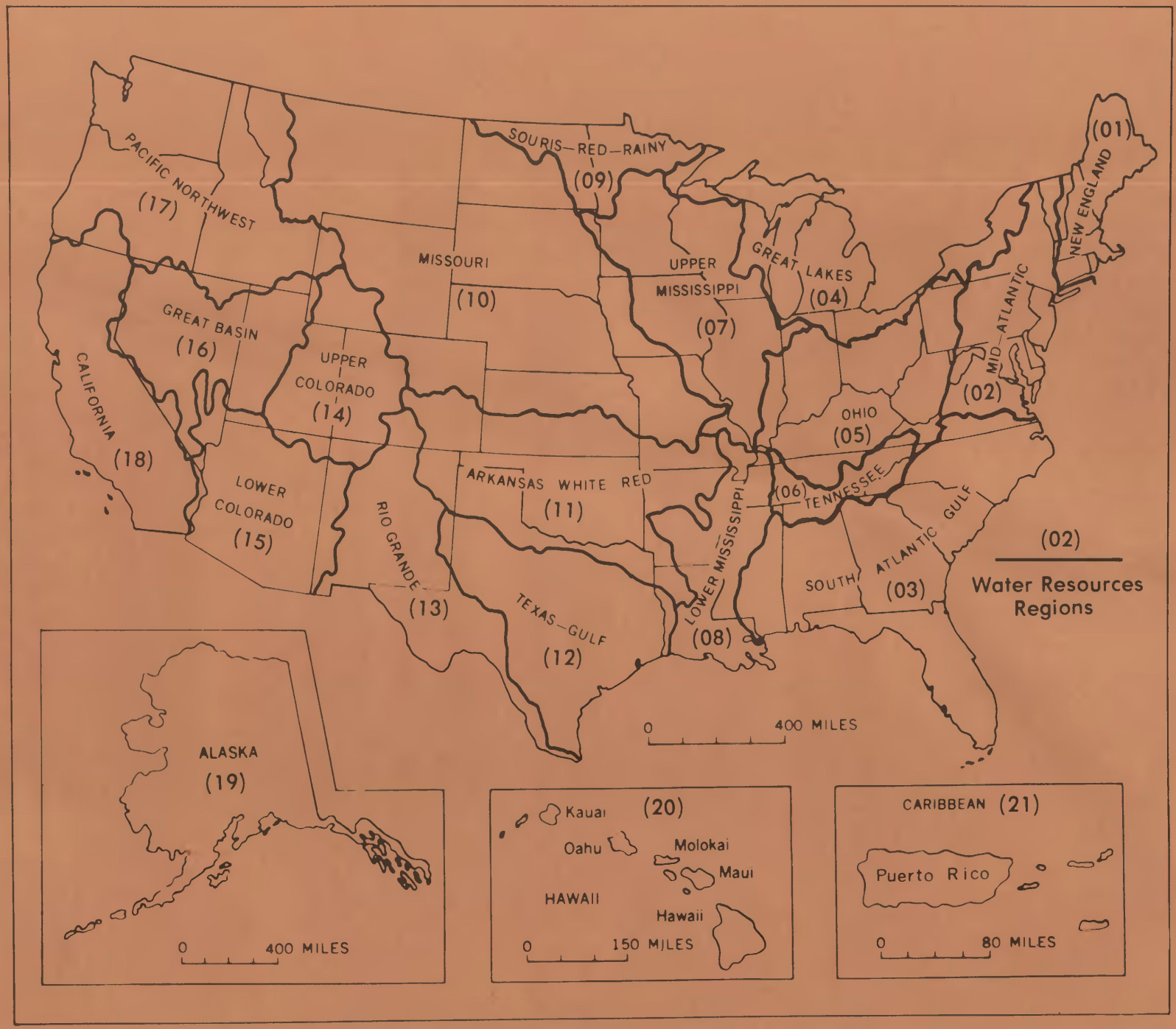
INTERAGENCY ADVISORY COMMITTEE ON WATER DATA

NOTES ON SEDIMENTATION ACTIVITIES CALENDAR YEAR 1986

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 1986

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

September 1987

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 1986" was contributed by the representatives of participating Federal agencies. Suggestions for improving the report are welcome.

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SUBCOMMITTEE ON SEDIMENTATION
OF THE
INTERAGENCY ADVISORY COMMITTEE ON WATER DATA
1986

DEPARTMENT OF AGRICULTURE

C. Don Clarke (Member)
Soil Conservation Service
Room 6128, P.O. Box 2890
Washington, D.C. 20013
Phone: 202/382-0136
FTS 382-0136

David A. Farrell (Member)
Agricultural Research Service
Room 201, Building 005, BARC-WEST
Beltsville, Maryland 20705
Phone: 301/344-4246
FTS 344-4246

Warren C. Harper (Member)
Forest Service, USDA
Room 1210 RPE, P.O. Box 2417
Washington, D.C. 20013
Phone: 202/235-8178
FTS 235-8178

M. Dean Knighton (Alternate)
Forest Service, USDA
Room 1206 RPE, P.O. Box 2417
Washington, D.C. 20013
Phone: 202/235-1071
FTS 235-1071

DEPARTMENT OF COMMERCE

Richard B. Perry (Member)
National Ocean Service
Room 1026, NOAA, N/CG2X2
6001 Executive Boulevard
Rockville, Maryland 20852
Phone: 301/443-8251
FTS 443-8251

David B. Duane (Alternate)
National Sea Grant College Program
Room 824, NOAA, R/SE1
6001 Executive Boulevard
Rockville, Maryland 20852
Phone: 301/443-8894
FTS 443-8894

DEPARTMENT OF DEFENSE

Yung H. Kuo (Member)
U.S. Army Corps of Engineers
ATTN: DAEN-CWH-Y
Room 2114, Pulaski Building
20 Massachusetts Avenue, N.W.
Washington, D.C. 20314-1000
Phone: 202/272-8507
FTS 272-8507

Lewis A. Smith (Alternate)
U.S. Army Corps of Engineers
ATTN: DAEN-CWH-Y
Room 2114, Pulaski Building
20 Massachusetts Avenue, N.W.
Washington, D.C. 20314-1000
Phone: 202/272-8506
FTS 272-8506

DEPARTMENT OF ENERGY

Shou-Shan Fan (Member)
Federal Energy Regulatory Commission
Room 203G
400 1st Street, N.W.
Washington, D.C. 20426
Phone: 202/376-9253
FTS 376-9253

Thomas G. Frangos (Member)
Office of Environmental Guidance
Department of Energy, EH 23
Washington, D.C. 20585
Phone: 202/252-4606
FTS 252-4606

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Truman Goins (Member)
Office of Environment and Energy
Room 7176
451 7th Street, S.W.
Washington, D.C. 20410
Phone: 202/755-7894
FTS 755-7894

DEPARTMENT OF THE INTERIOR

G. Douglas Glysson (Member)
U.S. Geological Survey
415 National Center
Reston, Virginia 22092
Phone: 703/648-5317
FTS 959-5317

Daniel P. Muller (Member)
Bureau of Land Management
Room 909, Premier Building
18th and C Streets, N.W.
Washington, D.C. 20240
Phone: 202/653-9210
FTS 653-9210

William L. Jackson (Alternate)
Bureau of Land Management
Denver Federal Service Center
Building 50
Denver, Colorado 80225
Phone: 303/236-0148
FTS 776-0148

Roy H. Rush (Chairman)
U.S. Bureau of Reclamation
Room 7444, Code 736
18th and C Streets, N.W.
Washington, D.C. 20240
Phone: 202/343-3588
FTS 343-3588

Merlin S. Ahrens (Alternate)
U.S. Bureau of Reclamation
Room 7455, Code 720
18th and C Streets, N.W.
Washington, D.C. 20240
Phone: 202/343-5275
FTS 343-5275

Ranvir Singh (Member)
Office of Surface Mining
Western Technical Center
1020 15th Street
Denver, Colorado 80202
Phone: 303/844-2578
FTS 564-2578

DEPARTMENT OF TRANSPORTATION

Daniel S. O'Connor (Member)
Federal Highway Administration
Room 3109, Nassif Building
400 7th Street, S.W. (HNG-31)
Washington, D.C. 20590
Phone: 202/472-7690
FTS 472-7690

D. C. "Charlie" Woo (Alternate)
Federal Highway Administration
6300 Georgetown Pike (HNR-10)
McLean, Virginia 22101-2296
Phone: 703/285-2444
FTS 285-2444

INDEPENDENT AGENCIES

Robert T. Joyce (Member)
Tennessee Valley Authority
320 Evans Building
524 Union Avenue
Knoxville, Tennessee 37902
Phone: 615/632-6360
FTS 856-6360

Robert E. Thronson (Member)
U.S. Environmental Protection Agency
Room 819, East Tower
401 M Street, S.W.
Washington, D.C. 20460
Phone: 202/382-7104
FTS 382-7104

OWDC LIAISON

Donald K. Leifeste
U.S. Geological Survey
417 National Center
Reston, Virginia 22092
Phone: 703/648-5022
FTS 959-5022

LOCATIONS OF NAWDEX ASSISTANCE CENTERS

ALABAMA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 520 19th Avenue, Tuscaloosa, AL 35401
TELEPHONE:
Commerical: (205) 752-8104 FTS: 229-2976
OFFICE CONTACT: W. Scott McEwen

ALASKA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 4230 University Drive, Suite 201, Anchorage, AK 99508-4664
TELEPHONE:
Commercial: (907) 271-4138 FTS: 8-(907)-271-4138
OFFICE CONTACT: Robert D. Lamke

NAME: Public Inquiries Office, U.S. Geological Survey
ADDRESS: Room 101, 4230 University Drive, Anchorage, AK 99508-4664
TELEPHONE:
Commercial: (907) 561-5555 FTS: 8-(907)-271-4320
OFFICE CONTACT: Elizabeth C. Behrendt

ARIZONA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Federal Building, FB-44, 300 West Congress Street,
Tucson, AZ 85701
TELEPHONE:
Commercial: (602) 792-6629 FTS: 762-6629
OFFICE CONTACT: Colleen A. Babcock

ARKANSAS

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 700 West Capitol, 2301 Federal Office Building,
Little Rock, AR 72201
TELEPHONE:
Commercial: (501) 378-6391 FTS: 740-6391
OFFICE CONTACT: John E. Owen

CALIFORNIA

NAME U.S. Geological Survey, Water Resources Division
ADDRESS: Room 2235, Federal Building, 2800 Cottage Way,
Sacramento, CA 95825
TELEPHONE:
Commercial: (916) 978-4633 FTS: 460-4633
OFFICE CONTACT: John S. Bader

NAME: Public Inquiries Office, U.S. Geological Survey
ADDRESS: 7638 Federal Building, 300 North Los Angeles Street,
Los Angeles, CA 90012
TELEPHONE:
Commercial: (213) 894-2850 FTS: 798-2850
OFFICE CONTACT: David Compas

NAME: Public Inquiries Office, U.S. Geological Survey
ADDRESS: Room 3128, Mail Stop 533, Building 3, 345 Middlefield Road,
Menlo Park, CA 94025
TELEPHONE:
Commercial: (415) 323-8111, x2817 FTS: 467-2817
OFFICE CONTACT: Bruce S. Deam

NAME: Public Inquiries Office, U.S. Geological Survey
ADDRESS: 504 Custom House, 555 Battery Street, San Francisco, CA 94111
TELEPHONE:
Commercial: (415) 556-5627 FTS: 556-5627
OFFICE CONTACT: Patricia A. Shiffer

COLORADO

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Mail Stop 415, Box 25046, Building 53, Denver Federal Center,
Lakewood, CO 80225
TELEPHONE:
Commercial: (303) 236-4886 FTS: 776-4886
OFFICE CONTACT: Harold E. Petsch, Jr.

NAME: Public Inquiries Office, U.S. Geological Survey
ADDRESS: 169 Federal Building, 1961 Stout Street, Denver, CO 80294
TELEPHONE:
Commercial: (303) 837-4169 FTS: 8-564-0111 (ask for 837-4169)
OFFICE CONTACT: Irene V. Shy

CONNECTICUT

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Room 525, Abraham A. Ribicoff Federal Building, 450 Main Street, Hartford, CT 06103
TELEPHONE:
Commercial: (203) 722-2528 FTS: 244-2528
OFFICE CONTACT: Lawrence A. Weiss

DELAWARE

(See U.S. Geological Survey Office in Maryland)

DISTRICT OF COLUMBIA

NAME: Public Inquiries Office, U.S. Geological Survey
ADDRESS: 1028 General Services Building, 18th and F Streets, N.W., Washington, DC 20405
TELEPHONE:
Commercial: (202) 343-8073 FTS: 8-(202)-343-8073
OFFICE CONTACT: Bruce A. Hubbard

FLORIDA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 227 North Bronough Street, Suite 3015, Tallahassee, FL 32301
TELEPHONE:
Commercial: (904) 681-7620 FTS: 965-7620
OFFICE CONTACT: Donald W. Foose

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 9100 NW 36th Street Miami, FL 33102
TELEPHONE:
Commercial: (305) 594-0655 FTS: 350-5382
OFFICE CONTACT: Ellis Donsky

FLORIDA--continued

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Suite 216, Federal Building, 80 North Hughey Avenue,
Orlando, FL 32801
TELEPHONE:
Commercial: (305) 648-6191 FTS: 820-6191
OFFICE CONTACT: Larry D. Fayard

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Suite B-5, 4710 Eisenhower Boulevard, Tampa, FL 33614
TELEPHONE:
Commercial: (813) 228-2124 FTS: 826-2124
OFFICE CONTACT: G. Lynn Barr

GEORGIA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Suite B, 6481 Peachtree Industrial Boulevard, Doraville, GA 30360
TELEPHONE:
Commercial: (404) 331-4858 FTS: 242-4858
OFFICE CONTACT: Timothy W. Hale

HAWAII

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: P.O. Box 50166, 300 Ala Moana Boulevard, Honolulu, HI 96850
TELEPHONE:
Commercial: (808) 541-2820 FTS: 551-2820
OFFICE CONTACT: Salwyn S. Chinn

IDAHO

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 230 Collins Road, Boise, ID 83702
TELEPHONE:
Commercial: (208) 334-1750 FTS: 554-1750
OFFICE CONTACT: Luther C. Kjelstrom

ILLINOIS

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Champaign County Bank Plaza, Fourth Floor, 102 East Main Street,
Urbana, IL 61801
TELEPHONE:
Commercial: (217) 398-5353 FTS: 8-(217)-958-5353
OFFICE CONTACT: G. Wayne Curtis

ILLINOIS--continued

NAME: Illinois State Water Survey Division
ADDRESS: 2204 Griffith Drive, Champaign, IL 61820
TELEPHONE:
Commercial: (217) 333-2211
OFFICE CONTACT: Robert A. Sinclair or Douglas Noel

INDIANA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Suite 201, 6023 Guion Road, Indianapolis, IN 46254
TELEPHONE:
Commercial: (317) 927-8640 FTS: 336-8640
OFFICE CONTACT: E. James Crompton

IOWA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Room 269, Federal Building, P.O. Box 1230, 400 South Clinton Street, Iowa City, IA 52240
TELEPHONE:
Commercial: (319) 337-4191
OFFICE CONTACT: Matt Donath

NAME: Iowa Department of Natural Resources, Geological Survey Bureau
ADDRESS: 123 North Capitol Street, Iowa City, IA 52242
TELEPHONE:
Commercial: (319) 338-1173
OFFICE CONTACT: Richard L. Talcott

KANSAS

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 1950 Constant Avenue-Campus West, Lawrence, KS 66046
TELEPHONE:
Commercial: (913) 864-4321
OFFICE CONTACT: Charlene E. Merry

KENTUCKY

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 2301 Bradley Avenue, Louisville, KY 40217
TELEPHONE:
Commercial: (502) 582-5241 FTS: 352-5241
OFFICE CONTACT: Tim Liebermann

LOUISIANA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: P.O. Box 66492, 6554 Florida Boulevard, Baton Rouge, LA 70806
TELEPHONE:
Commercial: (504) 389-0281 FTS: 687-0281
OFFICE CONTACT: Max J. Forbes or Christie Stuart

MAINE

(See U.S. Geological Survey Office in Massachusetts)

MARYLAND

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 208 Carroll Building, 8600 LaSalle Road, Towson, MD 21204
TELEPHONE:
Commercial: (301) 828-1535 FTS: 922-7872, 7849
OFFICE CONTACT: Robert W. James, Jr. or Myron N. Lys

NAME: M/A Sigma Data
ADDRESS: 5515 Security Lane, Rockville, MD 20852
TELEPHONE:
Commercial: (301) 984-3636 FTS: 8-(202)-984-3636
OFFICE CONTACT: Ralph Tartaglione

NAME: General Sciences Corporation
ADDRESS: Metro-Plex, 8401 Corporate Drive,
Landover, MD 20785
TELEPHONE:
Commercial: (301) 459-9494 FTS: 8-(202)-459-9494
OFFICE CONTACT: Stuart Wollman

MASSACHUSETTS

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Suite 1309, 150 Causeway Street, Boston, MA 02114-1384
TELEPHONE:
Commercial: (617) 223-2822 FTS: 223-2822
OFFICE CONTACT: James D. Linney

NAME: Environmental Research and Technology, Inc.
ADDRESS: 696 Virginia Road, Concord, MA 01742
TELEPHONE:
Commercial: (617) 369-8910
OFFICE CONTACT: Peter Shanahan, Water Resources Operations

MICHIGAN

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Suite 5, 6520 Mercantile Way, Lansing, MI 48911
TELEPHONE:
Commercial: (517) 377-1608 FTS: 374-1608
OFFICE CONTACT: Gary C. Huffman or John B. Miller

MINNESOTA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 702 Post Office Building, St. Paul, MN 55101
TELEPHONE:
Commercial: (612) 725-7841 FTS: 725-7841
OFFICE CONTACT: James E. Jacques

MISSISSIPPI

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Suite 710, Federal Building, 100 West Capitol Street,
Jackson, MS 39269
TELEPHONE:
Commercial: (601) 965-4600 FTS: 490-4600
OFFICE CONTACT: Fred Morris, III

MISSOURI

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Mail Stop 200, 1400 Independence Road, Rolla, MO 65401
TELEPHONE:
Commercial: (314) 341-0824 FTS: 277-0824
OFFICE CONTACT: Wayne R. Berkas

MONTANA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Drawer 10076, Federal Building, 301 South Park Avenue,
Helena, MT 59626-0076
TELEPHONE:
Commercial: (406) 449-5496 FTS: 585-5496
OFFICE CONTACT: Jay H. Diamond

NEBRASKA

NAME U.S. Geological Survey, Water Resources Division
ADDRESS: Room 406, Federal Building, 100 Centennial Mall, North,
Lincoln, NE 68508
TELEPHONE:
Commercial: (402) 471-5082 FTS: 541-5082
OFFICE CONTACT: Donald E. Schild

NAME: Nebraska Natural Resources Commission
ADDRESS: P.O. Box 94876, 301 Centennial Mall South, Lincoln, NE 68509
TELEPHONE:
Commercial: (402) 471-2081
OFFICE CONTACT: Mahendra K. Bansal, Head, Natural Resources Data Bank

NAME: HDR Systems, Inc.
ADDRESS: 8404 Indian Hills Drive, Omaha, NE 68114
103 Oronoco Street, Alexandria, VA 22314
TELEPHONE:
Commercial: (402) 399-1400
(703) 683-3400
OFFICE CONTACT: Robert P. Rohrbough (Omaha)
Dr. Edward A Miller, Jr. (Alexandria)

NEVADA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Room 227, Federal Building, 705 North Plaza Street,
Carson City, NV 89701
Telephone:
Commercial: (702) 882-1388 FTS: 470-5656
OFFICE CONTACT: Kerry T. Garcia

NEW HAMPSHIRE

(See U.S. Geological Survey Office in Massachusetts)

NEW JERSEY

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Mountain View Office Park, 810 Bear Tavern Road, Suite 206,
West Trenton, NJ 08628
TELEPHONE:
Commercial: (609) 771-3900
OFFICE CONTACT: Jayne E. May

NEW MEXICO

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Room 720, Western Bank Building, 505 Marquette, N.W.,
Albuquerque, NM 87125
TELEPHONE:
Commercial: (505) 766-2246 FTS: 474-2246
OFFICE CONTACT: Linda Beal

NEW YORK

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: P.O. Box 1669, Albany, NY 12201
TELEPHONE:
Commercial: (518) 472-3107 FTS: 562-3107
OFFICE CONTACT: Lloyd A. Wagner

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 5 Aerial Way, Syosset, NY 11791
TELEPHONE:
Commercial: (516) 938-8830 FTS: 8-(516)-938-8830
OFFICE CONTACT: George W. Hawkins

NORTH CAROLINA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: P.O. Box 2857, Raleigh, NC 27602
TELEPHONE:
Commercial: (919) 755-4789 FTS: 672-4789
OFFICE CONTACT: Joseph S. Riggsbee

NORTH DAKOTA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 821 East Interstate Avenue, Bismarck, ND 58501-1199
TELEPHONE:
Commercial: (701) 255-4011, ext. 604 FTS: 783-4604
OFFICE CONTACT: Russell E. Harkness

OHIO

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 975 West Third Avenue, Columbus, OH 43212
TELEPHONE:
Commercial: (614) 469-5553 FTS: 943-5553
OFFICE CONTACT: Ann E. Arnett

OKLAHOMA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Room 621, 215 Dean A. McGee Avenue, Oklahoma City, OK 73102
TELEPHONE:
Commercial: (405) 231-4256 FTS: 736-4256
OFFICE CONTACT: Lionel D. Mize

OREGON

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Suite 300, 847 N.E. 19th Avenue, Portland, OR 97232
TELEPHONE:
Commercial: (503) 231-2024 FTS: 429-2024
OFFICE CONTACT: Suzanne J. Miller

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: c/o Oregon Water Resources Department, 3850 Portland Road, N.E., Salem, OR 97310
TELEPHONE:
Commercial: (503) 378-3671 FTS: 8-(503)-378-3671
OFFICE CONTACT: Robert L. Moffatt

PENNSYLVANIA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Fourth Floor, Federal Building, P.O. Box 1107, 228 Walnut Street, Harrisburg, PA 17108
TELEPHONE:
Commercial (717) 782-3851 FTS: 590-3851
OFFICE CONTACT: Robert E. Helm

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Great Valley Corporate Center, 111 Great Valley Parkway, Malvern, PA 19355
TELEPHONE:
Commercial: (215) 647-9008 FTS: 8-(215)-647-9008
OFFICE CONTACT: Deloris W. Speight

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Room 2204, Moorhead Federal Building, 1000 Liberty Avenue, Pittsburgh, PA 15222
TELEPHONE:
Commercial: (412) 644-2864 FTS: 722-2864
OFFICE CONTACT: John K. Felbinger

PUERTO RICO (includes Virgin Islands)

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: GPO Box 4424, San Juan, PR 00936
TELEPHONE:
Commercial: (809) 783-4660 FTS: 8-(809)-753-4414
OFFICE CONTACT: Carmen Garcia, Editorial Assistant
Hector Colon-Ramos, Project Contact

RHODE ISLAND

(See U.S. Geological Survey Office in Massachusetts)

SOUTH CAROLINA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Strom Thurmond Building, Suite 658, 1835 Assembly Street,
Columbia, SC 29201
TELEPHONE:
Commercial: (803) 765-5966 FTS: 677-5966
OFFICE CONTACT: C. Scott Bennett

NAME: South Carolina Water Resources Commission
ADDRESS: P.O. Box 4440, Columbia, SC 29240
TELEPHONE:
Commercial: (803) 737-6550
OFFICE CONTACT: Joe Harrigan

SOUTH DAKOTA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Room 317, Federal Building, 200 4th Street, S.W.,
Huron, SD 57350
TELEPHONE:
Commercial: (605) 353-7176
OFFICE CONTACT: Rick D. Benson

TENNESSEE

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: A-413 Federal Building, U.S. Courthouse, Nashville, TN 37203
TELEPHONE:
Commercial: (615) 736-5424 FTS: 852-5424
OFFICE CONTACT: Jerry F. Lowery

TEXAS

NAME: Texas Natural Resources Information System
ADDRESS: P. O. Box 13231, Austin, TX 78711-3231
TELEPHONE:
Commercial: (512) 463-8337
OFFICE CONTACT: Sam McCulloch

UTAH

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Room 1016, Administration Building, 1745 West 1700 South, Salt Lake City, UT 84104
TELEPHONE:
Commercial: (801) 524-5654 FTS: 588-5654
OFFICE CONTACT: Scott D. Bartholoma

NAME: Utah Division of Water Rights
ADDRESS: Room 231, 1636 West North Temple, Salt Lake City, UT 84116
TELEPHONE:
Commercial: (801) 533-6071
OFFICE CONTACT: James Riley

NAME: Center for Water Resources Research
ADDRESS: Utah State University, Logan, UT 84322
TELEPHONE:
Commercial: (801) 750-3157 or 3192 FTS: 8-(801)-750-3157 or 3192
OFFICE CONTACT: Christopher J. Duffy or Gene Israelsen

NAME: Public Inquiries Office, U.S. Geological Survey
ADDRESS: 8105 Federal Building, 125 South State Street, Salt Lake City, UT 84138
TELEPHONE:
Commercial: (801) 524-5652 FTS: 588-5652
OFFICE CONTACT: Wendy R. Hassibe

VERMONT

(See U.S. Geological Survey Office in Massachusetts)

VIRGINIA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: National Water Data Exchange, 421 National Center, Reston, VA 22092
TELEPHONE:
Commercial: (703) 648-5663 FTS: 959-5663
OFFICE CONTACT: Marybell F. Peters

VIRGINIA--continued

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Room 606, 3600 West Broad Street, Richmond, VA 23230
TELEPHONE:
Commercial: (804) 771-2427 FTS: 925-2427
OFFICE CONTACT: Edward H. Nuckels

NAME: Virginia Water Resources Research Center
ADDRESS: Virginia Polytechnic Institute and State University,
617 North Main Street, Blacksburg, VA 24060
TELEPHONE:
Commercial: (703) 961-5624
NAWDEX CONTACT: T. W. Johnson

NAME: Public Inquiries Office, U.S. Geological Survey
ADDRESS: Room 1C402, 503 National Center, Reston, VA 22092
TELEPHONE:
Commercial: (703) 648-6892 FTS: 959-6892
OFFICE CONTACT: Margaret E. Counce

WASHINGTON

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Suite 600, 1 Washington Plaza, 1201 Pacific Avenue,
Tacoma, WA 98402
TELEPHONE:
Commercial: (206) 593-6510 FTS: 390-6510
OFFICE CONTACT: John R. Williams

NAME: Public Inquiries Office, U.S. Geological Survey
ADDRESS: 678 U.S. Courthouse, West 920 Riverside Avenue, Spokane, WA 99201
TELEPHONE:
Commercial: (509) 456-2524 FTS: 439-2524
OFFICE CONTACT: Jean E. Flechel

WEST VIRGINIA

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 603 Morris Street, Charleston, WV 25301
TELEPHONE:
Commercial: (304) 347-5130,,5132 FTS: 930-5130, 5132
OFFICE CONTACT: Colleen K. Cooper

WISCONSIN

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: 6417 Normandy Lane, Madison, WI 53719
TELEPHONE:
Commercial: (608) 274-3535
OFFICE CONTACT: Robert B. Bodoh

WYOMING

NAME: U.S. Geological Survey, Water Resources Division
ADDRESS: Room 4007, J. C. O'Mahoney Federal Center, P.O. Box 1125, Cheyenne, WY 82003
TELEPHONE:
Commercial: (307) 772-2153 FTS: 772-2153
OFFICE CONTACT: Stanley A. Druse

NAME: Wyoming Water Research Center
ADDRESS: Wyoming University, P.O. Box 3067, University Station, Laramie, WY 82071
TELEPHONE:
Commercial: (307) 766-2143 FTS: 328-1110
OFFICE CONTACT: Barry Lawrence

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 continued at the 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 yield were made in the following watersheds:

   a. Public law 566.

Major Drainage	Watershed	Stream	County	State
St. Johns	Presque Isle Stream	Preseque Isle	Aroostock	Maine

   b. River Basin Investigations.

Major Basin	Basin Reported	State
Naragansat	Maskerchug	Rhode Island

MID ATLANTIC REGION

CORPS OF ENGINEERS

North Atlantic Division

Baltimore District

Sedimentation Surveys - Reservoirs

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 data was analyzed in January 1986.

The total amount of sediment in Almond Lake below elevation 1300 ft msl. is approximately 631 ac-ft. This represents 4.3% of the original storage at elevation 1300 ft. msl. (spillway crest). There is effectively no storage in the reservoir below elevation 1240 ft msl. Winter pool, elevation 1255 ft msl. has lost 89% of its storage to sediment and summer pool, elevation 1255 ft msl. has lost 89% of its storage to sediment and summer pool, elevation 1255 ft msl. has lost 55% of its storage to sediment.

Almond Lake has been severely impacted by accumulated sediment. Basically there is no winter pool and summer pool storage has been depleted by over 50 percent. Recreation at the project has all but been eliminated due to the sediment problem. In order to revive water based recreation, the summer pool level should be raised. A pool level of approximately 1260 ft msl. would probably provide adequate water for recreational purposes. The feasibility of raising the lake and actual level should be determined by a thorough re-evaluation of the project. A revised winter pool level should also be determined by that same study. The present 1250 ft msl. winter pool presents a major control problem because of the very small (46 ac-ft.) volume of water below elevation 1250 ft msl.

2. Bloomington Lake, MD and WV. Reconnaissance sediment surveys with spot measurements were performed at Bloomington Lake in January and December of 1986.

A sediment reconnaissance survey was undertaken during January 1986 to estimate the sediment accumulation in Bloomington Reservoir. The reconnaissance survey was initiated to follow up the November 1984 survey, which estimated that sediment was accumulating 0.75 times faster than originally anticipated in the Sedimentation Design Memorandum. During the 1984 survey, approximately 30% of the reservoir area was exposed.

During the January survey, sediment depth was measured at 21 cross sections in the lake bed. The lake was at elevation 1370, and over 50% of the reservoir area was exposed. The sediment in the unmeasured portion of the reservoir was assumed to decrease in a linear fashion from the last measured cross section to zero at the dam. The average-end-area-method was used. This results in a conservative estimate of the sediment in the reservoir.

As a result of the survey, it was estimated that approximately 900 acre-feet of sediment has deposited since the reservoir first filled. This represents a rate of approximately 240 acre-feet per year, almost 12 times faster than originally estimated in the sedimentation D.M. The sedimentation will affect the allocation of storage in Bloomington Lake, and may ultimately affect operation of the project.

Sedimentation within Bloomington Lake is occurring at a very rapid rate. This is due in part to the fact that the acid water accelerates deposition within a lake. Sediment depths in the relatively flat portions of the exposed lake bed showed only a slight additional accumulation. This is probably because there were few significant inflow events in the period between the two surveys. However, sediment accumulation near the river channel has decreased. This is due to the fact that while the lake is drawn down, higher flows in the river erode the sediment deposited along the river channel. This sediment is deposited farther downstream, with the majority ending up in the pool. Therefore, the location of sediment deposits are dependent on the operation of the reservoir. Drawdowns of the lake result in increased sedimentation in the downstream reaches of the reservoir. As a result, it appears that there is a significant quantity of sediment in the unsurveyed lower portion of the reservoir, and the actual quantity of sediment within the reservoir may be greater than previously estimated.

