US Army Corps
of Engineers ®
Kansas City District

FLOOD FIGHTING TECHNIQUES WORKSHOP

Belcher-Lozier Levee 9 July 2011

April 2013

US Army Corps
of Engineers.

U.S. ARMY CORPS OF ENGINEERS
KANSAS CITY DISTRICT
EMERGENCY MANAGEMENT BRANCH

601 E. 12TH Street, Room 164
Kansas City, Missouri 64106-2896

24-Hour Phone Number: 816-426-6320

Fax: 816-389-2036

U.S. Army Corps of Engineers Date of _____
Kansas City District
Request:
ATTN: Emergency Management Branch
601 East 12th, Room 164
Kansas City, Missouri 64106

Dear Sir:

The purpose of this letter is to request Rehabilitation Assistance from the Corps of Engineers under Public Law 84-99 for the repair of the _____ Levee (or other type of flood control project) that was damaged by flood on or during the period _____, 20_____. The project is Active in the Rehabilitation and Inspection Program, and was last inspected by the Corps of Engineers on _____. The location of the levee and a brief description of the damage are as follows:

Project Identification Number _____
River or Stream _____ Bank (circle): Left, Right, Both, or Channel
Description of Damage:
_____
_____
_____
City _____ County _____ State _____
Section _____ Township _____ Range _____

Public Sponsor Point of Contact:
Name: _____
Address: _____
Telephone: (W) _____ (H) _____
(C) _____

Sincerely,

_____

US Army Corps
of Engineers.

FLOOD FIGHTING TECHNIQUES
TABLE OF CONTENTS

SECTION 1

FLOOD FIGHT TECHNIQUES

BRIEFING SLIDES

SCHEDULE OF INSTRUCTION

- Introduction/Welcome
- Features of Flood Control Works (FCW) & Terminology
- FCW Design Features
- Operation, Maintenance, Requirements, & Procedures
- Weather, Rivers, & Lakes Information

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SCHEDULE OF INSTRUCTION (cont)

- High Water Effects on FCW
- Flood Fighting Organization
- Flood Fighting Assistance
- Flood Fighting Techniques

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FLOOD CONTROL WORKS (FCW)

- Design
- Construction
- Operations & Maintenance

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THREE TYPES OF FLOOD CONTROL WORKS

- Levees and/or Floodwalls
- Channel Improvements
- Dams

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THREE TYPES OF LEVEE SYSTEMS

- Federal Levee Systems
- Non-Federal Levee Systems in Corps Levee Program (Public Law 84-99)
- Other Levee Systems

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THREE TYPES OF LEVEE SYSTEMS

FEDERAL LEVEE SYSTEMS

- Congressionally Authorized
- Designed and constructed by Corps of Engineers
- Local Sponsor Owns, Operates and Maintains
- Inspected annually
- Technical report and rating furnished to Local Sponsor
- Eligible for assistance under Public Law 84-99 if rating is Acceptable/Minimally Acceptable

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THREE TYPES OF LEVEE SYSTEMS

NON-FEDERAL LEVEE SYSTEMS

- Designed and constructed by others
- Meets construction and maintenance requirements
- Inspected every two years
- Inspection results and rating furnished to local sponsor
- Eligible for assistance under Public Law 84-99 if rating is Acceptable/Minimally Acceptable

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THREE TYPES OF LEVEE SYSTEMS

OTHER LEVEE SYSTEMS

- Not inspected by Corps of Engineers
- Not eligible for assistance under Public Law 84-99

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FCW DESIGN FEATURES

- Basic Sections
- Features Awareness During Flood Fight
- Proposed FCW Alterations/ Repairs & General work near a FCW

