADVISORY COMMITTEE ON WATER DATA

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division
Office of Water Data Coordination
417 National Center
Reston, Virginia 22092

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PREFACE

This report is a digest of information furnished by Federal agencies conducting sedimentation investigations. The decision to publish the report was made in 1946, from a proposal by the Chairman of the Federal Interagency River Basin Committee, Subcommittee on Ground Water. The subcommittee approved the proposal and agreed to issue this report as a means of effecting better coordination of the work of various Federal agencies in the field of sedimentation. From 1946 to 1947, the report was issued on a quarterly basis; from 1948 to 1953, reports were issued every 6 months; and from 1954 to the present, the report has been issued annually.

Descriptions of work in progress or planned are included in the report, as well as important findings, new methods, new publications, information relating to laboratory and research activities, and other pertinent information. The material is organized by major drainage regions in the conterminous United States, Alaska, Hawaii, and the Caribbean.

Until 1979, each issue of this publication contained a list of stations where sediment data are collected, giving the station location, drainage area, and other related information. Because the station list did not change significantly from year to year, it was eventually deleted from the publication. Also, because most users of the station list were only interested in the stations in a certain geographic area, it was felt that their needs could be served more efficiently by acquiring the necessary information through the National Water Data Exchange (NAWDEX). Therefore, locations and addresses of NAWDEX assistance centers are included in this report.

Information for "Notes on Sedimentation Activities, Calendar Year 1985" was contributed by the representatives of participating Federal agencies. Suggestions for improving the report are welcome.

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OFFICE CONTACT: Janet Wiley

SERVICE CHARGES

Charges for NAWDEX services are assessed at the option of the organization providing the requested data or data service. Search assistance services are provided free by NAWDEX to the greatest extent possible. Charges are assessed, however, for those requests requiring computer services, extensive personnel time, duplicating services, or service costs accrued by NAWDEX from other sources in the course of providing services. In all cases, charges assessed by NAWDEX Assistance Centers will not exceed the direct costs incurred in responding to the data request. Estimates of cost are provided by NAWDEX upon request and in all cases where costs are anticipated to be substantial.

ADDITIONAL INFORMATION

For additional information concerning the NAWDEX program or its services, contact:

Program Office
National Water Data Exchange (NAWDEX)
U.S. Geological Survey
421 National Center
12201 Sunrise Valley Drive
Reston, VA 22092

Telephone: 703/860-6031
FTS 928-6031

NEW ENGLAND REGION

GEOLOGICAL SURVEY

St. John Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Aroostook River at Caribou, ME, and bimonthly at St. John River near Van Buren, ME, as a part of the National Stream Quality Accounting Network (NASQAN).

Penobscot Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Penobscot River at Eddington, ME, as a part of NASQAN.

Kennebec Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Kennebec River near North Sidney, ME, as a part of NASQAN.

Androscoggin Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Androscoggin River at Brunswick, ME, as a part of NASQAN.

2. Suspended-sediment data are being collected on a quarterly basis at Wild River at Gilead, ME, as a part of the National Hydrologic Benchmark Network.

Maine Coastal Subregion

1. Suspended-sediment data are being collected on a quarterly basis at St. Croix River at Milltown, ME, and bimonthly at Narraguagus River at Cherryfield, ME, as a part of NASQAN.

Saco Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Saco River at Cornish, ME, and at Presumpscot River near West Falmouth, ME, as a part of NASQAN.

Merrimack Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Merrimack River above Lowell, MA, as a part of NASQAN.

Connecticut Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Connecticut River at Wells River, VT, and at Connecticut River at North Walpole, NH, and at Connecticut River at Thompsonville, CT, as a part of NASQAN.

2. Suspended-sediment data are being collected on approximately a daily basis at Stony Brook near Suffield, CT, Salmon River near East Hampton, CT, and Coginchaug River at Rockfall, CT, to determine daily sediment loads. The data collection is being done in cooperation with the State of Connecticut Department of Environmental Protection.

Massachusetts-Rhode Island Coastal Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Charles River at Dover, MA, at Blackstone River at Millville, MA, and at Pawcatuck River at Westerly, RI, as a part of NASQAN.

Connecticut Coastal Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Housatonic River at Stevenson, CT, and quarterly at Shetucket River at South Windham, CT, and at Quinebaug River at Jewett City, CT, as a part of NASQAN.

St. Francois Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Black River at Coventry, VT, as part of NASQAN.

Special Studies

1. Daily suspended-sediment sampling began in June 1985 at Housatonic River near Kent, CT, in the Connecticut Coastal Subregion, as part of a study to determine the rate and methods of PCB transport in the river. The study is being conducted in cooperation with the State of Connecticut Department of Environmental Protection.

For additional information about Geological Survey activities within this region, contact the following office:

District Chief, WRD
U.S. Geological Survey
150 Causeway Street, Suite 1309
Boston, MA 02114

SOIL CONSERVATION SERVICE

1. Studies of sediment damages and determinations of sediment yields were made in the following watersheds:

   a. Public Law 566.

Major Drainage	Watershed	Stream	County	State
Penobscot	Kenduskeag	Kenduskeag	Penobscot	Maine
St. Johns	Perley Bridge	Perley Bridge	Aroostock	Maine
Naragansett Bay	Aquidneck Island		Newport	Rhode Island

   b. River Basin Investigations

Major Basin	Basin Reported	State
Farmington	Clam River	Massachusetts
St. Johns	Central Aroostock Co.	Maine

2. Reservoir Sedimentation Surveys.

   A reservoir sedimentation survey was made on the following reservoir:

Reservoir	County(s)	State
North silver	Berkshire	Massachusetts

3. Special Studies.

   a. A special study of gullies on cropland caused by snow melt is being carried out on 8,000 acres in Presque Isle Twp., Aroostock County, Maine. Information gathered includes: frequency of occurrence, size, soil loss, and crop management practices that protect the soil or allow gully formation.

   b. A study similar to the gully study in Maine was conducted on Aquidneck Island, Rhode Island.

MID ATLANTIC REGION

CORPS OF ENGINEERS

North Atlantic Division

Baltimore District

Sedimentation Surveys - Reservoir

1. Almond Lake. A sediment survey was conducted at Almond Lake in November 1985. The method of survey was volumetric rather than the more conventional transit survey.

The lake was filled from normal summer pool elevation 1255 ft msl to elevation 1270 ft msl. Filling began on 17 October 1985 and elevation 1270 ft msl was reached on 13 November 1985. The lake was then put into a steady fall. The lake was dropped to elevation 1240 ft msl. The thirty foot drawdown required six (6) days (19 Nov - 24 Nov). Inflow and outflow were measured each time the lake fell one foot. The data will give information on the real amount of storage released during the time period. This can be compared to the volume calculated from the present storage curves with the difference representing the storage lost to sedimentation. The data will be analyzed in January 1986.

2. Bloomington Lake. Additional studies to quantify the sediment accumulation problem were initiated in late December 1985 and will be completed in early 1986. A reconnaissance surey will be conducted in areas of the reservoir exposed by the winter drawdown. A limited number of cross sections will be taken in these exposed areas to better determine sedimentation rates. No survey concurrent with this effort is planned for underwater ranges. The data will be analyzed early in 1986.

Sediment Removal

Project	Stream	Removal Location	Amount Removed (cu. yds.)
Almond Lake, NY	Canacadea Creek	NY Rt. 21 Branch	2379
Arkport Dam, NY	Canesteo River	Intake channel	5290
		Paved Outflow Channel	70
Canesteo, NY	Purdy Creek	Confluence of Bennett Cr.	2500
		Check Dam	3060
Corning, NY	Cutler Creek	Upper channel and drop structures	227
		Outlet of twin conduits to Chemung River	285
		Bucket of twin conduits	156
Hornell, NY	Canesteo River	Channel from Cedar Creek to Cosby Creek	2203

Chauncey Run	Chauncey Run Check Dams	250
	Confluence of Chauncey Run and Canesteo River	220
Cosby Creek	Check Dam	2414
	Check Dam bucket and Channel below check dam	463
	TOTAL	19517

Sediment Studies

1. Reservoirs. Cowanesque Lake. A sediment study was conducted for Cowanesque Lake in 1985. The study was to determine the effects on sediment storage due to the proposed permanent pool of El. 1080 ft msl.

A sediment rating curve was developed for the stream gage located at Lawrenceville, PA. This curve was then used to determine the total basin sediment yield of 128 tons/mi^2/yr. The total basin sediment yield was then converted to an estimate of the total sediment deposited in the lake for a 100 year project life. A trap efficiency of 0,91 was used. The total sediment deposited for 100 years was calculated to be 2,300 AC-FT.

Once the quantity of sediment which will be deposited in the lake was established, the next step in the evaluation was to determine how the deposits were distributed in the reservoir. Several distribution methods were utilized including empirical methods such as the Empirical-Area-Reduction Method, the Area-Increment Method and the Pool-Elevation-Duration Method. The generalized computer program HEC-6 was investigated and was deemed inappropriate for this evaluation.

The method adopted for sediment distribution at Cowanesque Lake was the Empirical-Area-Reduction Method. The method recognizes that distribution of sediment is dependent on (1) reservoir operation, (2) texture and size of sediments, (3) shape of reservoir and (4) volume of sediment deposited. It is widely used by the Corps of Engineers and the Bureau of Reclamation for distribution of sediment in reservoirs.

The results of this analysis and the original data are presented below.

Recalculated Data:

a. Total Sediment Deposited = 2,300 AC-FT

b. Total Sediment Deposited Above 1080 ft. msl (30%) = 690 AC-FT

c. Total Sediment Deposited below 1080 ft. msl (70%) = 1,610 AC-FT

Original Data (from original water supply contract):

a. Total Sediment Deposited = 1,950 AC-FT

b. Total Sediment Deposited above 1080 ft. msl (63.3%) = 1,235 AC-FT

c. Total Sediment Deposited below 1080 ft. msl (36.7%) = 715 AC-FT

2. Channels. Canesteo River, Chauncey Run, Cosby Creek, and Canacadea Creek, Hornell, NY. A hydraulic and sedimentation study was forwarded to Baltimore District in 1984 and was reviewed and analyzed in 1985. The conclusions reached were that although there were considerable amounts of sediment in the channels, the backwater problem being experienced was due to a State of NY causeway and bridge. An additional finding was that the hydraulic capacity of the channels free of any sediment was still not as great as previously thought. No action has been taken to date other than disclosure of the study findings.

New York District

The District conducted sediment tests at the following locations:

Project Name & Number	Grain Size	Bulk Sed.	Elu-triate	Con-solid-ation	Micro-biolog-ical	Bio-Assay	Bio-accum-ulation
Newark Bay-64							
Main Channel	X	X	X			X	X
South Reach	X	X	X			X	X
Off Channel	X	X	X			X	X
Kill Van Kull-63							
entrance	X	X	X			X	X
Sandy Hook Bay							
U.S. Navy	X	X	X			X	X
Sheepshead Bay-31							
Federal Chan-nel	X	X	X			X	X
Kingsboro College	X	X	X			X	X
Mud Dump Site	X						
WES Mgt Study							
Newark Bay	X	X	X	X	X		
Passaic River	X	X	X	X	X		
Hackensack Riv.	X	X	X	X	X		
Arthur Kill North	X	X	X	X	X		
Kill Van Kull	X	X	X	X	X		
Newtown Creek	X	X	X	X	X		
Arthur Kill South	X	X	X	X	X		

Raritan Bay					
West	X	X	X	X	X
Raritan Bay					
East			X		X
Upper Bay, NY			X		X
Flushing Bay			X		X
Ambrose Channel			X		X
Bowery Bay			X		X

Philadelphia District

Sediment Load Measurements. Daily sampling continued from November 1947 to present on the Schuykill River at Manayunk, PA.

MID-ATLANTIC REGION

GEOLOGICAL SURVEY

Richelieu Subregion

1. Suspended-sediment data are being collected on a periodic basis at Richelieu River (Lake Champlain) at Rouses Point, NY, as a part of the National Stream Quality Accounting Network (NASQAN).

Upper Hudson Subregion

1. Suspended-sediment data are being collected on a daily basis at Hudson River at Stillwater, NY, and Hudson River at Waterford, NY, in cooperation with the New York State Department of Environmental Conservation. Suspended-sediment data are being collected on a periodic basis at Hudson River at Rogers Island at Fort Edward, NY, and Hudson River at Schuylerville, NY.

2. Suspended-sediment data are being collected on a periodic basis at Hudson River at Green Island, NY, as a part of NASQAN.

3. Suspended-sediment are being collected on a periodic basis at Esopus Creek at Shandaken, NY, as a part of the National Hydrologic Benchmark Network.

Lower Hudson-Long Island Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Passaic River at Little Falls, NJ, and quarterly at Raritan River at Queens Bridge at South Bound Brook, NJ, as a part of NASQAN.

Delaware Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Maurice River at Norma, NJ, and West Branch Wading River at Maxwell, NJ, and on a quarterly basis at Delaware River at Trenton, NJ, and Toms River near Toms River, NJ, as a part of NASQAN.

2. Suspended-sediment data are being collected on a monthly basis at McDonalds Branch in Lebonon State Forest, NJ, as a part of the National Hydrologic Benchmark Network.

3. Suspended-sediment data are being collected on a daily basis at Schuylkill River at Philadelphia (Manayunk), PA. The data will be anaylzed by the U.S. Army Corps of Engineers to evaluate the Delaware River dredging programs.

Susquehanna Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Susquehanna River at Danville and at Susquehanna River at Harrisburg as part of NASQAN.

2. Suspended-sediment data are being collected at Juniata River at Newport, PA, as a Federal sediment index station.

3. Suspended-sediment data are being collected on a bimonthly basis at Susquehanna River at Conowingo, MD, as a part of NASQAN and on a daily basis, beginning July 1984, as part of a Fall-Line Monitoring project.

Upper Chesapeake Subregion

1. Suspended-sediment data are being collected on a daily basis at Choptank River near Greensboro, MD, as part of the Federal Collection of Basic Records (CBR) program, Fall-Line Monitoring project, and as a part of NASQAN.

2. Suspended-sediment data are being collected on a bimonthly basis at Patuxent River near Bowie, MD, as a part of NASQAN and on a daily basis, beginning October 1984, as part of a Fall-Line Monitoring project.

Potomac Subregion

1. Suspended-sediment data are being collected on a daily basis at Monocacy River at Reichs Ford Bridge near Frederick, MD, in cooperation with the Maryland Geological Survey.

2. Suspended-sediment data are being collected on a daily basis at Potomac River at Point of Rocks, MD, as a part of the Federal CBR program.

3. Suspended-sediment data are being collected on a bimonthly basis at Potomac River at Shepherdstown, WV, Potomac River at Chain Bridge, Washington, D.C., and Shenandoah River at Millville, WV, as a part of NASQAN.

Lower Chesapeake Subregion

1. Suspended-sediment data are being collected on a daily basis on Rappahanock River at Remington, VA, as a Federal sediment index station.

2. Suspended-sediment data are being collected monthly at Rappahannock River near Fredericksburg, VA, Mattaponi River near Beulahville, VA, Pamunkey River near Hanover, VA, and James River at Cartersville, VA, as part of NASQAN and a Fall-Line Monitoring program of the Chesapeake Bay.

3. Suspended-sediment data are being collected quarterly at Holiday Creek near Andersonville, VA, as part of the National Hydrologic Benchmark Network.

4. Suspended-sediment data are being collected on a bimonthly basis at Appomattox River at Matoaca, VA, as part of NASQAN.

Special Studies

1. A study of agricultural best management practices in the carbonate region of southeastern Pennsylvania was started in the Conestoga River basin in Lancaster County, PA, during 1982. Suspended-sediment, nutrient, and pesticide data were collected during 1984 from the Little Conestoga Creek near Morgantown and near Churchtown, from a 25-acre corn and alfalfa field and from a 50-acre corn field that were selected for conservation treatment with best management practices. Automatic samplers are used at each of the sites.

2. Suspended-sediment data were collected from the Swatara Creek at two locations, above Pine Grove and at Suedberg, PA, with automatic samplers. The sediment data were collected as part of a project to determine sedimert deposition rates in a proposed reservoir.

3. Sediment data are being collected with automatic samplers from three streams in the lower Susquehanna River basin as part of a study of nutriert discharges. Samples are also obtained from an additional four streams during storms.

4. Suspended-sediment data are being collected with automatic samplers from two 200-acre agricultural basins in the noncarbonate region of southeastern Pennsylvania. The study is designed to evaluate the effects of best management practices on sediment and nutrient discharge.

5. A study to help the National Park Service develop best management practices for Prince William Forest Park in Prince William County, VA, was begun in 1983. Suspended-sediment data are being collected every other day by local observers and during storms by automatic samplers at three sites on the South Fork Quantico Creek and at one site on the Quantico Creek. Suspended-sediment data are also being collected on a monthly basis at eight other sites and on a semiannual basis at nine other sites (sediment data collection activities discontinued June 1985).

For additional information about Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
208 Carroll Building
8600 LaSalle Road
Towson, MD 21204

District Chief, WRD
U.S. Geological Survey
P.O. Box 1669
Albany, NY 12201

District Chief, WRD
U.S. Geological Survey
Room 409, Federal Building
402 East State Street
Trenton, NJ 08608

District Chief, WRD
U.S. Geological Survey
603 Morris Street
Charleston, WV 25301

District Chief, WRD
U.S. Geological Survey
P.O. Box 1107
Harrisburg, PA 17108

Chief, Virginia Office, WRD
U.S. Geological Survey
3600 West Broad Street, Room 606
Richmond, VA 23230

SOIL CONSERVATION SERVICE

1. Studies of sediment damages and determinations of sediment yields were made for work plans in the following watersheds:

   a. Public Law 534.

Major Drainage	Watershed	Stream	County	State
Potomac	Moffett Creek	Moffett Creek	Augusta	Virginia

   b. Public Law 566.

Major Drainage	Watershed	Stream	County	State
Chesapeake Bay	U. Chester River	Chester River	Kent & Queen Anne Kent	Maryland Delaware
Delaware River	Crosswicks Creek	Crosswicks & Doctors	Monmouth & Mercer	New Jersey
James River	Cripple Creek	Cripple Creek	Wythe Smythe	Virginia

   c. River Basin Investigations.

Major Basin	Basin Reported	State
New Jersey (Selected Areas)	New Jersey	New Jersey

   (A state wide analysis of erosion rates within the agricultural watersheds of western and southern New Jersey)

2. Reservoir Sedimentation Surveys.

A reservoir sedimentation survey was made on the following reservoirs:

Reservoir	County	State
Little Deer Creek	Harford	Maryland
Pretty Boy	Baltimore	Maryland
Loch Raven	Baltimore	Maryland
Liberty	Baltimore	Maryland
Martin Creek, PA 467	Susquehanna	Pennsylvania
Kaercher Creek, PA 476	Berks	Pennsylvania
Brandywine Creek	Chester	Pennsylvania
South Fork #5	Hardy	West Virginia

3. Special Studies

a. Studies of small gullies on cropland are being carried out in portions of Delaware, Pennsylvaia, Maryland, New JErsey, and Virginia. Information on lcations, frequency of occurrence, size, soil loss, and farming practices are being gathered. Analysis will be performed later.

b. Daily suspended sediment samples are being gathered on the La Platte PL-566 Watershed, Chittendon County, Vermont, to monitor the effects of land treatment measures being installed. A similar study is being carried out on the St. Alban's Bay Watershed Rural Clean Water Project, Franklin County, Vermont. Both watersheds drain into Lake Champlain.

CORPS OF ENGINEERS

South Atlantic Division

Charleston District

Coastal Shoreline Monitoring. Monitoring of coastal shoreline changes for the newly constructed weir jetty system at Little River Inlet, South Carolina, was continued during 1983. The initial 5-year monitoring program for the recently constructed weir jetty system at Murrells Inlet, South Carolina, was completed in October 1982. The anticipated report date for the Murrells Inlet Monitoring Program is May 1984. A reduced monitoring effort for a second 5-year period was continued in 1983 for Murrells Inlet. The monitoring of the projects is being performed to determine the effect that a weir jetty system has on littoral transport processes and adjacent shorelines. Data being gathered for monitoring these projects include:

a. controlled aerial photography,
b. beach profiles upcoast and downcoast of the jetties,
c. wave data,
d. hydrographic surveys of the inlet area, and
e. structural performance.

The data which is gathered on a regular basis is being forwarded to the Coastal Engineering Research Center at U. S. Army Engineers Waterways Experiment Station in Vicksburg, Mississippi, for analysis and report preparation.

Charleston Harbor Section 111 (Mitigation of Shore Damage Due to Federal Navigation Projects) Study. A Section 111 study is currently being conducted for the Charleston Harbor jetties at Charleston, South Carolina. An evaluation of the changes in the rate of beach erosion in the vicinity of the jetties is being made on the basis of historical data extracted in large from USC&GS surveys and charts. Due to the age of the jetties and various man-made alterations affecting Charleston Harbor the following time frames have beer selected for determining any changes in the rate of erosion:

a. 1851-1857 (Before construction of Charleston Harbor jetties)
b. 1860-1869 (During construction of Charleston Harbor jetties)
c. 1900-1910 (Post construction of Charleston Harbor jetties)
d. 1921 (Post construction of Charleston Harbor jetties)
e. 1963-1965 (Post construction of Charleston Harbor jetties)
f. 1985 (Post construction of Charleston Harbor jetties)

The Coastal Engineering Research Center at the U.S. Army Engineers Waterways Experiment Station in Vicksburg, Mississippi, was contracted to furnish support to the District in analyzing the historical data in a three-phase program. Phase I, completed in October 1984, was to digitize the survey

sheets for the five time periods to create a digital data base. Phase II, completed in October 1985, used the new National Ocean Service Cooperative Shoreline Movement maps to verify and adjust the vertical datum changes in the Charleston Harbor area to a common reference elevation and locate backshore topographic data for incorporation into the data base. Also, during Phase II, Charleston District obtained a current set of beach profiles at 2,000 foot intervals and oceanward to the 30-foot contour for incorporation into the data base. Phase III will involve assessing the relationships between the acts of nature and men and the rates of volumetric change with a view towards identifying culpability of the Federal Government, should it exist. The anticipated report date for this project is August 1986.

Cooper River Rediversion Project Construction of the Cooper River Rediversion Project, which will reduce shoaling and restore to some degree the historic saline regiment to Cooper River and Charleston Harbor, was completed in 1985. The project consists of a canal about 11.7 miles in length. Beginning at the northeast corner of Lake Moultrie, the canal proceeds generally eastward to a 84,000 kw hydropower plant near St. Stephen, South Carolina, and thence to its confluence with the Santee River at Mattassee Lake. The post construction monitoring of the entrance, intake, and tailrace canals included the establishment of a monumented baseline and cross sections. The cross sections in the entrance and intake canals are located approximately every 1,000 feet, while those in the tailrace canal are 500 feet apart initially to insure detection and quantification of potential erosion and bank sloughing. Additional cross sections were taken at all canal transitions and bridge crossings for a total of 114 cross sections. Seven cross sections were taken in the Santee River to monitor the effects of the project on the river. These sections are to be surveyed annually for the first three years, then again in the fifth year of operation and thereafter at five-year intervals unless conditions warrant otherwise. The first set of cross sections were taken in January and February 1985. The second annual survey will be taken in the spring of 1986.

Bank-to-bank cross sections are also being taken at 1,000-foot intervals in the Charleston Harbor (Cooper River) from Fort Sumter to Snow Point. These sections will be used to monitor sediment movement in the harbor as a result of the reduced fresh water releases into the river from Lake Moultrie. These cross sections will reveal any sloughing of navigation channel banks and will aid in determining effects on sediment deposits outside of these channels. These cross sections are to be taken annually for a five-year period. The first set of cross sections were taken in December 1984 and January 1985. The second set of cross sections are scheduled to be taken in the spring of 1986.

Suspended Sediment Sampling. Suspended sediment data is being collected by USGS on a monthly basis at three locations on the Santee River in the vicinity of St. Stephens, South Carolina where the tailrace canal of the Cooper River Rediversion project enters the Santee River.

Mobile District

Sedimentation Range Network Monitoring.

1. The sedimentation range networks in Demopolis, Gainesville, Aliceville, Columbus and Aberdeen Lakes were resurveyed during the year. These lakes are located on the Tombigbee River and are part of the Tennessee-Tombigbee Waterway.

2. A network of ranges was installed and surveyed in Lock A, B, C, D, and E Pools on the Canal Section of the Tennessee-Tombigbee Waterway.

Sedimentation Studies.

1. The sedimentation studies of the Alabama, Apalachicola, Pascagoula, and Tombigbee Rivers and Tibbee Creek will continue through 1986.

2. A sedimentation study was initiated on Boguefala, Boguegaba, Mantachie and Donivan Creek. These tributaries enter the Tombigbee River in northeast Mississippi.

Suspended Sediment Investigations.

1. Suspended sediment samples were periodically collected under a cooperative agreement by the U. S. Geological Survey Districts as follows:

Alabama	Alabama River at Montgomery, AL Black Warrior River near Northport, AL Tombigbee River at Gainesville, AL
Florida	Apalachicola River at Chattahoochee, FL
Georgia	Chattahoochee River near Whitesburg, GA Chattahoochee River at West Point, GA Flint River at Newton, GA Oostanaula River at Resaca, GA Etowah River near Kingston, GA
Mississippi	Noxubee River at Macon, MS Town Creek near Nettleton, MS

2. The collection of suspended sediment samples on a daily basis was continued on the Tombigbee River at Columbus, Aberdeen and Amory, Mississippi. At about 5-week intervals, samples were taken from the Tombigbee River at four bendway cutoff locations; from the Chuquatonchee Creek at West Point, MS; from the Weaver Creek at Amory, MS; from the Boquefala and Boguegaba Creeks at Carolina, MS; from the Mantachie Creek at Dorsey at MS; from the Donivan Creek at Kirkville, MS; from the Okatibee Creek at Meridian and Arundel, MS and at Okatibee Dam; from the Apalachicola River at Blountstown and Wewahitchka, FL.

Savannah District

1. The District has performed three surveys of Tybee Beach since October 1985 to monitor erosion and accretion in the vincinity of the seawall and the north-end groin.

2. The District is continuing to monitor aggredation and degredation downstream of three reservoir projects on the Savannah River, with a special monitoring program at Richard B. Russell as each of its four conventional power units is placed into operation.

Wilmington District

Inlet Sedimentation

1. Masonboro Inlet.

a. Purpose. To determine the rate and extent of shoaling between the jetties and in the sound areas behind the inlet.

b. Type of Survey. Hydrographic.

c. Elements Measured. Depths in the inlet and beach profiles.

d. Survey Scope. Complete hydrographic surveys are made of the inlet between the jetties and Banks Channel, Shinn Creek, and Masonboro Channel. In addition, surveys are made of the adjacent beaches, Wrightsville Beach and Masonboro Island, to determine impacts of the jetties on the stability of the shorelines and regulate sand bypassing requirements.

e. Surveys of the inlet are made at 6-month intervals whereas beach surveys are made annually.

f. Based on the results of the surveys, sand bypassing from Masonboro Inlet will be accomplished beginning in March 1986 with approximately 870,000 cubic yards being pumped northward to Wrightsville Beach and 1,100,000 cubic yards placed on Masonboro Island to the south.

2. Carolina Beach Inlet

a. Purpose. To monitor the rate of shoaling in a deposition basin constructed in the inlet. The deposition basin is to be used as a source of future beach nourishment material for the Town of Carolina Beach.

b. Type of Survey. Hydrographic.

c. Elements Measured. Depths in the deposition basin and beach profiles.

d. Survey Scope. Hydrograhic surveys are made of the deposition basin and the inlet ocean bar and interior channels. Beach profile surveys are made on Masonboro Island and Carolina Beach. The survey data is used to determine nourishment requirements for Carolina Beach and assess the ability of the deposition basin to trap sufficient quantities of material to satisfy the nourishment requirements.

e. Surveys of the deposition basin and beach profiles are made annually.

f. The deposition basin was dredged in the spring of 1985. Monitoring surveys are scheduled for the spring of 1986, therefore, there are no results at this time.

3. Oregon Inlet.

a. Purpose. To measure shoaling rates in a dredge maintained navigation channel across the inlet's ocean bar and monitor the response of the adjacent beaches, Bodie Island to the North and Pea Island to the south.

b. Type of Survey. Hydrographic.

c. Elements Measures. Depths in the inlet bar channel and beach profiles.

d. Survey Scope. Hydrographic surveys are made approximately every two weeks in the bar channel, extending from the Bonner Bridge seaward to the 25-foot depth contour. Beach profiles are made along 3 miles of beach both north and south of the inlet every two months.

e. The beach profile surveys were begun in 1983. Due to this relatively short period of record, no conclusions have been reached as to the impact of dredging on the stability of the beaches. The bar channel surveys, on the other hand, indicate rapid channel shoaling, particularly following coastal storms.

SOUTH ATLANTIC-GULF REGION

GEOLOGICAL SURVEY

Chowan-Roanoke Subregion

1. Suspended-sediment data are collected bimonthly at Dan River at Paces, VA, and quarterly at Nottoway River near Sebrell, VA, Meherrin River at Emporia, VA, and Blackwater River near Franklin, VA, as a part of the National Stream Quality Accounting Network (NASQAN).

2. Suspended-sediment data are collected quarterly at Roanoke River at Roanoke Rapids, NC, as part of NASQAN.

Neuse-Pamlico Subregion

1. Suspended-sediment data are being collected on a daily basis at the main station on the Chicod Creek and on a monthly basis at three sites in the Chicod Creek watershed near Grimesland, NC, in cooperation with the U.S. Department of Agriculture, Soil Conservation Service. These data will be used to determine changes caused by channelization which was completed in 1981.

2. Suspended-sediment data are collected bimonthly at Neuse River at Kinston, Tar River at Tarboro, and Contentnea Creek at Hookerton, NC, as a part of NASQAN.

3. Suspended-sediment data are being collected monthly and during floods at six headwater stations on the Neuse River to determine the quality of inflow into the new (1983) 12,500-acre Falls Reservoir. This effort is part of a cooperative program with the U.S. Army Corps of Engineers (COE). Monthly sediment samples are collected below Falls Reservoir on the Neuse River in cooperation with the North Carolina Department of Natural Resources and Community Development.

4. Suspended-sediment data are collected monthly and during floods at three sites in the eastern Piedmont province for defining the effects of various land uses on sediment and biological characteristics.

Cape Fear Subregion

1. Suspended-sediment data are being collected on a monthly basis at Haw River near Bynum, and Haw River near Moncure, NC, in cooperation with the North Carolina Department of Natural Resources and Community Development.

2. Suspended-sediment data are collected quarterly on the Cape Fear River at Lock 1 near Kelly, NC, as part of the NASQAN program.

3. Suspended-sediment data are collected monthly and during floods at three headwater stations to determine the quality of inflow into the new (1982) 13,900-acre Jordan Lake in cooperation with the COE.

4. Suspended-sediment data are being collected on a monthly basis and during floods at five sites in the Grove Creek basin, near Kenansville, NC, to define effects of channel modifications, in cooperation with the North Carolina Department of Human Resources.

Pee Dee Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Scape Ore Swamp near Bishopville, SC, as a part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a bimonthly basis at Lynches River at Effingham, SC, Black River at Kingstree, SC, Pee Dee River near Rockingham, NC, and at Pee Dee River at Pee Dee, SC, as a part of NASQAN.

3. Suspended-sediment data are being collected daily and more frequently during flood events at the Yadkin River at Yadkin College, NC, as part of the Federal Collection of Basic Records (CBR) program.

Santee-Edisto Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Lakes Marion-Moultrie Diversion Canal near Pineville, SC, and at Edisto River near Givhans, SC, and quarterly at Coosawhatchie River near Hampton, SC, as a part of NASQAN.

2. Suspended-sediment data are being collected on a monthly basis at Crawl Creek near Pineville, SC, Santee River below St. Stephens, SC. This is being done in cooperation with the COE.

Ogeechee-Savannah Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Upper Three Runs near New Ellenton, SC, as a part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a quarterly basis at Savannah River near Clyo, GA, and at Ogeechee River near Eden, GA, as a part of NASQAN.

Altamaha-St. Marys Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Falling Creek near Juliette, GA, as a part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a bimonthly basis at Altamaha River near Everett City, GA, and quarterly at Satilla River at Atkinson, GA, and bimonthly at St. Mary's River near Macclenny, FL, as a part of NASQAN.

St. Johns Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at three sites in Florida as a part of NASQAN.

Southern Florida Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at seven sites in Florida as a part of NASQAN.

Peace-Tampa Bay Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at five sites in Florida as a part of NASQAN.

Suwannee Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at four sites in Florida as a part of NASQAN.

Ochlockonee Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at two sites in Florida as a part of NASQAN.

2. Suspended-sediment data are being collected on a periodic basis at one site in Florida as a part of the National Hydrologic Benchmark Network.

Apalachicola Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at three sites in Florida as a part of NASQAN. Suspended-sediment data are being collected periodically at 16 sites in the Apalachicola River basin in cooperation with the COE.

2. Suspended-sediment data are being collected on a bimonthly basis at Flint River at Newton, GA, and Chattahoochee River near Columbia, AL, as part of NASQAN.

Choctawhatchee-Escambia Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at four sites in Florida as a part of NASQAN.

Alabama Subregion

1. Suspended-sediment data are being collected 10 times per year and quarterly at Alabama River near Montgomery, AL, in cooperation with the COE, as a part of NASQAN, respectively, and bimonthly at Alabama River at Claiborne, AL, as a part of NASQAN.

Mobile-Tombigbee Subregion

1. Suspended-sediment data are being collected 10 times per year at Tombigbee River at Gainesville, AL, and at Black Warrior River at Northport, AL, in cooperation with the COE, monthly at Tombigbee River at Gainesville, bimonthly at Black Warrior River below Warrior Dam near Eutaw, AL, and quarterly at Tombigbee River at Coffeeville lock and dam, AL, as a part of NASQAN.

2. Suspended-sediment data are being collected on a quarterly basis at Blackwater River near Bradley and Sipsey Fork near Grayson, AL, as a part of the National Hydrologic Benchmark Network.

3. Suspended-sediment data are being collected on about a 6-week basis at Town Creek at Nettletown, MS, and at Noxubee River at Macon, MS, in cooperation with the COE.

Pascagoula Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Pascagoula River near Benndale, MS, and quarterly at Wolf Creek near Landon, MS, as a part of NASQAN.

2. Suspended-sediment data are being collected on a quarterly basis at Cypress Creek near Janice, MS, as a part of the National Hydrologic Benchmark Network.

3. Suspended-sediment data are being collected on a quarterly basis at Escatawpa River near Agricola, MS, as part of NASQAN.

Pearl Subregion

1. Suspended-sediment data are being collected on a daily basis at Pearl River near Bogulusa, LA, as a part of the Federal CBR program.

2. Suspended-sediment data are being collected on a bimonthly basis at Bogue Chitto River near Bush, LA, as a part of NASQAN.

Special Studies

1. Suspended-sediment and bed-material data are being collected periodically and during two storm events per year at five sites in order to gage sediment deposition in certain Georgia reservoirs as part of a cooperative program with the COE.

2. Suspended-sediment data are collected at 15-minute intervals during storm runoff from two 6-acre farm tracts used to evaluate land-management practices in northern Guilford County, NC. Sediment data are also collected at a 600-acre multiuse site and a 34-acre forested site in conjunction with the program, conducted in cooperation with the Guilford County Soil and Water Conservation District.

For additional information about Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
520 19th Avenue
Tuscaloosa, AL 35401

District Chief, WRD
U.S. Geological Survey
6481 Peachtree Industrial Blvd.
Suite B
Doraville, GA 30360

District Chief, WRD
U.S. Geological Survey
Suite 710, Federal Building
100 West Capitol Street
Jackson, MS 39269

District Chief, WRD
U.S. Geological Survey
1835 Assembly Street, Suite 658
Columbia, SC 29201

District Chief, WRD
U.S. Geological Survey
227 N. Bronough Street, Suite 3015
Tallahassee, FL 32301

District Chief, WRD
U.S. Geological Survey
P.O. Box 66492
Baton Rouge, LA 70896

District Chief, WRD
U.S. Geological Survey
P.O. Box 2857
Raleigh, NC 27602

Chief, Virginia Office, WRD
U.S. Geological Survey
3600 West Broad Street, Room 606
Richmond, VA 23230

SOIL CONSERVATION SERVICE

1. Studies of sediment damages and determinations of sediment yields were made for work plans in the following watersheds:

a. Public Law 566.

Major Drainage	Watershed	Stream	County	State
Choctawhatchee	Harrison Mill Panther Creek	Harrison Mill and Panther Cks.	Dale, Houston, and Geneva	AL
Apalachicola	Shoal Creek (continuation)	Shoal Creek	Marion	GA
Savannah	Cason Branch - Duhart Creek	Cason Branch Duhart Creek	Jefferson	GA
Altamaha	Horse Creek	Horse Creek	Telfair	GA
Neuse	Upper Contentnea	Contentnea Ck.	Wilson, Nash	NC
Santee-Cooper	Sandy Run	Sandy Run Ck.	Rutherford	NC
Santee-Cooper	Indian, Howard, and Beaver Dam	Indian Ck.	Lincoln,	NC

b. River Basin Investigations

Major Basins	Study Area	State
Alabama, Tennessee, Tombigbee, Northeast Gulf and Black Warrior	Entire State	AL
Southeast Georgia Land and Water Resource Cooperative Study - 28 Counties (continuation)	Savannah Ogeechee Altamaha Suwannee	GA
Upper Chattahoochee River	Chattahoochee	GA

2. Reservoir Sedimentation Surveys.

Reservoir sedimentation surveys were made on the following reservoirs:

Reservoir	County(s)	State
Bull Creek No. 3	Muscogee	GA
Bull Creek No. 4	Muscogee	GA
Byrum	Suffold	VA

3. Special Studies.

a. Flood Plain Damage Assessment

Project Name	Counties	State
No Action FY 85		
Southeast Georgia Land and Water Resource Cooperative Study (continued)	28 (6.8 million acres)	GA

b. A study of small gullies on cropland is being carried out on portions of the Bright Leaf Tobacco area in the Piedmont and the peanut area of the Coastal Plain in Virginia.

GREAT LAKES REGION

CORPS OF ENGINEERS

North Central Division

Buffalo District

Sediment Analysis for Cazenovia Creek Ice Retention Structure at West Senenca, NY. Cazenovia Creek, located in central Erie County, NY, has a drainage basin area of 144 square miles. The damages that occur are a result of flooding which generally occur during later winter and early spring when major runoff events from snowmelt and rainfall combine with ice jamming. An ice retention structure is the proposed alternative for the Section 205 Project (Small Flood Control Projects) at Cazenovia Creek, West Seneca, New York, as discussed in the Detailed Project Report. One significant aspect of this study is whether the structure will have an effect on erosion and deposition.

A sediment analysis was performed for this study, to determine the effect of the proposed structure on future erosion and deposition. Field data were collected to locate areas of erosion and deposition and to identify the lithology and provinence of the sediment in the channel. A study performed by Maddalena (1985) was utilized to determine the amount of scour in one seasonal flow.

In addition, a field investigation was performed by Geotechnical Section Personnel to determine the areal extent of the existing channel bars in order to quantify the volume of sediment that is transported during various flows.

Results from the sediment analysis show that all of the sediment is moved during flows with a recurrence of 2.3 years. The average quantity of bedload moved is 1,609 cubic yards per year. The quantity of sediment that is expected to accumulate upstream of the project site will significantly effect the efficiency of the project by reducing the capacity of the ponding area. Maintenance dredging will be required.

Sedimentation Report on Cattaraugus Creek, Harbor, NY. Canaseraga Creek is approximately 70 miles long with a watershed covering 554 square miles and flows generally westward entering Lake Erie about 24 miles southwest of Buffalo, NY. The Cattaraugus Creek project is primarily a small-boat navigation project but also is expected to provide some flood control. Construction of the project was completed in January 1983 and consists of: (a) two breakwaters and a berm with an aggregate length of 2,500 feet in Lake Erie at the mouth of Cattaraugus Creek; (b) an outer entrance channel 8 feet deep, 100 to 200 feet wide and 1,375 feet long; (c) an inner entrance channel 6 feet deep, 100 feet wide and 3,625 feet long; and (d) development of recreational facilities for breakwater fishing.

In January 1983 the Buffalo District, in cooperation with CERC, initiated a 4-year monitoring program at Cattaraugus Creek under the Monitoring Completed Projects Program. As a part of this program beach and offshore profile surveys of the project area and adjacent shoreline were conducted in June 1985. The surveys cover 10,000 feet of shore. In addition, 35 sediment samples were collected over a 2,500-foot wide grid centered at the harbor entrance from survey profile lines north, south and offshore of the project area. Also, six samples were collected at points along the channel. The samples were evaluated for grain-size distribution.

Sedimentation Report on Presque Isle State Park, PA. Presque Isle is a large recurved sand spit which completely shelters the harbor for Erie, PA, and functions as a very popular State park. Since 1975, the Buffalo District, in cooperation with the Commonwealth, conducts an annual replenishment program. In 1985, 278,800 tons of medium sand was obtained from various land sources located within a 2-mile radius of Erie, PA, and placed on the beach. Also, a 1,000-foot test section of gravel beach was placed between Groin No. 9 and Groin No. 10 along the neck of the peninsula during May 1985. About 29,000 tons of bank run gravel were placed and covered with a 6-inch layer of sand (4,000 tons). The gravel beach was monitored from April 1985 through November 1985. Beach and offshore profile surveys were taken once a month through gravel beach area and through adjacent 1,000-foot beach areas, to either side. In addition, 21 sediment samples were collected during each survey. The samples are currently being evaluated for grain-size distribution.

Sedimentation Report on Lakeview Park, OH. Lakeview Park is located one mile west of Lorain Harbor on the south shore of Lake Erie. In the summer of 1977, three detached offshore breakwaters plus 100,000 cubic yards of beach fill were placed as a cooperative beach erosion control project for Lakeview Park. Beach fill from commerical sources was placed at the west end of the park as part of the periodic replenishment program, 6,000 cubic yards in July 1980 and 3,000 cubic yards in September 1981. In May 1985, 3,000 cubic yeards of sand were recirculated within the project area by excavating sand at the east end of the beach and deposition it at the eroded west end.

Environmental Analyses of Harbor Sediments for O&M Program. In 1985, sediment samples were obtained from the following list of project locations within the Buffalo District. Sediment sampling consisting of bulk sediment metals and organics testing was conducted at Toledo, Conneaut, Huron, Rocky River, Sandusky, Rochester and the St. Lawrence River between Massena and Alexandria Bay. Particle size analyses were done at all locations. Studies on phosphorus availability to algae were done at Toledo. Plant and animal bioaccumulation studies were conducted at the Times Beach Dredge Disposal Site, Buffalo, NY Groudwater quality monitoring was also done at the Times Beach Site.

The purpose of the testing is to evaluate the sediments for open-land or confined disposal following maintenance dredging.

Project Location	No. of Samples	Type of Test: Bulk Sediment	Type of Test: Other
Toledo, OH	10	Metals	Phosphorus
		Organics	Bio-Availability
Conneaut, OH	16	Metals	Bioassay
		Organics	Elutriate
Huron, OH	16	Metals	Bioassay
		Organics	Elutriate
Rocky River, HO	6	Metals	---
Sanduky, OH	17	Metals	Bioassay
		Organics	Elutriate
Rochester, NY	14	Metals	Bioassay
		Organics	Elutriate
St. Lawrence River	9	Metals	Elutriate
		Organics	Bioassay
Times Beach Disposal Area Buffalo, NY		Plant and Animal Bioassay Ground Water Monitoring	

Shoaling Rate Determination for Recreational Harbors. Historically, long-term average shoaling rates of .2 feet per year were used in estimating dredging activity. In 1985, Little Sodus Bay Harbor and Rocky River Harbor utilized a variable shoaling rate which specifies shoaling to be a function of an independent variable - the depth of the channel measured in feet below low water datum (LWD). Equilibrium shoaling elevations were developed for each of the harbors. The results are shown in the table below:

Harbor	Equilibrium Shoaling Elevation
Little Sodus Bay Harbor	234.6
Rocky River Harbor	
Entrance - 10'	564.6
Middle - 6'	564.4
Upstream - A	565.1
Upstream - B	565.7

Note: Ricky River Harbor consists of three channel segments with various dredging maintenance depths.

The equilibrium shoaling eleveation represents the elevation in which shoaling will cease and the harbor will maintain itself. Utilizing the equilibrium shoaling elevation, variable dredging plans and scenarios were developed over a 50-year planning period (1985-2035) in which dredging intervals, depth of dredging, volume of initial dredging, and volume of subsequent dredging were determined.

Detailed information may be obtained from the following Buffalo District Reports:

Economic Analysis of Dredging at Rocky River Harbor, and
Econimic Analysis of Dredging at Little Sodus Bay Harbor

Reservoir Sedimentation Survey on Mt. Morris Dam. Mt. Morris Dam is located on the Genesse River in Livingston County, NY about 67 miles upstream from the mouth. The reservoir is entirely contained in the deep valley gorge of the rive between Mt. Morris and the lower Portage Falls. In accordance with EM 1100-2-4000, Reservoir Sedimentation Investigation Progra, a resurvey was conducted in 1982 for this reservoir. Resurvey report was finalized and approved by the Division.

In January 1980, the first photogrammetric survey was conducted. The area capacity curve developed from this survey was used for the 1982 sedimentation survey. It was compared to the area capacity curve developed from the range survey profile in 1963 to determine the net change. Results show that total sediment accumulation occupied 11 percent of the total reservoir storage at the spillway level. This value may not be representative of actual reservoir sedimentation, however, because the method of analysis changed between 1963 and 1980 due to problems with the eariler survey methods. The surveys that were conducted in 1963 and 1957 used the range profile method and the survey of 1980 used the photogrammetric method. To ensure a more accurate long term rate of sediment accumulation, another photogrammetric survey is planned to compare with the original photogrammetric survey of 1980. When completed, a schedule for future photogrammetric surveys will be determined. This entire program is subject to funding constraints.