It is recommended that a full instrumented survey of the sedimentation cross sections within the reservoir be made.

3. Cowanesque Lake. During October 1986, Cowanesque Lake was drawn down to elevation 1035 to allow maintenance removal of approximately 120 cubic yards of sediment from the Tompkins boat launch area. While the lake was drawn down, district personnel performed a reconnaissance survey of the reservoir area. Sediment depth data on the exposed portions of the lakebed was obtained. Approximately 30% of the reservoir area was exposed at this time.

From this survey, it was estimated that approximately 300 ac-ft of sediment has accumulated within Cowanesque Reservoir since its initial filling. This represents a rate approximately 2.5 times greater than originally estimated in the sedimentation D.M. Sedimentation and erosion in the Cowanesque River upstream of the project has been identified as a problem in the past. The material in the river is washed downstream into the reservoir.

Presently, sediment in the Cowanesque Reservoir represents a maintenance problem, not an operational one. Maintenance removal of 4 feet of sediment at the Tompkins boat launch was necessary due to the fact that sediment, by its nature, will deposit in the headwaters of a lake. Sediment rapidly choked the narrow access channel leading from the Tompkins boat launch into the main river channel. Sediment accumulation at the more downstream Lawrence boat launch is not a problem. Sedimentation at Tompkins will continue as long as the existing pool is maintained.

The reformulated 1080 pool level will result in increased sedimentation due to the fact that the trap efficiency of the pool is increased, that is, a greater percentage of the inflowing sediment will remain in the pool. An increased yield of approximately 30% is expected due to the increased trap efficiency. However, the 1080 pool has a volume 4.66 times greater than the present 1045 pool, and sediment should not be a problem provided recreation areas are properly designed. Boat launches at the headwaters of a lake are subject to more rapid sedimentation and will eventually be adversely impacted. Areas subject to relatively heavy sedimentation such as the Cowanesque River, are more susceptible. Recreation areas for the reformatted 1080 pool should be located at a point in the reservoir far enough downstream so that they are not impacted by the initial deposition of sediment at the headwaters of the lake.

Sediment at Cowanesque Lake will be monitored periodically to ensure that no operational problems occur. If sedimentation continues at a significant rate, a fully instrumented sediment survey will be recommended. This type of survey will yield a more reliable estimate of the sediment in the reservoir.

Sediment Removal

Project	Stream	Removal Location	Amount Removed (cubic yards)
Almond Lake, NY	Canacadea Creek	NY Rte. 21 Bridge	3,962
Arkport Dam, NY	Canisteo River	Intake channel	5,415
		Stilling basin	580
Binghamton, NY	Pierce Creek	Upper unpaved channel	1,906
Canisteo, NY	Purdy Creek	Check dam	5,313
		Confluence with Bennet Creek	615
Corning, NY	Cutler Creek	Upper channel and drop structure	2,154
		Upper drop structure bucket	20
		Drainage ditch entering upper drop structure	454
Cowanesque Lake, PA	Cowanesque River	Tompkins boat launch	120
Hornell, NY	Chanucey Run	Check dams	519
	Crosby Creek	Check dam	3,415
Lisle, NY	Dudley Creek	Confluence with Tioughnioga River	819
Whitney Point Village, NY	Tioughnioga River	Channel	1,410
		Total Removed	26,792 c.y

New York District

The District conducted sediment tests at the following locations.

Project Name & Number	Grain Size	Bulk Sediment	Elutriate	Microbiological	Biossay	Bioaccumulation
New York Harbor (#62):						
Red Hook Flats Anchorage	X	X	X		X	X
Bay Ridge & Red Hook Channels (#34):						
Bay Ridge Channel	X	X	X		X	X
Red Hook Channel	X	X	X		X	X
Raritan River (#70):						
Main Channel	X	X	X		X	X
Raritan River to Arthur Kill Cut-off Channel (#72):	X	X	X		X	X
Long Island Intracoastal Waterway, NY (#22):	X					
Hudson River (#48):						
Haverstraw Bay	X	X	X	X		

Philadelphia District

Sediment Load Measurements. Daily sampling continued from November 1947 to September 1986 on the Schuylkill River at Manayunk, PA. Monitoring discontinued as of 1 November 1986.

Sediment Studies. Prompton Reservoir - In October 1986, analyses began to determine the sedimentation rate of the Prompton Reservoir which is being studied for possible modification to add water supply storage. Determination of the sedimentation rate is necessary in order to determine the estimated 100 year accumulation of sediment volume within the reservoir for allocation of inactive storage. Three methods will be utilized to determine the sedimentation rate at Prompton Reservoir. They are as follows:

a. Analyses of accumulated sediment from three sedimentation surveys that have been taken during the 26 year life of the existing project.

b. Analysis of accumulated sediment reported in reservoirs in the geographical location of Prompton Reservoir.

c. Measurement of sediment during high inflow periods by the U.S. Geological Survey during the upcoming year.

The results of the three methods of determining sedimentation rates will be compared and a rate adopted for use in determining long term sediment storage requirements.

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 and once during each of five storm events 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. Beginning in October 1986, suspended-sediment and bottom material data are being collected on a quarterly basis and twice annually during storm events at Basgalore Creek near Swedesboro, NJ, in cooperation with the Gloucester County Improvement Authority to monitor effects of landfill operation on surface-water quality. Bottom material samples will be analyzed for content of trace elements and organic contaminants.

4. Suspended-sediment and bottom material data are being collected in 1987 on a monthly basis, during a storm event, and during low, base-flow conditions from selected reaches of Stoney Brook, Bedens Brook, and Jacobs Creek, NJ, in cooperation with the New Jersey Department of Environmental Protection as

part of the District Intensive Assessment Program. Bottom sediment will be analyzed for content of trace elements and organic contaminants.

5. Suspended-sediment and bottom sediment data were collected in 1985 on a monthly basis, during a storm event, and during low, base-flow conditions from selected reaches of the Rockaway River, NJ, in cooperation with the New Jersey Department of Environmental Protection as part of the District Intensive Assessment Program. Bottom sediment was analyzed for content of trace elements and organic contaminants.

6. 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. (Fall-Line Monitoring program discontinued June 30, 1986). Continued bimonthly as part of NASQAN.

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 sediment 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 nutrient 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.

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
810 Bears Tavern Road
Suite 206
West Trenton, NJ 08628

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 yeilds were made in the following watersheds:

a. Public Law 566.

Major Drainage	Watershed	Stream	County	State
Susquehanna River	Cedar Run	Cedar Run	Clinton Centre	Pennsylvania
Shenandoah River	Middle River	East Dry Branch	Augusta	Virginia
Lake Champlain Richelieu	Lower Missisquoi	Lower Missisquoi	Franklin	Vermont

b. River Basin Investigations.

Major Basin	Basin Reported	State
Delaware River	Crosswick Creek	New Jersey
Vermont (Statewide)	Vermont (Statewide)	Vermont

2. Reservoir Sedimentation Surveys.

Reservoir sedimentation surveys were made in the following reservoirs:

Reservoir	County	State
Noxontown Lake	New Castle	Delaware
Greene-Dreher, PA-446	Pike Monroe	Pennsylvania
Little Schuylkill River, PA-425	Schuylkill	Pennsylvania

3. Special Studies.

a. Pennsylvania - Ephemeral gully erosion is being studied on approximately 40,000 acres in Adams County. Data is being collected by air photo interpretations and ground truthing.

b. Vermont - LaPlatte River Watershed Comprehensive Water Quality Montioring and Evaluation Project is continuing. St. Albans Bay Watershed CM&E Project (water quality) is continuing. A five year inventory of over 70 ephemeral gully erosion sites is scheduled. The fourth year inventory was completed.

c. New Jersey - A three year study of ephemenral gullies on croplard on selected sites in a five county area in Southern New Jersey is in progess. The second year of study has been completed.

d. Delaware - A three year study of ephemeral gullies at selected sites on the Coastal Plain is under way. The second year of study has been completed.

e. New York - A four year study of ephemeral gully erosion on the Saratoga Watershed has been completed.

CORPS OF ENGINEERS

South Atlantic Division

Charleston District

Coastal Shoreline Monitoring - Monitoring of coastal shoreline changes for the recently constructed jetty systems at Little River and Murrells Inlets, South Carolina, continued through 1986. The initial five-year monitoring program for Murrells Inlet, South Carolina, was completed in October 1982. The anticipated report date for the first phase of the Murrells Inlet Monitoring Program is May 1987. The reduced monitoring effort for the second five-year period was continued during 1986 for Murrells Inlet. The initial five-year monitoring effort being implemented for the remainder of the year. 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
e. structural performance

The data, which is gathered on a regular basis, is forwarded to the Coastal Engineering Research Center at US 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 has been made on the basis of historical data extracted from USC&GS surveys and charts. Due to the age of the jetties and various manmade alterations affecting Charleston Harbor, the following time frames have been 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 US 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. The Coastal Engineering Research Center has completed their analysis. The final project report is scheduled for completion in September 1987.

Cooper River Rediversion Project - The post-construction monitoring of the entrance, intake and tailrace canals was begun following completion of the Cooper River Rediversion Project in 1985. The monitoring consists of 114 cross sections across the canals plus seven cross sections across the Santee River and a photographic history of bank erosion. The monitoring is to be done 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 second annual survey was taken in December 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 are being 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 second set of cross sections are scheduled to be taken in January 1987.

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 - The sedimentation range networks in Demopolis, Gainesville, Aliceville, Columbus and Aberdeen Lakes were resurveyed during the year. In addition, the Bay Springs Lake Sedimentation Range Network, installed by the Nashville District, has been resurveyed. These lakes are located on the Tennessee-Tombigbee Waterway.

Sedimentation Studies

1. The sedimentation studies of the Alabama, Apalachicola and Tombigbee Rivers and the Tennessee-Tombigbee Waterway will continue through 1987.

2. Suspended sediment sampling stations added during 1986 are as follows:

Chickasaw Bogue Creek at Linden, AL
Noxubee River Near Geiger, AL
Tombigbee River at Jackson, AL
Buttahatchee River near Aberdeen, MS
Tombigbee River at Bigbee, MS
Luxapallila Creek at Columbus, MS
Chipola River at Cochrane Landing, FL

3. Sampling was discontinued on Chuquatonchee and Weaver Creeks in Northeast Mississippi and Okatibbee Creek in East-Central Mississippi.

Suspended Sediment Investigations

1. Suspended sediment samples were periodically collected under a cooperative agreement by the respective U.S. Geological Survey districts at the following locations:

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, Amory and Fulton, Mississippi. Additionally, samples were periodically obtained from the Tombigbee River at four bendway cutoff locations. Also, suspended sediment and bed samples for various studies were obtained from streams located throughout the district.

Savannah District

1. Budgetary constraints on both navigation and reservoir projects have resulted in severe restrictions on sedimentation measurements. Before and after dredging surveys for navigation projects were taken throughout the year. Surveys of Tybee Beach began October 1984 and monitoring of erosion and accretion are continuing.

2. Grab samples of bottom sediment were taken in Jekyll Creek. Approximately ten samples were taken. These data are being used in a model study for reduction of shoaling in the creek.

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 was accomplished between April and July 1986 with 870,000 cubic yards being pumped northward to Wrightsville Beach and 1,128,000 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 inlet and beach profiles.

d. Survey Scope. Hydrographic 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 with approximately 765,000 cubic yards of material being pumped southward to the north end of Carolina Beach. A survey of the deposition basin made in the spring of 1986 indicated that over 220,000 cubic yards of sand had accumulated in the trap.

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 Measured. 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).

Cape Fear Subregion

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

2. Suspended-sediment data are collected bimonthly at 15 small headwater sites of the Haw River in cooperation with the city of Greensboro. The data will be used to define the effects of runoff from the city on primary receiving waters.

3. 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, Rocky River near Norwood, 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 bimonthly 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 Black-water 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.

3. Suspended-sediment data are collected monthly and more frequently during high flows at 10 forested basins across North Carolina. Sizes of basins range from 0.6 to 7.5 square miles. Conducted in cooperation with the North Carolina Department of Natural Resources and Community Development, the data will help define background levels of sediment in the State's streams.

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 677A
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 determination of sediment yields were made for the following activities:

   a. Public Law 566

Major Drainage	Watershed	Stream	County	State
Choctawhatchee-Escambia	Camp Branch		Dale & Houston	Alabama
Mobile-Tombigee	Dry Creek		Marengo	Alabama
Middle Tennessee-Elk	Big Nance Creek		Lawrence	Alabama
Mobile-Tombigee	Powell Creek		Marengo	Alabama
Apalachicola	Shoal Creek (continuation)	Shoal Creek	Marion	Georgia
	North Lanier	Chestatee	White Hall Lumpkin	Georgia
	Turkey Creek	Turkey Creek	Dooly Houston	Georgia
Savannah	Cason Branch Duhart Creek	Cason Branch Duhart Creek	Jefferson	Georgia
Altamaha	Horse Creek	Horse Creek	Telfair	Georgia
Ogeechee	Upper Fifteen Mile	Upper Fifteen Mile	Emanuel	Georgia
Cape Fear	Maxwell Creek	Maxwell Creek	Duplin	North Carolina
Cape Fear	Goshen Swamp Creek	Goshen Swamp Creek	Duplin Sampson Wayne	North Carolina
Santee-Cooper	Little Yadkin River	Littel Yadkin River	Stokes Surry Forsyth	North Carolina
Santee-Cooper	Richardson Creek	Richardson Creek	Union Anson	North Carolina
Santee	Little River (Supplement No. 1)	Little River	Laurens	South Carolina

Major Drainage	Watershed	Stream	County	State
Pee Dee	Salem Community (Eastern Portion)	High Hill Creek	Florence	South Carolina

b. River Basin Investigations

Major Basin	Study Area	State
Santee-Cooper	Broad-Catawba	North Carolina

2. Reservoir sedimentation surveys were made in the following reservoirs:

Reservoir	County	State
Hazel Creek #7	Habersham	Georgia
North Fork Broad River #2	Stephens	Georgia

3. Special Studies

a. The Site Specific Cropland Erosion Inventory, a statewide inventory of cropland erosion in which was completed in 1984, was updated in 1986.

b. Estimates of offsite sediment damages resulting from cropland erosion and estimates of sediment reduction with conservation treatment were made for the following Public Law 566 land treatment watersheds:

Major Drainage	Watershed	Stream	County	State
Edisto	West Orangeburg	South Fork Edisto River	Orangeburg Aiken	South Carolina
Pee Dee	Thompson-Westfield Creek	Thompson Creek Westfield Ck.	Chesterfield Anson Union	South Carolina North Carolina
Santee	Little Saluda River	Little Saluda River	Edgefield Saluda	South Carolina
Edisto	North Fork Edisto River	North Fork Edisto River	Calhoun Lexington Orangeburg	South Carolina

CORPS OF ENGINEERS

North Central Division

Buffalo District

Genesee River Basin Study - As part of the Genesee River Basin Study Reconnaissance Report, dated August 1986, streambank erosion was analyzed to determine the extent of the problem within the basin. Loss of land was estimated by reach, based on length of eroding banks and rates of erosion, as determined from field surveys and map and photo analysis. It was estimated that approximately 56 acres/yr are lost to bank erosion over the entire length of the river.

Section 14 (streambank and Shoreline Protection for Public Facilities) Sugar River at Constantableville, New York, Initial Appraisal - A field reconnaissance of the Sugar River at Constableville, New York was performed at two sites to evaluate the severity of streambank erosion that threatened a sewage treatment plant and a county road. Measurements of the existing bank were obtained in the field. Based upon limited available information, the rate of channel bank recession was calculated and an economic cost/benefit analysis was performed.

Environmental Analyses of Harbor Sediments for O&M Program

1. Sediment Testing - Sediment samples were obtained from the following project locations within the District. Sediment sampling consisting of bulk chemical, elutriate and bioassay testing was completed at Dunkirk, Fairport and Erie Harbors. Additional testing consisted of Solids, Metals and Organic testing at Ashtabula and Bulk Chemical and EP Toxicity Tests at Fort Drum.

Project	No. of Station	Type of Test
Dunkirk Harbor, NY (Navigation Channels)	13	Bulk Chemical, Elutriate, Biossay
Fairport Harbor, OH (Navigation Channels)		Bulk Chemical, Elutriate, Biossay
Erie Harbor, PA (Navigation Channels)	16	Bulk Chemical, Elutriate, Biossay
Ashtabula Harbor, OH (Sed. Filter Press)		Solids, Metals, Organics
Fort Drum, NY (Pond sediments)	2	Bulk Chemical, EP Toxicity Tests

2. Sediment and Water Quality Testings. The purpose of the testing is to evaluate the sediments for suitability for a particular type of disposal following maintenance dredging of the Federal Navigation channels. In addition, specific water quality and sediment testing projects are summarized in the following.

Project	No. of Station	Type of Test
Toledo Harbor:	25	
(Open-lake disposal monitoring)		Water Quality
(Outfall monitoring)		Water Quality
(Proposed Open-lake)		Bulk Chemical
(Disposal Site)	5	Benthic Survey
Times Beach CDF	9	
Buffalo, NY		
(Groundwater Monitoring)		Water Quality
(Food Chain Studies)		Containment Uptake by insects, birds, waterfowl
Cleveland Harbor, OH		Water Quality
(Proposed CDF Site)		Bulk Chemical
(Cuyahoga River)	48	Bulk Chemical
(Cleveland Harbor)		Elutriate, Bioassay
Rochester Harbor, NY	4	Water Quality of Dredge overflow and Open-lake disposal
(Navigation Channels)		
West Harbor, OH	8	Bulk Chemical
(Proposed Open-lake disposal sites)		Benthic Survey

Since much activity has been focused on investigations at Toledo, Times Beach CDF, Cleveland, Rochester and West Harbor, discussion of the projects is presented in more detail.

a. Toledo, OH. Open-lake disposal of 800,000 yd^3 of dredge material from the Toledo navigation channels occurred this year. There has been much opposition to open lake disposal by local government and Ohio EPA. One reason is alleged high inputs of phosphorus with associated algal blooms. The Toledo Water Dept. maintains the disposal operation is affecting water quality during disposal operations. The data has not been fully analyzed to date, but preliminary analysis does not indicate water quality violations directly attributable to disposal (i.e., storm resuspension and tributary runoff are major reasons for observed WQ violations). Ohio EPA and Locals asked EPA Region V to Reclassify all sediments as polluted and requiring confined disposal. EPA maintained classification of lake channel sediments as non to moderately polluted and suitable for open-lake disposal. A great deal of

difficulty is anticipated in obtaining 401 Certification for the current disposal site or a newer proposed open-lake site three miles further to the Northeast. Chemical, Benthic, and Bioassay tests have been conducted at this site.

b. Times Beach CDF, Buffalo, NY. During 1986, efforts at the Times Beach CDF were concentrated on obtaining speciments of songbird, waterfowl, muskrats, and other terrestrial animals which reproduce or spend much of their life cycle at the site. These samples will be analyzed for organic and heavy metal toxicants found in lower food chain organisms (i.e., earthworms, insects, plants) to determine the extent of biomagnification through food chains. Groundwater monitoring at nine well locations within the Times Beach CDF continues to ascertain any groundwater contamination from leaching of disposed sediments.

c. Cleveland, OH. A large amount of sediment, benthic and water quality sampling and analyses was conducted at proposed lake-side sites for a new Cleveland CDF. The water quality section provided major analysis for and prepared the Letter Report for the new Cleveland CDF.

d. Rochester, NY. As part of the 401 Certification for dredge disposal at Rochester, the Buffalo district agreed to conduct water quality testing from overflow dredging and open-lake disposal at Rochester. These tests showed no significant increase in hopper solids associated with overflow and resuspension of coliform bacteria in the project lower turning basin. There was no measurable influence of open-lake disposal on open-lake water quality (i.e., L. Ontario). A decision was made to suspend overflow dredging at Rochester at the present time because of coliform resuspension.

e. West Harbor, OH. Sediment bulk chemical, bioassay, and benthic survey testing was completed at two proposed open-lake disposal sites for west Harbor. This data will be used for 404 evaluation of alternative disposal sites.

Chicago District

Waukegan Harbor, Illinois. A sediment sampling program was conducted in Waukegan Outer Harbor during April 1986 in relation to proposed dredging of the Outer Harbor. Six cores were taken in the approach channel and south of the North Breakwater. Analyses included particle sizing, total PCBs and aroclor 1254, and elutriate tests for suspended solids, total solids, total volatile solids, lead, and zinc. The background water was also analyzed for Nitrogen Ammonia. The data is available in the district files.

Michigan City, Indiana. A report was completed in April 1986 presenting the results of analyses on Michigan City Harbor and Trail Creek sediments sampled during December 1985. The report is available from the district files.

Detroit District

Sediment Sampling Activities

1. Environmental Analysis. Sediment samples were obtained at the following locations for environmental analysis. Bulk chemical, elutriate and benthos testing were completed at Kenosha and Green Bay harbors in support of Operations and Maintenance (O&M) confined disposal facility (CDF) projects. Bulk chemical, elutriate and benthos testing were completed at Kewaunee, Holland, New Buffalo, Bolles, Duluth-Superior and Alpena harbors in support of O&M predredging operations. Bulk chemical, elutriate and benthos testing were completed at Hammond Bay, Algoma, Les Cheneaux, Eagle, Menominee and Bay Port harbors and Lake St. Clair as part of a routine, periodic sediment testing program.

Elutriate testing included tests for nutrients, metals and chlorinated organics. The sampling and analysis were conducted to determine the present level of sediment contamination and to evaluate the most appropriate method of disposal of dredged material.

Dioxin and dibenzofuran analyses were conducted on sediments collected in the Saginaw River in support of predredging operations and in the Duluth-Superior harbor in support of predredging and beach nourishment operations.

2. Section 111 (Mitigation of Shore Damage Due to Federal Navigation Projects) Monitoring. Sediment sampling was conducted at St. Joseph, Holland, Grand Haven and Lexington harbors as part of a formal monitoring program of Section 111 beach nourishment projects.

The sediment sampling was conducted 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.

Sedimentation Surveys

1. Section 111 Monitoring. Hydrographic surveys were conducted at the following harbors in 1986.

Harbor	Number of Surveys	Number of Survey Lines
St. Joseph, MI	2	27
Holland, MI	2	10
Grand Haven, MI	2	13
Lexington, MI	1	10 plus inner harbor

The surveys were accomplished as 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 each harbor to 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 within the harbor structures at Lexington was made in 1986 to record bottom elevations as part of a study to determine the extent of shaling within the harbor structures.

2. Operations and Maintenance Surveys. Hydrographic surveys were completed at 80 Great Lakes harbors, channels and rivers. Condition surveys were made at 60 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 made at 20 locations in support of O&M maintenance dredging operations. "Prior" surveys were conducted to determine the shoaling conditions before scheduled dredging. "After" surveys confirm that the required dredging depth was achieved.

Special Studies. Fort Wayne, Indiana Flood Control. The United States Geological Survey, under contract with the Detroit District, completed a sedimentation study of the three tributary rivers within metropolitan Fort Wayne, the St. Marys, Maumee and St. Joseph. The study included sampling of both bed load and suspended sediments at various stages of river flows.

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.

4. Suspended-sediment data are being collected on a periodic and storm-event basis at the Fox River at Appleton, WI, and intermittently at the Fox River outlets from Lake Winnebago at Neenah, WI, and at Menasha, WI. These data are being collected in cooperation with the Wisconsin Department of Natural Resources.

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.

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.

2. Suspended-sediment data (quantity and quality) are being collected in the Irondequoit basin, Monroe County, NY, to determine the effects of the instream impoundment on streamflow and water quality in a small residential headwater basin.

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
5957 Lakeside Boulevard
Indianapolis, IN 46254

SOIL CONSERVATION SERVICE

1. Special Studies

a. Sediment analyses were made for 65 counties in the state of Ohio for Impact of Erosion and Conservation Study in Ohio.

b. A study of sediment, nutrients, and pesticides is being conducted for the Defiance County Soil and Water Conservation District within the Lost Creek Watershed, a tributary of the Tiffin River.

CORPS OF ENGINEERS

OHIO RIVER DIVISION

Report on Sedimentation Activities in the Ohio River Division is as follows:

Huntington District

Sedimentation Surveys.

1. Sutton Lake, Elk River, West Virginia. A report on the 1984 sedimentation reconnaissance survey was completed in 1986. Fathometer profiles were obtained for 18 sediment ranges in the seasonal pool. Results of the survey indicated that sedimentation in the seasonal pool area was not excessive.

2. East Lynn Lake, Twelvepole Creek, West Virginia. A report on the 1985 sedimentation reconnaissance survey was completed in 1986. Fathometer profiles were obtained along 14 sediment ranges within the seasonal pool. Results of the survey indicated that sedimentation in the seasonal pool area was not excessive.

3. Summersville Lake, Gauley River, West Virginia. A report on the 198- sedimentation reconnaissance survey was completed in 1986. Lake bottom profiles along 15 sediment ranges within the seasonal pool were obtained. Results of the survey indicated that sedimentation in the seasonal pool area was not excessive.

4. Burnsville Lake, Little Kanawha River, West Virginia. A report on the 1985 sedimentation resurvey of 28 sediment ranges in the seasonal pool area and four sediment ranges downstream of the dam were completed in 1986. The annual rate of sedimentation in the seasonal pool area at Burnsville Lake, from 1979 to 1985 was computed as 0.07 acre-feet per square mile of contributing drainage area.

5. Fishtrap Lake, Levisa Fork, Kentucky. A report on the 1984 sedimentation resurvey of 22 sediment ranges in the seasonal pool area and four sediment ranges downstream of the dam was completed in 1986. The resurvey indicated that the annual rate of sedimentation for the 5.80 year period between the August 1978 and the June 1984 resurveys was 0.60 acre-feet per square mile of contributing area.

6. Leesville Lake, McGuire Creek, Ohio. A reconnaissance survey of 11 sedimentation ranges was completed in 1986. A report on the results of the survey will be completed in 1987.

7. Wills Creek Lake, Wills Creek, Ohio. A reconnaissance survey of seven sedimentation ranges was completed in 1986. A report on the results of the survey will be completed in 1987.

8. Atwood Lake, Indian Fork of Conotton Creek, Ohio. A reconnaissance survey of 11 sedimentation ranges was completed in 1986. A report on the results of the survey will be completed in 1987.

9. Deer Creek Lake, Deer Creek, Ohio. A reconnaissance survey of 10 sedimentation ranges at Deer Creek Lake was completed in 1986. A report on the results of the survey will be completed in 1987.

10. Paint Creek Lake, Paint Creek, Ohio. A resurvey of 18 sedimentation ranges at Paint Creek Lake was completed in 1986. A report on the resurvey will be completed in 1987.

Sediment Load Measurements

1. Fishtrap Lake, Levisa Fork, Kentucky. Suspended sediment data were collected by the Huntington District at the Levisa Fork at Big Rock, Virginia, gaging station and at gaging stations on five tributary streams in the Fishtrap Lake Drainage Basin during 1986.

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 two tributary streams in the Dewey Lake Drainage Basin during 1986.

3. R.D. Bailey Lake, Guyandot River, West Virginia. Collection of suspended sediment data by the Huntington District at the Clear Fork and the Baileysville monitoring stations was discontinued in 1986.

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 1986.

5. Levisa Fork, Big Sandy River Basin, Grundy, West Virginia. The West Virginia U.S. Geological Survey collected suspended sediment data under a contract with the Huntington District during FY 86. The purpose of the data collection program is to establish a sediment data base for use in estimating future channel maintenance requirements. Collection of data was discontinued after FY 86.

Louisville District

Sedimentation Surveys.

1. Carr Fork Lake, Carr Fork of North Fork Kentucky River, Kentucky. A report on the 1984 sedimentation survey was completed in 1986. Thirty-three ranges were surveyed within the seasonal pool area. Results of the survey indicated that the annual rate of sedimentation within the seasonal pool from 1976 to 1984 was 1.77 acre-feet per square mile of contributing drainage area. This rate of sedimentation is considered high and further investigations will be made to determine the causes of the high rate of deposition.

2. Cave Run Lake, Licking River, Kentucky. A sedimentation survey of Cave Run Lake was completed in 1986. A report on the results of the 1986 survey will be submitted in 1987.

3. Nolin Lake, Green River Basin, Kentucky. A sedimentation survey of Nolin Lake was completed in 1986. A report on the results of the survey will be completed in 1987.

4. Huntington Lake, Wabash River Basin, Indiana. A sedimentation survey of Huntington Lake was completed in 1986. A report on the results of the survey will be completed in 1987.

5. Monroe Lake, Wabash River Basin, Indiana. A sedimentation survey of Monroe Lake was completed in 1986. A report on the results of the survey will be completed in 1987.

Nashville District

Sedimentation Surveys

1. J. Percy Priest Lake, Stones River, Tennessee. A resurvey of sedimentation ranges at J. Percy Priest Lake was completed in July 1986. A report on the results of the survey will be submitted in 1987. Preliminary results indicate an annual sediment deposition rate of 0.4 acre-feet per square mile of contributing drainage area for the period between July 1978 and July 1986. This annual rate of sedimentation is greater than the annual rate of 0.14 acre-feet per square mile determined for the period 1968-1978 but is not excessive or detrimental to the operation of the project.

2. Martins Fork Lake, Martins Fork, Kentucky. A resurvey of the Martins Fork sediment range network was completed during April 1986. Preliminary results of the survey indicated that the rate of sedimentation continues to be high. A report on the results of the survey will be completed in early 1987.

3. Lake Cumberland, Cumberland River, Kentucky. A resurvey of the Wolf Creek sediment range network was conducted in October 1986. A report on the results of the resurvey will be submitted in 1987.

Sediment Load Measurements

1. Yellow Creek Basin, Middlesboro, Kentucky. In June 1986, the U.S. Geological Survey began collection of sediment samples at mile 0.6 of Stoney Fork, a tributary to Yellow Creek at Middlesboro, Kentucky. The work is being accomplished by contract with the Corps. Sampling frequency is at least every two weeks during normal flows and two to three times during high flow periods. Samples are analyzed for concentrations and if sand is present, a sand separation is performed. Sampling with a continuous sediment monitor on Bennetts Fork at Middlesboro began in 1985 and continued through 1986. The sediment sampling program is part of investigations for structural solutions to flood problems at Middlesboro under the Section 202 (Public Law 96-367) program.

2. Upper Cumberland River Basin, Kentucky. The U.S. Geological Survey continued to collect sediment grab samples at Harlan, Pineville, and Barbourville, Kentucky under a contract with the Corps. Samples are collected weekly during normal flows and at least two samples are taken during flood events. The sampling program is in support of investigations for structural flood control alternatives under the Section 202 (Public Law 96-367) program.

3. Sweetwater Creek, Florence, Alabama. Collection of suspended sediment data at two locations on Sweetwater Creek in Florence, Alabama was discontinued in April 1986. Sampling began in July 1985 and consisted of one sample each week during normal flows and three samples during storm events. The data is being used to define sediment inflows from Sweetwater Creek and for design of sediment control alternatives for the proposed Florence, Alabama Port.

4. Martins Fork Lake, Martins Fork, Kentucky. Collection of suspended sediment by the U.S. Geological for the Corps at Martins Fork Lake began in 1985 and continued in 1986. Samples are taken at a location three miles upstream of dam, above the seasonal pool level. Daily samples are collected during normal flows and additional samples are collected during periods of high flow. The data will be used by WES and the Nashville District as input for an HEC-6 sediment transport study of the reservoir.

