GUIDANCE MANUAL FOR LOCATION STANDARDS AND SPECIAL ENVIRONMENTAL AREAS

OFFICE OF SOLID WASTE
U.S. ENVIRONMENTAL PROTECTION AGENCY

6 August 1981

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PREFACE

The Resource Conservation and Recovery Act of 1976 (RCRA), as amended (42 USC 6901 et seq.), requires the U.S. Environmental Protection Agency (EPA) to institute a hazardous waste management program. Section 3004 of RCRA directs the EPA to promulgate standards, including requirements respecting the location, design, and construction of hazardous waste treatment, disposal, and storage facilities. These location standards are found at 40 CFR 264.18. They were promulgated on 12 January 1981 (46 FR 2848-2849).

The purpose of this Guidance Manual is to assist the permit writers in EPA's Regional Offices in interpreting the requirements of the location standards and in evaluating permit applications. Part I of this manual provides guidance on the standards, and Part II pertains to other Federal environmental laws that might affect the permitting of hazardous waste management facilities. The information contained in this Manual also will be of assistance to facility owners and operators in interpreting and complying with the location standards and other Federal environmental laws.

This Manual is not a regulatory action and the suggestions contained herein are not mandatory or enforceable. The guidance provided represents the best information available to the EPA.

Comments are requested from EPA's Regional Offices on this Guidance Manual. Comments should be mailed to:

Cindy Hoppmann
WH-565
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

PART I

GUIDANCE FOR THE LOCATION STANDARDS

Chapter 1

Locating Hazardous Waste Facilities in Floodplains

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1.0 INTRODUCTION

The Part 264 standards are permitting standards, standards that EPA will use as the basis for writing hazardous waste permits. On January 12, 1981 (46 FR 2803) EPA promulgated a portion of the Part 264 standards, including standards for the location of hazardous waste facilities at 40 CFR 264.18. Location of facilities in 100-year floodplains is addressed. Facilities located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout of any hazardous waste unless the waste can be safely removed from the site before the facility is flooded. Pages 2848 and 2849 of the January 12th Federal Register contain the full text of the standards and associated definitions (i.e., 100-year flood, 100-year floodplain, and washout).

In order to determine if the location of a facility is of concern with respect to the floodplain location standard, the owner or operator must determine if the facility is within a 100-year floodplain. Section 2.0 of this chapter presents guidance on this subject, including information on the National Flood Insurance Program. Section 3.0 summarizes the different conditions under which flooding can occur, the characteristics of floods, and the potential damages that floods are capable of rendering to hazardous waste facilities. Parameters that should be considered in planning for and design of flood control measures are presented in Section 4.0. That section also contains a description of flood proofing and flood protection methods that may be employed at hazardous waste facilities. Section 5.0 provides a brief discussion of the most significant Federal legislation related to floodplain management, as well as a discussion of state floodplain management programs. Coastal zone management programs are discussed in Section 5.0.

2.0 IDENTIFYING THE 100-YEAR FLOODPLAIN

As the floodplain standard specifies, owners or operators of facilities located within the 100-year floodplain must design, construct, operate, and maintain their facility to prevent washout or ensure safe removal of the waste before the facility is flooded. This section offers guidance on the means that are available for determining if a facility is located in a 100-year floodplain. This determination may be simple for areas where the characteristics of the 100-year frequency flood have been determined and mapped, or it may be more time consuming and costly where no maps exist and a determination must be made by consultants.

The Federal Insurance Administration, through the National Flood Insurance Program, is the prime supplier of floodplain maps. Other Federal agencies supply maps or information that will help in determining the boundaries of the 100-year floodplain and the characteristics of the 100-year flood.

2.1 The National Flood Insurance Program

The National Flood Insurance Program (NFIP) is a Federal program that enables property owners to buy flood insurance at a reasonable cost if the communities in which they are located carry out local floodplain management measures to protect lives and new construction from the hazards of flooding. The NFIP was established through the National Flood Insurance Act of 1968 and is administered by the

Federal Insurance Administration (FIA) within the Federal Emergency Management Agency (FEMA). Within the NFIP, a community may be in either the Emergency Program or the Regular Program. The NFIP is a phased system; certain regulations, studies, and mapping efforts are triggered depending upon whether the community is in the "Emergency Program" (the initial phase) or the "Regular Program" (the final phase) (FEMA, 1980).

Communities in the Emergency Program receive a Flood Hazard Boundary Map (FHBM), which shows the flood-prone areas within the community which are subject to flooding from a 100-year flood. These areas are labeled as "special flood hazard areas" or "A Zones" on FHBMs. The boundary of the 100-year floodplain is approximate on these initial maps and elevations of the 100-year flood are not given.[1] FHBMs have been prepared for nearly all flood-prone communities in the United States (FIA, 1977).

FHBMs are useful for providing an initial rough indication of whether the facility is in a 100-year floodplain. Where the facility is located in a borderline situation, the EPA permitting official may require a more precise determination of the 100-year floodplain boundary, depending upon the location of the facility, with respect

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[1]The FEMA publication "How to Read Flood Hazard Boundary Maps" (October, 1978) is available from the FIA Regional Offices listed in Table 1.

to the flooding sources, the type of facility, and the type of waste treated, stored, or disposed of.

If an owner or operator wishes to appeal the boundaries of the 100-year floodplain on a FHBM he may submit technical or scientific data to the appropriate FIA Regional Office to prove that FIA's boundaries are incorrect. This appeal process should be completed before Part B of a RCRA permit is submitted to EPA.

Detailed field engineering surveys, called "Flood Insurance Studies", are conducted while the community is in the Emergency Program. Information obtained during the Flood Insurance Study is used to prepare a Flood Insurance Rate Map (FIRM) and a Flood Boundary and Floodway Map (commonly termed a "Floodway Map"). The FIRM gives precise boundaries of the 100-year floodplain and therefore should be used by the owner or operator, where available, to determine if the facility is located in the 100-year floodplain. In addition, FIRMs show the location of the expected whole-foot water surface elevation of the 100-year flood[1/], and they delineate risk zones used for insurance purposes[2/].

The floodway map delineates the floodway, which is the channel of a river or other watercourse and adjacent land areas that (1) are

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1/ FEMA uses "base flood" when referring to the 100-year flood.

2/ A FEMA publication which explains "How to Read a Flood Insurance Rate Map" (April, 1980) is available from the FIA Regional Offices listed in Table 1 (at the end of this section).

flooded more frequently than areas farther away from the channel but within the 100-year floodplain, and (2) are subject to high velocity flows. FIA warns that development in this area is more susceptible to flood damage than any other location in the 100-year floodplain (FIA, 1978). Therefore, the floodway should be avoided in selecting a site for a hazardous waste facility.

The Flood Insurance Study is published in preliminary form and notice to this effect is published in local newspapers twice. A 90-day formal appeal period follows the second publication, during which the community (or property owners via the community) can review and appeal the data contained in the Study. If there are appeals, these are resolved, and then the Flood Insurance Study, FIRM, and Floodway Map are published as final.

After this formal appeal period, property owners have the right to appeal information in the Flood Insurance Study or on the FIRM or Floodway map at any time. Such an appear must be accompanied by technical or scientific data proving FIA's conclusions are incorrect. Appeals should be directed to the appropriate FIA Regional Office (see Table 1 at the end of this section). Again, it is essential that these appeals of FIA floodplain information and maps be concluded before the owner or operator submits Part B of the RCRA permit application to EPA.

The Federal Insurance Administration also maps coastal areas as part of the National Flood Insurance Program. The Flood Hazard Boundary Map issued for coastal areas is very similar to that issued for areas subject to riverine flooding. The A-zone or special flood hazard area delineates the boundaries of the 100-year floodplain. When a Flood Insurance Rate Map is prepared for a coastal community the A-zone is partitioned into an A-zone and a V-zone (see Figures 1 and 2). The V-zone is closer to the source of flooding; it is the area subject to [velocity] wave action. In general, the V-zone is the area subject to three-foot (or greater) breaking wave. The A-zone is the area which is subject to flooding by the 100-year flood at the 100-year flood stillwater elevation; this zone is not subject to significant wave action.

2.2 Sources of Floodplain Identification Information

2.2.1 Obtaining FIA Maps

The National Flood Insurance Community Status Book, published by FEMA, lists, by state, communities that are in the Emergency and Regular Programs and also communities that are not participating in the NFIP but which have FHBMs, FIRMs, or Floodway Maps. This book is published bimonthly and is available in separately bound copies for each state, or, if nationwide information is needed, in a bound copy for the entire nation. Copies are free. In order to be put on the distribution list for the states indicated below, call toll free the following numbers:

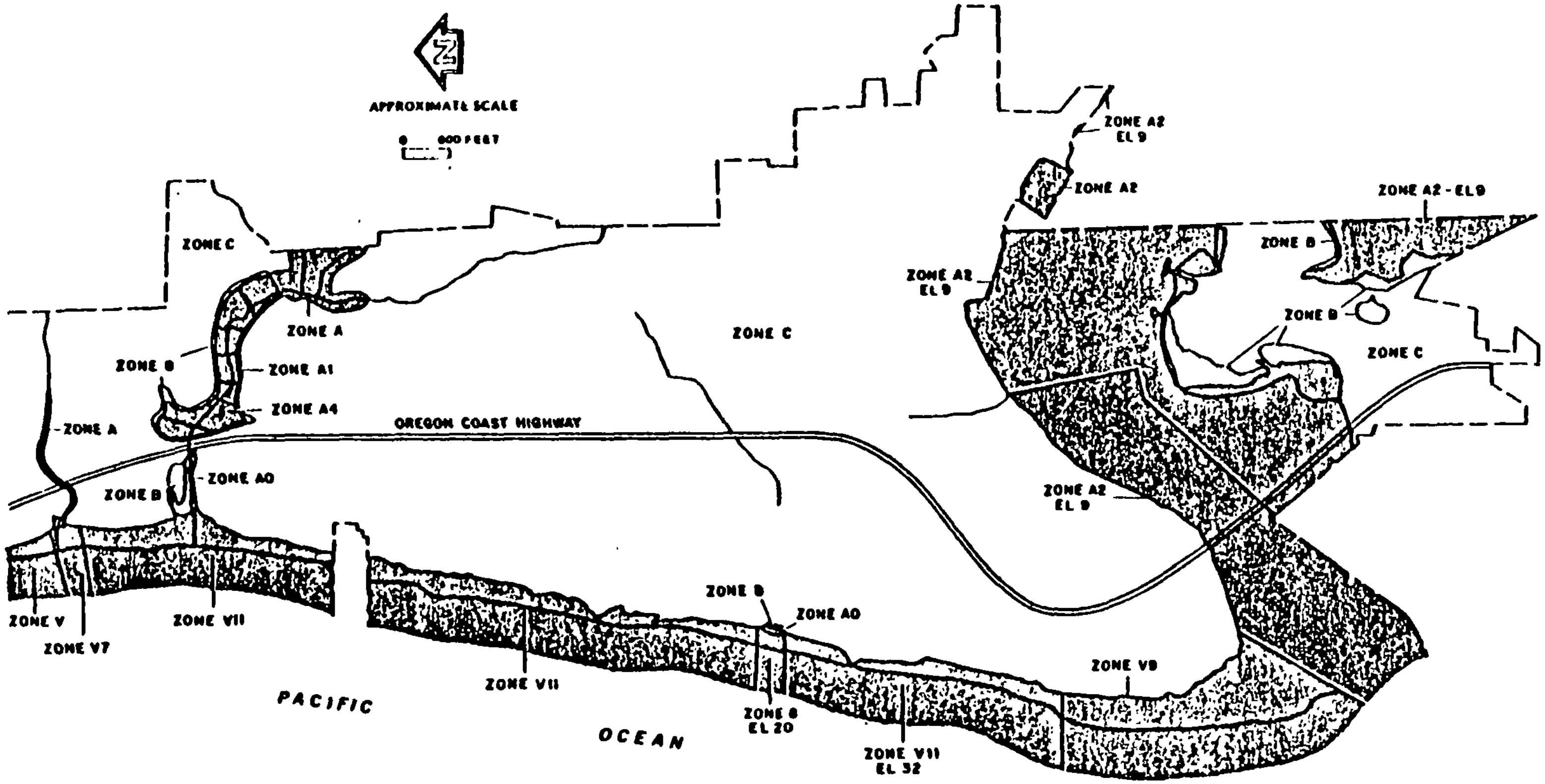


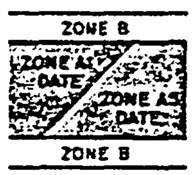
FIGURE 1
EXAMPLE FLOOD INSURANCE RATE MAP

KEY TO MAP

100-Year Flood Boundary ————
500-Year Flood Boundary ————

Zone Designations* With Date of Identification e.g., 12/2/74

100-Year Flood Boundary ————
500-Year Flood Boundary ————



Base Flood Elevation Line With Elevation In Feet**	——513——
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7 ×
River Mile	• M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

For adjoining map panels, see separately printed Index To Map Panels.

For description of Elevation Reference Marks, see Panel 510129 0015 B.

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.

To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program at (800) 638-6620, or (800) 424-8872.