Chicago District

Michigan City, Indiana. A sediment sampling program was conducted in Michigan City Harbor and Trail Creek during December 1985 in relation to proposed maintenance dredging at the navigation channel. Core samples of bottom sediments were collected at thirteen locations. The sediment samples were analyzed for physical and chemical properties including sieve analysis, TVS, COD, nutrients, heavy metals, PCB's and PAH compounds.

Detroit District

Environmental Analysis of Sediment Samples. In 1985, sediment samples were obtained at the following locations for environmental analysis. Bulk chemical, elutriate and benthos testing were completed at Pointe Mouillee and at Green Bay, Milwaukee and Manitowoc harbors in support of Confined Disposal Facility (CDF) repair and capping projects. Bulk chemical, elutriate and benthos testing were completed at Harbor Beach in support of new project dredging operations. Bulk chemical, elutriate and benthos testing were completed at Kenosha, Manitowoc, Traverse City, Harrisville, Charlevoix harbors and the Detroit River as part of a routine, periodic sediment analysis update. Bulk chemical, elutriate and benthos testing were completed at Fort

Wayne and Ecorse Creek in support of flood control excavations at those locations.

Elutriate testing included analyses for nutrients, metals and chlorinated organics. These analyses provide an indication of biological mobility of contaminates and/or an indication of the characteristics of CDF interior water.

Section 111 (Mitigation of Shore Damage Due to Federal Navigation Projects) Monitoring. In 1985, sediment sampling was conducted at the following Great Lakes harbors as part of a formal monitoring program of Section 111 beach nourishment projects.

Ludington	Holland	Port Sanilac
Grand Haven	Lexington	

The sediment sampling was done in conjunction with hydrographic surveys and consisted of grab samples collected at established points along the shoreline from the bluff toe to the 20 foot depth contour. A gradation analysis was performed on each sample. The results of the analysis will be used to determine the sediment gradation distribution in the vicinity of each harbor and the stability profile of nearshore sediments.

Hydrographic surveys were conducted at the following harbors in 1985.

Harbor	Number of Surveys	Number of Survey Lines
Lexington	1	10, plus south inner harbor
Port Sanilac	1	10
St. Joseph	1	27
South Haven	2	13
Holland	2	10
Grand Haven	1	13
Muskegon	1	7
White Lake	2	8
Ludington	1	16, plus south inner harbor

The surveys were accomplished as a part of the formal monitoring program in support of O&M Section 111 beach nourishment activities. The surveys were made along established range lines, using automated positioning and survey equipment, from the shoreline to the 30 foot depth contour. The reach of shoreline surveyed extends on either side of the harbor for a distance of 2 to 3 miles. The surveys document nearshore conditions at the time of the survey and, when compared with previous surveys, show changes that may have occurred in the bathymetry.

A survey of the area with the harbor structures at Lexington and Ludington were made in 1985 to record bottom elevations as part of a study to determine the extent of shoaling within the harbor structures.

Operations and Maintenance Surveys. In 1985, hydrographic surveys were completed at 75 Great Lakes harbors, channels and rivers. Condition surveys were done at 50 locations to record the bathymetry of navigable waters. The results of the surveys are compiled and disseminated to the public in "Notice to Mariners" bulletins if there are significant changes affecting navigation. Prior and after surveys were done at 25 locations in support of O&M maintenance dredging operations. "Prior" surveys were conducted to determine th shoaling conditions before scheduled dredging. "After" surveys cofirm that the required dredging depth was achieved.

Special Studies

1. Extended Season Navigation Study - In 1985, a sedimentation survey was undertaken in connection with the Extended Season Navigation. The study investigated water quality and sedimentation rate of the Detroit River and St. Clair River. The sedimentation study is divided into two areas, sediment flux and sedimentation rate.

The sediment flux study was conducted in cooperation with the Cold Regions Research and Engineering Laboratory (CRREL). The study obtained trap samples which were used to determine the effect of ship passage on bottom sediments. The study was undertaken from December 1984 to March 1985 at four locations on the Detroit and St. Clair Rivers. The collected samples were analyzed for turbidity and suspended and dissolved solids.

The sedimentation rate study was conducted during the Winter of 1984-85 at four sites on the Detroit and St. Clair Rivers. The study used in-place sedimentation collectors developed by CRREL to determine the baseline (with Winter navigation) Winter sedimentation rate.

The results of both studies will be included in a report titled "Water Quality Investigations, Extension of Winter Navigation Season, Detroit-St. Clair River System", to be completed in 1986.

2. Fort Wayne Flood Control - In 1985, two studies were done at Fort Wayne, Indiana as part of the reconnaissance phase of a planned flood control project. A total of 67 borings were made within the study area. Each boring was made to a depth of 30 to 40 feet. Grain size and engineering properties tests were performed on each sample to determine site characteristics and to classify the material under the levees. The second study consisted of sediment sampling of the three tributary rivers, the St. Marys, Maumee and St. Joseph rivers. Bulk analysis testing was done on the collected samples to determine the contamination parameters to the excavatable bank and bottom material and determine the most appropriate method of disposal of the dredged material.

GREAT LAKES REGION

GEOLOGICAL SURVEY

Western Lake Superior Subregion

1. Suspended-sediment data are being collected on a periodic and storm-event basis at Nemadji River near South Superior, WI, and at Bad River near Odanah, WI, on a quarterly basis at Baptism River near Beaver Bay, MN, and on a bimonthly basis at St. Louis River at Scanlon, MN, as a part of the National Stream Quality Accounting Network (NASQAN).

Southern Lake Superior-Lake Superior Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Washington Creek at Windigo (Isle Royale), MI, as a part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a quarterly basis at Ontonagon River near Rockland, MI, Sturgeon River near Chassell, MI, and at Tahquamenon River near Tahquamenon, MI, as a part of NASQAN.

Northwestern Lake Michigan Subregion

1. Suspended-sediment data are being collected on an intermittant basis at Popple River near Fence, WI, as a part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a bimonthly basis at Fox River at Wrightstown, WI, and Escanaba River at Cornell, MI, and on a quarterly basis at Menominee River near McAllister, WI, and Ford River near Hyde, MI, as a part of NASQAN.

3. Suspended-sediment data are being collected on a periodic and storm-event basis at:

Bower Creek near Green Bay, WI
East River at Allouez Avenue at Green Bay, WI
East River at Hwy 32 at Green Bay, WI
East River at Monroe Avenue at Green Bay, WI

in cooperation with the Fox Valley Water Quality Planning Agency; and at White Creek at Forest Glen Beach near Green Lake, WI, in cooperation with the Green Lake Sanitary District.

Southwestern Lake Michigan Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Milwaukee River at Milwaukee, WI, and at Manitowac River at Manitowac, WI, as a part of NASQAN.

2. Suspended-sediment data was collected on a weekly basis at Little Calumet River at Munster, IN, in cooperation with the U.S. Army Corps of Engineers (COE).

Southeastern Lake Michigan Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Grand River at Eastmanville, MI, and St. Joseph River at Niles, MI, and on a quarterly basis at Kalamazoo River at Saugatuck, MI, as a part of NASQAN.

Northeastern Lake Michigan-Lake Michigan Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Manistique River above Manistique, MI, and at Manistee River at Manistee, MI, and on a quarterly basis at Muskegon River near Bridgeton, MI, as a part of NASQAN.

2. Suspended-sediment data are being collected in cooperation with Grand Traverse County and the Michigan Department of Natural Resources on a 4- to 6-week interval at the following sites:

Anderson Creek near Buckley, MI
Green Lake Inlet near Interlochen, MI
Boardman River above Brown Bridge Pond near Mayfield, MI
East Creek near Mayfield, MI
Boardman River near Mayfield, MI
Swainston Creek at Mayfield, MI
Boardman River near Traverse City, MI
Boardman River at Traverse City, MI
Hospital Creek at Traverse City, MI
Mitchell Creek at Traverse City, MI
Acme Creek at Acme, MI
Yuba Creek near Acme, MI
Tobeco Creek near Elk Rapids, MI
Battle Creek near Williamsburg, MI
Williamsburg Creek near Williamsburg, MI

On a quarterly basis at the following sites:

Fife Lake Outlet near Fife Lake, MI
Mason Creek near Grawn, MI
Duck Lake Outlet near Interlochen, MI
Betsie River near Karlin, MI
South Branch Boardman River near South Boardman, MI
North Branch Boardman River near South Boardman, MI
Jackson Creek near Kingsley, MI
Jaxon Creek near Mayfield, MI
West Branch Jaxon Creek near Mayfield, MI
Ceder Run near Ceder, MI

Northwestern Lake Huron Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Cheboygan River at Cheboygan, MI, Thunder Bay River at Alpena, MI, and Au Sable River near Au Sable, MI, as a part of NASQAN.

Southwestern Lake Huron-Lake Huron Subregion

1. Suspended-sediment data are being collectd on a quarterly basis at Pigeon River near Caseville, MI, Rifle River near Sterling, MI, and at Saginaw River at Saginaw, MI, as a part of NASQAN.

St. Clair-Detroit River Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Clinton River at Mount Clemens, MI, as a part of NASQAN.

2. Suspended-sediment data are being collected in cooperation with the Huron-Clinton Metropolitan Authority on a monthly basis at the following sites:

Huron River at Milford, MI
Huron River near New Hudson, MI

Western Lake Erie Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Maumee River at Waterville, OH, as a part of NASQAN.

2. Suspended-sediment data are being collected on a daily basis at Sandusky River near Fremont, OH, in cooperation with the Ohio Department of Natural Resources.

3. Suspended-sediment data are being collected on a quarterly basis at River Raisin near Monroe, MI, as a part of NASQAN.

Southern Lake Erie Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Cuyahoga River at Independence, OH, as a part of NASQAN.

2. Suspended-sediment data are being collected on a daily basis at Cuyahoga River at Hiram Rapids, OH, in cooperation with the City of Akron.

3. Suspended-sediment data are being collected on a daily basis at Grand River at Painseville, OH, in cooperation with the Ohio Department of Natural Resources.

Eastern Lake Erie-Lake Erie Subregion

1. Suspended-sediment data are being collected on a periodic basis at Cattaraugas Creek at Gowanda, NY, Niagara River (Lake Ontario) at Fort Niagara, NY, and Tonawanda Creek at Batavia, NY, as a part of NASQAN.

Southwestern Lake Ontario Subregion

1. Suspended-sediment data are being collected on a periodic basis at Genesee River at Charlotte Docks at Rochester, NY, as a part of NASQAN.

Southeastern Lake Ontario Subregion

1. Suspended-sediment data are being collected on a periodic basis at Oswego River at Lock 7 at Oswego, NY, and at Sandy Creek at Adams, NY, as a part of NASQAN.

Northeastern Lake Ontario-Lake Ontario-St. Lawrence Subregion

1. Suspended-sediment data are being collected on a periodic basis at Black River at Watertown, NY, Raquette River at Raymondville, NY, St. Regis River at Brasher Center, NY, St. Lawrence River at Cornwall, Ontario, near Massena, NY, and at Oswegatchie River at Heuvelton, NY, as a part of NASQAN.

Special Studies

1. Water-Resources Investigations Report 85-4312 entitled "Suspended Sediment in Minnesota Streams" by L. H. Tornes was approved for publication.

For additional information about Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
Champaign County Bank Plaza
102 East Main St., 4th Floor
Urbana, IL 61801

District Chief, WRD
U.S. Geological Survey
6520 Mercantile Way, Suite 5
Lansing, MI 48910

District Chief, WRD
U.S. Geological Survey
702 Post Office Building
St. Paul, MN 55101

District Chief, WRD
U.S. Geological Survey
P.O. Box 1669
Albany, NY 12201

District Chief, WRD
U.S. Geological Survey
975 West Third Avenue
Columbus, OH 43212

District Chief, WRD
U. S. Geological Survey
1815 University Avenue
Madison, WI 53705-4042

District Chief, WRD
U.S. Geological Survey
6023 Guion Road
Suite 201
Indianapolis, IN 46254

OHIO REGION

CORPS OF ENGINEERS

Ohio River Division

Report on sedimentation activities in the Ohio River Division is as follows:

Sedimentation Surveys.

1. Burnsville Lake, Little Kanawha River, West Virginia. A resurvey of 34 existing sediment ranges at Burnsville Lake was conducted in 1985. Current ground profiles were obtained for 30 sediment ranges upstream of the dam and for four sediment ranges downstream of the dam. A report on the resurvey is scheduled for completion in 1986.

2. East Lynn Lake, Twelvepole Creek, West Virginia. Uncontrolled fathometer profiles at 14 existing sediment ranges upstream of the dam at East Lynn Lake were obtained in 1985. A report on the reconnaissance survey is scheduled for completion in 1986.

3. Summersville Lake, Gauley River, West Virginia. Uncontrolled fathometer profiles at 15 existing sediment ranges upstream of the dam and coordinate positions of sediment range and monuments not previously determined at Summerville Lake were obtained in 1985. A report on the reconnaissance survey is scheduled for completion in 1986.

4. Atwood Lake, Indian Fork of Conotton Creek, Ohio. A report on the 1981 sedimentation survey at Atwood Lake was submitted to and approved by the Ohio River Division in 1985. An original network of 11 sediment ranges in the seasonal pool was established at Atwood Lake in 1981. Original profiles for the 11 sediment ranges were estimated from 1934 property maps and assumed to represent the range profiles at the time storage began in 1940. The 1981 sedimentation survey of the seasonal pool at Atwood Lake indicated a sedimentation rate of 0.37 acre-feet per year per square mile of contributing drainage area. This rate of sedimentation is not excessive and is not detrimental to operation of the project. A reconnaissance level survey is scheduled for 1986.

5. Grayson Lake, Little Sandy River, Kentucky. A report on the 1982 resurvey of 24 sediment ranges upstream of Grayson Dam and two sediment ranges downstream of the dam was submitted to and approved by the Ohio River Division in 1985. The rate of sedimentation below seasonal pool at Grayson Lake, between the time of dam closure in 1965 and the resurvey in 1982, was indicated to be 0.34 acre-feet per year per square mile of contributing drainage area. This rate of sedimentation is not excessive and is not detrimental to the operation of the project. A selected range survey is scheduled for 1987.

6. Beach City Lake, Sugar Creek, Ohio. A report on the 1984 sedimentation survey at Beach City Lake was submitted to and approved by the Ohio River Division in 1985. A network of 37 sediment ranges in the flood control pool area at Beach City Lake was established in 1984. Profiles to represent the original conditions at the sediment ranges were estimated from available data. The rate of sedimentation of Beach City Lake below flood control pool elevation 976.5 feet was estimated to be 0.42 acre-feet per year square mile of contributing drainage area. This rate of sedimentation is not excessive and is not detrimental to the effective operation and management of the project. A selected range sedimentation survey is scheduled for 1989.

7. Dewey Lake, Johns Creek, Kentucky. A report on the 1984 resurvey of 18 sediment ranges upstream of the dam and three ranges downstream of the dam at Dewey Lake was submitted to and approved by the Ohio River Division in 1985. The resurvey of selected sediment ranges in 1984 indicated that the sediment rate for the latest period between resurveys, 1978 to 1984, was less than the rates determined for the previous two periods between resurveys, 1973 to 1975 and 1975 to 1978. The rate of sedimentation indicated for the total period from 1953 to 1984 was 0.40 acre-feet per year per square mile of contributing drainage area. A selected range sedimentation survey is scheduled for 1989.

8. Pleasant Hill Lake, Clear Fork of the Mohican River, Ohio. A letter report on the 1984 sedimentation investigation of reconnaissance scope was submitted to and approved by the Ohio River Division in 1985. Uncontrolled fathometer profiles within the seasonal pool were obtained along eight sediment ranges. The 1984 sedimentation reconnaissance indicated that sedimentation in the seasonal pool area was not excessive. A reconnaissance level survey is scheduled for 1989.

9. Piedmont Lake, Stillwater Creek, Ohio. A letter report on the 1984 sedimentation investigation of reconnaissance scope was submitted to and approved by the Ohio River Division in 1985. Fathometer profiles, within horizontal control, were obtained along 15 sediment ranges within the seasonal pool. The rate of sedimentation at Piedmont Lake indicated by the 1974 and 1979 sedimentation surveys appeared excessive. The 1984 sedimentation reconnaissance indicated that sedimentation in the seasonal pool continues to be excessive; however, no major operational difficulties are being experienced at this time. A selected range survey is scheduled for 1989.

10. Senecaville Lake Seneca Fork of Wills Creek, Ohio. A letter report on the 1984 sedimentation investigation of reconnaissance scope was submitted to and approved by the Ohio River Division in 1985. Uncontrolled fathometer profiles within the seasonal pool were obtained along seven sediment ranges. The rate of sedimentation in the lake indicated by the previous sedimentation survey in 1945 appeared excessive. The 1984 sedimentation reconnaissance indicated that sedimentation in the seasonal pool has continued at a high rate; however, there are no major operational difficulties at the project at this time. A reconnaissance level survey is scheduled for Senecaville Lake during 1989.

11. Tappan Lake, Little Stillwater Creek, Ohio. A letter report on the 1984 sedimentation investigation of reconnaissance scope was submitted to and approved by the Ohio River Division in 1985. Uncontrolled fathometer profiles within the seasonal pool were obtained along eight sediment ranges. The 1984 sedimentation reconnaissance at Tappan Lake indicated that sedimentation in the seasonal pool area was not excessive. A reconnaissance level survey is scheduled for Tappan Lake during 1989.

12. Salamonie Lake, Salamonie River, Indiana. The report on the 1984 sedimentation resurvey was submitted to and approved by the Ohio River Division in 1985. Twenty-one sedimentation ranges were surveyed. Results of the survey showed the annual rate of sedimentation to be 0.51 acre-feet per year per square mile of contributing drainage area. The average dry weight of the lake bottom sediment samples was 68.6 pounds per cubic foot. The rate of sedimentation is not excessive and is not having a detrimental effect on the operation of the project. A resurvey of sedimentation ranges is scheduled for 1994.

13. Carr Fork Lake, Carr Fork, Kentucky. A sedimentation survey of Carr Fork Lake was completed in 1985 and the report of the sedimentation survey is scheduled for completion in 1986.

14. Cave Run Lake, Licking River, Kentucky. A sedimentation survey of Cave Run Lake was completed in 1985 and the report of the sedimentation survey is scheduled for completion in 1986.

15. Nolin Lake, Nolin River, Kentucky. A sedimentation survey of Nolin Lake was completed in 1985 and the report of the sedimentation survey is scheduled for completion in 1986.

16. Cagles Mill Lake, Mill Creek, Indiana. A sedimentation survey of Cagles Mill Lake was completed in 1985 and the report of the sedimentation survey is scheduled for completion in 1986.

17. Berlin Lake, Mahoning River, Ohio. The report on the July 1983 sedimentation survey was submitted to and approved by the Ohio River Division in 1985. Thirty sedimentation ranges were surveyed. Results of the survey indicated the annual rate of sedimentation to be 0.78 acre-feet per year per square mile of contributing drainage area. This rate of sedimentation represents a reduction in the rate of sedimentation determined from the previous survey of November 1951. The current rate of sedimentation does not impose any adverse conditions on the operation of the project.

18. Conemaugh River Lake, Conemaugh River, Pennsylvania. The report on the October 1982 sedimentation survey of Conemaugh River Lake was submitted to the Ohio River Division for review and approval in 1985. The report is presently under review. Forty-one sedimentation ranges were surveyed. Results of the survey indicated the annual rate of sedimentation to be 0.28 acre-feet per year per square mile of contributing drainage area.

19. Mahoning Creek Lake, Mahoning Creek, Pennsylvania. The report on the October-December 1984 selected sedimentation range survey was submitted to and approved by the Ohio River Division in 1985. Nine sedimentation ranges were

selected for resurvey. Results of the selected range survey indicated the annual rate of sedimentation to be decreasing compared to the results of previous surveys. Sedimentation currently does not impose any adverse conditions on the operation of the project.

20. M. J. Kirwan Dam and Reservoir, West Branch Mahoning River, Ohio. A selected range, sedimentation survey was conducted in 1985. A report on the survey will be submitted in 1986.

21. Shenango River Lake, Shenango River, Pennsylvania. A selected range, sedimentation survey was conducted in 1985. A report on the survey will be submitted in 1986.

22. Martins Fork Lake, Martins Fork, Kentucky. The report on the June 1984 sedimentation range survey was submitted to and approved by the Ohio River Division in 1985. Twenty-three sedimentation ranges were resurveyed. The survey results showed that between June 1983 and Jun 1984, a sediment deposition rate of 1.9 acre-feet per year per square mile of contributing drainage area which is an increase from previous surveys. Currently, sedimentation is not advesely effecting operation of the project. A suspended sediment monitoring program was initiated in November 1985. A complete sedimentation survey was also completed in 1985 and a report on the survey will be completed in early 1986.

23. Laurel River Lake, Laurel River, Kentucky. A sedimentation survey of Laurel River Lake was completed in 1985 and the report of the sedimentation survey is scheduled for completion in 1986.

24. Old Hickory Lake, Cumberland River, Tennessee. A sedimentation survey of Old Hickory Lake was completed in 1985 and the report of the sedimentation survey is scheduled for completion in 1986.

Sediment Load Measurements.

1. Fishtrap Lake, Levisa Fork, Kentucky. Suspended sediment data were collected by the Huntington District at the Levisa Fork at Big Fork, Virginia, gaging station and at gaging stations on five tributary streams in the Fishtrap Lake Drainage Basin throughout 1985.

2. Dewey Lake, Johns Creek, Kentucky. Suspended sediment data were collected by the Huntington District at the Johns Creek at Meta, Kentucky monitoring station and at gaging stations on three tributary streams in the Dewey Lake Drainage Basin throughout 1985.

3. R. D. Bailey Lake, Guyandotte River, West Virginia. Suspended sediment data were collected by the Huntington District at the Clear Fork and at the Baileysville monitoring stations throughout 1985.

4. Yatesville Lake, Blaine Creek, Kentucky. Suspended sediment data were collected by the Huntington District at the Blaine Creek at Blaine, Kentucky monitoring station throughout 1985.

5. Sweetwater Creek, Florence, Alabama. In July 1985, the Nashville District contracted with the U.S. Geological Survey to begin collecting suspended sediment samples and measurements of discharge at two sites on Sweetwater Creek. The samples will be used to define sediment inflows from Sweetwater and allow proper design of sediment control alternatives for the proposed Florence Port.

6. Upper Cumberland River Basin, Kentucky. The Nashville District's agreement with the U.S. Geological Survey to collect suspended sediment samples was continued for four locations in the Upper Cumberland River Basin. The locations are (1) Clover Fork at Harlan, (2) Cumberland River at Pineville, (3) Yellow Creek at Middlesboro, and (4) Cumberland River at Barbourville. At Middlesboro, a recording suspended sediment monitor was installed on Bennetts Fork, a tributary entering the Yellow Creek Diversion Canal. On Martins Fork, a recording suspended sediment monitor was placed in operation in November 1985 to measure sediment inflow into Martins Fork Lake.

OHIO REGION

GEOLOGICAL SURVEY

Upper Ohio Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Allegheny River at New Kensington, PA, Monangahela River at Braddock, PA, Beaver River at Beaver Falls, PA, Ohio River at Benwood, near Wheeling, WV, and at Little Kanawha River at Palestine, WV, as a part of the National Stream Quality Accounting Network (NASQAN).

2. Suspended-sediment data are being collected on a daily basis at East Branch Shade River near Tuppers Plains, OH, West Branch Shade River near Harrisonville, OH, and West Branch Shade River near Burlingham, OH, in cooperation with Ohio Department of Natural Resources.

3. Suspended-sediment data are being collected on a daily basis at Wheeling Creek near Blaine, OH, in cooperation with the Ohio Department of Natural Resources.

Muskingum Subregion

1. Suspended-sediment data are being collected on a daily basis at Muskingum River at McConnelsville, OH, in cooperation with the Ohio Department of Natural Resources.

Hocking Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Hocking River below Athens, OH, as a part of NASQAN.

Kanawha Subregion

1. Suspended-sediment data are being collected on a near quarterly basis at Kanawha River at Winfield, WV, as a part of NASQAN.

2. Suspended-sediment data are being collected on a daily and storm-event basis at Elk River at Sutton, WV, Elk River at Queen Shoals, WV, and at Elk River at Blue Creek, WV. Also, suspended-sediment data are being collected on a periodic basis and during selected storm events at Buffalo Creek at Clay, WV, Big Sandy Creek near Clendenin, WV, Little Sandy Creek near Elkview, WV, and Blue Creek near Quick, WV, in cooperation with the West Virginia Department of Natural Resources, Water Resources Division.

3. Suspended-sediment data are being collected on a periodic basis and during selected storm events at Elk River below Webster Springs, WV, Left Fork Holly River near Replete, WV, and at Right Fork Holly River at Guardian, WV, in cooperation with the West Virginia Department of Natural Resources, Water Resources Division.

4. Suspended-sediment data were collected on an event basis at Soak Creek at Sophia, WV, in cooperation with the U.S. Soil Conservation Service.

5. Suspended-sediment data are being collected on a bimonthly basis as part of NASQAN on the New River at Glen Lyn, VA.

Raccoon Subregion

1. Suspended-sediment data are being collected on a daily basis in cooperation with the Ohio Department of Natural Resources at the following stations:

Raccoon Creek near New Plymouth, OH
Lt. Raccoon Creek at Vinton, OH
Lt. Raccoon Creek near Ewington, OH
Raccoon Creek at Bolin Mills, OH
Raccoon Creek near Adamsville, OH

Scioto Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Scioto River at Higby, OH, as a part of NASQAN.

Big Sandy-Guyandotte Subregion

1. Suspended-sediment data are being collected on a near bimonthly basis at Guyandotte River at Branchland, WV, as a part of NASQAN.

2. Suspended-sediment data were collected on a periodic basis and during selected storm events, in cooperation with the U.S. Army Corps of Engineers (COE), Huntington District, at the following stations (discontinued September 30, 1985):

Tug Fork at Glenhayes, WV
Tug Fork near Kermit, WV
Tug Fork at Fort Gay, WV

3. Suspended-sediment data are being collected on a bimonthly basis at Big Sandy River at Louisa, KY, as part of NASQAN.

4. Suspended-sediment data are being collected (beginning October 1985) on a daily basis, and more frequently during storm events, at Levisa Fork near Grundy, VA, in cooperation with the COE, Huntington District.

5. Suspended-sediment data were collected on a bimonthly basis in cooperation with the COE, Huntington District, at the following stations (discontinued September 30, 1985):

Levisa Fork at Pikeville, KY
Levisa Fork at Paintsville, KY
Levisa Fork at Louisa, KY
Big Sandy River near Burnaugh, KY

Great Miami Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Whitewater River at Brookville, IN, as a part of NASQAN.

2. Suspended-sediment data are being collected on a bimonthly basis at Great Miami River at New Baltimore, OH, as a part of NASQAN.

Middle Ohio Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Upper Twin Creek at McGaw, OH, and at South Hogan Creek near Dillsboro, IN, as a part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a daily basis at Little Miami River at Milford, OH, in cooperation with the Ohio Department of Natural Resources.

3. Suspended-sediment data are being collected on a quarterly basis at Ohio River at Greenup Dam, KY, and Ohio River at Markland Dam, KY, as a part of NASQAN.

Kentucky-Licking Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Licking River at Butler, KY, and on a bimonthly basis at Kentucky River at Lock 2 at Lockport, KY, as a part of NASQAN.

Green Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Green River near Beech Grove, KY, as a part of NASQAN.

2. Suspended-sediment data are being collected on a daily basis at Green River at Munfordville, KY, as a part of the Federal Sediment Index Network.

Wabash Subregion

1. Suspended-sediment data were collected quarterly at White River at Hazelton, IN, as part of NASQAN.

2. Suspended-sediment data are being collected on a quarterly basis at Wabash River at New Harmony, IN, and at Little Wabash River at Main Street at Carmi, IL, as a part of NASQAN.

Cumberland Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Cumberland River at Carthage, TN, and at Cumberland River near Grand Rivers, KY, as a part of NASQAN.

2. Suspended-sediment data are being collected on a daily and storm-event basis in cooperation with the COE, Nashville District, at the following stations:

Clover Fork at Harlan, KY
Yellow Creek near Middlesboro, KY
Cumberland River at Barbourville, KY
Cumberland River near Pineville, KY
Cumberland River at Cumberland Falls, KY
Cumberland River at Williamsburg, KY
Martins Fork above Smith, KY

Lower Ohio Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Rolling Fork near Lebanon Junction, KY, and Ohio River at Cannelton Dam, KY, and on a bimonthly basis at Ohio River at Lock and Dam 53 near Grand Chain, IL, and Salt River at Shepherdsville, KY, as part of NASQAN.

Special Studies

1. Suspended-sediment data were collected with an automatic sampler at Enlow Fork near West Finley, PA. These data were collected as part of a study to evaluate the effects of mining on streams in Washington County.

2. Suspended-sediment data are being collected with automatic samplers at two sites draining small basins (less than 100 acres) in Ritchie County, WV. These data are part of a study to evaluate the effects of sediment control measures on soil erosion and sediment transport in areas of intensive oil and gas well development in Ritchie County.

3. Suspended-sediment data were collected with automatic samplers at two sites in the Big Sandy Creek basin in Fayette County, PA, during 1984. The data were collected as part of a study to evaluate the effects of surface mining on the Big Sandy Creek basin of southwestern Pennsylvania.

4. Suspended-sediment data were collected with automatic samplers at three sites in the Indian Creek basin in Westmoreland and Fayette Counties, PA. The data were collected as part of a study to evaluate the impacts of surface mining on Indian Creek.

5. A study of course material movement and channel adjustment in the South Fork Cumberland River basin, TN, is being conducted in cooperation with the Tennessee Division of Surface Mining and Reclamation.

6. In cooperation with the COE, four suspended sediment discharge stations are being operated; New River at New River, TN, Clear Fork near Rubbins, TN, South Fork Cumberland River at Leatherwood Ford, TN, and South Fork Cumberland River near Stearns, KY. These stations monitor daily and storm-event loads. These data will be used to define current water-quality conditions within the Big South National River and Recreation Area, TN.

For additional information about Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
Champaign County Bank Plaza
102 East Main Street, 4th Floor
Urbana, IL 61801

District Chief, WRD
U. S. Geological Survey
208 Carroll Building
8600 La Salle Road
Towson, MD 21204

District Chief, WRD
U.S. Geological Survey
A-413 Federal Building
U.S. Courthouse
Nashville, TN 37203

District Chief, WRD
U.S. Geological Survey
2301 Bradley Avenue
Louisville, KY 40217

District Chief, WRD
U.S. Geological Survey
603 Morris Street
Charleston, WV 25301

District Chief, WRD
U.S. Geological Survey
6023 Guion Road
Suite 201
Indianapolis, IN 46254

District Chief, WRD
U.S. Geological Survey
P.O. Box 1107
Harrisburg, PA 17108

Chief, Virginia Office, WRD
U.S. Geological Survey
3600 West Broad Street, Room 606
Richmond, VA 23230

District Chief, WRD
U.S. Geological Survey
975 West Third Avenue
Columbus, OH 43212

SOIL CONSERVATION SERVICE

1. Studies of erosion and sediment yields were made in the following watersheds:

   a. Public Law 566.

Major Drainage	Watershed	Stream	County	State
Ohio River	Highland Creek	Highland	Henderson Union Webster	KY
Ohio River	Massac Creek	East Fork	McCracken	KY
Youghiogheny	Laurel Hill Creek	Laurel Hill Creek	Somerset	PA

2. Reservoir sedimentation Surveys.

   Reservoir sedimentation surveys were made on the following reservoirs:

Reservoir	County	State
Dunlap Creek, PA 470	Fayette	Pennsylvania
Harmon Creek, PA 484	Washington	Pennsylvania
Jacobs Creek, PA 657	Westmoreland	Pennsylvania

3. Special Studies

   a. In-depth inventorying and monitoring of land cover and potential erosion were conducted in Christian, Logan, Todd, Simpson, and Warren counties in Kentucky (Land and Water 201 - County/USDA/TVA Regional Resource Area). Landsat 4 TM imagery and ancillary data were used to map major land use and cover categories. Current digitized soil information was utilized to provide erosion estimates.

   b. A study was made of sediment eroded from 64,500 acres of abandoned lands strip mined for coal in southeastern Ohio. The Assessment was made by the Soil Conservation Service in conjunction with the U.S. Forest Service and the Ohio Department of Natural Resources, Division of Reclamation.

   c. The Kentucky Special Resource Study (KSRS) involves the assignment of measured amounts of sediment to upstream sources. The FASS (First Approximation of Suspended Sediment) procedure, developed by the Forest Service, was used to allocate sediment to sources on the following 13 watersheds:

Major Land Resource Area	Watershed	Size (acres)	County
Western KY Coal Fields	Lock Mary Reservoir	2,350	Hopkins
	Caney Creek	3,664	Grayson
Kentucky Bluegrass	Upper Green River	992	Lincoln
	Little Kentucky River	1,550	Henry
	Lake Reba	3,239	Madison
Pennyroyal	East Fork Pond River	13,376	Christian
	Mill Creek	4,646	Monroe
	Valley Creek	3,230	Hardin
Eastern KY Mountains and Coal Fields	Salt Lick Creek	2,200	Menifee
	Cranks Creek	15,872	Harlan
	Martins Fork	19,776	Harlan
Purchase Area	Massac Creek	9,344	McCracken
	East Fork Clarks River	4,164	Calloway

TENNESSEE REGION

GEOLOGICAL SURVEY

Upper Tennessee Subregion

1. Suspended-sediment data are being collected on a quarterly basis at French Broad River at Marshall, NC, and bimonthly at French Broad River near Knoxville, TN, Clinch River at Melton Hill Dam, TN, and Holston River near Knoxville, TN, as part of the National Stream Quality Accounting Network (NASQAN).

2. Suspended-sediment data are collected on a bimonthly basis at Little River above Townsend, TN, and quarterly at Cataloochee Creek near Cataloochee, NC, as a part of the National Hydrologic Benchmark program.

Middle Tennessee-Hiwassee Subregion

1. Suspended-sediment data are being collected on a monthly basis at Tennessee River at Watts Bar Dam, TN, as part of NASQAN.

2. Suspended-sediment data are being collected in the Tennessee River basin in Georgia at 3 sites on a monthly basis and at 13 sites on a semiannual basis as part of the Office of Surface Mining Coal Hydrology program.

Tennessee-Elk Subregion

1. Suspended-sediment data are being collected on a monthly basis at Tennessee River at South Pittsburg, TN, as a part of NASQAN.

2. Suspended-sediment data are being collected by an automatic PS-69 sampler at Tennessee-Tombigbee Waterway at Cross Roads, MS, in cooperation with the U.S. Army Corps of Engineers (COE).

Lower Tennessee Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Tennessee River at Pickwick Landing Dam, TN, and at Tennessee River at Highway 60 near Paducah, KY, as a part of NASQAN.

2. Suspended-sediment data are being collected on a periodic basis at Buffalo River near Flat Woods, TN, as part of the National Hydrologic Benchmark Network.

Special Studies

1. All available suspended-sediment data for the Tennessee River basin are being compiled, entered into the WATSTORE system, and analyzed in cooperation with Tennessee Tech University.

For additional information about Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
6481 Peachtree Industrial Blvd.
Suite B
Doraville, GA 30360

District Chief, WRD
U.S. Geological Survey
Room 436, Century Postal Station
300 Fayetteville Street Mall
Raleigh, NC 27602

District Chief, WRD
U.S. Geological Survey
2301 Bradley Avenue
Louisville, KY 40202

District Chief, WRD
U.S. Geological Survey
Suite 710, Federal Building
100 West Capitol Street
Jackson, MS 39269

District Chief, WRD
U.S. Geological Survey
A-413 Federal Building
U.S. Courthouse
Nashville, TN 37203

UPPER MISSISSIPPI REGION

CORPS OF ENGINEERS

North Central Division

Chicago District

Chicago River, North Branch. Suspended sediment sampling, funded by the District, is performed by a U.S.G.S. observer in conjunction with operation of U.S.G.S. discharge gage station number 05536000 on the North Branch Chicago River at Niles, Illinois. Data is available in the District files.

Little Calumet River at Munster, Indiana. Weekly suspended sediment sampling, funded by the District, is performed by a U.S.G.S. observer in conjunction with operation of U.S.G.S. discharge gage station number 05536195. Sediment parameters analyzed are Total Suspended Solids and Volatile Suspended Solids. Data is available in the District files.

Calument River, Illinois. A sediment sampling program was conducted in Lake Calumet, Chicago, Illinois during September 1985 in relation to a proposed reconnaissance study under Section 107 (Small Navigation Projects) of the River and Harbor Act of 1960, as amended. Grab samples of bottom sediments were collected and analyzed for physical and chemical properties including sieve analysis, TVS, COD, nutrients, heavy metals and PCB's. The results were presented in a report dated November 1985, and are available from the District.

Rock Island District

Suspended Sediment Sampling. Suspended load sampling is being conducted at 27 stations; 3 located on the Mississippi River and 24 on its tributaries, including 3 on the Illinois River and its tributaries. Eighteen long-term stations are operated and maintained directly by the District. Nine stations which began in conjunction with the GREAT II program are now being operated and maintained under a cooperative program with the U. S. Geological Survey.

Bedload Sampling. Bedload sampling is being conducted at 5 stations located on tributaries of the Mississippi River. Samples are collected during three peak flows for the year using the Helley Smith bedload sampler. All stations at which bedload samples are collected are operated and maintained in cooperation with the USGS. Records for the bedload stations are also maintained by the USGS.

Sedimentation Surveys. The survey of sedimentation ranges in Lake Red Rock was completed in 1985. A report detailing the results of this survey will be completed in June of 1986. Additionally, reports detailing the results of survey of Coralville Lake and Saylorville Lake completed during 1984, will be published in September 1986 and February 1987, respectively.

St. Paul District

Both suspended and bedload measurements were conducted daily at six stations by the U. S. Geological Survey under the sponsorship of the District and published in their Water Resources Data. These stations are at Anoka, MN on Mississippi River; near Big Stone City, SD on Whetstone River; near Odessa, MN on Yellow Bank River; at Mankato, MN on Minnesota River; at Winona, MN on Mississippi River and at McGregor, IA on Mississippi River.

UPPER MISSISSIPPI REGION

GEOLOGICAL SURVEY

Mississippi Headwaters Subregion

1. Suspended-sediment data are being collected on a daily basis during open water at Mississippi River near Anoka, MN, in cooperation with the U.S. Army Corps of Engineers (COE).

2. Suspended-sediment data are being collected on a bimonthly basis at Mississippi River near Royalton, MN, and on a quarterly basis at Mississippi River at Nininger, MN, as a part of the National Stream Quality Accounting Network (NASQAN).

Minnesota Subregion

1. Suspended-sediment data are being collected on a daily basis during open water at Minnesota River at Mankato, MN, and on a daily basis March through August at Whetstone River near Big Stone City, SD, and at Yellow Bank River near Odessa, MN, in cooperation with the COE.

2. Suspended-sediment data are being collected on a quarterly basis at Minnesota River near Jordon, MN, as a part of NASQAN.

St. Croix Subregion

1. Suspended-sediment data are being collected on a monthly basis at St. Croix River at St. Croix Falls, WI, as a part of NASQAN.

Upper Mississippi-Black-Root Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at North Fork Whitewater River near Elba, MN, as a part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a daily basis, or weekly during the ice period, at Mississippi River at Winona, MN, in cooperation with the COE.

3. Suspended-sediment data are being collected on a bimonthly basis at Durand and Black River at Galesville, WI, as a part of NASQAN.

4. Suspended-sediment data were collected on a weekly and runoff-event basis at Garvin Brook near Minnesota City and Stockron Valley Creek at Stockton, MN, through July 13, 1985.

Upper Mississippi-Maquoketa-Plum Subregion

1. Suspended-sediment data are being collected on a daily basis at Mississippi River at McGregor, IA, in cooperation with the COE, St. Paul District.

2. Suspended-sediment data are being collected on a periodic and storm-event basis to determine monthly suspended-sediment loads for the COE at the Grant River at Burton, WI.

Wisconsin Subregion

1. Suspended-sediment data are being collected on a periodic and storm-event basis at:

Black Earth Creek at Cross Plains, WI
Black Earth Creek at Black Earth, WI
Brewery Creek at Cross Plains, WI
Garfoot Creek at Cross Plains, WI

Samples are collected intermittently at 14 other sites on Black Earth Creek and small tributaries in the Cross Plains-Black Earth area. These data are being collected in cooperation with the Wisconsin Department of Natural Resources.

2. Suspended-sediment and bed-material data are being collected on a bimonthly basis as part of NASQAN and storm-event basis for the COE at Wisconsin River at Muscoda, WI.

Upper Mississippi-Iowa-Skunk-Wapsipinicon Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Mississippi River at Clinton, IA, and at Mississippi River at Keokuk, IA, as a part of NASQAN.

2. Suspended-sediment data are being collected on a daily basis at the following in cooperation with the Iowa Geological Survey:

Iowa River at Iowa City, IA
Ralston Creek at Iowa City, IA
Skunk River at Augusta, IA

3. Suspended-sediment data are also being collected on a bimonthly basis at Skunk River at Augusta, IA, as part of NASQAN.

4. Suspended-sediment data are being collected on a daily basis at Iowa River at Wapello, IA, in cooperation with COE, Rock Island District. Suspended-sediment data are also being collected on a bimonthly basis as part of NASQAN.

Rock Subregion

1. Suspended-sediment data are being collected on a periodic and storm-event basis at:

Jackson Creek at County Hwy H near Elkhorn, WI
Jackson Creek tributary near Elkhorn, WI
Delavan Lake tributary at South Shore Drive at Delavan Lake, WI

and on an intermittent basis at:

Jackson Creek at Mounds Road near Elkhorn, WI
Delavan Lake Inlet at U.S. Hwy 50 at Delavan Lake, WI
Delavan Lake Outlet at Bong Road near Delavan Lake, WI

These data are being collected in cooperation with the Delavan Lake Sanitary District.

2. Suspended-sediment data are being collected on a periodic and storm-event basis to determine monthly suspended-sediment loads for the COE, Rock Island District, at Sugar River near Brodhead, WI.

3. Suspended-sediment data are being collected on a storm-event basis in cooperation with Dane County, WI, at:

Pheasant Branch Creek at Middleton, WI, at U.S. Highway 12
Spring Harbor Storm Sewer at Madison, WI

4. Suspended-sediment data are being collected on a quarterly basis at Rock River near Joslin, IL, as part of NASQAN.

Des Moines Subregion

1. Suspended-sediment data are being collected on a daily basis at Des Moines River near Saylorville, IA, in cooperation with the COE, Rock Island District.

2. Suspended-sediment data are being collected on a daily basis at Des Moines River at St. Francisville, MO, in cooperation with the COE, Rock Island District, and bimonthly as part of NASQAN.

3. Suspended-sediment data are being collected on a daily basis at Middle Fork Raccoon River at Bayard, IA, and Middle Fork Raccoon River at Panora, IA. This study is a cooperative undertaking with the Engineering Research Institute, Iowa State University at Ames, IA (discontinued September 30, 1985).

Upper Mississippi-Salt-Subregion

1. Suspended-sediment data are being collected on a daily basis at Middle Fabius River near Monticello, MO, in cooperation with the COE, Rock Island District.

2. Suspended-sediment data are being collected on a daily basis and partica~-size data collected on a intermittent basis in cooperation with the COE:

North Fork Salt River near Hunnewell, MO
Middle Fork Salt River at Paris, MO

3. Suspended-sediment data are being collected on a daily basis at Salt River near New London, MO, and Mississippi River below Alton, IL, in cooperation with the COE, St. Louis District. Suspended-sediment data also are being collected on a quarterly basis at New London and a bimonthly basis at Alton as part of NASQAN.

Upper Illinois Subregion

1. Suspended-sediment data are being collected every other day, and more frequently during high flows at North Branch Chicago River at Neils, IL, in cooperation with the COE, Chicago District.

2. Suspended-sediment data are being collected on a quarterly basis at Illinois River at Marseilles, IL, as a part of NASQAN.

Lower Illinois Subregion

1. Suspended-sediment data are being collected three times a week, and more frequently during high flows, from the Illinois River at Henry, IL, in cooperation with the COE, Rock Island District. Suspended-sediment data are being collected every other day, and more frequently during high flows, at Mackinaw River below Congerville and Sangamon River near Oakford, IL, in cooperation with the COE, Rock Island District, and Illinois River at Valley City, IL, in cooperation with the COE, St. Louis District. Additional samples are collected on a bimonthly basis at Sangamon River near Oakford and on a quarterly basis at Illinois River at Valley City, IL, as part of the NASQAN program.

Upper Mississippi-Kaskaskia-Meramec Subregion

1. Suspended-sediment data are being collected every other day, and more often during high flows, in cooperation with the COE, St. Louis District at the following sites:

    Kaskaskia River at Cooks Mills, IL
    Kaskaskia River at Venedy Station, IL
    Big Muddy River at Murphysboro, IL

Suspended-sediment samples are also collected on a bimonthly basis at the Kaskaskia River at Venedy Station, IL, and Big Muddy River at Murphysboro, IL, as part of the NASQAN program.

2. Suspended-sediment data are being collected on a daily basis at Mississippi River at St. Louis, MO, in cooperation with the COE, St. Louis District.

3. Suspended-sediment data are being collected on a daily basis at Meramec River near Eureka, MO, and at Mississsippi River at Thebes, IL, in cooperation with the COE, St. Louis District. Suspended-sediment data also are being collected on a bimonthly basis at these two stations as a part of NASQAN.