Pittsburgh District

Sedimentation Surveys

1. Allegheny Lake, Allegheny River, Pennsylvania and New York. A selected range, sedimentation survey was conducted at Allegheny Lake in 1986. A report on the results of the survey will be completed in 1987. Preliminary results indicate that the rate of sedimentation in the reservoir is not excessive.

2. M.J. Kirwan Dam and Lake, Mahoning River Basin, Ohio. A selected range sedimentation survey at M.J. Kirwan Lake was completed in 1986. A report on the results of the survey will be completed in 1987. Preliminary results indicate that the rate of sedimentation in the reservoir is not excessive.

3. Shenango River Lake, Shenango River, Pennsylvania and Ohio. A selected range sedimentation survey at Shenango River Lake was completed in 1986. A report on the results of the survey will be completed in 1987. Preliminary results indicate that the rate of sedimentation in the reservoir is not excessive.

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 (discontinued September 1986), and at Elk River at Blue Creek, WV (discontinued September 1986). 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 (discontinued September 1986), 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, Black Fork at Webster Springs, WV, Elk River near 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.

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 are being collected on a bimonthly basis at Big Sandy River at Louisa, KY, as part of NASQAN.

3. Suspended-sediment data were collected on a daily basis, and more frequently during storm events, at Levisa Fork near Grundy, VA, in cooperation with the U.S. Army Corps of Engineers (COE), Huntington District (discontinued September 1986).

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 (discontinued September 1986).

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 (discontinued September 1986).

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, and on a bimonthly basis as part of NASQAN.

Wabash Subregion

1. Suspended-sediment data were collected quarterly at White River at Hazelton, IN, Wabash River at New Harmony, IN, and Whitewater River at Bookville, IN, as part of NASQAN.

2. Suspended-sediment data are being collected on a bimonthly basis at Little Wabash River at Main Street at Carmi, IL, and Embarras River at Sainte Marie, IL, as a part of NASQAN.

Cumberland Subregion

1. Suspended-sediment data are being collected on a bimonthly basis at South Fork Cumberland River near Stearns, KY, Cumberland River at Carthage, TN, and at Cumberland River near Grand Rivers, KY (discontinued September 1986), 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
Bennett Fork at Middlesboro, KY
Stony Fork at Middlesboro, 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 (discontinued September 1986), 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 (discontinued September 1986), Clear Fork near Robbins, TN (discontinued September 1986), South Fork Cumberland River at Leatherwood Ford, TN (discontinued September 1986), 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.

7. Suspended sediment, bed material, and bedload were sampled from three rivers at Fort Wayne, IN. Particle size distribution was determined for the samples. Six storms and three moderate to low flow periods were sampled. Bedload quantity was related to amount of sand and gravel deposits along each river. Particle size of the bedload decreased with increasing drainage area of the rivers. Suspended sediments varied greatly in concentration and were about 80 percent clay, 20 percent silt, and less than 1 percent sand. The data collection was done in cooperation with the U.S. Army Corps of Engineers.

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

District Chief, WRD
U.S. Geological Survey
Busey 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
5957 Lakeside Boulevard
Indianapolis, IN 46278

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 sediment damages and determinations of sediment yeilds were made in the following watersheds:

a. Public Law 566.

Major Drainage	Watershed	Stream	County	State
Levisa Fork River	Watkins Branch	Watkins Branch	Buchanan	Virginia
Levisa Fork River	Little Prater Creek	Little Prater Creek	Buchanan	Virginia
Kanawha River Basin	Indian Creek	Indian Creek	Monroe	West Virginia
Monogahela River	Teter Creek	Teter Creek	Barbour	West Virginia
Youghiogheny	Laurel Hill Creek	Laurel Hill Creek	Somerset	Pennsylvania
Wabash River	Mariah Creek	Mariah Creek	Sullivan Knox	Indiana
Green River	Little and Middle Pitman Creek	Pitman Creek	Green Taylor	Kentucky
Ohio River	Highland Creek	Highland Creek	Henderson Webster Union	Kentucky

2. Reservoir Sedimentation Surveys.

Reservoir sedimentation surveys were made in the following reservoirs:

Reservoir	County	State
Two private lakes	Wythe	Virginia
Mammoth Park Lake	Westmoreland	Pennsylvania
Sylvan Lake	Clark	Ohio
Wolf Run	Noble	Ohio
Cowbeel	Madison	Kentucky

3. Special Studies

a. Sediment analyses were made for 65 counties in the state of Ohio for Impact of Erosion and Conservation Study in Ohio.

b. General paper presented at Fourth Federal Interagency Sedimentation Conference, "Sediment Routing--An Electronic Spreadsheet Template."

c. "Use of Geomorphic Assessment to Predict Channel Stability" for Twin Rush Creek, Indiana, by Jerry Bernard and Elias Bloom, 1986, presented at the 1986 Summer Meeting of ASAE at San Luis Obispo, CA.

d. Erosion rates and watershed sediment yield to Brush Creek Reseroir (Data sheet 19-48) were determined for Vernon Fork of the Muscatatuck River, Jennings and Ripley Counties, Indiana.

e. A study was conducted: (1) to map major land cover categories and (2) to determine potential erosion in Christian, Logan, Simpson, Todd, and Warren Counties, Kentucky. Landsat Thematic Mapper data with 30 meter resolution was used to disctiminate land cover, a significant variable in the Universal Soil Loss Equation (USLE). Other pertinent information required for the USLE was obtained from various sources. All variables were processed through a software package, the Earth Resources Laboratory Applications Software (ELAS) (Graham, et al., 1980). Results were produced for use in management programs.

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 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 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 quarterly basis at Tennessee River at Pickwick Landing Dam, TN, and at Tennessee River at Highway 60 near Paducah, KY (discontinued September 1986), as a part of NASQAN.

2. Suspended-sediment data are being collected on a quarterly 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
Suite 710, Federal Building
100 West Capitol Street
Jackson, MS 39269

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
A-413 Federal Building
U.S. Courthouse
Nashville, TN 37203

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

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
Clinch River	Town Hill Creek	Town Hill Creek	Tazewell	Virginia
Clinch River	Lick Creek	Lick Creek	Russell & Dickenson	Virginia

TENNESSEE VALLEY AUTHORITY

Notes on Sedimentation Activities for Calendar Year 1986

Tennessee River Basin

SEDIMENT QUANTITY

Tellico Reservoir Sediment Range Survey--Forty-nine cross sections were sounded on Tellico Reservoir located on the Little Tennessee and Tellico Rivers. This was the second sedimentation survey conducted on the reservoir since dam closure in 1979. The original survey conducted in 1980 included 48 sediment ranges. For the recent survey, an additional range was established on Toqua Creek. Storage capacity and sediment volume calculations will be completed by early 1988.

Ocoee Reservoir (No. 1 and No. 3) Sediment Range Survey--Sediment range cross sections were sounded on Ocoee No. 1 and Ocoee No. 3 Reservoirs both located on the Ocoee River. Thirty-seven cross sections were sounded for Ocoee No.±1 and twenty-nine were sounded for Ocoee No.±3. Previous sedimentaiton surveys have been conducted in 1949, 1954, 1959, 1968, 1972, 1976, and 1982. Storage capacity and sediment volume calculations will be completed by early 1988.

SEDIMENT QUALITY

Sediment Oxygen Demand--Sediment oxygen demand (SOD) measurements were obtained at two locations on Tellico Reservoir. Measurements were made by both in situ and laboratory analytical techniques.

PCB Analyses of Sediment--Sediment cores were collected at six locations in Fort Loudoun Reservoir, eight locations in Tellico Reservoir, and three locations in Chilhowee Reservoir for the analyses of PCB content. PCB results were below analytical detection limits in all cases except for cores collected in the Third Creek and Goose Creek embayments of Fort Loudoun Reservoir.

7/1/87
FOE 0434V

UPPER MISSISSIPPI REGION

CORPS OF ENGINEERS

North Central Division

Chicago District

Chicago River, North Branch. Sediment sampling programs were conducted in the North Branch Chicago River during April and November 1986 in relation to proposed maintenance dredging. Five grab samples were taken from various bridges in April and analyzed for %solids, %volatile solids and total organic carbon. Four core composites and two area composites were taken in November with an Acker skid drill rig on a small pontoon barge. Bulk sediment and pore water analysis was preformed at the Corps Waterways Experiment Station in Vicksburg, Mississippi for twelve metals, Ammonia-N, total phosphorous, oil and grease, cyanide, PCBs (total and limited cogener), total solids, total volatile solids and total organic carbon. Data is available in the District files.

Rock Island District

Suspended Sediment Sampling. Suspended load sampling is being conducted at 26 stations, 3 located on the Mississippi River and 23 on its tributaries, including 3 on the Illinois River and its tributaries. Seventeen 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 3 stations located on tributaries of the Mississippi River. Samples are collected four times during 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 was completed in July of 1985. Additionally, a report detailing the results of a survey of Coralville Lake completed during 1984, will be published in final draft in February 1987. Work is presently underway to compile results of a 1984 survey of Saylorville Lake with a published report to be available in March 1987.

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 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 weekly basis 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.

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 were collected on a periodic and storm-event basis until June 30, 1986, 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-evert 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- and bedload-sediment data are being collected on a storm-evert basis at an inlet to a detention pond that discharges to Lake Wingra in Madison, WI. Suspended-sediment data are being collected on a storm-event basis at the two outlets from the detention pond. These data are being collected in cooperation with the Wisconsin Department of Natural Resources.

5. 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.

Upper Mississippi-Salt-Subregion

1. Suspended-sediment data are being collected on a daily basis and partical-size data collected on a intermittent basis in cooperation with the COE at the following stations:

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

2. Suspended-sediment data are being collected on a daily basis at Mississippi River below Alton, IL, in cooperation with the COE, St. Louis District, and on a bimonthly basis at Alton, IL, as part of NASQAN.

3. Suspended-sediment data are being collected eight times a year at Cuiver River near Troy, MO, as part of NASQAN and in cooperation with the Missouri Department of Natural Resources.

Upper Illinois Subregion

1. Suspended-sediment data were collected every other day, and more frequently during high flows at North Branch Chicago River at Niles, IL, in cooperation with the COE, Chicago District (discontinued September 1986).

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 were collected three times a week, and more frequently during high flows, from the Illinois River at Henry, IL (discontinued September 1986), in cooperation with the COE, Rock Island District. Suspended-sediment data were being collected every other day, and more frequently during high flows, at Mackinaw River below Congerville and Sangamon River near Oakford, IL (both discontinued September 1986), 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, IL, and Spoon River at Seville, IL, and on a quarterly basis at Illinois River at Valley City, IL (discontinued September 1986) 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 (discontinued September 1986), 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 Mississsippi River at Thebes, IL, in cooperation with the COE, St. Louis District. Suspended-sediment data also are being collected on a monthly basis in cooperation with the Missouri Department of Natural Resources.

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

5. Suspended-sediment data are being collected on a bimonthly basis at Meramac River near Eureka, MO, 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.

2. Suspended-sediment data were 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 (discontinued December 1986). The sediment data collected were used to monitor changes in sediment transport

during the reclamation of a strip-mined area by irrigating with digested sludge from sewage treatment facilities.

Laboratory Activities

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

Bay Creek at Nebo, IL
Turkey River at Garbor, IL
Crow Creek at Beltendort, IA
Green River at Geneseo, 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 Keosauqua, 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
Busey County Bank Plaza
102 East Main Street, 4th floor
Urbana, IL 61801

District Chief, WRD
U.S. Geological Survey
5957 Lakeside Boulevard
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/or determinations of sediment yields were made in the following watersheds:

a. Public Law 566

Major Drainage	Watershed	Stream	County	State
S. Zumbro River	Bear Creek	Bear Creek	Olmsted	Minnesota
Little Sioux River	West Wolf	West Wolf	Woodbury	Iowa
Mississippi	Herderson Creek	Herderson Creek	Mercer	Illinois
Sangamon River	Lake Decatur	Sangamon River	Macon	Illinois

b. River Basin Investigations

Major Basin	Basin Reported	State
Upper Minnesota River	Yellow Medicine	Minnesota
Upper Minnesota River	Redwood River	Minnesota
Northeast Iowa River	Northeast Iowa River Basin	Iowa
Skunk River	Skunk River Basin	Iowa
Upper Mississippi	Lower Kaskaskia River	Illinois

2. Reservoir Sedimentation Surveys

A. Reservoir sedimentation surveys were completed on the following:

Reservoir	County	State
Hambaugh Martin #1	Brown	Illinois
Lake Kinkaid (upper reach)	Jackson	Illinois
Lake Jacksonville	Morgan	Illinois

3. Special Studies

a. "Seasonal Sediment Yield to Mark Twain Lake, Missouri," a by product of the Upper Salt River Basin study, by V.L. Finney was Published in the Bulletin of the Association of Engineering Geologists, Vol. XXIII, No. 3, 1986.

b. A computer program for producing erosion maps was made by the Olmsted County Health Department, Minnesota.

c. A computer generated eroision map was produced for the South Zumbro Watershed, Structure Site BR-1, on Bear River, Olmsted County, Minnesota, by the Olmsted County Health Department.

d. A streambank and gully erosion study was made for the following watersheds in Illinois: Little Kinkaid River, Jackson County, Lake Peoria; Peoria, Woodford, and Tazewell Counties.

e. A lake shore erosion and sedimentation study was made for Lake Jacksonville in Morgan County, Illinois.

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 River Basin and the station previously established near Colt, AR in the L'Anguille River Basin. Suspended sediment samplers DH76TM, DH78, D74ALTM and bed sampler BMH60 was used. Records of discharge, observed suspended and bed sediment grain size distributions, observed suspended sediment concentrations, computed suspended sediment load and temperature are maintained.

New Orleans District

Sediment Load Measurements

1. Suspended sediment and bed material sampling was continued at the following 11 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; Lower Atchafalaya River at Morgan City, LA, monthly; Red River above Old River Outflow Channel, semimonthly; Atchafalaya Basin, Bayou Chene below Bayou Crook Chene, weekly; Atchafalaya Basin, Lake Long below Bayou La Rompe, weekly; Atchafalaya Basin, Little Tensas below Blind Tensas Cut, weekly; Atchafalaya Basin, East Access Channel above Chicot Pass, weekly.

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.

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 computations program using steady state hydraulics. STUDH is sediment transport program using unsteady two-dimensional flows in the horizontal plans.

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 program 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 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

The resurvey of the upstream sedimentation and downstream retrogression ranges at Rend Lake was completed. The data analysis was not completed due to a lack of funds. The data will be analyzed when funds are available.

The analysis of the 1984 resurvey at Lake Shelbyville and of the 1982 and 1984 resurveys at Carlyle Lake have been approved, subject to resolution of comments. The comments will be answered in early 1987.

Vicksburg District

Sedimentation Surveys. Channel geometry, such as cross sections and profiles, was made on many streams within the district during the year. These data, which are to be used in various hydrologic and hydraulic studies, were 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, MS; Vicksburg, MS; and Arkansas City, AR. 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 sample, bed material sample, temperature, discharge, and stage data are collected and computerized for many stations within the district has been continued. Sedimentation data were collected at approximately 40 stations during 1986. Bed samples were collected using either BM-54, BMH-60, or drag bucket bed material samplers, while suspended samples were collected using either D-48, D-57, D-61, or D-74 suspended material samplers or by dip sampling.

Office Investigations.

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

2. 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.

3. Red River Waterway.

(1) During early 1986, the velocity and sediment data acquisition program and subsequent report for the downstream approach to Lock and Dam No. 1 were completed. This data acquisition included identifying velocity

magnitudes and directions and obtaining both suspended sediment and bed material samples. The results of this velocity and sediment report verified the observation that increased sediment deposition in the area of the miter gates is experienced during periods of flow over the top of the downstream I-wall.

(2) A sediment investigation utilizing the 2-dimensional (TABS-2) numerical model was initiated in late 1986 to determine the most feasible and effective design of modifications to the Lock and Dam No. 1 structure and the dam outlet channel. The purpose of these modifications is to improve the sediment control both at the structure and in the downstream approach channel. The modifications include a downstream extension of the existing timber wall, construction of a silt barrier parallel to the riverside lock wall, raising the low area and side of the lock, and laying back the right bank of the dam outlet channel at the two construction points. Presently, several alternative lengths of the timber wall extension and varying amounts of bankline layback for the dam outlet channel are being costed.

(3) A sediment study is ongoing to determine the impact of the influx of sediment from bank caving above Shreveport, LA, on the Red River Waterway system. The study included comparison of bankline movement and channel cross sections over time to quantify bank caving throughout the Shreveport, LA, to Index, AR, reach. Also, a determination of the expected reduction in sediment influx due to construction of bank stabilization measures is included.

(4) The preparation of a Red River sediment DM has recently been initiated. The DM is to compile all existing sediment data and sediment studies and to document the approach to meeting continued sediment needs for construction and maintenance of Red River project features.

(5) During 1986, work on the TABS-2 numerical models for Locks and Dams Nos. 2 and 3 continued. The numerical model studies for Locks and Dams Nos. 4 and 5 were initiated. The purpose of these numerical models is to aid in the design of the structures and adjacent channels by identifying probable sediment transport characteristics for alternative features.

4. Demonstration Erosion Control Project. Several sediment studies and a comprehensive data collection program and underway as part of the DEC. The DEC is a joint effort between the district and the Soil Conservation Service to reduce flooding, erosion, and sedimentation problems in six watersheds in the Yazoo River Basin. These consist of:

(1) Detailed geomorphic and sediment transport studies were initiated in 1986 for Batupan Bogue, Hotophia Creek, and Hickahala Creek watersheds as part of the development of technical work plans for these watersheds.

(2) Automatic suspended-sediment sample stations have been installed in all six DEC watersheds. Stations on Batupan Bogue and Otoucalofa Creek have been in operation for approximately 2 years and stations on Hickahala Creek, Senatobia Creek, and Hotophia Creek have been operational for

approximately 1 year. Stations on Fannegusha Creek, Long Creek, and Harland Creek are scheduled to be operational in early 1987. These are being maintained and operated by U.S. Geological Survey for the district.

(3) A comprehensive data collection program was continued for Goodwin Creek. WES has completed an initial assessment of the Goodwin Creek sediment data and has initiated a study to develop procedures for the determination of total sediment load which could be applied to DEC watersheds and other Yazoo River watersheds for the district.

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 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, 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.

3. Suspended-sediment data are being collected by an automatic PS-69 sampler at Hotopha Creek near Batesville, MS, Otoucalofa Creek near Water Valley, MS, Hickahala Creek near Senatobia, MS, Senatobia Creek at Senatobia, MS, and Batupan Bogue at Grenada, MS, in cooperation with the interagency Demonstration Erosion Control Task Force.

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 Amite 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

4. Suspended-sediment and bed-material data are collected weekly by the COE in the Atchafalaya Basin at Bayou Chene above Bayou Crook Chene, East Access Channel above Lake Chicot, Lake Long below Bayou LaRompe, and Little Tensas Cut.

Special Studies

1. Suspended-sediment data are being collected at 15 stations on the St. Francis River and selected tributaries for the COE. Eight sites are collected on a monthly basis and the remaining seven 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 sediment samplers.

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. Suspended sediment samples are obtained once every 6 weeks at eight stations.

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.

5. In cooperation with the Louisiana Department of Transportation, Office of Public Works, an intensive suspended sediment-chemical characteristics study is being conducted on the lower Mississippi River from Tarbert Landing, MS, to Venice, LA. Eight sites are sampled on a monthly basis. Project is scheduled for completion in fiscal year 1986.

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 sediment damages and determinations of sediment yields were made for the following activities:

   a. Public Law 566

Major Drainage	Watershed	Stream	County	State
Lower Mississippi	Duck Creek	Duck Creek	Lonoke Prairie	Arkansas
Lower Mississippi	Dunn Creek	Dunn Creek	Lonoke Prairie	Arkansas
Yazoo River	South Delta	Numerous Channel	Humphreys Yazoo Sharkey	Mississippi

2. Reservoir sedimentation surveys (including watershed evaluation) were made in the following reservoirs:

Reservoir	County	State
*Smith Pond	Marshall	Mississippi
*Murphy Pond	Marshall	Mississippi
*Big Sand No. 11	Carroll	Mississippi
*Batupan Bogue No. 89	Montgomery	Mississippi

3. Special Studies

	Project Name	County	State
a.	*Ascalmore Channel Ranges and Watershed Evaluation	Tallahatchie	Mississippi
b.	Black Creek Watershed Evaluation	Holmes	Mississippi

*Performed with transfer funds from the Corps of Engineers.

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.

2. Daily observer sediment concentrations are collected as part of the U.S. Fish and Wildlife Service Refuge Monitoring Program at the following gaging stations:

Souris River near Bantry, ND
Willow Creek near Willow City, ND
Stone Creek near Kramer, ND
Deep River below Cut Bank Creek near Upham, ND
Boundary Creek near Landa, ND
Souris River near Westhope, ND

The samples at the above sites are collected during a 2-month period coinciding with the spring snowmelt.

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 River of the North at Emerson, Manitoba, Canada, as part of NASQAN. The Water Survey of Canada provides daily sediment concentrations information at this site.

4. Suspended-sediment data are being collected on a bimonthly basis at the Red Lake River at Crookston, MN, and quarterly 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 published.

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

   a. Public Law 566

Major Drainage	Watershed	Stream	County	State
Souris	Noonan		Divide	North Dakota

2. Special Studies

   a. Ephemeral gully erosion data were collected in conjunction with the Des Lacs Souris River Basin Study.

MISSOURI REGION

BUREAU OF RECLAMATION

James River Stabilization Study. - A contract was awarded to the combine of Morrison-Maierle-Montgomery to examine the effects of using the James River channel to convey Garrison Diversion Unit discharges through North Dakota. The study is to determine preproject and postproject river channel conditions such that economic and environmental evaluations can be made of the best program for minimizing impacts on the river and stabilizing the channel. The study will be done by establishing pre- and postproject hydraulic and sediment transport conditions in the river and assessing those areas subject to erosion and inundation. The study will be completed in 1988.

Platte River Environmental Studies. - An assessment of morphologic changes in the Platte River channel in Central Nebraska is underway. To date river transects have been established and monitored for 3 years. Present and historical bed elevations and channel slopes have been established and compared. Sediment transport rates will be evaluated at several locations and attempt will be made to correlate changes with time. Channel geometry changes will be compared over time and correlated with changes in streamflow and sediment load. Sediment transport modeling is proposed as a means of predicting long term channel changes.

Buffalo Bill Reservoir Hydrographic Resurvey. - A hydrographic survey was completed for Buffalo Bill Reservoir on the Shoshone River near Cody, Wyoming. The bathymetric survey data was then used together with a 1980 above water photogrammetric survey to produce a new topographic map of the reservoir area. The bathymetric data was obtained by means of the Mini Ranger III automated survey system.

MISSOURI BASIN REGION

CORPS OF ENGINEERS

Missouri River Division

Kansas City District

Sediment Load Measurements. The measurements of suspended sediments were continued at 16 stations through the water year. At the end of the water year 9 of these stations were closed. The following is a listing of the closed stations.

RIVER BASIN	LOCATION	PERIOD OF RECORD (years)
OSAGE		
Osage River	Harry S. Truman Reservoir (below)	9
S. Grand River	Clinton, Missouri	6
Osage River	Schell City, Missouri	6
Marais des Cygnes River	State Line, Kansas	6
KANSAS		
Kansas River	Turner, Kansas	8
Kansas River	Desoto, Kansas	13
Kansas River	Lecompton, Kansas	12
Kansas River	Wamego, Kansas	9
Wakarusa River	Clinton Lake (below)	9

Currently in operation are three main stem Missouri River stations and two Kansas River stations. The Missouri District of the U.S. 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 at St. Joseph, Kansas City and Herman, Missouri. The Kansas District of the U.S. Geological Survey is collecting continuous depth integrated samples at six or seven verticals at Ft. Riley and Eudora, Kansas for the purpose of computing total sands in the cross-section. The remaining two stations are located on the Smokey Hill River. One station is located below Kanopolis Lake and the other station is an inflow station to Kanopolis Lake.

Monitoring Program. Outlet channel degradation. The monitoring program being conducted below the 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, bankline movements, suspended solids, recreational boating and swimming velocities, cove entrances, boat docks, and/or any other related physical phenomena which may be attributed to hydropower generation. The monitoring reach extends approximately 44 miles below the Harry S. Truman damsite. Erosion sites were located downstream at locations considered to be the most vulnerable to attack. Additional sites have been added in areas not exposed to direct hydropower discharges 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. All of these sites were initially

surveyed on a monthly basis, but because of the apparent stability and only minor bank losses experienced to date, these sites now are surveyed approximately once every three to four months. Intensive thalweg-timed depth integrated sediment samples and point velocities are collected for each increase in the incremental step-up of power generation. This calendar year data was collected for a 4-unit, low tailwater, peaking power generation test and a uniformm flood evacuation. All previously collected data have been published, and those data collected this calendar year are in report preparation.

Special Studies. The Kansas River regulatory and monitoring study for regulating commercial sand dredging in the lower reaches of the river is continuing. This study is based on allowances of minimal impacts of permitting increments of 1, 3, & 5 ft., reached averaged, vertical depth for commercial dredging. This depth is based on the recommendation of a contract study performed by Daryl Simons, formerly of Simons, Li and Associates, Inc., Fort Collins, Colorado.

Omaha District

Sediment Load Measurements. The 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 bed samples at five vertical locations in the cross section. Samles 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. Four observation wells are read weekly to monitor groundwater changes associated with lake headwater aggradation effects in Lewis and Clark Lake, including the effects of delta growth at the mouth of the Niobrara River.

2. Niobrara Townsite and Fort Randall Project. Twelve wells at the old Niobrara townsite are read monthly and four wells upstream on the Missouri River are read weekly. Data from these wells are being 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 have been used to predict the groundwater levels associated with aggradation. Readings are taken once every two weeks.

4. Garrison Project. Nineteen wells immediately downstream of Garrison dam are read monthly. Data from these wells was used for the Garrison Additional Hydropower Study, and will be used in the future to assess interrelationships between river stages and groundwater levels.

5. 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, and will be used in the future to assess interrelationships between river stages and groundwater levels.

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

Reservoir Sediment Activities.

1. Fort Peck Project. A resurvey of 109 of 122 total ranges on the lake was made under A-E contract. Heavy late summer rains have postponed the completion of 12 of the 109 ranges until summer 1987. The profiles will be used to identify the amount and location of sediment accumulation and to update area-capacity volumes for use by the Reservoir Control Center. Bed material samples for grain size determination of the upstream end of the lake were collected by Corps' personnel.

2. Oahe Project. A resurvey was made of the Cheyenne River Arm of Lake Oahe. This included profiling all ranges, collection of bed material samples for grain size determination, and a water surface profile. All work was done under A-E contract. The data collected will be used to determine aggradation trends and effects in the arm as well as to study possible ice affected flooding problems claimed by a local landowner. In addition to the Cheyenne River Arm survey, the intake structure at Oahe Dam was sounded and a bed map developed to determine a potential location for the proposed bubbler system.

3. Fort Randall Project. A complete hydrographic resurvey was made of the Fort Randall aggradation reach. This included locating the monuments for the 45 ranges, replacing destroyed monuments, and repainting their location markers. The profiling of all ranges was done by A-E contract. In addition the 45 ranges, the contractor set monuments and profiled 5 new ranges on the White River. The data collected will be used to identify the amount and location of sediment accumulation and to update area capacity volumes for use by the Reservoir Control Center. A water surface profile of the degradation reach was measured by Corps personnel. The profile was made during a steady discharge of 45,000 cfs and will be used to identify changes in water surface slopes, indicate probable location of bed armoring, and help determine stage discharge rating curve trends at recording gages located in the area.

4. Gavins Point Project. A complete hydrographic resurvey was made of the Gavins Point degradation reach. This included locating the monuments for 46 ranges, replacing destroyed monuments, and repainting location markers (white plate on fence post). The profiling of all ranges was done by A-E contract. The survey will be used to determine degradation trends and bank erosion rates. In addition to the resurvey, bed material samples to be used

for grain size determination were collected and two water surface profiles for discharges of 16,000 and 45,000 cfs were measured in the degradation reach. The water surface profiles will be used to identify changes in water surface slopes, changes in channel flow capacity, to indicate probable location of bed armoring, and to help determine rating curve trends at recording gages located in the reach.

5. Salt Creek Project. Reconnaissance surveys were made on Pawnee and Branched Oak Reservoirs located near Lincoln, Nebraska. The surveys involved uncontrolled surveys of the underwater portion of index ranges. The data will be used to determine potential problem areas and the scheduling of future complete resurveys.

6. Papillion Creek Project. Reconnaissance surveys of the underwater portions of Papio Sites 18 and 20 located near Omaha, Nebraska were made. The profiles will be used to determine potential problem areas and the scheduling of future complete resurveys.

7. Pipestem Project. A reconnaissance survey was made of the underwater portion of ranges on Pipestem Reservoir, located near Jamestown, North Dakota. The data will be used to determine potential problem areas and scheduling of future complete resurveys.

8. Cherry Creek Project. Corps personnel obtained sediment grab samples downstream of the dam and oversaw the measurement of sediment depth measurements and collection of core samples in the intake structure before, during, and after flushing operations at Cherry Creek Dam, located in the Denver metropolitan area. The grab samples, sediment depth measurements, and core samples were used to assess the effectiveness of routine flushing operations to remove sediment deposits in the intake structure.

9. Chatfield Project. Five ranges were resurveyed under A-E contract. The work was done to account for discrepancies between the 1981 and 1984 surveys. It was determined that the 1981 survey was in error. The data is being used by an A-E contractor to update the area-capacity volumes for use in project regulation activities, and assess reductions in storage capacity from sediment depletion. Chatfield Reservoir is located in the Denver metropolitan area.

Special Studies.

1. Pierre-Ft. Pierre Groundwater Study-Stoeser Addition. A study of existing and future groundwater conditions in the Stoeser residential addition area of Pierre, South Dakota was completed. The study included an assessment of the relationship between Missouri River stages (both open flow and ice-affected) and groundwater levels in the areas as well as their contribution to a frost heave problem along Reen Street in the addition. From the assessment it appears that the frost heave problem along Reen Street may be attributed to freezing of excess water that, under a normal range of Missouri River flows, backs into and presumably leaks from a storm sewer located beneath the street.

2. Crystal Lake Section 22. A study was conducted under the Section 22 program to update the 1960 report "Review of Improvements to Crystal Lake, Nebraska." Crystal Lake is a former Missouri River oxbow lake located near South Sioux City, Nebraska that enjoyed popularity in the first half of this century as a recreation area for the Sioux City, Iowa metropolitan population. Siltation from Missouri River floods severly depleted its use for water based recreation. The current report explores options for restoring the lake using data obtained for the 1960 report.

3. Shoreline Erosion Studies. Ultimate shoreline erosion at various sites on Lake Oahe and Lake Francis Case were conducted in support of Operations Division.

4. Revision of Mainstem Area-Capacities. Capacity values corresponding to various pool levels for all Missouri River Mainstem Reservoirs were updated and revised to correct discrepancies occurring as a result of different historical survey and computation methods. Values were reviewed and revised, as necessary, for all reservoir surveys as were storage changes since closure. The revised tables were forwarded to the Reservoir Control Center.