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
AO	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

CITY OF
NEWPORT, OREGON
LINCOLN COUNTY

INITIAL IDENTIFICATION:
MAY 24 1974

FLOOD HAZARD BOUNDARY MAP REVISIONS:
JULY 2, 1976

FLOOD INSURANCE RATE MAP EFFECTIVE:
APRIL 15, 1980

FIGURE 2
EXAMPLE LEGEND FOR FLOOD INSURANCE RATE MAP

(800) 424-8872/73	Continental U.S. only
(800) 424-9080	Continental U.S. Hawaii, Alaska, Puerto Rico, and the Virgin Islands
755-9096	Washington, D.C. Metropolitan Area

FIA flood maps may be ordered from:

National Flood Insurance Program
P.O. Box 34294
Bethesda, Maryland 20034

Telephone: (800) 638-6620 (toll free)
(800) 492-6605 (toll free) in Maryland only
(301) 897-5900 (Washington, D.C. Metropolitan Area) (FIA, 1981)

These maps may also be obtained through the FIA Regional Offices listed in Table 1 and the state coordinating agencies for flood insurance listed in Table 2. These offices can also provide information on the NFIP and can help in deciphering FIA flood maps.

2.2.2 Additional Sources

For areas that have not been mapped by FIA, information to identify the 100-year floodplain can be obtained from the U.S. Army Corps of Engineers (COE), from the Soil Conservation Service (SCS), or from the U.S. Geological Survey (USGS). The COE is authorized to do floodplain information studies, at the request of state and local governments, that identify flood water elevations, flow velocities, and the floodplain for a flood of a specified frequency (usually the 100-year flood). Many of these studies have been completed and are available from the State Coordinating Agencies for Flood Insurance listed in Table 2 or from the U.S. Army Corps of Engineers District Offices listed in Table 3 and mapped in Figure 3. The COE also has a Floodplain Management Services Program that provides assistance to states and Federal agencies in interpreting hydrologic and hydraulic data that might be submitted to EPA with an independent determination of flood levels or flood boundaries. This assistance can be obtained at the District Offices.

In some cases the SCS carries out detailed engineering studies for FIA, which FIA publishes as Flood Insurance Studies. In some instances SCS has completed a study but FIA has not yet published it. The SCS State Conservationists listed in Table 4 can be contacted to determine if the locale of interest falls into that category. The State Conservationists will also provide Regional EPA personnel with assistance in interpreting independent floodplain analyses submitted to the Agency.

The U.S. Geological Survey operates a system of stream gauging stations across the United States. The USGS publishes basic hydrologic data from these stations, such as mean daily discharge values. The USGC also publishes "Flood Reports," which contain discharge data for floods and flood hydrographs. Lists of flood discharge peaks and frequency analyses (i.e., 10-year flood discharge) are also published for some stations. The USGS District

Offices (listed in Table 5) can be contacted for these publications and information about their stream gauging stations.

This basic hydrologic data is used in determining the magnitude of the 100-year frequency flood in terms of discharge, velocity, and elevation. These parameters are also needed for determining the extent of the 100-year floodplain and for designing flood control measures (e.g., dikes, flood-resistant tanks).

2.3 Independent Analyses

If an owner or operator of a facility is unable to obtain floodplain studies from FIA, COE, SCS, or USGS, or if he would like to appeal an existing study, he may choose to analyze the site himself or he may contract with an engineer or hydrologist to do the study for him. In either case, the sources of information and methods cited in the next paragraph can be used for determining flood frequency, elevations, and flood velocity.

Detailed information for defining the flooding potential at a specific location in terms of peak discharge and exceedance probability (e.g., 10-year, 50-year, 100-year floods) can be found in Guidelines for Determining Flood Flow Frequency, Bulletin #17A of the Hydrology Committee, revised June 1977, as published by the United States Water Resources Council. However, this kind of hydrologic analysis can be used only where stream gaging records are available for at least ten years. Detailed information for determining if proposed development in a floodway (such as a hazardous waste management facility) will increase 100-year flood elevations can be found in "The Floodway: A Guide for Community Officials", Number 4 in the Community Assistance Series published by the Federal Insurance Administration, Federal Emergency Management Agency, in September 1979.

TABLE 1

FEDERAL INSURANCE ADMINISTRATION
REGIONAL OFFICES

REGION I (CT, ME, MA, NH, RI, VT)

15 New Chardon Street
Boston, Massachusetts 02114
617-223-2612 (CML)
223-6324 (FTS)

REGION II (NJ, NY, PR, VI)

90 Church Street, Room 801
New York, New York 10007
212-264-4756 (CML)
264-4734, 264-4735 (FTS)

Region III (DE, DC, MD, PA, VA, WV)

Curtis Building
Sixth and Walnut Streets
Philadelphia, Pennsylvania 19106
215-597-9581 (CML)
597-9581 (FTS)

REGION IV (AL, FL, GA, KY, MS, NC, SC, TN)

1371 Peachtree Street, NE
Atlanta, Georgia 30309
404-881-2391 (CML)
257-2391 (FTS)

REGION V (IL, IN, MI, OH, WI)

300 South Wacker Drive
Chicago, Illinois 60606
312-353-0757 (CML)
353-0757 (FTS)

REGION VI (AR, LA, NM, OK, TX)

Earle Cabell Building
1100 Commerce Street
Dallas Texas 75242
817-387-5811 (CML)
749-9271 (FTS)

REGION VII (IA, KS, MO, NB)

Federal Office Building
911 Walnut Street
Kansas City, Missouri
816-374-2161 (CML)
758-2161 (FTS)

REGION VIII (CO, MT, ND, SD, UT, WY)

Room 311
909 17th Street
Denver, Colorade 80202
303-234-6582 (CML)
234-6582 (FTS)

REGION IX (AZ, CA, HI, NV)

450 Golden Gate Avenue
Post Office Box 36003
San Francisco, California 94102
415-556-3543 (CML)
556-3543 (FTS)

REGION X (AK, ID, OR, WA)

Room 3068
Arcade Plaza Building
1321 Second Avenue
Seattle, Washington 98101
206-486-0721 (CML)
396-0721 (FTS)

Adapted from: Federal Emergency Management Agency, 1980. Questions and Answers: National Flood Insurance Program, FIA-2. Washington, DC.

TABLE 2

STATE COORDINATING AGENCIES FOR FLOOD INSURANCE

STATE	AGENCY & ADDRESS	RESPONSIBLE OFFICIAL	CONTACT PERSON	TELEPHONE NUMBER
ALABAMA	Alabama Development Office State Planning Division State Capitol Building Montgomery, Alabama 36130	Bob A. Davis Director	Richard L. Dowdy	205-832-6400
ALASKA	Department of Community and Regional Affairs Division of Community and Regional Planning 225 Cordova, Building B Anchorage, Alaska 99501	Larry Kimball Director	Edward Busch	907-279-8636
ARIZONA	Arizona Water Commission 222 North Central Suite 850 Phoenix, Arizona 85004	William Mathews Chief	Abram H. Apollo	602-255-1566
ARKANSAS	State Dept. of Commerce Division of Soil & Water Resources 1818 W. Capitol Building A Little Rock, Arkansas 72202	John Saxton Director	John Saxton	501-371-1611
CALIFORNIA	State of California Department of Water Resources P O. Box 388 Sacramento, California 95802	Ronald B. Robie Director	Jack Pardee	916-445-7746
COLORADO	Colorado Water Conservation Board, Room 823 State Centennial Building 1313 Sherman Street Denver, Colorado 80202	Felix L. Sparks Director	Eugene Jencsock	303-839-3441
CONNECTICUT	Department of Environmental Protection Water Resources Unit Room 215, State Office Bldg. Hartford, Connecticut 06115	Benjamin Warner Director	Paul Biscuiti	203-566-7245
DELAWARE	Office of Management, Budget and Planning Townsend Building, 3rd Floor Dover, Delaware 19901	Nathan Haywood Director	Steve Corazza	302-678-4271

TABLE 2 (CONTINUED)

STATE	AGENCY & ADDRESS	RESPONSIBLE OFFICIAL	CONTACT PERSON	TELEPHONE NUMBER
FLORIDA	Department of Community Affairs 2571 Executive Center Circle East Howard Building Tallahassee, Florida 32301	John M. Heggen Secretary	Jim Sayes	904-488-7956
GEORGIA	Department of Natural Resources Environmental Protection Division Resource Planning Section Room 702 19 Martin Luther King Drive, S.W. Atlanta, Georgia 30334	Joseph Tanner Commissioner	Mary Lynn Miller	404-656-3214
HAWAII	Board of Land and Natural Resources Department of Land and Natural Resources P.O. Box 621 Honolulu, Hawaii 96809	William Y. Thompson Chairman	Albert Ching	808-548-7642
IDAHO	Department of Water Resources State House Boise, Idaho 83720	Steve Allred Director	Bill Gossett	208-334-4440
ILLINOIS	Illinois Department of Transportation Division of Water Resources 300 North State Street Room 1010 Chicago, Illinois 60610	Frank Kudrna Director	French Wetmore	312-793-3864
INDIANA	Department of Natural Resources Division of Water 608 State Office Building Indianapolis, Indiana 46204	Joseph D. Cloud Director	Gordon Lance	317-633-5267
IOWA	Iowa Natural Resources Council Wallace State Office Building Des Moines, Iowa 50319	James R. Webb Director	Jack Riessen	515-281-5029
KANSAS	Kansas Dept. of Agriculture Division of Water Resources 1720 South Topeka Avenue Topeka, Kansas 66612	Guy E. Gibson Chief Engineer	J. William Funk	913-757-3717

TABLE 2 (CONTINUED)

STATE	AGENCY & ADDRESS	RESPONSIBLE OFFICIAL	CONTACT PERSON	TELEPHONE NUMBER
KENTUCKY	Kentucky Department of Natural Resources Division of Water Resources Old Wilkinson School Street Building Frankfort, Kentucky 40601	Dave Rosenbaum Director	Donna Covington	502-564-3980
LOUISIANA	Department of Urban and Community Affairs 5790 Florida Boulevard Baton Rouge, Louisiana 70800	Harvey H. R. Britton Director	Regis Allison	504-925-3710
MAINE	Bureau of Civil Emergency Preparedness State House Augusta, Maine 04330	Lionel Cote Director	Leslie Higgins	207-622-6201
MARYLAND	Water Resources Administration Flood Control Section Tawes Office Building Department of Natural Resources Annapolis, Maryland 21401	Thomas C. Andrews Director	Margie Whilden	301-269-3826
MASSACHUSETTS	Water Resources Commission Division of Water Resources State Office Building 100 Cambridge Street Boston, Massachusetts 02202	Charles Kennedy Director	Michael Beshara	617-727-3267
MICHIGAN	Michigan Dept. of Natural Resources Water Management Division P. O. Box 30028 Lansing, Michigan 48909	Dr. Howard A. Tanner Director	Dan Morgan	517-373-3930
MINNESOTA	Department of Natural Resources Division of Water Third Floor Space Center Building 444 Lafayette Road St. Paul, Minnesota 55101	Larry Symour Director	Patricia Bloomgren	612-296-0444
MISSISSIPPI	Mississippi Research and Development Center P. O. Drawer 2470 Jackson, Mississippi 39205	Dr. Kenneth Wagner Director	Willard Inman	601-982-6376
MISSOURI	Disaster Planning and Operations Office P. O. Box 116 Jefferson City, Missouri 65102	George M. Aichison	Ross Richardson	314-751-2321

TABLE 2 (CONTINUED)

STATE	AGENCY & ADDRESS	RESPONSIBLE OFFICIAL	CONTACT PERSON	TELEPHONE NUMBER
MONTANA	Montana Department of Natural Resources & Conservation Water Resources Division 32 South Ewing Street Helena, Montana 59601	Orrin Ferris Administrator	Neil Mann	406-449-2064
NEBRASKA	Nebraska Natural Resources Commission 301 Centennial Mall South P. O. Box 94876 Lincoln, Nebraska 68509	Albert Matthews	Bob Hendrix	402-471-2081
NEVADA	Department of Conservation and Natural Resources Division of Water Resources 201 S. Fall Street Carson City, Nevada 89710	William Newman State Water Engineer	Brian Randall	702-470-5911
NEW HAMPSHIRE	Office of State Planning Division of Community Planning State of New Hampshire 2½ Beacon Street Concord, New Hampshire 03301	Ronald Pollack Director	V. Michael Blake	603-271-2155
NEW JERSEY	Department of Environmental Protection Bureau of Flood Plain Management Division of Water Resources P. O. Box CN029 Trenton, New Jersey 08625	John O'Dowd Chief	Clark Gilman	609-292-2296
NEW MEXICO	State Engineer's Office Bataan Memorial Building Santa Fe, New Mexico 87501	Steve Reynolds State Engineer	Fred Allen	505-827-2135
NEW YORK	New York State Department of Environmental Conservation Water Management 50 Wolf Road—Room 818 Albany, New York 12233	James Kelley Chief	Frank Dwyer	518-457-3157

TABLE 2 CONTINUED)