4. Suspended-data are being collected on a daily basis at Mississippi River at Chester, IL, in cooperation with the COE, St. Louis District.

Special Studies

1. Water-Resources Investigations Report 85-4312 entitled "Suspended Sediment in Minnesota Streams" by L. H. Tornes was approved for publication.

2. Suspended-sediment data are being collected every other day, and more frequently during high flows at Big Creek near Bryant, IL, in cooperation with the Metropolitan Sanitary District of Greater Chicago. The sediment data collected are used to monitor changes in sediment transport during the reclamation of a strip-mined area by irrigating with digested sludge from sewage treatment facilities.

3. Suspended-sediment samples are being collected at several locations in the low-level radioactive-waste disposal site at Sheffield, IL. The data will be used to determine the relation of sediment discharge to runoff for the site; the types and rates of geomorphic change; the potential for erosion and slumping; and to establish a data base to which changes caused by changing practices on the site can be compared.

Laboratory Activities

The Geological Survey laboratory in Iowa City, IA, analyzed suspended-sediment samples collected by the COE at:

Bay Creek at Nebo, IL
Wapsipinicon River at DeWitt, IA
Iowa River at Marengo, IA
Iowa River at Coralville Dam, IA
Mississippi River at Burlington, IA
Mississippi River at Keokuk, IA
Des Moines River near Stratford, IA
Raccoon River at Van Meter, IA
North River near Norwalk, IA
Middle River near Indianola, IA
South River near Ackworth, IA
Des Moines River near Tracy, IA
Des Moines River at Kedsauqua, IA
Mississippi River at East Dubuque, IL

For additional information about Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
Champaign County Bank Plaza
102 East Main Street, 4th floor
Urbana, IL 61801

District Chief, WRD
U.S. Geological Survey
6023 Guion Road, Suite 201
Indianapolis, IN 46254

District Chief, WRD
U.S. Geological Survey
P.O. Box 1230
Iowa City, IA 52244

District Chief, WRD
U.S. Geological Survey
702 Post Office Building
St. Paul, MN 55101

District Chief, WRD
U.S. Geological Survey
1400 Independence Road
Mail Stop 200
Rolla, MO 65401

District Chief, WRD
U.S. Geological Survey
1815 University Avenue
Madison, WI 53705

SOIL CONSERVATION SERVICE

1. Studies of sediment damages and determinations of sediment yields were made in the following watersheds:

   a. Public Law 566

Major Drainage	Watershed	Stream	County	State
Fox River	Long Lake	Squaw Creek	Lake	Illinois

   b. River Basin Investigations

Major Drainage	Basin Reported	Watershed	State
Upper Mississippi	Kankakee River		Illinois Indiana
Rush-Vermillion	N. Mississippi Valley Loess Hills	Isabelle Creek	Wisconsin
Grant--Little Maquoketa	N. Mississippi Valley Loess Hills	Rattlesnake Creek	Wisconsin

   c. Resource Conservation and Development

Project Name	County	State
Whiskey Hollow	Louisa	Iowa

2. Reservoir Sedimentation Surveys

   A reservoir sedimentation survey was made on he following reservoir:

Reservoir	County	State
Big Wyacondah	Davis	Iowa

3. Special Studies

   a. A stream channel erosion and sediment yield study was made for:

Major Drainage	Watershed	Stream	County	State
Sagamon River	Lick Creek	Lick Creek	Sangamon	Illinois

b. A procedure for determining sediment yield reduction due to conservation treatment on cropland was prepared for Wisconsin.

c. Ephemeral gully erosion was measured in the following areas:

Major Drainage	Stream	County	State
Mississippi River	Wyaconda River	Clark	Missouri
Mississippi River	Salk River	Monroe	Missouri

LOWER MISSISSIPPI REGION

CORPS OF ENGINEERS

Lower Mississippi Valley Division

Memphis District

Sediment sampling continued at 15 stations between Madison, AR and Fisk, MO previously established in the St. Francis Basin and the station previously estalished near Colt, AR in the L'Anguille River Basin. Suspended sediment samplers DH76TM, DH78, D74ALTM and bed sampler BMH60 were used. Types of records maintained are: discharge, observed suspended and bed sediment grain size distributions, observed suspended sediment concentrations, computed suspended sediment load and temperature.

New Orleans District

Sediment Load Measurements.

1. Suspended sediment and bed material samplings were continued at the following seven ranges: Mississippi River at Coochie, LA, semimonthly; Mississippi River at Tarbert Landing, LA, semimonthly; Old River Outflow Channel near Knox Landing, LA, semimonthly; Atchafalaya River at Simmesport, LA, semimonthly; Wax Lake Outlet at Calumet, LA, monthly; and Lower Atchafalaya River at Morgan City, LA, monthly.

2. Suspended sediment samples were taken with a U. S. P-46, or U. S. P-61 sampler. Bed material samples were taken with a BM-54 sampler or drag bucket type sampler. Daily suspended sediment samplers were taken with a trap type sampler.

Office Investigations.

For the District, WES is performing an investigation of the Atchafalaya Bay, incorporating both physical and mathematical models to study the bay hydrodynamics and the effects the Atchafalaya River will have in the future. Two sediment models are being used to forecast long term evolution of the delta, HAD-1 and STUDH. HAD-1 is a pseudo two dimensional sediment computation program using steady state hydraulics. STUDH is sediment transport program using unsteady two dimensional flows in the horizontal plane.

A computer Data Base System is being used to store hydrographic data for the period of record in the District. It is also used to analyze, store, and retrieve sediment data.

The District has a contract with Louisiana State University to study the Atchafalaya Delta. The task involves updating information on the historical growth of the delta, conducting a field data collection and monitoring

programs to compute flow and sediment budgets and correlate suspended sediment concentrations with LANDSAT digital data in the area, and performing grain size analyses on suspended sediment and bed-material samples of the delta.

St. Louis District

A resurvey of upstream and downstream retrogression ranges at Rend Lake was initiated. The survey will be completed in early 1986. The data analysis will be completed by late 1986 or early 1987.

The analysis of the 1984 resurvey at Lake Shelbyville has been completed and forwarded for approval.

The analysis of the 1982 and 1984 resurvey data at Carlyle Lake has been completed and forwarded for approval.

Vicksburg District

Sedimentation Surveys. Channel geometry data, such as cross sections and profiles, were made on many streams within the District during the year. This data, which is to be used in various hydrologic and hydraulic studies, was collected by surveying existing and new permanent ranges, temporary ranges, and fathometer spot surveys.

Sediment Load Measurements.

1. Both bed sample and suspended sample measurements are being made weekly at three locations on the Mississippi River. These locations are Natchez, Mississippi; Vicksburg, Mississippi; and Arkansas City, Arkansas. Bed material samples are gathered using a BM-54 bed material sampler, and suspended material samples are collected using a P-61 suspended materials sampler.

2. An ongoing program in which the suspended material sample, bed material sample, temperature, discharge, and stage data are collected and computerized for many stations within the District has been continued. Sedimentation data was collected at approximately 40 stations during 1985. Temporary sampling stations were established above and below Lock and Dam 1 on the Red River to determine the deposition rate of the approach channel. Bed samples are collected using either BM-54, BMH-60, or drag bucket bed material samples while suspended samples are collected using either D-48, D-57, D-61, or D-74 suspended materials samplers.

Office Investigations.

a. The Mississippi River sediment data has been analyzed to determine sediment discharge curves at each of the three stations.

b. A comprehensive data collection program was continued for Goodwin Creek. This data collection program is being continued by the Agricultural Research Service at no cost to the District.

c. A sediment investigation to determine the deposition rate of the approach channel to Lock and Dam 1 on the Red River was continued in 1985 and expanded to include the effects of sediment deposition on the operation of the downstream floating guide wall. Both one-dimensional (HEC-6) and two-dimensional (TABS-2 system) computer models were used in this investigation.

d. Several sediment studies were initiated in 1985 for the lock and dam system on the Red River. One-dimensional (HEC-6) and/or two-dimensional (TABS-2 system) computer models were used. These studies consisted of:

(1) Assessment of the effects of hydropower operation on the deposition rates for Lock and Dam 1, 2, 3, 4, and 5.

(2) Determination of the deposition rate for the approach channel to Lock and Dam 2.

(3) Assessment of the possible deposition problems at the proposed locations for Lock and Dams 4 and 5.

Southwestern Division

Little Rock District

Sediment sampling continued at Dam No. 2, L&D No. 3, L&D No. 4, L&D No. 5 and David D. Terry L&D on the Arkansas River. Samples were taken intermittently with USD-49 and the concentration in terms of the percent of weight were obtained.

LOWER MISSISSIPPI REGION

GEOLOGICAL SURVEY

Lower Mississippi-Hatchie Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Mississippi River at Memphis, TN, and on a monthly basis at Obion River at Obion, TN, and at Hatchie River at Bolivar, TN, as a part of the National Stream Quality Accounting Network (NASQAN).

Lower Mississippi-St. Francis Subregion

1. Suspended-sediment data are being collected on a quarterly basis at St. Francis River at Parkin, AR, and bimonthly at St. Francis Bay at Riverfront, AR, as a part of NASQAN.

Lower Mississippi-Lower White Subregion

1. Suspended-sediment data are being collected on a quarterly basis at White River at Clarendon, AR, as a part of NASQAN.

Lower Mississippi-Lower Arkansas Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Arkansas River at Dam 2 near Gillett, AR, as part of NASQAN.

Lower Mississippi-Yazoo Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Yazoo River at Redwood, MS, and on a quarterly basis at Mississippi River near Arkansas City, AR, and Yazoo River near Shell Bluff, MS, as a part of NASQAN.

2. Suspended-sediment data are being collected by a automatic PS-69 sampler at North Fork Tillatoba Creek near Teasdale, MS, in cooperation with the U.S. Soil Conservation Service.

Lower Red-Ouachita Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Ouachita River at Columbia, LA, at Red River near Simmesport, LA, and on a quarterly basis at Ouachita River at Camden, AR, as a part of NASQAN. Sediment data are being collected on a quarterly basis at Big Creek at Pollock, LA, as a part of the National Hydrologic Benchmark Network.

Boeuf-Tensas Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Tensas River at Tendal, LA, and bimonthly at Boeuf River at Fort Necessity, LA, as a part of NASQAN.

Lower Mississippi-Big Black Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Big Black River at Bovina, MS, and quarterly at Homochitto Creek at Rosetta, MS, and Mississippi River at Vicksburg, MS, as part of NASQAN.

Lower Mississippi-Lake Maurepas Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Arite River at 4-H Camp near Denham Springs, LA, Tangipahoa River at Robert, LA, Lower Grand River at Bayou Sorrel, LA, and at Tchefuncta River near Covington, LA, as a part of NASQAN.

Louisiana Coastal Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Bayou Teche at Keystone Lock and Dam below St. Martinville, LA, Mermentau River at Mermentau, LA, and at Calcasieu River near Kinder, LA, and monthly at Atchafalaya River near Melville, LA, as a part of NASQAN and in cooperation with the U.S. Army Corps of Engineers (COE).

2. Suspended-sediment data are being collected on a bimonthly basis at the following sites as a part of NASQAN.

Mississippi River at Belle Chasse, LA
Mississippi River near St. Francisville, LA

3. Suspended-sediment and bed-material data are collected at the following sites on a monthly basis in cooperation with the COE:

Lower Atchafalaya River at Morgan City, LA
Wax Lake Outlet at Calumet, LA

Special Studies

1. Suspended-sediment data are being collected at 22 stations on the St. Francis River and selected tributaries for the COE. Eight sites are collected on a monthly basis and the remaining 14 sites are collected on a monthly basis from November through June. Monitoring is expected to continue from year to year as the need exists.

2. An interagency study is being conducted to quantify sediment transport to Reelfoot Lake. Three stations have been equipped with automatic samplers and three stations are sampled manually.

3. In cooperation with the Tennessee Department of Transportation, a study of man-induced channel adjustments in the fluvial channels of western Tennessee is being conducted.

4. In cooperation with the U.S. Soil Conservation Service, an intensive study of channel adjustment and sediment transport is being conducted on the Cane Creek basin in the Hatchie River basin. Two stations on Cane Creek have been equipped with PS-69 samplers.

Laboratory Activities

The Geological Survey sediment laboratory located in Baton Rouge, LA, analyzed suspended-sediment and bed-material samples collected by the COE at the following locations:

Old River Outflow near Knox Landing
Red River above Old River Outflow
Mississippi River at Coochie
Mississippi River at Tarbert Landing
Atchafalaya River at Simmesport
Bayou Chene above Bayou Crook Chene
East Access Channel above Lake Chicot
Lake Long below Bayou LaRompe
Little Tensas below Blind Tensas Cut

For additional information about Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
Federal Office Building
Room 2301
700 West Capitol Avenue
Little Rock, AR 72201

District Chief, WRD
U.S. Geological Survey
P.O. Box 66492
Baton Rouge, LA 70896

District Chief, WRD
U.S. Geological Survey
Suite 710, Federal Building
100 West Capitol Street
Jackson, MS 39269

District Chief, WRD
U.S. Geological Survey
A-413 Federal Building
U.S. Courthouse
Nashville, TN 37203

SOIL CONSERVATION SERVICE

1. Studies of erosion rates and sediment damages were made for analyses of accelerated land treatment for watershed protection plans in the following watersheds:

   a. Public Law 566.

Major Drainage	Watershed	Stream	County	State
Mississippi River	Obion River	Spring Creek	Weakley Henry Carroll	TN
Tennessee River	White Oak	White Oak Creek	Hardin McNairy Henderson Chester	TN
Tennessee River	Elk River	Beans Creek	Franklin Lincoln	TN

2. Reservoir sedimentation Surveys.

   Reservoir sedimentation surveys were made on the following reservoirs:

Reservoir	County	State
Reelfoot Indian Creek DS No. 7	Obion	TN
Cane Creek DS No. 19	Lauderdale	TN

3. Special Studies

   Ephemeral gully erosion measurements were continued in the following area:

Major Drainage	Stream	County	State
Arkansas River	Spring River	Jasper	Missouri

SOURIS-RED-RAINY REGION

CORPS OF ENGINEERS

North Central Division

St. Paul District

Sediment loads were measured by the U. S. Geological Survey at two river stations (near Kindred, ND on Sheyenne River and at Walhalla, ND on Pembina River) under the District sponsorship.

SOURIS-RED-RAINY REGION

GEOLOGICAL SURVEY

Souris Subregion

1. Suspended-sediment data are being collected on a periodic basis at Souris River near Westhope, ND, as part of the National Stream Quality Accounting Network (NASQAN). Additional periodic suspended-sediment data were collected at Souris River near Verendrye, ND.

Red Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Sheyenne River at Kindred, ND, and Red River at the north at Halstad, MN, as a part of NASQAN.

2. Suspended-sediment data are being collected on a periodic basis at Beaver Creek near Finley, ND, as a part of the National Hydrologic Benchmark Network.

3. Suspended-sediment data are being collected on a bimonthly basis at the Red Lake River at Crookston, MN, and at Roseau River below State Ditch 51 near Caribou, MN, as a part of NASQAN.

Rainy Subregion

1. Suspended-sediment data were collected on a quarterly basis at Little Fork River at Littlefork, MN, and at Kawishiwi River near Ely, MN, and on a bimonthly basis at Rainy River at Manitou Rapids, MN, as part of NASQAN.

Special Studies

1. Water-Resources Investigations Report 85-4312 entitled "Suspended Sediment in Minnesota Streams" by L. H. Tornes was approved for publication.

For additional information about Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
702 Post Office Building
St. Paul, MN 55101

District Chief, WRD
U.S. Geological Survey
821 East Interstate Avenue
Bismarck, ND 58501

SOIL CONSERVATION SERVICE

1. Reservoir Sedimentation Studies

A reservoir sedimentation survey was made on the following reservoir:

Reservoir	County	State
Big Coulee Dam	Towner	North Dakota

MISSOURI REGION

BUREAU OF RECLAMATION

A hydrographic survey was completed for Jamestown Reservoir in southeastern North Dakota. Jamestown Reservoir is located on the James River. In conjunction with this survey, three wildlife refuge ponds on the James River upstream of the reservoir were also surveyed. Underwater topographic maps of the refuge ponds were prepared.

MISSOURI BASIN REGION

CORPS OF ENGINEERS

Missouri River Division

Kansas City District

Sediment Load Measurements. The measurement of suspended sediment was continued at 17 stations through the water year. At the end of the water year, three stations were closed. Two of these stations were located below Harry S. Truman Dam in the Lake of the Ozarks' pool and were used for monitoring purposes. By name these sites were called Buffalo Cove and Lake Ozards, Missouri. The third station closed was Lake City, Missouri, located on the Little Blue River. At the beginning of the 1986 water year two stations on the Kansas River were reactivated, Fort Riley and Eudora, Kansas. These stations were reopened for specific data collection and the sampling techniques are not typical as usually practiced by the Corps. Six or seven verticals are being sampled utilizing a P61A1 sampler. The sample or samples collected are continued depth integrated. This sampling methodology is for the purpose of computing the total sand in the cross sections in order to calibrate a budget model to be utilized in monitoring commercial sand dredging. The number of samples collected during the water year will be dependent on the stage discharge events. Currently in operation are three main stem Missouri River stations and 16 tributary stations. The Missouri District of the US Geological Survey collects monthly points, depth integrated, and bed material samples under the cooperative stream gauging program on the main stem of the Missouri River. The Kansas District of the US Geological Survey is performing the sampling described above under the cooperative stream gauging program on the Kansas River. The remaining stations are operated by contract observers or project personnel.

Lake and Reservoir Sediment Activities.

1. Melvern. Although the initial resurvey for this lake was performed during calendar year 1984, it became necessary for the water portion to be resounded during 1985. Discrepancies became apparent when a cross sectional analysis was made. Wire weight measurement at the lake confirmed errors in the soundings. The error was the result of improper calibration of the sounder. Calculation of the volume loss utilizing the resounded range sections indicate a volume loss of approximately 2,500 acre-feet. This value is closer to the anticipated loss based on historic basin yields.

2. Harry S. Truman. The monitoring program below Harry S. Truman project, in the headwaters of the Lake of the Ozarks, Osage arm, is continuing. This program is to monitor the effects on degradation, deposition, bank lines changes, suspended solids, recreational boating and swimming velocities, cove entrances, coves, boat docks, and on any other related physical phenomena which may be attributed to hydropower generation. The reach being monitored has been extended some 10 plus miles for a total

reach of 44 miles below the Harry S. Truman damsite. The extension of the monitoring reach came about during a review of "Donwstream Effects Due to Harry S. Truman Dam and Reservoir Hydropower Operations" by a task group comprised of professors from the University of Missouri, both Columbia and Rolla campuses. Dr. Daryl Simons, a consultant for the task group, suggested the extension to cover the deposition of the resuspended delta sediments. Field measurements have confirmed this extension as a valid suggestion. Erosion sites were initially located downstream at locations considered the most vulnerable to attack. Additional sites have been added in areas not exposed to hydropower flows for comparison of natural erosive spalling which may be attributed to saturation, freeze and thaw, wind, and/or boat waves. Other sites have also been added where local landowners have complained about water frontage losses. These sites were initially surveyed on a monthly basis, but because of the apparent stability and minor bank losses experienced to date, these sites now are surveyed approximately once every three months. Because of the almost constancy of the suspended material concentration, two downlake observer stations were closed at the end of the water year 1985. Intensive thalweg-timed depth integrated sediment samples are collected for each increase in the incremental step up of power generation. This calendar year, however, data collection was limited to flood evacuation flows and no peaking power generation tests were made because of the steady pool elevation maintained by Union Electric Corporation in the Lake of the Ozarks. Resurvey of all downstream COE and UE ranges from the damsite downstream to LOZ mile 50 were collected and have been partially analyzed. All previous data collected have been published, and those data collected during this calendar year are in preparation.

Special Studies.

1. Kansas River. A management study performed by Dr. Daryl Simons, formerly of Simons, Li & Associates, Inc., Fort Collins, Colorado, has been completed. This study analyzed various depths of dredging to determine the short and long term effects upon the channel bed and banks. A regulatory and monitoring plan, as well as an Environmental Impact Statement, is presently being conducted based on minimal impacts of permitting 5.0 ft., reach averaged, vertical depth commercial dredging, as recommended by the above study.

Omaha District

Sediment Load Measurements. The Omaha District operated five suspended sampling stations during the year. One is a Missouri River station and four are major tributary stations. The U.S. Geological Survey operates the stations under a cooperative stream gaging program and includes computation and publication of sediment load records. In addition, with the Corps' assistance, they collect suspended sediment samples, bed material samples, and flow velocity data in the Missouri River at Nebraska City, Nebraska; Omaha, Nebraska; and Sioux City, Iowa. Data collected include point-integrated samples, flow velocity, and a bed sample at five vertical locations in the cross section. Samples are obtained from a boat at each station at about six

week intervals during the open water season. This data will be used to document the bed material load being transported by the Missouri River.

Ground Water Measurements.

1. Niobrara River. Five observation wells are read weekly to monitor ground water changes associated with lake headwater aggradation effects. It is anticipated that delta growth at the mouth of the Niobrar will cause ground water levels to rise in this area.

2. Niobrar Townsite and Ft. Randall Project. Twelve wells at the old Niobrar townsite are read monthly and four wells upstream on the Missouri River are read weekly. Data from these wells will be used to monitor the ground water impacts of aggradation in the Missouri River.

3. Pierre, South Dakota. Nine observation wells were installed in 1983 in response to local complaints of high ground water levels. Two additional wells were installed in December 1985 as part of the Pierre-Fort Pierre Ice Affected Flooding Study. Data from these wells will be used to predict the ground water levels associated with aggradation.

4. Garrison Project. Seventeen wells immediately downstream of Garrison Dam are read monthly. Data from these wells was used for the Garrison Additional hydropower Study.

5. Buford-Trenton Irrigation District. Fourteen wells are read monthly, quarterly or bi-weekly to monitor the effect of Missouri River stage increases on local ground water levels.

6. Fort Peck Project. Twenty-two wells immediately downstream of Fort Peck Dam are read monthly. Data from these wells was used for the Fort Peck Additional Hydropower Study.

Reservoir Sediment Activities.

1. Fort Peck Project. A survey was made of the Fort Peck Lake to locate and mark sediment range monuments. About one half of the monuments were located and marked by a steel post with a two-foot by six-inch white steel plate bolted to it. The remainder of the ranges will be marked prior to start of the resurvey of the lake scheduled for 1986.

2. Garrison Project. A complete resurvey was made of the Garrison degradation reach. This included profiling of all ranges by A-E contract, collection of bed material samples for grain size determination, and a water surface profile during a steady discharge of 21,000 cfs from Garrison Dam by Corps personnel. The data collected will be used to determine the degradation trends, bank erosion rates, and the impacts of bank stabilization work. The

water surface profile will identify changes in water surface slopes, indicating probable location of bed armoring, and help determine stage-discharge rating curve trends at the four stage recording gages located in the reach.

3. Big Bend Project. A partial survey was made on a ten-mile reach of Lake Sharpe from the downstream end of LaFramboise Island to two miles downstream of Antelope Creek. This survey covered most of the same reach that was surveyed without control in 1984; however, an azimuth was obtained from cross-section orientation and distance from sounding boat to water's edge was determined by stadia readings. All sediment ranges were sounded as well as cross sections at about 1000-foot intervals between the ranges using land features for location. A bed map of the reach was developed in an effort to determine if sediment had accumulated in locations that would be undetected with established sediment range resurveys. It was found that the sediment range placement, approximately one range per mile, was adequate to monitor the Lake Sharpe delta growth; however, it did not identify the flow meander pattern over the delta which is obvious when the intermediate cross-section soundings are used.

4. FortRandall Project. A complete resurvey was made of the Fort Randall degradation reach. The reach was last surveyed in 1980. The survey included corss-section soundings of all established sediment ranges by A-E contract and collection of bed samples for grain size determination. The survey will be used to determine degradation trends and bank erosion rates.

5. Gavins Point Project. A complete sedimentation resurvey was made of Lewis and Clark Lake this year. Observations included the sounding of all sediment ranges on the land and cross-section profiles on five Niobrara River ranges by A-E contract. All of the Niobrara ranges were surveyed in 1984 when the Gavins Point Pool Raise Ground Water Study was made; therefore, it was determined that a survey of five index ranges on the Niobrara River was sufficient to document changes in the last year. Bed surface samples were collected for grain size determination and a water profile was measured through the delta reach by Corps personnel. The data will be used to identity amount and location of sediment accumulation and to update area capacity volumes for use by the Reservoir Control Center.

6. Salt Creek Project. A resurvey was made on Twin Lakes and Yankee Hill reservoirs. This was the second resurvey of the lakes since completion. All sediment ranges were surveyed and volume computations for a revised elevation capacity relationship will be completed in 1986.

7. Papillion Creek Acctivities. The Sediment D.M. for Papio Site 18 was prepared and sent to Missouri River Division office for review. Our Survey and Mapping Section has been requested to establish fifteen aggradation and four degradation ranges to monitor the impact of dam construction.

8. Bowman-Haley Project. A contour bed map was developed of a portion of Bowman-Haley reservoir immediately upstream of the dam. A study was initiated

to determine the feasibility of constructing a system to periodically withdraw water from the lower part of the reservoir to improve the water quality in the lake. The bed map was necessary to ensure that the original topography of the lake area was not altered during construction.

Special Studies.

1. Pierre/Fort Pierre Ice-Affected Flooding. A study of potential alternatives to reduce ice affected flooding downstream of Oahe Reservoir in the cities of Pierre and fort Pierre, south Dakota, was completed. The most promising alternative appears to be the installation of a bubbler system in Oahe Reservoir to raise warmer bottom water up where it can be drawn off and released downstream, moving the ice formation out of the problem area.

A data collection program has been initiated to help identify and define the ice problem downstream of Oahe Dam. Air temperature, downstream water temperatures and location of head of ice are being monitored daily with water temperature profiles in the reservoir and ice thicknesses downstream being taken several times over the winter.

2. Aggradation Assessment - Lake Sharpe. A study to determine the 50-year future delta of Big Bend Reservoir was conducted. Preliminary projections show an averaged increase in bed elevation of approximately two feet near Pierre.

3. Flood Protection Project at Sidney, Nebraska. A channel stability analysis was completed on the proposed channelization and channel realignment of Lodgepole Creek and Deadwood Draw at Sidney, Nebraska. Results of the analysis indicate the potential for severe degradation resulting in relatively high channel maintenance costs for the proposed project.

4. IALLUVIAL. A contract was completed by the University of Iowa further refining IALLUVIAL, the computer-based flow- and sediment-routing model being developed jointly by the Omaha District and the University of Iowa. This contract called for the reformulation of the sediment continuity equation to yield conservation of sediment by size fraction, performance of necessary additions and modifications to the computer coding, and verification using the Missouri River.

An additional phase of work was initiated to extend the model to include the Missouri River reach from Omaha to Rulo, modify the coding to permit simulations of aggradation/degradation on multiple tributary streams, and produce a User's and Programmer's Manual. Also included in this phase is the compilation of all available hydrologic data pertaining to the Platte-Missouri River confluence. This work will be completed in 1986.

5. Cherry Creek Channel Stability Analysis. Completed the above study under contract with Goodson & Associates, Inc. of Denver, Colorado. The objective of this study was to identify and evaluate erosion problem areas in

the Cherry Creek channel, from Cherry Creek Dam, Denver, Colorado, to the channel confluence with the South Platte River, and to present alternative solutions to minimize or eliminate erosion problems that place constraints on operational releases from the dam.

6. Lake Sakakawea Shoreline Erosion Study. Conducted a study under contract with Dr. John Reid of the University of North Dakota to develop an improved method for predicting shoreline erosion. Dr. Reid is using the District's historic range line data, together with over two years of data at twenty erosion stations, to develop an equation for predicting shoreline erosion on Lake Sakakawea. The results of this study will be applied to erosion problems on the other mainstem reservoirs. Field data collection for this study was completed in October 1985, with a final report due in January 1986.

7. Garrison Additional Hydropower Study - Ground Water Investigation. A study was completed to determine the effect of various hydropower alternatives on ground water levels in the flood plain below Garrison Dam. A one-dimensional transient-flow ground water model was used to predict the effect of a fluctuating river stage or reregulation pool upon nearby ground water levels. Predications were made for project alternatives, including the addition of one to three power units and a reregulation pool at either of two sites, as well as for baseline conditions.

8. Reconnaissance Study of Recreation Areas - Fort Randall and Oahe Projects. A study of erosion and sedimentation problems at recreation areas on Lake Oahe and Lake Francis Case was initiated in November 1985. Site visits and data collection were completed at both projects before cold weather set in. The final report for Lake Oahe has been completed; the report for Lake Francis Case is in progress.

9. Denver Water Department Environmental Impact Statement. Represented the District on the channel stability work group and reviewed methodology which will be used to assess the impacts of diminished or increased flows upon alluvial channels. This project is scheduled for completion in 1986.

10. Shoreline Erosion Studies. Assessment of shoreline erosion at various sites on Lake Oahe in support of Real Estate Division.

11. Oil and Gas Lease Permit Review. This office reviews oil and gas lease permit applications and recommends minimum elevations for surface occupancy to prevent inundation of oil and gas facilities adjacent to rivers or reservoirs. This work was done on an intermittent basis for Real Estate Division.

12. Snyder-Winnebago Oxbow Lake Ground Water Study. Initiated a study under contract with the Iowa USGS to determine the effect of Missouri River degradation on ground water and oxbow lake levels. The reconnaissance portion of the study was completed in 1985, with the development of a numerical model planned for 1986.

13. Update of Missouri River Degradation Report - Ground Water Appendix. Updated the ground water appendix to include data collected in the past two years.

MISSOURI REGION

GEOLOGICAL SURVEY

Saskatchewan Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at St. Mary's River at Montana, USA-Alberta, Canada, border, as a part of the National Stream Quality Accounting Network (NASQAN).

Missouri-Marias Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Missouri River at Toston, MT, and bimonthly at Missouri River at Fort Benton, MT, and at Marias River near Chester, MT, as a part of NASQAN.

Missouri-Musselshell Subregion

1. Suspended-sediment data are being collected on a daily basis at Missouri River near Landusky, MT, and at Musselshell River at Mosby, MT, in cooperation with the U.S. Army Corps of Engineers (COE).

2. Suspended-sediment data are being collected on a bimonthly basis at Missouri River below Fort Peck Dam, MT, as a part of NASQAN.

Milk Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Milk River at Nashua, MT, as a part of NASQAN.

2. Suspended-sediment data are being collected on a quarterly basis at Little Peoples Creek near Hays, MT, as part of the Federal Collection of Basic Records (CBR) program.

3. Suspended-sediment data are being collected on a quarterly basis at Rock Creek below Horse Creek near the international boundary, as a part of the National Hydrologic Benchmark Network.

Missouri-Poplar Subregion

1. Suspended-sediment data are being collected on a monthly basis at the following sites to define water-quality characteristics of the Poplar River basin:

    Poplar River at international boundary
    East Poplar River at international boundary
    East Fork Poplar River near Scobey, MT

2. Suspended-sediment data are being collected on a bimonthly basis at Missouri River near Culbertson, MT, as a part of NASQAN.

3. Suspended-sediment data are being collected on a monthly basis at Big Muddy Creek near Antelope, MT, and on a quarterly basis at Beaver Creek at international boundary as part of the Federal CBR program and the Water Ways Treaty Program, respectively.

Upper Yellowstone Subregion

1. Daily suspended-sediment data are being collected on a seasonal schedule in cooperation with the Montana Department of Health and Environmental Sciences at the following stations:

Lamar River near Gardner, MT
Yellowstone River at Corwin Springs, MT
Yellowstone River near Livingston, MT

2. Suspended-sediment data are being collected on a bimonthly basis at Yellowstone River near Livingston, MT, and quarterly at Yellowstone River at Billings, MT, as part of NASQAN.

Big Horn Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Bighorn River at Bighorn, MT, as a part of NASQAN.

2. Suspended-sediment data are being collected on a monthly and storm-event basis at East Fork Wind River near Dubois, WY, as part of the Missouri River basin program.

3. Suspended-sediment data are being collected on a daily basis at Fifteenmile Creek near Worland, WY, in cooperation with the Wyoming Department of Environmental Quality.

4. Suspended-sediment data are being collected on a monthly and storm-event basis at Bighorn River at Kane, WY, as a part of the Missouri River basin program.

5. Suspended-sediment data are being collected on a monthly basis at Fivemile Creek and Muddy Creek near Shoshoni, WY, in cooperation with the U.S. Bureau of Reclamation (discontinued September 30, 1985).

6. Suspended-sediment data are being collected on a bimonthly and storm-event basis at Wind River below Boysen Reservoir, WY, as part of NASQAN.

Powder-Tongue Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Tongue River at Miles City, MT, and a bimonthly basis at Powder River at Broadus, MT, as a part of NASQAN.

2. Suspended-sediment data are being collected on a daily basis March through September at Powder River at Moorhead, MT, and at Powder River at Broadus, MT, as part of the Federal CBR program.

3. Suspended-sediment data are being collected on a monthly basis in cooperation with the U.S. Bureau of Land Management at the following stations:

Tongue River at Tongue River Dam near Decker, MT
Hanging Woman Creek near Birney, MT

4. Suspended-sediment data are being collected on a monthly basis at Tongue River at Birney Day School near Birney, MT, as part of the Federal CBR program.

Lower Yellowstone Subregion

1. Suspended-sediment data are being collected on a daily basis at Yellowstone River near Sidney, MT, in cooperation with the COE.

2. Suspended-sediment data are being collected at the following sites in cooperation with the U.S. Bureau of Land Management:

Armells Creek near Forsyth, MT (quarterly)
Rosebud Creek at mouth near Rosebud, MT (quarterly)
Burnes Creek near Serage, MT (monthly)

Missouri-Little Missouri Subregion

1. Suspended-sediment data are being collected on a periodic basis at Bear Den Creek near Mandaree, ND, as part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a periodic basis at Little Missouri River near Watford City, ND, as part of NASQAN.

3. Suspended-sediment data are being collected on a quarterly basis at Deep Creek near Amidon, ND, as part of the coal hydrology program (discontinued September 30, 1983).

Missouri-Oahe Subregion

1. Suspended-sediment data are being collected on a periodic basis at Knife River at Hazen, ND, at Heart River near Mandan, ND, and at Cannonball River at Breien, ND, as a part of NASQAN.

2. Suspended-sediment data are being collected on a periodic basis at Grand River at Little Eagle, SD, and Moreau River near Whitehorse, SD, as a part of NASQAN.

3. Suspended-sediment data are being collected on a bimonthly basis at Moreau River near Whitehorse, SD, as a part of NASQAN.

Cheyenne Subregion

1. Suspended-sediment data are being collected on a periodic basis at Belle Fourche River near Elm Springs, SD, and at Cheyenne River at Cherry Creek, SD, as a part of NASQAN.

2. Suspended-sediment data are being collected on a storm-event basis at miscellaneous sites.

3. Suspended-sediment data are being collected on a quarterly basis at Castle Creek above Deerfield Dam, near Hill City, SD, as a part of the National Hydrologic Benchmark Network.

Missouri-White Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Missouri River at Pierre, SD, and at Missouri River below Fort Randall Dam, SD, as a part of NASQAN.

2. Suspended-sediment data are being collected on a daily basis at Bad River near Fort Pierre, SD, and at White River near Oaeoma, SD, in cooperation with the COE.

Niobrara Subregion

1. Suspended-sediment data are being collected on approximately a bimonthly basis at Niobrara River near Verdel, NE, as a part of NASQAN.

James Subregion

1. Suspended-seiment data are being collected on a periodic basis at James River at LaMoure, ND, James River at Pingree, ND, James River at Jamestown, ND, and James River near Ludden, ND, as part of the Missouri River program.

2. Suspended-sediment data are being collected on a periodic basis at James River near Columbia, SD, and at James River near Scotland, SD, as a part of NASQAN.

Missouri-Big Sioux Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Big Sioux River at Akron, IA, as a part of NASQAN.

North Platte Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at North Platte River near Lisco, NE, as a part of NASQAN.

2. Suspended-sediment data are being collected on a monthly basis at Encampment River above Hog Park Creek near Encampment, WY, as a part of the National Hydrologic Benchmark Network.

3. Suspended-sediment data are being collected on a 6-week and flow-event basis at Deer Creek in canyon near Glenrock, WY.

4. Suspended-sediment data are being collected on a monthly and storm-event basis at North Platte River at Alcova, WY, as part of NASQAN.

South Platte Subregion

1. Suspended-sediment data are being collected on a quarterly basis at South Platte River at Julesburg, CO, as a part of NASQAN.

Platte Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Platte River near Duncan, NE, as a part of NASQAN.

2. Suspended-sediment data are being collected on a quarterly basis at Platte River at Louisville, NE, as a part of NASQAN.

Loup Subregion

1. Suspended-sediment data are being collected once during winter months and twice during spring high-flow periods at Loup River near Genoa, NE, as a part of NASQAN.

2. Suspended-sediment data are being collected on a bimonthly basis at the diversion to the Loup River Power Canal near Genoa, NE, as part of NASQAN.

3. Suspended-sediment data are being collected on a quarterly basis at Dismal River near Thedford, NE, as part of the National Hydrologic Benchmark Network.

Elkhorn Subregion

1. Suspended-sediment data are being collected at Elkhorn River at Waterloo, NE, on a bimonthly basis as a part of NASQAN.

Missouri-Little Sioux Subregion

1. Suspended-sediment data which includes bed material, suspended-sediment samples, and velocities at several points in a vertical are being collected at the following stations in cooperation with the COE, Omaha District:

Missouri River at Sioux City, IA
Missouri River at Omaha, NE
Missouri River at Nebraska City, NE

2. Suspended-sediment data are being collected at Missouri River at Sioux City, IA, and Missouri River at Omaha, NE, as a part of NASQAN.

Missouri-Nishnabotna Subregion

1. Suspended-sediment data are being collected on a daily basis at Nodaway River at Clarinda, IA, in cooperation with the Iowa Geological Survey.

2. Suspended-sediment data are being collected on a quarterly basis at Nishnabotna River above Hamburg, IA, as a part of NASQAN.

3. Suspended-sediment data are being collected on a quarterly basis at Platte River at Sharps Station, MO, and bimonthly at Missouri River at St. Joseph, MO, as a part of NASQAN.

Republican Subregion

1. Suspended-sediment data are being collected on a 6-week basis at Beaver Creek at Cedar Bluffs, KS, South Fork Sappa Creek near Brewster, Prairie Dog Creek above Keith Sebelius Lake, and White Rock Creek near Burr Oak, KS, in cooperation with the Kansas Water Office.

2. Suspended-sediment data are being collected on a 6-week basis at Republician River near Clay Center, KS, as part of NASQAN.

Smoky Hill Subregion

1. Suspended-sediment data are being collected on a 6-week basis at Smoky Hill River at Enterprise, KS, Saline River at Tescott, KS, North Fork Smoky Hill River near McAllaster, KS, Big Creek near Hays, KS, North Fork Big Creek near Victoria, KS, Saline River near Russell, KS, North Fork Solomon River at Glade, KS, and South Fork Solomon River above Webster Reservoir, KS, in cooperation with the Kansas Water Office.

2. Suspended-sediment data are being collected on a 6-week basis at Solomon River at Niles, KS, in cooperation with Kansas Department of Health and Environment.

Kansas Subregion

1. Suspended-sediment data are being collected on a 6-week basis at Kansas River at Wamego, KS, Little Blue River near Barnes, KS, and Stranger Creek near Tonganoxie, KS, in cooperation with the Kansas Water Office, and at Big Blue River near Manhattan, KS, as part of NASQAN.

2. Suspended-sediment data are being collected on a 6-week basis at Kings Creek near Manhattan, KS, as part of the National Hydrologic Benchmark Network.

3. Suspended-sediment data are being collected on a 6-week basis at Kansas River at DeSoto, KS, as part of NASQAN.

Chariton-Grand Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Elk Creek near Decatur City, IA, as part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a quarterly basis at Grand River near Summer, MO, and at Chariton River near Prairie Hill, MO, as a part of NASQAN.

Gasconade-Osage Subregion

1. Suspended-sediment data are being collected on a 6-week basis at Dragoon Creek near Burlingame, KS, and Pottawatomie Creek near Garnett, KS, in cooperation with the Kansas Water Office.

2. Suspended-sediment data are being collected on a bimonthly basis at Osage River below St. Thomas, MO, and at Gasconade River above Jerome, MO, as a part of NASQAN.

3. Suspended-sediment data are being collected on a bimonthly basis at Osage River near Schell City, MO, as a part of NASQAN.

Lower Missouri Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Missouri River at Hermann, MO, as a part of NASQAN.

2. Suspended-sediment data are being collected on a bimonthly basis at Lamine River near Blackwater, MO, as part of NASQAN.

Special Studies

1. PS-69 pumping sediment samplers are operating at Lower Hay Creek Tributary near Wilbaux, MT, discontinued September 30, 1981, and at West Branch Antelope Creek Tributary No. 4 near Zap, ND, as part of EMERIA studies. Sediment data are collected at these and several other sites in the study basins.

2. A study to determine relations between sediment production and peak discharge for a storm-runoff event continued in Wyoming. Sediment data which are on file are being used in the study.

For additional information about Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
Bldg. 53, Denver Federal Center
Mail Stop 415, Box 25046
Lakewood, CO 80225

District Chief, WRD
U.S. Geological Survey
1950 Constant Ave., Campus West
Lawrence, KS 66046

District Chief, WRD
U.S. Geological Survey
Federal Building, Room 428
301 South Park Ave., Drawer 10076
Helena, MT 59626

District Chief, WRD
U.S. Geological Survey
821 East Interstate Avenue
Bismarck, ND 58501

District Chief, WRD
U.S. Geological Survey
P.O. Box 1125
Cheyenne, WY 82003

District Chief, WRD
U.S. Geological Survey
P.O. Box 1230
Iowa City, IA 52244

District Chief, WRD
U.S. Geological Survey
1400 Independence Road
Mail Stop 200
Rolla, MO 65401

District Chief, WRD
U.S. Geological Survey
Room 406, Federal Building
100 Centennial Mall, North
Lincoln, NE 68508

District Chief, WRD
U.S. Geological Survey
Federal Building, Room 317
200 4th Street, S.W.
Huron, SD 57350

SOIL CONSERVATION SERVICE

1. Studies of sediment damages and/or determinations of sediment yields were made for the following watersheds.

   a. Public Law 566.

Major Drainage	Watershed	Stream	County	State
Missouri River	East Yellow Creek	East Yellow Creek	Sullivan Linn Chariton	Missouri
Missouri River	Moniteau Creek	Moniteau Creek	Randolph Howard Boone	Missouri
Little Nemaha River	Upper Little Nemaha	Little Nemaha River	Lancaster Cass Otoe	Nebraska
Little Nemaha River	South Branch	Little Nemaha River	Johnson Lancaster Otoe	Nebraska
Nemaha River	Middle Big Nemaha	Nemaha River	Johnson	Nebraska
Elkhorn River	East-West-Dry	Maple Creek	Stanton Colfax Cumming Dodge Platte	Nebraska
Big Blue River	Soap Creek	Soap Creek	Gage	Nebraska
Nishnabotna River	Turkey Creek	Turkey Creek	Cass	Iowa
Boyer River	Mill-Picayune	Mill Creek	Shelby	Iowa
Nishnabotna River	Troublesome Creek	Troublesome Creek	Audubon	Iowa
East Nodaway River	A&T Long Branch	Long Branch Creek	Adams Taylor	Iowa

b. Public Law 534

Major Drainage	Watershed	Stream	County	State
Little Sioux River	West Wolf	West Wolf Creek	Woodbury	Iowa
Little Sioux River	Barber Hollow	Barber Creek	Monona	Iowa
Little Sioux River	Reed	Unnamed	Monona	Iowa

c. River Basin Investigations

Major Drainage	Basin Reported	State
Platte River	Sandhills Cooperative Study	Nebraska

d. Resource Conservation and Development

Project Name	County	State
Western Irrigation RC&D	Deuel	Nebraska
Long Pine RCWP	Brown	Nebraska
Lee's Creek RC&D	Morrill	Nebraska
Star Cemetary CAT	Holt	Nebraska
Rushville RC&D	Sheridan	Nebraska

e. Conservation Operations

Major Drainage	Watershed	County	State
Big Horn River	Unnamed tributary of Owl Creek	Hot Springs	Wyoming
North Platte River	Unnamed tributary	Platte	Wyoming
North Platte River	Chalk Draw	Carbon	Wyoming

2. Reservoir Sedimentation Surveys

Reservoir sedimentation surveys were made on the following reservoirs:

Reservoir	County	State
Boxelder Creek Watershed (B-5, B-6)	Larimer	Colorado 1/
Kiowa Creek Watershed (K-79)	El Paso	Colorado 1/
East Fork Reservoir #3	Furges	Montana
North Black Vermilliion, Site 74	Marshall	Kansas
Turkey Creek, Site 3	Dickinson	Kansas
Upper Salt Creek, Site 19	Mitchell	Kansas
Big Creek, Site 2	Coffey	Kansas
Mule Creek	Mills	Iowa

3. Special Studies

a. Flood Plain Management Studies

Project Name	County	State
South Logan Creek	Cedar Dixon Wayne	Nebraska

b. A special report on sediment yield to the Lower Republican River was prepared for the Corps of Engineers.