5. Crooked Creek Arm Aggradation Assessment. An assessment was made of deposition rates near a boat ramp located on the Crooked Creek Arm near its confluence with the Musselshell River Arm on Fort Peck Reservoir. This assessment is of special interest to people in the surrounding communities who are attempting to have the road leading to the ramp improved using government funding. The study showed an approximate one-half foot per year sediment deposition rate and a remaining useful life of about 25 years for the boat ramp.

6. Little Missouri River Arm Aggradation Assessment. A preliminary assessment was made of aggradation conditions in the vicinity of a recreation area on the Little Missouri River Arm of Garrison Reservoir. The assessment shows a remaining useful life of the area of only about 10 to 15 years. A reconnaissance survey will be made of the area and the data used to update the assessment during 1987.

7. U.S.G.S. Garrison Degradation Data Update. Garrison Dam degradation reach data, plotted and tabulated in a U.S.G.S. report, was updated using channel geometry and water surface profile information obtained since 1976,

8. Gavins Point Tailwater Control. An evaluation of the effects of various bed elevation and channel width changes on tailwater conditions below Gavins Point Dam using backwater analysis was initiated. Preliminary analysis shows that some type of control point apparently exists between river miles 795 and 805 (six to fifteen miles downstream from the dam).

9. Area-Capacity Study--Bear Creek. Area-capacity analysis was performed on Bear Creek Lake, located in the Denver metropolitan area. The total volume lost to sediment deposition since closure is 211 acre-feet, or approximately 70 acre-feet per year. The design sediment deposition rate is 20 acre-feet per year. While the measured depletion rate is over three times greater than originally expected, it must be noted that the measured rate is based upon

only three years of record and may possibly be attributed to urban development in the vicinity or higher than normal storm events. If the measured deposition is indicative of a long term average, the life of the project could be reduced drastically. No other unforeseen sediment concerns have occurred.

10. Area-Capacity--Holmes Lake (Salt Creek No. 17). Area-capacity analysis was completed on Holmes Lake (Salt Creek Lake No. 17), located near Lincoln, Nebraska. The measured sediment depletion rate is 4.5 acre-feet per year. Based upon 21 years of record, this rate is slightly lower than the original design estimate of about 6 acre-feet per year. It should be noted however, that during the first 14 years after closure, the lake experienced a depletion rate of less than one acre-feet per year, and for the next seven years a rate of just over 12 acre-feet per year. This significant increase is most likely due to urbanization of the watershed and may not be indicative of a long term trend. However, if this higher rate is indicative of a long term trend, the life of the project would be halved. While no sediment depletion problems have occurred to date at the project, shoreline erosion has been excessive and has caused some public concern due to its detrimental effect on recreation facilities located along the perimeter of the lake.

11. Area-Capacity--Papio Site 16. Area-capacity analysis was completed on Papio Site 16 (Standing Bear Lake), located near Omaha, Nebraska. The volume lost to sediment depletion rate is 214 acre-feet, or about 27 acre-feet per year. The design long term average annual depletion rate is 15.5 acre-feet, with a range of a high of 64 acre-feet per year during urban construction, to a low of 4 acre-feet per year following urbanization of the entire watershed. While urbanization of the watershed is limited to date, higher than normal runoff events have occurred between surveys, which may account for the higher than expected measured depletion rate. No unforeseen sediment problems have occurred as of yet.

12. Area-Capacity--Papio Site 20. Area-capacity analysis was performed on the first complete hydrographic survey of Papio Site 20 Reservoir, located near Omaha, Nebraska. Because it is the original survey, no sediment depletion volumes may be calculated. The reservoir capacity below the maximum pool elevation of 1126.0 feet m.s.l. is 17,088 acre-feet. The expected average annual sediment depletion rate at this site is about 25 acre-feet per year, varying from 60 acre-feet per year during urban construction periods to a low of 8 acre-feet per year after urbanization of the entire watershed.

13. Area-Capacity--Gavins Point Reservoir (Lewis and Clark Lake). Area-capacity analysis was completed for the 1985 resurvey if Lewis and Clark Lake. The measured sediment depletion rate in the lake is 2774 acre-feet per year. The design depletion rate for the first 50 years of the reservoir is approximately 2400 acre-feet per year. While the measured rate is slightly higher than the design, sediment depletion rates has shown a general declining trend with time and may eventually approach the original projection. The most serious problems in Lewis and Clark Lake attributed to sedimentation are:

(a) Sediment deposition at the confluence of the Missouri and Niobrara Rivers. Deposition at this location has caused a reduction in channel capacity, overbank flooding during high releases from Fort Randall

Dam, possible rises in the water table, and the relocation of the city of Niobrara, Nebraska.

(b) Delta growth in the reach extending from Niobrara to Springfield, South Dakota, contributing to flooding of overbank areas, the development of a high production of organic materials and noxious weeds, and the relocation and modification of water supply facilities in Springfield.

(c) Sediment deposition in public use recreation areas.

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 in cooperation with Daniels County 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 6-week 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 6-week 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 daily basis during storm events for the nonwinter season at East Fork No Water Creek near Colter, WY, in cooperation with the Wyoming State Engineer.

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 Locate, MT, as part of the Federal CBR program.

3. Suspended-sediment data are being collected on a daily basis during storm events for the nonwinter season at Dead Horse Creek near Buffalo, WY, in cooperation with the Wyoming State Engineer.

4. Suspended-sediment data are being collected on a 6-week and storm-event basis in cooperation with the U.S. Bureau of Land Management at the following sites:

South Fork Power River near Kaycee, WY
Salt Creek near Sussex, WY
Power River at Sussex, WY
Power River at Arvada, WY

5. 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

6. Suspended-sediment data are being collected on a monthly basis at Hanging Woman Creek below Horse Creek near Birney, MT, and 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 (bimonthly)
Burns Creek near Serage, MT (monthly)

Missouri-Little Missouri Subregion

1. Suspended-sediment data are being collected on a bimonthly 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.

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 on Brush Creek near Beulah, ND, and Buffalo Creek tributary near Gascayne, ND, as part of a State monitoring program for coal development.

3. 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.

Missouri-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 daily basis during storm events during the nonwinter season at Black Thunder Creek near Hampshire, WY, in cooperation with the Wyoming State Engineer.

3. Suspended-sediment data are being collected on a 6-week and storm-event basis in cooperation with the U.S. Bureau of Land Management at the following sites:

Dry Fork Cheyenne River near Bill, WY
Cheyenne River near Dull Center, WY
Belle Fourche River below Moorcroft, WY

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

5. 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 periodic 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 Oacoma, SD, in cooperation with the COE.

3. Suspended-sediment data are being collected on a monthly basis at Little White River near Vetal, SD, and Little White River above Rosebud, SD, in cooperation with the U.S. Bureau of Reclamation (USBR).

Missouri-Andes Creek Subregion

1. Suspended-sediment data are being collected on a monthly basis at Andes Creek near Armour, SD, Lake Andes Tributary No. 1 near Lake Andes, SD, Lake Andes Tributary No. 2 near Lake Andes, SD, and Lake Andes Tributary No. 3 near Armour, SD, in cooperation with the USBR and as part of the Missouri River basin program.

Missouri-Choteau Creek Subregion

1. Suspended-sediment data are being collected on a monthly basis at Choteau Creek near Wagner, SD, and Choteau Creek near Dante, SD, in cooperation with the USBR.

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.

Missouri-James Subregion

1. Suspended-sediment data are being collected on a periodic basis at James River at LaMoure, ND, James River at Pingree, 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 Manfred, ND, James River near Grace City, ND, Lake Juanita tributary near Grace City, ND, James River above Arrowhead Lake near Kensal, ND, Kelly Creek near Bordulac, ND, James River at Jamestown, ND, and James River near Heela, SD, as part of the Garrison Diversion Refuge Monitoring Program.

3. Suspended-sediment data are being collected on a monthly basis at James River near Columbia, SD, and at James River near Scotland, SD, as a part of NASQAN, and the Missouri River basin program.

4. Suspended-sediment data are being collected on a periodic basis at James River at Ashton, SD, Snake Creek near Ashton, SD, Wolf Creek near Ree Heights, SD, Turtle Creek near Tulare, SD, Medicine Creek near Zell, SD, and James River at Huron, SD, in cooperation with the USBR.

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 storm-event basis at Deer Creek in canyon near Glenrock, WY.

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

5. Suspended-sediment data are being collected on a 6-week and storm-event basis at North Platt River near Goose Egg, WY, in cooperation with the U.S. Bureau of Land Management.

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.

2. Suspended-sediment data are being collected during high-flow periods at North Fork Cache La Poudre River at Livermore, CO.

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, as a part of NASQAN.

4. Suspended-sediment data are being collected on a monthly basis at Missouri River at St. Joseph, MO, in cooperation with the Missouri Department of Natural Resources.

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, KS, Prairie Dog Creek above Keith Sebelius Lake, KS, and White Rock Creek near Burr Oak, KS, in cooperation with the Kansas Water Office.

2. Suspended-sediment data are being collected on a bimonthly 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, Big Creek near Hays, 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 bimonthly basis at South Fork Solomon River at Osborne, KS, as part of NASQAN (beginning October 1, 1986).

Kansas Subregion

1. Suspended-sediment data are being collected on a 6-week basis at Little Blue River near Barnes, KS, in cooperation with the Kansas Water Office.

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

3. Suspended-sediment data were collected on a bimonthly basis from January to September at Kansas River at DeSoto, KS, and Big Blue River near Manhattan, KS, as part of NASQAN.

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

Kansas River at Fort Riley, KS
Kansas River at Wamego, KS
Kansas River at Topeka, KS
Kansas River at Lecompton, KS
Kansas River at Eudora, KS
Kansas River at DeSoto, KS

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 monthly basis at Grand River near Summer, MO, as a part of NASQAN, and in cooperation with the Missouri Department of Natural Resources.

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 monthly basis at Osage River below St. Thomas, MO, and at Osage River above Schell City, MO, as a part of NASQAN.

3. Suspended-sediment data are being collected on a monthly basis at Gasconade River near Jerome, MO, as a part of NASQAN, and in cooperation with the Missouri Department of Natural Resources.

Lower Missouri Subregion

1. Suspended-sediment data are being collected on a monthly basis at Missouri River at Hermann, MO, as a part of NASQAN, and in cooperation with the Missouri Department of Natural Resources.

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. Three stations were equipped with Manning samplers and were operated during the year for 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 in 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	Wolf River	Wolf River	Doniphan	Kansas
West Nishnabotna R.	Long Branch	Long Branch	Shelby Audubon	Iowa
Little Nemaha R.	South Branch	Little Nemaha	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

Flood Plain damage assessments; classical gully, and ephemeral gully evaluation; sediment storage computations; and stream stability interpretations were completed for the following watersheds:

Major Drainage	Watershed	Stream	County	State
Missouri River	Moniteau Creek	Moniteau Creek	Randolph Howard Boone	Missouri

Flood plain sediment, scour, and swamping damages were assessed through an ititial reconnaissance, and 50 structure site drainage areas were sampled to assess sheet and rill, classiscal gully, and ephemeral gully erosion, as well as related sediment damages on the following watersheds:

Major Drainage	Watershed	Stream	County	State
Missouri River	West Fork Grand	West Fk. Grand	Andrew Gentry Nodaway Worth	Missouri

Missouri River	East Fork Grand	East Fk. Grand	Harrison Worth Ringgold Union	Missouri Iowa

b. River Basin Investigations

Major Basin	Basin Reported	State
Platte River	Sandhills Cooperative Study	Nebraska
Republican River	Republican River Basin	Nebraska
White River/Hat Creek and Missouri River (Tributaries)	Nebraska Special Study	Nebraska

c. Resources Conservation and Development

Project Name	County	State
North Cedar	Clayton	Iowa
East and West Mapleton	Woodbury Monona	Iowa
Long Pine RCWP	Brown	Nebraska
Lee's Creek RC&D	Morrill	Nebraska
Long Pine Dump CAT	Brown	Nebraska
McCullock Hill Roadside CAT	Brown	Nebraska
Scholes Road Structure	Banner	Nebraska
McClung CAT	Keith	Nebraska

d. Conservation Operations

Major Drainage	Watershed	County	State
Flatwillow Creek	Flatwillow	Petroleum Fegus	Montana

(Joint effort of USDA, SCS, and Montana Department of Natural Resources and Conservation to evaluate effects of range plowout on sedimentation).

2. Reservoir sedimentation surveys were made in the following reservoirs:

Reservoir	County	State
Petroleum	Petroleum Fergus	Montana

3. Flood Plain Management Studies

Project Name	Counties	State
Upper Wood River	Custer, Dawson Buffalo	Nebraska
Lower Wood River	Buffalo, Hall Merrick	Nebraska

4. Special Studies

a. An historical analysis of meanders is underway in the Three Forks of the Grand River Basin Study, northwest Missouri.

b. A watershed geomorphic analysis for channel stability and salmonid habitat is being considered on the Long Pine Rural Clean Water Project in Nebraska.

c. Non-point sediment contributions and associated water quality effects are being studied in Elm Creek, Webster County, Nebraska, by the Nebraska Department of Environmental Control (DEC).

ARKANSAS-WHITE-RED-REGION

BUREAU OF RECLAMATION

McGee Creek Reservoir Sedimentation Monitoring. - A system of sediment ranges was established and surveyed in McGee Creek Reservoir to provide for future sedimentation monitoring.

CORPS OF ENGINEERS

Southwestern Division

Albuquerque District

Sedimentation Resurveys. Hydrographic resurveys of the sediment ranges were done in 1986 at John Martin (July), Trinidad (July), and Conchas (August) Reservoirs. Conchas Reservoir was also resurveyed by aerial methods in April 1986. The purpose of the survey is to determine changes in overall storage. The letter reports describing and analyzing the reservoir sedimentation resurvey at each of the projects is scheduled for completion in calendar year 1987.

Sediment Load Measurements.

1. Daily suspended sediment measurements were made at the stations (Arkansas River below John Martin Reservoir and Purgatoire River below Trinidad Lake near Trinidad) in this region.

2. Bed material samples were collected at each of the reservoirs during the hydrographic surveys. The samples will be analyzed for percent sediment, water content, density and grain size. The results will be included in the letter report.

Other Investigations:

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

2. In June-July 1986 a survey was initiated to re-establish damaged or missing range monuments at John Martin Dam. The work was completed prior to the hydrographic survey at John Martin Dam.

3. The Hydrologic Engineering Center under contract with the District completed the sediment investigation on the Arkansas River between Pueblo, Colorado and John Martin Dam. The final report prepared in 1986, is now available.

Little Rock District

Sedimentation Surveys. Sediment ranges in Pools 2, 3, and 6 were resurveyed with Motorola automated hydrographic survey equipment.

Sediment Load Measurements. Measurements continued at 34 stations on Arkansas River, Mulberry, Spadra Creek, Little Piney Cree, Piney Creek, Petit Jean, Fourche La Fave, White River, Taylor Bay, James River, Briant Creek, North Fork, Current River, Black River, Piney Fork, Strawberry River and Little Red River. 76 sediment measurements were obtained and the concentration in percent of weight records maintained.

Tulsa District

Sedimentation Surveys. Original survey of Arcadia Lake, Oklahoma was completed along with original survey of three relocated sedimentation ranges at Skiatook Lake, Oklahoma. Resurveys of Lock and Dam No. 13, Arkansas and Oklahoma and Kaw Lake, Oklahoma and Kansas, were completed. Detailed hydrographic resurveys were performed at Cochiti and Conchas Lakes, New Mexico, and John Martin and Trinidad Lakes, Colorado, for Albuquerque District. The data collected for these surveys except for Conchas Lake have been processed and forwarded to the Albuquerque District and completion of Conchas is scheduled for 31 March 1987. Detailed hydrographic surveys performed for Fort Worth District includes Aquilla and Proctor Lakes, Texas, for sedimentation and Lake Nasworthy, Texas, for a flood insurance study. These surveys have been completed and forwarded to their respective offices in Fort Worth District. A reconnaissance survey was performed on the Grant River at Miami, Oklahoma.

Sediment Load Measurements. The suspended sediment sampling program consists of 45 stations in the Arkansas River Basin and 8 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 Council Grove, Elk City, Marion Lakes and John Redmond Reservoir, Kansas, has been submitted to Southwestern Division in January 1986 for review and approval.

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).

Upper Arkansas Subregion

1. Suspended-sediment data are being collected on a monthly basis approximately 6 months of the year 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 (BLM).

2. Suspended-sediment data are being collected on a bimonthly basis at Arkansas River at Portland, CO, as part of NASQAN.

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 daily basis, approximately 6 months of the year, at Badger Creek upper station near Howard, CO, and Badger Creek lower station near Howard, OC, in cooperation with the BLM.

6. 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 Palmer Lake, 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

SOIL CONSERVATION SERVICE

1. Studies of sediment damages and determination of sediment yields were made for the following activities:

a. Public Law 566

Major Drainage	Watershed	Stream	Counties	State
Arkansas River	Rolling Hills Urban Study	Spunky Creek	Tulsa	Oklahoma
Arkansas River	Wagoner County Study	Porter	Wagoner	Oklahoma
Arkansas River	Bois d'Arc	Bois d'Arc	Kay	Oklahoma
Arkansas River	Brazil Creek	Mutiple Tribs.	LeFlore Haskell Latimer	Oklahoma
No. Canadian River	Woodward Gully	Sugar Creek of the North	Woodward	Oklahoma
Canadian River	Buckhead	Buckhead	Cleveland	Oklahoma
Red River	Lower Bayou	Lower Bayou	Love	Oklahoma
Cimarron River	Wildhorse Cr.	Wildhorse Cr.	Payne	Oklahoma
Cimarron River	Fairview FPM Study	Sand	Major	Oklahoma
Red River	Waterfall-Gilford	Waterfall Cilford	McCurtain	Oklahoma
Red River	Beaver Creek	Little Beaver	Stephens Grady	Oklahoma
Grand River	Upper & Lower Big Cabin	Multiple Tribs.	Craig	Oklahoma

b. River Basin Investigations

Major Basins	Study Area	State
Red River North Canadian South Canadian	Southwest Oklahoma Erosion and Sediment Study-22 Counties	Oklahoma

2. Reservoir sedimentation surveys were completed on the following reservoirs:

Reservoir	County	State
Fish Peak-Carbon Arroyo Watershed (FPC-1)	Las Animas	Colorado
Fort Carson (3 reservoirs)	El Paso Pueblo	Colorado

3. Special Studies

Project Description	County	State
a. Deep Fork River Erosion and Sediment Study - Requested by the Corps of Engineers who are studying alternatives to reduce flooding and impaired drainage damages along the Deep Fork River.	Lincoln Okfuskee Creek	Oklahoma
b. Drilling and sampling abandoned coal mine pit that is releasing acid water into stream channel.	Rogers	Oklahoma

TEXAS-GULF REGION

CORPS OF ENGINEERS

Southwestern Division

The SWD Laboratory received 1,313 bottled samples for determination of percent of sediment and 136 bed load material samples.

Fort Worth District

The field work for resurvey of Proctor Reservoir was completed during FY 86. Analysis of this data is now underway.

Galveston District

A total of 340 inplace samples were obtained from 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 number of samples taken are as follows:

NAVIGATION PROJECT	NUMBER OF SAMPLES
Gulf Intracostal Waterway	248
Miscellaneous	9
Sabine-Neches Waterway	5
Houston Ship Channel	23
Freeport Harbor	16
Galveston Harbor	5
Matagorda Ship Channel	34
Total	340

Surveyed cross-sections were established for the Horsepen and Langham diversion channel in Addicks Reservoir and for the Mason Creek diversion channel and Buffalo Bayou in Barker Reservoir. Staff gages were placed to monitor sediment accumulations.

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, TX, 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 (discontinued September 1986).

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 (discontinued September 1986), 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 (discontinued September 1986).

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 (discontinued September 1986), as part of NASQAN.

2. Suspended-sediment data are being collected on a storm-event basis at Cypress Creek near Westfield, TX, in cooperation with the U.S. Army Corps of Engineers, Galveston, beginning October 1, 1986.

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 and periodic basis at Brazos River at Richmond, TX, as part of the Federal CBR program and also as part of NASQAN (daily sampling discontinued September 1986).

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 (discontinued September 1986), as a part of NASQAN. The collection of suspended-sediment data at Llano River at Llano, TX (discontinued September 1986) 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 (discontinued September 1986).

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

RIO GRANDE REGION

BUREAU OF RECLAMATION

Rio Grande Floodway Maintenance Studies. - During the recent period of successive high runoff years and the corresponding high water levels in Elephant Butte Reservoir, the levee controlled floodway of the Rio Grande upstream of the reservoir has undergone significant aggradation. Reservoir and river ranges have been surveyed to determine the rate and quantity of aggradation. A program to model the river aggradation has been developed to evaluate the viability of the present floodway and conveyance channel and to develop alternative ways of maintaining the conveyance channel and developing new floodway schemes.

Velarde Community Ditch Project. - The downstream aprons of diversion structures on the Upper Rio Grande were designed to be constructed of riprap. Spring runoff with discharges of 5,000 ft^3/s or more caused movement of the riprap placed on the downstream face of completed structures. The riprap was examined in an effort to produce a more permanent protection for the downstream apron of the structures.

Heron Reservoir Hydrographic Resurvey. - The storage loss in Heron Reservoir based on the 1984 Hydrographic Survey is 850 acre-feet. This storage loss is derived from four sources: (1) the natural drainage above Heron (167 square miles contributing), (2) transbasin diversions through the Azotea Tunnel, (3) erosion of Azotea Creek downstream of the tunnel outlet, and (4) erosion of the banks on Willow Creek. That part of the loss derived from the natural drainage was estimated at 538 acre-feet for a yield rate of 0.236 acre-feet per square mile per year.

RIO GRANDE REGION

CORPS OF ENGINEERS

Southwestern Division

Albuquerque District

Sedimentation Surveys:

1. A hydrographic survey of the sediment ranges at Cochiti Reservoir was conducted in October 1986. Cochiti Reservoir was also resurveyed by aerial methods in August 1986. The purpose of the survey is to determine changes in overall reservoir storage. The letter report describing and analyzing the reservoir sedimentation resurvey at Cochiti Reservoir is scheduled for completion in calendar year 1987.

2. The new area-capacity tables for Cochiti Reservoir will be adopted on 1 January 1988.

Sediment Load Measurements:

1. Suspended sediment measurements were made at five stations in the Rio Grande region. 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 samplers according to flow conditions. Samples are not usually accrued on weekends and holidays.

2. Bed material samples were collected at Cochiti during the hydrographic survey. The samples will be analyzed for percent sediment, water content, density and grain size. The results will be included in the letter report.

Other Investigations: Abiquiu, Cochiti, Galisteo, and Jemez Canyon Dams continued to be operated to control sediment 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 bimonthly basis at Red River below Questa, NM, and Rio Hondo near Valdez, NM, and at Rio Bueblo de Taos below Los Cordouas, NM, in cooperation with the New Mexico Interstate Streams Commission (NMISC).

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

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 Bureau of Indian Affairs.

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 U.S. Bureau of Land Management (BLM), NMISC, and COE.

6. Suspended-sediment data are being collected on a bimonthly basis at Rio Grande at San Felipe, NM, Rio San Jose near Grants, 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 (annually), 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 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 and was changed to a Hydrologic Benchmark Station on October 1, 1986.

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 (discontinued September 1986).

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, and at Arroyo Colorado at Harlingen, TX (started October 1, 1986), as part of NASQAN.

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

Green River Endangered Species Habitat Studies. - A sediment sampling program was initiated in 1986 to describe the sediment transport regime of the Green River in the vicinity of Vernal, Utah. Since the closure of Flaming Gorge Reservoir in 1963, the annual hydrograph of the Green River has been altered. Three sampling locations have been established to collect suspended sediment and bed material samples in an effort to quantify the sediment transport characteristics of the Green River from its exodus from Split Mountain Canyon downstream to just below its confluence with the White River. This data is being collected to establish the relative stability of the Green River channel through this reach which is an important nursery habitat for the endangered Colorado squawfish. Sediment data collection will continue through Spring 1988.

Lake Powell Hydrographic Resurvey. - A hydrographic survey of Lake Powell on the Colorado River in Utah and Arizona upstream of Glen Canyon Dam was completed. The survey covered the full length of Lake Powell above the dam extending up the Colorado River to Cataract Canyon, up to San Juan River to the canyon area above Piute Farms, and up all of the major tributaries. A total of 390 reservoir sections were sounded. Aluminum caps were anchored in the canyon walls to mark range ends for future surveys.

Degradation Resurvey below Glen Canyon Dam. - The degradation range survey made on the Colorado River in October 1983 between Glen Canyon Dam and Lees Ferry was analyzed. The results showed the reach to have changed minimally since the 1975 survey. The river bed was scoured in several locations where a sand bottom existed due to the high spillway releases in the spring and summer of 1983.

Glen Canyon Environmental Studies. - Sediment data were collected at five sampling stations in the 240-mile reach of the Colorado River below Glen Canyon Dam to evaluate the short and long term impacts of sediment movement to the resources of the river such as camping beaches, terrestrial habitat, aquatic habitat, and rapids. The basic data included such items as bed material size, channel cross section profiles, discharge measurements, variation of bed materials in the section, and suspended sediment concentration and size analysis. The data were used to define sand load rating curves at the five sampling locations developed from computations of the sediment transport by the Modified Einstein Method. The sand load rating curves were used to compute the volume of sand either deposited or scoured in the main channel of the Colorado River under different flow release patterns at Glen Canyon Dam. A report was completed titled, "Sediment Data Collection and Analysis for Five Stations on the Colorado River from Lees Ferry to Diamond Creek."

The basic data were used as input to the STARS (Sediment Transport and River Simulation) model to mathematically simulate the movement of water and sediment through the study reaches of the Colorado River in the Grand Canyon. A unique feature of this one-dimensional, steady state model is the use of streamtubes to vary the hydraulic and sediment transport characteristics

across a cross section. Scour can be modeled at one portion of a cross section while concurrent deposition occurs in another portion. The user can choose from a variety of sediment transport equations. A special routine is included in the model to reduce, if necessary, the computed transport rate to the supply limited rate. Other routines are added to route water and sediment over bedrock outcrops. A second report titled, "Sediment Transport and River Simulation Model," describes the STARS model input, output, and design. Also included are example applications and a sensitivity analysis for the STARS model applied to the reach of the Colorado River immediately downstream from Glen Canyon Dam.

The Colorado River in the Grand Canyon has a large capacity to store sand along its streambed. Sand supplied by the tributaries will either be carried downstream by the main channel flow or stored on the streambed. Sand that is stored along the streambed is a possible source of material for beach deposition during high flow events. If there is little or no sand stored in the streambed prior to a high flow event the beaches could experience significant erosion. The STARS model was used to evaluate the relative impacts of powerplant operations on the storage of sand in the main channel. A third report was completed and titled, "Results and Analysis of the STARS Modeling Efforts of Colorado River in the Grand Canyon." Based on sand material in the streambed and that supplied by tributaries, the model computed changes in sand load transport, channel shape, and bed material size gradation with time for the Colorado River downstream from Lees Ferry. An additional model was developed for the Colorado River to augment the STARS model. The STAB (Sediment Transport Analysis Budget) model computes a mass balance of sand between Glen Canyon Dam and the five sampling stations. Input to the STAB model are the discharge hydrographs at the dam and the five sampling stations on the Colorado River plus discharge hydrographs for the Paria River, Little Colorado River, and Kanab Creek. Also needed are the sand load-discharge rating curves for each sampling station on the main stem and tributaries. From this information the STAB model derives a sand load hydrograph for the sampling stations on the main stem and tributaries. From the computed sand inflow and outflow from a reach the change in sand storage was determined for a given release scenario from the dam. Although the STAB model does not account for all the physical processes included in the STARS model, the STAB model was useful for short term analysis and provided a quick and inexpensive method to evaluate release patterns from Glen Canyon Dam.

Colorado River Basin Salinity Control Project. - A scour study was completed for a brine supply pipeline crossing of the East Paradox Valley Unit. A design scour depth of 6.8 feet was estimated for a 100-year flood peak of 1,710 ft^3/s.

Cross Drainage Scour Study, Paradox Valley. - A cross drainage scour study was made for the brine pipeline crossing of East Paradox Creek. The estimated 100-year flood peak scour depth is 7 feet.

Cross Drainage Scour Study, Dolores Project. - Drainage crossings for the Monument Creek and Cross Canyon Laterals in the Dolores River Drainage were evaluated for scour potential. Local scour estimates for 100-year flood peaks were estimated as given in the following table.

UPPER COLORADO REGION

GEOLOGICAL SURVEY

Colorado Headwaters Subregion

1. 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.

2. 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).

3. 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 bimonthly basis level at Colorado River near Cisco, UT, as part of NASQAN.

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 eight times per year at Yampa River near Maybell, CO.

2. Suspended-sediment data are being collected on a 6-week and storm-event basis at Savery Creek near Savery, WY, in cooperation with the Wyoming Water Department Commission.

3. Daily suspended-sediment data and periodic bedload data are being collected during the snowmelt runoff period in cooperation with the Wyoming Water Department Commission at the following stations:

Battle Creek near Encampment, WY
East Fork Savery Creek ner Encampment, WY
Big Sandstone Creek near Savery, WY

4. Suspended-sediment data are being collected quarterly at Williams Fork River at mouth near Hamilton, CO, in cooperation with Moffat County.

5. Suspended-sediment and bedload data are being collected six times per year at the following sites in the coal mining region of the Yampa River basin:

Middle Creek above Dam Site near Oak Creek, CO
Yampa River above Dam Site near Oak Creek, CO
Martin Creek above Dam Site near Oak Creek, CO

These stations are operated in cooperation with the Upper Yampa Water Conservancy District.

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

Piceance Creek below Rio Blanco, CO (periodic)
Piceance Creek tributary near Rio Blanco, CO (periodic)
Piceance Creek above Ryan Gulch, CO (periodic)

These stations are operated in cooperation with Rio Blanco County.

7. Suspended-sediment data are being collected on a comprehensive level at White River near Watson, UT, in cooperation with the Utah Department of Natural Resources.

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

9. 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.

10. Suspended-sediment data are being collected biweekly to define the sediment characteristics at Fortification Creek near Fortification, CO, in cooperation with the Colorado River Conservation District. Three yearly bedload samples are also being collected.

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

Upper Colorado Subregion

1. Suspended-sediment data are being collected on a comprehensive level primarily during the runoff season at West Divide Creek near Raven, CO, in cooperation with the Colorado River Water Conservation 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.

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 comprehensive 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. A study in cooperation with the Colorado River Water Conservation District to define the sediment characteristics in the White River will entail collecting suspended-sediment data quarterly at the following sites:

North Fork White River at Buford, CO
South Fork White River at Budges Resort, CO
Wagon Wheel Creek at Budges Resort, CO
South Fork White River near Budges Resort, CO
South Fork White River near Buford, CO
White River below Meeker, CO
White River above Crooked Wash near Rangely, CO

3. Study is being preformed to determine what metals are being transported on the sediments and in solution in the Ledville, CO, area.

4. Sediment data for the State of Colorado are being collected to determine sediment yield in the State.

5. Four studies to determine total sediment load at potential reservoir sites continued.

6. A study to determine source areas of sediment and define current sedimert load in fountain Creek in the Colorado Springs, CO, area continued.