STATE	AGENCY & ADDRESS	RESPONSIBLE OFFICIAL	CONTACT PERSON	TELEPHONE NUMBER
N. CAROLINA	Department of Natural & Economic Resources Division of Community Assistance P. O. Box 27687 Raleigh, North Carolina 27611	Billy Ray Hall Acting Director	June Beane	919-733-2850
N. DAKOTA	State Water Commission State Office Building 900 E. Boulevard Bismark, North Dakota 58501	Vernon Fahy State Engineer	William Hanson	701-224-2750
OHIO	Ohio Department of Natural Resources Flood Plain Management Unit Ohio Dept. Building Fountain Square—Building E Columbus, Ohio 43224	Dr. Robert W. Teater Director	Pete Finke	614-466-6020
OKLAHOMA	Oklahoma Water Resources Board Northeast 10th & Stonewall 12th Floor Oklahoma City, Oklahoma 73105	James Barnett Executive Director	Harold Springer	405-271-2555
OREGON	Oregon Water Resources Dept. Milcreek Office Park Salem, Oregon 97310	James Sexson Director	Jake Szromek	503-378-3671
PENNSYLVANIA	Department of Community Affairs South Office Building Capitol Complex—Rm. 508 Harrisburg, Pennsylvania 17120	William R. Davis Secretary	Bruce Hoarn Kerry Wilson	717-787-7400
PUERTO RICO	Puerto Rico Planning Board P. O Box 41119, Minillas Station Santurce, Puerto Rico 00940	Miguel A. Rivera-Rios	Doris L. Oxman	809-726-7110
RHODE ISLAND	R.I. Statewide Planning Program 265 Melrose Street Providence, Rhode Island 02907	Daniel W. Varin Chief	Victor J. Parmontier	401-277-2656
S. CAROLINA	South Carolina Water Resources Commission P. O. Box 4515 3830 Forest Drive Columbia, South Carolina 29240	Clair P. Guess, Jr. Executive Director	Don Whetstone	803-758-2514
S. DAKOTA	State Planning Bureau State Capitol Pierre, South Dakota 57501	Ben Bucks Commissioner	Kirk Grau	605-224-3661

TABLE 2 (CONTINUED)

STATE	AGENCY & ADDRESS	RESPONSIBLE OFFICIAL	CONTACT PERSON	TELEPHONE NUMBER
TENNESSEE	Tennessee State Planning Office 660 Capitol Hill Building Nashville, Tennessee 37219	Donald Waller Director of Local Planning	Kenneth McKnight	615-741-2211
TEXAS	Texas Department of Water Resources Flood Protection & Disaster Assistance 1700 North Congress Avenue Austin, Texas 78701	Harvey Davis Executive Director	Everett W. Rowland	512-475-2171
UTAH	Department of Natural Resources Division of Water Resources 231 East 4th South Salt Lake City, Utah 84114	Gordon E. Harmston Executive Director	Barry Saunders Gene Bigler	801-533-5401
VERMONT	Agency of Environmental Conservation Division of Water Quality State Office Building Montpelier, Vermont 05602	David L. Clough Director	Roy Gaffney	802-828-2761
VIRGINIA	State Water Control Board P. O. Box 11143 Richmond, Virginia 23220	R. V. Davis	Dale Jones	804-257-0075
WASHINGTON	Department of Ecology Olympia, Washington 98504	Wilbur Hallauer Director	Edward Hammersmith	206-754-2040
W. VIRGINIA	Disaster Recovery Office 1591 Washington Street, East Charleston, West Virginia 25305	Daniel S. Green Manager	Karen Farmer	304-348-0188
WISCONSIN	Department of Natural Resources Flood Plain-Shoreline Management Section P. O. Box 7921 Madison, Wisconsin 53707	Anthony Earl Secretary	Larry Larson	608-266-0161
WYOMING	Wyoming Disaster and Civil Defense Agency P. O. Box 1709 5500 Bishop Boulevard Cheyenne, Wyoming 82001	James L. Spence Adjutant General Wyoming Nat'l Guard	Bill Reiling	307-777-7566

TABLE 2 (CONCLUDED)

STATE	AGENCY & ADDRESS	RESPONSIBLE OFFICIAL	CONTACT PERSON	TELEPHONE NUMBER
DISTRICT OF COLUMBIA	Office of Environmental Planning and Management Legislative Branch 415 12th Street, N.W. Suite 308 Washington, D.C. 20004	Malcolm C. Hope Administrator	Carl Pace	202-727-5701
VIRGIN ISLANDS	Virgin Islands Planning Board P. O. Box 2606 Charlotte Amalie, St. Thomas, Virgin Islands 00801	Thomas Blake Planning Director	Darlin Brin	809-774-1730

Source: Federal Emergency Management Agency, 1980. Questions and Answers - National Flood Insurance Program. Federal Insurance Administration, FIA-2. June.

TABLE 3*

U.S. ARMY CORPS OF ENGINEERS DISTRICT OFFICES

Office, Chief of Engineers
Department of the Army
Washington, D.C. 20314
(202) 272-0001

Districts:

U.S. Army Engineer District, Memphis
668 Federal Office Building
Memphis, Tennessee 38103
(901) 521-3221

U.S. Army Engineer District, New Orleans
P.O. Box 60267
New Orleans, Louisiana 70160
(504) 865-1121

U.S. Army Engineer District, St. Louis
210 North 12th Street
St. Louis, Missouri 63101
(314) 263-5545

U.S. Army Engineer District, Vicksburg
P.O. Box 60
Vicksburg, Mississippi 39180
(601) 634-5000

U.S. Army Engineer District, Kansas City
700 Federal Building
601 East 12th Street
Kansas City, Missouri 64106
(601) 374-3896

U.S. Army Engineer District, Omaha
6014 U.S. Post Office and Court House
215 N. 17th Street
Omaha, Nebraska 68102
(402) 221-3020

U.S. Army Engineer Division, New England
424 Trapelo Raod
Waltham, Massachusetts 02154
(617) 894-2400

U.S. Army Engineer District, Baltimore
P.O. Box 1715
Baltimore, Maryland 21203
(301) 962-2020

U.S. Army Engineer District, New York
26 Federal Plaza
New York, New York 10007
(212) 264-7464

U.S. Army Engineer District, Norfolk
803 Front Street
Norfolk, Virginia 23510
(804) 441-3500

U.S. Army Engineer District, Philadelphia
U.S. Custom House
2nd and Chestnut Streets
Philadelphia, Pennsylvania 19106
(215) 597-4701

U.S. Army Engineer District, Buffalo
1776 Niagara Street
Buffalo, New York 14207
(716) 876-5454

U.S. Army Engineer District, Chicago
219 S. Dearborn Street
Chicago, Illinois 60604
(312) 353-6400

U.S. Army Engineer District, Detroit
P.O. Box 1027
Detroit, Michigan 48231
(313) 226-6413

U.S. Army Engineer District, Rock Island
Clock Tower Building
Rock Island, Illinois 61201
(309) 788-6361

U.S. Army Engineer District, St. Paul
1210 U.S. Post Office and Custom House
St. Paul, Minnesota 55101
(612) 725-7506

U.S. Army Engineer District, Alaska
P.O. Box 7002
Anchorage, Alaska 99510
(907) 864-0113

U.S. Army Engineer District, Portland
P.O. Box 2946
Portlnnd, Oregon 97208
(503) 665-4166

U.S. Army Engineer District, Seattle
1519 Alaskan Way, South
Seattle, Washington 98134
(206) 764-3742

U.S. Army Engineer District, Walla Walla
Building 602
City-County Airport
Walla Walla, Washington 99362
(509) 525-5500

U.S. Army Engineer District, Huntington
P.O. Box 2127
Huntington, West Virginia 25721
(304) 529-5253

U.S. Army Engineer District, Louisville
P.O. Box 59
Louisville, Kentucky 40201
(502) 582-5601

U.S. Army Engineer District, Nashville
P.O. Box 1070
Nashville, Tennesee 37202
(615) 251-5646

*See Figure 3.

TABLE 3 (Concluded)

U.S. Army Engineer District, Pittsburgh
Federal Building
1000 Liberty Avenue
Pittsburgh, Pennsylvania 15222
(412) 644-6800

U.S. Army Engineer District, Charleston
P.O. Box 919
Charleston, South Carolina 29402
(803) 724-4258

U.S. Army Engineer District, Jacksonville
P.O. Box 4970
Jacksonville, Florida 32201
(904) 791-2234

U.S. Army Engineer District, Mobile
P.O. Box 2288
Mobile, Alabama 36628
(205) 690-2011

U.S. Army Engineer District, Savannah
P.O. Box 889
Savannah, Georgia 31402
(912) 944-5822

U.S. Army Engineer District, Wilmington
P.O. Box 1890
Wilmington, North Carolina 28401
(919) 343-4647

U.S. Army Engineer Division, Pacific Ocean
Building 96
Fort Armstrong
Honolulu, Hawaii 96813
(808) 438-1331

U.S. Army Engineer District, Los Angeles
P.O. Box 2711
Los Angeles, California 90053
(213) 688-5522

U.S. Army Engineer District, Sacramento
650 Capitol Mall
Sacramento, California 95814
(916) 440-2292

U.S. Army Engineer District, San Francisco
100 McAllister Street
San Francisco, California 94102
(415) 556-0985

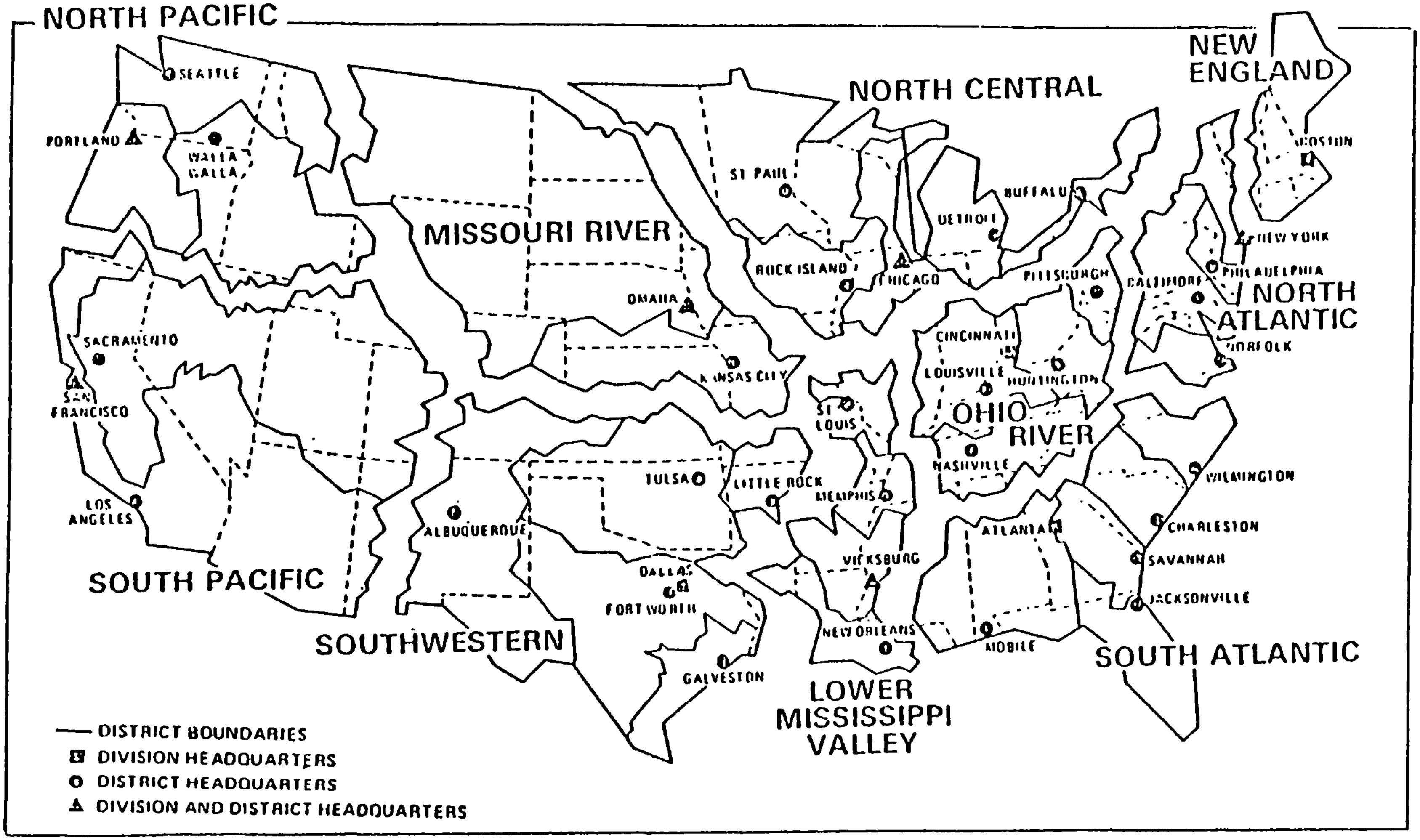
U.S. Army Engineer District, Albuquerque
P.O. Box 1580
Albuquerque, New Mexico 87103
(505) 292-4669

U.S. Army Engineer District, Galveston
P.O. Box 1229
Galveston, Texas 77550
(713) 763-1211

U.S. Army Engineer District, Little Rock
P.O. Box 867
Little Rock, Arkansas 72203
(501) 378-5551

U.S. Army Engineer District, Forth Worth
P.O. Box 17300
Fort Worth, Texas 76102
(817) 334-2150

U.S. Army Engineer District, Tulsa
P.O. Box 61
Tulsa, Oklahoma 74101
(918) 581-7395



[a]The Alaska District Headquarters, Anchorage, Alaska, is included in the North Pacific Division.
[b]The State of Hawaii and Islands in the Pacific are included in Honolulu District, Pacific Ocean Division, with Headquarters at Honolulu, Hawaii.
[c]The Territory of Puerto Rico and adjacent Islands is included in Jacksonville District, South Atlantic Division.