1/ Computations and reports on these surveys have not been completed.

c. A special study was initiated with the Nebraska Department of Environmental Control to evaluate water quality and non-point sediment contributions along part of Elm Creek (tributary of Republic River) in Webster County, Nebraska.

d. Potential sediment analysis applications using Ground Penetrating Radar (GPR) were evaluated in the Sandhills region of Nebraska.

e. In cooperation with the Laboratory for Remote Sensing and Mapping Science, University of Georgia, a demonstration project was started to evaluate the use of photogrammetric methods to measure sediment deposits and streambank erosion at B-2 and B-6 Reservoirs, Boxelder Creek Watershed in Colorado. This consisted of low level aerial photos of the reservoir areas from which topographic maps will be prepared with a scale of 1 inch=100 feet and contour interval of one foot. The areas will be photographed again and new maps prepared following any larger flood event.

f. A sedimentation study of Petrolia Reservoir and upper drainage area was completed under a cooperative agreement between the Montana Department of Natural Resources and Conservation and the Soil Conservation Service. This reservoir, in Petroleum County, is at the junction of Yellow Water and Flat Willow Creeks. The purpose of the study is to determine increased sediment yield due to extensive amount of rangeland plowout in the Petrolia Reservoir drainage area. A survey is now underway in the Yellowtail drainages, as part of the same cooperative agreement.

ARKANSAS-WHITE-RED REGION

CORPS OF ENGINEERS

Southwestern Division

Albuquerque District

Sediment Load Measurements. Suspended sediment measurements were made daily (more frequent when sediment content varies noticeably) at two stations (Arkansas River below John Martin Reservoir and Purgatoire River below Trinidad Lake near Trinidad) in this region.

Other Investigations.

1. Trinidad and John Martin Dams continued to be operated to control sediment in the Arkansas River Basin.

2. The Hydrologic Engineering Center under contract with the District undertook a sediment investigation on the Arkansas River between Pueblo, Colorado and John Martin Dam. The study was primarily to analyze the future performance of various flood control alternatives in the vicinity of La Junta, Colorado with regard to channel stability, sediment movement and project maintenance. A draft report has been completed and is being reviewed at the District level. The hydrologic Engineering Center is in the process of preparing the final report, which will be available in January 1986.

Little Rock District

Sedimentation Surveys. Sediment ranges in Ozark Lake and Dardanelle Lake were resurveyed with Motorola automated hydrographic survey equipment.

Sediment Load Measurements. Measurements continued at 34 stations during the year on Arkansas River, Mulberry, Spadra Creek, Little Piney Creek, Piney Creek, Petit Jean, Fourche LaFave, White River, Taylor Bay, James River, Bryant Creek, North Fork, Current River, Black River, Piney Fork, Strawberry River and Little Red River. 84 sediment measurements were obtained and the concentration in percent of weight records maintained.

Tulsa District

Sedimentation Surveys. The original survey of Skiatook and the resurveys of Council Grove Lake, Kansas; Wister and Hugo Lakes, Oklahoma; and Lake Texoma, Oklahoma and Texas; were completed during 1985. The resurveys of Kaw Lake, Oklahoma and Kansas; and Lock and Dam No. 13, Oklahoma and Arkansas; were initiated during 1985 with expected completion by 1 April 1986. The sedimentation range line clearing at Arcadia Lake, Oklahoma was completed and the survey of the ranges has been initiated. The installation of pole monuments at Fort Supply and Heyburn Lakes, Oklahoma was performed.

Sediment Load Measurements. The suspended sampling program consists of 45 stations. Presently, there are 37 operational stations in the Arkansas River Basin and eight operational stations in the Red River Basin. Samplers DH 48 and DH 49 were used.

Other Investigations. Reservoir Sediment Data Summaries (ENG Form 1787) for Marion Lake was forwarded to SWD in 1984 for review and the review has not been completed. Software developments have progressed during 1985 in processing the Sediment Data Summaries and should be completed in early spring 1986. Forecasting and predicting sediments in reservoirs has been expanded to provide information on lake storage depletion and sediment deposition.

ARKANSAS-WHITE-RED REGION

GEOLOGICAL SURVEY

Upper White Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at North Sylamore Creek near Fifty Six, AR, as part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a bimonthly basis at White River at Newport, AR, as a part of the National Stream Quality Accounting Network (NASQAN).

3. Suspended-sediment data are being collected on a daily basis at the following stations in cooperation with the U.S. Soil Conservation Service:

Little Black River near Grandin, MO
Little Black River below Fairdealing, MO
Logan Creek at Oxly, MO
Little Black River at Success, AR

4. Suspended-sediment data are being collected periodically at Little Black River ditch 2 near Sinsabaugh, MO, in cooperation with the U.S. Soil Conservation Service.

Upper Arkansas Subregion

1. Suspended-sediment data are being collected on a monthly basis at Badger Creek, Upper station near Howard, CO, and Badger Creek, Lower station near Howard, CO, in cooperation with the U.S. Bureau of Land Management.

2. Suspended-sediment data are being collected on a bimonthly basis at Arkansas River at Portland, CO, in cooperation with the U.S. Bureau of Reclamation (USBR), Lower Missouri River Basin Region.

3. Suspended-sediment data are being collected on a bimonthly basis at Halfmoon Creek near Malta, CO, as a part of the National Hydrologic Benchmark Network.

4. Suspended-sediment data are being collected on a daily basis at the following stations, in cooperation with the U.S. Army:

Purgatoire River near Thatcher, CO
Taylor Arroyo blw. Rock Crossing near Thatcher, CO
Chacauco Creek at mouth near Timpas, CO
Bent Canyon Creek at mouth near Timpas, CO
Purgatoire River at Rock Crossing near Timpas, CO
Burke Arroyto Trib near Thatcher, CO
Big Arroyo near Thatcher, CO

5. Suspended-sediment data are being collected on a periodic basis at the following stations, in cooperation with the city of Colorado Springs:

Monument Creek above North Gate Boulevard at U.S. Air Force Academy, CO
Monument Creek at Pikeview, CO
Monument Creek at Bijou Street at Colorado Springs, CO
Fountain Creek near Colorado Springs, CO
Fountain Creek at Colorado Springs, CO
Fountain Creek at Secrity, CO

Middle Arkansas Subregion

1. Suspended-sediment data are being collected on a 6-week basis at the following sites in cooperation with the Kansas Water Office:

Arkansas River at Syracuse, KS
Whitewoman Creek near Leoti, KS
Mulberry Creek near Dodge City, KS
Arkansas River near Kinsley, KS
Pawnee River near Larned, KS
Walnut Creek at Albert, KS
Rattlesnake Creek near Macksville, KS
Cow Creek near Claflin, KS
Cow Creek near Lyons, KS
Arkansas River near Hutchinson, KS
Little Arkansas River at Alta Mills, KS
North Fork Ninnescah River above Cheney Reservoir, KS
South Fork Ninnescah River near Pratt, KS
South Fork Ninnescah River near Murdock, KS
Ninnescah River near Peck, KS
Slate Creek at Wellington, KS
Whitewater River at Towanda, KS
Arkansas River at Arkansas City, KS
Walnut River at Winfield, KS

2. Suspended-sediment data are being collected on a 6-week basis at Arkansas River near Coolidge, KS, as part of NASQAN.

3. Suspended-sediment data are being collected on a 6-week basis at Little Arkansas River at Valley Center, KS, in cooperation with the U.S. Army Corps of Engineers (COE).

Upper Cimarron Subregion

1. Suspended-sediment data are being collected on a 6-week basis at Bear Creek near Johnson, KS, Cavalry Creek at Coldwater, KS, North Fork Cimarron River at Richfield, KS, and Crooked Creek near Nye, KS, in cooperation with the Kansas Water Office.

2. Suspended-sediment data are being collected at Cimarron River near Englewood, KS, in cooperation with the USBR.

Lower Cimarron Subregion

1. Suspended-sediment data are being collected at Cimarron River near Buffalo, OK, as a part of NASQAN.

2. Suspended-sediment data are being collected at Cimarron River at Perkins, OK, in cooperation with the COE and as a part of NASQAN.

Arkansas-Keystone Subregion

1. Suspended-sediment data are being collected at Arkansas River near Ponca City, OK, Salt Fork Arkansas River Near Jet, OK, and Salt Fork Arkansas River at Alva, OK, in cooperation with the COE.

2. Suspended-sediment data are being collected at Arkansas River at Ralston, OK, as a part of NASQAN, and in cooperation with the COE.

Neosho-Verdigris Subregion

1. Suspended-sediment data are being collected on a 6-week basis at Lightning Creek near McCune, KS, and at Neosho River near Parsons, KS, in cooperation with the Kansas Water Office.

2. Suspended-sediment data are being collected on a 6-week or periodic basis at the following sites in cooperation with the COE:

Otter Creek at Climax, KS
Elk River at Elk Falls, KS
Big Hill Creek near Cherryvale, KS
Neosho River at Council Grove, KS
Neosho River near Americus, KS
Cottonwood River below Marion Lake, KS
Cottonwood River near Plymouth, KS

3. Suspended-sediment data are being collected at Newt Graham Lock and Dam (Verdigris River) near Inola, OK, and at Neosho River below Fort Gibson Lake near Fort Gibson, OK, as a part of NASQAN.

4. Suspended-sediment data are being collected at Neosho River near Commerce, OK, in cooperation with the COE.

5. Suspended-sediment data are being collected at Tar Creek at Miami, OK, as part of a study of water discharging abandoned zinc mines in northeastern Oklahoma.

Upper Canadian Subregion

1. Suspended-sediment data are being collected at the following stations at this indicated frequency in cooperation with the New Mexico Interstate Stream Commission:

Cimarron River near Cimarron, NM (semiannual)
Ponil Creek near Cimarron, NM (bimonthly)
Rayado Creek near Cimarron, NM (bimonthly)
Mora River at La Cueva, NM (bimonthly)
Ute Reservoir near Logan, NM (annual)
Revuelto Creek near Logan, NM (bimonthly)

2. Suspended-Sediment data are being collected on a bimonthly basis at the Canadian River near Sanchez, NM, in conjunction with the Water Quality Surveillance Program in cooperation with the New Mexico Interstate Stream Commission.

3. Suspended-sediment data are being collected on a bimonthly basis at the Canadian River above New Mexico-Texas State line as a part of NASQAN.

Lower Canadian Subregion

1. Suspended-sediment data are being collected at Canadian River near Whitefield, OK, and at Canadian River near Canadian, TX, as part of NASQAN.

2. Suspended-sediment data are being collected at Little River near Bowlegs, OK, in cooperation with the USBR.

3. Suspended-sediment are being collected at Canadian River at Calvin, OK, as a part of NASQAN and in cooperation with the COE.

North Canadian Subregion

1. Suspended-sediment data are being collected at North Canadian River at Woodward, OK, and at Beaver River at Beaver, OK, as a part of NASQAN.

2. Suspended-sediment data are being collected at North Canadian River near Wetumka, Ok, as a part of NASQAN.

3. Suspended-sediment data are being collected at the following sites in cooperation with the COE:

Beaver River near Guymon, OK
Beaver River near Hardesty, OK
North Canadian River near Seiling, OK
North Canadian River below Lake Overholser near Oklahoma City, OK
Deep Fork near Arcadia, OK
Deep Fork near Warwick, OK

4. Suspended-sediment data are being collected at Deep Fork near Beggs, OK, for NASQAN and in cooperation with the COE.

5. Suspended-sediment data are being collected at North Canadian River near Harrah, OK, in cooperation with the Oklahoma Water Resources Board.

Lower Arkansas Subregion

1. Suspended-sediment data are being collected at Arkansas River at Tulsa, OK, and on a bimonthly basis at Arkansas River at Dam 13 near Van Buren, AR, and at Arkansas River at David D. Terry Lock and Dam below Little Rock, AR, as a part of NASQAN.

2. Suspended-sediment data are being collected at Illinois River near Tahlequah, OK, in cooperation with the COE.

Red Headwaters Subregions

1. Suspended-sediment data are being collected periodically at North Fork Red River near Headrick, OK, at Salt Fork Red River near Elmer, OK, at Prairie Dog Town Red River near Wayside, TX, and at Prairie Dog Town Fork Red River near Childress, TX, as a part of NASQAN.

Red-Washita Subregion

1. Suspended-sediment data are being collected periodically at Red River near Burkburnett, TX, at Red River at Denison Dam near Denison, TX, and at Red River near Gainesville, TX, as a part of NASQAN.

2. Suspended-sediment data are being collected at Washita River near Dickson, OK, in cooperation with the COE and as a part of NASQAN.

3. Suspended-sediment data are being collected on a periodic basis at the following sites in cooperation with the COE:

Red River near Quanah, TX
North Wichita River near Truscott, TX
Red River near DeKalb, TX

4. Suspended-sediment data are being collected at Blue Beaver Creek near Cache, OK, as part of the National Hydrologic Benchmark Network.

Red-Sulphur Subregion

1. Suspended-sediment data are being collected at Kiamichi River near Big Cedar, OK, as a part of the National Hydrologic Benchmark Network and in cooperation with the COE.

2. Suspended-sediment data are being collected on a quarterly basis at Little River at Millwood Dam, near Ashdown, AR, and at Sulphur River south of Texarkana, AR, and bimonthly at Red River at Index, AR, as a part of NASQAN.

3. Suspended-sediment data are being collected on a quarterly basis at Twelvemile Bayou near Dixie, LA, and Red River at Alexandria, LA, as a part of NASQAN.

4. Suspended-sediment data are being collected on a daily basis at Bayou Pierre near Lake End and on a monthly basis at Grand Bayou near Coushatta, LA, as a part of a lignite study for the Louisiana Office of Public Works.

For additional information about Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
Federal Office Building
Room 2301
700 West Capitol Avenue
Little Rock, AR 72201

District Chief, WRD
U.S. Geological Survey
P.O. Box 66492
Baton Rouge, LA 70896

District Chief, WRD
U.S. Geological Survey
215 Dean A. McGee Avenue
Room 621
Oklahoma City, OK 73102

District Chief, WRD
U.S. Geological Survey
Building 53, Denver Federal Center
Mail Stop 415, Box 25046
Lakewood, CO 80225

District Chief, WRD
U.S. Geological Survey
1950 Constant Avenue - Campus West
Lawrence, KS 66046

District Chief, WRD
U.S. Geological Survey
505 Marquette NW, Room 720
Western Bank Building
Albuquerque, NM 87102

District Chief, WRD
U. S. Geological Survey
649 Federal Building
300 East 8th Street
Austin, TX 78701

SOIL CONSERVATION SERVICE

1. Studies of sediment damages and determinations of sediment yields were made in the following watersheds:

   a. Public Law 566.

Major Drainage	Watershed	Stream	County	State
Arkansas River	Brazil Creek	Brazil	LeFlore Haskell McCurtain	OK
Arkansas River	Tulsa Urban Study	Euchee Polecat Fisher Anderson	Tulsa Creek Osage	OK
Red River	Upper Red River	Little Beaver	Grady Stephens	OK

2. Reservoir Sedimentation Surveys.

   Reservoir sedimentation survey were made on the following:

Reservoir	County(s)	State
Sandstone Creek, Site No. 14	Roger Mills	OK
Sandstone Creek, Site No. 16	Roger Mills	OK
Sandstone Creek, Site No. 16A	Roger Mills	OK
Whiteshield Creek, Site No. 4	Beckham	OK
Caston Mountain Creek, Site No. 1	LeFlore	OK
Cane Creek, Site No. 11	Okmulgee	OK
Fish Peak-Carbon Arroyo Watershed (FPC-1)	Las Animas	CO[1/]
Five Reservoirs	Fort Carson El Paso and Pueblo	CO[1/]

1/ Reports on these surveys have not been completed.

TEXAS - GULF REGION

CORPS OF ENGINEERS

Southwestern Division

The SWD Laboratory received 1397 bottled samples for determination of percent of sediment. There were 149 bed load material samples received for testing.

Galveston District

A total of 261 inplace samples were obtained from nine navigation projects. These samples were analyzed to determine the quality of the sediment relative to chemical constituents which would be resuspended during dredging disposal activities and construction. The projects sampled and the number of samples taken are as follows:

Navigation Project	No. of Samples Taken
Corpus Christi Ship Channel	18
Freeport Harbor	6
Galveston Harbor	8
Gulf Intracoastal Waterway	151
Houston Ship Channel	5
Matagorda Ship Channel	21
Sabine-Neches Waterway	18
Trinity River	11
Miscellaneous	23
TOTAL	261

Surveys were done on the diversion channel for Mason Creek (Barker Reservoir) to determine the sediment accumulation during Fiscal Year 1985. Total of four sections were surveyed.

TEXAS-GULF REGION

GEOLOGICAL SURVEY

Sabine Subregion

1. Suspended-sediment data are being collected at Sabine River near Ruliff, TX, as a part of the National Stream Quality Accounting Network (NASQAN).

2. Suspended-sediment data are being collected on a daily basis at Bayou Grand Cane near Stanley, LA, Bayou Castor near Logansport, TX, and Bayou San Patricio near Benson, LA, as a part of a lignite study for the Louisana Office of Public Works. Suspended-sediment data is also being collected at Bayou Grand Cane near Stanley, LA, and Bayou Castor near Logansport, T', on an event basis with a PS-69.

3. Suspended-sediment data are being collected on a daily basis at Big Sandy Creek near Big Sandy, TX, in cooperation with the U.S. Bureau of Reclamation (USBR) beginning October 1, 1984.

Neches Subregion

1. Suspended-sediment data are being collected on a periodic basis at Neches River at Evadale, TX, as a part of NASQAN.

Trinity Subregion

1. Suspended-sediment data are being collected on a periodic basis at Mountain Creek near Cedar Hill, TX, Duck Creek near Garland, TX, and at Kings Creek near Kaufman, TX, as a part of the Federal Collection of Basic Records (CBR) program (discontinued September 30, 1982).

2. Suspended-sediment data are being collected on a periodic basis at Trinity River at Trinidad, TX, as a part of NASQAN.

3. Suspended-sediment data are being collected on a periodic basis at Trinity River at Romayor, TX, and at Chocolate Bayou near Alvin, TX, as a part of NASQAN.

4. Suspended-sediment data are being collected on a daily basis at Bedias Creek near Madisonville, TX, in cooperation with the USBR.

Galveston Bay - San Jacinto Subregion

1. Suspended-sediment data are being collected on a periodic basis at West Fork San Jacinto River near Conroe, TX, and at Buffalo Bayou at West Belt Dr., Houston, TX, as part of NASQAN.

Middle Brazos Subregion

1. Suspended-sediment data are being collected on a periodic basis at Salt Fork Brazos River near Aspermont, TX, Double Mountain Fork Brazos River near Aspermont, TX, Brazos River near Highbank, TX, and at Brazos River near South Bend, TX, as a part of NASQAN.

Lower Brazos Subregion

1. Suspended-sediment data are being collected on a daily basis at Brazos River at Richmond, TX, as part of the Federal CBR program and also as part of NASQAN.

2. Suspended-sediment data are being collected four times a year at South Fork Rocky Creek near Briggs, TX, as a part of the National Hydrologic Benchmark Network.

3. Suspended-sediment data are being collected on a periodic basis at Little River near Cameron, TX, as a part of NASQAN.

Upper Colorado Subregion

1. Suspended-sediment data were being collected on a periodic basis at Colorado River above Silver, TX, as a part of NASQAN.

Lower Colorado-San Bernard Coastal Subregion

1. Suspended-sediment data are being collected on a periodic basis at Colorado River at Austin, TX, Colorado River at Wharton, TX, Colorado River near San Saba, TX, and at San Bernard River near Boling, TX, as a part of NASQAN. The collection of suspended-sediment data at Llano River at Llano, TX, began April 1, 1979, as part of NASQAN.

2. Suspended-sediment data for total-load determination is being collected on a periodic basis at Colorado River above Columbus, TX, in cooperation with the Lower Colorado River Authority beginning October 1, 1982.

Central Texas Coastal Subregion

1. Suspended-sediment data are being collected on a periodic basis at Guadalupe River at Victoria, TX, San Antonio River at Goliad, TX, Lavaca River near Edna, TX, and at Mission River at Refugio, TX, as a part of NASQAN.

Nueces-Southwestern Texas Coastal Subregion

1. Suspended-sediment data are being collected on a periodic basis at Nueces River near Three Rivers, TX, as a part of NASQAN.

For additional information about Geological Survey activities within this region, contact the following office:

District Chief, WRD
U.S. Geological Survey
649 Federal Building
300 East 8th Street
Austin, TX 78701

District Chief, WRD
U.S. Geological Survey
P.O. Box 66492
Baton Rouge, LA 70896

SOIL CONSERVATION SERVICE

1. Reservoir Sedimentation Surveys

   a. Reservoir sedimentation surveys were made on the following reservoirs:

Reservoir	County	State
Site 6, Cummins Creek	Fayette	TX
Site 9, Cummin Creek	Fayette	TX

   b. The following reservoir sedimentation surveys were reported but omitted from "NOTES ON SEDIMENTATION ACTIVITIES CALENDAR YEAR 1984".

Reservoir	County	State
Dawson City Lake	Navarro	TX
Lake Jacksboro	Jack	TX
White Rock Lake	Dallas	TX
Site 3B, Denton Creek	Montague	TX
Site 3-4, Denton Creek	Montague	TX
Site 3-6, Denton Creek	Montague	TX
Site 3-7, Denton Creek	Montague	TX
Site 11B, Elm Fork	Cooke	TX

RIO GRANDE REGION

BUREAU OF RECLAMATION

A hydrographic survey was completed for McMillan Reservoir in southeastern New Mexico. McMillan Reservoir is on the Pecos River. Brantley Dam, located downstream from McMillan, is currently under construction.

Current plans call for the breaching of McMillan Dam. The survey was undertaken to provide area-capacity information for Brantley Dam. The survey will also provide information on possible problems with flow through the current McMillan Reservoir area after McMillan Dam is breached.

RIO GRANDE REGION

CORPS OF ENGINEERS

Southwestern Division

Albuquerque District

Sedimentation Surveys.

1. A new area-capacity table will be adopted on 1 January 1986, for Abiquiu Reservoir. A letter report describing and analyzing the reservoir sedimentation survey has been completed and is presently being reviewed at the District Level.

2. Two letter reports describing the reservoir sedimentation resurveys at Jemez Canyon Reservoir and Abiquiu Reservoir are under review at the Division.

Sediment Load Measurements: Suspended sediment measurements were made at five stations. These stations are located on Rio Chama above Abiquiu Dam, below Abiquiu Dam, near Chamita, NM; on Rio Grande below Cochiti Lake; and on Jemez River below Jemez Canyon Dam. All samples are secured by the DH-48, DH-59, or DH-49 according to flow conditions. Samples are not usually accrued on weekends and holidays.

Other Investigations: Abiquiu, Cochiti, Galisteo, and Jemez Canyon Dams continued to be operated to control flow in the Rio Grande.

RIO GRANDE REGION

GEOLOGICAL SURVEY

Rio Grande Headwaters Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Rio Grande near Lobatos, CO, as a part of the National Stream Quality Accounting Network (NASQAN).

Rio Grande-Elephant Butte Subregion

1. Suspended-sediment data are being collected on a semiannually basis at Red River below Fish Hatchery near Questa, NM, and Embudo Creek at Dixon, NM, in cooperation with the New Mexico Interstate Streams Commission (NMISC) and the U.S. Bureau of Land Management (BLM).

2. Suspended-sediment data are being collected on a bimonthly basis at Rio Chama above Abiquiu Reservoir, NM, Rio Chama below Abiquiu Dam, NM, and at Rio Chama near Chamita, NM, in cooperation with the U.S. Army Corps of Engineers (COE).

3. Suspended-sediment data are being collected on a daily basis at Rio Grande at Otowi Bridge near San Ildefonso, NM, and at Rio Grande near Albuquerque, NM, as a part of the Federal Collection of Basic Records (CBR) program.

4. Suspended-sediment data are being collected on a daily basis at Rio Grande below Cochiti Dam, NM, in cooperation with the COE.

5. Suspended-sediment data are being collected on a daily basis at Arroyo Chico near Guadalupe, NM, at Rio Puerco above Arroyo Chico near Gaudalupe, NM, and at Rio Puerco near Bernardo, NM, in cooperation with the BLM, NMISC, and COE.

6. Suspended-sediment data are being collected on a bimonthly basis at Rio Grande at San Felipe, NM, and at Rio Grande at Isleta, NM, in conjunction with the Water Quality Surveillance Program and financed cooperatively by NMISC.

7. Suspended-sediment data are being collected at Santa Fe River above Cochiti Dam, NM (quarterly), Cochiti Lake, NM (semiannually), and Jemez River near Jemez, NM (semiannually), in cooperation with the NMISC.

8. Suspended-sediment data are being collected on a daily basis at Rio Grande near Bernardo, NM, at Rio Grande at San Acacia, NM, and at Rio Grande at San Marcial, NM, in cooperation with NMISC.

9. Suspended-sediment data for total-load determinations are being collected on a monthly basis at Rio Grande at Albuquerque, NM, at Rio Grande near Bernardo, NM, at Rio Grande at San Acacia, NM, and Rio Grande at San Marcial, NM, in cooperation with NMISC.

10. Suspended-sediment data are being collected on a quarterly and storm-event basis at Rio Mora near Terrero, NM, as a part of the National Hydrologic Benchmark Network.

11. Suspended-sediment data are being collected on a bimonthly basis at Pecos River above Santa Rosa Lake, NM, and Pecos River near Acme, NM, in cooperation with NMISC.

12. Suspended-sediment data are being collected on a bimonthly and intermittent basis at Pecos River below Sumner Dam, NM (formerly called Alamagordo Dam), in cooperation with NMISC, and as a part of NASQAN.

13. Suspended-sediment data are being collected on a daily basis at Pecos River at Santa Rosa, NM, and at Pecos River near Artesia, NM, as part of the Federal CBR program.

14. Suspended-sediment data were collected on a bimonthly basis at Pecos River near Puerto de Luna, NM, in conjunction with the Water Quality Surveillance Program and in cooperation with NMISC.

15. Suspended-sediment data are being collected on a bimonthly basis at Pecos River at Red Bluff, NM, at Rio Grande at El Paso, TX, and at Rio Grande at Fort Quitman, TX, as a part of NASQAN.

Rio Grande-Amistad Subregion

1. Suspended-sediment data are being collected on a periodic basis at Rio Grande at Foster Ranch, near Langtry, TX, and at Devils River at Pafford Crossing, near Comstock, TX, as a part of NASQAN.

Rio Grande Closed Basins Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Rio Tularosa near Bent, NM, and at Mimbres River near Mimbres, NM, as a part of NASQAN.

Lower Pecos Subregion

1. Suspended-sediment data are being collected on a periodic basis at Pecos River near Langtry, TX, as a part of NASQAN.

Rio Grande-Falcon Subregion

1. Suspended-sediment data are being collected on a periodic basis at Rio Grande at Laredo, TX, as a part of NASQAN.

Lower Rio Grande Subregion

1. Suspended-sediment data are being collected on a periodic basis at Rio Grande River near Brownsville, TX, as part of the Federal CBR program as part of NASQAN (daily sampling discontinued September 30, 1983).

2. Suspended-sediment data are being collected on a weekly or more frequent basis at North Floodway near Sebastion, TX, and at Arroyo Colorado Floodway at El Fuste Siphon, south of Mercedes, TX, as part of the Federal CBR program (discontinued September 30, 1983).

Special Studies

A water-quality monitoring plan for the Rio Grande and Red River in Taos County, NM, was initiated in October 1978 by the BLM. The study objectives are to monitor long-term changes in water quality (chemical and sediment) at 12 selected sampling sites. BLM personnel collect monthly samples and the Geological Survey analyzes the samples and publishes the data.

For additional information about Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
Bldg. 53, Denver Federal Center
Mail Stop 415, Box 25046
Lakewood, CO 80225

District Chief, WRD
U.S. Geological Survey
505 Marquette, N.W., Room 720
Western Bank Building
Albuquerque, NM 87102

District Chief, WRD
U.S. Geological Survey
649 Federal Building
300 East 8th Street
Austin, TX 78701

UPPER COLORADO REGION

BUREAU OF RECLAMATION

A hydrographic survey for Lake Powell is planned for 1986. Lake Powell, formed by Glen Canyon Dam, is located on the Colorado River. The survey promises to be a challenge, partially due to the sheer depth and length of Lake Powell.

A streambed scour estimate was made for the 100-year peak discharge on Mack Wash near the crossing of the Government Highline Canal in western Colorado. The anticipated scour depth is 8 feet.

The STARS (Sediment Transport and River Simulation) model will be used to predict the sediment transport of the 225 river miles of the Colorado River from Lees Ferry to Diamond Creek. This modeling effort will help determine the relative impacts of the seven different future release scenarios at Glen Canyon Dam on the main channel of the Colorado River. The model will provide information on hydraulic and sediment parameters at each cross section and show how they change with time. This information would include the amount of scour or fill and rate of sediment transport at each cross section and the volume of material removed from the river. Since the STARS model is one-dimensional, sediment movement within large eddies, downstream from rapids or constrictions, cannot be modeled. Many of the popular camping beaches exist downstream of rapids near eddies. However, any sediment that is either removed or added to the beaches through eddy currents must be transported by the main channel flow.

The river bed geometry for 225 miles of the Colorado River will be estimated from 650 river channel cross sections. Of these 650 cross sections, 209 were measured with sonar and 441 were estimated using top widths from low flow aerial photographs, depths from a measured profile, and side slopes from the 209 measured cross sections. Verification of the cross section data was obtained by comparing computed versus measured water surface elevations at 15 major rapids and at the 5 gaging stations.

Information on the bed material size gradations will be estimated from the channel bottom maps. These maps were constructed from side scan sonar charts and low flow aerial photography. The maps divide the channel bottom into two major categories: Transportable material and immovable material (boulders or bedrock). The transportable material is further divided by bed-form; classified as either sediment waves or smooth bottom. As a first approximation, the smooth bottom material is assumed to be coarser than the sediment wave material.

The water discharge will be the released scenario from Glen Canyon Dam plus estimates of the tributary flows based upon historical records.

The sediment supply from ungaged tributaries will be estimated from the three gaged tributaries and sediment surveys of Lake Mead.

Calibration and verification of the STARS model on the Colorado River will be done using data collected at the five sampling stations (Lees Ferry, above Little Colorado River, near Grand Canyon, above National Canyon, and above Diamond Creek) during the period from July to December 1983 and from October 1985 to February 1986. Once calibration and verification are complete, the STARS model will be used to predict the relative impacts of Glen Canyon Dam on the Colorado River for the seven different release scenarios. Comparisons will be made of the sediment transport rates, the amount of scour or fill, and the volume of material removed.

UPPER COLORADO REGION

GEOLOGICAL SURVEY

Colorado Headwaters Subregion

1. Suspended-sediment data are being collected on a daily basis at East Middle Fork Parachute Creek near Rio Blanco, CO, and East Fort Parachute Creek near Rulison, CO, in cooperation with the U.S. Navy.

2. Suspended-sediment data are being collected on a once-a-week basis at Colorado River near Cameo, CO, in cooperation with the Colorado River Water Conservation District.

3. Suspended-sediment data are being collected on a bimonthly basis at Colorado River near Colorado-Utah State line as a part of the National Stream Quality Accounting Network (NASQAN).

4. Suspended-sediment and bedload data are being collected on a comprehensive level at Rock Creek near Crater, CO, and Muddy Creek at Karemmling, CO, in cooperation with Colorado River Water Conservation District.

Gunnison Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Gunnison River near Grand Junction, CO, as a part of NASQAN.

Upper Colorado-Dolores Subregion

1. Suspended-sediment data are being collected on a comprehensive level at Colorado River near Cisco, UT.

2. Suspended-sediment data are being collected on a bimonthly basis at Dolores River near Cisco, UT, as a part of NASQAN.

Great Divide-Upper Green Subregion

1. Suspended-sediment data are being collected on a daily basis at Green River near Green River, WY, as a part of the Federal Collection of Basic Records Program.

2. Suspended-sediment data are being collected on a monthly basis at Green River near Greendale, UT, as a part of NASQAN.

White-Yampa Subregion

1. Suspended-sediment data were obtained on a quarterly basis at Yampa River near Maybell, CO, and at Little Snake River near Lily, CO, as a part of NASQAN.

2. Suspended-sediment data are being collected on a 6-week and flow-evert basis at Savery Creek near Savery, WY.

3. Suspended-sediment data are being collected on a weekly basis at Yampa River near Maybell, CO, and on a weekly basis at Little Snake River near Lily, CO, in cooperation with the Colorado River Water Conservation District.

4. Suspended-sediment data are being collected quarterly at several sites in the coal mining region of the Yampa River basin. At the following stations samples are collected eight times per year:

Middle Creek near Oak Creek, CO
Foidel Creek near Oak Creek, CO
Foidel Creek at mouth near Oak Creek, CO

These stations are operated in cooperation with the U.S. Bureau of Land Management (BLM).

5. Suspended-sediment data are being collected at several stations in the Piceance Creek basin to monitor the potential impact of the oil shale development project.

Piceance Creek below Rio Blanco, CO (daily)
Stewart Gulch above West Fork, CO (periodic)
Piceance Creek tributary near Rio Blanco, CO (periodic)
Willow Creek near Rio Blanco, CO (periodic)
Piceance Creek above Hunter Creek, CO (daily)
Piceance Creek below Ryan Gulch, CO (daily)
Piceance Creek at White River, CO (periodic)
Corral Gulch below Water Gulch, CO (periodic)
Corral Gulch near Rangely, CO (daily)

These stations are operated in cooperation with Rio Blanco County.

6. Suspended-sediment data are being collected on a comprehensive level at White River near Colorado-Utah State line in cooperation with the Utah Department of Natural Resources.

7. Suspended-sediment data are being collected on a bimonthly basis at White River near Ouray, UT, as part of NASQAN.

8. Suspended-sediment and bedload data are being collected on a comprehensive level at White River below Boise Creek near Rangely, CO, in cooperation with Colorado River Water Conservation District.

9. Suspended-sediment data are being collected quarterly at the following stations in cooperation with the Upper Yampa Conservancy District:

White River below Meeker, CO
Fish Creek at upper station near Steamboat, CO
Walton Creek near Steamboat, CO

10. Suspended-sediment data are being collected on a comprehensive level at Yampa River near Oak Creek, CO, in cooperation with the Upper Yampa Conservancy District.

Lower Green Subregion

1. Suspended-sediment data are being collected on a monthly basis at San Rafael River near Green River, UT, in cooperation with the U.S. Bureau of Reclamation (USBR).

2. Suspended-sediment data are being collected on a monthly basis at Price River near Woodside, UT, in cooperation with the USBR.

3. Suspended-sediment data are being collected on a bimonthly basis at Green River at Green River, UT, as part of NASQAN.

Upper Colorado-Dirty Devil Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Colorado River at Lees Ferry, AZ, as part of NASQAN.

2. Suspended-sediment data are being collected on a monthly basis at Muddy Creek at Delta Mine, near Hanksville, UT, in cooperation with the BLM.

San Juan Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Vallecito Creek near Bayfield, CO, as a part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a daily basis at Animas River at Farmington, NM, as a part of NASQAN.

3. Suspended-sediment data are being collected on a daily basis at San Juan River at Shiprock, NM, as a part of the U.S. Geological Survey Coal Hydrology Program.

4. Suspended-sediment and bedload data are being collected on a comprehersive level at the following stations in cooperation with Mineral County:

Periodic suspended sediment

West Fork San Juan River at West Fork Campground, CO
Wolf Creek at Wolf Creek campground bridge, CO

Daily suspended sediment plus bedload

Windy Pass Creek at Highway 160, CO
West Fork San Juan River at County Line, CO

5. Suspended-sediment data are being collected on a quarterly basis at San Juan River near Bluff, UT, as part of NASQAN.

Special Studies

1. A study to determine relations between sediment production and peak discharge for a storm-runoff event, continued in Wyoming. Existing sediment data are being used in the study.

2. As part of the Federal program for determining baseline conditions in the areas of potential oil-shale development in the White River basin, UT, suspended-sediment data are being obtained on a comprehensive level at 4 sites and monthly at 12 sites.

For additional information about Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
Federal Building, FB-44
300 West Congress
Tucson, AZ 85701

District Chief, WRD
U.S. Geological Survey
505 Marquette, N.W., Room 720
Western Bank Building
Albuquerque, NM 87102

District Chief, WRD
U.S. Geological Survey
P.O. Box 1125
Cheyenne, WY 82003

District Chief, WRD
U.S. Geological Survey
Bldg. 53, Denver Federal Center
Mail Stop 415, Box 25046
Lakewood, CO 80225

District Chief, WRD
U.S. Geological Survey
Room 1016 Administration Building
1745 West 1700 South
Salt Lake City, UT 84104

SOIL CONSERVATION SERVICE

1. Studies of sediment damages and determinations of sediment yields were made in the following watersheds:

   a. Public Law 566

Major Drainage	Watershed	Stream	County	State
Strawberry River	Sand Wash	Sand Wash	Duchesne	Utah

2. Reservoir Sedimentation Surveys.

   A reservoir sedimentation survey was made on the following reservoir:

Reservoir	County(s)	State
Rootcap Wash Watershed (RW-1)	Montrose	Colorado 1/

1/ Computations on this survey have not yet been completed.

LOWER COLORADO REGION

BUREAU OF RECLAMATION

A sediment study was prepared for the proposed New Waddell Dam on the Agua Fria River. The estimated 50- and 100-year sediment accumulations in the reservoir are 70,490 acre-feet and 101,680 acre-feet for a reservoir normal water surface at elevation 1694 feet m.s.l.

Potential streambed scour estimates were made for the design of several features of the Tucson Aqueduct. The scour potential associated with 100-year peak discharges were:

Feature	Scour depth
Santa Cruz River siphon	3 feet
San Xavier Pumping Plant	6 feet
San Xavier-Brawley discharge line	3-6 feet

The 50-year sedimentation of the cross drainage ponding against Reach 5 of the Tucson Aqueduct was computed. The three ponding areas are anticipated to retain 246, 298, and 295 acre-feet of sediment, respectively.

LOWER COLORADO REGION

GEOLOGICAL SURVEY

Lower Colorado-Lake Mead Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at the following sites as part of the National Stream Quality Accounting Network (NASQAN):

Virgin River above Halfway Wash near Riverside, NV
Muddy River above Lake Mead near Overton, NV

2. Suspended-sediment data are being collected on a monthly basis at the following sites in cooperation with the U.S. Bureau of Land Management.

Las Vegas Wash near Henderson, NV
Las Vegas Wash near Boulder City, NV

3. Suspended-sediment data are being collected at North Fork Virgin River above Zion Narrows, near Glendale, UT, in cooperation with the Utah Department of Natural Resources.

Little Colorado Subregion

1. Suspended-sediment data are being collected on a daily basis in cooperation with the U.S. Corps of Engineers (COE) at Little Colorado River near Joseph City, AZ.

2. Suspended-sediment data are being collected on a flow-event basis at Leroux Wash near Holbrook, AZ, in cooperation with the COE.

3. Suspended-sediment data are being collected on a quarterly basis at Little Colorado River at Cameron, AZ, as a part of NASQAN.

4. Suspended-sediment data are being collected on a monthly basis at Zuni River above Black Rock Res., NM, in cooperation with the U.S. Bureau of Reclamation (USBR) and at Rio Puerco at Gallup, NM, on a semiannual basis in cooperation with the New Mexico Interstate Stream Commission (NMISC).

Lower Colorado Subregion

1. Suspended-sediment data are being collected as part of NASQAN at:

Colorado River below Hoover Dam, AZ (bimonthly)
Bill Williams River near Planet, AZ (quarterly)

Upper Gila Subregion

1. Suspended-sediment data are being collected on a quarterly and storm-event basis at Mongollon Creek near Cliff, NM, as a part of the National Hydrologic Benchwork Network.

2. Suspended-sediment data are being collected on a bimonthly basis at Gila River near Redrock, NM, as part of NASQAN, and at San Francisco River near Glenwood, NM, in cooperation with NMISC.

3. Suspended-sediment data are being collected on a quarterly basis at Gila River at Calva, AZ, as a part of NASQAN.

Middle Gila Subregion

1. Suspended-sediment data are being collected on a quarterly basis as a part of NASQAN at the San Pedro River below Aravaipa Creek, near Mammoth, AZ.

2. Suspended-sediment data are being collected on a monthly basis at Gila River at Kelvin, AZ, and San Pedro River below Aravaipa Creek, near Mammoth, AZ, in cooperation with the USBR.

Salt Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Wet Bottom Creek near Childs, AZ, as a part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a bimonthly basis as a part of NASQAN at:

Gila River above diversions, at Gillespie Dam, AZ
Gila River near Dome, AZ

Sonora Subregion

1. Suspended-sediment data are being collected on a quarterly basis as a part of NASQAN at the Vamori Wash at Kom Vo, AZ.

Special Studies

1. A long-term, ongoing statewide program in Nevada of investigations of sediment and debris transported by flash floods continued during 1985.

For additional information about U.S. Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
Federal Building
301 West Congress Street, FB-44
Tucson, AZ 85701

Nevada State Office Chief
Idaho-Nevada District
U.S. Geological Survey
Federal Building, R. 227
705 North Plaza Street
Carson City, NV 89701

District Chief, WRD
U.S. Geological Survey
505 Marquette NW, Room 720
Western Bank Bldg.
Albuquerque, NM 87102

District Chief, WRD
U.S. Geological Survey
Room 1016 Administration Building
1745 West 1700 South
Salt Lake City, UT 84104

SOIL CONSERVATION SERVICE

1. Reservoir Sedimentation Surveys.

   a. A reservoir sedimentation surveys was made on the following reservoir:

Reservoir	County(s)	State
Gila Valley Arroyos Watershed, Site 11	Grant	New Mexico

GREAT BASIN REGION

GEOLOGICAL SURVEY

Bear Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Bear River near Corinne, UT, as a part of the National Stream Quality Accounting Network (NASQAN).

Great Salt Lake Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Red Butte Creek at Fort Douglas, near Salt Lake City, UT, as part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a quarterly basis at Weber River near Plain City, UT, and at Jordan River at Salt Lake City, UT, as a part of NASQAN.

Escalante - Sevier Lake Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Sevier River near Lynndyl, UT, and at Beaver River at Adamsville, UT, as a part of NASQAN.

Black Rock Desert-Humboldt Subregion

1. Suspended-sediment data are being collected bimonthly at the following sites as part of NASQAN:

    Humboldt River near Carlin, NV
    Humboldt River near Imlay, NV
    Humboldt River near Rye Patch, NV
    Quinn River near McDermitt, NV

2. Suspended-sediment data are collected periodically at Gance Creek near Tuscarora, NV, as part of a cooperative program with U.S. Bureau of Land Management.

Central Lahontan Subregion

1. Suspended-sediment data are being collected at the following sites as part of NASQAN:

    Walker River near Wabuska, NV (bimonthly)
    Carson River near Fort Churchill, NV (quarterly)
    Truckee River near Nixon, NV (quarterly)

2. Suspended-sediment data are being collected twice-yearly at the following sites in cooperation with the U.S. Army Corps of Engineers:

Martis Creek at Highway 267 near Truckee, CA
Martis Creek Lake near Truckee, CA
Martis Creek near Truckee, CA

Central Nevada Desert Basins Subregion

1. Suspended-sediment data are being collected quarterly at Steptoe Creek near Ely, NV, and South Twin River near Round Mountain, NV, as part of the National Hydrologic Benchmark Network.

Special Studies

1. A long-term, ongoing statewide program of investigations of sediment and debris transport by flash floods continued during 1985.

A long-term investigation of sediment and debris hazards related to flooding is in the fourth investigative year at the Nevada Test Site. A progress report describing results of a paleoflood study conducted as part of this program is nearly complete.

For additional information about U.S. Geological Survey activities within this region, contact the following offices:

Nevada Office Chief
Idaho - Nevada District
U.S. Geological Survey
Federal Building, Room 224
705 N. Plaza Street
Carson City, NV 89701

District Chief, WRD
U.S. Geological Survey
1016 Administration Building
1745 West 1700 South
Salt Lake City, UT 84104

SOIL CONSERVATION SERVICE

1. Studies of sediment damages and determinations of sediment yields were made in the following watersheds:

   a. River Basin Investigations

Major Drainage	Basin Reported	State
Great Salt Lake	Shambip River	Utah

PACIFIC NORTHWEST REGION

BUREAU OF RECLAMATION

An analysis was made of the potential for sluicing deposited sediment from the reservoir behind Black Canyon Dam on the Payette River. The analysis was supported by a trial sluicing run. It was concluded that to maximize the sluicing ability, the reservoir must be held at a minimum elevation while making maximum discharges. However, less than the average annual sediment inflow can be sluiced and power production would be foregone during the sluicing operation.

PACIFIC NORTHWEST REGION

CORPS OF ENGINEERS

North Pacific Division

Portland District

Sedimentation Surveys

1. Reservoir Surveys. One reservoir (lake) sediment range survey report was completed and three are in progress. No resurveys were accomplished, but three are planned.

a. Surveys. The Lake Sediment Ranges Design Memorandum No. 19 for Applegate Lake, Applegate River, Oregon, was completed and published in October 1985. The sediment range reports for Lost Creek, Elk Creek, and Mount St. Helens projects are in progress and should be completed in 1986. The Sedimentation Design Memorandum for the Toutle River sediment retention structure below Mount St. Helens will also be completed in 1986.

b. Resurveys. The resurveys of Umatilla, Willow Creek, and Fern Ridge lakes, which were scheduled for 1985, have been postponed and will be completed at a later date.

2. Channel Surveys. Channel survey work has been done on the river channels below Mount St. Helens in response to the sediment caused flooding danger resulting from the erosion of the debris avalanche. The following two reports on the river channels below Mount St. Helens volcano were completed in 1985. Other reports on this subject have been noted in previous annual notes.

a. Reports completed.