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
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
Room 1016 Administration Building
1745 West 1700 South
Salt Lake City, UT 84104

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

SOIL CONSERVATION SERVICE

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

   a. Public Law 566

Major Drainage	Watershed	Stream	County(s)	State
Strawberry River	Sand Wash	Sand Wash	Duchesne	Utah

   b. River Basin Investigation

Major Drainage	Watershed	Stream	County	State
Strawberry River (revised from 1985)	Sand Wash	Sand Wash	Duchesne	Utah

   c. Conservation Operations

Major Drainage	Watershed	Stream	County(s)	State
Weber Basin	All	All	Morgan Salt Lake Summit Wasatch	Utah
Little Snake River	Grieve Reservoir	E. Sweetwater Gulch	Carbon	Wyoming

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

Reservoir	County	State
Rootcap Wash Watershed (RW-1)	Montrose	Colorado_1/
Two small reservoirs in the drainage area of RW-1, Rootcap Wash Watershed	Montrose	Colorado
I W-1, in Indian Wash Watershed, and six small reservoirs in the drainage of I W-1	Mesa	Colorado
Fredonia FRS	Coconino	Arizona

_1/ Computations Not completed.

3. Special Studies

a. Price River Basin-Roam Cliffs Drainage Area-Minnie Maud Summit Watershed, Carbon County, Utah. Erosion and sedimentation studies in Utah's Rangeland Erosion Targeting Program.

BUREAU OF RECLAMATION

Spring Canyon. - A sediment study was prepared for Spring Canyon Reservoir, a proposed pumped storage facility to be operated in conjunction with Lake Mead. A 100-year sediment accumulation of 1,570 acre-feet was estimated based upon a regional sediment yield curve and a small concentration for water pumped from the bottom of Lake Mead.

Middle Gila River Sediment Study. - A sediment sampling program was established to monitor sediment being transported in and through the canal system serving the Gila River Indian Community. Six sampling sites were established on the canal system to collect suspended sediment and bed material samples. The results of the sediment sampling program will be used to develop alternative means of handling sediment diverted into the distribution system.

Granite Reef Aqueduct. - Sedimentation estimates were completed for four retention dikes along Reach 11 of the Granite Reef Aqueduct. The 50-year sediment deposition estimates were based on natural conditions (no urbanization) and the Southwest yield curve. Results are as follows:

Dike No. 1	1360 acre-feet
Dike No. 2	1440 acre-feet
Dike No. 3	1040 acre-feet
Dike No. 4	1280 acre-feet

Tuscon Aqueduct. - An analysis of the scour potential for drainage crossings of Reach 5 of the Tucson Aqueduct was completed. The following table summarizes the results.

Scour Estimates for Siphon Crossings of Reach 5 of the Tucson Aqueduct

Flood Study Area	Field Notes Channel Station (ft)	Mean Bed Material Diameter (D_{50}) (mm)	Main Channel Average Velocity (ft/s)	Scour Estimate (ft)
1	131+11	4.8	12.0	5.
2	157+45	4.2	11.6	5.
3	170+54	6.0	12.7	6.
3	172+04	6.0	10.9	5.
3	174+77	6.0	11.2	5.
4	198+91	6.4	12.5	6.
5	213+37	6.0	11.9	5.
6	227+63	2.3	11.7	5.
7-A	258+80	1.7	7.7	3.
7-B	264+97	1.7	7.2	3.

A separate analysis of the cross drainage scour potential for the San Joaquin Siphon at Station 264+00 of Reach 5 of the Tucson Aqueduct was completed. A recommended scour estimate of 4 feet was computed for a 100-year peak discharge of 565 ft^3/s and a median bed material size of 1.7 mm.

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 at Littlefield, AZ
Virgin River above Halfway Wash near Riverside, NV (discontinued September 1986)
Muddy River above Lake Mead near Overton, NV

2. 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.

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

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).

2. Suspended-sediment data are being collected on a comprehensive level at the Idaho-Utah State line in cooperation with Utah Department of Natural Resources.

3. Suspended-sediment data are being collected on a comprehensive level at Little Bear River below Davenport Creek near Avon, UT, in cooperation with the Utah Department of Natural Resources.

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 (discontinued September 1986)

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 1986.

A long-term investigation of sediment and debris hazards related to flooding is in the fifth investigative year at the Nevada Test Site.

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
U.S. Geological Survey
Room W-2234, Federal Building
2800 Cottage Way
Sacramento, CA 95825

District Chief, WRD
U.S. Geological Survey
1016 Administration Building
1745 West 1700 South
Salt Lake City, UT 84104

SOIL CONSERVATION SERVICE

1. Downstream sediment impacts were quantified on the following project:

   a. Public Law 566

Major Drainage	Watershed	Counties	State
Santa Marina River	Oso Flaco	San Luis Obispo	California
Walker River	East Walker River	Lyons	Nevada

   b. River Basin Investigation

Major Drainage	Watershed	State
Great Salt Lake Drainage	Shampip River Basin	Utah
Great Salt Lake Drainage	Weber River Basin	Utah

2. Reservoir sedimentation surveys were made in the following reservoirs:

Reservoir	County	State
Eight-Mile Creek	Elko	Nevada

3. Special Studies

   a. Utah Lake Drainage Basin - West Canyon Watershed (canal-watershed sedimentation study).

   b. Sevier Lake Drainage Basin-Willow Creek Subwatershed, Servier County, Utah. Erosion and sedimentation study in Utah's Rangeland Erosion Targeting Program.

BUREAU OF RECLAMATION

Oroville-Tonasket Pumping Plants. - Several alternatives were examined as a means of reducing the sediment being pumped by the five pumping plants on the Okanogan River. Profiles of suspended sediment concentrations were developed for the river at various stages. Settling basin sizes were determined for each plant based upon the pumping rates and a previously determined sediment rating curve for the river. About 200 cubic yards of material would be deposited in each settling basin per year in removing all material coarser than 200 mesh.

PACIFIC NORTHWEST REGION

CORPS OF ENGINEERS

North Pacific Division

Portland District

Sedimentation Surveys

1. Reservoir Surveys. Two sediment reports were issued and one reservoir resurvey was completed during 1986.

a. Reports. The following two sediments reports for the Mount St. Helens sediment retention structure (SRS) were issued during 1986:

(1) Design Memorandum No. 3. This report (i) summarized the procedures and rationale used to forecast the erosion and sediment yields from the Mount St. Helens debris avalanche, (ii) defined the rate and pattern of the sediment deposition expected upstream of the SRS, and (iii) estimated the quantities and the schedules of future downstream dredging.

(2) Design Memorandum No. 11. This report presented the procedures and schedules for monitoring the sediment deposition upstream, and the resulting downstream impacts of the SRS.

b. Resurveys. A resurvey of the sediment deposition in the Cottage Grove reservoir was completed in December 1986 when the lake was lowered for trashrack cleaning. A report will be issued in 1987 of the deposition in the reservoir. When last resurveyed in 1966, after 24 years of operation the average annual sediment deposition was only 0.13 acre-feet/square mile of drainage area.

2. Channel Surveys. Channel surveys were done in the Toutle/Cowlitz River system downstream of Mount St. Helens to monitor sediment movement from the debris avalanche and in the Columbia River to monitor shoaling in the navigation channel.

a. Toutle/Cowlitz River. Field data collected by the Portland District included:

- 300 bed material samples.
- 100 suspended sediment samples in the Cowlitz River at Kelso.
- Cross-section at 50 locations on the Cowlitz and lower Toutle Rivers 5 times during the year.
- 23 water surface profiles of the lower Cowlitz River.

In addition, the District partially funded the USGS gaging stations on the Toutle River at Tower Road, Kid Valley and Elk Rock.

The above data was used in the preparation of the two Mount St. Helens design memoranda, and in monitoring the levels of flood protection along the Lower Cowlitz River.

b. Columbia River. Field data collected by the District included:

- Hydrographic surveys.
- Suspended sediment sampling.
- Bedload measurements.
- Velocity measurements.
- Discharge measurements.

The hydrographic surveys are regularly done to identify shoaling areas and to determine the dredging required to maintain the authorized Columbia River navigation channel.

The water and sediment measurements were made during a 25-hour synchronous survey at 7 cross-sections in a 20-mile tidal reach of the Columbia River. There is particularly heavy shoaling in this reach and the purpose of this study is to determine the causes of the shoaling and the means to reduce the dredging. The velocity and discharge measurements were used to develop and calibrate a 2D hydraulic model (RMA-1 and RMA-2v) of the reach. The sediment measurements will be used for prototype and analytical studies of sediment movement in the reach. Site specific sediment measurements will be done in 1987 for use in developing and calibrating the sediment portion (STUDH) of the 2D model.

3. Equipment Used. Most sediment samples and water measurements were taken with standard P-61, P-63, D-74, and BM-54 samplers; Helley-Smith bedload samplers; pipe dredges; Price velocity meters; and VADA directional meters. Hydrographic surveys were made by special survey boats equipped with electronic fathometers.

Seattle District

Bed materials were sampled in 1985 and 1986 in salmon-spawning gravels on the White River downstream of Mud Mountain Dam. The sampling methods used are given in U.S. Fish and Wildlife Service Fishery Bulletin, 63:575-588, 1964: "A Method of Measuring Mortality of Pink Salmon Eggs and Larvae," W. McNeil.

A total suspended sediment rating curve was developed for the Snoqualmie River at Snoqualmie, Washington. The rating curve was developed using methods given in Techniques of Water-Resources Investigations of the United States Geological Survey, Book 3, Chapter C2, 1970: "Field Methods for Measurement of Fluvial Sediment," H. P. Guy and V. W. Norman.

Walla Walla District

Sedimentation Surveys.

a. Lower Granite Lock and Dam. All existing sediment ranges between River Miles (RM) 107.73 and 143.31 on the Snake River, and between RM 0.1 and 2.34 on the Clearwater River were resounded in the fall. Ranges about these limits were not resurveyed since previous surveys had indicated only minimal change.

b. McNary Lock and Dam. A resurvey of the 28 sediment ranges on the Columbia River between McNary Dam and Richland, four ranges at the mouth of the Yakima River, and the 23 existing ranges on the Walla Walla River was in progress at the close of calendar year 1986 and should be completed early year 1987.

c. Little Goose Lock and Dam. A condition survey consisting of close interval soundings and the development of channel bottom contour maps was performed at Schultz Bar (RM 100 to RM 102). The purpose of this survey was to determine the shape and location of sediment deposits which have been encroaching on the navigation channel.

Sediment Collection Activities. The U.S. Geological Survey collected 28 surface grab samples in the Schultz Bar reach. These samples were analyzed for grain size distribution.

Other Investigations. A project study was initiated to determine the impacts of sedimentation, dredging, and in-water dredge disposal on the Lower Granite pool in order to determine the most effective method of maintaining adequate freeboard on the Lewiston Levees.

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 (both discontinued September 1986), and at South Fork Coeur d'Alene River at Cataldo, ID, 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 were collected from January through June 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)
Clark Fork at Turah Bridge near Bonner, MT (daily)
Blackfoot River near Bonner, MT (monthly)

2. Daily suspended-sediment data was collected from July through December at the following sites under a Federal Energy Regulatory Commission permit with Montana Power Company:

Clark Fork at Turah, MT
Blackfoot River near Bonner, MT
Clark Fork above Missoula, MT

3. 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 Jocko River near Arlee, MT
Flathead River at Perma, MT

4. 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)

5. 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.

6. 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.

7. 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.

8. 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.

9. 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 and bedload data are collected weekly during spring runoff at Granite Creek and Little Granite Creek near Bondurant, WY, as part of a special research project.

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 Boise River near Parma, 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 data are being collected at Snake River at Burbank, WA, as a part of NASQAN.

3. 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 were collected from Owyhee River near Owyhee, OR, as part of NASQAN (discontinued September 1986).

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 (discontinued September 1986) 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 (discontinued September 1986), and Cowlitz River at Kelso, WA (discontinued September 1986) 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, 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 were collected on a quarterly basis at North Fork Quinault River near Amanda Park, WA, as part of the National Hydrologic Benchmark Network (discontinued September 1986).

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 (discontinued September 1986), Skagit River near Mount Vernon, WA, Snohomish River near Monroe, WA (discontinued September 1986) and at Puyallup River at Puyallup, WA, as a part of NASQAN.

Oregon Closed Basins Subregion

1. Suspended-sediment data were collected on a periodic basis at Donner and Blitzen Rivers near Frenchglen, OR, as a part of NASQAN (discontinued September 1986).

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 and horizontal profiles of suspended sediment and velocity. Bedload samples are being collected with enlarged Helley-Smith samplers at several sites. Several bedload equations are being tested for use on steep streams. Methods are being developed for understanding variations in discharge in time and space. To improve the control of measuring and sampling equipment, staylines were installed at the cableways at North Fork Toutle River above Bear Creek, North Fork Toutle River at Kid Valley, Toutle River at Tower Road gaging stations, and Muddy River below Clear Creek near Cougar, Washington.

3. Research continued on a suitable approach for sediment transport computer models to treat Washington's steep river slopes. An approach using the method of characteristics initially looked appealing and promising. However, the method has failed to maintain satisfactory conservation of mass. It has been established that the cause of the nonconservation lies with the method itself, rather than with an error in formulation. This is a surprising result, since the three-point method of characteristics, especially in explicit form, is commonly referenced in the literature. No modifications of the method, including attempts at higher orders of approximation, have resulted in a satisfactory remedy. Unless some variant of the method that preserves mass can be discovered, alternate solution methods applicable to steep-slope river dynamics will be necessary.

4. Channel geometry was collected for the lower Puyallup, White, and Carbon Rivers to determine channel capacity and to aid in evaluating bedload movement. Suspended-sediment and Helley-Smith bedload samples were collected at three sites on the Puyallup River, one site in the Carbon River, and one site on the White River. These data are used to estimate the bedload movement into the lower Puyallup River system.

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

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

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
1201 Pacific Avenue, Suite 600
Tacoma, WA 98402

SOIL CONSERVATION SERVICE

1. Studies os erosion and 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	Tammany Creek	Tammany Creek	Nez Perce	Idaho
Mid-Columbia	Upper Stage Gulch	Stage Gulch	Umatilla	Oregon

   b. River Basin Investigations

Major Drainage	Basin Reported	State
Snake River	Camas Creek	Idaho
Snake River	Lower Portneuf	Idaho
Snake River	Little Potlatch River	Idaho
Snake River	Raft River	Idaho
Snake River	Lake Irrigation District	Idaho
Snake River	Gooding Wind Erosion	Idaho
Coastal	-	Oregon 1/

   c. Resource Conservation & Development

Project Name	County	State
Continental Mine	Boundary	Idaho
Twin Bridges	Madison	Idaho
Broadford	Blaine	Idaho
Fishhawk Lake	Washington Clatsop	Oregon

   d. Conservation Operations

Major Drainage	Watershed	County	State
Snake River	Tucannon River	Columbia Garfield	Washington

2. Reservoir sedimentation studies were made on the following reservoir:

Reservoir	County(s)	State
Hawkins	Bannock	Idaho

3. Special Studies

   a. Suspended and bedload stream samples were collected over a 3 month period, and bed material sample were collected at 4 locations over a 6 month period in the Tucannon River in Columbia and Garfield Counties, Washington. Field evaulation of sediment delivery ratios was made for 194 hydrologic units.

_1/ Determined reduction of erosion caused by installation of best managemnt practices in the Tillamook Rural Clean Water Project.

CALIFORNIA REGION

BUREAU OF RECLAMATION

Tule Lake Hydrographic Survey - A hydrographic survey was completed on Sump 1A and Sump 1B of Tule Lake in the Klamath River Valley in northern California. The survey data was used to produce new topographic maps of the reservoirs and to estimate their sedimentation rates. The bathymetric survey data were obtained by means of the Mini Ranger III survey system and a survey crew working with standard land survey equipment in a small boat.

CORPS OF ENGINEERS

South Pacific Division

Los Angeles District

Reservoir Sedimentation. Sediment Data Summary Sheets (ENG Form 1787) for Big Tujunga, Cogswell, Devils Gate, Lopez, and San Dimas flood control basins; Puddingstone Diversion Dam; and, Auburn, Blanchard, Deer, Fieldbrook, Nichols and Rowley 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 Street, San Bernardino County, CA (Gage No. 11059300); Little Colorado River near Joseph City and Holbrook, AZ (Gage No. 09397000).

Office Activities.

1. Completed sediment transport analysis on Calleguas Creek, Ventura County, California. The purpose of the study was to analyze existing sedimentation problems to identify the necessity for developing plans for flood control works. The analyses was conducted using a sediment budget approach. The study was contracted to DMA Consulting Engineers.

2. Currently in progress is a sediment transport analysis for the lower Santa Ana River, California, as part of the Santa Ana River Phase II GDM. 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 analysis consists of a sediment yield analysis of the canyon watershed, a qualitative and quantitative assessment of the river, and a detailed sediment routing analysis.

3. Currently in progress on the Sediment Discharge-analysis into the Pacific Ocean as part of the Coast of California Storm and Tidal Wave Study (CCSTWS). The on-going study efforts are concerned with the San Diego Region, encompassing the streams and watersheds draining to the California coast from the U.S.-Mexican International Border to Dana Point. The study efforts are designed to provide quantification of average annual sediment discharge for existing watershed conditions, as well as for the hypothetical 2-, 10-, 25-, 50-, 100-, and 200-year frequency floods. The first of the three phases of the project is currently being conducted by the Architect-Engineering firm of Simons, Li, and Associates.

4. Currently in progress on the study for the Prediction of Debris Yield for Southern California Watersheds. This study is to establish a comprehensive and updated approach to the analyses and design of debris basins. A multiple linear regression analysis between the debris yield per square mile and a number of physically realistic and easily obtainable

physiographic, hydrologic and meteorologic factors is being performed. Analysis indicates that the dependent variable, namely the debris yield per square mile, is highly correlated with total storm precipitation, peak flow, drainage area size, relief ratio, and a non-dimensional fire factor. In as much as the occurrence of rainfall and fire events are independent random processes, coincident frequency analysis depicting a relationship between fire-frequency and the frequency of rainfall will also be presented to evaluate the cumulative effect of past fires on debris yield from a watershed following a rainfall event of certain frequency.

5. Currently in progress on the Migration Potential Analysis of Depleted Uranium in a Stream Bedload Environment at Yuma Proving Grounds (YPG), Arizona. This study is designed to assess potential surface water contamination, resulting from the release of Depleted Uranium (DU) contaminants into the environment. The release of DU contaminants is attributable to ongoing and/or anticipated testing and operational activities at YPG. This study attempts to statistically quantify the assessment of the potential for the migration of DU particles of various sizes and shapes in a stream bedload environment. Quantitative results delineating the extent of contamination of DU particles entering the Imperial Wildlife Refuge, 8 km. to the Southwest of the basin, during a 20-year period will be presented, subject to conceptually realistic scenarios. This study is currently being conducted by the Architect-Engineering firm of ENTECH Engineers, Inc.

Sacramento District

Reservoir Sedimentation. Sediment Data Summary Sheets (ENG Form 1787) for Isabella and Black Butte Lakes were completed.

Sediment Sampling.

1. Routine samples of lake outflows were collected and analyzed for suspended sediment at Black Butte, Pine Flat, Kaweah, Success and Isabella Lakes. For analyses, grab samples obtained in one-gallon containers were used. U.S. Geological Survey maintain and publish discharge record.

2. Samples for total sediment load were collected at four sites on Cache Creek. Total sediment load was also sampled at three sites on the Russian River and turbidity was sampled at two of these sites. D49 or P61 samplers were used to collect suspended sediment, and Helley Smith sampler for bedload measurement.

Sediment Studies.

1. Cache Creek Basin, California - C,P&E Study. The proposed project involves enlarging the outlet channel of Clear Lake in the upper part of the basin (i.e., watershed) and enlarging the existing sediment basin in the lower basin. A Sediment Engineering (S.E.) Investigation is ongoing to evaluate the impact of proposed upper basin project features on the creek channel morphology through Capay Valley, downstream of Clear Lake. A sediment monitoring program initiated in October 1983 was concluded this year and includes streamflow and total load sediment gage data at the upstream and

downstream boundaries of Capay Valley. Sediment transport routings and geomorphic studies using these data and that from previous programs were initiated this year to evaluate project impacts.

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 this 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 integrity of the overall Sacramento River Flood Control System. A unique analytical approach, including use of a two-dimensional hydrodynamic and sediment transport model, was utilized in the design of project features and development of a sediment management plan for the basin. Based on the results from the two-dimensional model, project features being proposed include enlarging and raising of existing perimeter levees, and reconstructing and raising an existing outlet weir in two phases through the project life.

2. Dry Creek (Sonoma County), California - Construction. An S.E. Investigation of Dry Creek, between the 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 multi-disciplinary 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. In conjunction with the S.E. Investigation, a data collection program in the basin is continuing, including collection of stream flow and total load sediment data at three stations. A preliminary report, outlining the results of the S.E. Investigation, will be issued in the Spring 1987.

3. Sacramento River Geomorphic Study - Construction. Bank protection measures on the Sacramento River are proposed for two reaches: In the Butte Basin flowage area, the vicinity of the Butte Basin "flow split" area; and Chico Landing to Red Bluff. The purpose of these measures is to preserve the historical division of flows into the main leveed floodway so the Sacramento River and into the natural overflow area of 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 floodflows in excess of design capacity down the leveed floodway and endangering the integrity of the overall Sacramento River flood control system. In the Chico Landing to Red Bluff reach, bank protection measures are proposed as part of an overall comprehensive program for channel stabilization. A preliminary geomorphic analysis was performed this year to evaluate if the proposed bank protection measures would be effective in their stated purpose and evaluate possible modifications to insure their effectiveness. A detailed geomorphic analysis will be conducted next year regarding these questions.

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 riverbed 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 would deprive the river of an important source of the fish spawning gravels - the eroding banks. A preliminary study was conducted to address these concerns and identify what impacts, if any, there would be on the fish spawning habitat.

5. Wildcat/San Pablo Creeks (Contra Costa County), California - GDM. An S.E. investigation to determine the impacts that proposed flood control channels would on channel morphology and sediment transport in the project area was extended. The proposed channels (2) would carry a relatively course bedload and empty into environmentally sensitive tidal marshes. In the original selected plan, 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 a modified plan developed during plans and specifications for the project channels, a transition zone was added to one of the project channels near its mouth to capture any remaining coarse sediments, not captured by the upstream sediment debris basin, before they can flow into the environmentally sensitive marsh. In addition, the downstream reaches of both project channels were widened to encourage deposition of sediments in the channels prior to their exist into the marsh areas.

San Francisco District

Sediment Studies

1. Alcatraz Dredge Material Disposal Site. As first reported in 1985, numerous studies were implemented 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. Two dredge material retention studies were conducted at Alcatraz during 1986-87. Contractor reports on these studies will be available in mid-1987.

The sediment transport studies are continuing to address both short- and long-term transport of disposal material. WES has completed 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.

To address our long-term goal, a numerical model to simulate long-term hydrodynamic circulation and sediment transport has been selected. The selected model is "TABS-II" and the District is working to set boundary conditions, and verify and calibrate the proposed model.

2. San Lorenzo River Study. The deposition of sediment in the San Lorenzo River Flood Control Project, constructed in 1962, has substantially 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 was also 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 WES study is now complete and the publication of the final report is expected in early 1987. The results of the WES study provided the basis upon which various alternative plans to return the capacity of the project to its design conditions were compared; a report documenting the District's findings is currently in preparation. The District anticipates that the results of the current special study will lead to a continuation of the feasibility study in FY 1989.

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 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.

3. 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).

4. 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.

5. 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 (discontinued September 1986):

Cache Creek at Yolo (storm event)
Cache Creek at Capay Bridge (storm event)
Cache Creek near Brooks (daily)
Cache Creek above Rumsey (daily)

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:

Rattlesnake Creek near Macksville, KS
Cow Creek near Lyons, 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
Slate Creek at Wellington, KS
Arkansas River at Arkansas City, KS
Whitewater River at Towanda, KS

2. Suspended-sediment data are being collected on a quarterly 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 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 U.S. Bureau of Reclamation (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 (discontinued September 1986), 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 (discontinued September 1986), and at Red River near Gainesville, TX (discontinued September 1986), 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 bimonthly basis at Cossatot River near Vandervoort, AR, as part of the National Hydrologic Benchmark Network.

4. 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.

5. 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

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 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

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. 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.

2. 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 was discontinued September 1986:

San Gregorio Creek at San Gregorio
Salinas River near Spreckels
Pescadero Creek near Pescadero
San Lorenzo River at Big Trees

3. 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 are being collected on a daily basis and morthly estimates of bedload discharge are made at Santa Ana River at Santa Ana, and San Juan Creek at San Juan Capistrano, in cooperation with Orange County Environmental Management Agency.

3. 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.

4. 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
Los Penasquitos 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

5. 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.

6. 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.

7. 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 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 erosion and sediment damages and determination of sediment yeild were made for the following projects:

   a. River Basin Investigation

Major Drainage	Watershed	State
Merced River	Sand Creek	California

ALASKA REGION

CORPS OF ENGINEERS

North Pacific Division

Alaska District

Sediment Studies. There were two sediment transport studies initiated in 1985 which continued through 1986. Both were conducted by the U.S. Geological Survey.

1. Kuskokwim River at Crooked Creek was initiated to determine the annual bedload transport rate for a Planning study on navigation improvements. Bedload and suspended sediment were collected by USGS four times during the open water season.

2. Matanuska River at Palmer was initiated to determine annual bedload transport for Regulatory Functions Branch which was reviewing gravel extraction permit requests. The Matunuska River is a popular gravel source for construction projects. There was concern that if more gravel was extracted than what could be replaced annually downstream erosion might result. Bedload, suspended sediment and stream discharge were collected four times during the open water season.

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

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 sedimert 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

LABORATORY AND OTHER RESEARCH ACTIVITIES

ARIZONA

Research activities at the Aridland Watershed Management Research Unit in Tucson, Arizona include the following:

1. About twice as much tebuthiuron is removed in runoff water and sediment when tebuthiuron pellets are applied to wet soil than when applied to dry soil. Surface wetness had little influence on the distribution of teuthiuron in the soil profile. One day after treatment about 90% of the tebuthiuron was in the surface 15 cm. After two days significant amounts of tebuthiuron were found in the 15 to 30 cm depth. After 168 days approximately one-half of the applied tebuthiuron was found in the soil. Tebuthiuron is usually detected in runoff water and sediment 168 days after treatment, but the amount is equivalent to less than 1×10^{-3} kg/ha. When tebuthiuron was applied in the fall, we found greater amounts being removed by simulated rainfall than in the spring because sediment yield was much greater in the fall than in the spring.

2. INTERPRETATIONS: The Green-Ampt infiltration equation, kinematic equations for overland flow, and erosion equations for rill and interrill erosion were applied to existing rainfall simulator data. These analyses illustrated the influence of vegetative canopy cover and litter an rock-fragment ground cover on infiltration rates, overland flow hydraulic resistance, interrill sediment detachment rates, and sediment transport rates in rills. From these results we concluded that the proposed experimental design and analysis procedures will allow determination of rill and interrill soil erodibility and the impact of cover and management practices upon infiltration, runoff, and erosion on rangeland areas in the West.

3. A compilation of data from four western rangeland rainfall simulator experimental sites was made and the data were published in the Proceedings of a Rainfall Simulator workshop held in Tucson, Arizona in January, 1985 (Simanton et al., 1986). This data base represents the largest of its kind for rangeland erosion studies carried out under almost identical experimental design criteria. This allows for direct comparisons among the four ecosystems studied. Rangeland experimental procedures have been finalized and are comparable to cropland erosion study procedures. These comparable procedures will allow for development of basic erosion estimating equations using similar input variables from a very wide range of ecosystems and management alternatives.

   Factors Affecting Rangeland Erosion: Simulator data from a multi-year data base of 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 (Simanton et al., 1986). Erosion amounts were correlated to runoff amount which in turn increased with decreasing vegetation and rock fragment cover (Lane, et al., 1986).

Time Related Changes in Rangeland Erosion: Simulator studies on large plots on semiarid rangeland in southeastern Arizona have indicated that erosion rates per unit of rainfall energy changed with time during a four-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 studies indicated that at least two years of seasonal rainfall simulations were needed before erosion and runoff rates reached equilibrium with rainfall energy input (Simanton and Renard, 1986).

4. The effort to incorporate state-of-the-art knowledge on applying the USLE to rangelands has involved intensive work with rainfall erosivity (R). Investigations have shown that the average annual R algorithm, which Wischmeier and Smith (1978) related to the 2-year frequency, 6-hour amount, has a considerably different value than that measured in other portions of the country (Tracy et al., 1984). Problems are also encountered with estimating the erosive energy accumulated in snow, as well as with estimating the R value in the coastal provinces of California, Oregon, and Washington. Corrections to handle these specific problems have been proposed and/or developed. In a planning session held in Portland, Oregon, at the SCS WNTC, Renard demonstrated that the kinetic energy x maximum 30-min intensity can be approximated from recording raingage data having longer recording intervals than those used in the original development by Wischmeier.

   The results were demonstrated for gages widely distributed around the country. Using this analysis as a basis, the SCS has awarded a contract to J. Istok, at Oregon State University, to systematically develop corrections for approximately 500 USWB gages in the western U.S. which record at hourly intervals, and with this data, develop isoerodent maps for the highly variable climatic conditions of the West. The cover-management factor (C) of the USLE is another major problem on rangeland. Laflen (ARS, Ames, IA), working with ARS simulator data from Tucson and other locations, has developed a subfactor approach for calculating the parameter value which considers prior land use, plant canopy, surface cover (including erosion pavement), and surface roughness. The subfactor approach requires an estimate of the amount of roots in the upper 100 mm of the soil profile. Analyses are also underway, and a paper has been prepared to consider the steeper slopes commonly encountered on rangelands (the LS or topographic factor by McCool (Pullman, WA) and Foster (W. Lafayette, IN). A draft has been prepared of the support practice factor chapter by Foster and Renard which is still undergoing review. The chapter addresses conservation practices which would typically be used in connection with ranch/range management activities.

For additional information, contact Dr. Kenneth G. Renard, Research Leader, Aridland Watershed Management Research Unit, USDA-ARS, 2000 E. Allen Road, Tucson, Arizona 85719.

Literature Cited

Simanton, J.R.; Johnson, C.W.; Nyhan, J.W.; and Romney, E.M. 1986. Rainfall simulation on rangeland erosion plots. Proc. Rainfall Simulator Workshop, Soc. for Range Mgt., Tucson, AZ, Jan. 14-16, 1985. p 11-17, 43-68.

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Lane, L.J.; Simanton, J.R.; Hakonson, T.E.; and Romney, E.M. 1986. Large-plot infiltration studies in desert and semiarid rangeland areas of the southwestern U.S.A. Accepted for publication in Proc. International Conference on Infiltraton Development and Application, Univ. of Hawaii, Jan., 1987.

Tracy, F.C.; Renard, K.G.; and Fogel, M.M. 1984. Rainfall energy characteristics for southeastern Arizona. In: Water Today and Tomorrow. Proc.