FIGURE 3

DIVISIONS AND DISTRICES SERVED BY THE U.S. ARMY CORPS OF ENGINEERS DISTRICT OFFICES[a,b,c]

TABLE 4

SOIL CONSERVATION SERVICE STATE CONSERVATIONISTS

William B. Lingle
Wright Building
138 South Gay Street
P.O. Box 311
Auburn, Alabama 36830
534-4535 (FTS)
205-821-8070 (CML)

Weymeth E. Long
Suite 129, Professional Bldg.
2221 E. Northern Lights Blvd.
Anchorage, Alaska 99504
907-276-4246 (FTS & CML)

Thomas G. Rockenbaugh
230 N. 1st Avenue
3008 Federal Building
Phoenix, Arizona 85025
602-261-6711 (FTS & CML)

Maurice J. Spears
Federal Building, Room 5029
700 West Capitol Street
P.O. Box 2323
Little Rock, Arkansas 72203
740-5445 (FTS)
501-378-5445 (CML)

Francis C. H. Lum
2828 Chiles Road
Davis, California 95616
916-758-2200 ext. 210 (FTS & CML)

Robert Halstead
2490 West 26th Avenue
P.O. Box 17107
Denver, Colorado 80217
327-4275 (FTS)
303-837-4275 (CML)

Jack G. Davis
Mansfield Professional Park
Route 44A
Storrs, Connecticut 06268
244-2547/2548 (FTS)
203-429-9361/9362 (CML)

Otis D. Fincher
Treadway Towers, Suite 2-4
9 East Loockerman Street
Dover, Delaware 19001
487-5148 (FTS)
302-678-0750 (CML)

William E. Austin
Federal Building
P.O. Box 1208
Gainesville, Florida 32602
946-3871 ext. 100 (FTS)
904-377-8732 (CML)

Dwight M. Treadway
Federal Building
355 E. Hancock Avenue
P.O. Box 832
Athens, Georgia 30603
250-2275 (FTS)
404-546-2274 (CML)

Jack P. Kanalz
300 Ala Moana Blvd.
Room 4316
P.O. Box 5004
Honolulu, Hawaii 96850
808-546-3165 (FTS & CML)

Amos I. Garrison, Jr.
Room 345
304 North 8th Street
Boise, Idaho 83702
554-1601 (FTS)
208-384-1601 ext. 1601 (CML)

TABLE 4 (Continued)

Warren J. Fitzgerald
Federal Building
200 W. Church Street
P.O. Box 678
Champaign, Illinois 61820
958-9147/9125 (FTS)
217-356-3785 (CML)

Buell M. Ferguson
Atkinson Square-West
Suite 2200
5610 Crawfordsville Road
Indianapolis, Indiana 46224
331-6515 (FTS)
317-269-3785 (CML)

William J. Brune
693 Federal Building
210 Walnut Street
Des Moines, Iowa 50309
515-862-4260 (FTS & CML)

John W. Tippie
760 South Broadway
P.O. Box 600
Salina, Kansas 67401
752-2911 (FTS)
913-825-9535 (CML)

Glen E. Murray
333 Waller Avenue
Lexington, Kentucky 40504
355-2749 (FTS)
606-233-2749 ext. 2749 (CML)

Alton Mangum
3737 Government Street
P.O. Box 1630
Alexandria, Louisiana 71301
497-6611 ext. 233 (FTS)
318-448-3421 (CML)

Eddie L. Wood, Jr.
USDA Building
University of Maine
Orono, Maine 04473
833-7393 (FTS)
207-866-2132/2133 (CML)

Gerald R. Calhoun
Room 522, Hartwick Building
4321 Hartwick Road
College Park, Maryland 20740
301-344-4180 (FTS & CML)

Benjamin Isgur
29 Cottage Street
Amherst, Massachusetts 01002
413-549-0650 (FTS & CML)

Arthur H. Cratty
Room 101
1405 South Harrison Road
East Lansing, Michigan 48823
374-4242 (FTS)
517-372-1910 ext. 242 (CML)

Harry M. Major
200 Federal Bldg. & U.S. Courthouse
316 North Robert Street
St. Paul, Minnesota 55101
612-725-7675 (FTS & CML)

Chester F. Bellard
Milner Building, Room 590
210 South Lamar Street
P.O. Box 610
Jackson, Mississippi 39205
490-4335 (FTS)
601-969-4330 (CML)

Kenneth G. McManus
555 Vandiver Drive
Columbia, Missouri 65201
276-3145 (FTS)
314-442-2271 ext. 3155 (CML)

TABLE 4 (Continued)

Van K. Haderlie
Federal Building
P.O. Box 970
Bozeman, Montana 59715
585-4322 (FTS)
406-587-5271 ext. 4322 (CML)

Benny Martin
Federal Building
U.S. Courthouse, Room 345
Lincoln, Nebraska 68508
541-5300 (FTS)
402-471-5301 (CML)

Gerald C. Thola
Room 308
U.S. Post Office Building
P.O. Box 4850
Reno, Nevada 89505
470-5304 (FTS)
702-784-5304 (CML)

Donald G. Burbank
Federal Building
Durham, New Hampshire 03824
834-0505 (FTS)
603-868-7581 (CML)

Plater T. Campbell
1370 Hamilton Street
P.O. Box 219
Somerset, New Jersey 08873
342-5225 (FTS)
201-246-1205 ext. 20 (CML)

Albert W. Hamelstrom
517 Gold Avenue, SW
P.O. Box 2007
Albuquerque, New Mexico 87103
474-2173 (FTS)
505-766-2173 (CML)

Robert L. Hilliard
U.S. Courthouse & Federal Bldg.
100 S. Clinton Street, Room 771
Syracuse, New York 13260
950-5494 (FTS)
315-423-5493 (CML)

Jesse L. Hicks
310 New Bern Avenue, Federal Building, Room 544
P.O. Box 27307
Raleigh, North Carolina 27611
672-4210 (FTS)
919-755-4165 (CML)

Allen L. Fisk
Rosser Avenue & Third Street
Federal Building
P.O. Box 1458
Bismarck, North Dakota 58501
783-4421 (FTS)
701-255-4011 ext. 421 (CML)

Robert E. Quilliam
Room 522
200 North High Street
Columbus, Ohio 43215
943-6962 (FTS)
614-469-6785 (CML)

Roland E. Willis
Agriculture Building
Farm Road & Brumley Street
Stillwater, Oklahoma 74074
728-4360 (FTS)
405-624-4360 (CML)

Guy W. Nutt
Federal Office Building
1220 S.W. 3rd Avenue
Portland, Oregon 97209
423-2751 (FTS)
503-221-2751 (CML)

TABLE 4 (Continued)

Graham T. Munkittrick
Federal Bldg. & Courthouase
Box 985 Federal Square Station
Harrisburg, Pennsylvania 17108
590-2202 (FTS)
717-782-4403 (CML)

I. R. Emmanuelli
Caribbean Area
Federal Office Bldg., Room 633
Sixth Floor
Hato Rey, Puerto Rico 00918
Mailing Address:
GPO Box 4868
San Juan, Puerto Rico 00936
809-753-4206

Donald M. McArthur
46 Quaker Lane
West Warwick, Rhode Island 02893
401-828-1300 (FTS)

George E. Huey
240 Stoneridge Drive
Columbia, South Carolina 29210
677-5681 (FTS)
803-765-5681 (CML)

Robert D. Swenson
Federal Building
200 4th Street, S.W.
P.O. Box 1357
Huron, South Dakota 57350
782-2333 (FTS)
605-352-8651 (CML)

Donald C. Bivens
675 U.S. Courthouse
Nashville, Tennessee 37203
852-5471 (FTS)
615-749-5471 (CML)

George C. Marks
W.R. Poage Federal Building
101 S. Main Street
P.O. Box 648
Temple, Texas 76501
736-1214 (FTS)
817-773-1711 ext. 331 (CML)

George McMillan
4012 Federal Building
125 South State Street
Salt Lake City, Utah 84138
588-5050 (FTS)
801-524-5051 (CML)

Robert Shaw
1 Burlington Square, Suite 205
Burlington, Vermont 05401
832-6794 (FTS)
802-862-6501 ext. 6261 (CML)

David N. Grimwood
Federal Bldg., Room 9201
400 N. 8th Street
P.O. Box 10026
Richmond, Virginia 23240
925-2457 (FTS)
804-782-2457 (CML)

Lynn A. Brown
360 U.S. Courthouse
W. 920 Riverside Avenue
Spokane, Washington 99201
439-3711 (FTS)
509-456-3711 (CML)

Craig M. Right
75 High Street
P.O. Box 865
Morgantown, West Virginia 26505
923-7151 (FTS)
304-599-7151 (CML)

TABLE 4 (Concluded)

Jerome C. Hytry
4601 Hammersley Road
Madison, Wisconsin 53711
364-5351 (FTS)
608-252-5351 (CML)

Frank S. Dickson, Jr.
Federal Office Building
P.O. Box 2440
Casper, Wyoming 82601
328-5201 (FTS)
307-265-5550 ext. 3217 (CML)

Source: U.S. Department of Agriculture, 1980. Soil Conservation Service, P.O. Box 2890, Washington, D.C. 20013. October.

TABLE 5

U.S. GEOLOGICAL SURVEY
DISTRICT OFFICES

STATE	DISTRICT OFFICE
Alabama	District Office U.S.G.S. Room 202 Oil and Gas Board Building P.O. Box V University, Alabama 34586 (205) 752-8104
Alaska	District Office U.S.G.S. Skyline Building 218 E. Street Anchorage, Alaska 99501 (907) 277-5526
Arizona	Arizona District Office U.S.G.S. Federal Building 301 West Congress Tucson, Arizona 85701 (602) 792-6671
Arkansas	Arkansas District Office U.S.G.S. 2301 Federal Building 700 W. Capital Avenue Little Rock, Arkansas 72201 (501) 378-5246
California	California District Office U.S.G.S. 55 Oak Grove Avenue Menlo Park, California 94025 (415) 323-8111
Colorado	Colorado District Office U.S.G.S. Denver Federal Center, M.S. 415 P.O. Box 25046 Lakewood, Colorado 80225 (303) 234-5092

TABLE 5 (Continued)

STATE	DISTRICT OFFICE
Connecticut	Connecticut District Office U.S.G.S. 135 High Street Room 235 Hartford, Connecticut 06101 (203) 244-2528
Delaware	Subdistrict Office U.S.G.S. 200 New Street Federal Building, Room 1201 Dover, Delaware 19901 (302) 734-2506
District of Columbia	Public Inquiries Office[a] Room 1028 GSA Building 19th and F Streets, Northwest Washington, D.C. 20244 (202) 343-8073
Florida	Florida District Office U.S.G.S. Suite F-240 325 John Knox Road Tallahasee, Florida 32303 (904) 386-1118
Georgia	Georgia District Office U.S.G.S. 6481 Peachtree Industrial Boulevard Suite B Doraville, Georgia 30360 (404) 221-4858
Guam	Subdistrict Office U.S.G.S. P.O. Box Y Building 104 Navy Public Works Center Agana, Guam 96910 339-9123

[a]No District or Subdistrict Offices listed.

TABLE 5 (Continued)

STATE	DISTRICT OFFICE
Hawaii	Hawaii District Office U.S.G.S. 5th Floor 1833 Kalakaya Avenue Honolulu, Hawaii 96815 (808) 955-0251
Idaho	Idaho District Office U.S.G.S. P.O. Box 036 Room 365 Federal Building 560 West Fort Street Boise, Idaho 83724 (208) 384-1750
Illinois	Illinois District Office U.S.G.S. P.O. Box 1026 605 North Neil Street Champaigne, Illinois 61820 (217) 359-3918
Indiana	Indiana District Office U.S.G.S. 1819 North Meridian Street Indianapolis, Indiana 46202 (317) 269-7101
Iowa	Iowa District Office U.S.G.S. Room 269 Federal Building 400 South Capitol Street P.O. Box 1230 Iowa City, Iowa 52240 (319) 338-0581
Kansas	Kansas District Office U.S.G.S. 1950 Avenue "A" - Campus West University of Kansas Lawrence, Kansas 66045 (913) 864-4321
Kentucky	Kentucky District Office U.S.G.S. Room 572, Federal Building 600 Federal Place Louisville, Kentucky 40202 (502) 582-5241

TABLE 5 (Continued)

STATE	DISTRICT OFFICE
Louisiana	Louisiana District Office U.S.G.S. P.O. Box 66492 6554 Florida Boulevard, Room 215 Baton Rouge, Louisiana 70896 (504) 387-0181
Maine	Subdistrict Office U.S.G.S. 26 Ganneston Drive Augusta, Maine 04330 (207) 623-4797
Maryland	Maryland-Delaware DC District Office U.S.G.S. 208 Carroll Building 8000 LaSalle Road Parkville, Maryland 21204 (301) 828-1535
Massachusetts	New England District Office U.S.G.S. Suite 1001, 10th Floor 156 Causeway Street Boston, Massachusetts 02114 (617) 223-2822
Michigan	Michigan District Office U.S.G.S. 2400 Science Parkway Red Cedar Research Park Okemos, Michigan 48864 (517) 372-1910
Minnesota	Minnesota District Office U.S.G.S. 1033 New Post Office Building St. Paul, Minnesota 55101 (612) 735-7841
Mississippi	Mississippi District Office U.S.G.S. 430 Bounds Street Jackson, Mississippi 39206 (601) 969-4600

TABLE 5 (Continued)