(1) Mount St. Helens, Cowlitz and Toutle Rivers, Sedimentation Study/1985.....Oct 85

(2) Mount St. Helens, WA., Decision Document.....Oct 85

b. Scope. The Mount St. Helens sedimentation reports and studies include the results of various numerical, analytical, and prototype studies. These studies were completed with the assistance of the Vancouver office of the U.S. Geological Survey, the Hydrologic Engineering Center at Davis, the Waterways Experiment Station in Vicksburg, and a Technical Advisory Group comprised of sedimentation specialists from across the United States. The Portland District Sedimentation Section gathered and analyzed a large volume of data to support the studies.

(1) About 200 river or streambed material samples were obtained between the mouth of the Columbia River and the volcano.

(2) More than 140 suspended sediment samples were taken.

(3) More than 35 river discharge measurements were made to define sample points.

(4) In the upper Toutle River basin, 17 cross-sections were surveyed at unique locations to monitor the effects of the planned Spirit Lake drawdown.

(5) Fourteen water-surface profiles were surveyed at 12 points on the Cowlitz River from the mouth to river mile (RM) 20.

(6) A maximum of 49 cross-sections were surveyed five times in the Cowlitz River from the mouth to RM 22.

(7) A maximum of 15 cross-sections were surveyed five times in the Toutle River from the mouth to RM 4.

(8) To note changes in channel geometry, nearly 270 cross-sections between the mouth of the Toutle River and Spirit Lake were photogrammetrically developed for each of the years 1980, 1982, 1984, and 1985.

(9) Numerous computer model simulations were conducted for Toutle River sediment transport and water surfaces at LT3 (a temporary sediment stabilization basin).

c. Equipment. Most sediment sampling was done using standard equipment available from St. Anthony Falls or normal alternative sources. The notable exception was the utilization of a new type core sampler for a few bed material samples.

3. Harbor Surveys. Harbor and navigation channel hydrographic surveys are continued year-round on the Columbia River harbors and navigation channel, and on the 11 harbors along the Oregon coast. Formal study reports are issued from time to time.

a. Reports completed. A report, Studies to Control Shoaling of the Navigation Channel Lower Columbia River, was completed and published in January 1985.

b. Reports planned.

(1) A Value Engineering study regarding removal of sand waves in the Columbia River is in progress and expected to be completed in 1986.

(2) A Columbia River study on the effects of sedimentation on the proposed coal channel deepening project between RMs (-)2 and 18 is in progress and scheduled to be completed in December 1987.

c. Scope. Harbor and navigation channel surveys are continuous and used for year-round maintenance dredging.

(1) The Columbia River between RMs 4 and 145 was surveyed four times.

(2) Three surveys were done on the 11 coastal harbors and/or channels.

d. Equipment. The harbor and navigation channel surveys are made by special survey boats equipped with electronic fathometers (echo sounders). The surveys are then displayed on aerial photographs at various scales. A vibracore sampler was used to obtain satisfactory samples below the surface of the harbor/navigation-channel bed.

Sediment Load Measurements. one sedimentation station is operated by Portland District for the Mount St. Helens studies. This station, on the Cowlitz River at Kelso, Washington, is operated during high-water periods. Samplers P-74, P-63, BM-54 are used. The District partially funds the U.S. Geological Survey for sediment records at several other locations in the Mount St. Helens area, as well as near other District projects.

Other Investigations. New Equipment/Research. The District is testing the Helley-Smith sampler.

Seattle District

Samples were obtained from sediment deposits in the Mud Mountain Reservoir pool. Grain sizes of the sediment deposits varied from silts-fine sands to coarse gravels-cobbles. This information will be used in future sediment modeling studies of Mud Mountain Reservoir.

The District is also in the process of applying the TABS-2 open channel hydraulics and sedimentation model for analysis of sedimentation processes on the proposed Snoqualmie River floodway at Snoqualmie, Washington. CY 1985 activities included hydraulic model setup and sampling of overbank sediment deposits.

Walla Walla District

Sediment Surveys. Most of the existing sediment ranges on Lower Granite Reservoir were resurveyed in 1985. In addition, six new ranges were established and measured on the lower Clearwater River in the pool area.

Investigations.

1. Studies continued for Lower Granite to evaluate future deposition in the pool and what permanent measures may be taken to preserve freeboard at the Lewiston levees. Required work was also completed so dredging could be accomplished in the Lower Granite pool in 1986.

2. Sediment samples were taken and studies were made to evaluate a planning project to drain Malheur Lake by constructing a channel to South Fork Malheur River. The study concentrated on the erosion and deposition that would be expected along South Fork Malheu River.

PACIFIC NORTHWEST REGION

GEOLOGICAL SURVEY

Kootenai-Pend Oreille-Spokane Subregion

1. Suspended-sediment data are being collected on a periodic basis from Pend Orielle River at international boundary and at Spokane River at Long Lake, WA, as a part of the National Stream Quality Accounting Network (NASQAN).

2. Suspended-sediment data are being collected on a daily basis by a PS-69 at Kootenai River at Porthill, ID, as part of the U.S. Geological Survey waterways-treaty program, and as part of NASQAN.

3. Suspended-sediment data are being collected on a quarterly basis at Hayden Creek below North Fork, near Hayden Lake, ID, as part of the National Hydrologic Benchmark Network.

Upper Columbia Subregion

1. Suspended-sediment data are being collected at the following stations in the upper Clark Fork drainage in cooperation with the Montana Governor's office:

Clark Fork at Deer Lodge, MT (daily)
Little Blackfoot River near Garrison, MT (monthly)
Flint Creek near Drummond, MT (monthly)
Rock Creek near Clinton, MT (monthly)
Clrerk Fork at Turah Bridge near Bonner, MT (daily)
Blackfoot River near Bonner, MT (monthly)

2. Suspended-sediment data are being collected on a bimonthly basis in cooperation with the Bureau of Indian Affairs at the following stations:

Mission Creek above Reservoir near St. Ignatius, MT
South Fork Jocloo River near Arlee, MT
Flathead River at Perma, MT

3. Suspended-sediment data are being collected at the following sites as part of NASQAN:

Clark Fork below Missoula, MT (bimonthly)
Flathead River at Columbia Falls, MT (quarterly)

4. Suspended-sediment data are being collected on a daily basis at Flathead River at Flathead, British Columbia, in cooperation with the Montana Bureau of Mines and Geology.

5. Suspended-sediment data are being collected on a periodic basis at Columbia River at Northport, WA, at Columbia River at Vernita Bridge, near Priest Rapids Dam, WA, and at Okanogan River at Malott, WA, as a part of NASQAN.

6. Suspended-sediment data are being collected on a periodic basis at Andrews Creek near Mazama, WA, as a part of the National Hydrologic Benchmark Network.

7. Suspended-sediment data are being collected on a quarterly basis at Columbia River at Richland, WA, in cooperation with the U.S. Department of Energy.

8. Suspended-sediment data are being collected monthly at Clark Fork near Cabinet, ID, in cooperation with the Idaho State Department of Health and Welfare.

Yakima Subregion

1. Suspended-sediment data are being collected periodically at Yakima River near Union Gap, WA, and at Yakima River at Kiona, WA, as part of NASQAN.

Upper Snake Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Cache Creek near Jackson, WY, as a part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected on a daily basis by a PS-69 sampler and bedload data collected during spring runoff at Little Granite Creek near Bondurant, WY, as part of a special study for the Forest Service. Suspended-sediment and bedload data are collected weekly during spring runoff at Granite Creek near Bondurant, WY.

3. Suspended-sediment data are being collected on a bimonthly basis at Snake River near Heise, ID, as a part of NASQAN.

Middle Snake Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Snake River at King Hill, ID, and Snake River at Weiser, ID, as a part of NASQAN.

2. Suspended-sediment data are being collected on a quarterly basis at Big Jacks Creek near Bruneau, ID, as a part of the National Hydrologic Benchmark Network.

Lower Snake Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Salmon River near White Bird, ID, and Clearwater River at Spalding, ID, as part of NASQAN.

2. Suspended-sediment and bedload data are being collected on a weekly basis at South Fork Salmon River near Krassel RS, ID, in cooperation with Idaho State Department of Fish and Game.

3. Suspended-sediment data are being collected at Snake River at Burbank, WA, as a part of NASQAN.

4. Suspended-sediment data are being collected on a periodic basis from Minam River at Minam, OR, as a part of the National Hydrologic Benchmark Network, and from Owyhee River near Owyhee, OR, as part of NASQAN.

Middle Columbia Subregion

1. Suspended-sediment samples are being collected on a periodic basis at John Day River near McDonald Ferry, OR, and at Deschutes River near Biggs, OR, and bimonthly at Klickitat River near Pitt, WA, as a part of NASQAN.

Lower Columbia Subregion

1. Suspended-sediment data are being collected on a periodic basis at Columbia River at Warrendale, OR, Lewis River at Ariel, WA, and Cowlitz River at Kelso, WA, as a part of NASQAN.

2. Suspended-sediment data are being collected on a daily basis at Bull Run River near Multnomah Falls, OR, South Fork Bull Run River near Bull Run, OR, North Fork Bull Run River near Multnomah Falls, OR, and at Fir Creek near Brightwood, OR, in cooperation with the city of Portland, OR, to provide needed information to define the effects of activities in the basin.

Willamette Subregion

1. Suspended-sediment data are being collected on a periodic basis from Tualatin River at West Linn, OR, and at Willamette River at Portland, OR, as a part of NASQAN.

Oregon-Washington Coastal Subregion

1. Suspended-sediment data are being collected on a periodic basis at Rogue River near Agress, OR, Umpqua River near Elkton, OR, Siuslaw River near Mapleton, OR, Alsea River near Tidewater, OR, Nehalam River near Foss, OR, Chehalis River at Porter, WA, Willapa River near Willapa, WA, and at Queets River near Clearwater, WA, as a part of NASQAN, and at South Umpqua River at Roseberg, OR, in cooperation with Douglas County.

2. Suspended-sediment data are being collected on a quarterly basis at North Fork Quinault River near Amanda Park, WA, as part of the National Hydrologic Benchmark Network.

3. Suspended-sediment data are being collected on a biweekly basis from Applegate River near Copper, OR, in cooperation with the U.S. Army Corps of Engineers.

Puget Sound Subregion

1. Suspended-sediment data are being collected on a periodic basis at Elwha River at McDonald Bridge near Port Angeles, WA, Skagit River near Mount Vernon, WA, Snohomish River near Monroe, WA, and at Puyallup River at Puyallup, WA, as a part of NASQAN.

Oregon Closed Basins Subregion

1. Suspended-sediment data are being collected on a periodic basis at Donner and Blitzen Rivers near Frenchglen, OR, as a part of NASQAN.

Special Studies

1. Suspended-sediment and bed-material data are being collected on a periodic basis at the following stations:

N.F. Toutle River above Bear Creek near Kid Valley, WA
Green River above Beaver Creek near Kid Valley, WA
S.F. Toutle River at Camp 12 near Toutle, WA
N.F. Toutle River at Kid Valley, WA
Toutle River at Tower Road near Silver Lake, WA
Muddy River below Clear Creek near Cougar, WA
Clearwater River near mouth, near Cougar, WA

Automatic pumping sediment samplers are also operated at most sites. The goal is to compute daily sediment discharges and to continue evaluation of the sediment systems of streams affected by the 1980 eruption of Mount St. Helens.

2. Channel geometry data are being collected at 30 sites to support research on erosional processes and evolution of drainage systems. Sediment transport and hydraulic data are being collected at stations in the Toutle River basin to describe vertical profiles of suspended sediment and velocity. Bedload samples are being collected with Helley-Smith samplers at several sites. To improve the control of measuring and sampling equipment, staylines were installed at the cableways at N.F. Toutle River above Bear Creek, N.F. Toutle River at Kid Valley, and Toutle River at Tower Road gaging stations.

3. Work continued in the sediment-transport modeling project on the long-term goal of developing suitable computer models. In calendar year 1985, William G. Sikonia of the Washington Office, Pacific Northwest District, WRD, began work on development of a new sediment-transport model. An approach using either an implicit or explicit method of characteristics looks promising. The implicit method has been used successfully for water-transport problems in a finite-difference setting by J. Edenhofer, G. Schmitz, G. Seus, and H. Czirwitzky at the Technische Universitat Munchen, West Germany. Robert Baltzer and Vincent Lai, WRD, Reston, are familiar with this method and are also interested in investigating it further. The explicit method has been used successfully, again for water-transport problems in a finite-difference setting, by Vincenzo Casulli of the Instito per le Applicasioni del Calcolo, Rome, Italy, and Ralph Cheng, WRD, Menlo Park, CA. Sikonia is using a finite-element setting--tests of the approach on simple but demanding problems have been encouraging.

For additional information about U.S. Geological Survey activities within this region, contact the following offices:

District Chief, WRD
U.S. Geological Survey
230 Collins Road
Boise, ID 83702

District Chief, WRD
U.S. Geological Survey
Federal Building, Room 428
301 So. Park Avenue, Drawer 10076
Helena, MT 59626-0076

Office Chief, WRD
U.S. Geological Survey
847 NE 19th Avenue
Suite 300
Portland, OR 97232

District Chief, WRD
U.S. Geological Survey
P.O. Box 1125
Cheyenne, WY 82003

Office Chief, WRD
U.S. Geological Survey
1201 Pacific Avenue, Suite 600
Tacoma, WA 98402

SOIL CONSERVATION SERVICE

1. Studies of sediment damages and determinations of sediment yields were made in the following watersheds:

   a. Public Law 566

Major Drainage	Watershed	Stream	County	State
Snake River	Canyon East Fork	East Fork	Power	Idaho
Spokane River	Tensed/Lolo	Lolo Creek	Benewah	Idaho
Snake River	Tammany Creek	Tammany Creek	Nez Perce	Idaho
Snake River	Lower Sand Creek	Sand Creek	Bonneville	Idaho
Snake River	Dry Fork	Dry Fork	Malheur	Oregon

   b. River Basin Investigations

Major Drainage	Basin Reported	State
Clearwater River	Long Hollow, Erosion Sedimentation Study	Idaho
Clearwater River	Mission Lapway Erosion Sedimentation Analysis	Idaho
Snake River	Camas Creek	Idaho

2. Reservoir Sedimentation Surveys.

   A reservoir sedimentation survey was made on the following:

Reservoir	County(s)	State
Magic Reservoir	Blan, Camas	Idaho

3. Special Studies.

   a.

Subregion	County	State
Central Snake	Malheur	Oregon

   Demonstration plots were studied to evaluate the effect of straw mulch on erosion rates and sediment yield.

b.

Subregion	County	State
Coastal	Jackson	Oregon

Measured sediment yield from corn and onion fields irrigated by furrow method.

c.

Subregion	County	State
Mid-Columbia	Crook, Grant Jefferson, Wheeler	Oregon

A study was conducted, using a Rocky Mountain Infiltrometer, to compare runoff and sediment yield with several range site parameters on three soils in central Oregon.

d. A draft summary of data has been prepared for the East High River Basin Study, Washington. Sedimentation studies were made in Grant and Adams Counties. Sediment catchment devices were installed on ten sites using sprinkler irrigation systems, and seven sites using furrow irrigation.

e. A site specific Model of Water and Sediment Yield is being developed for the Tucannon River Watershed in southeastern Washington. The model uses a modification of MUSLE to estimate sediment yield. This model plus associated models of temperature, sediment intrusion in spawning redds, dissolved oxygen transfer and percent fry emergence are input to the "Tucannon River Computer Program," that simulates fish survival. Data collected has included bed material samples freeze cores of artificial redds over a time period of sediment intrusion, associated dissolved oxygen as sediment intrusion accumulated, and limited suspended and bedload samples.

f. A reconnaissance level evaluation of erosion and sedimentation conditions contributing to the reduction of channel capacity in the Snake River near Clarkston, Washington and Lewiston, Idaho, has been completed. The study assesses current erosion rates by land-use area and presents an analysis of the potential for sedimentation reduction to the Lower Granite Reservoir that could be achieved through the application of land treatment practices. Costs of installation and an estimate of the expected rate of application are provided. It is estimated that 39% of the sediment yield to the Lower Granite Reservoir is derived from non-irrigated cropland, 33% from federal land, 18% from streambank erosion, 6% from rangeland, 2% from nonfederal forest land, 1% from pastureland, and less than 1% from irrigated cropland and other land.

CALIFORNIA REGION

BUREAU OF RECLAMATION

A sediment study was prepared for the Grass Valley Creek drainage which enters the Trinity River downstream of Trinity Dam. A flow duration, sediment rating curve procedure was used to compute a sediment yield rate of 2.15 acre-feet per square mile per year. Modified Einstein computations were used to expand the sediment rating curve to a total load curve. The proposed Buckhorn Debris Dam will trap approximately 20 acre-feet per year.

CALIFORNIA REGION

CORPS OF ENGINEERS

South Pacific Division

Los Angeles District

Reservoir Sedimentation. Sediment Data Summary Sheets (ENG Form 1787) for Big Dalton, Big Tujunga, Cogswell, Devils Gate, Eaton Wash, Hansen, Live Oak and Swapit flood control basins; Puddingstone Diversion Dam, San Gabriel Dam No. 1, and Afton, Annette Jo, Chamberlain, Denivelle, Dry Cayon, Fieldbrook, Flowerpark, Inverness, Jasmine, Monument Canyon, Nadal Rye, Snow Drop and Sunset Canyon - Deer debris basins were completed.

Sediment Sampling Stations. The following USGS sediment sampling stations are funded in part by the District: Santa Ana River at Mentone, CA (Gage No. 11051500); Santa Ana River near E St., San Bernardino County, CA (No. 11059300); Little Colorado River near Joseph City and Holbrook, AZ (No. 09397000); Mission Creek near Santa Barbara Mission, Santa Barbara County, CA (No. 11119745).

Office Activities

1. Completed Skunk Creek and New River, Arizona, Sedimentation Study in support of the New River, Skunk Creek, and Agua Fria River General Design Memorandum. The sedimentation study was conducted to analyze the sediment transport characteristics of the proposed floodway for the 100-year flood and for flows over the life of the project. Three levels of analysis were utilized to assess the flood control plan: (1) qualitative geomorphic analysis; (2) quantitative geomorphic analysis; and (3) a mathematical model simulation.

2. Currently in progress is development of the Plan of Study for Sedimentation Analysis in support of the Coast of California Storm and Tidal Wave Study. This year, a literature review was completed of all Southern California Coastal Streams.

3. Currently in progress is a sediment transport analysis on Calleguas Creek, Ventura County, California. The purpose of the study is to analyze the existing sedimentation problems to identify the necessity for developing plans for flood control works. The analyses will be conducted using a sediment budget approach.

4. Currently in progress is a sediment transport analysis for the Lower Santa Ana River, California, as part of the Santa Ana River Phase II General Design Memorandum. The purpose of this study is to analyze the hydraulic design of the proposed improvement to ensure that the project will function properly under sediment loads imposed by a variety of flow conditions. The analyses consist of a sediment yield analysis of the canyon watershed, a qualitative and quantitative assessment of the river, and a detailed sediment routing analysis.

Sacramento District

Sediment Sampling. Routine samples of lake overflows were collected and analyzed for suspended sediment at Black Butte, Pine Flat, Kaweah, Success and Isabella Lakes. On Cottonwood Creek at Cottonwood, California total sediment-load samples were collected. This station was discontinued on 30 September 1985. Total sediment load was also sampled at three sites on the Russian River, and turbidity was also sampled at two of these sites.

Sediment Studies

1. Cache Creek, CA - C,P & E Study. The proposed project involves enlarging the outlet channel of Clear Lake in the upper part of the basin and enlarging an existing sediment basin in the lower basin. A Sediment Engineering (S.E.) Investigation is ongoing to evaluate impact of proposed upper basin project features on the Creek's channel morphology through Capay Valley, downstream of Clear Lake. A sediment monitoring program initiated in October 1983 is continuing and includes streamflow and total load sediment gages at the upstream and downstream boundaries of Capay Valley.

An S.E. investigation is also underway to evaluate enlargement of the existing sediment debris basin at the mouth of Cache Creek. The purpose of the basin is to prevent sediments from entering and depositing in the Yolo Bypass, which would impact on the flood conveyance capability of this water course and the integrity of the overall Sacramento River flood control system. Project features being evaluated include enlarging and raising of existing perimeter levees, and reconstructing and raising an existing outlet weir. A unique analytical approach, including use of a two dimensional hydrodynamic and sediment transport model, is being utilized in the design of project features and development of a sediment management plan for the basin.

4. Dry Creek (Sonoma County), CA - Construction. An S.E. Investigation of Dry Creek, between the (recently closed) Warm Springs Dam and its confluence with the Russian River is ongoing. This reach has a history of bank erosion (and other sediment transport related) problems. Before dam closure, some bank and bed stabilization works were authorized and constructed. The purpose of the S.E. Investigation is to determine project impacts on the sediment transport and channel morphology of the study reach and how best to proceed with future (if necessary) bank and/or bed stabilization works. The investigation is taking a multidisciplinary approach to analysis of Dry Creek problems, including consideration of the hydraulic, hydrologic, sediment transport and geomorphic aspects of the Creek and its contributing watershed. A data collection program in the basin is continuing, including collection of streamflow and total load sediment data at three stations. Also, sediment survey ranges along the Creek were resurveyed; and bed and bank material samples were collected for use in the S.E.I.

3. Sacramento River Bank Protection Project. Construction - Bank protection measures on the Sacramento River are proposed in the vicinity of the Butte Basin "flow split" area. The purpose of these measures is to preserve the historical division of flow into the main leveed floodway of the Sacramento River and into the natural overflow area of the Butte Basin. Due

to changes to the Sacramento River course in this vicinity, concern has been raised that this division of flow might change, possibly routing flood flows in excess of design capacity down the leveed floodway and endangering the integrity of the overall Sacramento River Flood Control System. An S.E. Investigation has been initiated to evaluate if the proposed bank protection measures would be effective and evaluate possible modifications to ensure their effectiveness.

4. Sacramento River Fish Gravel Study. - Construction. Historically, the upper Sacramento River has been a prime water course for fish spawning. This is due to a number of reasons, including flow and temperature conditions and suitability of river bed material. Typically, suitable size and gradation of bed material (i.e. Fish Spawning Gravels) ranges from 0.5 to 6 inch in size. Recently, concern has been raised that proposed bank protection measures in the upper Sacramento River will deprive the River of an important source of the fish spawning gravels - the eroding banks. An S.E. Investigation was initiated to address these concern and identify what impacts, if any, there would be on the fish spawning habitat.

5. Sacramento River Deep Water Ship Channel (Sediment Trap). Construction - An S.E. Investigation was initiated in Fiscal Year 1984 to evaluate the engineering and economic feasibility of constructing a sediment trap in the ship channel. Such a trap could, if properly designed, capture sediments in a very localized area, thus reducing annual ship channel maintenance dredging costs by reducing the aerial extent of dredging. This investigation was suspended pending availability of funding for the project.

6. Wildcat/San Pablo Creeks (Contra Costa County), California. G.D.M. An S.E. Investigation to determine the impacts that proposed flood control channels would have on channel morphology and sediment transport in the project area was completed. The proposed project channels (two) would carry a relatively coarse bedload and empty into environmentally-sensitive tidal marshes. A sediment debris basin was incorporated into one of the project channels to preserve its flood conveyance capability and protect the downstream marsh from coarse bedload deposition. In addition, channels were cut through the tidal marshes to the open waters of San Pablo Bay so that sediments would be carried through to the Bay rather than be deposited in the environmentally-sensitive marshes.

San Francisco District

Sedimentation activities that were conducted within the District's boundaries during calendar year 1985 consisted primarily of on-going dredging and related hydrographic surveys for purposes of maintaining Federal harbors and channels free of sedimentation and a study of sediment related problems at the Corps' San Lorenzo River (Santa Cruz, California) flood control project. Activities related to the Alcatraz dredge material disposal site and San Lorenzo River Study are descirbed below.

Alcatraz Dredge Material Disposal Site. As reported in 1985, numerous studies were implemeted as a result of material accumulation at the Alcatraz disposal site. In July 1985, all study activities related to the disposal of dredged

material were consolidated into the Disposal Management Program (DMP). Monthly bathymetric surveys are continuing at the Alcatraz site. Survey data to date have indicated retention of material disposed at the Alcatraz site. Material is still accumulating at the site.

In July 1985, all use of the Alcatraz site was temporarily suspended while course of the site were drilled to determine the nature of the shoaled material. The borings showed that disposed material is mounded up to 114 feet over the original bay bottom. The most recently deposit material is an intermixed and interlayered sand and highly plastic clay that forms a layer up to 46 feet thick. This material overlies a more consolidated layer of older dredged material composed primarily of clays. Beneath the older dredge material, naturally occurring dense sands and stiff clays were encountered.

Based on this information, interim measures to manage disposal at the Alcatraz disposal site were implemented until more permanent management techniques are developed through the DMP. The most significant measure, now in effect, is the requirement for homogenous slurry disposal of material disposed at each of the three existing Bay disposal site. This requirement is intended to enhance the dispersal of disposed consolidated material such as the stiff clays encountered in the boring program to lessen the rate of accumulation at the sites. The composition of the slurry is dependent upon the physical properties of the sediments. The interim management policy requires that the water content of the slurry must be adjusted to achieve a liquidity index of 4.5 or greater to enhance dispersal of the material in the water column.

The liquidity index is determined by the Atterberg liquid and plastic limits of the material. The water content required to meet a liquidity index of 4.5 will vary with different types of material and dredging locations. Thus, a requirement for Atterburg testing for all dredging projects over 10,000 cubic yards at the Alcatraz site, and over 100,000 cubic yards for the other two existing sites, has been implemented. More data are being collected, and the apparent relationship is currently under study at WES. Those study results are expected later this year, and revision of our interim measures to reflect that information is anticipated soon thereafter.

We know that not all of the disposed material at the site remains within the site boundaries. In July of 1985, currents at the Alcatraz site were measured to help predict the transport of disposed material. Current meters were placed at several locations and depths at the disposal sits. The results of the data collected indicated that currents generally are in the east-west direction.

The sediment transport study will attemp to address both short- and long-term transport of disposed material. We have initiated two investigations to address these concerns. The first is a flume test being conducted by WES. The flume test will be used to determine the critical shear stress for erosion of the material as well as the erosion rates (above this threshold shear stress) for various sediments at various liquidity indices. These results will be used to determine if the slurry approach for enhancing dispersal is appropriate, and will further define the physical characteristics of the slurry.

WES is also conducting a computer simulation of disposal at Alcatraz using a model called DIFID, Disposal from Instantaneous Dump. This model determines the short-term fate of discharged dredged material. Input for this model will come from the flume test and the current measurements taken at the Alcatraz disposal site last July.

To address our long-term goal, additional studies, including a numerical model to simulate long-term hydrodynamic circulation and sediment transport, is under consideration. A preliminary proposal, a determination will be made on the need to establish boundary conditions, and verify and calibrate the proposed mode.

San Lorenzo River Study. The deposition of sediment in the San Lorenzo River Flood Control Project, constructed in 1962, has sustantially reduced the flood-carrying capacity of the project. The Waterways Experiment Station (WES) was contracted in 1985 to analyze the actual carrying capacity of the river during various flood events using the sediment model HEC-6, with special emphasis on re-creating the January 1982 flood event which was estimated to have a return frequency of about once in thirty years. WES has also been asked, as a part of the study, to determine the average annual sediment load based on 47 years of record using the calibrated HEC-6 model. The results of the WES study will provide the basis upon which to compare various alternative plans to return the capacity of the project to its design condition. To date, the HEC-6 study is nearly complete, and the entire study is estimated to be completed in mid 1986.

CALIFORNIA REGION

GEOLOGICAL SURVEY

North Coastal Subregion

1. Suspended-sediment and bedload data are being collected in Redwood National Park to evaluate the sediment transport rates caused by both natural processes and logging activities within the park. Data collection began in 1973 in cooperation with the National Park Service. The Park Service is using this data to develop management practices that will reduce erosion rates. The current sampling network includes the following stations:

Redwood Creek near Blue Lake (daily)
Lacks Creek near Orick (monthly)
Redwood Creek above Panther Creek (monthly and storm event)
Panther Creek near Orick (monthly)
Coyote Creek near Orick (monthly)
Little Lost Man Creek near Orick (monthly)
Redwood Creek at Orick (daily)

2. Suspended-sediment data were collected on the Hoopa Indian Reservation to determine the variation in sediment transport rates within the reservation and to use as a data base for comparison of transport rates with the forest areas adjacent to the reservation. The transport comparisons will be used by the Bureau of Indian Affairs to evaluate the impact of the timber harvesting and management practices within the reservation on the local fisheries. Estimates of bedload discharge were included in this study. Data collection began in the 1982 water year and included the following stations (discontinued April 1985):

Supply Creek at Hoopa (daily)
Supply Creek near Hoopa (storm event)
Mill Creek at Hoopa (storm event)
Mill Creek near Hoopa (storm event)
Soctish Creek at Hoopa (storm event)
Pine Creek near Weitchtec (storm event)

3. Suspended-sediment data are being collected on a daily basis and bedload data on a periodic basis at Grass Valley Creek at Fawn Lodge near Lewiston and at Trinity River below Limekiln Gulch near Douglas City, in cooperation with Califronia Department of Water Resources and the Bureau of Reclamation, respectively.

4. Suspended-sediment data are being collected on a quarterly basis at Elder Creek near Branscomb, as part of the National Hydrologic Benchmark Network, and at Smith River near Crescent City, as part of National Stream Quality Accounting Network (NASQAN).

5. Suspended-sediment data are being collected on a bimonthly basis at Klamath River near Klamath and at Eel River at Scotia, as part of NASQAN.

6. Suspended-sediment and bedload data are being collected on a periodic basis at Little Grass Valley Creek near Lewiston and Grass Valley Creek near French Gulch, in cooperation with the U.S. Bureau of Reclamation.

Sacramento Basin Subregion

1. Suspended-sediment and bedload data are being collected in Capay Valley to evaluate the impact of enlarging the Clear Lake outlet channel on the Cache Creek Channel Morphology. Data collection began in October 1983, in cooperation with the U.S. Army Corps of Engineers (COE). The current sampling program includes the following stations plus survey and bed-material data collected at 10 cross sections in Capay Valley:

Cache Creek at Yolo (storm event)
Cache Creek at Capay Bridge (storm event)
Cache Creek near Brooks (daily)
Cache Creek above Rumsey (daily)

2. Suspended-sediment data are being collected on a daily basis at Feather River near Gridley, in cooperation with California Department of Water Resources, and at Sacramento River at Freeport, in cooperation with the COE.

3. Suspended-sediment data were collected on a periodic basis at Cottonwood Creek near Cottonwood, in cooperation with the COE (discontinued May 1985).

4. Suspended-sediment data are being collected on a bimonthly basis at Sacramento River at Keswick, as part of NASQAN.

North Lahontan Subregion

1. As part of the Tahoe Monitoring Program, suspended-sediment data are being collected from seven streams that drain into Lake Tahoe. The relation of sediment discharge to algae growth in the lake is being studied by the University of California at Davis. The sediment data collection program is in cooperation with the California Department of Water Resources and the University of California at Davis, and includes the following daily sediment stations:

Upper Truckee River at South Lake Tahoe
General Creek near Meeks Bay
Blackwood Creek near Tahoe City
Ward Creek at Highway 89
Snow Creek at Tahoe Vista*
Third Creek near Crystal Bay, NV*
Trout Creek near Tahoe Valley

*(discontinued September 1985)

2. Suspended-sediment data are being collected on a daily basis and bedload data on a periodic basis at Edgewood Creek near Stateline and Logan House Creek near Glenbrook, as part of a sediment budget study in the Lake Tahoe Basin in cooperation with the Tahoe Regional Planning Agency.

3. Suspended-sediment data are being collected on a periodic basis at Martis Creek at Highway 267 near Truckee, Martis Creek Lake near Truckee and Martis Creek near Truckee, in cooperation with the COE; and at Sagehen Creek near Truckee, in cooperation with the University of California at Davis.

4. Suspended-sediment data are being collected on a bimonthly basis at Susan River at Susanville, as part of NASQAN.

San Francisco Bay Subregion

1. Suspended-sediment and bedload data are being collected in the Cull Creek and San Lorenzo Creek Basins to document sediment transported into Cull Creek and Don Castro Reservoirs, respectively, and to test erosion control procedures. Data collection began in the 1979 water year, in cooperation with Alameda Country Flood Control and Water Conservation District, and includes the following stations:

San Lorenzo Creek above Don Castro Reservoir near Castro Valley (daily)
Cull Creek above Cull Creek Reservoir near Castro Valley (daily)
Cull Creek Tributary No. 4 above CC Reservoir (storm event)

2. Suspended-sediment data are being collected on a daily basis and bedload data on a periodic basis at Pena Creek near Geyserville, Dry Creek near Geyserville, and Russian River near Guerneville, in cooperation with the COE.

3. Suspended-sediment data are being collected on a daily basis and bedload data on a periodic basis at Permanete Creek and WF Permanente Creek near Monte Vista to evaluate the sediment transport rates caused by both natural processes and limestone quarrying activities within the Permanente Creek basin. Data collection began in October 1984, in cooperation with Santa Clara Valley Water District.

4. Suspended-sediment data are being collected on a bimonthly basis at Napa River near Napa, as part of NASQAN.

5. Suspended-sediment data are being collected twice per year at two stations on Los Gatos Creek and bed-material data are being collected twice per year at 12 stations in the Guadelupe River basin, as part of the Santa Clara County Water Quality Study. Data collection began in 1982, in cooperation with the Santa Clara Valley Water District.

San Joaquin Basin Subregion

1. Suspended-sediment data are being collected on a daily basis at San Joaquin River at Vernalis, in cooperation with the California Department of Water Resources.

2. Suspended-sediment data are being collected on a quarterly basis at Mokelumne River at Woodbridge, as part of NASQAN, and at Merced River at Happy Isles Bridge near Yosemite, as part of the National Hydrologic Benchmark Network.

3. Suspended-sediment data are being collected at 11 stations on a biweekly basis and at 33 stations on a synoptic basis, as part of the data-collection program for the San Joaquin River Water Quality Study. Bed-material data are also being collected at 24 stations, once or twice per year. Data collection began in 1985, in cooperation with the U.S. Bureau of Reclamation.

Central Coastal Subregion

1. A resurvey of Loch Lomond Reservoir in the San Lorenzo River basin in Santa Cruz County was completed in August 1982. The survey was undertaken following landslides and sediment deposition related to the January 1982 storm events. Results of the survey and bed core samples that were taken during the survey will be published in 1985.

2. Suspended-sediment data were collected on a daily basis and monthly estimates of bedload discharge were made at San Jose Creek at Goleta, in cooperation with the COE (discontinued April 1985).

3. Suspended-sediment and bedload data are being collected on a periodic basis at San Antonio River near Lockwood, and at Nacimiento River near Bryson, in cooperation with Monterey County Flood Control and Water Conservation District.

4. Suspended-sediment and bedload data are being collected on a periodic basis at four streams between Half Moon Bay and Monterey Bay, in cooperation with the Department of Boating and Waterways. The cooperator will use this data and estimates of sediment loads from discontinued sediment stations to develop a management plan for beach areas along the California coast. Data collection began in October 1985 and includes the following stations:

San Gregorio Creek at San Gregorio

5. Suspended-sediment data are being collected on a bimonthly basis at Salinas River near Chular and on a quarterly basis at Pajaro River at Chittenden, as part of NASQAN.

Tulare Basin and South Lahontan Subregions

1. Suspended-sediment data are being collected on a bimonthly basis at Kings River below NF near Trimmer and Kern River at Kernville, and on a quarterly basis at Owens River near Big Pine, as part of NASQAN.

South Coastal Subregion

1. Suspended-sediment data are being collected once per year at 10 stations in the Santa Monica Mountains, as part of the Santa Monica Mountains Water Quality Study. Data collection began in 1982 in cooperation with the National Park Service.

2. Suspended-sediment data were collected on a daily basis at San Diego Creek at Culver Drive near Irvine, San Diego Creek at Campus Drive near Irvine, and at Peters Canyon Wash near Irvine to test the trap efficiency of two siltation basins located in the lower reaches of San Diego Creek basin. Estimates of bedload discharge at the San Diego Creek at Campus Drive and

Peters Canyon Wash stations and periodic surveys of the siltation basins were included in this study. The sediment discharge and survey data along with an assessment of factors controlling sediment yield within the basin will be used by the cooperator, City of Newport Beach, to effectively manage factors which may have detrimental impacts on the physical and biological habitat of Newport Bay. Data collection began in the 1983 water year and was discontinued in April 1985.

3. Suspended-sediment data are being collected on a daily basis and monthly estimates of bedload discharge are made at Santa Clara River at Montalvo, in cooperation with Ventura County PWA and California Department of Boating and Waterways (discontinued September 1985), and at Santa Ana River at Santa Ana, and San Juan Creek at San Juan Capistrano, in cooperation with Orange County Environmental Management Agency.

4. Suspended-sediment data are being collected on a daily basis at Santa Ana River near Mentone and on a periodic basis at Santa Ana River near San Bernardino, in cooperation with the COE.

5. Suspended-sediment and bedload data are being collected on a periodic basis, in cooperation with the California Department of Boating and Waterways and the COE, at the following stations:

Carmel Creek near Del Mar
Carroll Creek near La Jolla
Arroyo Trabuco at San Juan Capistrano
San Luis Rey River at Oceanside
San Diequito River near Del Mar
San Mateo Creek at San Onofre

6. Suspended-sediment data are being collected on a bimonthly and storm-event basis at Santa Ana River below Prado Dam, in cooperation with Orange County Environmental Management Agency.

7. Suspended-sediment data are being collected on a daily basis and monthly estimates of bedload discharge are made at Ventura River near Ventura, in cooperation with California Department of Boating and Waterways.

8. Suspended-sediment are being collected on a quarterly basis at Los Angeles River at Long Beach and Santa Clara River at Los Angeles-Ventura County Line, as part of NASQAN.

Colorado Desert Subregion

1. Suspended-sediment data are being collected on a quarterly basis at Alamo River near Calipatria and on a bimonthly basis at New River near Calexico (discontinued February 1985) as part of NASQAN.

For additional information about U.S. Geological Survey activities within this region, contact the following office:

District Chief, WRD
U.S. Geological Survey
2800 Cottage Way
Sacramento, CA 95825

SOIL CONSERVATION SERVICE

1. Studies of sediment damages and determinations of sediment yields were made in the following watersheds:

   a. Public Law 566

Major Drainage	Watershed	County	State
San Diego River	San Vicente	San Diego	CA
Santa Clara River	Mint Canyon	Ventura	CA
Sacramento River (Cache Creek)	Long Valley	Lake	CA
Napa and Russian Rivers	Hillside Vineyards	Napa and Sonoma	CA
Eel River	Tomki Creek	Mendocino	CA
San Joaquin and Merced Rivers	Stockton Creek	Merced	CA

2. Special Studies

Major Drainage	Watershed	Stream	County	State
Trinity River	Grass Valley Creek	Grass Valley and Little Grass Valley Creeks	Trinity	CA

Erosion and sediment yield rates were determined by sources for the Bureau of Reclamation. SCS developed alternative land treatment plans to show the costs of various levels of sediment reduction. The report was used in the Bureau's EIS on the Trinity River Rehabilitation Project.

Major Drainage	Watershed	Stream	County	State
Feather River	North Fork Feather River	Rock Creek	Plumas	CA

SCS is reviewing the results of a sediment model for Rock Creek developed by a private contractor for Pacific Gas and Electric Company (PG&E). PG&E requested assistance from SCS to determine if erosion sources in the upper watershed of a power reservoir could be reduced with land treatment under the PL-566 program.

ALASKA REGION

CORPS OF ENGINEERS

North Pacific Division

Alaska District

Kuskowkwim River at Crooked Creek. Bedload and suspended sediment were collected four times.

Matanuska River at Palmer. Bedload, suspended sediment and stream discharge were colleccted four times.

ALASKA REGION

GEOLOGICAL SURVEY

Arctic Slope Subregion

1. Suspended-sediment data are being collected on a periodic basis at the Kuparuk River near Deadhorse, AK, as part of the National Stream Quality Accounting Network (NASQAN).

Northwest Subregion

1. Suspended-sediment and bed-material data are being collected on a periodic basis at Kobuk River near Kiana, AK, as part of the Collection of Basic Records Program.

Yukon Subregion

1. Suspended-sediment data are being collected on a periodic basis at the Yukon River at Pilot Station, AK, as a part of NASQAN.

2. Suspended-sediment data are being collected periodically at the Tanana River at Nenana, AK, as part of NASQAN.

Southwest Subregion

1. Suspended-sediment data are being collected on a periodic basis at Nushagak River at Ekwok, AK, and at Kuskokwim River at Crooked Creek, AK, as part of NASQAN. Bedload data are being collected at the Kuskokwin River site in cooperation with the U.S. Army Corps of Engineers (COE).

South-Central Region

1. A suspended-sediment data program funded by Alaska Power Authority, as part of their evaluation of the proposed Watana and Devil's Canyon hydroelectric power sites, was continued through 1985. Suspended-sediment data are being collected on a periodic basis at Chulitna River near Talkeetna, AK, Susitna River near Denali, AK, Susitna River near Gold Creek, AK, Susitna River near Talkeetna, AK, Susitna River near Cantwell, AK, and at Susitna River at Sunshine, AK. Bedload data were obtained at various sites on the Chulitna, Susitna, and Talkeetna Rivers near Talkeetna, Susitna River at Sunshine, and the Yentna River near Susitna Station.

Report: Knott, J. M., and Lipscomb, S. W., 1985, Sediment discharge data for selected sites in the Susitna River Basin, Alaska, October 1982 to February 1984: U.S. Geological Survey Open-File Report 85-157, 62 p.

2. A cooperative study with the Municipality of Anchorage was initiated in 1983 to determine annual suspended-sediment inflow and outflow of Potter Marsh. Suspended-sediment data were obtained at three sites during the 1985 water year.

3. Suspended-sediment data are being collected on a periodic basis at Talkeetna River near Talkeetna, AK, as part of the National Hydrologic Benchmark Network.

4. Suspended-sediment data are being collected on a periodic basis at Susitna River at Susitna Station, AK, and at Copper River near Chitina, AK, as a part of NASQAN.

5. Suspended-sediment and bedload data are being collected on a periodic basis at Matanuska River near Palmer, AK, as part of a cooperative program with the Alaska Department of Natural Resources and COE.

6. A cooperative study with the Municipality of Anchorage was initiated in 1985 to determine sediment movement into, within, and out of Eklutna Lake. Suspended-sediment samples are being collected daily and bedload samples are being collected periodically.

7. Suspended-sediment data are being collected on a miscellaneous basis at the following sites:

Willow Creek near Willow, AK
Deception Creek near Willow, AK

Southeast Subregion

1. As part of the cooperative program with the U.S. Forest Service, suspended-sediment data are being collected on a periodic basis at the following sites:

Hamilton Creek near Kake, AK
Rocky Pass Creek near Point Baker, AK
Greens Creek near Juneau, AK
Kadashan River above Hook Creek near Tanakee, AK

2. Suspended-sediment data are being collected on a periodic basis at the Stikine River near Wrangell, AK, and at Skagway River at Skagway, as part of NASQAN.

3. A cooperative program with the City and Borough of Juneau, to obtain suspended-sediment samples at Gold Creek near Juneau, was initiated in 1984 and continued in 1985.

For additional information about U.S. Geological Survey activities within this region, contact the following office:

District Chief, WRD
U.S. Geological Survey
4230 University Drive, Suite 201
Anchorage, AK 99508-4664

SOIL CONSERVATION SERVICE

1. Special Studies

SCS is studying a solution to flooding and erosion on the Delta Agricultural Project which is currently putting sediment into Clearwater Lake and threatening Clearwater Creek. Clearwater is a large spring fed, clear stream which stays open year round and is a popular fishing and recreational river. It is in hydrologic unit 19030004 and drains into the Delta River which drains to the Tanana River and then to the Yukon River.

HAWAII REGION

GEOLOGICAL SURVEY

Hawaii Subregion

1. Suspended-sediment data are being collected bimonthly at Honolii Stream near Papaikou, Hawaii, as a part of the National Hydrologic Benchmark Network.

2. Suspended-sediment data are being collected bimonthly at Wailuku River at Hilo, Hawaii, as a part of National Stream Quality Accounting Network (NASQAN).

Maui Subregion

1. Suspended-sediment data are being collected bimonthly at Kahakuloa Stream near Honokohau, Maui, as a part of NASQAN.

Molokai Subregion

1. Suspended-sediment data are being collected bimonthly at Halawa Stream near Halawa, Molokai, as a part of NASQAN.

Oahu Subregion

1. Suspended-sediment data are being collected at the following sites:

   Waikele Stream, Waipahu, Oahu, on a daily basis as part of the Federal CBR program.

   Kalihi Stream, at Kalihi, Oahu, quarterly as a part of NASQAN.

   Kamooalii Stream near Kaneohe, Oahu, on a daily basis in cooperation with the U.S. Corps of Enginners.

2. In cooperation with Hawaii State Department of Transportation, daily suspended-sediment data are being collected at the following stations on Oahu:

   Luluku Stream near Kaneohe

Kauai Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at Waimea River at Waimea, Hawaii, as a part of NASQAN.

Special Studies

1. A cooperative study with Hawaii State Department of Health was initiated to study the effects of cell-grazing method on soil loss and water quality on Hawaii Island. Erosion and suspended-sediment data are being collected at one cattle-grazing site near Kamuela on Hawaii Island.

For additional information about U.S. Geological Survey activities within this region, contact the following office:

District Chief, WRD
U.S. Geological Survey
P.O. Box 50166
Honolulu, HI 96850

CARIBBEAN REGION

CORPS OF ENGINEERS

South Atlantic Division

Jacksonville District

Suspended Sediment Sampling.

1. Daily collection continued at Rio Fajardo, below Fajardo, P.R., in cooperation with the U. S. Geological Survey for preparation of General Design Memorandum for Rio Fajardo Dam.