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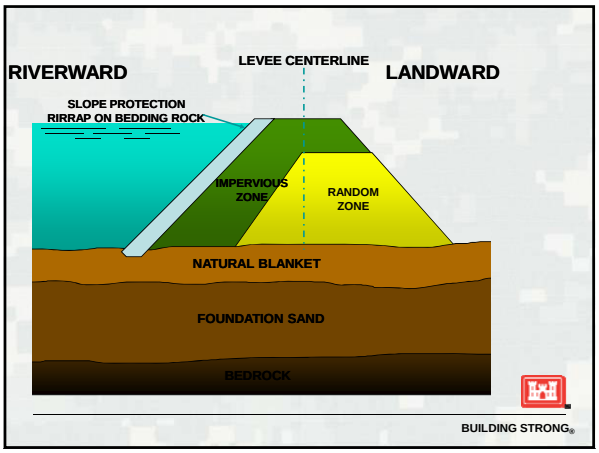
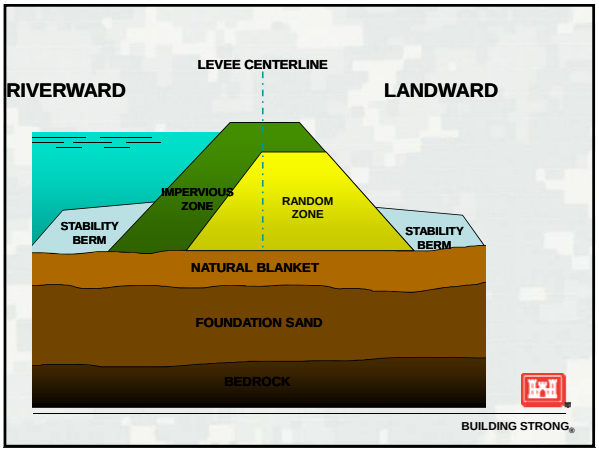
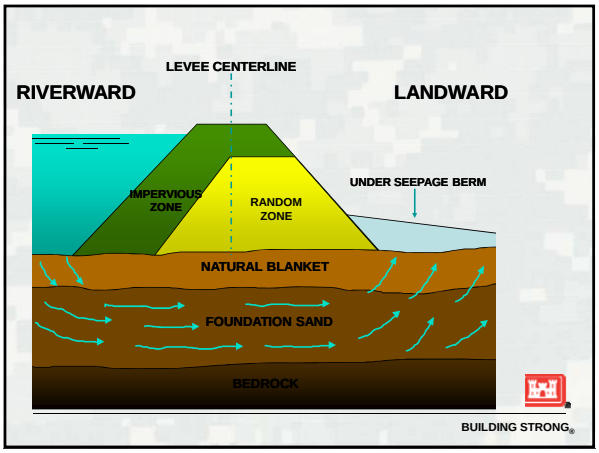
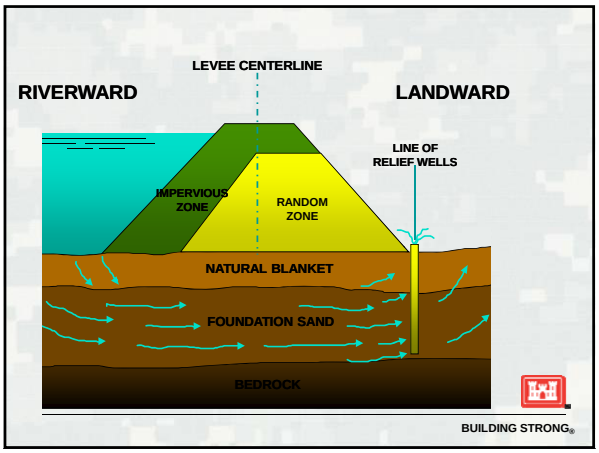
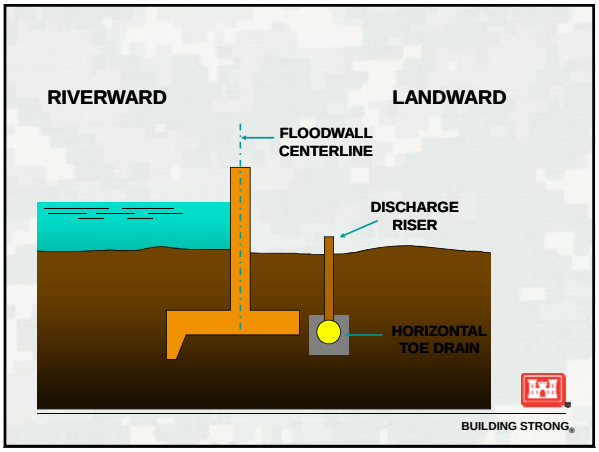

RIVERWARD
LEVEE CENTERLINE
LANDWARD
SLOPE PROTECTION
RIRRAP ON BEDDING ROCK
IMPERVIOUS ZONE
RANDOM ZONE
NATURAL BLANKET
FOUNDATION SAND
BEDROCK
BUILDING STRONG®


RIVERWARD
LEVEE CENTERLINE
LANDWARD
IMPERVIOUS ZONE
RANDOM ZONE
STABILITY BERM
STABILITY BERM
NATURAL BLANKET
FOUNDATION SAND
BEDROCK
BUILDING STRONG®


RIVERWARD
LEVEE CENTERLINE
LANDWARD
IMPERVIOUS ZONE
RANDOM ZONE
UNDER SEEPAGE BERM
NATURAL BLANKET
FOUNDATION SAND
BEDROCK
BUILDING STRONG®





PROPOSED ALTERATIONS TO FLOOD CONTROL WORKS

- Submit for sponsor & COE review to ensure the FCW integrity is maintained
- Submit all proposed work within the critical area--generally 300' riverward to 500' landward (Concerned with any work between the unit and the river/tributary/ditch)
- Title 33 (in O&M) requires District Engineer approval

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PROPOSED ALTERATIONS TO FLOOD CONTROL WORKS (CONT)

- COE Guidance for Proposed Work
- Common alterations which may impact the FCW
  - ►Excavation of or fill onto blanket
  - ►Pipe through levee
  - ►Structures--riverward & landward
  - ►Ponding area development

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COE GUIDANCE

- Guidance--For Work Proposed Near or Within a Federally Constructed Flood Control Works
- Guidance can be found at: **http://www.nwk.usace.army.mil/Missions/EngineeringDivision/GeotechnicalBranch/GeotechnicalDesignandDamSafety.aspx**
- Not intended to be the sole source for design; design should be in accordance with COE criteria and acceptable industry standards
- Not intended to be used for construction plans and specifications

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COE GUIDANCE

Guidance--For Work Proposed Near or Within a Federally Constructed Flood Control Works (cont.)