COLORADO

Research Activities within the Hydro-Ecosystem Research Unit in Fort Collins, Colorado include the following:

1. Soil losses from intensively cropped fields depend on the rate of sediment production by rainfall and runoff, the transport capability of the concentrated flow, and the size and density of the sediment. Experimental data collected by scientists at the USDA Sedimentation Laboratory show that row-sideslope erosion rates and sediment size distributions vary greatly among typical flatland soils. For bedded fields, the row furrow gradient often is insufficient to transport all sediment eroded from the sideslopes, so much of it may remain in the furrows. A physically-based furrow model was developed, in cooperation with the above scientists, which treats the dynamic interrelations of runoff erosion, soil characteristics, and movement of eroded soil along bedded furrows. Data from a field study of bedded rows with furrow gradients ranging from 0.5 to 6.5 percent was simulated, and the role played by rainfall intensity, soil and furrow parameters were examined. Results from the simulations agree well with the field measurements. These results show that much of the coarsest sediment deposits are at the flatter gradients but that most are carried at the intermediate gradients, and furrow rilling occurs at steep gradients.

2. A modeling study was initiated to investigate techniques for mathematical simulation of morphological evolution of erodible channels. Natural streams are self-regulating in that they adjust their characteristics in response to changes in activities such as agricultural land management or channelization works. As a result of this adjustment streams usually experience aggradation, or bed and bank erosion, or lateral channel migration, or a combination of these. The present study is currently being focused on schemes for simulating erodible channels undergoing both bed deformation and width adjustment within their own alluvium. This capability is a radical improvement over existing models that simulate channel metamorphosis exclusively as a consequence of longitudinal scour and fill. Some of the investigated schemes were tested using laboratory data collected at Colorado State University and the University of Roorkee, India. Results from these preliminary tests are encouraging and illustrate the robustness of the present schemes.

3. A physically-based computer model was developed to quantify the cause and effect relationship between the survival of anadromous salmon species and the quality of aquatic habitat supported by gravel-bed streams. This study was carried out under the sponsorship of SCS. The intragravel stage of the life cycle of salmonid fish is a critical period during which they are most susceptible to injury from high levels of fine sediments in the gravel substrate. Excessive amounts of fines may injure the ova, reduce oxygen supplying intragravel flow, and inhibit the removal of embryo metabolic wastes. Furthermore, increased amounts of fines exert a biochemical oxygen demand that reduces the supply of oxygen to salmonid eggs, and entrap the fry within the gravel as they try to emerge. The present model simulates all the important processes that affect intrusion of fine sediment and dissolved oxygen transport and consumption in spawning habitat. In addition to being the first model of this kind ever developed anywhere, the model is computationally highly

efficient and preliminary validation runs demonstrate that it exhibits the expected response.

4. Sediments eroded from a plot during and after simulated rainfall events of varying intensity and duration were collected using the indoor rainfall simulation facility at the National Soil Erosion Lab, West Lafayette, IN. The soil selected for the study was a forest soil that had been cropped for a number of years. Sediments were analyzed for aggregate size distribution, aggregate stability, and particle size analysis. Aggregates within each of the size classes were analyzed for organic C, N and P content, and are currently being analyzed for labile N and humic acid/fulvic acid ratio. Preliminary results indicate that the organic matter content of macroaggregates eroded from the plot is higher than the organic matter content of eroded microaggregates. These results are in agreement with the findings of other researchers who have analyzed the association of organic matter with aggregate size in grassland soils.

5. A simplified process model which estimates runoff and soil loss from unit surfaces has been developed and tested with a limited amount of field data. The SP model (Hartley, D.M. A simplified process for water and sediment yield from single storms, Part I - model formulation. Accepted for publication in Transactions of the ASAE. Manuscript SW-1278.) simulates an idealized runoff hydrograph and sediment yield from upland surfaces which are homogeneous with respect to their hydrologic and erosion characteristics. Model results have been compared with data from natural rainfall and simulated rainfall plots. (Hartley, D.M. A simplified process model for water and sediment yield from single storms, Part II - performance. Accepted for publication in Transactions of the ASAE. Manuscript SW-1383.). Preliminary results indicate that the model has promise as a runoff and erosion estimation tool. In order to facilitate cooperation with other scientists in further testing and refinement of the SP model, the model has been coded in standard Fortran-77 which will run on most mainframe computers as well as DOS PCs which support Microsoft Fortran version 3.3, its equivalents or higher versions of Fortran-77. The code is well-commented and should present little difficulty to prospective users providing they have access to SW-1278 (cited above) to guide them in selecting parameter values.

For additional information contact Donn G. DeCoursey, Research Leader, USDA-ARS - Northern Plains Area, P. O. Box E, Fort Collins, CO 80522.

GEORGIA

Research activities at the Southeast Watershed Research Laboratory, Tifton, Georgia, include the following:

1. Soil loss and sediment transport as part of an intensive ARS-USGS groundwater study in the aquifer recharge region of the upper Coastal Plain near Plains, Georgia continued in 1986. Rainfall, runoff, groundwater stage, and pond storage and losses are being monitored on three small watersheds ranging in size from 20 to 300 acres. Objectives include evaluation of sediment and associated pesticide movement from lots, field-sized areas and small watersheds. Water quality and sediment transport/deposition from a field-sized area and suspended sediments moving in ephemeral flow areas and from a farm pond are being measured. Results from this study will provide information defining sediment and surface pesticide movement in a groundwater recharge region.

2. A computer method was developed for efficiently coupling long-term rainfall records with short-term rainfall, runoff, and sediment yield data to obtain probability distributions of sediment yield from agricultural watersheds with different cropping-tillage systems. This method, which incorporates a recursive equation derived from probability generating functions, was used with a 34-year rainfall record and short-term data on rainfall, runoff, and sediment yield from three field-sized watersheds located near Watkinsville, Georgia. Several different cropping-tillage systems were in effect on the field watersheds for periods of 1 to 4 years. The developed computer method provided probability distributions of sediment yield for each total-year multicropping-tillage system and for individual crop seasons as well. These computed sediment yield probability distributions provide for evaluating sediment yield risk associated with implementation of the different crops and tillage systems on field watersheds similar to those at Watkinsville, Georgia.

3. A three year study to evaluate soil erodibility, cover factor for peanuts, erosion from raised bed planting systems, and soil crusting in the Georgia Coastal Plain was completed. A rotating-boom rainfall simulator was used to apply rainfall at a rate of 2.5 in/hr to 12'x35' test plots. Minimal differences in erosion rates were observed for plots with 100% plant cover as compared to plots that were bedded, but not planted. Large differences in erosion rates were observed, however, when these plots were compared to freshly tilled plots.

4. Measurements of suspended and dissolved sediments in Little River watershed streamflow to determine the relationship of dissolved and suspended sediment to total sediment were completed. Samples were collected weekly at gaging stations K, F, and B which have drainage areas of 16.7, 114.9, and 334.3 km^2, respectively. Suspended and dissolved sediment fractions were separated using 0.45 millipore filters. Results of the analyses indicate that dissolved solids concentrations generally exceed suspended solids concentrations in the stream systems.

5. Further analysis of Cs-137 data from a 7.25 ha field/forest system showed that about twice as much deposition took place in the adjacent riparian forest as was eroded from the upland field. The excess deposition came in streamflow from upstream areas. Total Cs-137 activity, depth to peak activity, and depth to zero activity increased going downslope from the field to the stream channel.

For additional information contact L. E. Asmussen, Laboratory Director, USDA-ARS, Southeast Watershed Research Laboratory, P. O. Box 946, Tifton, GA 31793.

GEORGIA

Research activities at the Southern Piedmont Conservation Research Center, Watkinsville, Georgia include the following:

1. Concentrated-flow (or ephemeral gully) erosion is responsible for serious gully formation on cropland. Gullies formed by concentrated flows are nuisances because they force farmers to alter tillage practices by filling the gullies before resuming normal field operations or planting the next crop. This cyclic process of gully erosion and the subsequent filling of those gullies reduces crop yield in and adjacent to these drainageways. Two serious limitations in developing a predictive methodology for concentrated flow erosion are the difficulty of conducting field studies and the lack of data on which to base and test models. However, current experimental studies indicate that modern photogrammetric techniques applied to sequential, large-scale aerial photographs keyed to the cropping cycle can be used reliably to determine the volume of soil lost to concentrated-flow erosion. Vertical measurement accuracies of ± 10 mm to ± 25 mm and contour intervals of 0.15 m to 0.30 m have been obtained which permits quantification of erosion and deposition along most field gullies. Presently, we are integrating photogrammetric measurements of elevation, slope, and gulley parameters with information on soil series, profile description, precipitation, and cropping practices to form a data base. These data bases will be used with geographic information systems software to develop approaches that are realistic in understanding processes and establishing models for concentrated-flow erosion.

2. Loss of soil and water resources from agricultural cropland is affected both by rainfall characteristics such as intensity and amount and by conditions of the soil and plant cover. Rainfall characteristics, although somewhat variable with season, are highly variable within season and can only be predicted in probablistic terms for long-range planning purposes. We used short-term data on rainfall, runoff, and soil loss with a 34-year rainfall record from a nearby gage to obtain estimated probability distributions of soil loss and rainfall retention for individual crops grown in different seasons under conventional tillage. These estimated probability distributions were compared to examine the combined effects of season and crop on losses of soil and water resources from Southern Piedmont fields. Comparisons of the estimated probability distributions of soil loss rate for summer and winter crop reveals greater probabilities for high soil loss rates for the summer crop season than for the winter crop season for three study sites. Comparison of estimated soil loss probabilities among sites shows the effects of land slope length and gradient, soil characteristics, and terraces and grassed waterways. These comparisons of estimated soil loss and rainfall retention probabilities provide for evaluating the risks of soil and water losses associated with different crops and seasons on field-sized watersheds in the Southern Piedmont, thereby providing information useful for better resource planning and management.

For additional information, contact Adrian W. Thomas, Research Leader, USDA-ARS, Southern Piedmont Conservation Research Center, P. O. Box 555, Watkinsville, GA 30677.

IDAHO

Research activities at the Northwest Watershed Research Center, Boise, Idaho, include the following:

1. Water year runoff for 1986 was about 130 percent of the 23-year average at the Reynolds Creek Watershed Outlet Station, drainage area 234 km^2 and weir elevation 1098 m. The peak streamflow was 67 percent of the yearly average peak and occurred February 18, 1987; consistent with the usual peak flows from winter snowmelt, rain-on-snow, and frozen soil. The water year suspended sediment yield at this station was 870 metric tons, about 70 percent of average. Apparently, higher than normal streamflows in 1982, 1983, and 1984 have scoured fine sediment from the streambeds and sediment yields per unit of runoff were lower than expected from earlier records.

2. A rotating boom rainfall simulator has been procured for use on sagebrush rangelands in the northwest U.S. to contribute to the Water Erosion Prediction Project (WEPP). Site selection is in cooperation with the Soil Conservation Service and Bureau of Land Management. Plot treatments and simulation procedures are coordinated with other rangeland WEPP studies.

3. Natural runoff-erosion plots have been established at two locations on the Reynolds Creek Watershed, using stockpile soil of known erodibility, zero cover, and 9 percent slopes, to determine equivalent rainfall-runoff erosivity values for snowmelt, rain-on-snow, and frozen soil conditions. Insulated tanks are used to measure winter runoff and soil loss from the plots.

4. Personnel from the Northwest Watershed Research Center assisted in instrumentation to measure streamflow and sediment transport on the Tucannon River in southeastern Washington and in applying the modified USLE to rangelands in the watershed.

5. A study was initiated in sampling, washing, and drying roots to evaluate root biomass for shrub and interspace areas on sagebrush rangelands. Separation of Cryptogams and plant crowns from roots near the ground surface is difficult and causes great variability in results. The influence of roots on erosion needs thorough investigation.

For additional information contact Wilbert H. Blackburn, Research Leader, USDA-ARS, Northwest Watershed Research Center, 270 South Orchard, Boise, ID 83705

INDIANA

Research activities at the National Soil Erosion Research Laboratory in West Lafayette, Indiana, include the following:

1. A national project-the USDA Water Erosion Prediction Project (WEPP)-involving the Agricultural Research Service, Soil Conservation Service, and Forest Service of USDA, the Bureau of Land Management of USDI, USDOE National Laboratories, Universities, and other cooperators is developing new technology to calculate rates of soil erosion, deposition, and sediment yield for field-sized areas. This technology, being developed to replace the Universal Soil Loss Equation, is based on fundamental hydrologic and erosion processes and measurable properties of climate, soil, cover, plant growth, and management systems for land uses including cropland, pastureland, rangeland, disturbed forestland, roads, surface mines and construction sites. The research underway to develop this technology involves field experiments on about 70 soils across the US to develop soil erodibility relationships, laboratory research to better understand the fundamentals of erosion processes, and analytical research to develop the governing mathematical relationships. The core of the hydrology and erosion components of the hillslope segment of the model has been developed.

2. The Universal Soil Loss Equation (USLE), widely used by several agencies to compute sheet and rill erosion, is being revised and updated. This multi-agency project is incorporating data collected since 1978, when the USLE was last revised. Previous analyses used to develop USLE factor relationships are also reviewed and revised. The update will include a greatly expanded erosivity map of the western US based on data from more than 700 weather stations, an extensive reconsideration of soil erodibility, revised slope length and steepness relationships that consider the relative magnitudes of erosion caused by flow and that caused by raindrop impact, a subfactor method based on measurable properties to calculate values for the cover-management factor, cover-management factor values for rangeland, forestland, and disturbed land based on a much expanded data base, and contouring factor values related to ridge height, grade along the ridge, and erosivity of severe storms. A first version of the Users Manual is being drafted for review during the summer of 1987.

3. Deposition of sediment from shallow flow on concave slopes is being studied in the laboratory. These studies showed that particle density is important as well as particle size in determining rates of deposition and how sediment is sorted during deposition. Rainfall on the shallow flow significantly reduced deposition on the concave bed and increased sediment yield from the bed. These studies are being conducted over a range of soil types that produce sediment of widely varying properties. Results from this research are being incorporated in the sediment transport and deposition components of models used to estimate erosion and sediment yield from field-sized areas.

4. Field studies are being conducted to study how crop residue incorporated in the soil and soil consolidation since last tillage affect erosion by raindrop impact and erosion by flow. This research is being conducted over a range of soil types where on some soils, erosion is not expected to change with time as the soil consolidates while on other soils, erosion is expected to decrease by as much as 75 percent as the soil consolidates. Also, field studies were conducted on tillage practices that had been in place for several years to evaluate how soil erosion changes over time after the initiation of conservation tillage. These experiments are being conducted using field plots and rainfall simulators.

5. Laboratory studies are being conducted to develop an improved understanding of fundamental erosion processes. The results show how erosion by raindrop impact is related to properties of the raindrop and to mechanical, chemical, and biological properties of the soil. These studies, which employ both single drop and multi-drop rainfall simulators, are using a wide range of soil samples collected from across the US. Results from this laboratory research are being compared with results from field studies to improve procedures used to evaluate soil erodibility. A laboratory study is also underway to determine how buried pieces of crop residue in the soil can act as grade control structures and reduce rill erosion. A laboratory flume is under construction for detailed studies of erosion by flow.

For further information, contact Harold L. Barrows, Director, USDA-Agricultural Research Service, National Soil Erosion Research Laboratory, Purdue University, W. Lafayette, IN 47907.

IOWA

Research activities at the Watershed Research Unit in Treynor, Iowa, include the following:

1. Long-term records of sediment yield from fields cropped to corn were evaluated to assess the significance of large events in establishing average annual sediment production. 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. Measurement of runoff and sediment yield from two conventionally tilled fields, one reduced tillage field, and one terraced with reduced tillage field, all cropped to corn, continued.

For additional information contact Allen T. Hjelmfelt, Jr., Research Leader, USDA-ARS, Central Plains Area, Watershed Research Unit, 269 Agricultural Engineering Building, University of Missouri-Columbia, Columbia, MO 65211.

MARYLAND

Research activities at the Hydrology Laboratory Research Program in Beltsville, Maryland include the following:

1. Suspended sediments are a major factor affecting water quality in many aquatic ecosystems. Research was undertaken to determine the application of digital spectral data collected by the multispectral scanner (MSS) on the Landsat satellite for estimating suspended sediments in aquatic ecosystems where mean annual concentrations of suspended sediments are greater than 50 mg l^{-1}. Digital spectral data from fourteen MSS scenes of Moon Lake in Coahoma County, Mississippi, were analyzed and compared with ground measurements of total solids and suspended sediments in the lake surface water for the period between January 1983 and May 1985. Coefficients of determination (R^2) greater than 0.81 were calculated between MSS band 2 (0.6-0.7 μm) or band 3 (0.7-0.8 μm) and suspended sediments or total solids. Coefficients of determination for multiple regression using 3 or 4 MSS bands were greater than 0.90. This study showed that digital spectral data from the Landsat satellites can be used to locate and monitor surface suspended sediments in aquatic ecosystems. With such a digital computer technique, entire regions can be surveyed quickly to locate aquatic ecosystems with suspended sediment problems. Conservation efforts can then be concentrated on those aquatic ecosystems with the most serious suspended sediment problems and soil conservation strategies developed in their watersheds to control erosion and sediment yield and thus to improve water quality.

2. An airborne laser was used to measure surface heights over simulated concentrated flow erosion (ephemeral) gullies. Flights were made at altitudes of 50, 100, and 150 meters. Preliminary analyses of the laser data clearly indicated the location, depth, and cross-section of gullies which were approximately 30 cm wide and 15 cm deep. These results suggest that airborne laser technology could be used to detect and monitor gullies caused by concentrated flow erosion. Research continues on developing methods to quantify the amount of soil loss from this type of erosion.

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 at Morris, Minnesota, include the following:

1. AGNPS, an Agricultural Non-Point Source pollution model, has been developed to assess the water quality from agricultural watersheds. It is a single-event based model that works on a cell basis. These cells divide up the watershed into uniform, square areas that are treated homogeneously. The basic components of the model are hydrology, erosion, sediment transport, and transport of nitrogen, phosphorus, and chemical oxygen demand. For each of the cells as well as the entire watershed, calculations are made for runoff volume, peak concentrated flow, upland erosion, and total channel erosion. Calculated sediment is broken down into five particle size classes -- clay, silt, small aggregates, large aggregates, and sand. The pollutant transport portion is subdivided into one part handling soluble pollutants and another part handling sediment attached pollutants. The transport of sediment, nutrients, and flow from the headquarters of a watershed to the outlet are routed in such a manner that the flow at any point within the watershed can be examined. In this way, output information at the watershed outlet can be used to assess the potential pollution hazard posed by the watershed as a whole while critical areas within the watershed needing remedial measures to improve the quality of runoff at the outlet can be pinpointed. Runoff samples from measurable rainfall runoff events were collected at selected locations in seven different watersheds over the past 3 years in order to accumulate data for testing the accuracy of AGNPS. This data, along with additional current data found in the literature, were used to adjust model values of extraction coefficients of soluble N and P in runoff to more accurately reflect measured nutrient concentrations in runoff.

2. A frost model has been developed to predict the rate and depth of frost penetration as well as the timing and rate of frost melt under three tillage systems and two levels of crop residue. The model is based on simple heat flow considerations in a two layer system (snow and soil) and is driven by commonly available average daily temperature and snow depth data. Constant values of snow and soil thermal conductivity, hydraulic conductivity and soil heat capacity are used. Modifications are underway that will expand the two layer system to include tillage and residue layers, that will modify snow thermal conductivity with snow pack density and change soil thermal conductivity, hydraulic conductivity and heat capacity as a function of soil water content. Temperature input data is also to be changed to use average surface temperatures over 4- to 6-hour time intervals. The changes will allow for prediction of the number of surface freeze-thaw cycles and thus give an evaluation of soil erodibility during spring thaw, the amount of water accumulation in frozen soil and the location of ice lenses.

3. A series of studies has been undertaken to develop basic information on how freeze-thaw processes affect soil strength, aggregate stability, and subsequent soil erodibility during this vulnerable period. Three common agricultural soils of Western Minnesota and Eastern South Dakota were studied to determine the effects 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 of each soil using a technique which divides the stability of soil aggregates into their relative susceptibility to breakdown by interrill erosive forces and rill erosive forces. For all soils, stability of soil aggregates to breakdown by raindrop impact forces was not affected by freezing and thawing as much as was their susceptibility to breakdown by runoff forces. Aggregates stability of all soils generally decreased as the number of freeze-thaw cycles increased. The soils with higher organic matter content, responded more to this treatment than did the silt loam which had very little organic matter. Moisture content at time of freezing affected the aggregate stability of all soils. Maximum stability was achieved when the loam and clay loam soils were frozen at about 1/3 bar tension and the silt loam soil was frozen at 1/10 bar tension. With all soils, aggregate stability decreased as soil became drier, reaching a minimum at 15-bar tension.

4. The erodibility of partially thawed soil under fall moldboard plow and fall chisel plow tillage each with and without residue was investigated. Sixteen plots were installed before fall freeze up. Neutron access tubes were installed for soil moisture readings and CRREL frost tubes were installed in a manner allowing measurement of both soil frost and snow depth over winter. Initial surface roughness measurements were also recorded. During spring thaw a rainfall simulator was used to apply water at the rate of 6.4 cm/hr to the plots at different stages of soil thawing. Soil moisture (0- to 30-cm depth), depth to frost, surface roughness and bulk density was determined just prior to rainfall application. Total water applied, total runoff, sediment yield and mean weight diameter of eroded aggregates were measured for each application. Marked and unexpected differences between the two tillage treatments were found. The fall chisel treatment gave, with one exception, the greatest runoff and the highest rate of soil loss. The exception was the 100% runoff with relatively little soil loss that was recorded from the fall plow-no residue treatment. The data recorded raises questions that are being investigated further.

5. Preliminary evidence suggests that soil aggregate stability is altered following soybeans or sunflowers when grown in normal rotation. In 1982, field plots with four replicates each of corn-soybean and wheat-sunflower rotations were established to study the effects of microbial activity and soil organic matter on soil aggregates stability and soil and nutrient losses. Sampling and analyses were initiated during the 1983 growing season. Each season, weekly samples have been collected for total organic matter, water soluble organic matter, and microbial respiration rate measurements. Residue bags have been placed at depths of 0, 4, and 8 inches for biweekly retrieval for 6 months each year, from early fall to freeze-up and spring thaw to mid-summer, to study the rate of residue decomposition. Qualitative and quantitative determination of total and water soluble polysaccharides from soils on these plots are also being made. Each year simulated rainfall from a rainulator has been applied to the plots during the growing season to induce soil loss and runoff. When simulated rainfall was applied early in the growing season, the plots planted to soybeans or sunflowers the preceding year averaged two to four

times greater soil losses than did the plots which had been planted to corn or wheat. With canopy development, the differences decreased. Stability measurements indicate about a 25% reduction in aggregate stability on the corn plots which had been in soybeans the previous year. Preliminary analysis of the data suggest that with corn and wheat the amount of organic matter entering the soil is relatively constant through the growing season. However, the amount of organic matter entering the soil when soybeans and sunflowers are growing decreases through the growing season.

6. Trials of three tillage systems: (1) conventional -- fall moldboard plow, spring disk; (2) fall chisel plow, spring field cultivate; and (3) ridge till were conducted with monitoring of soil physical and chemical properties as related to management systems with particular emphasis on soil erosion induced changes. A corn-soybean rotation was established with each crop grown in alternate years. Corn was the rotation crop for the 1986 crop year. Trial sites are located on a Ves loam on three slope positions -- 8% slope, 4% slope, and 1% slope. Detailed examination of the trial areas show the majority of the soils to be in a slightly eroded condition. Planting direction is both up and down slope and sideslope for the steeper slope positions. Detailed topographic data were taken on all plot sites, both upland areas and grass land border strips at the base of each plot for estimation of yearly erosion. Grass land border strips are 40 feet wide. Preliminary analysis of soil physical properties was initiated, but samples were limited to the surface horizon. High moisture content of subsurface horizons would not allow adequate sampling. No significant yield differences between tillage systems or row direction was noted. Exceptionally high corn yields were measured on all plots due to higher than normal rainfall. Overall plot average yield was 175 bu/a. Soil test analysis and other observations indicate that no differences in management will be required for the various treatment for the 1987 crop year.

7. An infiltration model was developed using the Green-Ampt approach for disturbed soils subject to surface sealing and consolidation. The soil is modeled as a three-layer profile, including: (1) the surface layer, which is subject to surface sealing, (2) the tilled layer, which is subject to consolidation, and (3) the untilled layer, which is assumed to extend infinitely downward. During an infiltration event, the wetting front passes from the surface layer, through the tilled layer, into the untilled layer. At the time of ponding, the wetting front can be in any of the three layers, depending on the soil conditions and hydraulic parameters. The input data required by the model can be divided into three categories: rainfall parameters, soil parameters, and calculation Parameters. The model is written in FORTRAN and consists of the main program and five subroutines. The model although usable is still undergoing testing.

For additional information contact Charles A. Onstad, Director, USDA-ARS, North Central Soil Conservation Research Laboratory, North Iowa Avenue, 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. A comprehensive series of rough-bed flume experiments has been completed, in which both the time-mean and the turbulent fluctuation features of the velocity profile have been investigated in detail. The data acquisition requirements and the displayed data characteristics encountered during these experiments have been used as the design constraints for an extensive data acquisition and analysis computer program (VELMEAS). The program includes capability for (a) primary data acquisition; (b) Probability Density Function (PDF) display; and (c) statistical analysis of PDF, including calculation of the mean, mode, standard deviation, skewness, and kurtosis. The statistical computations are done by calculation of the first to fourth moments of the PDF, introduction of the Shepard's corrections, and computation of the beta and gamma parameters. This results in a most general statistical analysis, suitable for use with any kind of PDF, and not inextricably tied to assumptions of normal distribution. The program also includes capability for boundary layer shear flow analysis by powerful objective regression and iterative fitting techniques that remove elements of subjectivity from determination of velocity profile virtual origins, determination of the effective thicknesses of the inertial and wake regions, and determination of values for the Karman coefficient, the profile intercept, and the wake strength coefficient. Although the process is not yet complete, the program will ultimately be produced in a portable non-machine-dependent form suitable for acquiring and analyzing any data signal that can be transduced into a voltagle signal, and not just velocity profile data.

2. The technology Applications Project (TAP) in the Watershed Processes Research Unit at the USDA Sedimentation Laboratory is developing a surface and subsurface topographic analysis facility to allow the computer-oriented evaluation of overall watershed conditions such as drainage net characteristics, statistical analysis of relief, spatial statistics of surface and subsurface soil types, seasonal and yearly land use, sediment production, and other features. Emphasis is on rapid automated analysis of remote-sensed information to allow SCS planning parties or management bodies of drainage or soil conservation districts to develop rapid response time in planning soil conservation and flood control programs, with appropriate weighting of all significant factors such as watershed cropping capability, watershed ecology, economy, and demography.

3. Development of mathematical models to predict the amounts of insecticides that will be transported in runoff from farm fields has been hindered by a lack of knowledge of certain processes, including (i) insecticide disappearance (volatilization and degradation) from plants after spraying and (ii) the amount of insecticide washed from plants by rainfall. When

rain occurs after an insecticide has been applied, pest control may be reduced, depending on the amount of insecticide washed from the plants. Simple equations were developed describing (i) the disappearance rates of methyl parathion, toxaphene, and fenvalerate from cotton plants and (ii) the amounts of these compounds washed from the plants by simulated rainfall as functions of time after application and loads on the plants. This information will improve the accuracy of predictions made in mathematical model simulations of foliar washoff and routing, and will aid in developing guidelines for respraying for pest control following natural rainfall or overhead irrigation. Methyl parathion and fenvalerate are used extensively for cotton insect control in the South during July, August, and September -- months of high intensity thunderstorms. Toxaphene was used extensively in the U. S. prior to 1983 and is still used outside the U. S.

4. Agricultural runoff from seven crop and tillage practices were studied to determine the 5-d biochemical oxygen demand (BOD_5). Mean BOD_5 concentrations for the practices ranged from 10 to 25 mg O_2 L^{-1} as compared to 4 to 56 mg O_2 L^{-1} for individual storm events. In general, there was no difference in BOD_5 concentrations between conventional and no-till practices. Biochemical oxygen demand-time relationships were found to best fit a first-order reaction equation. The aqueous phase was the dominant source of BOD_5, amounting to 64 > 17% (1SD) of the total BOD_5 in runoff from no-till soybeans, double-cropped with winter wheat (Triticum aestivum L.). However, additional data indicate that conventional tillage practices, producing higher sediment concentrations, may result in a greater proportion of the BOD associated with the sediment phase.

5. Low-drop grade control structures are often used in high gradient streams to control channel erosion caused by headcutting and bank failure. Stilling basins located immediately downstream from these grade control structures are designed to dissipate the energy of water flowing through the structures. Fisheries characteristics of stilling basins associated with grade control structures were examined in an ecological evaluation of stabilization measures installed in a demonstration erosion control project (DEC) in Bluff line streams of the Yazoo River headwaters in North Mississippi. Two positive environmental attributes of these pools were (1) greater growth and fisheries potential than natural scour holes found in these streams and (2) the incorporation of permanent pools into channels whose features are mainly transient. These permanent pools provide an improvement in fisheries resources and an environmental enhancement for rural America in addition to controlling channel erosion problems.

6. A study of an intensively cultivated alluvial watershed found that seven years after spraying had ceased, DDT was still available to surface waters in streams and lakes and aquatic life by way of eroded soil from farm fields and deposited sediments in stream and lake bottoms. Low concentrations of the pesticide were persistent from headwaters to mouth of the stream. Residual pesticide concentrations increased during periods of maximum runoff which corresponded with the winter rainy season and minimum vegetative cover on the soil. No significant declines in

concentrations of DDT in surface waters were found in comparisons with two earlier studies nor were any declines in surface water contamination noted during this three year study. However, concentrations in fish flesh were significantly less than those recorded in previous studies. Knowledge of pesticide sources and sinks can benefit action and regulatory agencies on a state and federal level in interpretation of field data. Documentation of the long-term residual nature of DDT suggests that regions of the world where DDT is still used routinely cannot expect any short term disappearance after use ceases.

7. Studies in the Mississippi Delta showed that about 85% of the sediment outflow was clay from both a 259 ha watershed located near Greenville, MS, and a 37 ha watershed located near Clarksdale, MS. Total sediment lost from the larger watershed was 5.2 t/ha and 6 t/ha from the smaller watershed. These findings are particularly significant because most of the farm chemicals transported in runoff are carried by the clay fractions of sediment.

8. Sediment sizes in runoff were measured from slope lengths of 23 to 183 meters on a low slope of 0.2 percent. No difference in sediment sizes was found due to slope length. However, over 70% of the sediment clay was carried in aggregates of silt and sand size. Also, the total sedimen lost was composed of 40 % more clay than was found in the surface soil. These results are essential for improving prediction models of erosion on slopes and from fields.

9. Sediment loads have been measured since 1980 for most flow events in the Goodwin Creek Research Watershed, a subwatershed of the Demonstration Erosion Control (DEC) Project. These measurements reveal variability in the loads for any depth of flow with standard deviations on the order of the average load for that depth. Such variability precludes reliable single-event estimates of the sediment loads, but averages for each quarter-foot depth increment have defined average regression equations that may be used to estimate the expected long-term yields of fines and sand-size sediment for typical or hypothetical flow event.