STATE	DISTRICT OFFICE
Missouri	Missouri District Office U.S.G.S. 1400 Independence Road Mail Stop 260 Rolla, Missouri 05401 (314) 364-3680, ext. 185
Montana	District Office U.S.G.S. Room 421, Federal Building 316 N. Park Avenue P.O. Box 3698 Helena, Montana 59601 (406) 449-5263
Nebraska	Nebraska District Office U.S.G.S. Room 477 Federal Building and U.S. Courthouse 100 Centenial Mall North Lincoln, Nebraska 68508 (402) 471-5082
Nevada	Nevada District Office U.S.G.S. 227 Federal Building 705 North Plaza Street Carson City, Nevada 89701 (702) 882-1388
New Hampshire	Subdistrict Office U.S.G.S. Room 210 Federal Building 55 Pleasant Street Concord, New Hampshire 03301 (603) 224-7273
New Jersey	New Jersey District Office U.S.G.S. P.O. Box 1238 Room 420 Federal Building 402 East State Street Trenton, New Jersey 08607 (609) 989-2162

TABLE 5 (Continued)

STATE	DISTRICT OFFICE
New Mexico	New Mexico District Office U.S.G.S. Western Bank Building, Room 815 505 Marquette N.W. Alburquerque, New Mexico 87125 (505) 766-2246
New York	New York District Office U.S.G.S. Room 341 P.O. and Courthouse Albany, New York 12231 (518) 472-3107
North Carolina	North Carolina District Office U.S.G.S. P.O. Box 2857 Room 440 Century Station P.O. Building Raleigh, North Carolina 27602 (919) 755-4510
North Dakota	North Dakota District Office U.S.G.S. P.O. Box 778 Room 232 New Federal Building Bismarck, North Dakota 58501 (701) 255-4011
Ohio	Ohio District Office U.S.G.S. 271 West Third Avenue Columbus, Ohio 41212 (614) 469-5553
Oklahoma	Oklahoma District Office U.S.G.S. Room 621 201 Northwest 3rd Street Oklahoma City, Oklahoma 73102 (405) 231-4256
Oregon	Oregon District Office U.S.G.S. 86 Northeast Holladay Street P.O. Box 3202 Portland, Oregon 97208 (503) 234-3361

TABLE 5 (Continued)

STATE	DISTRICT OFFICE
Pennsylvania	District Office U.S.G.S. 4th Floor Federal Building P.O. Box 1107 Harrisburg, Pennsylvania 17108 (717) 782-3468
Puerto Rico	Caribbean District Office U.S.G.S. Building 652 Fort Buchanan P.O. Box 34168 San Juan, Puerto Rico 00934 (809) 783-4660
Rhode Island	Subdistrict Offict U.S.G.S. Federal Guilding and U.S. Post Office, Rocm 224 Providence, Rhode Island 02903 (401 528-4383
South Carolina	South Carolina District Office U.S.G.S. Suite 200 2001 Assembly Street Columbia, South Carolina 29201 (803) 765-5966
South Dakota	South Dakota District Office U.S.G.S. Room 231 Federal Building P.O. Box 1412 Huron, South Dakota 57350 (605) 352-8651
Tennessee	Tennessee District Office U.S.G.S. A-413 Federal Building Nashville, Tennessee 37203 (615) 749-5424
Texas	Texas District Office U.S.G.S. 649 Federal Building 300 East 8th Street Austin, Texas 78701 (512) 397-5766

TABLE 5 (Continued)

STATE	DISTRICT OFFICE
Utah	Utah District Office U.S.G.S. 8002 Federal Building 125 South State Street Salt Lake City, Utah 84138 (801) 524-5663
Vermont	Field Headquarters U.S.G.S.[a] P.O. Box 628 8 East State Street Montpelier, Vermont 05602 (802) 223-8614
Virginia	Virginia District Office U.S.G.S. Room 304 200 West Grace Street Richmond, Virginia 23220 (804) 782-2427
Virgin Islands	Office of the U.S. Government Comptroller for the Virgin Islands P.O. Box 7730 Charlotte Amalie St. Thomas, Virgin Islands 00801 (809) 774-1371
Washington	Washington District Office U.S.G.S. 1201 Pacific Avenue Suite 600 Tacoma, Washington 98402 (206) 573-6510
West Virginia	West Virginia District Office U.S.G.S. Federal Building and Court House, Room 3017 500 Quarrier Street, East Charleston, West Virginia 25301 (304) 343-6181
Wisconsin	Wisconsin District Office U.S.G.S. 1815 University Avenue, Room 200 Madison, Wisconsin 53706 (608) 262-2488

[a]No District of Subdistrict Offices listed.

TABLE 5 (Concluded)

STATE	DISTRICT OFFICE
Wyoming	Wyoming District Office U.S.G.S. 4020 House Avenue P.O. Box 2087 Gheyenne, Wyoming 82001 (307) 778-2220

Source: U.S. Department of the Interior, 1979. Information Sources and Services Directory. Office of Library and Information Services. Washington, D.C.

3.0 TYPES OF FLOODS, ASPECTS OF FLOODS WHICH DETERMINE THE DEGREE OF FLOOD DAMAGE, AND POTENTIAL FLOOD DAMAGES TO HAZARDOUS WASTE MANAGEMENT FACILITIES

Wastes that are washed out of a facility during a flood contaminate surface waters and may adversely affect aquatic and vegetative life. Increased amounts of leachate from land disposal and land treatment facilities produced during a flood are likely to increase the risk of soil and groundwater contamination. Both of these exposure pathways may result in adverse effects on human health.

This chapter discusses different types of floods that can occur in a 100-year floodplain, hazards specific to alluvial fan flooding and coastal flooding, aspects of flooding which determine the degree of damage a flood is capable of rendering (e.g., duration, velocity), and potential flood damages to management units at a hazardous waste facility.

3.1 Types of Floods

Floods are commonly classified according to their source (e.g., riverine and lacustrine) or by some distinguishing charcteristic (e.g., sheet runoff and ponding). The most common types of floods are described below.

3.1.1 Riverine Floods

Riverine floods inundate the floodplain surrounding a channeled flow of water (e.g., a river) due to increases in the surface elevation or velocity of flow. The velocities of riverine floods can reach up to thirty feet per second.

3.1.2 Shallow Floods

Sheet runoff and ponding are two types of shallow floods. Sheet runoff is the broad, relatively unconfined downslope movement of water across gently sloping terrain that results from many sources, including intense rainfall and/or snowmelt and the overflow from a channel which crosses a drainage divide. Sheet runoff is typical in aras of low topographic relief (FIA, 1977). Ponding is a result of runoff or other flows collecting in a depression. Ponding may occur in depressions behind accumulations of soil and rock.

3.1.3 Lacustrine Floods

Lacustrine flooding is the increase in surface elevation of a lake. Long-term fluctuations are caused by an increase or decrease of precipitation over the lake basin. Short-term water fluctuations can be caused by wind blowing over the lake. The wind can drive surface water in large volumes to the shore, thereby raising the level at one side of the lake and lowering it on the opposite side. This effect is more pronounced in bays where the rising water is concentrated in a restricted space within the shores (FIA, 1977).

3.1.4 Alluvial Fan Flooding

Alluvial fans are found in hilly or mountainous regions. The flood is channelized near the apex of the fan but the water course becomes increasingly unpredictable as the flow nears the toe of the fan.

3.1.5 Coastal Floods

Coastal flooding is the inundation of a coastal area that is accompanied by wave action. The most significant causes of water level fluctuations in coastal 100-year floodplains are storm surges and tsunamis. Storm surges are increases in wave frequency and height with resultant super-elevation of water on shore. These abnormal rises in water level in near-shore regions will not only flood low lying terrain, but provide a base on which high waves can build to attack the upper part of a beach and penetrate farther inland. This kind of flooding can cause severe damage. Tsunamis are long-period gravity waves generated by such disturbances as earthquakes, landslides, volcanic eruptions, and explosions near the sea surface. Stretches of the United States' coast line historically susceptible to tsunamis are Puget Sound, Washington; Monterey and San Francisco, California; and Hawaii.

3.2 Hazards Specific to Alluvial Fan Flooding and Coastal Flooding

3.2.1 Alluvial Fan Flooding

Alluvial flooding is similar to riverine flooding with the exception that a chance always exists that a hazardous waste management unit will not be subject to flooding at all due to the fact that the location of the flood channel is unpredictable. For example, if levees are placed to protect a structure from a predicted channelized flow, a chance exists that the flow will not run parallel to the levee, but rather perpendicular to it. In such cases a four to six foot per second velocity might be sufficient to disintegrate an earthen levee. (See Chapter 4 for a discussion of 'vees). In addition, the location of obstructions that might influence the path of the flood channel should also be considered when siting a facility in an alluvial fan.

3.2.2 Coastal Flooding

Coastal areas may be subject to high velocity waters, accompanied by waves greater than three feet. Structures between 1000 to 2000 feet inland from shore have been known to be vulnerable to wave action, particularly if they were not elevated above the wave hazard elevation (height of the incoming waves). Structures located 500 feet inland have been severely impacted by wave action associated with the 100-year frequency storm (Department of the Army, 1975). Within the 500-foot limit, conventional structures have been completely destroyed and concrete and steel structures have been gutted, with only the frame remaining intact. Also, cinder block structures have proven to be more vulnerable to wave attack than wood structures due to their rigid nature (Department of the Army, 1975). Therefore, the distance that a facility is sited inland is critical for purposes of determining the degree of flood damage that the facility may be subject to.

3.3 Aspects of Floods Which Determine the Degree of Flood Damage

The Department of the Army (1972) has identified aspects of floods that are critical in determining the degree of damage that floods may render. These are listed below with the most critical aspects listed first.

3.3.1 Depth

Depth of flood waters around a structure is by far the most critical element to be considered in planning and designing flood control measures. The depth of flood waters determines to a great extent the strength and stability requirements for the structure as a whole and for individual structural elements below the design flood level.

3.3.2 Velocity

Velocity of flood water during overbank flow conditions affects scouring, sediment transportation, debris load, and dynamic loading on structures and obstructions. Flood velocities vary from point to point in a floodplain and over the area of inundation. From a practical standpoint, velocities up to five feet per second are not uncommon or unusual and their effects on structures may be dealt with by application of normal design methods and procedures. Velocities up to ten feet per second could occur, particularly in close proximity to the channel, but are believed to be unusual and to require special methods and techniques. A velocity of ten feet per second is considered to be the upper limit for which flood control measures are economically effective, except for special structures and facilities built at the edge of a channel, where permitted.

3.3.3 Duration

The duration of a flood, as measured from the time the body of water overflows its banks, reaches its crest elevation, and then recedes to within its banks, is important from the standpoint of saturation of soils and building materials, seepage, achievement of full pressure in soils and under foundations, and other time-dependent effects. In addition, the duration of the flood affects the provisions of standby utilities and services.

3.3.4 Rate of Rise and Fall

The rate of rise and fall of a flood to and from its crest affects the sizing of flooding and draining provisions, where such are required. It also affects in certain cases the implementation of contigent or emergency flood control measures and must be recognized in investigations of slope stability for a condition of quick drawdown.

3.3.5 Advance Warning

The length of advance warning available from flood forecasting is all-important, particularly in relation to contingent flood control methods which require definite amounts of lead time for protective measures to be placed into effect and for facilities which plan to remove waste before flood waters reach the facility.

3.3.6 Debris Load

The amount and type of floating debris carried by the flood waters can result in substantial loads against buildings and structures and can cause blockages of channels and passageways. Debris load includes logs, tree branches and trees, lumber, displaced sections of frame structures, drains, tanks, and runaway boats and barges. Broken-up ice blocks and large masses of broken-up ice sheets predominate in the floating solids borne by flood waters in certain areas of the country during early spring floods. Ice blockage of channels or ice jams that frequently occur in certain areas contribute significantly to the flood hazard and related problems.

3.3.7 Wave Action

A degree of wave action is inherent to all large expanses of water under the action of the wind. For typical riverine floods, wave action is nominal and allowances can be made for it by providing a suitable freeboard. Wave action is most significant for coastal floods which are caused by persistent storms, for example, nor'easters, tsunami waves, or hurricanes. These cases require special design considerations and procedures.

3.4 Potential Flood Damage to Management Units of a Hazardous Waste Facility

3.4.1 Landfills

Potential damages to an operating landfill range from solution of the waste to total washout. The effects on containerized waste in landfills is also described below.

- Waste solution and suspension will be present during flooding of a landfill containing bulk wastes, but these will not present a problem in landfills containing drummed wastes, unless the containers are leaking.

- All flooding, except for ponding, carries with it the potential for erosion of loose landfill cover material. ~~and, hence, a greater rate of leachate production and flow.~~ Erosion is particularly significant at landfills which are constructed so that the waste is above the mean ground level.

- All ~~level~~ flooding, with the exception of sheet runoff, can cause increased leachate production by adding water to the volume of wastes in the landfill and causing varying degrees of landfill saturation. The greater the depth of water over the landfill, the greater the pressure will be on the contained material and hence, the greater the rate of leachate production and flow.

- The steady rise of water associated with the flooding of lakes and similar slow accumulations of water can cause structural damage to waste containers in a landfill due to the pressures exerted by hydrostatic loads[1]. This is more likely to occur when the containers are structurally weak.

- The high flow velocities in conjunction with the large volumes of water associated with riverine, alluvial, and coastal flooding can completely washout a landfill, including the removal of drummed wastes from the area.

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[1] Hydrostatic loads are caused by water either above or below the ground surface, free or confined, which is either stagnant or moves at very low velocities (i.e., up to five feet per second) (Department of the Army, 1972). For a more in-depth discussion of water loads, see Section 4.2.5.