- It is intended to provide the reader with an appreciation of the flood control works features
- It is intended to be used as general guidance for design and acceptable construction practices
- Dynamic document subject to revisions--comments are welcomed

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LEVEE MAINTENANCE & INSPECTIONS

MAINTENANCE MEASURES

- Promote and maintain growth of sod
- Exterminate burrowing animals and repair damages
- Provide for routine mowing of the levee; minimum of twice during the growing season
- Remove wild growth and drift deposits from the levee embankment and foreshore area
- Repair damage to riprap, grouted gutters, and slopes caused by erosion and other forces

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LEVEE FEATURES

LEVEE CROWN
ROAD

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LEVEE FEATURES

RIVERSIDE
LEVEE SLOPE

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LEVEE FEATURES

LANDSIDE SLOPE STABILITY BERM

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LEVEE FEATURES

RIPRAP ON RIVERSIDE SLOPE

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LEVEE FEATURES

RIPRAP ON RIVERSIDE SLOPE (NOTICE BREAKDOWN OF STONE)

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LEVEE FEATURES

HANNIBAL RR BRIDGE (PROVIDES FLOOD STAGE READINGS FOR THE MISSOURI RIVER AT KANSAS CITY)

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LEVEE FEATURES

SLOPE GAUGE LOCATED NEXT TO FLAPGATE

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LEVEE FEATURES

DRAINAGE STRUCTURE OPERATING MECHANISM

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LEVEE FEATURES

OUTLET FOR DRAINAGE STRUCTURE

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LEVEE FEATURES

DRAINAGE STRUCTURE ON FLOODWALL

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LEVEE FEATURES

OUTLET FOR DRAINAGE STRUCTURE WITH BAFFLES

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LEVEE FEATURES

SUBSIDENCE AT WINGWALL DOWNSTREAM OF DRAINAGE STRUCTURE

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LEVEE FEATURES

STOPLOG GAP FOR RAILROAD

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LEVEE FEATURES

STOPLOG GAP FOR RAILROAD

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LEVEE FEATURES

SLOTTED PORTION FOR STOPLOGS

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LEVEE FEATURES

STOPLOG GAP IN FLOODWALL BEING CLOSED

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LEVEE FEATURES

STOPLOG GAP IN FLOODWALL CLOSED (LANDSIDE)

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LEVEE FEATURES

EMERGENCY SAND STOCKPILE FOR SANDBAGGING

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LEVEE FEATURES

SANDBAG GAP ON ROAD

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LEVEE FEATURES

SANDBAG GAP BEING CLOSED

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LEVEE FEATURES

SANDBAG FILLING CREW

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LEVEE FEATURES

"BAGGER BUDDY" SANDBAG FILLING MACHINE

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LEVEE FEATURES

SANDBAG GAP IN FLOODWALL

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LEVEE FEATURES

OPENING FOR ROLLING GATE IN FLOODWALL

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LEVEE FEATURES

ROLLING GATE IN FLOODWALL

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LEVEE FEATURES

LANDSIDE OF FLOODWALL

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LEVEE FEATURES

TOE DRAIN
RISER
LANDSIDE OF
FLOODWALL

BUILDING STRONG®

LEVEE FEATURES

TOE DRAIN
RISER
LANDSIDE OF
FLOODWALL

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LEVEE FEATURES

EXCAVATION
LANDSIDE OF
FLOODWALL

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LEVEE FEATURES

RIPRAP ON RIVERSIDE OF FLOODWALL

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LEVEE FEATURES

DECORATIVE FLOODWALL

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LEVEE FEATURES

PUMPING PLANT

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LEVEE FEATURES

PUMPING PLANT

BUILDING STRONG®

LEVEE FEATURES

PUMPING PLANT FOR RELIEF WELL COLLECTOR SYSTEM

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LEVEE FEATURES

RELIEF WELL COLLECTOR SYSTEM

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LEVEE FEATURES

RELIEF WELL WITH TOP OPEN

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LEVEE FEATURES

FLOAT VALVE FOR RELIEF WELL

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LEVEE FEATURES

IMPROVED CHANNEL MEETS NATURAL CHANNEL

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IMPROVED CHANNEL

BUILDING STRONG®

LEVEE FEATURES

IMPROVED CHANNEL : CONCRETE WITH LOW FLOW TROUGH

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LEVEE FEATURES

IMPROVED CHANNEL : CONCRETE WITH WEEP HOLE FLAPS

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LEVEE FEATURES

IMPROVED CHANNEL : BRUSH CREEK KCMO

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LEVEE FEATURES

IMPROVED CHANNEL : BRUSH CREEK KCMO

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LEVEE MAINTENANCE & INSPECTIONS

(cont.)

MAINTENANCE MEASURES

- Maintain access roads and ramps
- Remove trash, refuse, and other objectionable material from the levee crown, slopes, and foreshore
- Replace any surfacing material, which has been displaced, washed out, or removed
- Remove willows, weeds, and other vegetation from the stone slope protection

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LEVEE MAINTENANCE & INSPECTIONS
(cont.)