10. Ratings have been improved for the supercritical-flow flumes that are being used in the Goodwin Creek Research Watershed (a DEC subwatershed) to facilitate flow and sediment load measurements. These structures were designed to provide stable flow ratings and cause the sediment to be conveyed through them in suspension when supercritical flow is maintained. Variable downstream conditions from some of these structures alter the theoretical ratings and flume model tests revealed no unique ratings adjustment although they verified the theoretical ratings for continually accelerating flow through the structures. Peak flows through all upstream and downstream structures were found to be correlated with a correlation coefficient greater than 90%. Consequently, rating adjustments for suspect conditions in a particular structure are adjusted by weighting discharge-per-unit-area coefficients of nearby structures.

11. Erosion by concentrated runoff was measured for row furrow with gradients of 2, 3-1/2, 5, 6-1/2, and 8% at eight flow rates equivalent to runoff from row lengths up to about 100 meters. Scour erosion was minor at 2%,

but it became serious at 3-1/2% and was severe at steeper gradients. Much of the sediment from the silt loam soil eroded in the form of aggregates, some as large as 25 mm at the higher flows on the steeper gradients. Results from this research provide row-grade limitations necessary to control rilling and help identify erosion control practices that are effective on sloping cropland.

12. Ephemeral Gully Erosion Equals Sheet/Rill Erosion. Ephemeral gully erosion produced about one half of the total soil loss from a 4.7 acre gaged field site planted in soybeans. In contrast to erosion such as estimated by the USLE, ephemeral gully erosion is largely dependent upon concentrated flow magnitudes and, for this site, runoff rates varied directly with within-storm rainfall rates. Studies are being implemented to more fully define the relations between ephemeral gully erosion and short-time runoff rates. A topographic model has been developed to define flow concentration zones within a field-sized drainage area. Results of these continuing studies will improve the accuracy of erosion assessment programs, such as the NRI, and will contribute to the design of more efficient on-site erosion abatement programs.

13. Mathematical analysis of rain infiltration in soil profiles for a variety of profile and rainfall conditions is continuing. The analyses are based on seeking integral solutions of the Richards' equation using a spectral series approach of wetting front expansion. Recently, a closed form, implicit expression for incipient ponding was obtained for a homogeneous soil profile subjected to rainstorm of nondecreasing rainfall intensities. The expression yields ponding time as a function of soil hydraulic (saturated hydraulic conductivity, diffusivity function) and rainfall characteristics (rainfall intensity at incipient ponding; cumulative rainfall).

For additional information contact Neil L. Coleman, Director, USDA-ARS National Sedimentation Laboratory, P. O. Box 1157, Oxford, MS 38655, telephone 601-232-2900.

MISSOURI

Research activities at the Watershed Research Unit program in Columbia, Missouri, include the following:

1. A rainfall simulator was constructed and field tested to rain on an area 1.0-m wide by 10.0-m long. A single row of 8100 V-jet nozzles delivered rainfall to the soil at variable rates depending upon the delay time between oscillations. Inflow was added at the upper end of each plot to simulate runoff from different upland slope lengths. Runoff erosivity is represented by the equation: $D_r = k_r(T_e - T_{cr})$, where D_r is the soil detachment rate in the rill, k_r is the soil erodibility value, T_e is effective shear stress, and T_{cr} is critical shear stress. A study using this rainfall simulator was conducted on a Mexico silt loam (Udollic Ochraqualf) to evaluate how different levels of incorporated residue (from 0 to 5000 kg/ha) and soil consolidation by wetting and drying affect soil detachment. Results from this study and other studies using this rainfall simulator will provide relationships needed to develop physically based erosion models.

2. Runoff, soil, and dissolved phosphorus (P) losses were measured from no-till soybeans grown with cover crops of: 1) chickweed, 2) canada bluegrass, and 3) downy brome. Each cover treatment was replicated twice in a completely randomized design. Canada bluegrass and downy brome reduced soil losses about 90% when compared to the check (no cover crop) treatment. Dissolved P concentrations in runoff were over 50% higher from the canada bluegrass and downy brome treatments than from the check. In another study, runoff and soil losses were measured from 28 corn and soybean cropped plots. Characterization of soil and residue conditions after tillage and over time continued. An equation was developed to predict soil microrelief as a function of cumulative rainfall since tillage. Changes in soil porosity as influenced by tillage and rainfall were determined. Residue cover was measured after each primary and secondary tillage operation. Adequate prediction of soil detachment and transport depends on a thorough knowledge of how tillage, cropping, and rainfall alter soil and residue conditions.

3. Precipitation, erosivity, runoff and soil loss amounts from a 24-year period of conventional and conservation tillage of corn grown on claypan soil were analyzed by cropstage periods of rough fallow (F); seedbed (SB); rapid growth (P1&2); reproduction and maturation (P3); and residue (P4). Summary statistics showed the amounts to be highly variable year to year. For all cropstages, mean runoff from the conservation tillage treatment was less than that for conventional tillage. However, the difference was statistically significant ($p < 0.05$) only for cropstages SB and P4. The most substantial difference in runoff between the tillage treatments was in cropstage SB, where mean runoff for conservation tillage was 33% less than that for conventional tillage. Except for cropstage F, mean soil loss for conservation tillage in each cropstage was less than soil loss for conventional tillage. The difference was statistically significant ($p < 0.05$) in cropstages SB, P1&2 and P4. As

observed for runoff, the greatest effect of tillage on soil loss was also in cropstage SB when there was little plant canopy protection of the soil surface. The remaining residues and chisel tillage of the conservation tillage treatment were very effective in reducing runoff and soil loss in this period compared to conventional tillage methods.

For additional information contact Allen T. Hjelmfelt, Jr., Research Leader, USDA-ARS, Central Plains Area, 269 Agricultural Engineering Building, University of Missouri-Columbia, Columbia, MO 65211.

NEBRASKA

Research activities at the Soil and Water Conservation Research Unit at the University of Nebraska-Lincoln, Lincoln, Nebraska, include the following:

1. Size distribution of sediment was measured under simulated rainfall conditions at selected downslope distances on plots with corn residue rates ranging from 0.00 to 6.73 t/ha. The formation of rills caused increases in the percentage of larger sized sediment material. Greater surface cover usually resulted in an increase in the percentage of smaller sized sediment. Considerable variation in the size of sediment from both rill and interrill areas was found with downslope distance. On interrill regions, the presence of residue served to reduce sediment size along the entire plot length. Transport of aggregated sediment occurred on each of the residue treatments.

2. A rainfall simulator was used to measure the effects of varying rates of sorghum and soybean residue on runoff and erosion. In general, increased surface cover caused reduced runoff, sediment concentration and soil loss. Substantial reductions in erosion resulted from the use of small amounts of crop residue. Regression equations were obtained which related surface cover to residue mass. Equations describing relative runoff, sediment concentration and soil loss as a function of surface cover were also developed. Runoff, sediment concentration and soil loss were all found to be highly correlated to surface cover.

3. Because of the relatively large sediment concentrations sometimes found on upland regions, adsorption of fluorescent dye onto sediment may be of concern. A laboratory study was conducted to identify the effects of sediment and dye concentration on adsorption. Sediment and dye concentration were both found to significantly affect adsorptive dye loss of rhodamine WT and sulpho rhodamine B. Regression equations were developed which related dye adsorption to sediment and dye concentration. For a particular soil and dye material, regression equations may be used to correct for adsorptive dye loss. Sulpho rhodamine B is recommended as the dye of choice for the given experimental conditions.

For additional information, contact James F. Power, Research Leader, USDA-ARS, University of Nebraska, Room 122 Keim Hall, Lincoln, NE 68583-0915.

OKLAHOMA

Research activities at the Water Quality and Watershed Research Laboratory in Durant, Oklahoma, included the following:

1. Accurate predictions of sediment and associated nutrient transport are important from land use, management, and environmental standpoints. To predict sediment yield for individual runoff events the Modified Universal Soil Loss Equation (MUSLE) was employed for 23 grassed and cropped watersheds in the Southern Plains over study periods of 3 to 5 years. Use of MUSLE involved both measured and computed runoff energy factors. Corresponding losses of soluble P were predicted using a soil P desorption equation, and particulate P and N losses were predicted using a relationship between enrichment ratio (nutrient content of sediment/source soil) and soil loss. In general, the results indicate that MUSLE and the nutrient equations provided realistic estimates of sediment and nutrient transport in runoff.

2. Two basic scale watersheds in the Washita River Basin, in Oklahoma, Winter Creek and the Little Washita River were analyzed to determine the impacts of floodwater retarding structures on the sediment loads delivered to the main stem of the river. The SWRRB model was used to simulate the daily flows, peak rates, and sediment loads with and without the structures installed. The results from the simulation model were compared with measured flow and sediment loads from each of the watersheds. The Little Washita watershed simulation showed a reduction of approximately 29 percent in sediment yield due to structures installed during the period 1973 to 1983. Similarly, a 19% reduction was found on Winter Creek for the period 1966 to 1977. Conventional techniques for analyzing offsite impacts applied to the Little Washita data had shown no significant reduction in sediment yield due to structures. The results are discussed in relation to climatic variability on watershed treatment measures and the value of using a simulation model as a tool to identify offsite impacts.

3. Eleven miles (18.3 km) of the Sugar Creek channel were dredged in 1967. Because the channel gradient, .0015 foot per foot, was too steep for the sandy alluvium, across sectional area of the channel nearly doubled in two years. By 1969, maximum deposition on the lower end of Sugar Creek and in the Washita River was 6 feet, and the deposited volume was 650 acre-feet. By 1973, much of the deposition from Sugar Creek had been transported downstream, and the new bed was parallel to and approximately two feet higher than the bed of 1966.

   To reduce the erosion taking place in the dredged channel Kellner jacks, riprap, tree plantings and fencing were installed. After several years, most of the dredged channel had stabilized. However, bank and bed erosion are still taking place further upstream as a result of the dredging. Within the Sugar Creek valley, the water table has been lowered and flooding has virtually been eliminated. Thus, much of the former Bermuda grass pasture has been replaced by higher value crops.

The Tonkawa Creek channel was dredged for 3.6 miles (6 km) in 1973. This channel has 1.4 miles (2.3 km) of .0016 gradient and 2.2 miles (3.7 km) of .0007 gradient, and riprap was installed on the banks soon after dredging. Also, Tonkawa Creek has only 10 to 15 percent as much flow volume and peak as Sugar Creek. Thus, there have been no erosional problems within the Tonkawa Creek channel.

4. Soils of the world are labeled with cesium-137 as a result of fallout from nuclear tests. The radioactive cesium moves with the clay because it is tightly adsorbed. Therefore measurements of the redistribution of radioactive cesium can be used to estimate erosion and sediment deposition rates. Measurements of cesium-137 concentrations in uneroded soils across the southern U.S. indicated that the cesium-137 input was proportional to the average annual rainfall. Vertical distribution of cesium-137 within the profile was related to soil properties rather than to rainfall. Cesium-137 concentrations decrease exponentially from the surface downward in uncultivated soils but concentrations are uniform throughout the plow layer of cultivated soils. Therefore, different techniques are needed to measure erosion rates on cultivated land, forest land and range land. Similar concentration profiles in a forest and an adjacent clear-cut area with steep slope in Oklahoma indicated little erosion or mixing of the soil profile by the forest harvesting procedures. Comparisons of total cesium-137 activities in a forested area and a nearby peanut field in the coastal plain of Georgia indicated extensive losses of clay from the cultivated field. Thus, techniques for accurately estimating volumes of soil need additional refinement but the method shows promise as a useful tool for measuring soil loss and sediment deposition and for understanding erosional processes.

5. Rainfall, runoff, and sediment yield were measured from a .599-ha gullied watershed with a gullied area of 22%. Rainfall, total watershed runoff, runoff from the ungullied area of the watershed, and runoff volume times peak runoff rate for 72 storms were fitted by linear and logarithmic least square analyses to the sediment yield from the gullied area of the watershed. The equations developed were used to predict sediment yields from the gullied area for comparison with measured yields for 64 storms. Runoff volume times peak runoff rate explained a larger percent of the variation in sediment yield from gullied area than the other variables. Negative yields were predicted by four of the linear equations at low values of the independent variables. There was a trend with all of the equations for the error to increase as the independent variable increased. Predictions errors were as high as 80 to 90% for some of the larger storm events. The unexplained variation is due to changes in the susceptibility and availability of material for erosion and transport and to changes in watershed hydrologic conditions.

6. Runoff and sediment yields were correlated to watershed drainage densities derived by various procedures for 17 watersheds in the U.S. Southern Plains. The best correlations, $r2 = 0.88$ for runoff and $r2 = 0.83$ for sediment yield, resulted with drainage densities determined with a remote sensing technique using aerial photography. The procedure used to determine drainage density is described in detail because drainage density

is affected by the scale of the base map or aerial photo, the magnification of the viewing instrument, and the definition for an initial channel. These relationships, proven only for U.S. Southern Plains watersheds, will be useful for prediction purposes if similar correlations are found for the other areas.

7. Research concerning the remote sensing of suspended sediment in surface waters has been carried out in three stages: 1) laboratory measurements were made under carefully controlled conditions using a large optical tank facility where sediments collected from two different impoundments were suspended, 2) hand held spectroradiometer measurements were made at 25 nanometer intervals in the visible and near infrared spectrum over impounded water containing various concentrations of suspended sediments, and 3) data obtained from over thirty environmental satellite (LANDSAT) scenes over a period of four years were analyzed, and correlated with ground truth data. The laboratory and hand held radiometer results show that reflectance in the near infrared region, 700-950 nanometers, is nearly proportional to suspended inorganic sediment concentrations. The LANDSAT data show definite but lower correlation with suspended sediments at the same near infrared wavelengths with the added benefit of providing a synoptic image.

8. Because of concern about agricultural chemicals and heavy metals accumulating in valley alluvium within a large, dominantly agricultural river basin, about 54,000 hectares (133,000 acres) in southwestern Oklahoma, alluvial cross-section deposits were sampled and compared to associated upland soil materials. Parameters measured included plant nutrients (N, P, K), soil reaction (pH), pesticides (organochlorides, organophosphates, and phenozys), heavy metals (As, Cd, Pb, Th, and U), particle-size distribution, and fallout Cs-137 (to estimate sediment deposition). Plant nutrient contents, except for K, tended to be lower in the alluvial deposits than in the soils. Differences in pH were minor. No problems with pesticide residues were evident. The low and/or uniform heavy metal contents indicated no lingering, deleterious impact from mining or industrial activities. Particle size and Cs-137 data indicated a preferential sorting and deposition of sediment materials, with the fines moving farther downstream. Generally, results indicated a decreasing removal of plant nutrients and other chemicals from the upland soils during a recent 5-year period with improved soil conservation practices.

For additional information contact Frank R. Schiebe, Director, USDA-ARS, Southern Plains Area, P. O. Box 1430, Durank, Oklahoma 74702.

PENNSYLVANIA

Research activities at the Northeast Watershed Research Laboratory in University Park, Pennsylvania, include the following:

1. Conventional analysis of potential sediment yield on mined and reclaimed areas requires estimates of soil loss either on annual or design storm basis. Conservation practices and holding ponds subsequently put in place may be either over- or under-engineered for a particular location. The study examined in detail probability that a 6.8 ha (16.8 acre) site may exceed a predetermined soil loss cutoff value for a 1-yr-24 hr. design storm. Computations were carried out using recently developed erosion-deposition model and probability kriging algorithms. Results showed potential zones of soil depletion and accretion, ranking them in terms of probability of occurrence. Biomass productivity of reclaimed topsoil was computed and effect of changes because of erosion or deposition were examined.

For additional information contact A. S. Rogowski, 111 Research Bldg. A, 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. Testing and refinement of EPIC continued, and now the model is near completion. During 1986 an interactive data entry system, EASE (Entry and Assembly System for EPIC) was developed. Both EPIC and EASE computer programs were adapted to PC applications. The rainfall simulator was made more generally applicable by installing an exponential distribution to replace the skewed normal when data are limited. Also a technique was developed to estimate wet-dry probabilities from average number of rainy days. New components were developed for simulating furrow diking and water table dynamics. The water table is driven by 30-day moving accumulation of rainfall and potential evaporation. The percolation component was modified to provide potential upward water movement when field capacity is exceeded.

2. The EPIC crop growth model was modified to increase the sensitivity of economic yield to drought and temperature stress. The EPIC soybean N fixation model was developed and tested in collaboration with French scientists. The effect of temperature stress during corn grain filling was studied as a possible explanation of yield differences between midwest and southern states. Data analysis showed that conversion from intercepted photosynthetic active radiation to biomass ranged from approximately 3 $g \cdot MJ^{-1}$ for sorghum, rice, and wheat to 3.9 for corn and sunflower. A general system was developed to predict anthesis and maturity of corn, sorghum, rice, and wheat.

3. Work continued on developing and testing the SWRRB model. Various components of the SWRRB model were tested, including ET, crop growth, peak rates, transmission losses, return flow, and sediment routing.

   An ephemeral gully erosion model was added to SWRRB. It operates on a landscape with three separate slopes and accounts for deposition and degradation in the channel. Deposition is a function of sediment fall velocity and degradation is based on Bagnold's Stream Power Concept.

   An expert system was developed to aid in estimating surface runoff and in spillway design.

   The off-site effects of erosion were studied and modeled for a large watershed in Dallas, Texas. Field data and computer simulations were used to determine the effects of urbanization on basin water yield and reservoir sedimentation.

For additional information contact Jimmy R. Williams, Hydraulic Engineer, USDA-ARS, P. O. Box 6112, Temple, TX 76503-6112.

WASHINGTON

The following research is being conducted by the Land Management and Water Conservation Research Unit at Pullman, Washington:

1. Analysis has been completed on 10 years of rill erosion data collected from rainfed cropland of the Pacific Northwest. The analysis provided relationships for the effect of slope length and steepness on erosion from steep croplands under conditions of thaw-weakened soil.

2. Runoff plots have been installed at the Palouse Conservation Field Station at Pullman 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) determine the effect of crop treatments on runoff and soil loss; (2) determine the effect of slope length on relative magnitudes of sheet and rill erosion; and (3) develop a residue effectiveness relationship. Instrumentation includes frost depth gages to determine the effect of crop treatment on frost depth and subsequent runoff and erosion during periods of thawing soil.

3. A subfactor method of determining crop management factors (C factor in the USLE) has been developed and output is being used by SCS in Idaho, Oregon, and Washington. Nine years of runoff and erosion plot data from the Palouse Conservation Field Station at Pullman is being used to substantiate and improve the method. Work is continung to improve the consistency of the data and to apply the method to additional crop rotations.

4. Shallow frozen soil is a major factor causing runoff and severe erosion in the Pacific Northwest and other States of the U.S. where intermittent frost occurs, but is very unpredictable due to many influences in a short time span. A detailed mathematical model has been developed and tested which computes a simultaneous solution of the vertical soil heat and water (SHAW) budget for two meters above and below the soil surface to account for the hourly impacts of climate, residues, snow cover, and tillage. This research model has proven to be quite accurate on farmland studies over two test years. Further parameter methodology and sensitivity analyses will aid in broader applications.

5. 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, which provide critical shear strength and rill erodibility data, will be used to improve winter erosion prediction with runoff/erosion models.

6. Breakpoint precipitation data are extremely sparse in the western U.S. This has necessitated calculating rainfall erosivities from an empirical relationship. A recent study indicated the feasibility of using 15- and 60-minute precipitation data to estimate EI values that would be calculated from breakpoint rainfall data. Research is being conducted to apply the method to the entire western U.S. where orographic effects and the scarcity of data have hampered efforts to improve erosion prediction.

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

Orville Tonasket Pump Intakes. - A 1:32 scale model was used to help investigate ways to reduce sediment passing through pod well screen type intakes. Part of the study was done to observe the nature of deposits around and near the pod support pier structure. Suspended sediment was simulated with light weight sediment to help investigate vertical distribution of sediment and how it relates to the pumping problems and possible solutions.

CORPS OF ENGINEERS

The Hydrologic Engineering Center

The U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC) continued to be active in research and applications of numerical modeling procedures for river mechanics in 1986. HEC assisted the Portland and Sacramento Districts of the Corps in application of two-dimensional hydrodynamic and sediment models. The Portland application involved analyzing methods for reducing maintenance dredging in the lower Columbia River. The Sacramento application involved the design of a sedimentation maintenance plan for the Cache creek settling basin.

Work continued on improving the capability for simulation of mud flows. This work is motivated by concern arising from control of sediments on Mt. St. Helens and FEMA needs for improved floodway definition that arose from mud flow events in Utah in 1983. Numerical model development has proceeded utilizing both one- and two-dimensional approaches. The HEC coordinated a physical laboratory experiment performed by the University of California at Davis designed to obtain data to improve the description of friction losses in the numerical models of mud flows.

A project was initiated for FEMA to investigate the applicability of the floodway concept to certain unique situations. Some of the situations involve sediment transport concerns such as: alluvial streams, braided streams, and alluvial fans.

The HEC continued routine maintenance and support of the computer program HEC-6 "Scour and Deposition in Rivers and Reservoirs." A microcomputer version of the program was developed and sent to several sites for testing. Public release of the microcomputer version is scheduled for 1987.

CORPS OF ENGINEERS

Waterways Experiment Station

Title of Study:

Barrier Island Sedimentation Studies

Point of Contact:

Mr. F. Anders and Mr. M. Byrnes, WESCR-PM

Water Resources Region:

All barrier coastlines

Summary of Accomplishments:

A technical report entitled "Sediment Budget for Isle Dernieres, LA" was published. A final draft for a miscellaneous paper entitled "Annotated Bibliography of New Jersey Coastal Geomorphology" was completed and sent to OCE for review. Two CETN's; "Shoreline Mapping Techniques," and "Remotely Operated Sediment Coring (ROSCO) System" were published. The following reports have been through a first draft and are currently undergoing internal review: an annotated bibliography on sea level rise (TR), an engineer manual on beach erosion and shoreline restoration, a shoreline change history of the Delmarva peninsula (TR), the sedimentology, stratigraphy, and relative sea-level history of the Virginia barrier islands (TR), the geomorphic response of inlet dominated barrier island systems to sea-level rise (MP), and a technical report on the exchange of sediment between a beach and shoal in Florida (TR). Field data was collected on the beach and in the nearshore zone during the SUPERDUCK experiments. Offshore vibracores were collected from the shoal field at Ocean City, MD, as were numerous beach and nearshore sediment samples for immediate analysis in a beach-fill investigation and future analysis of shoal origin and migration. Data was assembled and analyzed for shoreline change studies of northern New Jersey, South Carolina, and Homer Spit, Alaska. A manuscript was submitted and accepted in Environmental Management, and four pages were accepted for presentation and publication in Coastal Sediments '87. One presentation of work in progress was made to the American Geophysical Union.

Title of Study:

Field Measurement of Sediment Transport Rates in the Nearshore Zone

Point of Contact:

Dr. N. Kraus, WESCR

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 (SUPERDUCK) held at the Coastal Engineering Research Center's Field Research Facility. A technical paper on sample weighing method was published. A full-scale laboratory flume experiment on the characteristics of the sediment trap was performed. At SUPERDUCK, six or seven 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 preliminary analysis of the DUCK 85 data was made. The transport rate data were found to be of high quality and very consistent. A more accurate sediment transport rate formula than the one presently used was developed.

Title of Study:

Physical Hydraulic Movable-Bed Modeling

Point of Contact:

Dr. J. Fowler, WESCW-P

Water Resources Region:

Coastlines with sediment transport

Location:

WES; Field Research Facility, Duck, NC

Objectives:

To evaluate state-of-the-art technology in movable-bed modeling of coastal processes and to define/improve limits of accuracy and applicability.

Summary of Accomplishments:

Coastal Engineering Technical Note on Two-Dimensional Movable-Bed Models and appropriate uses of these. The guidance contained in this CETN is based on results of movable-bed flume tests conducted during FY 85 and FY 86. This will allow improved understanding of how movable-bed flume studies are conducted and the circumstances under which they should be used. This will be expanded to include three-dimensional models as additional testing and analysis is accomplished.

Annotated Bibliography on Physical Movable-Bed Models. This report will be of great assistance for any researchers doing work in the physical modeling of sediment transport field. It will also be useful as a source of information to Corps districts or others who require a physical model as part of planning and design of coastal projects.

Two-Dimensional Model Tests of Various Sand Sizes. Thirty-two flume tests were completed during the period Aug 86 thru Dec 86. The purpose of these tests was to compare the effect of sand size on profile development in movable-bed model tests. As these results are compiled and evaluated, additional guidance will be provided to standardize testing procedures in this area of study.

Construction and operation of 3-D model of temporary groin located at the Field Research Facility in Duck, North Carolina. Construction was completed on this model in FY 86 and tests are ongoing to learn more about scale effects associated with movable-bed models. The knowledge gained from this model study will enhance our ability to interpret data obtained from movable-bed models and further evaluate limitations of these models.

Title of Study:

Shoreline Change on the North New Jersey Coast

Point of Contact:

Dr. N. Kraus, WESCR

Conducted For:

U.S. Army Corps of Engineers, New York District

Water Resources Region:

North New Jersey coast

Location:

WES

Objectives:

A model for estimating shoreline change and longshore sand transport rates along the northern coast of New Jersey was developed. The model allows representation of large numbers of groins, beach fill, seawalls, and other real world effects. A storm-induced dune erosion numerical model was also developed and implemented for this coast.

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 developed at WES was used to simulate shoreline change along approximately 15 km of north New Jersey coastline. The model was calibrated using measured shoreline change at Sandy Hook.

Title of Study:

Wind-Blown Sand and Growth of Sand Dunes

Point of Contact:

Dr. N. Kraus, WESCR

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:

One technical paper was published which reviews calculation procedures and the data base for computing the sand transport rate by wind. Laboratory data were acquired under contract of measurements of dune growth at fences. Work began on a literature review of dune growth at fences.

Title of Study:

Mississippi River Passes Channel Sedimentation Study

Point of Contact:

Mr. Mike Trawle, WESHE-E

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 (SWP) sedimentation of deepening the navigation channel from 40 to 45 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 model 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

Point of Contact:

Mr. Mike Trawle, WESHE-E

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 overdepth 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 1986 include the completion of a draft technical report describing the evaluation of selected advance maintenance projects. Work is undreway 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:

Fine-Grain Shoaling in Navigation Channels

Conducted for:

Office, Chief of Engineers

Summary of Accomplishments:

a. A series of 18 erosion tests were completed on two estuarine sediments, each with three bulk densities and three sand contents. Another series of erosion tests was completed in another test facility. The report is in publication.

b. An analytic, two-dimensional vertically averaged dredge plume model was formulated and tested.

c. Theoretical and model development work continued on the formation and consolidation of deposited sediment.

Future Work:

Report writing on settling, deposition, consolidation, and erosion will complete this study.

Title of Study:

Improved Numerical Procedures for Deep Draft Channels

Conducted for:

Office, Chief of Engineers

Summary of Accomplishments:

The 3D models were incorporated into a multidimensional modeling framework, which allows 1D, 2D and 3D formulations in a single application. Several enhancements were made to the 3D models to make model runs more economical. The turbulence closure for vertical exchanges was improved for application to stratified flow conditions.

The 3D models were applied to several field sites.

The TABS-2 system was used extensively at WES and by some Corps field offices. In addition, numerous private companies and universities have obtained and are using the system.

Support for the 2D modeling system was provided by WES to the field offices of the Corps.

Title of Study:

Stable Flood Control Channel Design (Improvements)

Conducted For:

Office, Chief of Engineers

Summary of Accomplishments:

Data was collected on Corps of Engineers flood-control channel projects for an evaluation of channel stability assessment tools. Guidance on conducting a channel stability analysis for the design of stable flood-control channels was drated. A draft report of a nationwide inventory of CE flood control projects was prepared.

Title of Study:

Storm Erosion Study

Point of Contact:

Mr. W. Birkemeler

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 between 1962 and 1978.

Since the historic data cover only the beach above mean sea level, a new field study, begun in 1981, seeks to investigate nearshore changes. Four profile lines located at CERC's Field Research Facility are surveyed bi-weekly and after storms out to a depth of 10 meters with the Coastal Research Amphibious Buggy (CRAB). These data provide a detailed look at beach and nearshore response which was previously unavailable. The 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 changes result from the exchange of sediment from the beach to the nearshore bar and on/offshore oscillations of the bar.

During 1986, a report presenting the first four years of CRAB survey data along with associated wave and water level data was drafted and is awaiting publication. The three-dimensional response of the nearshore zone was also measured during the SUPERDUCK experiment held during September and October 1986 at the Field Research Facility. This was the third in a series of experiments designed to quantify the processes controlling rapid three-dimensional profile evolution.

The personal computer version of the Interactive Survey Reduction Program (ISRP) became widely used in a number of Corps district offices. ISRP is a computer program for the interactive processing of beach and nearshore survey data. VOLUME, a companion program used to compute various profile change parameters was developed and distributed to Corps users.

FEDERAL HIGHWAY ADMINISTRATION

The Federal Highway Administration (FHWA) concentrated its activities on six major areas: evaluation of embankment stability subject to flood overtopping, control of culvert outlet erosion, control of stream instability at highway crossings, bridge scour studies, 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 (HRP) and in the National Cooperative Highway Research Program (NCHRP).

Evaluation of Embankment Stability Subject to Flood Overtopping- The objective 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 selected protective measures to stabilize the embankment. The final report, was published in 1986 and is available through NTIS.FHWA/RD-86/126, "Development of a Methodology for Estimating Embankment Damage Due to Flood Overtopping".

B. A large scale study of protective measures for embankments subject to overtopping was underway as a follow-up 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 under contract DTFH61-83-C-00131, "Overtopping Damage Minimization".

Control of Culvert Outlet Erosion - The objectives of these studies are to investigate the various flow condition 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 results include procedures to determine the shortest roughness ring chamber design that effectively reduces culvert outlet velocities. Ring chamber diameters are functionally related to upstream Froude number and flow depth. The final report was published in 1986 and is available through NTIS.

   FHWA/OH-84/007, "Internal Energy Dissipators for Culverts."

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. 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 include three volumes. Volumes 1 and 2 were published in 1986. Volume 3 was being prepared for publication.

   Blodgett, J.C., "Rock Riprap Design for Protection of Stream Channels Near Highway Structures. Volume 1 - Hydraulic Characteristics of Open Channels," U.S. Geological Survey Water-Resources Investigations Report 86-4127, U.S. Geological Survey, Sacramento, California, 1986.

   Blodgett, J.C. and McConaughy, C.E., "Rock Riprap Design for Protection of Stream Channels near Highway structures. Volume 2 - Evaluation of Riprap Design Procedures," U.S. Geological Survey Water-Resources Investigations Report 86-4128, U.S. Geological Survey, Sacramento, California, 1986.

B. The U.S. Geological Survey completed a study, sponsored by FHWA, at the Gulf Coast Hydroscience Center in Bay St. Louis, Mississippi which evaluated failure criteria and hydraulic resistance of several flexible lining materials used in highway channels. Materials tested included: 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 was published in 1986 and is available through NTIS.

   FHWA/RD-86/114, "Performance of Flexible Ditch Lining", (NTIS No. PB 86226065/AS Price $13.95).

Bridge Scour Studies - The objective of these studies is to investigate expected scour at bridges. Goals include developing procedures for assessing vulnerability of bridge to scour, developing an improved sediment transport model, and developing prediction equations for pier, abutment and contraction scour at bridges.

A. Field scour studies were being sponsored by Arkansas, Arizona, Louisiana, Oklahoma and Washington under the HPR program. These studies will document scour at bridge sites during floods.