3.4.2 Land Treatment Areas

Land treatment areas are subject to the following:

- Waste solution or suspension and leachate production from all types of floods

- Erosion from all types of floods except ponding

- High volocity/high volume floods such as riverine, alluvial, and coastal, which may completely remove soil layers with incorporated waste

3.4.3 Surface Impoundments

Surface impoundments are potentially subject to waste solution or suspension that would persist in the impoundment long after the flood waters had receded. Impoundments are also subject to overflow from all types of floods, and high velocity/high volume floods may even remove sludges which have accumulated on the bottom.

3.4.4 Waste Piles

All types of flooding can result in solution or suspension of waste in a pile. Depending upon the velocity of flood waters, the pile may erode or it may be completely washed out. The high flow velocities associted with riverine, alluvial, and coastal flooding can result in complete washout of the pile. The waste pile may remain saturated or partially saturated after the flood waters have subsided, thereby causing increased leachate production in the pile. Saturation of the pile can also weaken its lower "strata" and result in collapse of the pile and subsequent washout.

3.4.5 Tanks

During flood conditions, tanks are subject to overflow, structural damage, and flotation. Tank overflow is dependent upon the height of the above-ground portion of the tank, the level of the waste in the tank, if the tank is covered or uncovered, and the elevation of the flood waters. Structural damage can be caused by hydrostatic pressure and impact loads[1] in excess of the design strength. Hydrostatic loads on underground and above-ground tanks are of potential concern during all types of floods except sheet runoff, which is too shallow to exert significant hydrostatic pressure. Structural damage to above-ground or partially above-ground tanks may be caused by impact loads of floating debris during all types of floods, but particularly by floods that are characterized by high velocity waters.

Structural damage to the tank can also occur as a result of saturation and erosion of soil that serves either as the base of the tank or as the foundation for a base made of another material (e.g., concrete or asphalt). In both cases, the support capability of the soil is decreased by removal or settling and tank damage can result. Flotation of tanks is a concern during high velocity/high volume floods and during lacustrine floods due to volume of water alone.

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[1] Impact loads result from floating debris, ice, and any floatable object or mass carried by flood waters striking against structures or parts thereof (Department of the Army, 1972).

Such removal of tanks is likely to result in structural damage and release of hazardous waste.

3.4.6 Incinerators

Incinerators that are flooded may be subject to waste solution or suspension or complete washout in the storage and operating components of the unit. Incinerators are subject to the same mechanisms of structural damage and flotation that were identified above for tanks.

3.4.7 Containers

The effects of flooding on containers disposed of in a landfill was discussed in Section 3.3.1. Containers also present hazards because they float. Containers may be carried in flood waters and may break open at some distance from the facility, releasing waste to the environment; or, they may be transported some distance from the facility where an unknowing person may open the drum, with lethal consequences.

4.0 DESIGN AND CONSTRUCTION OF FACILITIES TO PREVENT WASHOUT

If owners or operators do not opt to establish procedures which result in hazardous waste at the facility being moved before flood waters reach the facility, the regulation requires that the facility be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood. This chapter discusses differences between new and existing facilities in this regard and flood proofing and flood protection measures that can be applied to hazardous waste facilities.

4.1 New vs. Existing Facilities

A number of different factors will be considered in determining how a new facility will comply with the floodplain location standard vs. how an existing facility will comply. A new facility has more leeway with regard to placement of management units on the available property. In the early stages of facility design, consideration should be given to the orientation of the facility or management units thereof, with respect to the probability of the facility being flooded from all sides, as opposed to only the side exposed to the flood source, and with respect to proximity to other structures. Sites located closer to the flood sources will have a greater chance of being inundated from all sides than would a site that is farther away from the flood source, i.e., juxtaposed to the 500-year floodplain. Flood water elevations and velocities associated with the 100-year flood must also be identified at the facility location in order to design flood control measures that are adequate for the potential flooding hazards at the facility. If a new facility is sited near other existing structures, the addition of the facility may increase flood water elevations and flow velocities upstream or downstream, or it may expose the facility to an existing channel effect created by the other structures or exacerbate the channel effect on structures downstream from the facility. These analyses can be made using existing topographic and flood data maps or from aerial photographs. If none of these is available, a general examination of the site and its surrounding area will have to be made to gather the appropriate data from which to make the analyses.

In order to comply with the floodplain location standard, existing hazardous waste management facilities located in a 100-year floodplain may have to modify management units at the facility, build diversion structures, or pursue other alternatives such as facility relocation or, in the case of on-site facilities, off-site waste management. The cost of retrofitting a facility with respect to unit modification and diversion structure construction will probably be greater than the cost of including these parameters in the initial facility design. In addition, the cost of retrofitting will be very site specific and will vary in economies of scale. In any case, cost analysis data are not available for retrofitting off-site or on-site facilities and this topic is not addressed in this document, but only mentioned as a potential problem that existing facilities may encounter in complying with the floodplain standard.

The units in a facility may be modified in accordance with flood proofing options presented in Section 4.2. Fencing can be added, post-closure slope of a landfill increased, piles or incinerators removed and placed at higher elevations, drainage capacity added, and tanks anchored. However, it may be too difficult, impossible, or too costly to regrade land treatment areas, to change the slope of operating landfills, or to replace existing tanks and containers. In most cases, diversion structures will have to be constructed instead of, or in addition to, unit modification.

Diversion structures may be added to a facility in accordance with the discussion presented in Section 4.3. The availability of space and borrow material of acceptable quality will be one of the factors that will determine the feasibility of constructing diversion structures. If the geologic foundation is too permeable, or the water table is too high, levee construction may not be feasible. If space is limited, the slope of a levee may be too steep for the compaction characteristics of the available borrow. Space must also be available and the geologic foundation adequate for seepage control materials to be installed. If the site borrow is inappropriate for use in construction, or if no area for borrow exits, consideration must be given to acquiring acceptable borrow and to the associated costs.

Facility relocation is probably the most costly alternative among the four presented above (i.e., unit modification, diversion structures, off-site management, relocation). This costly and time-consuming process may be exacerbated if wastes have to be removed from the site and if additional land has to be purchased. For on-site facilities that handle smaller quantities of waste, off-site treatment and disposal will probably be more cost-effective than retrofitting.

4.2 Flood Proofing

The objective of flood proofing is to allow flood waters to come into contact with structures but to prevent damage to them. It is possible to flood proof structural components of facilities such as tanks, containers, incinerators, and structures utilized in chemical, physical, and biological treatment. Of course, flood protection, or a barrier between the facility or a portion thereof and flood waters, is also an option which can be used at these management units to prevent washout.

The methods of flood proofing used, and specific design of flood proofing at facilities, is tailored to the management units at the facility and the type and degree of flood hazards which the facility is subject to. However, general guidance can be given on flood proofing methods which may be used at hazardous waste facilities.

4.2.1 Freeboard

Freeboard is the allowance in a surface impoundment or a tank for an additional volume of water to be contained with the waste volume. Below-grade or partially above-grade surface impoundments and tanks can be designed with a freeboard capacity sufficient to contain flood waters of low elevation (e.g., sheet run-off). The volume of freeboard necessary to prevent overflow will vary with the size of the containment device, the maximum amount of precipitation or run-off accompanying the 100-year storm or flood, and whether diversion systems are available to shunt the excess waste/water mixture to containment devices or treatment systems. Drainage pipes or channels and diversion systems are particularly important in areas subject to heavy precipitation and wind-induced wave action.

4.2.2 Grading of Landfills and Land Treatment Areas

As precipitation on landfill and land treatment areas can contribute to leachate production, the surface of these areas should be sloped enough to cause most of the rainfall to run off. The surface grade should be greater than two percent to promote run-off, but less than five percent to reduce flow velocities and minimize soil erosion (Sittig, 1979). In most cases, flood diversion structures will also be needed to prevent washout of waste. Procedures for evaluating surface slope inclination are provided in the EPA publication "Evaluating Cover Systems for Solid and Hazardous Waste", September 1980 (SW-867).

4.2.3 Drainage Capacity

A drainage system should be available to drain run-off from land treatment areas and landfills that have been graded to facilitate run-off and from other areas of the facility where contaminated run-off may be produced (e.g., loading/unloading areas). This drainage system may also serve as a run-on diversion system for run-off from areas surrounding the landfill or land treatment areas. In the case of landfills, portable drainage structures may be more economical than permanent structures because the location of fill areas is constantly changing (U.S. EPA, 1978). Landfills should also be equipped with leachate collection systems that can accommodate increased leachate due to flooding.

Procedures for evaluating drainage systems, in particular, drainage ditches and culvert design, are provided in the U.S. EPA publication cited above, "Evaluating Cover Systems for Solid and Hazardous Waste".

4.2.4 Fencing

Fencing that does not obstruct flood waters may be of use in situations where it is likely that flood waters will carry debris, which could damage tanks, containers, incinerators, and treatment units, or enhance erosion of levees or waste piles. The entire facility may be fenced or just those portions where damage may occur from floating debris. Use of fencing will be limited to situations where flood water velocity is relatively low and debris is not likely to exert an impact load greater than the fence can withstand.

Fencing of storage areas for containers will also prevent flotation of containers provided that a "roof" (which may be constructed of fencing) is provided which is extensive enough to prevent the containers from floating up and out of the fenced area.

4.2.5 Structural Integrity

Containers, tanks, incinerators, and treatment units should be designed to withstand hydrostatic and hydrodynamic loads or pressures associated with the 100-year flood at the facility's location. A brief discussion of hydrostatic and hydrodynamic loads follows[1].

Flood waters surrounding a structure induce hydrostatic and hydrodynamic loads on the structure iteself. Hydrostatic loads (pressures) are induced by water which is either stagnant or moving at low velocity. Hydrodynamic loads result from the flow of water against and around a structure at moderate or high velocities. Impact loads are imposed on the structure by water-borne objects, and their effects become greater as the velocity of flow and the weight of objects increase.

Hydrostatic loads or pressures, at any point of flood water contact with the structure, are equal in all directions and always

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[1]This discussion is exerpted from Flood-Proofing Regulations. Department of the Army, June 1972.

act perpendicular to the surface on which they are applied. Pressures increase linearly with depth or "head" of water above the point under consideration. The summation of pressures over the surface under consideration represents the load acting on that surface. For structural analysis purposes, hydrostatic loads are defined to act vertically downward on structural elements such as roofs, decks and similar overhead members having a depth of water above them; vertically upward or in uplift when they act at the underside of generally horizontal members such as slabs and footings and the net effect is upward; laterally when they act in a horizontal direction on walls, piers, and similar vertical structural elements. For purposes of their Flood-Proofing Regulations, the Corps of Engineers has assumed that hydrostatic conditions prevail for still water and water moving with a velocity of less than five feet per second. It is estimated that hydrodynamic effects up to the stated velocity can be conservatively recognized in the freeboard allowance.

As the flood waters flow around a structure at moderate to high velocities, they impose additional hydrodynamic loads on the structure. These loads consist of frontal impact by the mass of moving water against the projected width of the obstruction represented by the structure, draft effect along the sides of the structure, and eddies or negative pressures on the downstream side. For velocities ranging up to ten feet per second, it is considered most practical to make allowances for the hydrodynamic effects by converting them into an equivalent hydrostatic condition. For special structures or conditions and for velocities greater than ten feet per second, a more detailed analysis and evaluation should be made utilizing basic concepts of fluid mechanics and/or hydraulic models.

Either the designer/manufacturer of the tank, container, incinerator, or treatment unit or an engineer experienced in design for flood hazards should be consulted about the structure's ability to maintain integrity in the event of a 100-year flood at the facility. A hydrologist may have to be consulted at the same time if characteristics of the flood flow need to be elaborated upon in order to design or retrofit structures at a facility.

Sources for design and construction specifications for 55-gallon drums and tanks are Chemical Engineers Handbook (Perry and Chilton, 1973) and Mechanical Engineers Handbook (Baumeister et al., 1978). These do not give the hydrodynamic or hydrostatic pressures that various kinds of drums and tanks are capable of withstanding; however, these values can be calculated by an engineer from the information given.

A major concern in flood proofing of tanks is hydrostatic loads acting to uplift the tank and/or its base, thus causing flotation. As there is a possibility that tanks will be empty or partially filled when a flood stage is reached, an effort should be made to design the tank to be stable <u>when empty</u>. Listed below are methods that are commonly used to increase the stability of tanks (Wood, 1981):

- Drawdown piling may be attached to the perimeter of the tank's base (provided that the base is attached to the tank) or the perimeter of the tank bottom.
- The base of the tank may be extended (usually only practicable for smaller tanks due to cost).
- Dead weight of tank may be increased (usually only practicable for tanks with low cost construction materials such as concrete).
- Rock or soil may be piled, compacted, and graded around bottom of tank

4.3 <u>Flood Protection</u>

Flood protection strategies prevent flood waters from reaching the facility or portions thereof. Flood protection can take the form of diversion structures, such as levees and floodwalls, or elevation of portions of the facility above the 100-year flood elevation (plus a few feet for safety).

Although flood protection measures will be needed to prevent washout at most facilities that are located in a 100-year floodplain, flood protection measures are probably the only way to prevent washout of surface impoundments, landfills, waste piles, and waste applied to the land (land treatment).

4.3.1 Diversion Structures

Diversion structures can be levees (or dikes), floodwalls, or ditches. Levees are the most commonly used diversion structures for protection against flooding. If a site is diked so that it will no longer be inundated by the 100-year flood, it is in fact no longer within the 100-year floodplain and is in compliance with the location standards.