INSPECTIONS

- No unusual settlement, sloughing, or material loss from the levee crown or levee cross section has taken place
- There is no caving or sliding of material on either side of the levee which might affect stability
- There is no evidence of seepage, saturated areas, or sand boils, and that runoff is not ponding along the levee toes
- Riprap has not been displaced, washed out, or removed

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LEVEE MAINTENANCE & INSPECTIONS
(cont.)

INSPECTIONS

- Nothing is being done to inhibit or discourage the development of sod, such as burning during inappropriate seasons
- Access roads are properly maintained and closed to the public where applicable
- No unauthorized traffic on levee crown
- No unauthorized construction occurring within “THE CRITICAL AREA” (300 ft riverward & 500 ft landward of centerline of levee)

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DRAINAGE STRUCTURES

MAINTENANCE

- Gates shall be examined and trial operated at intervals not to exceed 90 days and/or during and immediately after each flood event
  - ► Pipes, gates, riprap, headwalls, and operating mechanisms are in good condition
  - ► Fires are not being built in or near the structures
  - ► Inlet and outlet channels are open and clear of trash, debris, sediment deposits, and tree growth

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DRAINAGE STRUCTURES

MAINTENANCE (cont.)

- Safety or stability of the structures is not endangered through erosion
- Gatewells are not plugged or damaged
- Damaged, broken or missing parts shall be repaired or replaced immediately

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DRAINAGE STRUCTURES

(cont.)

FLAP GATES

- Inspected at least every 90 days for correct operation and proper seating
- Lubricate hinge bars and gate frame at least every 90 days or after each high river stage
- Remove silt and debris in order to provide free movement
- Inlet and outlet ditches are maintained to allow for proper drainage runoff

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DRAINAGE STRUCTURES

(cont.)

SLUICE GATES

- Inspect and lubricate the operating stem
- Inspect sluice gate guides, guide brackets and gate wedges for wear and corrosion
- Once every five years, remove the operating stem cover, clean and lubricate the threaded portion of the operating stem
- Periodically operate the sluice gate to its fully opened and closed position slowly and carefully checking for misalignment or problems in operation

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INSPECTION OF NEW AND IMPROVED CHANNEL

MAINTENANCE

- The channel is clear of debris, or tree growth
- The channel is not being restricted by the deposition of waste material, building of unauthorized structures, or other encroachments
- The capacity of the channel is not being reduced by the formation of shoals
- No unusual bank erosion or sliding has occurred
- Riprap is in sound condition

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INITIAL FLOOD FIGHT PREPARATION

LOCAL SPONSORS DUTIES AND RESPONSIBILITIES

- Review O&M Manual Requirements and ISOP
- Implement the Alert Notification Roster
- Check Serviceability and Availability of Emergency Flood Fighting Equipment
- Arrange for Continuous Recording of Gage Readings
- Determine Field Conditions of Flap Gates, Drainage Structures, and Slope Gages

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INITIAL FLOOD FIGHT PREPARATION

LOCAL SPONSORS DUTIES AND RESPONSIBILITIES (cont.)

- Sluice Gates Behind Flap Gates Will Not Be Closed Unless the Flap Gate Does Not Operate Properly (Corps generally advises to close as most sponsors will close anyway)
- Closure of Stoplog or Sandbag Gaps Requires Adequate Time and Advance Notice
  - ► Notify Railroad Company and Others
  - ► Keep News Media and Public Informed
- Conduct Preoperational Checks and Services of All Pumping Plants

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LEVEE PATROL'S DUTIES/ RESPONSIBILITIES

LEVEE

- Sand boils or unusual wet areas
- Look for slides or sloughs
- Look for wave wash or scouring of riverside embankment slope
- Look for low areas in the levee crown
- Record gage reading hourly (High Priority Item)
- Report any unusual condition

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LEVEE PATROL'S DUTIES/ RESPONSIBILITIES (cont.)

FLOOD WALLS

- Look for saturated areas or sand boils
- Look for settlement of floodwall
- Look for bank caving which may effect the stability of the floodwall
- Inspect toe drain risers
- Inspect for possible leakage at the monolith joints
- Record gage readings hourly (High Priority Item)
- Report any unusual conditions

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LEVEE PATROL'S DUTIES/ RESPONSIBILITIES (cont.)