2. Daily collection continued at Rio Lousia, near San Lorenzo, P.R.; Rio Valenciano, near Juncos, P.R.; Rio Cayaquas, near San Lorenzo, P.R. in coperation with USGS at these three proposed dam sites.

3. New sampling station was undertaken in 1985 at Rio Rosario, near Rosario, P.R., in coperation with USGS for daily collection at the proposed dam site.

CARIBBEAN REGION

GEOLOGICAL SURVEY

Puerto Rico Subregion

1. Suspended-sediment data are being collected on a bimonthly basis when flow is above normal at 59 sites in cooperation with the Puerto Rico Environmental Quality Board (PREQB).

2. Suspended-sediment data are being collected on a bimonthly basis at the following sites as a part of the National Stream Quality Accounting Network (NASQAN):

Río de la Plata at Toa Alta, PR
Río Grande de Manatí near Manatí, PR
Río Grande de Añasco near San Sebastián, PR
Río Grande de Patillas near Patillas, PR

3. Suspended-sediment data are being collected on a weekly basis and during high flows at Río Tanamá near Utuado, PR, in cooperation with PREQB.

4. Suspended-sediment data are being collected on a daily basis at Río Rosario near Hormigueros PR, and during high flood events at at Rio Fajardo near Fajardo, PR in cooperation with the U.S. Army Corps of Engineeers (COE).

Special Studies

1. Suspended-sediment data are being collected on a weekly basis and during high flows at the following sites in cooperation with PREQB, COE, Puerto Rico Department of Natural Resources (PRDNR), and Puerto Rico Aqueduct and Sewer Authority (PRASA) to determine the sediment load from those small basins to Lago Loíza, a water supply reservoir:

Quebrada Blanca at Jagual, PR
Quebrade Salvatierra near San Lorenzo, PR
Quebrade Caimito near Juncos, PR
Quebrada Maney near Guarbo, PR
Río Turabo Borinquen, PR

2. Suspended-sediment data are being collected on a daily basis at the following sites in cooperation with PREQB, PRASA, PRDNR, and COE as part of a project to determine the sediment load at these three proposed dam sites:

Río Cayaguas at Cerro Gordo, PR
Río Valenciano near San Lorenzo, PR
Río Grande de Loíza at Quebrada Arenas, PR

3. Suspended-sediment data are being collected daily at the following sites in cooperation with PREQB, PRDNR, PRASA, and COE to determine total sediment input from Río Grande de Loíza Basin to Lago Loí reservoir:

Río Grande de Loí at Caguas, PR
Río Gurabo at Gurabo, PR

4. Bed-material samples will be collected twice a year at the following sites in cooperation of PREQB, PRDNR, PRASA, and COE as part of a project to determine the total bed-material discharge from these subbasins to Lago Loíza:

Río Grande de Loíza at Quebrada Arenas, PR
Quebrada Blanca at Jagual, PR
Quebrada Salvatierra near San Lorenzo, PR
Río Cayaguas at Cerro Gordo, PR
Río Turabo at Borinquen, PR
Río Grande de Loíza at Caguas, PR
Quebrada Caimito near Juncos, PR
Río Valenciano near Juncos, PR
Quebrada Mamey near Gurabo, PR
Río Gurabo at Gurabo, PR

5. Twelve sedimentation surveys will be conducted at 12 water-supply reservoirs to investigate the impact of sediment deposition on the reservoirs capacity.

For additional information about Geological Survey activities within this region, contact the following office:

District Chief, WRD
U.S. Geological Survey
G. P. O. Box 4424
San Juan, PR 00936

SOIL CONSERVATION SERVICE

1. Reservoir Sedimentation Surveys.

The following reservoir sedimentation survey was performed in cooperation with the U.S. Geological Survey.

Reservoir	Stream	Subregion
Lago Loiza	Rio Grande de Loiza	Puerto Rico

LABORATORY AND OTHER RESEARCH ACTIVITIES

AGRICULTURAL RESEARCH SERVICE

ARIZONA

Research activities at the Aridland Watershed Management Research Unit (formerly Southwest Rangeland Watershed Research Center) in Tucson, Arizona include the following:

1. Research has continued to adapt the individual terms of the Universal Soil Loss Equation (USLE) to conditions encountered in the rangeland areas of the western U.S. Major problems involve the rainfall erosivity value (R), the cover-management factor (C), the topographic factor (LS), and the support practice factor. Progress in adapting these terms for rangeland conditions is now essentially completed and available for review.

2. The WEPP (Water Erosion Prediction Project) is a new initiative in USDA started in April, 1985. A Core Team has been formed, user requirements have been written and reviewed by SCS, and the experimental design for the field work is being developed. Closed-form analytic solutions to the coupled overland flow and sediment detachment-transport equations have been found for several assumptions on the rainfall-runoff detachment processes. It was found that the current procedure of using a constant rainfall intensity during rainfall simulator studies is not adquate to determine parameters for most of the assumed rainfall-runoff detachment equations. Therefore, investigations are being undertaken to automatically vary rainfall intensity from 60 mm/h to 120 mm/h and back during an experimental run.

3. Research was conducted on the hydrologic component of the SPUR model (Simulation of Productivity and Utilization on Rangeland) to examine the sensitivity of its output to changes in parameter values, to validate the model for application on a small watershed in southern Arizona, and to illustrate the model's use as a management tool. The most significant parameters were identified, and the model reproduced trends in measured runoff and sediment yield, but poorly represented extreme events in the validation study. The current version of the model was shown to have some utility in assessing the impact of upland land uses and erosion control practices on downstream sediment yield from semiarid rangeland watersheds. However, a more direct linkage between upland and channel erosion and sedimentation processes will be required to more accurately evaluate the downstream results of upland erosion control measures. The present version of the hydrologic model duplicates the observed phenomena of decreasing water yields per unit area and decreasing peak discharge per unit area with increasing watershed area. This suggests that the processes causing the decreases (transmission losses, partial area contributions, and attenuation in routing) are being approximated in the model. Moreover, these findings support the idea that, to model semiarid watersheds accurately, the stream channels must be represented in ways which reflect the spatial variability of complex watersheds. In a similar manner, observed sediment yields per unit area decrease with increasing watershed areas.

4. A compilation of data from four western rangeland rainfall simulator experimental sites was made, and the data submitted for publication in

the Proceedings of a Rainfall Simulator Workshop held in Tucson, AZ in January, 1985. This data base represents the largest of its kind for rangeland erosion studies carried out under identical experimental design criteria, and allows direct comparisons among the four ecosystems studied.

5. Data from 36 large (3.05 by 10.7 m) experimental plots, in Arizona and Nevada, have shown that rock fragments (erosion or desert pavement) decreased erosion on rangeland and, in some cases, appeared to be more dominant than vegetation canopy. Erosion amounts were correlated with runoff amounts which, in turn, increased with decreasing vegetation and rock fragment cover.

6. Rainfall simulation plots, on semiarid rangeland plots in southeastern Arizona, have indicated that erosion rates per unit of rainfall energy changed with time during a 4-year study. Erosion rate changes corresponded to observed changes in runoff rate, and were also reflected in changes in Universal Soil Loss Equation erosion-estimating factors. The study indicated that at least 2 years of seasonal rainfall simulations are needed before erosion and runoff rates reach equilibrium with rainfall energy input.

For additional information, contact Kenneth G. Renard, Research Leader, USDA-ARS, Aridland Watershed Management Research Unit, 2000 E. Allen Rd., Tucson AZ 85719

COLORADO

Research activities at the Hydro-Ecosystem Research Group in Fort Collins, Colorado include the following:

1. The geometry of alluvial stream channels changes with time as a result of changing water and sediment discharge rates. Better quantitative analyses are needed to predict the effect of upstream sediment loads on channel bank and bed stability. A model that simulates these changes has been formulated and applied to a hypothetical erodible channel to demonstrate the capabilities of the model. The model considers both vertical and lateral scour and fill. This capability is a significant improvement over existing models that simulate channel metamorphosis exclusively as a result of longitudinal scour and fill while ignoring channel width changes. The knowledge gained from this study will be useful in improving the predictive capabilities of models used to assess the offsite impact of upland management practices on downstream channel stability.

2. Two-thirds of the 1500 sq. km. Tucannon River watershed in southeastern Washington is devoted to agriculture. Erosion from the cultivated fields contributes most of the fine sediments transported by the river. These fine sediments (including organic matter) have seriously affected salmonid spawning areas, food chain, and aquatic habitats in the Tucannon River, that once supported highly valuable salmon and steelhead populations. The Soil Conservation Service implemented a large cooperative Tucannon River Basin study to demonstrate the enormous potential benefits attributable to proper soil and water conservation measures; they will be needed to rehabilitate this extensive and valuable aquatic resource. A computer model that estimates the sediment yields expected from all parts of the watershed under alternative management practices has been developed. A second model uses the output from the sediment yield model to simulate the intrusion of fine sediments into spawning grounds. These models were developed as part of the ARS contribution to this cooperative study. The models will be used in conjunction with other physical, biological and economical models developed for use in this assessment effort. The outcome of this study is expected to show a net benefit of millions of dollars as a result of improved spawning conditions. The numerical value is not presently known because the study is not complete.

3. A Simplified Process (SP) model for single-storm water and sediment yield from unit surfaces was developed and coded. The formulation attempts to minimize both data requirements and computational effort while maintaining a relatively high degree of similitude with hydrologic, hydraulic and erosion processes. The model avoids hydraulic routing and sophisticated numerical techniques, but is still capable of synthesizing an idealized storm hydrograph based on kinematic wave theory. The model accounts for interception, depression storage, infiltration, soil detachment by raindrops and surface runoff and sediment transport processes in its determination of water and sediment yield. Methods for estimating model parameters have also been

developed. A report on this work has been submitted to the ARS Water Erosion Prediction Project (WEPP) coordinator and circulated among WEPP team members for their consideration.

For additional information contact Donn G. DeCoursey, Research Leader, USDA-ARS, P. O. Box E, 301 South Howes, Fort Collins, CO 80522.

GEORGIA

Research activities at the Southern Piedmont Conservation Research Center, Watkinsville, Georgia include the following:

1. Concentrated flow erosion or recurring small gullies is very common on most tilled agricultural lands. Only recently has enough national concern emerged to classify this problem as a high priority research need. Photogrammetry, which is defined as the art and science of deriving accurate measurements from image data; has been tested in gully erosion investigations. A joint research effort by the University of Georgia Geography Department, Soil Conservation Service and Agricultural Research Service has developed aerial photogrammetric techniques and found them capable of mapping sizeable fields accurately enough to measure eroded soil from small gullies. By photographing at critical times corresponding to tillage, planting and harvesting the amount of soil moved into the gully by plowing and then eroded out can be quantified. Both, the eroded soil and deposition within the field can be accurately measured. More than 40 tons have been found to have eroded from some field gullies with approximately 2 acres of drainage area in 6 months. These gully erosion studies are being conducted in Georgia and Mississippi. A project utilizing these same principles have been initiated to monitor the annual accumulation of sediments deposited in flood control reservoirs in the Western United States. Presently, several reservoirs are being studied in Colorado.

For additional information contact Adrian W. Thomas, Research Leader, USDA-ARS, Southern Piedmont Conservation Research Center, P. O. Box 555, Watkinsville, GA 30677.

GEORGIA

Research activities at the Southeast Watershed Research Laboratory, Tifton, Georgia, include the following:

1. Soil loss and sediment transport studies in the aquifer recharge region of the upper Coastal Plain of Georgia were initiated in 1985. This study is part of an intensive ARS-USGS groundwater study. Objectives include evaluation of sediment and associated pesticide movement from plots, field-sized areas, and small watersheds. Rainfall, runoff, groundwater stage, as well as pond storage and losses are being monitored on 3 small watersheds (20-300 acres) near Plains, Georgia. Water quality and sediment transport/deposition from a field-sized area, as well as suspended sediments moving in ephemeral flow areas and from the farm pond are being measured. Results from this study will provide information defining sediment and surface pesticide movement in a groundwater recharge region.

2. Analysis of soils from a row crop field and an adjacent bottomland forest for 137-Cs content was completed in cooperation with the ARS Water Quality and Watershed Research Laboratory in Durant, OK. Preliminary analysis of the data indicated that approximately 90 cm of deposition has taken place since the early 1960's at the field corner. Moving away from this field corner, deposition decreased at a rate of about 2.5cm/m. In the bottomland forest, deposition was greatest about 30m from the field edge and declined going toward the stream channel. Further and more detailed data analysis will be done in the future.

3. Experiments were completed to evaluate several USLE parameters typical to the Georgia Coastal Plain. These parameters include the soil erodibility factor, the cover factor for crops previously not included in the USLE handbook, the effect of raised bed planting systems, and soil crusting. Utilizing a rotating-boom rainfall simulator and 12' x 35' USLE test plots, 40 plot runs were conducted. The collected erosion, runoff, and plot characteristic data have been tabulated and analylsis is in progress. Initial data analysis indicates that transport of soil material is controlled more by overland flow than rainfall energy. Thus, minimal differences in erosion rates are observed with 100% plant cover.

4. Measurements of suspended and dissolved sediments in Little River Watershed streamflow continued at three sites. Samples were collected weekly at gaging stations K, F, and B, which are 16.66, 114.87, and 334.33 km, respectively. In addition to weekly sampling, streamflow was intensively sampled during the highflow events of February-April 1985. Suction filtration using 0.45 m millipore filters was used to separate the suspended and dissolved sediment fractions. Data analyses indicate that dissolved solids concentrations generally exceed suspended solids concentrations in the stream systems.

5. A study to evaluate sediment yields from field scale watersheds of the Coastal Plain was completed. Initiated in March 1981 and completed in December 1985, this study is designed to evaluate the effects of conservation tillage on sediment and water yields. Rainfall depths runoff rates and sediment concentrations are being measured for five fields ranging

in size from 0.60 to 1.77 ha. Crop rotations consists of corn, peanuts, and soybeans in both conventional and minimum tillage systems. The collected data have been tabulated, entered into the computer, data analysis is in progress.

For additional information contact L. E. Asmussen, Research Leader, USDA-ARS, Southeast Watershed Research Laboratory, P. O. Box 946, Tifton, GA 31793

IDAHO

Research activities at the Northwest Watershed Research Center, Boise, Idaho, include the following:

1. Water year runoff for 1985 was 61 percent of average at the Reynolds Creek Outlet station, drainage area 234 km^2 and weir elevation 1098 m. The peak streamflow rate at the Outlet was the lowest during 19 years of record. Suspended sediment yield was 14.5 percent of average, the second lowest of record. Suspended sediment yield at the Reynolds Creek Tollgate station, 54 km^2 drainage area and weir at 1403 m elevation, was 9.5 percent of average and the second lowest of record. Suspended sediment yield at the Reynolds Mountain East station, 0.4 km^2 drainage area and weir at 2019 m elevation, was 42 percent of average and the third lowest of record. Long-term records show the relative influence of snowmelt and rainfall on sediment yield.

2. Results of sediment yield and transport studies on Reynolds Creek and tributaries were reported in the Proceedings of the Fourth Interagency Sedimentation Conference, Las Vegas, Nevada, April 1986. Also, rangeland erosion studies were discussed and references to pertinent publications cited.

3. Thunderstorm events, May 20 and 24, 1985, produced peak yearly streamflows at some watershed stations and caused noticeable erosion. The maximum suspended sediment concentration from a 0.9 ha watershed was 60,000 mg/l and the total sediment yield was 0.18 tons/ha, near record values. Annual sediment yield from a 1.26 ha watershed about 7 km away was only 25 percent of average.

4. Rainfall simulation-erosion studies on sagebrush rangeland showed that interspace areas produced about 2 1/2 times as much runoff and 8 times as much soil loss as from the shrub canopy zone. Information from this study explains much of the disparity between soil loss measurements on small and large erosion plots. Evaluation of the relative contribution of different plant species to canopy and ground cover is under investigation.

5. Total 1985 sediment yield was 0.055 tons/ha from the Upper Sheep Creek Watershed, 26 ha drainage area. Sediment measurements are made in conjunction with intensive precipitation, snowmelt, and subsurface flow studies on the watershed.

For additional information contact Clifton W. Johnson, Hydraulic Engineer, USDA-ARS, 270 South Orchard, Boise, ID 83705

USDA-ARS

INDIANA

Research activities at the National Soil Erosion Research Laboratory in W. Lafayette, Indiana include the following:

1. The Universal Soil Loss Equation (USLE) and its main guideline manual Agriculture Handbook 537 are being revised in a national project led by the National Soil Erosion Research Laboratory (NSERL). In addition to ARS, the project involves the Soil Conservation Service, Forest Service, Extension Service, Bureau of Land Management, State Agricultural Experiment Stations, and several DOE laboratories. Major improvements in the USLE will include: better definition of climatic erosivity in the West, guidelines for estimating soil erodibility values for soils not fitting the USLE erodibility nomograph, revised slope length and steepness relationships, a subfactor method for estimating cover-management factor values, significantly improved applicability to forest and range lands, and new factor values for supporting practices. Background research being conducted at the NSERL includes development of: improved guidelines for estimating soil erodibility, new slope length and steepness relationships, and new relationships to estimate contouring factor values. Background material from contributing scientists is due April 1986 and the first draft of the Users Manual is due April 1987.

2. The ARS in cooperation with the Soil Conservation Service, Forest Service, and Bureau of Land Management has initiated the USDA-Water Erosion Prediction Project (WEPP) to develop improved erosion prediction technology to replace the Universal Soil Loss Equation (USLE). This research is being led by a Core Team of ARS scientists and user representatives from the action agencies. User Requirements that define the requirements for the new technology have been developed and are available for distribution. This new erosion prediction technology will be based on fundamental erosion processes of detachment, transport, and deposition and will be driven by the hydrologic variables of rainfall, runoff, snowmelt, and added water from irrigation. Field research will determine soil erodibility factor values for interrill and rill erosion and parameter values for the influence of cover-management for certain "key" soils and crop, range, and forest situations. The initial version of the new model, which will embody the new erosion prediction technology, is due August 1989. Research at the National Soil Erosion Research Laboratory to support WEPP includes development of: laboratory procedures for easily measuring soil erodibility factor values, improved equations to calculate decomposition of plant material in and on the soil, improved sediment transport and deposition equations, equations for characteristics of sediment and organic material associated with sediment, and equations for the separate effects of cover, management and tillage on rill and interrill erosion.

3. A better understanding of sediment transport and deposition processes by shallow flow is being developed from a laboratory study using natural soil and a concave slope under simulated rainfall. This research is studying how flow hydraulics and sediment characteristics influence the selective transport and deposition of sediment. The transport of

soluble organic carbon in the runoff and organic carbon associated with sediment is also being studied to determine how organic carbon is selectively removed from the soil and transported and deposited by shallow flow in typical field situations. These results will be used to improve erosion and water quality models.

4. Research using field data and an analytical, process-based erosion model has developed improved equations for rill erosion. The study explored alternative equation forms for rill erosion and how equation form affects computed erosion rates over the rising limb of a runoff hydrograph. Also, the research provided parameter values for rill erosion equations to improve the applicability of process-based erosion models to field situations. Research has also been initiated to study the effects of crop residue incorporation and soil consolidation on rill erosion after tillage.

5. Analytical research in cooperation with the Purdue Agricultural Experiment Station is studying how knowledge of the variability of erosion and crop productivity over a field or farm can help farmers make management decisions. ANSWERS, a hydrologic, erosion, and sediment delivery model, is being used to compute the spatial variability in erosion over three Indiana farms of widely varying topographies and soils. The cropping-management systems being analyzed are conventional, reduced, and no-till forms of tillage for continuous corn. Loss of productivity caused by erosion is being computed with the widely used Productivity Index and EPIC models. while the economic impact of lost crop productivity is being computed with economic models used in farm planning.

6. A field study showed how rainfall pattern can affect infiltration, runoff, erosion, and nutrient loss from plots under simulated rainfall. For conditions of high infiltration rates, the storm that peaked at the end of the event at an intensity quadruple the average intensity caused much more runoff and soil loss than did a uniform storm at the average intensity. The storm that peaked about 1/3 of the way through the event at an intensity double that of the uniform intensity caused much less runoff and soil loss than did the uniform storm. Runoff and soil loss from rain on wet soils was affected by the pattern of the preceding storm on initially dry soil. Although further analytical and field research under a wider range of conditions is needed, greater consideration in erosion research should be given to storm pattern for the conditions of this study.

7. Research is developing improved equations for the decomposition of plant material, including crop residue and roots, on and in the soil. These relationships are for models such as EPIC and the new erosion model being developed by the USDA-Water Erosion Prediction Project. This research is studying decomposition under the conditions of low moisture and low temperature. The research is emphasizing the decomposition of wheat, corn, and soybean residues. The amount of crop residue on and in the soil greatly affects erosion rates.

8. Twenty soils varying in texture from a sand to a clay were tested to evaluate the effect of surface seal formation and subsequent drying on the amount of soil detached by the impact of a single waterdrop. Single

drop splash and fall-cone strength determinations were made on these soils in an uncrusted condition, in a crusted condition immediately following 1 h of simulated rainfall (63 mm/h), and after 2 to 4 weeks of drying. The splash for the uncrusted condition ranged from 8.9 to 61.0 mg/drop and for the crusted condition, from 0.8 to 13.7 mg/drop. Subjecting the crusted soils to one drying cycle did not significantly alter the splash amount. Splash was correlated with soil strength for both uncrusted and crusted conditions for finer-textured soils; however, for sands and sandy loams additional research is required for soil strength-based splash models for crusted conditions.

For additional information, contact Harold L. Barrows, Director, USDA-Agricultural Research Service, National Soil Erosion Research Laboratory, Purdue University, W. Lafayette, IN 47907.

AGRICULTURAL RESEARCH SERVICE
Ames, Iowa

1. The Soil and Water Conservation Research Unit has developed a method for predicting erosion from concentrated flow channels. The method uses either the Lotus spreadsheet or the basic language on an IBM compatible personal computer. The method is designed for rapid determinations under field conditions. It requires a minimum of input data and tables and graphs furnished make it possible to estimate many parameter values easily. The method is undergoing field testing and verification. Work is underway to extend the method to more complex topography, yet maintain ease of use.

2. Research is underway to determine the effect of prior cropping and time on rill and interrill soil erodibility and critical shear. Work is also beginning to develop relationships between soil properties and rill and interrill soil erodibility and critical shear. Results of these studies will be used in the development of a replacement for the Universal Soil Loss Equation.

   For additional information, contact John M. Laflen, Research Leader, USDA-ARS, 211 Davidson Hall, ISU, Ames, IA 50011.

U.S. DEPARTMENT OF AGRICULTURE-ARS

IOWA

Research activities at the Watershed Research Unit in Treynor, Iowa, include the following:

1. Concentrated flow erosion from conventional and conservation tilled watersheds at Treynor, Iowa, was 7.6 and 0.9 t/a, respectively, for eleven runoff events during May and June 1984. One storm contributed 3 t/a of concentrated flow erosion in May 1985 on the conventionally tilled watershed. Concentrated flow erosion contributed one-third of the 1984 sediment yield and all of the sediment yield for the one storm in 1985 on the conventionally tilled watershed.

2. Long-term records of soil loss from plots and sediment yield from plots and sediment yield from fields cropped to corn were evaluated to assess the significance of large events in establishing average annual sediment production. At Kingdom City, Missouri, the thirty-seven year average annual soil loss greater was 8 Mg/ha. Only nine of those thirty-seven years showed soil loss greater than average. On an individual event basis, four percent of the events accounted for fifty percent of the total soil loss. At Treynor, Iowa, the eighteen-year average sediment yield was 25 Mg/ha. Only four years exhibited sediment yield greater than the average. Three percent of the events accounted for more than fifty percent of the total erosion.

For additional information contact Allen T. Hjelmfelt, Jr., Research Leader, USDA-ARS, Central Plains Area, Watershed Research Unit, 207 Business Loop 70 East, Columbia, MO 65203.

MARYLAND

Research activities at the Hydrology Laboratory Research Program in Beltsville, Maryland include the following:

Sediment accumulation is a problem in lakes and reservoirs in the Mississippi River valley from the Gulf of Mexico to Minneapolis, Minnesota, the area covered in this review. Rates of sediment accumulation exceeding 3 cm/yr have been measured at individual sites over the entire area. The average rate for 328 sediment profiles collected was 2.49 cm/yr for the 1954-1964 time period and 1.74 cm/yr for the time period since 1964. These rates of sediment accumulation are a cause for concern and pose a threat to aquatic environments throughout the valley. Although the sediment accumulation rates have decreased by 30% for the time period since 1964, when compared with the 1954-1964 time period, the rates since 1964 are still of great concern to those in the Mississippi River valley. These rates of sediment accumulation will fill many of the backwater impoundments along the upper Mississippi River within 50-100 years. Many of the small reservoirs are also rapidly filling or have already become filled. Sediment accumulation rates were highest in the smaller reservoirs and lakes. These reservoirs are often built to trap sediment from agricultural watersheds to protect downstream aquatic environments. As these small reservoirs fill with sediment, they will lose their capacity to protect the downstream areas from sediment build-up and more sediment may reach these downstream areas. Sediment accumulation is high in the lakes formed in abandoned channels in the Mississippi River delta. Although these lakes have contributing watersheds with low relief, sediment is still being transported from the contributing areas to these lakes at an alarming rate. Sediment accumulation continues to be a problem within the Mississippi River valley. Efforts must continue to develop better and more cost-effective methods to protect upland watersheds from erosion so that the unique and valuable aquatic environments of the Mississippi River valley can be protected and preserved for future generations to enjoy.

For additional information contact A. Rango, Research Leader, USDA-ARS Hydrology Laboratory, Building 007, BARC-W, Beltsville, Maryland 20705.

MINNESOTA

Research activities at the North Central Soil Conservation Research Laboratory, Morris, Minnesota, include the following:

1. The influence of crop residue-microbial activity (MA) interactions on aggregate stability and soil and nutrient losses continue to be studied on corn-soybean and wheat-sunflower rotations. Early in the growing season, soil losses from plots planted to soybeans or sunflowers the preceding year were higher (up to 300%) than from plots which had been planted to corn or wheat. With canopy development, differences decreased. Particle size distributions of sediments in runoff were measured and the stability of both in situ aggregates and eroded aggregates from rainulator tests were determined in the laboratory. Preliminary analysis of the data shows that in areas planted to either soybeans or sunflowers, both oilseed crops, the average aggregate stability of in situ soil aggregates the following spring is reduced by 25%. This effect tends to gradually diminish over the growing season so that in the fall of the year differences are minimal. Since increased erosion can be attributed to reduced aggregate stability, this apparent effect of oilseed crops on aggregate stability can be significant in the early spring and early summer and, thus, is being studied further. The relationships among the factors of microbial activity (especially microbial and soil respiration), available C and N, crop and crop rotation, soil aggregate stability, and soil polysaccharides and how these relationships contribute to the increased potential for erosion after growing sunflowers and soybeans are also being looked at. Differences in residue decomposition rates, soil respiration, and microbial biomass indicate MA in soil receiving sunflower residue to be high through July, then decline rapidly, MA in soil receiving corn and wheat residue to be relatively high throughout the growing season, and MA in soil receiving soybean residue to be relatively low throughout the season. Residue CN ratios and/or water soluble carbon concentrations may explain these differences.

2. In colder climates, it is known that during the period of spring thaw, soil is extremely susceptible to erosion from snowmelt and rainfall. Most current erosion models do not include erodibility relationships for this unique condition. Consequently, a series of studies has been undertaken to develop basic information on how freeze-thaw processes effect soil strength and subsequent erodibility. These studies have looked at the effect of freeze-thaw activity on soil aggregate stability as a function of the rate of freezing, the number of freeze-thaw cycles, and the soil moisture content at the time of freezing. Stability measurements were made on soil aggregates under conditions with and without rainfall impact energy using a drop tower technique. Results appear to differ markedly between soil types. From the standpoint of aggregate stability, Barnes loam, which has about 6% organic matter content, was less affected by the moisture content of the aggregates at the time of freezing than by either the rate of freezing or the number of freeze thaw cycles. The opposite was true for both Crofton silt loam and Forman clay loam, which have 0.5% and 3.7% organic matter, respectively. For these soils, moisture content at time of freezing had the greatest effect on the stability of the aggregates after thawing. For all three soils tested, the stability of soil aggregates to

2. Cont.
breakdown by raindrop impact forces was not affected by freezing and thawing as much as was their susceptibility to breakdown by runoff forces.

3. A rainulator has been used to apply known amounts of rainfall energy in the spring of the year, before spring tillage, to field plots established on different textured soils. A history of wheel traffic has been established on all plots in the two years preceding rainulator tests. Standard runoff collection procedures were modified to seprate erosion and runoff occurring in the wheel track from that occurring in the nontracked areas. Various field and laboratory measurements were made to determine basic cause and effect relationships between wheel traffic, soil compaction, and erosion. This included the density and stability of soil clods, surface roughness and porosity, clod size distribution, etc. Analysis of the results have not yet been completed. Results will be used to modify C-factor estimates to account for compaction in the universal soil loss equation.

4. Two simplified hydrologic models, one large scale and one small scale, have been developed to analyze nonpoint source pollution from agricultural watersheds. The large scale model is designed for watersheds larger than 500 acres in size and can be run on either a main frame computer or a PC. The size of watershed it can handle is limited only by the capacity of the computer used. The small scale model is intended for watersheds from 1 to 500 acres and is programmed for use on a small hand-held calculator. The models input existing or proposed land conditions and output erosion, sediment transport, nutrient transport, and flow information. The transport of sediment, nutrients, and flow from the headwaters of a watershed to the outlet is simulated in a manner such that the flow at any point within the watershed can be examined. Output information at the watershed outlet can be used to assess the potential pollution hazard posed by the watershed as a whole while specific areas within the watershed needing remedial measures to improve the quality of runoff at the outlet can be pinpointed. The models can also be used to assess the effects of applying alternative management systems within a watershed. Watershed data was collected from two instrumented watersheds and one noninstrumented watershed for testing and verifying the accuracy of the models. Appropriate modifications were made to the models based on the accumulated data.

5. The occurrence and development of soil crusts are not well understood. Soil characteristics influence the effect that energy derived from weathering processes have on the soil surface. External energy modifiers such as crop residues also play important roles in seal and crust development. Studies have been started to relate changes of random roughness, depressional storage, bulk density, and hydraulic conductivity as a function of soil and weather properties. During the wetting process even without kinetic energy present, random roughness and hydraulic conductivity decrease and bulk density increases. A general relation has been developed relating changes in these properties as a function of water added. When the soil surface layer is exposed to rainfall, a surface seal develops, limiting infiltration. Development of the seal depends on both the kinetic energy striking the soil surface and soil properties. Previous researchers have developed an exponential decay relationship between

5. Cont.
conductivity and kinetic energy which incorporates a soil structural stability constant. Some data have been collected to establish a relationship for the soil stability factor in terms of soil physical properties. Using data from soils studied in the droptower, a tentative relation has been developed incorporating bulk density and the soil silt content. Research, both in the laboratory and field, will be continued to quantify the relations between degrading weather conditions and soil properties and the effect they have on the soil hydrologic variables.

6. A simple soil frost model has been developed to predict the rate and depth of frost penetration as well as the rate and timing of frost melt under three tillage methods and two levels of residue. The model is based on simple heat flow considerations and is driven by commonly available daily temperature and snow depth data. At present, it is assumed that the average daily surface temperature can be approximated by the average daily air temperature. The heat loss or gain from the soil is computed and daily changes in frost depth of surface thaw are determined from an iterative process that continually computes a balance between this heat loss or gain and the heat flow from the unfrozen soil. A sensitivity analysis of the model has been run and predicted results have been compared with field observations.

For additional information contact Charles A. Onstad, Director, USDA-ARS, North Central Soil Conservation Research Laboratory, Morris, MN 56267

U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE

MISSISSIPPI

Research activities at the USDA Sedimentation Laboratory at Oxford, Mississippi include the following:

1. Suspended sediment in open channels has been found to decelerate the flow in the high concentration region near the channel bed. Flow continuity then requires a concommitant acceleration in the upper part of the flow. This change in shape of the velocity profile appears in law-of-the-wall coordinates as a thinning of the near-bed inertial (logarithmic) part of the profile, a thickening of the far-bed wake-region part of the profile, and a downward shift of the inertial part of the profile. The magnitude of the downward shift caused by sediment suspension is a function of the gross flow Richardson number and the suspended sediment particle size. During these profile shape changes, the Karman coefficient remains essentially constant and the Coles wake strength coefficient increases from a clear-water value of about 0.2 to a capacity suspension value of about 0.9.

2. Soil loss was measured from no-till, no-till plant and cultivate, and conventional-till cotton. Soil loss ratios were computed for each cropstage of the tillage systems for use in the USLE to estimate soil loss. Soil loss from conventionally tilled continuous cotton averaged over 70 t/ha·yr in contrast to previously measured soil losses of 19 to 16 t/ha·yr from soybeans and corn, respectively, under similar tillage and climatic conditions. Beneficial effects of conservation tillage were seen in the comparison of plots conventionally tilled after 11 years of no-till and conventionally tilled after 11 years of conventional-till. The no-till history reduced erosion by 47%, reduced runoff from 48% to 35% of the rainfall, and increases seed cotton yield about 20%.

3. Near boundary flow: A new method has been devised to describe the velocity distribution in the near-boundary region. It defines a continuous distribution from the dominantly viscous region into the fully turbulent flow zone for smooth and rough boundaries and drag reducing flows. The model is based on a parabolic distribution of eddy diffusivity that is shifted toward the boundary as the boundary roughness increases. Since a finite diffusivity is predicted at the flow boundary for rough surfaces, the model eliminates the divergence of suspended sediment concentrations based on the diffusion analogy. Investigation of the suspended sediment distribution based on these concepts is continuing.

4. Measurements of the sediment loads in the Goodwin Creek Research Watershed are continuing. Regression equations have been defined for ETR and automatic point samples and compared to define sampling "efficiencies" for the automatic samples. Long-term average transport relationships are based on the average concentrations observed within 1/4-foot stage increments. Temporal deviations from the average relationships are accounted for through a shift or tracking factor, which is used to estimate the sediment loads for time periods between samples. Deviations

from the average concentration for a given station and stage are large with standard deviations on the order of the average concentration itself.

5. Runoff volumes and soil losses from two field sites were measured during 1985 to document the influences of ephemeral gullying. Both field sites are about 4 acres in size but subject to different management practices. For the field site maintained in pasture, runoff was relatively low and soil losses were negligible. For the field site cropped with soybeans, runoff rates and volumes were relatively large but, more significantly, runoff became progressively flashy as the concentrated-flow ephemeral gully developed. Soil loss from the cultivated field was relatively large but this analysis is not complete at this time.

6. Recent research has shown that much of the sediment eroded from agricultural soils is transported as aggregates that are much larger, although somewhat less dense, than the primary particles of which they are composed. Furthermore, sediment eroded by concentrated flow from rills is often considerably coarser than sediment from interrill areas of the same soils. In experiments using intense simulated rainstorms, the content of sand-sized sediment was about 20% greater for rill-source than interrill-source sediment for both silt loam and clay soils. Sediment size has a major effect on transportability and subsequent deposition, so the relative portion of the total sediment that originates from rill versus interrill sources can affect sediment size distribution and resulting transport considerably.

7. Sediment lost in runoff depends on water intake characteristics of soils. The effect of rainstorm intensity and energy on the conductive properties of surface seals was investigated on packed soil columns of an Atwood soil. Intensities of 20, 30, 40, 60 and 90 $mm \cdot hr^{-1}$ were applied at an energy of 0.0275 $kJ \cdot m^{-2}$ per mm of rain. Seal development was described in terms of a seal hydraulic conductance, defined as the ratio of infiltration rate over difference in hydraulic potential across the seal. Seal conductance values were estimated from infiltration data using an optimal solution of the Richards' equation for vertical infiltration and an equation for the flux across the seal. At incipient ponding, the hydraulic conductance increases 10 times as rain intensity increases 4 to 5 times. Following incipient ponding, the conductance decreased in an exponential-like manner with the cumulative rainfall energy. The conductance reached a constant, intensity dependent, value for energies larger than about 2.8×10^{-3} $k \cdot Jm^{-2}$.

8. Individual bed and bank volume changes have been documented for 30 reaches along a 3.86-km length of Goodwin Creek, northwestern Mississippi from November 1977 through July 1984. Total bank erosion for this 3.86 km channel length amounted to about 105,000 m^3 for this 6.65 year period of study. This is equivalent to an annual sediment production of 11.7 metric tons per hectare (5.1 tons per acre) for the entire 21.5 km^2 Goodwin Creek Watershed. Both bed and bank changes are variable in time and space, and neither exhibited a significant correlation with runoff volumes. Presumably, sediment availability from upstream sources limited bed changes but this could not be evaluated due to an incomplete sediment

budget for this interval. Bank scour was similarly variable due in large part to the occurrence of six large scale failures that appear to have frequencies different from the rest of this bank failure population. Bank scour was concentrated in late-Holocene material along the outer edge of large bends and the occurrence of four of the six extreme failure events at the most probable time of tension crack development suggests that mass failure of late-Holocene bank materials is a primary control of bank adjustment in this study area.

9. Fisheries characteristics of stilling basins associated with grade control structures were examined as part of an ecological evaluation of stabilization measures in a demonstration project on erosion control (DEC). Total weight and numbers of fish were similar for natural scour holes and man-made pools (stilling basins) below grade controls. Individual species and fisheries quality indices showed greater potential in man made pools. The study showed grade control structures to be stream management techniques which incorporate permanent pools into streams whose features are mainly transient. These pools provide improvement in fisheries resources in addition to controlling channel degradation problems.

For additional information contact Neil L. Coleman, Director, P.O. Box 1157, Oxford, Mississippi 38655; Telephone: 601-234-4121.

U.S. DEPARTMENT OF AGRICULTURE-ARS

MISSOURI

Research activities at the Watershed Research Unit in Columbia, Missouri, include the following:

1. Measurement of trap efficiency and reservoir water quality showed that two design features complement each other in improving water quality and reducing sedimentation in a small reservoir. The first feature is the 0.5 acre sediment basin which trapped 80% of the sediment that would have entered the 5.8 acre reservoir immediately downstream. The second feature is the bottom-withdrawal spillway that removes the sediment-laden water (density current) from the bottom of the reserovir. As a result the reservoir trapped only an additional 14% of the total sediment yield and benefitted from improved water quality. Thus, by reducing sediment inflow and bypassing density currents, sedimentation is greatly reduced and the quality of water stored in this reservoir is improved.

2. Soil samples were collected after seedbed preparation from eleven plot pairs established on a Mexico silt loam (Udollic Ochraqualf). Each plot pair contained a soybean and a corn plot that had been cropped continuously since 1980. Soil was packed in 0.3- by 1.0-m beds at bulk densities from 1.05 to 1.10 Mg/m^3. The beds were placed on a 9% slope under a variable intensity simulator equipped with a 80150 V-jet nozzle. Two constant intensity runs (64 mm/hr) were made, each separated by a 24 hr period. After the second run, four 15-min storms were applied at rates of 13, 38, 76, and 114 mm/hr. Data from each of the variable intensity sequences were fitted to the equation $E=aI^b$, where E is the soil loss (Mg/ha/hr), I is the rain intensity (mm/min), and a and b are the coefficient and exponent of best fit, respectively. Analysis of the a-values gives relative interrill erodibility values at a rain intensity of 1 mm/min. Differences in runoff, soil loss, and interrill erodibility between the soybean- and corn-cropped plots were not significant ($p<0.10$). Data from all plots for a given run sequence were then combined to evaluate variability in interrill erodibility. Interrill erodibilities (a-values) ranged from 4.6 to 8.7 Mg/ha/hr. The mean and standard deviation of 22 observations were 6.5 and 1.2 Mg/ha/hr, respectively (CV=18%). The b-values ranged from 1.5 to 2.8 with a mean and standard deviation of 1.8 and 0.3, respectively (CV=17%).

3. 1985 is the third year of a study designed to evaluate the effect of continuous corn and soybean cropping using three tillage methods on runoff and associated soil and phosphorus (P) losses. Results from three major runoff and soil loss events are consistent with prior data in that most variation in soil loss among the treatments is explained by differences in surface residue cover. No evidence of an independent soil effect of soybean cropping on soil loss is detectable. For conventional and chisel plow tillage methods, most

P in runoff is associated with soil movement. Residues, however, appear to be a major source of P in runoff from the no-till plots. Levels of P in the soil surface of plots have increased over three years of uniform cropping and tillage management in proportion to the amount of residue remaining after tillage. Hence, although crop residues decrease soil associated P movement in runoff by reducing erosion, P leached from residues can enhance P in runoff, both by direct addition and by increasing the P saturation on soil most vulnerable to detachment.

For additional information contact Allen T. Hjelmfelt, Jr., Research Leader, USDA-ARS, Central Plains Area, Watershed Research Unit, 207 Business Loop 70 East, Columbia, MO 65203.

AGRICULTURAL RESEARCH SERVICE

NEBRASKA

Research activities at the Soil and Water Conservation Research Unit at the University of Nebraska-Lincoln, Lincoln, Nebraska, include the following:

1. The effects of varying rates of corn residue on runoff and erosion from a loess soil in southwestern Iowa were measured using a rainfall simulator. Consistent reductions in runoff, sediment concentration and soil loss resulted from increased residue application. Small amounts of surface cover produced substantial reductions in erosion. A regression equation relating surface cover to residue weight was obtained. Equations describing relative runoff, sediment concentration and soil loss as a function of surface cover were also developed using regression analysis.

2. Hydraulic and soil loss variables were measured under simulated rainfall conditions at selected downslope distances on plots with corn residue rates ranging from 0.00 to 6.73 t/ha. Application of corn residue produced substantial reductions in runoff rate, runoff velocity, sediment concentration and soil loss rate along the entire slope length. On those plots subject to rilling, runoff rate, sediment concentration and soil loss rate usually increased with downslope distance. Interrill sediment concentration changed little with downslope distance while greater interrill soil loss rates were observed with increasing slope length.

3. Topsoil was added to an exposed C horizon of a loess soil in northeastern Nebraska in thicknesses of 0, 100, and 200 mm. The field was planted to dryland corn the first year, oats the second year, and corn the third and fourth years. Corn grain yield was significantly greater on the 100-mm and 300-mm topsoil treatments than with no topsoil; 300 mm of topsoil was required to increase oat grain yield. Results indicate there are characteristics of topsoil beneficial to plant growth that, once gone, cannot be readily replaced simply by adding fertilizer.

4. Water and sediment control basins formed with discontinuous, parallel terraces using riser inlets and underground pipe outlets were evaluated for soil erosion and sediment control on a loess-derived soil association in northeastern Nebraska. The structures, parallel to existing field boundaries, provided straight rows as well as erosion protection on severely dissected landscapes that were too undulating to farm using conventional terrace systems. With clean-cultivated corn, sediment trapping efficiency exceeded 97%, and the basins retained sediment near its point of origin. Sediment discharged during the initial runoff from a storm was found to be high in silt and low in clay particles.

For additional information, contact James F. Power, Research Leader, USDA-ARS, University of Nebraska, Room 122 Keim Hall, Lincoln, NE 68583-0915.

PENNSYLVANIA

Research activities of the Northeast Watershed Research Program at University Park, Pennsylvania include the following:

1. Having examined the apparent effects of different scales on erosion prediction over an area, we conclude that estimation of erosion on a 1-ha basis will likely lead to the optimum prediction capability, especially on mined and reclaimed lands in Appalachia. We base this conclusion primarily on the results of structural analysis of soil loss data that suggest a workable continuity range of about 0.1 km [3a = 3(0.035) = 0.105], on an exponential variogram model, and on the examination of relative dispersion and extension statistics that are about the same or smaller than for a smaller or a larger area.

2. Our findings, as well as the recent development of the erosion-deposition computer model, raise questions about the validity of extending USLE predictions to larger areas even when the USLE is applied in conjunction with the sediment delivery ratio. On the average, erosion as computed by the USLE and erosion and deposition as calculated by the model on a plot-size area were quite similar to erosion computed from experimental measurements of runoff and sediment load. The erosion pin data, however, overpredicted the experimental values, partly because of the increased amount of rain at each pin and partly because of the likelihood of enhanced turbulence in runoff. The last conclusion may lead to speculation about the relative effects of cover on erosion. While cover undoubtedly reduces detachment due to raindrop impact, the protruding stems might induce more runoff at the stem and introduce sufficient turbulence in surface flow to increase scour locally.

3. A model was developed to predict the effect of standing vegetation on sediment yield. The model is based on the relationship between local scour around standing vegetation and the role of plant population density in deposition. The model utilizes a spacing hydraulic radius to define the characteristic length applicable to the calculation of Reynold's and Froude's number. These numbers, indicative of a flow regime, are then used in conjunction with sediment transport parameters for determination of net erosion or deposition.

4. An erosion-deposition model, originally developed for a mainframe computer, was adapted for a IBM PC. With minimal adjustment it can also be used on other personal microcomputers. The model is user oriented and utilizes readily available data. It predicts distribution of erosion and deposition on a watershed and provides information for selecting optimal management practices. Its application is illustrated using rainfall, topography, and soil data from a mined and reclaimed watershed in Pennsylvania. The model satisfactorily predicted sediment load at the outlet of the watershed and at the holding ponds. The simulation package can be used to plan location of detention basins, in channel design studies, and in land use planning.

5. Extensive damages arise from streambank migration. A need for a comprehensive methodology which considers all the factors influencing river bank migration with a view of providing a quantitative estimate of sediment production is obvious. We developed a physically based model which considers all the processes and mechanisms whereby bank materials are delivered into the stream. It considers the drainage area as an integrated unit. Streams are broken into links and each link is considered as a fundamental unit for analysis. For each stream link, the model estimates the bank materials that would be entrained into the river flow.