4.3.1.1 Levees. For purposes of this document, a levee is defined as an embankment whose primary purpose is to furnish flood protection from seasonal highwater. Generally, levees are saturated for only short periods beyond the limits of capillary action; their alignment and height are dictated by flood protection requirements and space available for the foundation. This section addresses urban levees, i.e., levees that provide protection from flooding in communities, including all community associated industrial (such as a hazardous waste management facility), commercial, and residential activities. Agricultural levees are those used to protect farmland; they generally have a broader base and require more areas than do urban levees (Department of the Army, 1978).

Before a levee is designed for an area, a basic field investigation should be made to determine the suitability and feasibility of levee construction. The investigation should include a general geological reconnaissance, limited subsurface exploration, and soil tests. Based on this information, best engineering judgement should be used to determine if a levee can be feasibly constructed (Department of the Army, 1978). If it is determined that a levee will be used, a more extensive field investigation should be made that includes extensive geological reconnaissance, borings, test pits, geographical studies, vane shear tests, groundwater observations, and field pumping tests. This kind of extensive investigation is of particular importance if any one of the following conditions exists at the site:

- There is little or no previous experience with levee performance in the area or with similar soil or other foundation conditions.
- Levee heights will be great.
- Foundation soils are weak and compressible, highly variable along the projected alignment, or susceptible to liquefaction.
- Potential severe seepage problems exist.
- High water levels exist for long periods of time.
- Borrow is of low quality, has a high water content, or is variable along the projected alignment (Department of the Army, 1978).

The extensive reconnaissance of the site should include data regarding riverbank slopes, rock outcrops, earth and rock cuts and fills, surface materials, poorly drained areas, evidence of instability of foundations and slopes, emerging seepage, and natural and manmade physiographic features. Much of this information can be obtained from existing topographic, soil, and geologic maps, aerial photographs, boring logs and well data, and other engineering projects in the area. The geophysical analyses for shear strength, permeability, density, compaction, seismic activity, water content, and gradation should be conducted by experienced professionals.

Prior to emplacement of any fill or embankment materials, the area upon which fill is to be placed, generally including a five-foot strip measured horizontally beyond and contiguous to the toe line of the fill, should be cleared of standing trees and snags, stumps, brush, downed timber, logs and other growth, and all objects including structures on and above the ground surface or partially buried. The area should be stripped of topsoil and all other material that is considered unsuitable as foundation material. In cases where the foundation materials are highly pervious, it may be necessary to provide impervious cutoffs.

In most cases, a levee will be constructed of material located on-site. The material, usually earth, is excavated from areas called borrows that are located either in a large centralized area reserved expressly for this purpose or along either side of the alignment of the levee itself. Soils that are least suitable for levee construction are very wet, fine grained soils and high organic soils. Wet soils can be used, but the costs of drying are high. If wet soils are used, and the moisture content varies with seasonal changes, the soil data should be based on samples taken during the season in which the levee will be constructed. The optimum soils for use in levee construction are those that have low moisture content and high compaction characteristics.

One of the most common causes of levee failure is underseepage. Underseepage can result in excessive hydrostatic pressures beneath an impervious top stratum on the land side of a levee (see Figure 4), in sand boils, or in internal erosion. Methods for preventing levee failure due to seepage include the following:

- Cutoff trenches are the most effective means of seepage control and consist of excavated trenches backfilled with compacted earth or slurry located at the riverside levee toe.

- Seepage berms are primarily used with agricultural levees. They are constructed of layered earth and vary in length and weight for purposes of reducing uplift pressures at the levee landside toe.

- Pervious toe trenches control shallow underseepage at the landside toe and are usually used in conjunction with pressure relief wells.

- Pressure relief wells are used where cutoffs or trenches cannot be used (e.g., pervious stratum is too thick). Relief wells reduce uplife pressure and intercept and control seepage outlets.

- Riverside impervious blankets are natural fine-grained, impervious to semi-pervious soils underlying pervious sand and gravels. The effectiveness of this straum depends upon its thickness, length, and permeability. A large amount of space is needed for this seepage control method.

Levee height and slope depend upon the degree of soil compaction achievable, limitations of available space for construction, and

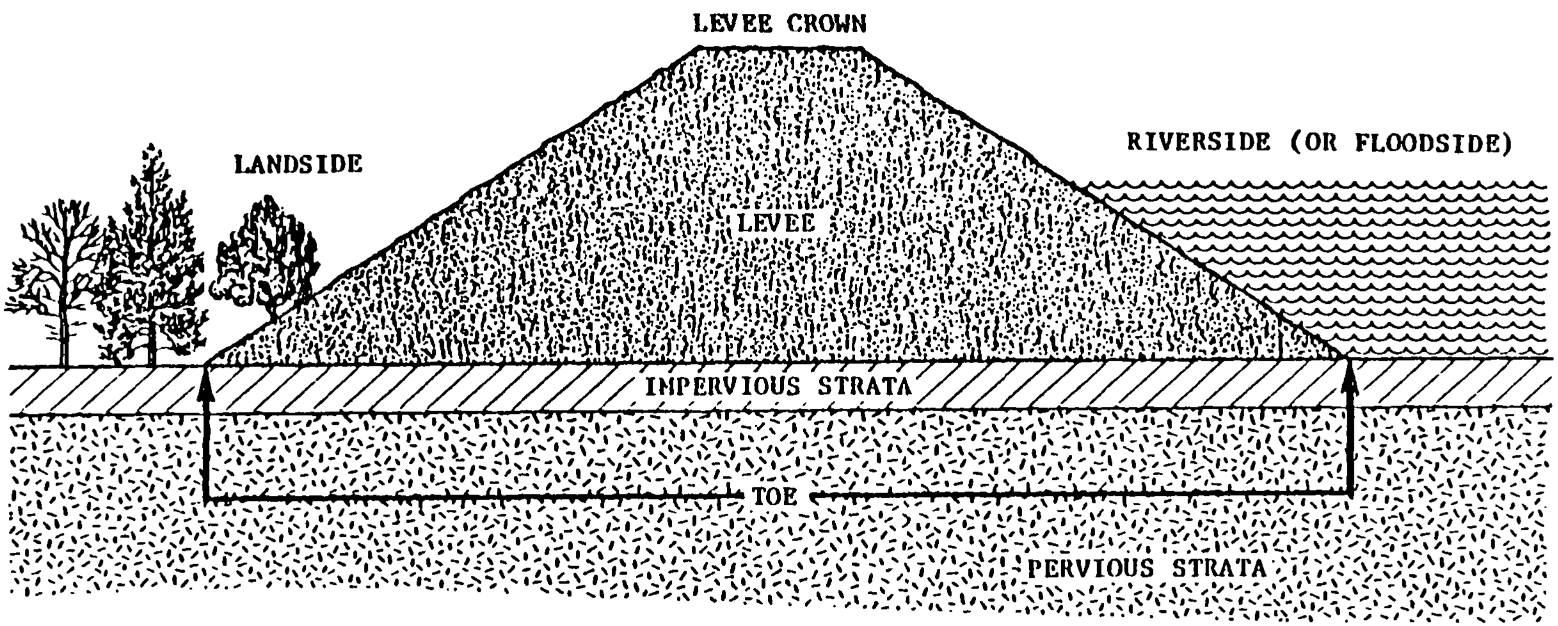

FIGURE 4

SCHEMATIC DIAGRAM OF A LEVEE

expected flood velocities and elevation. The levee should be built higher than the 100-year flood level to ensure a safety margin and to protect against wave action, when applicable, and to provide for levee settlement (Department of the Army, 1978).

The primary sources to aid in the design of levees and diversion structures is Design and Construction of Levees (Department of the Army, 1978). Additonal information can be found in Design of Small Dams (U.S. Bureau of Reclamation, 1973).

4.3.1.2 Floodwalls. A floodwall is a wall constructed specifically to prevent inundation of adjacent land. Floodwalls may be constructed of concrete, steel sheet piping, or other suitable structural materials (Department of the Army, 1948).

The method of seepage control for floodwalls include those described for levees, pumps, and pump sumps. Adequate expansion and contraction joints should be provided in the walls. Steel sheet pilings may be encased in concrete for corrosion protection, or they should be coated with a coal tar epoxy coating system (Department of the Army, 1972). The different kinds of floodwalls are (see Figure 5):

- Inverted T-type reinforced concrete cantilever wall bearing on a soil foundation
- Cantilever I-type sheet piling vertical wall deeply embedded and stabilized by the passive resistance of earth (should be limited to a maximum height of ten feet above final ground surface)
- Cellular wall filled with earth

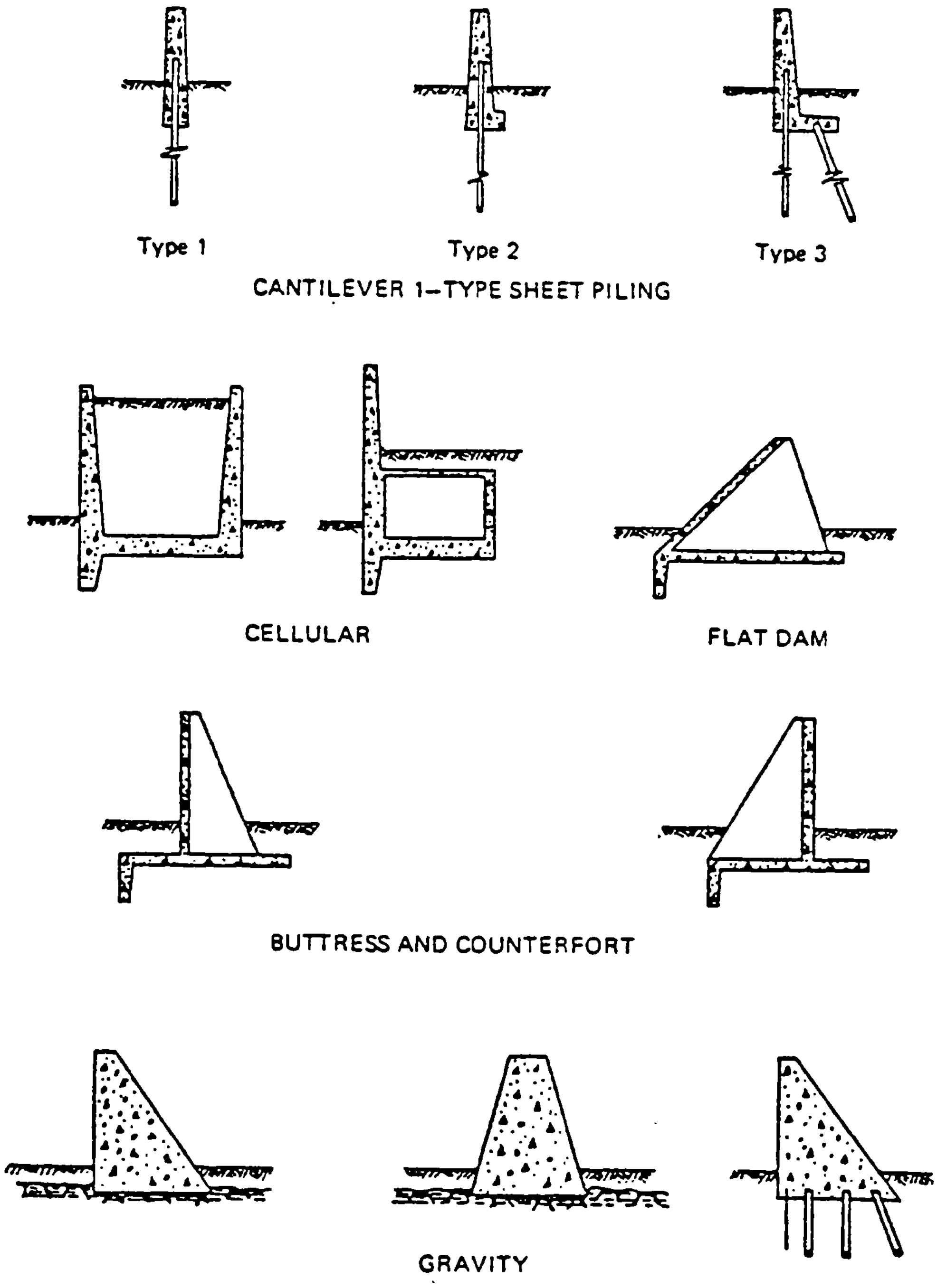

FIGURE 5

VARIOUS TYPES OF FLOODWALLS

Source: Department of the Army, 1972. Flood-Proofing Regulations. EP 1165-2-314. June.

- Flat deck dam type wall (costly and has a bulkly outline)
- Buttress and counterfort wall (should be considered for high walls; may be more economical than other types in this case)
- Gravity wall (may be most economical for low walls; should be considered whenever rock foundations are available) (Department of the Army, 1948)

A primary source to aid in the design of floodwalls is Wall Design: Floodwalls (Department of the Army, 1948[1]).

4.3.2 Unit Elevation

It is possible to protect surface impoundments, piles, tanks, incinerators, and storage areas for containers from inundation by the 100-year flood by constructing these units on earth fill that would place them at least a few feet above the 100-year flood elevation. The selection and placement of fill should be based on the effects of saturation from flood waters, on slope stability, on whether settlement is uniform or differential, and on scour potential. Vegetation will provide adequate scour protection for slopes exposed to flood velocities less than five feet per second; otherwise, stone or rock slope protection should be provided.