PUMPING PLANTS

- Qualified operator on duty
- Operator should inspect, trial operate and place in service all plant equipment
- Periodically walk perimeter of pumping plant
- Adequate ventilation is a must during prolonged operation and high temperatures

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WEATHER, RIVERS, AND LAKES INFORMATION

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WEATHER AND RIVER FORECAST RESPONSIBILITY

- CORPS OF ENGINEERS
- NATIONAL WEATHER SERVICE

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AVAILABILITY OF WEATHER, RIVER, AND LAKES INFORMATION

NATIONAL WEATHER SERVICE
- Weather
- River Forecasts
- Precipitation

CORPS OF ENGINEERS
- Projects
- Pool Elevation

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SOURCES OF WEATHER, RIVER, AND LAKES INFORMATION

- NATIONAL WEATHER SERVICE RADIO
- CORPS WATER CONTROL SECTION
- INTERNET
- CORPS OF ENGINEERS EOC

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INTERNET ADDRESSES

- National Weather Service
  http://www.crh.noaa.gov/mbrfc/
- Kansas City District Home Page
  http://www.nwk.usace.army.mil/

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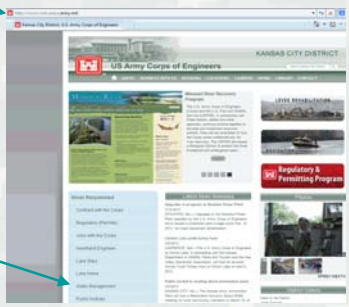
INTERNET ADDRESSES

http://www.nwk.usace.army.mil/



Click
"Water Management"

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INTERNET ADDRESSES

http://www.nwk.usace.army.mil/Locations/WaterManagement.aspx

This Screen will link you to various pages and web sites; some of most useful include:

Key Gages

MRR Daily River Bulletin

Other River and Lake Information:

- Missouri River Forecast Center
- NWS Kansas River Forecasts

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USE OF RIVER AND WEATHER DATA

- Actions Related to Key River Gages
- Provide Lead Time for Actions
- Documentation of High Water Event

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HIGH WATER EFFECTS ON FLOOD CONTROL PROJECTS

- Overtopping
- Sand Boils
- Seepage
- Sloughing
- Wave Wash
- Erosion

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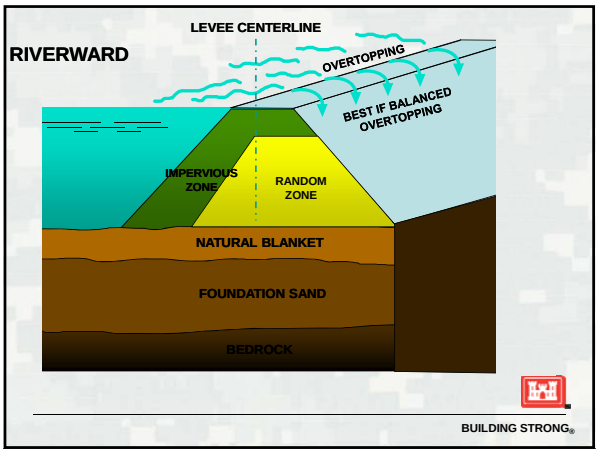

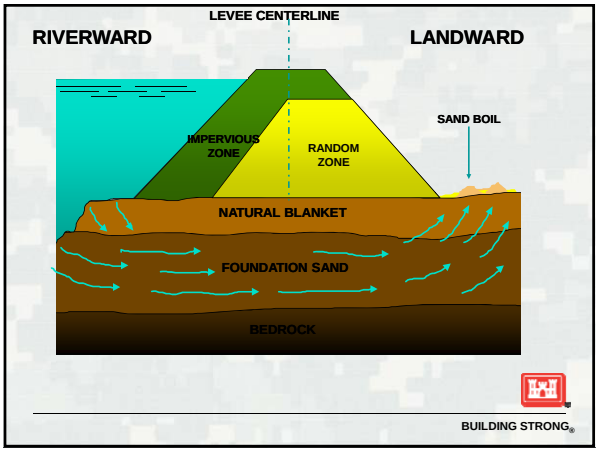

EFFECTS OF SANDBOILS

- Development of pipe under the levee
- Sloughing of landside levee slope near the toe
- Development of a landside shear or slide

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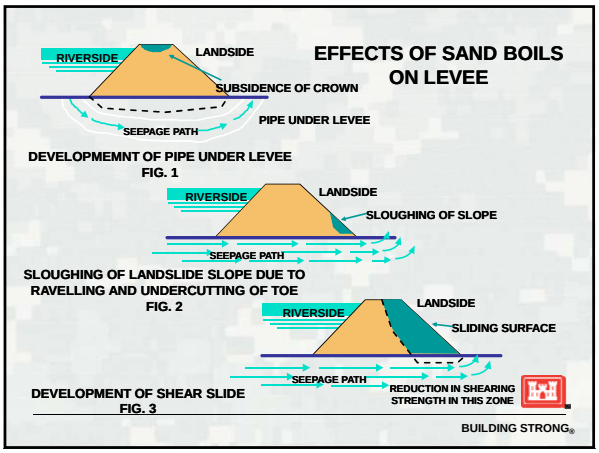
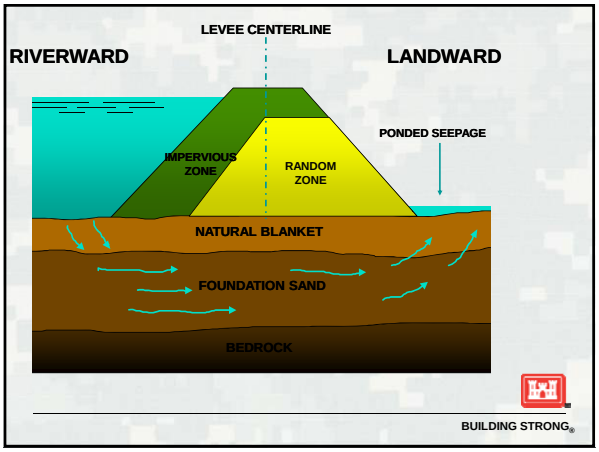
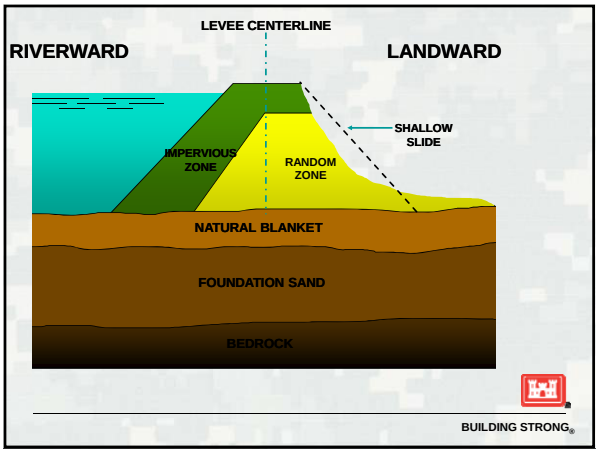