6. A biomass productivity model and a soil loss model were used to simulate effects of mining and erosion on the productivity potential of a 600 ha site. Biomass productivity, expressed as a relative productivity index PI ($0 \leq PI \leq 1$), was computed as a product of a root distribution function and limiting soil property levels derived from literature. Distribution of soil loss or deposition was estimated using a recently developed erosion-deposition model. Effects of two scenarios are compared. In the first, the site is assumed to have been surface mined for coal and the effects on productivity are examined if existing soil is replaced with a minesoil. In the second, erosion-deposition model is used to predict changes in productivity after a severe storm. Under the assumptions of this study, biomass productivity appears more likely to decline because of mining than because of erosion.

For additional information contact A. S. Rogowski, USDA-ARS, Northeast Watershed Research Center, University Park, PA 16802.

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
Southern Plains Area

Research activities at the Grassland, Soil and Water Research Laboratory in Temple, Texas include:

1. The EPIC crop growth model is being tested with data from 58 plots throughout the U.S. Test results are encouraging and have led to a number of model modifications. The evapotranspiration component of EPIC was refined by adding Penman's equation as an option to the Priestly-Taylor equation. Also, the two-stage soil evaporation component was replaced by a nonlinear function of depth and water content. Since Penman's equation requires relative humidity, a model was developed to generate these daily inputs based on monthly averages and whether the day had rainfall or not. Several new crop parameters were added to EPIC to allow more accurate simulation of leaf area index, biomass/energy, and root growth. Methods for estimating missing soil data were developed and added to EPIC. Thus, the required core data set for soil includes depth of layers, bulk density, texture, pH, C, and $CaCO_3$. A stochastic technique was developed for estimating runoff curve numbers. The new technique provides more realistic runoff estimates because it accounts for some of the uncertainty in assigning curve numbers based solely on soil water content.

2. The development of ALMANAC continued. Concepts of a potassium model were structured to facilitate interfacing with other model components. Cooperative work with French scientists (modeling and field experiments) is producing improvements in the crop growth and nutrient cycling components.

3. Work continued on developing and testing the SWRRB model. A method was developed for estimating return flow based on soil hydraulic properties. Previously, return flow travel time was a required input. Transmission losses, flood routing, and irrigation were added to SWRRB. Also, runoff was modeled for an urban watershed near Dallas, Texas, using the SWRRB model. A new sediment routing model was added to SWRRB. Deposition is based on fall velocity and degradation is based on Bagnold's stream power concept. Also, a first-cut ephemeral gully erosion model was developed and linked with SWRRB.

For more information contact Jimmy R. Williams, Hydraulic Engineer, USDA-ARS, P. O. Box 6112, Temple, TX 76503-6112.

AGRICULTURAL RESEARCH SERVICE

WASHINGTON

The following research is being conducted by the Land Management and Water Conservation Research Unit at Pullman, Washington:

1. Runoff plots have been installed on fields in eastern Washington on various crop treatments including conventionally tilled, conservation tilled, and direct stubble seeded winter wheat, and various primary tillages of wheat stubble. The purposes are (1) to determine the effect of crop treatments on (a) runoff, (b) soil loss, and (c) nitrogen and phosphorous in runoff water; (2) determine the effect of slope length on relative magnitudes of sheet and rill erosion; and (3) determine the effect of certain conservation practices on runoff and erosion. Instrumentation includes frost depth gages to determine the effect of crop treatment on frost depth and subsequent runoff and erosion following periods of frozen soil.

2. A subfactor method of estimating crop management factors (C factor in the USLE) has been developed and output is being used by SCS in Idaho, Oregon, and Washington. Seven years of runoff and erosion plot data from the Palouse Conservation Field Station at Pullman have been collected to substantiate and improve the method. Work is continuing to improve the consistency of the data and to apply the method to additional crop rotations.

3. Investigations into the effect of soil freezing and thawing on soil shear strength indicate very low surface shear strength during the thawing process. A flume study, in which soil is frozen and thawed under a range of soil moisture tensions, is being conducted to determine relationships between soil loss and applied shear stress. The results of this study will be used with soil freezing and thawing models to improve winter erosion prediction with the USLE and runoff/erosion models.

4. Analysis of short-term precipitation records from gages near Corvallis, Oregon, has indicated that relationships can be developed between 15-minute and hourly intensities, and between EI calculated from 15-minute and from hourly precipitation data. Thus, hourly precipitation data can be used to estimate the EI values that would be calculated from break-point data. A project is being initiated to apply this method across the western United States where break-point precipitation data are sparce.

For additional information, contact Donald K. McCool, USDA-ARS, Agricultural Engineering Department, 219 Smith Engineering Building, Washington State University, Pullman, Washington 99164-6120.

BUREAU OF RECLAMATION

The STARS (Sediment Transport and River Simulation) model was developed by the Bureau of Reclamation's Sedimentation and River Hydraulics Section, Denver, Colorado. The model can be used to mathematically simulate the movement of water and sediment through alluvial river channels. The unique feature of this one-dimensional, steady-state model is the use of stream-tubes (tubes of equal discharge) to vary the hydraulic and sediment transport characteristics across a cross section. This will allow a more realistic representation of sediment movement.

Data requirements for operation of the STARS model include hydraulic parameters such as cross section geometries, water discharges and temperatures at the upstream end, water surface elevations at the downstream end, as well as the associated sediment parameters such as size gradations of the streambed material and sediment supply to the study reach.

As verification, the STARS model has successfully reproduced the degradation of the Colorado River between Glen Canyon Dam and Lees Ferry for the 6.6-year period (2,424 days from February 11, 1959, to September 30, 1965). This verification consisted of matching the computed volume of material removed from the 15-mile reach to within 11 percent of the measured volume.

CORPS OF ENGINEERS

The Hydrologic Engineering Center

Mudflow simulation. The Hydrologic Engineering Center (HEC) was asked by the Omaha District Corps of Engineers to develop practical methods for analyzing mud and debris flow hazard areas. The most difficult aspect of this problem is to accurately simulate the dynamic movement of mudflows on alluvial fans and in alluvial channels. There are presently no methods capable of simulating mudflows on alluvial fans. In this current project, the HEC is developing a one-dimensional, unsteady model to simulate mudflow in alluvial channels. Mudlfow on an alluvial fan, however, is essentially a two-dimensional phenomenon and cannot be described by a one-demensional mode.

The one-dimensional mudflow routing model was applied to Rudd Creek, UT and to the Toutle River near Mt. St. Helens in Washington. The Toutle River application is being used to assist in the design of the Corps Sediment Retention Structure.

Future research will be aimed toward development of a two-dimensional mud routing model for simulation of events on alluvial fans. Also, laboratory experiments will be undertaken to verify the description of energy loss used in the one-dimensional model.

HEC-6. A two-week training course in sediment transport and operation of HEC-6 was given in January 1985.

Other HEC-6 activities consisted of routine distribution and user support. A microcomputer version of HEC-6 is scheduled for release in 1986.

CORPS OF ENGINEERS

Waterways Experiment Station

Title of Study:

Storm Erosion Study

Point of Contact:

Mr. W. Birkemeier

Conducted for:

U.S. Army Corps of Engineers

Water Resources Region:

All coastlines

Location:

Field Research Facility, Duck, NC

Summary of Accomplishments:

The purpose of this study is to develop an improved understanding of how beaches change during storms and other natural processes and to predict storm-induced beach changes. Initial efforts concentrated on use of historic CERC beach profile data collected from 1962 to 1978. These have been compiled and combined with the WES Phase III hindcast wave data and used to evaluate a Dutch method for predicting storm erosion.

Since the historic data cover only the beach above mean sea level, a new field study, begun in 1981, seeks to investigate nearshore changes. Two profile lines located at CERC's Field Research Facility are being surveyed bi-weekly and after storms out to a depth of about 10 meters using the Coastal Research Amphibious Buggy (CRAB). These data indicate that beach changes are small relative to offshore changes with most changes occurring in water depths less than 6 meters. Most of the observed profile changes result from the exchange of sediment from the beach to the nearshore bar and on/offshore oscillations of the bar.

During 1985 a report was published by ASCE which used field measurements at the FRF to evaluate a procedure for determining profile closure. A draft report which presents a compilation of storm erosion measurements was completed and is awaiting publication. An important data set, including surf zone process data, and three dimensional bathymetric response data was collected at the FRFas part of the Duck '85 experiment held in September. These data were presented at a conference hosted by the American Geophysical Union. The ISRP computer program for processing beach and nearshore survey data was modified to run on an IBM PC and distributed to users within the Corps.

Title of Study:

Kings Bay Coastal Processes Numerical Model

Point of Contact:

Dr. R. Vemulakonda, WESCR-P

Conducted for:

Naval Facilities Engineering Command, Department of the Navy

Water Resources Region:

South Atlantic

Location:

St. Marys Inlet, Borders on Georgia and Florida

Summary of Accomplishments:

St. Marys Inlet is the ocean entrance to Kings Bay Naval Submarine Base, GA. In view of the planned expansion of the base to receive Trident-class submarines, it is proposed to widen and deepen the navigation channels. The objective of this study was to determine the effect of plan conditions on hydrodynamics and channel shoaling in the exterior channel and recommend advance maintenance for different reaches of the channel.

A system of numerical models called Coastal and Inlet Processes (CIP) Numerical Modeling System was used in the study. It included models for tide, waves, wave-induced currents and noncohesive sediment transport. The sediment model used the results from the other models as input. The system was verified with available field data on tides and channel shoaling. It was run for existing as well as planned conditions and the effects of plan conditions were determined. Based on the results, recommendations on advance maintenance were made.

Title

Barrier Island Sedimentation Study

Point of Contact:

Dr. S. Kimball, WESCR-P

Water Resources Region:

All barrier coastlines

Location:

All barrier coastlines

Summary of Accomplishments:

Field data collection in the surf zone is a difficult operation under fair weather conditions and exceptionally hazardous during critical high energy events. To address the need for a reliable means of collecting sediment samples under high energy conditions, a remotely operated short coring system was designed and a prototype produced. The system, termed ROSCO, is mounted on a sled, and collects cores without assistance from divers or similar field personnel. ROSCO is being used in the field to assist district operations as well as the routine sediment collection efforts at the Coastal Engineer Research Center's Field Research Facility. Facilities have been completed and methodology established for the analysis of cores collected through ROSCO or conventional vibracoring systems. Software has been designed and implemented to complement analysis procedures. Sediment samples (vibracores, grab samples) were collected at Ocean City, MD, and Isles Derniers, LA, to document barrier island development and changes in sediment characteristics through time. Shoreline change maps have been produced for South Carolina, and a draft analysis of the shoreline change history of the Delmarva peninsula is complete. Technical notes have produced to document shoreline mapping techniques, the use of natural tracers for determining sediment transport direction and volume, and the development of the sediment coring system. Technical reports describe the sedimentary environment of the Louisiana coastline and probable trends in barrier evolution, the effects of sea level rise on barrier retreat in New Jersey and Virginia, and backbarrier sedimentation patterns along the Virginia coast. Presentations of work in progress were made to the Geological Society of America, the Association of Engineering Geologists, the Annual Assateague Shelf and Shore Conference, and the Gulf Coast Section of the AAPG. Several manuscripts were submitted to professional journals, including Environmental Geology, Journal of Sedimentary Petrology, and Marine Geology.

Title of Study:

Wind-Blown Sand and Growth of Sand Dunes

Point of Contact:

Dr. N. Kraus, WESCR-P

Conducted for:

U.S. Army Corps of Engineers

Water Resources Region:

All sandy coasts

Location:

WES

Objectives:

The purpose of this study is to develop a numerical model for calculating the sand transport rate by wind and to simulate the growth of sand dunes at barriers such as fences.

Summary of Accomplishments:

A literature review of the engineering applicability of presently available predictive expressions for the sand transport rate by wind was made, and a technical paper was submitted for publication. Relevant literature on coastal meteorology and boundary layers is presently being reviewed. Work is underway to develop a skeleton computer program for modeling dune growth at barriers. A field experiment also is being planned.

Title of Study:

Shoreline Change on the North New Jersey Coast

Point of Contact:

Dr. N. Kraus, WESCR-P

Conducted for:

U.S. Army Corps of Engineers, New York District

Water Resources Region:

North New Jersey coast

Location:

WES

Objectives:

The purpose of this study is to develop a model for estimating shoreline change and longshore sand transport rates along the northern coast of New Jersey. The model must allow representation of large numbers of groins, beach fill, seawalls, and other real world effects.

Summary of Accomplishments:

The wave field along the coast has been estimated by use of the Wave Information Study hindcasts and a newly developed model of combined refraction and diffraction (RCPWAVE). A data set comprised of 3 years of breaking wave height and angle at 150-m intervals along the coast was thus prepared for driving the shoreline change simulation model. A generalized shoreline change numerical model now in final stages of development at WES is being used to simulate shoreline change along approximately 15 km of north New Jersey coastline. The model has been calibrated using measured shoreline change at Sandy Hook. Model verification is in progress.

Title of Study:

Field Measurement of Sediment Transport Rates in the Nearshore Zone

Point of Contact:

Dr. N. Kraus, WESCR-P

Conducted for:

U.S. Army Corps of Engineers

Water Resources Region:

All coastlines

Location:

WES; Field Research Facility, Duck, NC; Louisiana coast

Objectives:

Accurate field measurements of sediment transport rates in the surf zone are lacking. The primary reason is the hostile environment of the surf zone, and a lack of an appropriate measurement technique. The purpose of this study is to develop measurement techniques for the transport rate and collect comprehensive and synoptic data on the sediment transport rate and its forcing agents of waves, currents, and winds.

Summary of Accomplishments:

A new type of sediment trap was developed and then deployed in a major field data collection project (DUCK-85) held at the Coastal Engineering Research Center's Field Research Facility. A method for rapidly weighing a large number of wet sediment samples was also developed in a laboratory experiment performed at WES, and utilized at DUCK-85. Technical papers on both the trap and the weighing method were submitted for publication. A full-scale laboratory flume experiment on the characteristics of the sediment trap is now in planning.

At DUCK-85, 6 or 7 traps were simultaneously deployed across the surf zone to measure the vertical and lateral distributions of the longshore sand transport rate, together with measurements of the currents and waves. A pioneering experiment to measure the sand transport rate and hydrodynamics of a rip current also was performed. The data is now under analysis, but preliminary study of the transport rate data indicates very promising results. This data is unique in the world, and much progress can be anticipated through the techniques developed and data collected in this initial stage of the study program.

Title of Study:

Mississippi River Passes Channel Sedimentation Study

Conducted for:

New Orleans District

Summary of Accomplishments:

The Mississippi River Passes Channel Sedimentation Study is reimbursable work, funded by the New Orleans District, Corps of Engineers. The objective of the study is to predict the impact on Southwest Pass Sedimentation of deepening the navigation channel from 45 to 55 ft. The study approach includes using both the existing physical model and a 3-D numerical sedimentation modeling system (TABS-3) to predict deepened channel maintenance dredging requirements. The physical model has been reactivated including modifications to improve boundary control. A numerical model of the entire Mississippi River Delta from Venice, LA, has been developed. The numerical model encompasses Southwest Pass, South Pass, and Pass A Loutre, as well as the main distributaries from these passes.

Future work will consist of testing to predict the effect of deepening on SWP sedimentation and model testing to predict the effect of additional training works along SWP on channel sedimentation. A draft Technical Report describing the model study with results and recommendations will be prepared for publication.

Title of Study:

Advance Maintenance for Entrance Channels

Conducted for:

Office, Chief of Engineers

Summary of Accomplishments:

The Advance Maintenance for Entrance Channels study is a unit of the Improvement of Operations and Maintenance Techniques (IOMT) program, funded by the Office, Chief of Engineers. The objective of the study is to develop rational criteria for the use of advance maintenance dredging, i.e., overwidth and/or over depth dredging, for entrance channels by evaluating the effect of depth and width on dredging frequency. A literature survey to determine the state of the art was conducted. Corps-dredged entrance channels have been identified, and those to which advance maintenance is applied have been so designated. Specific projects have been analyzed to determine the effect of channel depth and width on dredging frequency and volume. The analysis was conducted using an empirical technique based on historical dredging records.

Accomplishments during 1985 include the evaluation of West Coast, East Coast, and Gulf navigation channel projects. A draft TR descibing the evaluation of these projects with regard to Advance Maintenance effectiveness has been completed. Work is underway on an Engineer Technical Letter (ETL) draft describing a new empirical technique for predicting the effect on dredging requirements.

Future work includes publication of the ETL describing an empirical approach to the prediction of advance maintenance effectiveness, and publication of the technical report describing the results of the evaluation of specific advance maintenance projects.

Title of Study:

Improved Dredging Methods

Conducted for:

Office, Chief of Engineers

Summary of Accomplishments:

The Improved Dredging Methods project is a portion of the Improvement of Operations and Maintenance Techniques (IOMT) research program, funded by the Office, Chief of Engineers. The objective of the project is to investigate potential improvements in existing maintenance dredging methods in support of COE civil works missions. The project was begun in October 1982. Accomplishments in 1985 include:

a. Instituted field evaluation of the wear characteristics of high density polyethylene (HDPE) dredge pipe. Results to date substantiate laboratory findings that HDPE pipe has resistance to wear that is superior to steel dredge pipe.

b. Initiated a study into the usefulness and application of dredge production meters. This task has not progressed sufficiently to draw conclusions or make recommendations for Corps-wide use.

Future work will continue evaluation of dredge production meters and will be involved in developing equipment and techniques for measuring sediment volumes in hopper dredges and scows. Information for ER 1130-2-307, Dredging Practices and Policies, will also be generated from this project.

Title of Study:

Fine-Grained Shoaling in Navigation Channels

Conducted for:

Office, Chief of Engineers

Summary of Accomplishments:

a. Flume tests of erosion and deposition were made to investigate the relationships between bed shear and settling velocity, and the vertical transport of sediment from the bed.

b. Settling tests were performed on Corpus Christi sediments, in the field and in the laboratory. Previously-developed methods of analysis for turbulent suspension and consolidation behavior were evaluated.

c. Laboratory experiments were conducted to investigate erosion of fine sediments by wave turbulence.

d. Long flume experiments were conducted to investigate density-driven sediment flows.

Future Work:

a. Laboratory experiments will also be conducted to investigate the effect of shear on hindered-settling consolidation, age hardening, and aggregate formation.

b. Field demonstration will be arranged for determination of bed density and comparisons made to acoustic detection of the "bed."

Title of Study:

Improved Numerical Procedures for Deep Draft Channels

Conducted for:

Office, Chief of Engineers

Summary of Accomplishments:

The users manual for the previously developed TABS-2 2D modeling system for water and sediment movement was published and public release of the 2D system initiated. The 2D system was expanded to include three dimensions and the modeling system was applied to New York Harbor.

A contract was negotiated for extensive improvements to the 3D modeling system.

The TABS-2 system was used extensively at WES and by some field Corps offices.

Support for the 2D modeling system was provided by WES to the field offices.

Title of Study:

Interior Channels Waterway Modeling for Naval Submarine Base, Kings Bay, Georgia

Conducted for:

U.S. Navy, OICC TRIDENT, Naval Facilities Engineering Command, Kings Bay, GA

Water Resources Region:

North Atlantic

Location:

Cumberland Sound - Kings Bay, GA

Summary of Accomplishments:

An elaborate multi-tasked hybrid (combined physical and numerical) modeling investigation is being conducted to examine the hydrodynamic characteristics associated with the interior navigation channel and harbor facilities, tc predict maintenance dredging requirements for planned channel enlargements, and to evaluate possible remedial measures to reduce these requirements.

A fixed-bed physical scale model is used to investigate three-dimensional hydrodynamic characteristics (velocity and water levels) and to generate dynamic boundary forcing functions for the numerical models. The extensive marsh areas within the Cumberland Sound estuary greatly influence the hydrodynamic characteristics. A wetting and drying algorithm has been developed and incorporated into the finite element numerical modeling system (TABS 2) improving simulation of the complex field conditions.

Model predictions indicate a substantial increase in maintenance dredging requirements for initial plan channel conditions. Several alternate routes for the Atlantic Intercoastal Waterway have been examined in the numerical models. A preferred reroute alternative has been selected for additional hybrid model investigation. This alternative will reduce initial submarine channel construction costs by about $3.4 million dollars, and benefit public safety and facility operations, while reducing overall maintenance requirements.

Additional remedial measures including channelization, tidal barrier and gate development, feasibility of sand bypassing and specialized dredging techniques, and assessment of sediment traps and flow training structures are being examined in attempts to further reduce maintenance dredging requirements.

Title of Study:

Principles of Channel Alignment on Navigable Alluvial Rivers, Phase I

Conducted for:

Office, Chief of Engineers

Summary of Accomplishments:

This study is the first phase of a broad-based, long-range, state-of-the-art study to determine the principles of natural stream tendencies with regard to channel alignment. The study is divided into phases with the exact scope of each phase based on the results of preceding phases. Phase I includes (a) review of published literature, (b) analysis of prototype data, and (c) development and checking of hypotheses for natural channel alignment for varying conditions. Phase II will involve laboratory investigations to validate hypotheses developed in Phase I. This research is necessary to develop criteria to ensure the most economical and stable alignment for navigation channels. Based on several papers presented at the Rivers '83 conference in October 1983, Mississippi River data for the 1880's and 1973-75 has been analyzed to determine various channel characteristics and relationships. The analysis included digitizing the prototype data for computations of relationships of radius of curvature to width ratios, spacing of crossing and point bars, and top bank controls. Based on the results of this analysis, the Vicksburg District detailed potamology surveys for the Mississippi River were obtained for an in-depth analysis of the 1880 and 1973-75 data. This data base is presently being assembled into usable form for this project. Luna Leopold's original work on radius to width ratio is also being reanalyzed. Results of the first phase of this study are expected to be included in Chapter 13 of EM 1110-2-1601 in FY 87.

Title of Study:

Stable Flood Control Channel Design (Improvements)

Conducted for:

Office, Chief of Engineers

Summary of Accomplishments:

Guidance on conducting a historical analysis for the design of stable flood control channels to be used by design offices of the Corps of Engineers (CE) was drafted. A nationwide inventory of CE flood control projects was conducted. This inventory lead to the identification of Corps design criteria needs.

Title of Study:

Numerical Model of Sedimentation, Lock and Dam No. 1, Red River

Conducted for:

U.S. Army Engineer District, Vicksburg

Summary of Accomplishments:

Our TABS-2 system was applied to the lower approach to the lock and dam on the Red River. The objective was to calculate the reduction in sediment deposits if the wall, which separates the lock approach from the spillway flow, was raised. This was the second application of our two-dimensional modeling system to a structural design problem.

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I - BOSTON, MASS

New Hampshire Erosion and Sediment Control Program

Region I has been working with the New England States and localities to strengthen programs to control erosion and sedimentation from intensified construction in developing areas and large scale construction projects such as shopping centers and resort developments in sensitive environments. Notably, New Hampshire has been expanding the scope and compliance of its permit program for "Significant Alteration of Terrain" (RSA 149:8-a). The New Hampshire Water Supply and Pollution Control Commission requires technical review and a permit for any earth disturbing activity that will exceed 100,000 continuous square feet or will take place in or near surface waters. The program covers construction, sand and gravel mining, and timber harvest. The level of detail in applications for construction permits increases with the project scale and proximity to and impact on waters. The Commission visits 30 to 40 percent of the sites at various phases of construction.

A recent episode of erosion and silting of Paugus Bay, Lake Winnepesauke, during heavy rain from clear cutting and excavation for a large resort development illustrates compliance problems and solutions. The Commission found that the scheduling and conduct of the actual work left extensive areas raw and exposed to storms. As a result, the Commission has imposed stringent requirements for the sequence and timing of construction. It has specifically required redesign of sediment basins to include fabric filter and other detention devices.

Accompanying the increased construction, especially major highway projects, has been a marked expansion of sand and gravel operations. To mitigate adverse impacts of these operations on watersheds and designated aquifers, the Commission adopted policies that extend the permit coverage beyond erosion and sediment control practices to maintain a minimum separation between the pit floor and water table, and to require reloaming and reseeding of completed sand and gravel excavation sites. Silting of the Pemigewasset River resulted from a poorly designed and maintained sump and discharge channel from a gravel pit for I-93 construction. As a result, the Commission issued a stop order and required a plan to insure river quality of background water level and turbidity discharge not exceeding 10 turbidity units. Design and operations requirements featured a settling basin, adequate settling times, rip rapping and silt fencing. A stringent gravel operation plan was devised and implemented to limit the initial creation of turbid water. Sampling was conducted at each stage.

For additional information contact Stephen J. DelDeo, New Hampshire Water Supply and Pollution Control Commission, telephone (603) 271-2358 or Bart Hague, Region I, USEPA, Room 2103, J.F. Kennedy Building, Boston, MA 02203, Telephone (617)223-3917.

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VI
DALLAS, TEXAS

EPA Region VI, in association with the Texas Water Commission, Texas Parks and Wildlife and U.S. Fish and Wildlife Service has initiated a study of the sediments in the upper Trinity River. The study is designed to evaluate the role of sediments in recurrent fish kills which have occurred in the upper Trinity over the past several years. Sediment quality and accumulation are being documented during low flow periods along with water column sampling during storm events. Resuspension of sediments is initially believed to be the major factor in the fish kills; however, the relative importance of oxygen demand and toxics has not been determined. The study will also attempt to identify the major sediment sources, both point and nonpoint.

For additional information contact Russell L. Bowen, U.S. EPA (6W-QT), 1201 Elm Street, Dallas, TX 75270 (FTS-729-2626).

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 10 - WATER DIVISION

SEATTLE, WASHINGTON

1. Region 10 in Seattle, Washington is working with EPA Headquarters to develop criteria which protect against impacts of sedimentation on fish habitat. A prerequisite to developing such criteria is development of a methodology to measure impacts to fish habitat which degrade the fisheries beneficial use. A habitat related methodology and criteria for protecting habitat are critical components in implementing an effective nonpoint source control program. Literature reviews will be used to assist in determining: (1) threshold of effect levels of sedimentation on salmonid early life history stages, and (2) appropriate methods for measuring habitat changes resulting from sedimentation.

   For additional information, contact Rick Albright, (206) 442-8514, FTS: 399-8514, EPA, 1200 Sixth Avenue, M/S 433, Seattle, Washington 98101.

2. Region 10 in Seattle, Washington is working with the Corps of Engineers to develop sediment quality values for the Puget Sound Estuary. It is intended that these values will be useful in judging the significance of toxic contaminants and as a basis for regulatory actions. The approach involves applying the equilibrium partitioning and apparent effects threshold methods to Puget Sound data to generate sediment quality values. The result will be the development of numerical values for specific chemical contaminants or groups of contaminants below which no adverse biological effects are known to occur.

   For additional information, contact Catherine Krueger, (206) 442-1287, FTS: 399-1287, EPA, 1200 Sixth Avenue, M/S 433, Seattle, Washington 98101.

ENVIRONMENTAL RESEARCH LABORATORY
ATHENS, GEORGIA

The Environmental Research Laboratory, Athens, GA, conducts and manages fundamental and applied research to predict and assess the human and environmental exposures and risks associated with conventional and toxic polutants in water and soil. Given the affinity of many pollutants to attach to solid particles, the research includes studies to understand the transport and transformation of chemicals in sediment in rivers, lakes, and estuaries.

1. Sediment-mediated Hydrolysis and Reduction Reactions

   During 1985, work in in sediment systems (freshwater) included the areas of sediment-mediated hydrolysis and reduction reactions. Specifically, the reduction of nitroaromatic compounds, azobenzene compounds, and halogenated aliphatic hydrocarbons were studied in sediment-water systems. Sediment was found to be necessary as a reactant--the disappearance rate constants are dependent upon sediment concentration--but reduction occurs only in the aqueous phase. Reduction of the haleogenated compounds was facile; for example, hexachlorethane's half-life was less than 30 minutes, with tetrachloroethylene being formed. Half-lives of four azobenzenes varied from 18 to 4500 minutes, forming the corresponding aniline compounds. Nitroaromatics are also reduced to anilines with half-lives ranging from 10 seconds to 120 minutes. Work continues on soil-mediated hydrolysis and on abiotic reduction in soil-water systems.

   For additional information contact N. Lee Wolfe, Environmental Research Laboratory, USEPA, Athens, GA 30613, (404) 546-3429, FTS: 250-3429.

2. Determination of Sediment Exchange Rate

   A cooperative project with the Massachusetts Institute of Technology formulates bed and suspended load equations consistent with existing theory but extends them to describe the exchange of sediment between the bed and water column for cohesionless particles of a fairly uniform size. Determination of the exchange rate of sediment allows tracking of contaminated sediment. Also studied is the effect of complex aggregate particles on sorption kinetics for hydrophobic chemicals and the effect of very small, nonsettlable colloidal particles on pollutant transport.

   For additional information, contact Steve McCutcheon, Environmental Research Laboratory, USEPA, Athens, GA 30613, (404) 546-3581, FTS: 250-3581.

3. Development of Cohesive Sediment Transport Model

   The objective of cooperative work with Clemson University is to develop a user manual for the cohesive sediment transport model SED III. SED III, a model originally developed for the U.S. Army Corps of Engineers, describes shoaling and scour in estuaries and other

bodies of water. Simulations are based on fairly elaborate descriptions of processes such as scour, deposition, and bed compaction for both cohesionless and cohesive particles of various sizes over a tidal tidal cycle or other periods of time during which the flow is unsteady.

For additional information, contact Steve McCutcheon, Environmental Research Laboratory, USEPA, Athens, GA 30613, (404) 546-3581 or FTS: 250-3581.

U.S. ENVIRONMENTAL PROTECTION AGENCY
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

ALBANY, NEW YORK

The New York State Department of Environmental Conservation, located in Albany, New York, has been the lead agency in the reclamation of the Hudson River, carrying out a project to demonstrate methods for the selective removal of polychlorinated biphenyls (PCBs) contaminating bottom sediments. Following removal, the sediments will be treated and buried in secure landfills where a monitoring system will be installed. The purpose of the project is determining the feasibility of indefinite storage in a secure landfill of toxic substances and ascertaining the improvement of the rate of recovery of a toxic contaminated national waterway. The U.S. Environmental Protection Agency (EPA), through funds allocated in Section 116 of the Clean Water Act (CWA), has sponsored various studies associated with this demonstration project.

This project has been under planning by the State since the late 1970's after it was discovered that PCBs from General Electric Company plants in Fort Edward and Hudson Falls had entered the river over an estimated thirty year period. A recent study, using refined techniques to project from samples taken, has estimated the total at 51,000 pounds in a five-mile section of the river. The present plan calls for the removal of 33,000 pounds of PCBs from identified "hot spots" in the five mile stretch. The continued presence of these pollutants in the river degrades the fishery and quality of the entire river. Contamination of fish that feed on other aquatic life in direct contact with PCB-contaminated sediments has forced the closing of several important fisheries. This PCB presence in sediments also poses a potential hindrance to navigational dredging because of the problem of sediment disposal.

A $26.67 million project for removal of the contaminated sediments to accelerate recovery of the river has been delayed because the courts invalidated the State's previous site chosen for disposal of the sediments. A new site has been selected and it is anticipated that construction work will be done in 1988 with dredging of the contaminated sediments from the river conducted during 1989 and site closure completed in 1990.

For additional information contact Mr. Richard Balla, Nonpoint Source Coordinator, Water Management Division, Environmental Protection Agency Region II, 26 Federal Plaza, New York, New York, 10278.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
GREAT LAKES NATIONAL PROGRAM OFFICE

CHICAGO, ILLINOIS

The Great Lakes National Program Office (GLNPO), located in Chicago, Illinois, has conducted monitoring of sediment contaminants, has sponsored research on the bioaccumulation of contaminants from sediments, and has sponsored demonstration projects on sediment and erosion control through conservation tillage practices.

1. Extensive surveys of bottom sediments were conducted of U.S. tributaries of the St. Marys River, St. Clair River, Lake St. Clair and the Detroit River as part of the U.S./Canada Upper Great Lakes Connecting Channels Study. Samples will be analyzed for particle size and priority pollutants.

   For additional information contact Anthony Kizlauskas, GLNPO, Chicago, Illinois, 60605, Telephone (312) 353-3576 - FTS: 353-3576.

2. Working under an Interagency Agreement with the Great Lakes National Program Office, the Great Lakes Fishery Laboratory (Ann Arbor, Michigan) of the U.S. Fish and Wildlife Service, developed a laboratory flow-through bioassay for evaluating bioaccumulation of toxic substances from sediments, and conducted a field exposure of caged test species to contaminated sediments in Green Bay, Wisconsin, for comparison with the results of the laboratory flow-through bioassay. In 1985, field exposures were carried out in the Detroit River for further evaluation of the laboratory test to assess in-place polluted sediment quality.

   For additional information contact Anthony Kizlauskas, (312) 353-3576, FTS: 353-3576.

3. Section 108(a) of the Clean Water Act provides for Great Lakes basin projects to demonstrate new and innovative methods to reduce, eliminate or remove pollutants from any part of the drainage basin. Presently this program is funding thirty-three Soil and Water Conservation Districts (SWCD) to demonstrate no-till farming practices. The objective of the projects is to reduce soil erosion and phosphorus loads to the Great Lakes. SWCD's participants are two (2) in New York on Lake Ontario, three (3) in Michigan, six (6) in Indiana and twenty-two (22) in Northwest Ohio on Lake Erie. In addition to this tillage effort, fertilizer and pesticides management are stressed.

   For additional information contact Ralph G. Christensen, GLNPO, Region V, USEPA, Chicago, Illinois, 60605, Telephone (312) 353-3545, FTS: 353-3545.

U.S. ENVIRONMENTAL PROTECTION AGENCY
LARGE LAKES RESEARCH STATION

GROSSE ILE, MICHIGAN

The US Environmental Protection Agency, Office of Research and Development, ERL-Duluth - Large Lakes Research Station at Grosse Ile, Michigan conducts and sponsors research related to sources and transport, fate, and effects of contaminated sediment.

1. Extensive sediment surveys were conducted in the mouth of the River Raisin (Monroe, Michigan) with emphasis on toxic organic compounds, heavy metals, and other physical and chemical properties.

2. A multi-disciplinary team of EPA and academic scientists began a three-year study of effects of in-place pollutants in the lower Detroit River in 1985. The objective is to develop predictive methodologies which will relate physical and chemical properties of sediments, and hydrodynamics of the site to exposure concentrations and effects of toxic substances.

For additional information contact William L. Richardson, Chief, LLRS, Grosse Ile, MI 48138, 313-226-7811.

ENVIRONMENTAL RESEARCH LABORATORY

NARRAGANSETT, RI

The Environmental Research Laboratory, located in Narragansett, Rhode Island, with its Field Station in Newport, Oregon, is the Agency's center for marine, coastal, and estuarine water quality research. The Laboratory is responsible for conducting research on marine disposal and discharge of contaminated sediments, sludges, and complex wastes as well as quality criteria for marine water and sediment.

1. Significance of Bioavailability and Bioaccumulation

The objective of this project is to develop or revise physical, chemical and biological screening procedures for predicting the bioavailability and potential bioaccumulation of organic contaminants from sediments. EPA's ocean disposal program requires techniques to evaluate the bioavailability and bioaccumulation potential of contaminants in the wastes. The research strategy integrates laboratory experiments, field assessment, and computer simulations. Kinetics of contaminant uptake, depuration and metabolism are being examined as well as the properties of sediments, contaminants and organisms that control bioaccumulation processes. Thermodynamic and kinetic models are being developed to predict accumulation potentials of contaminants. Controlled laboratory experiments will be conducted with pure compounds using field and laboratory-reared animals and with field-obtained contaminant sediments. Field experiments employing caged and native populations are conducted in conjunction with laboratory exposures.

For additional information, contact Dr. Henry Lee, ERLN Newport Field Station, Newport, OR 97365, Telephone (503) 867-4041.

2. Field Verification Program - Exposure Assessment

The Field Verification Program (FVP) is a five-year cooperative research program between EPA and the Army Corps of Engineers (1982-1987). Its purpose was to assess exposure and effects at a Central Long Island Sound disposal site. The exposure assessment portion of the work included the quantitative determination of particle entrainment at the disposal mound and a nearby reference site. The key approach was the development of a portable device to generate shear at the water-sediment interface and to measure resulting entrainment into overlying water (Particle Entrainment Simulator or PES). The device was developed with the University of California at Santa Barbara (Department of Mechanical and Environmental Engineering) and calibrated with an annular flume. Sediment entrainment or resuspension was quantitatively assessed in the laboratory and field as a function of physical shear, benthic biological activities and time following deposition and reworking.

For further information about this work contact: Dr. Wayne R. Davis, Research Aquatic Biologist, Environmental Research Laboratory, EPA, South Ferry Road, Narragansett, RI 02882, Telephone (401) 789-1071, FTS 838-5087.

3. New Bedford Harbor Sediment Toxicity Studies

The purpose of the proposed studies is to provide information on the effects of contaminated New Bedford Harbor sediments on mortality, behavior and reproduction of aquatic fauna (fish and amphipods) under controlled laboratory conditions. The acute toxicity of New Bedford Harbor sediments is being evaluated using a series of 10-day solid phase tests. The test sediments were chosen based on existing bulk sediment data in order to evaluate several sediment types in New Bedford Harbor. Six sites are being tested with the solid phase testing to include two controls, one from New Bedford Harbor and the other, a native sediment. The testing scheme using site sediments included a 10-day solid phase test with Rhepoxynius, and a 10-day solid phase test with Ampelisca. Using the toxicity data generated from the solid phase tests, one site sediment was chosen for 10-day solid phase tests to develop sediment LC50 values. The endpoints for both species were survival and emergence from the sediment. Each test was replicated once.

For further information about this work contact: David J. Hansen, Research Aquatic Biologist, Environmental Research Laboratory, EPA, South Ferry Road, Narragansett, RI 02882, Telephone (401) 789-1071, FTS 838-5087.

CRITERIA AND STANDARDS DIVISION

WASHINGTON, D.C.

Sediment Quality Criteria

This discussion is to provide additional information on the recent history, status, and projected future of the Office of Water's current effort to develop numeric sediment quality criteria. It is an update of the information presented on Pages 199-200 of the Notes for Calendar Year 1984.

1. The Problem - Toxic contaminants in bottom sediments of the Nation's lakes, rivers, and coastal water create the potential for continued environmental degradation. Existing data provides a strong indication that there are many locations where existing and projected sediment contaminant concentrations may have the potential for causing significant adverse effects to aquatic life and human health. Even where water column pollutant levels are less than established water quality criteria, contaminated sediments pose a threat to the environment. The absence of numerical sediment quality criteria has made it difficult to accurately assess the extent of the contaminated sediment problem. The development of sediment quality criteria will make it possible for the States, EPA and other institutions to implement regulatory, enforcement and clean-up actions, where necessary, and will assist in making decisions concerning the movement and disposal of contaminated sediments.

2. Criteria Development Effort - In July 1984, under the authority of the Clean Water Act, EPA initiated an effort to develop numerical sediment quality criteria. This effort began with a workshop in which national experts identified an approach by which EPA could develop numerical sediment quality criteria. This approach, the Equilibrium Partitioning Approach, consists of two methodologies, one for sediments contaminated with heavy metals, and one for sediments contaminated with nonpolar organic contaminants. Non-polar organics include the majority of organic contaminants entering receiving waters. Polar organics were not addressed because of the lack of scientific knowledge on these small percentage of chemicals. These methodologies focus on identifying the relative strength of sediment/contaminant bonds which in turn allows for predictions as to what portion of the contaminant will partition off the sediment (partitioning coefficient) and be available to biota. The amount of a pollutant that is predicted to be available to the biota can then be compared to existing water quality criteria to determine an appropriate exposure level.

   Efforts designed to fully develop both of these methodologies have been implemented. Existing literature is being reviewed to identify data pertinent to the criteria development effort. Laboratory and field studies are being conducted to assist in verifying the methodologies and to fill data gaps. Sediment values for several

non-polar organics will be developed by the end of 1987 and for several metals by the end of 1988. Both methodologies are still in the testing phase and formal criteria development will not start until appropriate testing and reviews are completed.

3. Potential Uses of Sediment Quality Criteria - A more complete understanding of the acuracy and meaning of developed sediment values is needed before a formal policy on the implementation and uses of sediment quality criteria can be developed. The possibility of joint (EPA-U.S. Army Corps of Engineers) funding of a study that evaluates a wide variety of potential sediment criteria uses is currently being considered. Some potential uses for sediment criteria have been identified as follows:

   (a) hazardous waste site evaluation and clean up,

   (b) regulating the disposal of materials in the ocean (e.g., sludge, dredged material),

   (c) designing waste load allocations,

   (d) establishing Best Management Practice designs for controlling non-point sources of pollution and

   (e) using sediment criteria to assess improvements to water quality.

4. Completed Activities - A variety of activities have been completed in an effort to develop sediment criteria. A list of these activities and a brief description of each follows:

   (a) Review of Methodologies - A variety of approaches that have potential for use in the development of sediment criteria are identified. The pros and cons of each approach were identified and evaluated with respect to EPA needs. (document)

   (b) National Perspective - Using STORET data, 48 contaminants suspected of being in concentrations of concern in the environment were identified. An assessment was conducted to determine the scope of the contaminated sediment problem and which contaminants are of primary concern. (document)

   (c) Criteria Development Workshop - A workshop was convened in November 1984, in which experts reviewed the documents identified in 1 and 2 above. Workshop members selected and tailored two approaches (one for metals and one for non-polar organics) to meet EPA criterion needs. (summary document)

(d) Workplan Development - An integrated workplan was developed and implemented which identifies specific activities, priorities and time frames involved in implementing the criteria development effort.

(e) Toxicity Testing - A protocol for sediment toxicity testing was developed for nonpolar organic compounds. This protocol outlines the methods for sediment toxicity testing for nonpolar organic compounds. (document)

(f) Detailed Theory Evaluation - Evaluation of sediment normalization theory for nonpolar hydrophobic organic chemicals. This study investigates aspects of the equilibrium partitioning approach including 1) an update of pertinent partitioning literature; 2) refinement and analysis of empirical regression equations; 3) evaluation of environmental variables influencing partitioning; and 4) estimated permissible sediment contaminant concentration (PCCs) based on refined equations. (document)

(g) Screening Level Concentrations (SLC's) - Using field data 12 SLC's were calculated for a variety of contaminants. SLC's identify a conservative no effect level and provide a check for evaluating the effectiveness of the equilibrium partitions approach. (document, will be distributed soon)

(h) Sediment Criteria and Hazardous Waste Sites - A workplan is being developed that explores the possibility of combining existing hazardous waste site cleanup activities with sediment criteria development acitivities.

5. Near-Term Activities

(a) Development of additional SLC's for chemicals of immediate concern.

(b) Finalizing sediment criteria development methodology and establishing four provisional sediment criteria (phenan threne, cadium-marine water and dieldrin, copper-fresh water. Also, obtainig the Science Advisory Board's review before seeking more formal public input and comment.

The first SLC's are as follows:

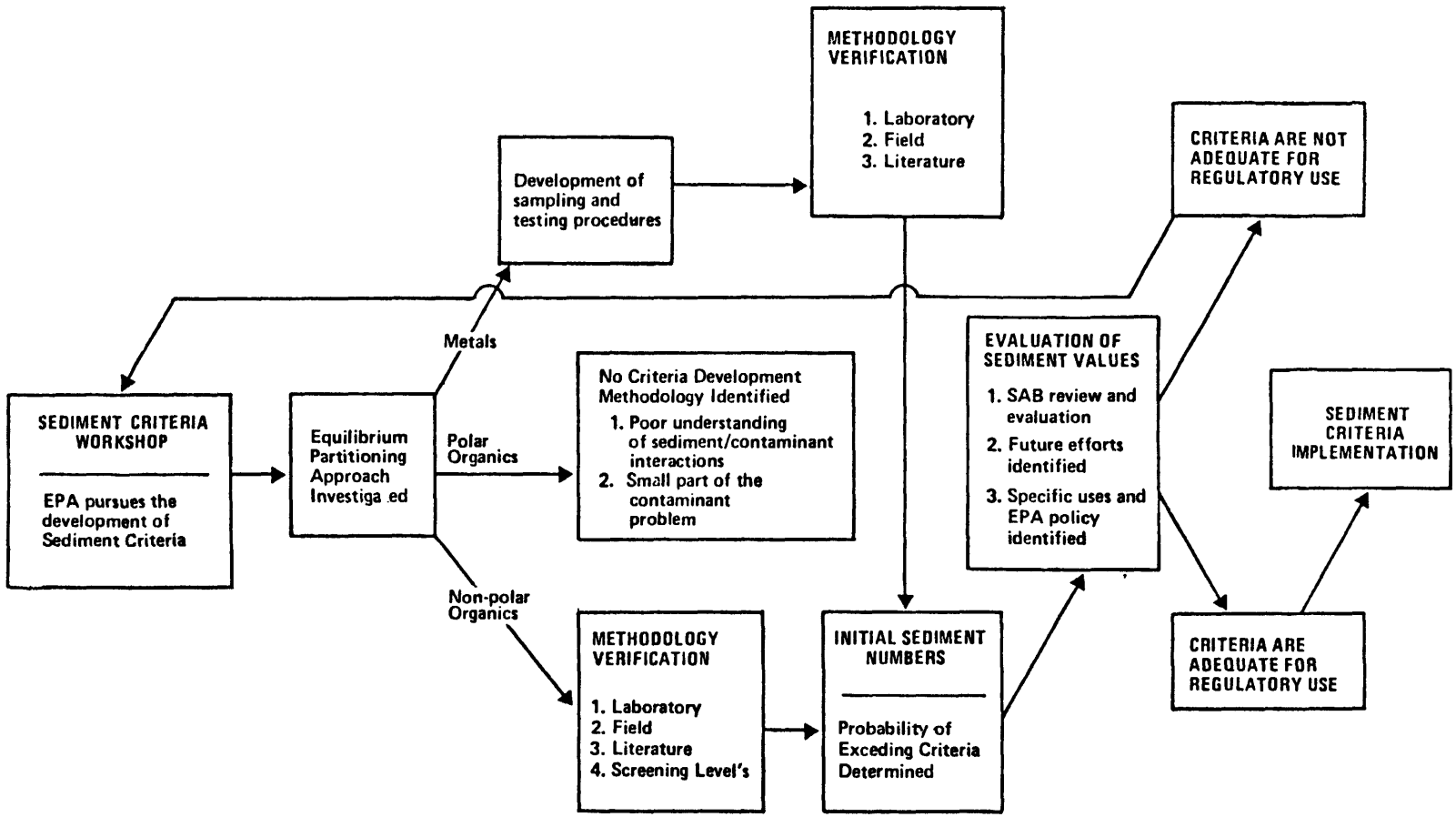
Contaminant	FRESH	MARINE
DDT	0.190	47.6
PCB's	0.290	4.36
Naphthalene		36.7
Penanthrene		25.1
Fluoranthrene		41.9
Benzo(a) Anthracene		26.9
Chreysene		26.1
Pyrene		38.1
Benzo(a) Pyrene		39.6
Dieldrin	0.021	
Chlordane	0.098	
Heptachlor	0.008	

Concentrations in ug/g

Although much work still remains to be done in the sediment criteria development effort and resources are limited, initial findings are very encouraging, particularly for nonpolar organic contaminants.