B. A special study sponsored by Virginia will investigate the feasibility of analyzing soil borings and other site data after a flood to reconstruct the amount of scour that may have occurred during a flood.

Control of Sediment Produced by Highway Construction - This problem consists of two stages: during construction and just after construction.

A. Sponsored by FHWA, the Native Plants, Inc. of Salt Lake City, Utah continued the study on "Accelerated Recovery 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.

B. 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 1986, six States were conducting studies designed to improve vegetation establishment techniques and subsequent management practices. The participating States were Arizona, California, Indiana, North Carolina, Oklahoma, and Washington.

Control of Highway Water Quality - 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 reports were published in 1986 and are available from NTIS.

FHWA/RD-84/057, "Sources and Migration of Highway Runoff Pollutants. Vol. I- Executive Summary" (NTIS No. PB 86227899/AS).

FHWA/RD-84/058, "Sources and Migration of Highway Runoff Pollutants. Vol. II - Methods" (NTIS No. PB 86227907/AS).

FHWA/RD-84/059, "Sources and Migration of Highway Runoff Pollutants. Vol. III - Research Report" (NTIS No. PB 86227915/AS).

B. The third phase of FHWA's research on 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 reports and an executive summary were published in 1986, and are available from NTIS.

FHWA/RD-84/062, "Effects of Highway Runoff on Receiving Waters. Vol. I- Executive Summary" (NTIS No. PB 86228194/AS).

FHWA/RD-84/063, "Effects of Highway Runoff on Receiving Waters. Vol. II- Research Report" (NTIS No. PB 86228202/AS).

FHWA/RD-84/064, "Effects of Highway Runoff on Receiving Waters. Vol. III- Resource Document for Environmental Assessment" (NTIS No. PB 8622821C/AS).

FHWA/RD-84/065, "Effects of Highway Runoff on Receiving Waters. Vol. IV- Procedural Guidelines for Environmental Assessment" (NTIS No. PB 86228228/AS).

FHWA/RD-84/066, "Effects of Highway Runoff on Receiving Waters. Vol. V- Guidelines for Conducting Field Studies" (NTIS No. PB 86228236/AS).

C. The Alaska Department of Transportation and Public Facilities continued the HPR study to evaluate the effectiveness of roadway drainage structures for fish passage.

D. 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 were established in 1986, and are available from NTIS. Work is underway to incorporate the guidelines into a Hydraulic Engineering Circular.

FHWA/RD-85/001, "Management Practices for Mitigation of Highway Stormwater Runoff Pollution. Vol. I- Guidelines" (NTIS No. PB 86226099/AS).

FHWA/RD-85/002, "Management Practices for Mitigation of Highway Stormwater Runoff Pollution. Vol. II- Literature Review" (NTIS No. PB 86226107/AS).

FHWA/RD-85/003, "Management Practices for Mitigation of Highway Stormwater Runoff Pollution. Vol. III- Research Report" (NTIS No. PB 86226115/AS).

FHWA/RD-85/004, "Management Practices for Mitigation of Highway Stormwater Runoff Pollution. Vol. IV- Executive Summary" (NTIS No. PB 86226123/AS).

E. 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 was published in 1986, and is available from NTIS. A follow-up study was underway at the University of Washington.

FHWA/RD-84/094, "Environmental Evaluation of Calcium Magnesium Acetate" (NTIS No. PB 86228541/AS).

F. 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 was continued in developing a computer model to estimate pollutant loading and will include a procedure to evaluate the potential impact to water resources.

G. An FHWA administrative contract research study, "Retention, Detention and Overland Flow For Pollutant Removal From Highway Stormwater," was continued 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.

H. An FHWA administrative contract research study, "Guidelines for Protective Systems for Spills of Hazardous Materials on the Highway System," was continued 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.

I. Five States continued 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".

J. 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 were published in 1986, and are available from NTIS.

FHWA/RD-85/057, "Vol. I-Highway Maintenance Impacts to Water Quality, Executive Summary" (NTIS No. PB 86228103/AS).

FHWA/RD-85/058, "Vol. II-Investigation of Impacts of Selected Highway Maintenance Practices on Water Quality" (NTIS No. PB 86228111/AS).

FHWA/RD-85/059, "Vol. III-Reference Manual for Assessing Water Quality Impacts from Highway Maintenance Practices" (NTIS No. PB 86228129/AS).

FHWA/RD-85/060, "Vol. IV-Guidelines for Minimizing Water Quality Impacts from Highway Maintenance Practices" (NTIS No. PB 86228137/AS).

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

At the Fourth Federal Sedimentation Conference, the project displayed working models of sediment samplers, video tapes of bedload-sampler experiments, and photographs of sampler installations. Two project members, Joe Beverage and Don Benson, also presented papers. Joe discussed "Continuous measurement of suspended sediment concentration" and Don explained "Development of a trace-metal P-61 point-integrating sampler."

An ASTM (American Society for Testing and Materials) guide entitled "Core sampling submerged, unconsolidated sediments" was submitted for balloting in 1987. The guide is divided into sections each of which discusses equipment and procedures for sampling in a particular range of water depths. Techniques for dissecting and preserving core samples are also presented.

The project continued to develop and test vibrational-type sediment-concentration gages. Joe Beverage moved the U-tube gage from a site near Madison, Wisconsin to a gaging station on the Toutle River. During 1987, the gage's response to high sediment concentration, low dissolved solids concentration, and nearly steady water temperature will be evaluated. Joe Szalona and John Skinner completed laboratory tests on a new straight-tube gage which can be submerged. A theory paper on the straight-tube gage is undergoing colleague review. Another paper, "Description and test of a straight-tube fluid-density gage for measuring suspended-sediment concentration in streams," was approved for publication.

Personnel at the Hydrologic Instrumentation Facility, the Sedimentation Project, and the Corps of Engineers (Vicksburg) collaborated in field testing a special P-61 suspended-sediment sampler. The new sampler collects a depth-integrated sample by compositing a series of small point-integrated samples. As the sampler is lowered through the flow, a valve opens for a few seconds and then closes. This open-close cycle is repeated several times before the sampler touches bottom. Data from the test will be analyzed in 1987.

Striving to reduce costs, project personnel designed and built an experimental bedload sampler that features a one-piece, cast-bronze body. The experimental model and a standard bedload sampler are slated for comparative testing in 1987.

Rotating valves on P-61 samplers occasionally bind and refuse to turn. An experimental valve that pinches a flexible tube is being tested as a possible remedy. Preliminary results indicate the new valve works reliably at depths less than about 20 ft. At greater depths, pressure expands the tube and interferes with its operation.

Production, calibration, distribution, and repair of samplers continued at a brisk pace during 1986. Corps of Engineers personnel assigned to the project supplied about 70 major pieces of sampling equipment.

CR098 SEDIMENT TRANSPORT PHENOMENA

TITLE: Measurement and Prediction of Sediment Transport Phenomena

PROJECT NUMBER: CR 74-098

LOCATION: Topical Research

PROJECT CHIEF: Hubbell, David W.

HEADQUARTERS OFFICE: Lakewood, CO

PROBLEM: In alluvial streams, for every different hydrologic condition, the bed configuration, sediment transport, and hydraulic characteristics mutually change to achieve quasi-equilibrium. These 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 relation 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 cannot be predicted with reliability. As a result, optimum utilization and management of a waterway usually is not assured; 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.

OBJECTIVE: 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, analyze existing data to relate bed-form characteristics and hydraulic and sedimentologic variables, and develop one or more bedload samplers 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, collect data on bed-form characteristics, sediment transport, and other pertinent variables as required to meet specific needs. Employ acoustic instrumentation, including side-scan sonar,

to measure bed configuration and movement, and use suitable bedload samplers, and suspended-load samplers, to define transport rates, possibly also applying tracer techniques. Finally, analyze data to define criteria for predicting bed form and to provide a better understanding of sediment transport phenomena. Study both sand-bed and gravel-bed streams.

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) affect of temporal and spatial variations on the accuracy of bedload sampling; (4) definition of particlesize distribution of coarse sediment by means of a new rapid-sieving apparatus; and (5) computation of particle-size statistics by computer. Additionally, a videotape on the characteristics and use of Helley-Smith type samplers was produced.

REPORTS APPROVED FOR PUBLICATION:

Hubbell, D. W., Stevens, H. H., Jr., 1986, Laboratory data on coarse-sediment transport for bedload sampler calibrations: U.S. Geological Survey Water-Supply Paper 2299 (in press).

Hubbell, D. W., and Stevens, H. H., Jr., 1986, Cascade-sieve shaker for rapid particle-size analysis of coarse sediment, in Selected Papers in Hydrologic Sciences: U.S. Geological Survey Water-Supply Paper (in press).

REPORTS PUBLISHED:

Hubbell, D. W., and Stevens, H. H. Jr., 1986, Facotrs affecting accuracy of bedload sampling: Proceedings, Fourth Federal Interagency Sedimentation Conference, 1986 (in press).

Carey, W. P., and Hubbell, D. W., 1986, Probability distributions for bedload transport: Proceedings, Fourth Federal Interagency Sedimentation Conference, 1986 (in press). (Aided with early mathematical derivations and critically reviewed sequential drafts of the report.)

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 85-4047, 77 p.

Hubbell, D. W., 1986, Bedload sampling and analysis: Proceedings, International Workshop on Problems in Gravel-Bed Rivers, 1985 (in press).

CR102 SEDIMENT IN RIVERS

TITLE: Movement and Storage of Sediment in River Systems

PROJECT NUMBER: CR 75-102

LOCATION: Nationwide

PROJECT CHIEF: Meade, Robert H.

HEADQUARTERS OFFICE: Lakewood, CO

PROBLEM: Sediment moves through a river system in response to specific events and changing conditions in the drainage basin. The movement of sediment is usually discontinuous. Episodes of movement are separated by periods of storage that can range from less than one year to more than one thousand. Understanding the movement and storage of sediment in rivers is important to navigation, flood control, and other aspects of river engineering, as well as to the prediction of the fate of contaminants absorbed on sediment particles.

OBJECTIVE: Assess: (1) changes in river sediment loads over periods of decades or longer, and the factors (natural or artificial) that cause the changes; (2) rates at which sediment is stored in river systems and the residence times of sediment particles in storage; and (3) sources, pathways, and sinks of sediment particles in river systems.

APPROACH: (1) Assess long-term changes in sediment loads from data previously collected by U.S. Geological Survey (USGS) and other agencies; (2) assess sediment storage will be assessed by repeated (annual) surveys of selected river channels, and by comparing old and new maps and aerial photographs of rivers and their flood plains in the upper Missouri River basin; and (3) assess sources, pathways, and sinks by intensive field studies (including tracer studies) of selected small rivers.

PROGRESS: Studied sediments along Whitewood Creek and the Belle Fouche River in South Dakota; between 1900 and 1977, approximately 100 million tons of finely-milled mine tailings containing arsenopyrite and other metallic sulfides were discharged into Whitewood Creek near Lead, South Dakota. Meander migration and overbank deposition have caused much of the sediment to be stored in the floodplain and on terraces along Whitewood Creek and the Belle Fourche River. The stored sediments vary considerably in texture and color and contain as much as 5400 parts per million of arsenic 25 kilometers downstream of Lead and 2000 parts per million of arsenic 60 kilometers downstream of Lead. Less than 20 percent of the mine tailings discharged are presently stored in the 30 kilometers of the Whitewood Creek floodplain between Lead and the Belle Fourche

River; a majority of the tailings discharged presently are stored in the floodplain along 200 kilometers of the Belle Fourche River between Whitewood Creek and the Cheyenne River. The contaminated floodplain sediments will remain a source of metals to adjacent streams for centuries. Resurvey of 20 cross sections of Powder River in southeastern Montana showed no significant changes since last year -- except for some widening of the 3 sections that were at or near places where meander cutoffs had occurred during the previous decade. A reconnaissance of the Apure River, a large alluvial tributary of the Orinoco River of Venezuela, was carried out in cooperation with the Venezuelan Ministry of the Environment and Renewable Natural Resources (MARNR). Preliminary data were collected on water discharge and sediment transport, and recommendations were made to MARNR for the design of a long-term study to assess some of the factors affecting the navigation of the river.

REPORTS APPROVED FOR PUBLICATION:

Meade, R. H., 1986, Movement and storage of sediment in river systems, in Lerman, A., and Meybeck, M., editors, Physical and chemical weathering in geochemical cycles: Dordrecht, Netherlands, Reidel Publishing Co. (in press).

Marron, D. C., and Popenoe, J. H., 1986, A soil catena on schist in northwestern California: Geoderma, in press.

Marron, D. C., and Laudon, J. A., 1986, Susceptibility to mudflows in the vicinity of Lassen Peak, California: in Selected Papers in the Hydrologic Sciences, U.S. Geological Survey Water Supply Paper 2310, in press.

Marron, D. C., Nolan, K. M., and Janda, R. J., 1986, Effects of logging and geology on hillslope erosion by surficial processes in the Redwood Creek Basin, in Nolan, K. M., Kelsey, H. M., and Marron, D. C., (eds.), Geomorphic processes and aquatic habitat in the Redwood Creek Basin, northwestern California: U.S. Geological Survey Professional Paper, in press.

Nolan, K. M., and Marron, D. C., 1986, Response of the Redwood Creek Stream channel to storms and land-use, 1936-82 in Nolan, K. M., Kelsey, H. M., and Marron, D. C., (eds.), Geomorphic processes and aquatic habitt in the Redwood Creek Basin, northwestern California: U.S. Geological Survey Professional Paper, inpress.

Nolan, K. M., Kelsey, H. M., and Marron, D. C., Summary of research in the Redwood Creek Basin, in Nolan, K. M., Kelsey, H. M., and Marron, D. C., (eds.), Geomorphic processes and aquatic habitat in the Redwood Creek Basin, northwestern California: U.S. Geological Survey Professional Paper, in press.

REPORTS PUBLISHED:

Nordin, C. F., Jr., and Meade, R. H., 1985, The Amazon and the Orinoco, in McGraw-Hill Yearbook of Science & Technoloy 1986: New York, McGraw-Hill, Inc. p. 385-390.

Meade, R. H., 1985, Suspended sediment in the Amazon River and its tributaries in Brazil during 1982-84: U.S. Geological Survey Open-File Report 85-492, 39 p.

CR105 CHANNEL MORPHOLOGY

TITLE: Effects of Water and Sediment Discharges on Channel Morphology

PROJECT NUMBER: CR 65-105

LOCATION: Topical Research

PROJECT CHIEF: Williams, Garnett P.

HEADQUARTERS OFFICE: Lakewood CO

PROBLEM: Channels on alluvial streams change with time. Bed elevations and channel widths may change, meander bends man shift both laterally and downstreamward, the sizes of the bed particles may change, in-stream bars may grow and migrate, and the amount and type of vegetation along the river may increase or decrease. Sometimes the change is minor and insignificant, even over decades, but in other cases catastrophic modifications occur in minutes. The transformations can be natural or man-induced, and they can have significant effects on man and the environment.

OBJECTIVE: Determine and analyze the influence of the major variables, particularly water and sediment discharges, governing channel morphology.

APPROACH: Study the effect of large sediment introductions on stream channels. Make field surveys and aerial-photograph analysis, perferably time-sequential, of stream reaches that have received exceptionally large sediment inputs. Document channel response, with a view toward eventually developing a general model of channel response.

PROGRESS: Completed a paper on techniques of paleohydrologic estimation, as an invited chapter for a book on Flood Geomorphology. A second chapter (coauthored with J.E. Costa) presents what is probably the first-ever geomorphologist-oriented succinct summary and explanation of the hydraulic, sedimentologic, and geomorphic measurements to make following a flood. In a third paper, meander geometry was found to correlate well with the geometry predicted by the theory of Langbein and Leopold (1966), and 40 empirical and practical equations were derived involving meander and channel size features.

WRD FEDERAL RESEARCH PROJECTS.....GEOMORPHOLOGY & SEDIMENT TRANSPORT

REPORTS APPROVED FOR PUBLICATION:

Williams, G. P., and Wolman, M. G., 1986, Effects of dams and reservoirs on surface water hydrology -- changes in rivers downstream from dams, in U.S. Geological Survey National Water Summary 1985, Hydrologic Events and Surface Water Processes: U.S. Geological Survey Water Supply Paper 2300 (in press).

Williams, G. P., Paleofluvial estimates from dimensions of former channels and meanders, in Baker, V. R., Kochel, R. C., and Patton, P. C., Flood Geomorphology: publisher not yet selected as of May, 1986.

Williams, G. P., and Costa, J. E., Geomorphic measurements after a flood: in Baker, Kochel and Patten, eds., Flood Geomorphology.

Williams, G. P., River meanders and channel size: submitted to Journal of Hydrology.

CR187 BEDLOAD TRANSPORT RESEARCH

TITLE: Hydraulics and Mechanics of Bedload-Transport Processes

PROJECT NUMBER: CR 74-187

LOCATION: Topical Research

PROJECT CHIEF: Emmett, William W.

HEADQUARTERS OFFICE: Lakewood, CO

PROBLEM: Of all processes operating in river channels, and especially of those processes of practical concern to engineers and others interested in river channel behavior, perhaps the least knowledge is available regarding the hydraulic 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: 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 at East Fork River, Wyoming, as related to sampler calibration, procedures of use, and process understanding, is complete. Sampler characteristics and field techniques have been stated; process data are being analyzed and interpreted. Data at other field sites continue to be collected, analyzed, and interpreted both as a separate study and as part of East Fork River study.

REPORTS APPROVED FOR PUBLICATION:

Mantz, P. A., and Emmett, W. W., 1986, Analysis of the United States Geological Survey sediment-transport data for some California streams: Munich, Germany, Proceedings, Euromech 192 Conference on Transport of Suspended Solids in Open Channels, June 11-15, 1985, in press.

REPORTS PUBLISHED:

Emmett, W. W., and Myrick, R. M., 1985, Field data describing the movement and storage of sediment in the East Fork River, Wyoming--Part V. Bedmaterial tracers, 1979 and 1980: U.S. Geological Survey Open-File Report 85-169, 365 p.

Emmett, W. W., and Myrick, R. M., and Martinson, H. A., 1985, Hydraulic and sediment-transport data, East Fork River, Wyoming, 1978: U.S. Geological Survey Open-File Report 85-486, 37 p.

CR266 ESTUARY SEDIMENTATION/EUTROPHICATION

TITLE: Transport and Deposition of Sediments and Sediment-Borne Contaminants in Tidal Rivers and Estuaries

PROJECT NUMBER: CR 81-266

LOCATION: Topical Research

PROJECT CHIEF: Glenn, Jerry L.

HEADQUARTERS OFFICE: Lakewood, CO

PROBLEM: Sediments that contain elevated concentrations of nutrients and trace metals are accumulating rapidly in part of the tidal Potomac River, the Potomac Estuary, and the adjacent marginal embayments. Accumulations of sediments and sediment-borne contaminants may limit significantly 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

OBJECTIVE: (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 (**210Pb, **14C, 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: Tests of sampling and measurement equipment to determine causes, rates and results of resuspension in shallow estuarine waters were begun in the estuary of the Potomac River near Piney Point, Virginia, and in the transition zone near Blossom Point. Bottom sediment samples were collected in the transition zone and were suspended in flow-through containers in the well-oxygenated water column at Blossom Point and the anoxic water column near Piney Point to determine the possible effects of resuspension on nutrient concentrations. The containers were retrieved and the sediments were sampled periodically for nutrient analyses over an eight-day period. Velocity measurement equipment, including a Marsh McBirney model 527 directional probe and a Price (optic head) current meter were tested from a small boat and from the dock at Piney Point. The equipment was difficult to handle by one person from a small boat, but worked well from the Piney Point dock.

REPORTS APPROVED FOR PUBLICATION:

Glenn, J. L., Bottom sediments and nutrients in the tidal Potomac System, Maryland: U.S. Geological Survey Water-Supply Paper 2234, 197 p.

CR273 HYDROLOGICAL-BIOLOGICAL INTERACTIONS

TITLE: The Interface of Hydrological and Biological Processes in Rivers

PROJECT NUMBER: CR 82-273

LOCATION: Topical Research

PROJECT CHIEF: Andrews, Edmund D.

HEADQUARTERS OFFICE: Lakewood, CO

PROBLEM: The geometry and pattern of river channels adjust to significant changes in the water discharge, size, and quantity of sediment supplied to the channel. When the quantity of water and sediment remains relatively constant, over a period of years, the channel geometry and pattern vary about a mean or quasi-equilibrium condition. Major watershed alterations that change the supply of water, sediment, and size of sediment reaching the channel necessitate an adjustment of the channel geometry and pattern and transform the channel from one quasi-equilibrium state to another. Between the two quasi-equilibrium states, there is a period of instability. Existing techniques for examining and predicting river channel adjustment have been developed primarily from investigation of quasi-equilibrium rivers. However, the dynamics and rate of river channel adjustment during the period of instability rarely have been studied, and are understood poorly. The length of time required for the complete adjustment is commonly a few decades to a century or more; in watersheds where various land-use changes occur every several years, the river channel may be adjusting continually to a different supply of water and sediment. An understanding of the dynamics and rate of river channel adjustment from one quasi-equilibrium state to another is very important to managing fluvial resources. One of the most frequent and important adverse impacts of river channel changes is damage to the aquatic ecosystem. When a river channel adjusts to a change in its watershed, the physical habitat of the aquatic organisms in the river may be reduced or even eliminated. In order to evaluate the biological impacts of watershed alteration, hydrologists frequently are asked to predict future hydraulic geometries and channel patterns so that changes in habitat can be assessed. The primary focus of this project is to understand the dynamics and rate of river channel change as they affect the physical habitat. The greatest deficiencies in our present knowledge of river channel adjustment as it relates to the aquatic ecosystem appear to be (1) the longitudinal sorting of bed material, especially gravel, (2) the formation of gravel bars, (3) adjustment of channel width, and (4) the rates at which the several hydraulic variables adjust.

OBJECTIVE: Describe the physical processes and rate at which a river channel adjusts due to a change in the water discharge, sediment size, and sediment load supplied to the channel concentrating on those aspects of the river channel known to influence significantly the aquatic ecosystem, that is the bed-material size distribution, the occurrence of bars, and channel width. Describe the hydraulic processes controlling these characteristics of river channel as well as the rate at which they function and develop mathematical models of the processes as required for longitudinal routing water and sediment. The ultimate goal of the project is to develop new analytical tools for describing river channel adjustment.

APPROACH: Because adjustment of a river channel may extend over a few decades to a century it is impractacal to observe the transition of a river channel from one quasi-equilibrium state to another quasi-equilibrium state however, instead, study the movement of bed material through a reach of channel in detail, considering the transport of bed materials, distance transported, and location (bed, banks, or bar) of deposition for each size fraction. Select two or three small, self-formed gravel-bed streams for this portion of the investigation that are also sites of active aquatic ecology research programs, and bedload transport rates, tracer particles, and mapping of channels features, describe the movement of coarse bed material through the study reaches, and formulate a physical model of gravel movement by size fraction. In addition, reconstruct the sequence and rate of adjustment for historical examples of river channel change to provide the temporal context in which to view a hydraulic characteristic at a particular point in time. Ideally, study current hydraulic processes and make ecological observations on the same river reaches that are used to reconstruct the historical data.

PROGRESS: Primary research activity has been an analysis of gravel transport, especially with regards to the influence of a range of particle sizes in the bed-material. This study has included new bedload transport measurements in Sagehen Creek as well as analysis of data collected by others. Data analysis has shown that most available sizes are transported by flow equal to or greater than the mean annual flood. The size distribution of the bedload is similar to that of the subsurface material, which characterizes the bulk of the sediment stored in a river reach. The material on the surface of a gravel bed stream is typically much coarser than either the bedload or the subsurface material. This coarse surface layer, or pavement, is present even while most available sizes are transported, and is the agent for accomplishing a near-equalization of the mobility of particles based on the size distribution of subsurface material. In particular, the relatively greater exposure of large surface particles to the flow eliminates most, but not all, of the differences in mobility between particles of differing sizes. Much of the remaining difference is eliminated by the relative abundance of the coarse particles in the surface compared to the small particles. Thus, the intrinsically

lower mobility of the coarse surface particles is counterbalanced by their greater availability to the flow. Field and laboratory results support this hypothesis. As the bedload transport rate approaches zero, the pavement devolves into an even coarser static armor.

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CR287 FLUVIAL PALEOHYDROLOGY

TITLE: Fluvial Paleohydraulics and Paleohydrology

PROJECT NUMBER: CR 84-287

LOCATION: Topical Research

PROJECT CHIEF: Costa, John E.

HEADQUARTERS OFFICE: Lakewood, CO

PROBLEM: Geomorphic therories on frequency and magnitude of flow events, developed from data on large streams, do not apply in small watersheds. Flow characteristics of small watersheds are extremely difficult to resolve because events affecting the flow 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.

OBJECTIVE: Provide geomorphic and stratigraphic-based estimates of magnitude and frequency of large flows events in small basins; compile existing information on landscape modifications and recovery rates and processes following large flows; identify discharge thresholds instigating major channel, flood plain, and hillslope changes.

APPROACH: Interpret the process, magnitude, and frequency of different kinds of events that affect flow in small basins using the stratigraphic (sediment) and geomorphic (landforms) remains of modern flow events. Develop techniques to interpret hydrodynamic stratigraphic data and moment analysis of sediment deposits to differentiate processes. Use laboratory experiments (for example, flume studies) to obtain data to model non-steady, non-uniform flow conditions and sediment deposit characteristics of small watersheds. Estimate frequency of flow events by using various Quaternary dating techniques where an appropriate sediment record exists. Use existing photographic and planimetric information from small basins that experienced large flows in historic times to identify the rates and processes by which basins "heal" following large events.

PROGRESS: (1) A new water-sediment flow classification has been developed which includes clear water to relatively dry hillslope flows. (2) Fundamental differences in failure mechanisms of different kinds of natural dams (ice, landslide, moraine) lead to different breach times; this directly effects peak discharge from dam failure. Project terminated.

WRD FEDERAL RESEARCH PROJECTS.....GEOMORPHOLOGY & SEDIMENT

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NR081 INTERAGENCY SEDIMENTATION PROJECT

TITLE: A Study of Measurement and Analysis of Sediment Loads in Streams

PROJECT NUMBER: NR 39-081

LOCATION: Topical Research

PROJECT CHIEF: Skinner, John V.

HEADQUARTERS OFFICE: Minneapolis, MN

PROBLEM: Knowledge of factors governing the movement and deposition of sediment in streams and reservoirs is of major importance to agencies involved in development of water and land resources of the nation. A knowledge of the sediment discharge of streams is essential to the efficient design and operation of projects for the storage and use of streamflow. Movement of sediment also affects aquatic life and the transport of certain types of chemical pollutants. Complicity of sediment phenomea are such that comprehensive investigations are essential to support accurate conclusions.

OBJECTIVE: Develop new techniques for measuring and analyzing the sediment discharge of rivers. Coordinate studies to meet the common needs of two or more agencies. Serves as (1) a focal point for establishing standard methods for sediment discharge measurements; (2) a center for developing both manual and automatic samplers; and (3) a center for procuring, calibrating and stocking sediment equipment used by federal agencies.

APPROACH: Use knowledge of hydraulics, physics, and electronics and develop new techniques for collecting sediment data. Evaluate new equipment under laboratory and field conditions. Distribute technical reports that explain research activities and manuals that explain equipment operation to all interested agencies.

PROGRESS: The interagency technical committee reviewed test data on nozzles for sampling bedload--sediment particles that roll and slide along river bottoms. From the six nozzles tested, one nozzle was selected as a tentative standard. The project has now designed a streamlined body for holding this standard nozzle and plans to start evaluating the body in about one month. The second draft of an American Society for Testing and Materials (ASTM) guide on core-sampling submerged sediment has been completed. This guide covers: (1) Core-sampling terminology; (2) advantages and disadvantages of different types of core samplers; (3) forms of core distortion that may occur during sampling; (4) techniques for minimizing distortion; and (5) methods for dissecting and preserving sediment cores. Field tests of a sediment-concentration gage were completed. The gage itself worked reliably; however, the pump used to supply river

water to the gage failed several times. A new gage that does not require pumps has been built and is now undergoing laboratory tests. This new gage can be mounted on a fixed support or suspended from a moveable cable car. Mechanical and thermal instabilities in the new gage have been traced to clamps that hold critical parts together. Improved clamps are being studied.

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NR107 SEDIMENT IMPACTS FROM COAL MINING

TITLE: Geomorphic and botantical impacts of sediment due to natural and unnatural land disturbance

PROJECT NUMBER: NR 84-107

LOCATION: Topical Research

PROJECT CHIEF: Osterkamp, Waite R.

HEADQUARTERS OFFICE: Reston, VA

PROBLEM: Increased sediment yields from mine spoils, reclaimed and urban areas, and agricultural lands is one of the largest problems being addressed by agencies such as the U.S. Office of Surface Mining and U.S. Soil Conservation Service. The acquisition and interpretation of sediment data are among the most deficient areas that must be considered by these agencies. The impacts on geomorphology and botany that are caused by induced sediment movement are sometimes intense; knowledge of these impacts is beneficial for understanding the effects of naturally occurring sediment movement.

OBJECTIVE: (1) Predict movement of sediment from naturally and unnaturally disturbed areas; assess existing techniques and develop new ones based on geomorphic, botanical, and statistical principles as aids in improving interpretive capabilities; evaluate geomorphic, botanical, and hydrologic changes caused by sediment movement from disturbed areas.

APPROACH: (1) Develop technology for determining amounts and rates of movement of sediment-size classes from disturbed areas based on factors such as land use, runoff, basin and landform morphology, and botanical indicators; (2) conduct research on the effect on landforms and vegetation of sediment movement using vegetation age, damage, and patterns of occurrence as indicators of the magnitude, frequency, and time of occurrence of destructive hydrologic events; (3) investigate the influence that ground-water movement exerts on sediment transport and changes in landforms by analyzing near-surface and subsurface rates of water and sediment movement (including piping, sapping and seepage erosion) in dynamic hydrologic systems; and (4) conduct research on the interactions between hydrology, water chemistry, and geochemistry as determinants of sediment movement through a hydrologic system, in conjunction and close coordination with other research and district personnel.

PROGRESS: An evaluation of mean-annual suspended-sediment yields in and adjacent to the major coal-producing areas of the eastern United States distinguished differences between disturbed and undisturbed conditions. Background yields, which reflect the natural characteristics of watersheds, are lowest in the eastern and northern portions of the coal areas, corresponding to basins having extensive forest cover and lakes. The greatest background sediment yields occur in Western Illinois and adjacent portions of Iowa and Missouri, areas of thick loess deposits. The greatest yields above background occur in southeastern Pennsylvania, western Illinois and adjacent portions of Iowa and Missouri, and in West Virginia and eastern Kentucky. The areas of highest yields above background in West Virginia and Kentucky correspond to areas of intensive surface mining for coal. A study of modified channels in west Tennessee has shown that woody riparian vegetation provides an accurate tool for estimating dates and rates of bank failure, sediment accretion, and stabilizing bank conditions. Botanical evidence of bank-evolution processes is particularly useful where other types of information are lacking. Similar types of botanical techniques have been used to date and estimate sedimentation rates following debris flows on Mount Shasta, California, and channel recovery following historic flooding along Plum Creek, Colorado.

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