EFFECTS OF SAND BOILS ON LEVEE
RIVERSIDE
LANDSIDE
SUBSIDENCE OF CROWN
PIPE UNDER LEVEE
SEEPAGE PATH
DEVELOPMEMNT OF PIPE UNDER LEVEE
FIG. 1
RIVERSIDE
LANDSIDE
SLOUGHING OF SLOPE
SEEPAGE PATH
SLOUGHING OF LANDSLIDE SLOPE DUE TO RAVELLING AND UNDERCUTTING OF TOE
FIG. 2
RIVERSIDE
LANDSIDE
SLIDING SURFACE
SEEPAGE PATH
REDUCTION IN SHEARING STRENGTH IN THIS ZONE
DEVELOPMENT OF SHEAR SLIDE
FIG. 3
BUILDING STRONG®


LEVEE CENTERLINE
RIVERWARD
LANDWARD
PONDED SEEPAGE
IMPERVIOUS ZONE
RANDOM ZONE
NATURAL BLANKET
FOUNDATION SAND
BEDROCK
BUILDING STRONG®


LEVEE CENTERLINE
RIVERWARD
LANDWARD
SHALLOW SLIDE
IMPERVIOUS ZONE
RANDOM ZONE
NATURAL BLANKET
FOUNDATION SAND
BEDROCK
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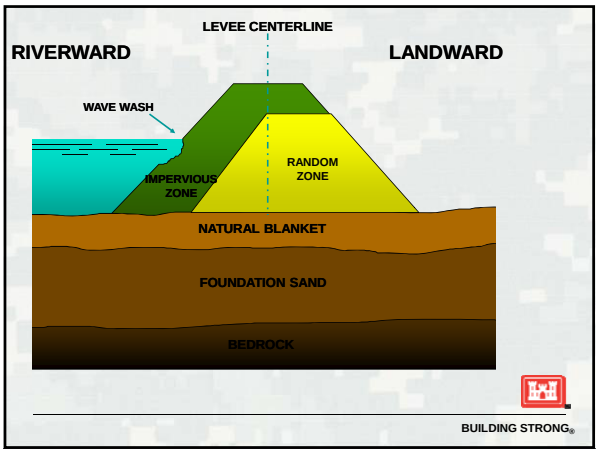

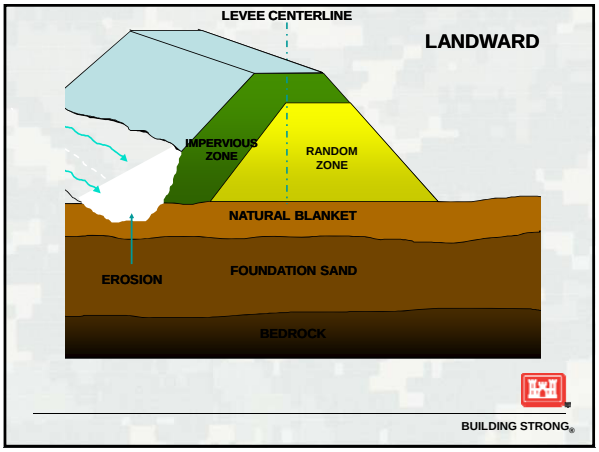

FLOOD FIGHTING ORGANIZATION

- Data Collection
- Project Operations
- Flood Fighting

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ASSEMBLY AREA

- Must Have Adequate Parking Spaces for Workers

.

- Transport Workers to Staging Area

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STAGING AREA

- CREW ASSIGNMENTS
- SANDBAG FILLING
- LOADING & HAULING OPERATIONS TO WORK SITE

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WORK SITE

Actual Sandbag Laying Operation to Construct Sandbag Levee and/or Sandbag Ring Levee

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HOW TO CONTROL SANDBOILS

- Construct a sandbag ring levee
- Method to be used for ringing sand boils are:
  - If at all possible construct on firm foundation.
  - Construct to a height sufficient to create a head.
  - The width of the base of the ring shall be at least 1 1/2 times the maximum height of the ring.
  - Bags should be filled between 1/2 to 2/3 full of clay or sand.
  - The bags should be placed with 1/3 overlap and be well mauled in place.