The attached flowchart depicts the sediment criteria development process. For additional information contact Chris Zarba, EPA, Criteria and Standards Division, Washington, DC 20460. Telephone (FTS) 472-3400

SEDIMENT QUALITY CRITERIA DEVELOPMENT



FEDERAL HIGHWAY ADMINISTRATION

The Federal Highway Administration (FHWA) concentrated its activities on five major areas: evaluation of embankment stability subject to flood overtopping, control of culvert outlet erosion, control of stream instability at highway crossings, control of sediment produced by highway construction, and control of highway water quality. Major efforts were carried out by staff and contract research, and by the various studies in the Highway Planning and Research Program (HPR) and in the National Cooperative Highway Research Program (NCHRP).

Evaluation of Embankment Stability Subject to Flood Overtopping - The objectives of these studies are to evaluate stability of embankments subject to flood overtopping and to determine expected rates of erosion when damages do occur. Various types of embankment materials and various types of protective measures are considered for these studies. In the overall design framework for highway stream crossings, these studies provide guidelines for risk analysis and lowest total expected cost design.

A. Simons, Li and Associates (SLA) completed a study sponsored jointly by FHWA and the U.S. Forest Service under contract DTFH61-82-C-00104 "Embankment Damage Due to Flood Overtopping." This was a large scale outdoor lab study to measure rates of embankment damage under various overtopping conditions. Two different embankment soil types were used, tests were conducted with and without grass covers and with and without a paved roadway on the top of the embankment. The U.S. Forest Service tests included a few select protective measures to stabilize the embankment. The final report should be available through NTIS in 1986.

B. A small scale centrifuge experiment was conducted by the University of Colorado at Boulder, Colorado, and was sponsored jointly by FHWA and the Waterways Experiment Station at Vicksburg, Mississippi. This study was an exploratory effort to determine if a centrifuge apparatus, rigged to handle water, could be a model for the large scale experiments. The final report, "Study of Embankment Performance During Overtopping and Throughflow," was published by the Department of Civil, Environmental, and Architectural Engineering, University of Colorado, Boulder, Colorado 80309, in June 1985.

C. A large scale study of protective measures for embankments subject to overtopping was being planned as a followup to the overtopping damage study in item A above. This study is co-sponsored by FHWA and the U.S. Bureau of Reclamation and is being conducted by Simons, Li and Associates in Fort Collins, Colorado.

Control of Culvert Outlet Erosion - The objectives of these studies are to investigate the various flow conditions and the forces involved at the outlet area, the material necessary to resist the erosion, and the special design of energy dissipators and stilling basins to control the erosion.

A. The University of Akron completed the study, sponsored under the HP&R program by the Ohio Department of Transportation, on "Internal Energy Dissipators for Culverts" which is a continuation of earlier work on this topic. The work included a laboratory investigation of staggered halves of roughness ring energy dissipators and resulted in a table of design coefficients for "standard" internal energy dissipator chambers. The draft final report was prepared and reviewed; it will be published soon.

Control of Stream Instability at Highway Crossings - The objectives of these studies are to evaluate the significance of natural stream adjustments on the structural integrity of highway crossings, to provide techniques for resolving the impact of these changes, then to provide guidelines for measures to mitigate stream instability at highway stream crossings.

A. As a result of the "Countermeasures" study completed in 1978, protective measures were identified that could benefit from additional evaluation and laboratory testing. One of these protective measures was spur or dike constructed along stream banklines. Although spurs and dikes have been applied nationwide there was no general guideline for their construction in application to protection of highway right-of-way. The Sutron Corporation in cooperation with the Pennsylvania State University completed the FHWA study entitled "Flow Control Structures for Highway Stream Crossings." The research evaluated present application of spurs and conducted laboratory flume studies to refine design guidelines for use by highway engineers. The final reports were published in July 1985:

   FHWA/RD-84/099, "Streambank Stabilization Measures for Highay Stream Crossings - Executive Summary."

   FHWA/RD-84/100, "Streambank Stabilizaton Measures for Highway Engineers."

   FHWA/RD-84/101, "Design of Spur-Type Streambank Stabilization Structures."

B. Sponsored by FHWA, the USGS continued a study on "Evaluation of Design Practices for Riprap Used in Protection of Highway Crossings." The study will determine, using field evaluation and collection of hydraulic data, the applicability of available riprap design procedures and provide guidelines for comprehensive design methods. Of special interest is the function of riprap in bends or when tested against impinging flow. Final reports are being prepared.

C. The FHWA continued the study of flexible linings in Drainage Ditches with the U.S. Geological Survey for a series of tests at their Gulf Coast Hydroscience Center in Bay St. Louis, Mississippi to evaluate the failure criteria and hydraulic resistance characteristics of some of the newer flexible lining materials as well as some traditional linings that have incomplete data. Materials being tested include: excelsior mat, single and double fiberglass roving, jute netting with straw and asphalt spray, jute netting with and without straw, Holdgro, Enka mat (lightweight), Erosionet with straw and asphalt spray, D_{50} 1-inch gravel (dumped and spread), and D_{50} 1-inch gravel rolled into soil. Results of this study

were incorporated into a revised version of FHWA's HEC-15, "Design of Roadside Channels with Flexible Linings," which was recently completed by Simons, Li and Associates under an Implementation contract. The final report for the USGS study will be available through NTIS in 1986.

Control of Sediment Produced by Highway Construction - This problem consists of two stages: during construction and just after construction.

A. The USGS Hawaii District, through the sponsorship of Hawaii Department of Transportation, completed the study on Rainfall-Runoff and Rainfall-Sedimentation Discharge Relations in Hawaii-type Watersheds. The objective of this study was to determine the effects of highway construction on the rainfall-runoff and rainfall-sedimentation discharge relations of a watershed on Moanalua Valley, Oahu, considering all significant basin characteristics. The results obtained will be used as a basis for deriving similar relations for other basins in Hawaii. Data collection and analysis were completed in 1980. The final report, "Hydrology and Sediment Transport, Moanalus Valley, Oahu, Hawaii," USGS Water-Resources Investigations Report 84-4156 was published in September 1984.

B. Sponsored by FHWA, the Native Plants, Inc. of Salt Lake City, Utah started an 18-month study on "Accelerated Recovery of Native Vegetation on Roadway Slopes After Construction." This study is for Federal lands such as those of Indian reservations, national forests, national parks, and areas under purview of the Bureau of Land Management. Low volume roads prevail. Emphasis of study is the restoration of vegetation, partly for aesthetic reasons, but also for erosion control by using appropriate plantings or seeding native to the area. Most of the study will consider barren and infertile areas commonly found among western mountains and deserts.

C. It is equally important that upon completion of highway construction, immediate and adequate protection against erosion be provided for slopes and other roadside areas affected by grading. In most regions of the country this has been accomplished with the establishment of proper management of vegetative cover. In 1985, ten States were conducting studies designed to improve vegetation establishment techniques and subsequent management practices. The participating States were Alabama, California, Georgia, Indiana, Maryland, Michigan, North Carolina, Oklahoma, Washington, and Wyoming. The following reports were published in 1985.

Pemberton, R. W., "Biological Control Research on Russian Thistle," Report No. FHWA/CA/HM-84/01, California Department of Transportation, Sacramento, California, April 1984.

Parks, D. M., and Nguyen, M., "Revegetation of Problem Soils on Road Slopes," Report No. FHWA/CA/TL-84/17, California Department of Transportation, Sacramento, California, June 1984.

Moser, B. C., and Kelley, R. J., "Techniques to Increase Survival of New Highway Plantings - Root Generation Portion," Report No. FHWA/IN/JHRP-82/22, Indiana Department of Highways, Indianapolis, Indiana, June 1985.

Verkade, S. D., and Carpenter, P. L., "Mycorrhizae and Their Role in Maintenance of Highway Plantings," Report no. FHWA/IN/JHRP-95/12, Indiana Department of Highways, Indianapolis, Indiana, 1985.

orre, D. J., "Embark-Telar-Surfactant-2, 4-D Combinations for Vegetation Management Along Indiana Roadsides," Report No. FHWA/IN/JHRP-85/1, Indiana Department of Highways (Purdue University), West Lafayette, Indiana, January 1985.

Gilbert, W. B., and DiPaola, J. M., "Selection, Establishment, and Maintenance of Vegetation Along North Carolina's Roadsides," Report No. FHWA/NC/85-003, North Carolina Department of Transportation, Raleigh, North Carolina, April 1985.

Miller, J. F., and Middlebrooks, P. B., "Herbicide Development and Usage for Highways, Final Report Phase II," Report No. FHWA/GA/84-7701, Georgia Department of Transportation, Atlanta, Georgia, April 1984.

"Evaluation of Effectiveness of Various Vegetation Covers in Controlling Slope Distress," Report No. 81-1, Missouri Highway and Transportation Department, Jefferson City, Missouri, October 1984.

"Evaluation of Erosion Control Materials for Ditches in Highway Corridors in Missouri," Report No. 81-3, MIssouri Highway and Transportation Department, Jefferson City, Missouri, June 1983.

"Evaluation of Erosion Control Materials for Slopes in Highway Corridors in Missouri," Report No. 81-4, Missouri Highway and Transportation Department, Jefferson City, Missouri, June 1983.

Control of Highway Water Qualilty - The objectives of these studies are to monitor the highway water pollution parameters and to devise cost effective means to control them.

A. The FHWA research study on "Sources and Migration of Highway Runoff Pollutants," was completed by the Environmental Research Center of Rexnord, Milwaukee, Wisconsin 53214. Monitoring was completed in Milwaukee, Wisconsin; Sacramento, California; Harrisburg, Pennsylvania; and Effland, North Carolina. The final report will be published in 1986.

B. The third phase of FHWA's research runoff quality to determine the impact of highway runoff on receiving waters was completed with the Engineering Research Center of Rexnord, Milwaukee, Wisconsin 53214. This research utilized both field and laboratory data to determine the actual effects of the runoff of operating highways on receiving water bodies. Results indicate that highways with traffic volumes less than 30,000 vehicles per

day the effects are minimal. A resource document, and procedural guidelines for environmental assessments were prepared along with guidelines for conducting field studies. These reorts and an executive summary and research report will be available from NTIS in 1986.

C. An interagency agreement with the U.S. Geological Survey is underway to do a study on "Procedure to Predict the Impact of Hydrologic Modifications by Highways on Wetlands." Its objective is to develop guidelines and procedures to utilize wetland hydrodynamics in the evaluation, analysis, and design of highway crossings in flood plains and wetlands. This work shall utilize the U.S. Geological Survey SIMSYS2D modeling system as the basic tool in accomplishing the above objectives. An access system shall be made available to State highway agencies which will permit highway agencies or their consultants to access SIMSYS2D through the U.S. Geological Survey's National Water Data Exchange (NAWDEX) on an AMDAHL 470 Computer or load modules, as appropriate. The tool developed shall have the capability for dealing with estuarine wetland systems. The study will also develop a training program and supporting materials to allow State highway agencies to develop capability and proficiency for use of hydrodynamics in the location, assessment and systems and in operation and utilization of SIMSYS2D.

D. The California Department of Transportation completed its HP&R study on "Mitigation of Highway Related Chemical Water Quality Pollutants," which dealt with reduction of sediment loads off of roadway slopes and the management of settling basins. The following reports were published in 1985.

Racin, J. A., and Parks, D. M., "Detention Basins at Two Snow Removal Maintenance Stations: An Evaluation," Report No. FHWA/CA/TL-84/11, California Department of Transportation, Sacramento, California, April 1984.

Racin, J. A., and Parks, D. M., "Sediment Basins with Slotted Riser Outlets: An Evaluation," Report No. FHWA/CA/TL-84/12, California Department of Transportation, Sacramento, California, April 1984.

E. The Alaska Department of Transportation and Public Facilities continued the HP&R study to evaluate the effectiveness of roadway drainage structures for fish passage.

F. The FHWA administrative contract to identify effective alternatives for mitigating highway stormwater runoff pollution was completed by Versar, Inc. of Springfield, Virginia. This state of the practice study developed an interim design guide for four mitigation practices: overland flow through grassed swales, retention basins, infiltration basins and wetlands. It also identified effective and noneffective design and operational practices for mitigation of highway runoff pollution. A guideline manual along with an executive summary, literature summary and research report will be available from NTIS in 1986. Work is underway to incorporate the guidelines into a Hydraulic Engineering Circular.

G. The Florida Department of Transportation completed an HP&R study to analyze the heavy metal input to receiving waters from highway stormwater runoff and determining any metal species change which occurs in the receiving water. The research also evaluated the environmental consequences. The final report was published in 1985.

Yousef, Y. A., Harper, H. H., Wiseman, L., and Bateman, M., "Consequertial Species of Heavy Metals," Report No. FHWA/FL/BMR-85-286, University of Central Florida, Orlando, Florida, 1985.

Yousef, Y. A., Wanielsta, M. P., Harper, H. H., Pearce, D. B., ad Tolbert, R. O., "Best Management Practices - Removal of Highway Contaminants by Roadside Swells," Report No. FL/DOT/BMR-84-274, University of Central Florida, Orlando, Florida, 1985.

H. An FHWA Region 15 Demonstration Project to illustrate techniques and equipment for sampling and analysis of highway stormwater runoff is now available. Demonstration studies in eight States were completed this year. The final report will be available in 1986. The manual to illustrate techniques and equipment for sampling and analyzing stormwater runoff was published.

Bellinger, W. Y., "Runoff Monitoring Quality and Quantity Test Methods," Report No. FHWA/DP-56/1, Federal Highway Administration, Washington, D.C., September 1980.

I. In response to the serious problems encountered with conventional deicing chemicals, sodium and calcium chloride, FHWA continued the development of an effective alternative material. Research identified Calcium Magnesium Acetate (CMA) as a promising alternative. Studies are now underway to develop a commercial source for CMA. Before extensive commitments for CMA are made, it is important to insure the environmental suitability of CMA. Research was completed with the Transportation Laboratory of CALTRANS to investigate CMA's compatibility with the environment and identify any potential problems. The report will be available from NTIS in 1986. A followup study was underway at the University of Washington.

J. The FHWA administrative contract to investigate highway maintenance activities, identify potential hazards to water quality, and develop guidelines for effective mitigation alternatives was completed. The final report will be available from NTIS in 1986.

K. In order to draw together the results of all the research on characterization of highway stormwater runoff, FHWA contracted with Woodward Clyde Consultants to develop a "Design Procedure to Estimate Pollutant Loading from Highway Stormwater Runoff." This study is developing a computer model to estimate pollutant loading and will include a procedure to evaluate the potential impact to water resources.

L. To transfer the technology to highway agency users, a "Highway Runoff/Water Quality Training Course" was developed for FHWA. The course included results from research on runoff characterization, water quality impact, environmental evaluation, best management practices and mitigation alternatives. Training courses started in 1985.

M. An FHWA administrative contract research study, "Retention, Detention and Overland Flow For Pollutant Removal From Highway Stormwater," was initiated this year by the Versar, Inc. of Springfield, Virginia. This research will develop performance criteria for mitigation measures using this subject removal mechanism. It will conduct laboratory tests and design for laboratory and field validations.

N. An FHWA administrative contract research study "Guidelines for Protective Systems for Spills of Hazardous Materials on the Highway System," was initiated this year by the Kansas State University of Manhattan, Kansas. This investigation will focus on areas of high risk where spills could result in severe, long term or permanent consequences. The emphasis of the research is on developing implementable procedures and guidelines for effective, practical, and feasible protective systems.

O. Five States are currently conducting investigations on effects of highway design, operation, and maintenance on water quality impacts and means to reduce such impacts.

Florida "Assimilative Capabilities of Highway Stormwater Runoff Retention Ponds"

Florida/USGS "Wetlands for Stormwater Treatment"

Florida/USGS "Impacts of Stormwater Management Practices on Ground Water"

Washington "Implementation of Highway Runoff Quality Research Results"

Massachusetts "Effectiveness of Drainage Features for Control of Ground Water Pollution"

Arizona "Porous Pavements for Control of Highway Runoff"

California "Effect of Bridge Repainting Operations on the Environment"

P. The URS Dalton, Inc. of Cleveland, Ohio completed the FHWA study on "Impacts of Highway Maintenance on Water Quality." This research focused on routine maintenance operations. An analysis was made of the most common routine maintenance operations to identify their potential to impact water quality. Based upon this analysis two activities, seal coating and application of herbicides were identified for further investigations. Field tests monitored runoff from both of these activities. Results indicated minimal effects on sensitive bioassays from

undiluted runoff. A Reference Manual for assessing water quality impacts and Guidelines for minimizing effects of maintenance practices were prepared. These manuals together with an executive summary and a research report will be available from NTIS in 1986.

Q. The Louisiana Department of Transportation completed its study on Health and Environmental Effects of MSMA. It found that the water quality impacts from MSMA pesticides were not significant. The final report was published in 1985.

Perry, D. L., and Germany, R., "Environmental and Health Effects of MSMA Along Selected Louisiana Highway," Report No. FHWA/LA-84-155(B), Louisiana Department of Transportation, Baton Rouge, Louisiana, 1985.

If more information is desired about these research studies, inquiries should be addressed to the sponsoring agencies.

GEOLOGICAL SURVEY, CORPS OF ENGINEERS, FOREST SERVICE, BUREAU OF RECLAMATION, AGRICULTURAL RESEARCH SERVICE, FEDERAL HIGHWAY ADMINISTRATION, AND BUREAU OF LAND MANAGEMENT

Federal Inter-Agency Sedimentation Project
St. Anthony Falls Hydraulic Laboratory
Minneapolis, Minnesota

An experimental sedimentation-concentration gage was moved from a station on Willow Creek to a station on Pheasant Branch. Both sites are near Madison, Wisconsin. During 1985, several runoff events were successfully monitored at the Pheasant Branch site. The gage was quite stable and its measurement errors were small--about 25 mg/L. Results of the field tests are preserted in a paper entitled, "Continuous Measurement of Suspended-Sediment Concentration" by John V. Skinner, Joseph P. Beverage, and Gerald L. Goddard. Interested parties can request a copy by calling FTS 787-3353.

An analysis of errors in sampling ice-covered rivers and a discussion pertaining to the measurement of scour around bridge piers were completed this year. Call FTS 787-3353 to request copies of the two reports.

A special straight-tube sediment gage was constructed this year. This gage, a submersible flow-through type, consists of a straight vibrating tube housed in a streamlined casing. Laboratory tests sbow the instrument is temperature sensitive and a mathematical model indicates welded joints in the instrument are probably causing the problem. A second straight-tube gage containing no welds has been designed and is being constructed.

A hand-held sampler for trace-metal studies was placed in production this year. The sampler, termed the DH-81, consists of a special cap, nozzle, and adapter. All of these parts are made of plastic. Any sample container with Mason jar threads can be used. All plastic parts can be autoclaved. The cost of the nozzle, cap, and adapter assembly is $27.50.

A new bed-material sampler consisting of a modified P-61 sampler body and a modified BM-54 sampling bucket was distributed this year. Compared to the BM-54, the new sampler is heavier and more streamlined. This new instrumert, which is called the BM-84, was successfully field tested in streams near Mount St. Helens. The sampler is activated electrically with a portable power pack.

Fifteen copies of a small, automatic pumping sampler, designated the PS-82, were produced this year. This sampler weighs about 35 pounds and holds 24 one-pint sample containers. Programmable sampling intervals can be shifted with changes in stage. The PS-82 is powered with one 12-volt battery.

A tentative standard for bedload sampler nozzles was approved by the technical committee. The project is now studying ways of fabricating an inexpensive body and tail assembly for the sampler.

All equipment developed by the project is first reviewed by the technical committee and then submitted to the Corps of Engineers contract and purchasing division. Manufacturing contracts are awarded through a competitive bid process and then the equipment items are delivered to the project for inspection and calibration. The project maintains a stock of replacement parts and also repairs damaged sampling equipment. Each year the project supplies sediment samplers and analyzers to about 300 field offices. All items are pictured and described in a catalog that, upon request, will be supplied free of charge.

The following table lists only the major pieces of equipment that the project supplies to government and educational institutions:

	Instrument	Sold During 1985	Sold During 1984	Inventory, Dec. 1985
DH-48	Hand sampler	71	19	139
DH-75P	Hand sampler	1	14	6
DH-75Q	Hand sampler	3	4	30
DH-59	Hand-line sediment sampler	3	3	20
DH-76	Hand-line sediment sampler	9	4	20
D-74	Depth-integrating sampler	23	18	20
D-74AL	Depth-integrating sampler	0	5	10
P-61	Point-integrating sampler	6	4	5
P-63	Point-integrating sampler	2	4	0
P-72	Point-integrating sampler	1	1	4
BMH-53	Bed-material hand sampler	0	3	59
BMH-60	Bed-material hand sampler	0	8	45
BM-54	Bed-material sampler	1	5	7
BM-84	Bed-material sampler	1	0	1
SA	Particle-size analyzer	1	4	3
PS-69	Pumping sampler	5	4	0
PS-82	Pumping sampler	9	0	6

GEOLOGICAL SURVEY

CR74-098 Sediment Transport Phenomena

Project Title: Measurement and Prediction of Sediment Transport Phenomena
WRD Project No.: CR74-098
Project Chief: Hubbell, David W.
Headquarters Office: Lakewood, Colorado
Field Location: Topical Research

Problem: In alluvial streams, for every different hydrologic condition, the bed configuration, sediment transport, and hydraulic characteristics mutually change to achieve a quasi-equilibrium. The changes affect the ability of the stream to convey given quantities of water, accommodate navigation, transport and dilute solid and solute wastes, support aquatic biota, and perform a variety of other similar functions. As yet, the relationships between pertinent hydraulic and sedimentologic variables are not completely understood, hence the extent to which important variables, particularly bed-form roughness and sediment transport, will change in response to natural or man-induced alterations to the flow regime can not be predicted with reliability. As a result, optimum utilization and management of a waterway usually is not assured and, often, modifications intended to enhance the utility of a waterway are ineffective or have adverse effects. Lack of understanding is due in part to inadequate instrumentation for measuring the bedload transport. This problem is particularly acute in areas where resources are being mined for energy development.

Objectives: To provide a more complete understanding of sedimentation phenomena in alluvial streams and the response of such streams to imposed changes through the use of improved instrumentation and better understanding of the relationships between hydraulic and sedimentologic variables, particularly (1) the relationships between the factors that most influence the formation and alteration of bed forms and the transport of bedload and bed-material load and (2) the interrelationships between bed-form characteristics and the transport of bedload and bed-material load.

Approach: Initially, existing data will be analyzed to relate bed-form characteristics and hydraulic and sedimentologic variables, and one or more bedload samplers will be developed to permit accurate measurements of bedload transport. The development of bedload samplers will be accomplished through a comprehensive testing and calibration program with prototype samplers in a specifically-designed laboratory facility capable of continuously measuring the discharge of bedload particles from 2 to 64 mm in diameter under different flow conditions. Later, data on bed-form characteristics, sediment transport, and other pertinent variables will be collected, as required, to meet specific needs; acoustic instrumentation, including side-scan sonar, will be employed to measure bed configuration and movement, and suitable bedload samplers, as well as suspended-load samplers, will be used to define transport rates. Tracer techniques also may be applied. Finally, data will be analyzed to define criteria for predicting bed form and to provide a better understanding of sediment transport phenomena. Both sand-bed and gravel-bed streams will be studied.

Progress: Reports were completed on the following subjects: (1) Development of a new analytical procedure for calibrating bedload samplers; (2) basic data on coarse sediment transport collected during laboratory calibration of bedload samplers; (3) effect of temporal and spatial variations on the accuracy of bedload sampling; (4) definition of particle-size distribution of coarse sediment by means of a new rapid-sieving apparatus; and (5) computation of particle-size statistics by computer.

Plans: Bedload-sampling techniques intended to minimize measurement errors and sampling effort, and alternate procedures for developing sampler-calibration curves, will be studied. Existing bedload transport relations will be examined using measured information from the bedload-sampler calibration experiments conducted at SAFHL. Participation in committee activity, particularly the Technical Committee of the Sedimentation Subcommittee, Federal Interagency Advisory Committee on Water Data will be continued.

Published Reports:

Hubbell, D. W., Stevens, H. H., Jr., Skinner, J. V., and Beverage, J. P., 1985, New approach to calibrating bedload samplers: American Society of Civil Engineers Proceedings, Journal of Hydraulic Engineering, v. 111, no. 4, p. 677-694.

Stevens, H. H., Jr., 1985, Computer program for the computation of total sediment discharge by the modified Einstein procedure: U.S. Geological Survey Water-Resources Investigations Report WRIR 85-4047, 82 p.

CR75-187: Bedload Transport Research

WRD Project No.: CR75-187
Project Chief: Emmett, William W.
Headquarters Office: Lakewood, Colorado
Field Location: Topical Research

Problem: Of all processes operating in river channels, and especially of those of practical concern to engineers and others interested in river channel behavior, perhaps the least knowledge is available regarding the hydraulics and mechanics of bedload transport. Before continuing advances in river channel behavior can be made, some understanding of the behavior of bedload sediment must be made.

Objective: (1) Define spatial and temporal variations in bedload transport rate for a single stage of flow; (2) define change in average magnitude of transport rate over a range in hydraulics of flow; (3) define change in average magnitude of transport rate over a range in channel geometry; and (4) analyze the data to evaluate the applicability of available bedload equations, suggest new coefficients for the existing equations, or propose new relations for predicting rates of bedload transport.

Approach: To use the conveyor-belt bedload-transport facility on the East Fork River near Pinedale, Wyoming, as a control to evaluate variability factors in bedload transport and to field calibrate the Helley-Smith bedload sampler; to use the calibrated Helley-Smith sampler in the systematic collection of bedload samples, along with the concurrent measurements of streamflow hydraulics, from a variety of sand- and gravel-bed streams, and, within the laws of general physics, stochastically develop empirical relations of bedload transport and interpret the physical significance of the developed relations.

Initiate at the conveyor-belt bedload-trap research facility a tracer study utilizing fluorescent particles to evaluate (1) residence time of sediment, (2) average speed of particles, (3) depth of bed material involved in transport, (4) dispersion of bed material, (5) short-term channel changes accompanying sediment transport, (6) influence of availability of sediment on transport rate, and other related aspects of sediment transport.

Progress: Collection of field data on the East Fork River as related to the calibration of the Helley-Smith bedload sampler and the fluorescent-tracer study has been completed. The bedload sampler has a near-perfect sampling efficiency for sediment particles in the size range of 0.5 to 16.0 mm. Daily bedload measurements at frequently spaced sections along a reach of the river demonstrate significantly different relations of bedload-transport rate to discharge from one section to another. Field data relating to the fluorescent-tracer study have been compiled and released in a series of open-file reports.

Related Reports (Project staff only; last 10 years only):

Emmett, W. W., 1975, Some observed rates of bedload transport (abstract): American Geophysical Union, Transaction, EOS, v. 56, no. 12, (December 1975), p. 981.

----- 1975, The channels and waters of the upper Salmon River area, Idaho: U.S. Geological Survey Professional Paper 870-A, p. A-1 to A-116 and i-viii.

Mahoney, H. A., Andrews, E. D., Emmett, W. W., Leopold, L. B., Meade, R. H., Myrick, R. M., and Nordin, C. F., Jr., 1976, Data for calibrating unsteady-flow sediment-transport models, East Fork River, Wyoming, 1975: U.S. Geological Survey Open-File Report 76-22, 293 p.

Druffel, Leroy, Emmett, W. W., Schneider, V. R., and Skinner, J. V., 1976, Laboratory hydraulic calibration of the Helley-Smith bedload sampler: U.S. Geological Survey Open-File Report 76-752, 63 p.

Leopold, L. B., and Emmett, W. W., 1976, Bedload measurements, East Fork River, Wyoming: Proceedings, National Academy of Sciences, v. 73, no. 4, p. 1000-1004.

Emmett, W. W., 1976, Bedload transport in two large, gravel-bed rivers, Idaho and Washington: Denver, Colo., Proceedings, Third Federal Inter-Agency Sedimentation Conference, March 22-26, p. 4-101 to 4-114.

Emmett, W. W., and Leopold, L. B., 1977, A comparison of observed sediment-transport rates with rates computed using existing formulas (abstract): Binghamton, N.Y., Proceedings, Eighth Annual Geomorphology Symposium, Sept. 23-24, p. 187-188.

Leopold, L. B., and Emmett, W. W., 1977, 1976 bedload measurements, East Fork River, Wyoming: Proceedings, National Academy of Sciences, v. 74, no. 7, p. 2644-2648.

Emmett, W. W., Burrows, R. L., and Parks, B., 1978, Sediment transport in the Tanana River in the vicinity of Fairbanks, Alaska, 1977: U.S. Geological Survey Open-File Report 78-290, 28 p.

Emmett, W. W., and Thomas, W. A., 1978, Scour and deposition in Lower Granite Reservoir, Snake and Clearwater Rivers near Lewiston, Idaho, U.S.A.: Journal of Hydraulic Research, v. 16, no. 4, p. 327-345.

Emmett, W. W., 1979, A field calibration of the sediment-trapping characteristics of the Helley-Smith bedload sampler: U.S. Geological Survey Open-File Report 79-411, 96 p.

Burrows, R. L., Parks, B., and Emmett, W. W., 1979, Sediment transport in the Tanana River in the vicinity of Fairbanks, Alaska, 1977-1978: U.S. Geological Survey Open-File Report 79-1539, 37 p.

Emmett, W. W., 1979, Aspects of bedload transport in rivers (abstract): Program with Abstracts, 32nd Annual Meeting, Rocky Mountain Section, Geological Society of America, v. 11, no. 6, p. 271.

Related Reports (Project staff only; last 10 years only):

Emmett, W. W., 1975, Some observed rates of bedload transport (abstract): American Geophysical Union, Transaction, EOS, v. 56, no. 12, (December 1975), p. 981.

----- 1975, The channels and waters of the upper Salmon River area, Idaho: U.S. Geological Survey Professional Paper 870-A, p. A-1 to A-116 and i-viii.

Mahoney, H. A., Andrews, E. D., Emmett, W. W., Leopold, L. B., Meade, R. H., Myrick, R. M., and Nordin, C. F., Jr., 1976, Data for calibrating unsteady-flow sediment-transport models, East Fork River, Wyoming, 1975: U.S. Geological Survey Open-File Report 76-22, 293 p.

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CR81-266 Estuary sedimentation and eutrophication

Project Title: Transport and deposition of sediments and sediment-borne contaminants in tidal rivers and estuaries
WRD Project No.: CR81-266
Project Chief: Jerry L. Glenn
Headquarters Office: Lakewood, Colorado
Field Location: Nationwide

Problem: Sediments that contain elevated concentrations of nutrients and trace metals are accumulating rapidly in parts of the tidal Potomac River, the Potomac Estuary, and the adjacent marginal embayments. Accumulations of sediments and sediment-borne contaminants may significantly limit the use of tidal waters and estuaries for commercial, recreational, and aquacultural purposes. The sediments decrease channel depths and widths to the detriment of commercial and recreational interests, and cover and destroy productive shellfish grounds. The nutrients are a factor in the development and maintenance of undesirable eutrophic conditions, including nuisance algae blooms and low levels of dissolved oxygen. Sedimentation and eutrophication problems in the Potomac are a consequence of essentially uncontrollable natural and potentially manageable anthropogenic influences. The problems began to develop naturally several thousand years ago when the current rise in sea level drowned the Potomac River and began the evolution of the modern tidal river-estuary system. The rate of development probably accelerated when white man began to clear adjacent forests for farms and cities and when agricultural, municipal, and industrial waste began to exceed the natural assimilative capacity of the evolving tidal river-estuary system.

Objectives: (1) To identify modern sources of sediments and nutrients. (2) To establish changes with time in sources or supply rates due to natural and anthropogenic influences. (3) To determine sediment and nutrient transport and deposition patterns. (4) To compute rates of accumulation and amounts of sediments and nutrients in selected hydrologic and geomorphic divisions of the Potomac system. (5) To compare supply and accumulation rates for prehistorical and historical periods with contemporary rates from concurrent transport studies.

Approach: Areal and stratigraphic distributions of sediments, nutrients, and trace metals will be determined by a combination of direct sampling (surface and core) and remote sensing (side scan sonar and subbottom profiling). Sediment samples will be analyzed for indicators of sources (particle size, mineralogy, nutrient and trace metal concentrations) and accumulation rates (^{210}Pb, ^{14}C, pollen concentrations and distributions). Sediment contributions from the shoreline source will be estimated by a combination of field mapping, monitoring, and sampling at selected sites, and by laboratory measurements from available air photographs and maps. Data will be integrated with results from measurements and models of modern sediment and nutrient transport to provide past and present sediment and nutrient budgets for selected Potomac reaches.

Progress and significant results: Geomorphic units and sedimentation rates were correlated with hydrologic conditions and sediment sources in the tidal Potomac system. Channels and channel-margin smooth flats are dominant geomorphic units in the river division, and channels and irregular slopes are dominant in the estuary division. Sedimentation rates in both units of the river division are large because of sediment inflow from the nearby Potomac River, high tides and diurnal landward currents, and decreasing competence of river currents. Sedimentation rates are small in much of the estuary division because minimal sediment is supplied from landward sources, from local shoreline erosion, from estuary tributaries, or from Chesapeake Bay. If average sedimentation rates are applied to geomorphic units in each division, the annual gross accumulation is about equal to the measured and estimated annual supply rates from all sources. The tidal Potomac system is a sink for all sediments supplied to it.

Nutrient concentrations in bottom sediments of the tidal Potomac system reveal nutrient sources and geochemical reactions. The river source is dominant for organic carbon and nitrogen throughout the tidal Potomac, but nonpoint sources result in increased total phosphorus concentrations in bottom sediments below outfalls in the metropolitan Washington, D.C. area. Extremely small phosphorus concentrations in the estuary may indicate periodic reducing conditions that result in release of phosphorus from bottom sediments.

Brief statement of progress: Geomorphic units and sedimentation rates have been related to sediment sources and changing hydrologic conditions. Nutrient concentrations reflect nutrient sources and geochemical reactions.

Plans for next year: Potomac data will be compiled and analyzed for a summary document. Limited work will continue on fine-sediment transport and resuspension in the Potomac estuary, and a field site will be selected for initial studies of coarse-sediment transport.

Reports Completed in 1985:

DeFries, R. S., 1985, Effects of land-use history on sedimentation in the Potomac estuary, Maryland: U.S. Geological Survey Water-Supply Paper 2234-K, 115 p.

Miller, A. J., 1984, Shore erosion as a sediment source to the tidal Potomac River, Maryland and Virginia: U.S. Geological Survey Water-Supply Paper 2234-E, 156 p.

Glenn, J. L., 1986, Bottom sediments and nutrients in the tidal Potomac system, Maryland and Virginia: U.S. Geological Survey Water-Supply Paper 2234-_, 272 p.

CR82-273: Interface of Hydrologic and Biologic Processes in Rivers

WRD Project No: CR82-273
Project Chief: Andrews, Edmund D.
Headquarters Office: Lakewood, Colorado
Field Location: Topical Research

Problem: In general, it is quite difficult to describe the future stability and productivity of a river ecosystem following a significant physical alteration of its watershed. Two fundamental deficiencies exist: (1) The dynamics of stream channel change are poorly understood, especially the rate at which the several hydraulic variables adjust to new conditions. The greatest shortcoming of our present knowledge in this area is the longitudinal sorting of bed-material particles. (2) The specific physical characteristics essential to the growth and maintenance of most organisms are not known in sufficient detail.

Objectives: Field research will describe the sequence and rate of change in the physical aspects of the aquatic ecosystem as a result of watershed alteration. Investigations will concentrate on understanding the component processes, especially bed-material sorting, meandering, and braiding required for a physically-based water and sediment routing model for gravel-bed streams.

Approach: The ideal approach for this investigation would be to observe the transition of a river channel from one quasi-equilibrium state through a period of instability to another quasi-equilibrium state as a result of a known change in the supply of water and sediment. Adjustment of a river channel, however, may extend over a few decades to a century. Such an investigation would be obviously impractical. Instead, two basic types of field studies will be combined. First, the movement of bed material through a reach of channel will be studied in detail. These investigations will consider the transport of bed material, distance transported, and location (bed, banks, or bar) of deposition for each size fraction. Two or three small, self-formed gravel-bed streams will be selected for this portion of the investigation. There are a number of such streams in the western United States which are also sites of active aquatic ecology research programs. By conducting the hydraulic studies on these rivers and in cooperation with the ecological investigations, the project focus on the interrelation of hydraulic processes and physical habitat will be enhanced. Using measured bedload transport rates, tracer particles, and mapping of channel features, the movement of coarse bed material through the study reaches will be described. To the extent possible, these observations will be generalized to formulate a physical model of gravel movement by size fraction.

The second part of this investigation will involve reconstructing the sequence and rate of adjustment for historical examples of river channel change. Because of the lack of detailed hydraulic measurements, this portion of the investigation will be necessarily more descriptive and qualitative than the first part. These observations, however, will be vitally important, as they will provide the temporal context in which to view the hydraulic characteristic at a particular point in time.

Progress: Intensive sampling of bed-material transport rate and associated hydraulic-characteristics in Sagehen Creek, California show that general motion of the streambed occurs very infrequently. The size distribution of surface bed-material measured during the spring snowmelt flood, including a period of record high flow, was essentially identical to the size distribution measured during periods of base flow. Thus, the relatively coarser bed surface which is observed at small discharges was in place and unbroken at very large discharges. A significant fraction of the bed particles as large as twice the median diameter of the surface material, however, were entrained at some time during the snowmelt flood.

Existence of a vertically sorting streambed while nearly all sizes of bed material were in transport was possible, because extremely few particles of any size were entrained at a given time. The displacement of tracer particles placed in Sagehen Creek during the 1981 and 1982 snowmelt flood showed that general motion of bed material did not occur. Rather, a few of the largest tracer particles were entrained whereas some of the smallest tracer particles did not move. Very few particles are entrained by the flow even at the largest discharges, because the shear stress almost never exceeds the threshold value by much. The critical value of the dimensionless shear stress, τ^*_{50}, for the median particle diameter in the bed surface of Sagehen Creek is 0.046, and is exceeded at discharges only slightly greater than bankfull. The maximum value of τ^*_{50} during the record peak snowmelt flood was 0.059. Moreover, the largest dimensionless shear stress during the 30 years of record is estimated to be ~0.06, or no more than 50 percent larger than the critical value. Therefore, general motion of the bed material in Sagehen Creek occurs rarely, if ever. Over a period of years, however, significant quantities of bed material including nearly all available sizes are transported while the bed surface remains unbroken. Hence, streambed surface cannot be a relict feature formed by an unrecorded large flood more than 30 years ago. The relatively coarser bed-material surface is constructed by and in equilibrium with small, but non-zero transport rates involving nearly all sizes of material. The bed surface of Sagehen Creek is a mobile bed feature formed by hydraulic conditions only slightly greater than required to entrain bed particles.

Plans for next year: The investigation of bed-material entrainment and transport in Sagehen Creek is nearly complete. Results of these observations have provided a detailed description of the flow conditions under which the relatively coarser bed particles are entrained and fine sediment, $\leq$1 mm in diameter is flushed from the streambed. The next phase of the Sagehen Creek project will be to study the deposition and accumulation of fine sediment in the streambed. The conclusion of this project will be to formulate a numerical model for routing fine sediment in a gravel-bed stream.

Reports completed in 1985:

Parker, Gary, and Andrews, E. D., 1985, Sorting of bedload sediment by flow in meander bends: Water Resources Research, v. 21(9), p. 1361-1373.

Andrews, Edmund D., 1986, Downstream effects of Flaming Gorge Reservoir on the Green River, Colorado and Utah: Bulletin, Geological Society of America (Accepted for publication).

Andrews, E. D., and Erman, D. C., 1986, Persistence in the size distribution of surficial bed-material during an extreme snowmelt flood: Water Resources Research, v. 22(2), p. 191-197.

Parker, Gary and Andrews, E. D., 1986, Time development of meander: Journal of Fluid Mechanics, v. 162, p. 139-156.

Andrews, E. D., and Parker, Gary, 1986, Formation of a coarse surface layer as the response to gravel mobility, in Gravel-Bed Rivers, Hey, R. D., Bathurst, J. C., and Thorne, C R., eds., John Wiley and Sons, New York.

CR84-287 Fluvial Paleohydrology

Project Title: Fluvial Paleohydraulics and Paleohydrology
WRD Project No.: CR84-287
Project Chief: Costa, John E.
Headquarters Office: Lakewood Colorado
Field Location: Topical Research

Problem: Fundamental flow characteristics of small watersheds are extremely difficult to resolve because events occur quickly and so little direct instrumentation is available, or capable, of recording the flows. It is difficult at present to differentiate different flow types (water, hyperconcentrated, debris flows) in small basins. Fundamental geomorphic theories on frequency and magnitude of flow events, developed from data on large streams, do not apply in small watersheds.

Objectives: The objectives of this project are:
to provide geomorphic and stratigraphic-based estimates of magnitude and frequency of large flows events in small basins;
to compile existing information on landscape modifications and recovery rates and processes following large flows; and
to identify discharge thresholds instigating major channel, flood plain, and hillslope changes.

Approach: The process, magnitude, and frequency of different kinds of flow events in small basins will be interpreted from the stratigraphic (sediment) and geomorphic (landforms) remains of modern flow events. Moment analysis of sediment deposits, and techniques of hydrodynamic stratigraphic interpretation will be developed to differentiate process. Laboratory experiments (eg. flume studies) will be used to model non-steady, non-uniform flow conditions and sediment deposit characteristics of small watersheds. Where an appropriate sediment record exists, frequency of flow events will be estimated by using various Quaternary dating techniques. Using existing data from small basins that experienced large flows in historic times, photographic and planimetric information will be used to identify the rates and processes by which basins "heal" following large events.

Progress: In 1985, three significant activities were completed which relate to sediment investigations. First, the hydraulics of the largest rainfall-runoff floods ever measured in the conterminous United States were compiled and analyzed. Several important results for future sediment transport research are (1) energy slope was always less than water-surface slope by values of 1 to 104 percent, (2) shear stresses for the 12 largest floods ranged between 61 and 855 newtons per square meter, and unit stream power from 212 to 8,131 newtons per meter per second. These values are not the largest ever measured, which indicates that maximum force in stream channels and resulting sediment transport and geomorphic change is controlled by the depth-slope product, not maximum discharge.

Second, peak flood discharges from the failure of natural and constructed dams, and some of the consequent upstream and downstream sedimentation effects, were documented in USGS Open-File Report 85-560. These effects include aggradation of the valley upstream by trapped sediment, triggering of landslides by the rapid draw-down of reservoir water-levels, large amounts of local scour and deposition downstream, erosion of bedrock along valley walls, and the formation of wide, shallow, braided channels downstream.

Third, denudation rates resulting from debris flows in mountain basins in California, Colorado, and Virginia were determined by measuring volumes and ages of deposits. Where debris flows are common, denudation rates are very high. Debris flow basins provide extreme examples of sediment storage and very low delivery ratios, and show that disequilibrium between hillslope and channel sediments may prevail over periods ranging from less than a decade to thousands of years.

Plans: In FY 1986, a more comprehensive examination of landslide dams, their stability, and failure mechanisms will be conducted in cooperation with Geologic Division. If time permits, this investigation will also include other kinds of natural dams. In addition, initial work is to begin on the description and documentation of thick valley-floor sediments deposited during catastrophic floods.

Publications:

Costa, J. E., 1985, Interpretations of the largest rainfall-runoff floods measured by indirect methods on small drainage basins in the conterminous United States: Proceedings, United States - People's Republic of China Bilateral Symposium on the Analysis of Extraordinary Flood Events, Nanjing, People's Republic of China, 80 p.

Osterkamp, W. R., and Costa, J. E., 1985, Denudation rates, sediment yields, and hillslope equilibrium in selected debris-flow basins of California, Colorado, and Virginia: Geological Society of America, Abstracts with Programs, v. 17, p. 683 (paper published in 4th Federal Interagency Sedimentation Conference Proceedings).

Costa, J. E., 1985, Floods from dam failures: U. S. Geological Survey Open-File Report 85-560, 54 p.