Incinerators and tanks could also be placed on columns, piers, or walls. These supporting structures should not restrict free passage of debris during a flood. If walls are used as elevating

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[1] This reference is being updated. The new edition should be available in the fall of 1981.

structures, the longest side of each wall should be positioned parallel to the expected flood flow. The design of the foundation supports for elevated structures should be based on effects of soil submergence and flood water related loads. Protective measures should also be taken against potential surface scour on the structure (Department of the Army, 1972).

4.4 General Design Manuals

General design, construction and operation practices for landfills can be found in Solid Wastes: Engineering Principles and Management Issues by Tchobanoglous et al. and in Landfill Disposal of Hazardous Wastes and Sludges by Sittig (see Section 6.0 for full citation). The second source also contains practices for land spreading and incineration. Another sources of aid in this regard is Elements of Hydraulic Engineering by Linsley and Franzini, 1955. No one source exists that gives flood control design and construction specifications for hazardous waste management facilities.

5.0 OTHER FEDERAL AND STATE FLOODPLAIN MANAGEMENT PROGRAMS

The annual losses of life and property throughout the United States due to floods and mudslides have increased as a result of development and population growth in areas subject to such hazards. Legislation has been passed to help mitigate these losses and to provide for the expeditious identification and mapping of floodplains and the dissemination of information concerning floodplains. The reader is referred to Chapter 2 for a review of the National Flood Insurance Program administered by the Federal Insurance Administration, and the activities of the Corps of Engineers, the Soil Conservation Service, and the United States Geological Survey with regard to floodplain maps and data and consultative services that these agencies provide to EPA permitting officials.

This chapter provides a brief discussion of the most significant Federal legislation related to floodplain management and state floodplain management regulations. The remainder, and the most lengthy portion, of this chapter is devoted to a discussion of the Coastal Zone Management Act of 1972 and state coastal zone management programs. This information is presented for owners or operators to increase their awareness of laws and regulations other than RCRA that might impact siting and operation of a facility in a floodplain.

5.1 The 100-Year Flood As A Regulatory Standard

The 100-year flood is the most widely used standard in flood-related legislation and regulation. Many of the states that regulate land-use, building, and construction in floodplains use the 100-year flood as the regulatory standard. The Federal Insurance Administration (FIA) of the Federal Emergency Management Agency (FEMA) and the U.S. Army Corps of Engineers (COE) have adopted the 100-year flood as a standard on which to base floodplain management measures.

Common use of the 100-year flood has resulted in a data base that is larger than that for any other flood period of significant magnitude. This is one of the reasons that EPA chose the 100-year flood as its regulatory standard for location of hazardous waste facilities.

5.2 Federal Legislation

A variety of Federal laws deal directly with specific and general aspects of flood control management. They focus on flood damage abatement, run-off and water retention, various aspects of flood control, and flood insurance. The Federal laws that specifically pertain to the mitigation of flood hazards and their subsequent effects are the National Flood Insurance Act of 1968, as amended, and the Flood Disaster Protection Act of 1973 (Department of Housing and Urban Development, 1974). The requirements of these acts were reemphasized in 1977 by Executive Order 11988. The Order directs all Federal agencies to take actions to reduce the risk of flood loss; to minimize the impacts of floods on human safety, health and welfare; and to restore and preserve the natural and beneficial values served by floodplains. An owner or operator of a hazardous waste management facility located in a floodplain may be affected by these statutes as well as others pertaining to flood control and management.

The responsibility for implementing Federal flood control policies is dispersed among different government agencies. The principal agencies are the Department of Agriculture, Department of the Army, Department of Commerce, Department of Health and Human Services, Federal Emergency Management Agency, Department of the Interior, Department of Transportation, Federal Power Commission, Small Business Administration, Tennessee Valley Authority, and the Water Resources Council (Hart et al., 1978).

Coastal zone management programs have become necessary to protect the coastal zones of the United States from degradation and destruction and to prevent or minimize costly damage to life and property caused by water level fluctuations and wave hazards in coastal regions. The vehicle used to meet these goals is the Coastal Zone Management Act of 1972, as amended (CZMA, Public Law 94-370). The CZMA will be discussed separately in Section 5.4.

5.3 Floodplain Management at the State Level

As of 1978, 24 states had statutory or administrative provisions for regulating development in floodplains, and there were substantial differences in the extent and nature of these state programs. State floodplain regulation has taken two principal routes: (1) direct regulation through land-use control and construction permit systems; and (2) development of standards for local regulations, with direct state regulation in the event of local failure to adopt and administer the state standards. Owners or operators are advised to consult state officials to determine if there are regulations or ordinances which they are required to comply with.

State coastal zone management programs are discussed in Section 5.4.

5.4 Coastal Zone Management

All coastal high hazard areas are within the 100-year floodplain, and, therefore, location of hazardous waste facilities in coastal areas subject to flooding at the 100-year frequency is subject to the floodplain location standard. To the extent that information is available on wave action, this factor must be considered when designing, constructing, maintaining and operating a facility to protect against washout (see 46 FR 2817).

The Coastal Zone Management Act (CZMA) of 1972, as amended, encourages states to develop comprehensive coastal resource management programs that balance conflicting development, protection, and recreation needs. The CZMA seeks to accomplish these goals primarily through a program of Federal planning grants to help the states better manage their coastal resources.

Under the CZMA, the National Oceanic and Atmospheric Administration's (NOAA) Assistant Administrator for Coastal Zone Management authorizes federal grants-in-aid for coastal states to develop and implement land management programs for their coastal areas. Once the Office of Coastal Zone Management (OCZM) approves a state's plan, facilities in that state must be sited and operated in a manner consistent with the state's CZM program. In accordance with the CZMA and with 40 CFR 122.12, EPA may not issue a permit for any activity affecting land or water use in the coastal zone until the applicant certifies that the proposed activity complies with the appropriate state's Coastal Zone Management Program, and the state or its designated agency concurs with the certification (or the Secretary of Commerce overrides the state's nonconcurrence). State CZM agencies use "consistency procedures," per the CZMA (15 CFR 930, Subpart B), to determine whether the permitted activity is consistent with the policies are procedures of their CZM program.

If the facility is in one of the coastal states covered by the CZMA (see Table 6), the permit applicant should determine if a CZM plan for the particular state has been approved by the U.S. Secretary of Commerce. The status of state coastal zone management programs as of January 30, 1981 is provided in Table 6. The state CZM agencies listed in Table 7 can be contacted for more up-to-date information. If there is an approved plan, the state CZM program office will help to make the initial determination as to whether the building of a facility on a proposed site is consistent with the CZM plan.

Applicants for an EPA permit can correspond directly with the appropriate state coastal zone management agency to secure a consistency determination, or they can request that EPA secure the determination.

A consistency determination is not required until the time of permit application. However, applicants are encouraged to consult the state CZM agency throughout planning and design of the facility in order to avoid any conflicts that may arise during the consistency review process.

Once a state CZM agency receives a request for a consistency determination, the state agency has 45 days to comment on the site selected for the hazardous waste facility. The response may take several forms, including:

- No comment (presumed to mean no objection)

- Support of the project (i.e., the project is consistent)
- Object to the project because of inconsistency
- Object to the project because there is unsufficient information

When a CZM office chooses to comment, the response is usually in the form of a letter or memorandum citing applicable coastal policies. In the event of an objection, the CZM agency's statement must describe how siting the hazardous waste facility would be inconsistent with elements of the CZM program for the state and must recommend modifications that would eliminate the inconsistency. Objections based on insufficent information must include a description of the information necessary to complete the state agency's review. Applicants may accept suggestions of the state CZM agency and revise plans or designs, or if so directed, supplement the previously deficient information. However, if there is serious disagreement, the applicant may personally request the Secretary of Commerce to mediate in the dispute or he may ask EPA to request a mediation for him. In the latter case, the Regional Administrator will make a determination that there is a sufficient basis for mediation before proceeding.

The Secretary of Commerce may waive the consistency requirement if (a) the proposed facility achieves other important objectives, (b) if there are no reasonable alternatives, or (c) it is in the public interest to do so.

TABLE 6

STATUS OF STATE COASTAL ZONE MANAGEMENT PROGRAMS

State	Actual or Estimated Federal Approval Data By Fiscal Year (ends 9/80)	Comments and Status 1/30/81
Washington	1976	Approved
Oregon	1977	Approved
California	1978	Approved
Massachusetts	1978	Approved
Wisconsin	1978	Approved
Rhode Island	1978	Approved
Michigan	1978	Approved
North Carolina	1978	Approved
Puerto Rico	1978	Approved
Hawaii	1978	Approved
Maine	1978	Approved
Maryland	1978	Approved
New Jersey (Bay and Ocean Shore Segment)	1978	Approved
Virgin Islands	1979	Approved
Alaska	1979	Approved
Guam	1979	Approved
Delaware	1979	Approved
Alabama	1979	Approved
South Carolina	1979	Approved
Louisiana	1980	Approved
Mississippi	1980	Approved
Connecticut	1980	Approved
Pennsylvania	1980	Approved
New Jersey (Remaining Section)	1980	Approved
Northern Marianas	1980	Approved
American Samoa	1980	Approved
Florida	1981	DEIS in Preparation
New Hampshire	1982	Legislation Needed
Texas	1982	Public Hearing Held in October on Public Hearing Draft
New York	1982	Legislation Pending
Ohio	?	Legislation Pending
Indiana	?	Legislation/Executive Order Needed
Georgia	Probably Not	
Virginia	Probably Not	
Minnesota	Probably Not	
Illinois	Probably Not	

Source: Office of Coastal Zone Management, 1981. Program Status. National Oceanic and Atmospheric Administration, Department of Commerce, Washington, D.C.

TABLE 7

STATE COASTAL ZONE MANAGEMENT PROGRAM MANAGERS

NORTH ATLANTIC REGION

Connecticut

Art Rocque
Director, Coastal Area Management Program
Department of Environmental Protection
71 Capitol Avenue
Hartford, Connecticut 06115
(203) 566-7404

Maine

Alec Giffin
State Planning Office
Resource Planning Division
189 State Street
Augusta, Maine 04333
(207) 289-3155

Massachusetts

Edward Reilly
Program Manager
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202
(617) 727-9530

New Hampshire

Jack Mettee
Office of State Planning
2½ Beacon Street
Concord, New Hampshire 03301
(603) 271-2155

TABLE 7 (Continued)

New Jersey

John Weingart
Bureau of Coastal Planning and Development
Department of Environmental Protection
P.O. Box 1889
Trenton, New Jersey 08625
(609) 292-9762

New York

Robert Hansen
Coastal Management Unit
Department of State
162 Washington Street
Albany, New York 12231
(518) 474-8834

Rhode Island

Leo McAloon, Jr.
Coastal Resources Management Program
Washington County Government Center
Tower Hill Road
South Kingstown, Rhode Island 02879
(401) 789-3048

SOUTH ATLANTIC REGION

Delaware

David Hugg Coastal Management Program
Office of Management, Budget and Planning
James Townsend Building
Dover, Delaware 19901
(302) 736-4271

Georgia

Bob Reimold
Coastal Resources Division
Department of Natural Resources
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Brunswick, Georgia 31520
(912) 264-4771

TABLE 7 (Continued)

Maryland

Sarah Taylor
Department of Natural Resources
Tidewater Administration
Tawes State Office Building
Annapolis, Maryland 21401
(301) 269-2784

North Carolina

Ken Stewart
Department of Natural Resources and Community Development
Box 27687
Raleigh, North Carolina 27611
(919) 733-2293

South Carolina

Wayne Beam
Wildlife and Marine Resources Department
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Columbia, South Carolina 29201
(803) 758-8442

Virginia

J. B. Jackson, Administrator
Council on the Environment
Ninth Floor, Ninth Street Office Building
Richmond, Virginia 23219
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GULF/ISLANDS REGION

Alabama

Dr. Bruce Trickey
Executive Director
Coastal Area Board
General Delivery
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TABLE 7 (Continued)

<u>Florida</u>

David Worley
Office of Coastal Zone Management
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<u>Louisiana</u>

Joel Lindsey
Coastal Management Section
Department of Natural Resources
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<u>Mississippi</u>

Victor Frankiewicz
Mississippi Bureau of Marine Resources
Department of Wildlife Conservation
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<u>Puerto Rico</u>

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Department of Natural Resources
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<u>Texas</u>

Mark Lawless
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TABLE 7 (Continued)

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GREAT LAKES REGION

Illinois

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Illinois Coastal Zone Management Program
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Indiana

Betty Krebes
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Indianapolis, Indiana 46204

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Chris Shafer
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Division of Land Use Programs
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Minnesota

Roger Williams
State Planning Agency
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TABLE 7 (Continued)

Ohio

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Department of Natural Resources
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Jim Tabor
Department of Environmental Resources
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Wisconsin

Al Miller
Office of Coastal Management
Department of Administration
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PACIFIC REGION

Alaska

Murray Walsh
Division of Policy Development and Planning
Office of the Governor
Pouch AP
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TABLE 7 (Continued)

American Samoa

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Development Planning Office
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Guam

Ronald Maben
Bureau of Planning
Government of Guam
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477-9502

Hawaii

Richard Poirier
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Northern Marianas

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TABLE 7 (Concluded)

Oregon

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Washington

Duane Wegner
Deparment of Ecology
PV-11
State of Washington
Olympia, Washington 98504
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Source: Office of Coastal Zone Management, 1981. Program Status. National Oceanic and Atmospheric Administration, Department of Commerce, Washington, D.C.

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