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EMERGENCY MANAGEMENT

Overview

- Mission to provide assistance when natural disasters or other emergencies occur
- Supplemental to State/Local efforts

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EMERGENCY MANAGEMENT

Overview

- Emergency Authorities:
  - AR 500-60
  - ER 500-1-1
  - National Response Framework

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EMERGENCY MANAGEMENT

- Assistance from the Kansas City District Corps of Engineers is available to aid in combating floods. The Kansas City District has been assigned the following responsibilities:
  - ► Recommend precautions or evacuations to affected local agencies or officials when flooding conditions are forecasted.
  - ► Furnish advice, supervision and materials, as appropriate to obtain the maximum benefit from the flood protection project.
  - ► Assist the Red Cross and Coast Guard in evacuation when demand exceeds their capability.
  - ► Assess flood damage. Assist local agencies to repair and restore flood-damaged FCW, as directed by applicable laws.

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Assistance from the Corps of Engineers under Public Law 84-99

- Prior to a Major Flood Event.
- Assistance during a Major Flood Event.
- Assistance after a Major Flood Event from Corps of Engineers and Federal Emergency Management Agency (FEMA).

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DISASTER PREPAREDNESS

- Prepare for immediate and effective response
- Preparedness Program includes:
  - ► Emergency Management Organization
  - ► Planning
  - ► Training
  - ► Exercises
  - ► Supplies & Equipment
  - ► Inspection program for non-Federal flood control structures
  - ► Inspection of Completed Works (Federal FCW)

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DISASTER PREPAREDNESS
TYPE OF ASSISTANCE

- Participation in emergency seminars, training and exercises
- Inspection of flood control works constructed or repaired by the Corps of Engineers
- Technical assistance for development of plans
- Upon request, inspection of non-Federal dams and flood control projects

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DISASTER PREPAREDNESS
CRITERIA FOR ASSISTANCE

- Role of the Corps of Engineers is supplemental to State and Local efforts during an emergency
- State and Local Governments are responsible for emergency preparedness, including stockpiling flood fight supplies and materials

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ADVANCE MEASURES

- Emergency Measures taken prior to a predictable, forecasted flood event to protect against loss of life or improved property

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ADVANCE MEASURES

TYPE OF ASSISTANCE

- Strengthening flood control structures
- Construction of temporary levees
- Channel clearance and dredging of Federal projects
- Relieving threat of flood from possible dam failures

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ADVANCE MEASURES

CRITERIA FOR ASSISTANCE

- Imminent threat of unusual flooding
- Written request from the Governor
- Supplement State and Local efforts

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FLOOD RESPONSE

- Emergency assistance to save lives and protect property during a flood
- Supplement State and Local Efforts
- Terminates when emergency is over i.e., floodwaters recede to within top of bank

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FLOOD RESPONSE

CRITERIA FOR ASSISTANCE

- State/Local entities must commit all available resources, including manpower, supplies and equipment
- State/Local entities must be prepared to replace in-kind or pay for supplies utilized

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FLOOD RESPONSE

Type of Assistance

- Includes, but is not limited to
  - ▸ Technical and Direct Assistance
  - ▸ Equipment & Supplies
  - ▸ Supplement Local Efforts
  - ▸ Rescue Operations

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FLOOD RESPONSE

TYPE OF ASSISTANCE

- Furnish equipment and materials
- Technical advice and assistance, i.e., how to treat sandboils, etc…
- Emergency repair to levees and other flood control works (Direct Assistance)
- Assist in search and rescue operations

BUILDING STRONG®

FLOOD RESPONSE

HOW TO OBTAIN HELP

- Contact Local Emergency Management Office
- Local EM contacts the State Emergency Management Office
- The State Emergency Management Office contacts the Corps of Engineers
- Strongly Recommend that you Contact the Corps Directly at 816-426-6320 when working through this process

BUILDING STRONG®

FLOOD RESPONSE

Help Us to Help You

- Notify Corps Emergency Management Office when you engage in Flood Fight Activities (816-426-6320)
- Follow the Directions in the O&M Manual regarding the operation of your unit during a flood
- Establish Levee Patrols and Record Gages on an hourly basis (Time, Location, and Stage)
- If you need Technical or Direct Flood Fight Assistance, Notify Us Immediately, DO NOT WAIT

BUILDING STRONG®

REHABILITATION ASSISTANCE

- Recovery program provides authority to repair flood control structures damaged or destroyed by flood
- Damages must exceed $15,000 to be eligible for rehabilitation assistance; anything less is considered within normal operation and maintenance cost

BUILDING STRONG®

REHABILITATION ASSISTANCE

CRITERIA FOR ASSISTANCE

- Active Status in Program (Acceptable or Minimally Acceptable Inspection Rating)
- Publicly Sponsored Project
- Non-Federal are cost shared at 80% Federal and 20% Sponsor
- Federal Levees are repaired at 100% Federal Cost

BUILDING STRONG®

REHABILITATION ASSISTANCE

CRITERIA FOR ASSISTANCE

- Public sponsor must Provide all Lands, Easements, Right-of-Way, and Earthen Borrow necessary to Rehabilitate Damaged FCW
- Deficient or deferred project maintenance will be accomplished by or at the expense of the Sponsor

BUILDING STRONG®

REHABILITATION ASSISTANCE

TYPE OF ASSISTANCE

- Rehabilitation Assistance is limited to the Repair or restoration of a flood control project to the pre-disaster condition

BUILDING STRONG®

REHABILITATION ASSISTANCE

Post-Flood Request for Assistance

- How to Request Rehabilitation Assistance
  - Inspect Your FCW for Damages
  - If you find damage and you believe the damage exceeds $15k, notify the Corps of Engineers in WRITING that you are requesting Rehabilitation Assistance

BUILDING STRONG®

QUESTIONS ???

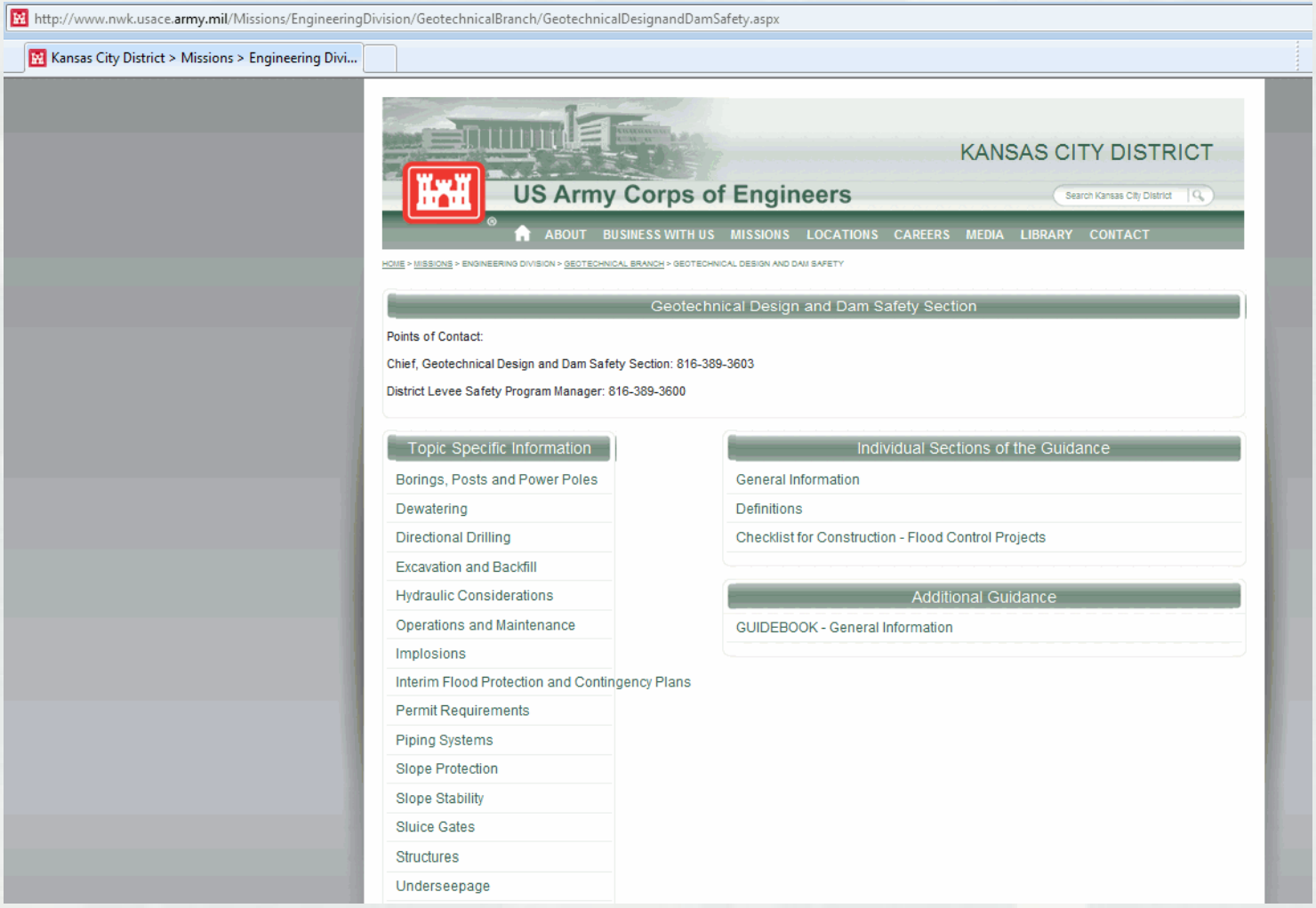
BUILDING STRONG®

SECTION 2

HOW TO FIND COE GUIDANCE FOR WORK NEAR OR WITHIN A FEDERALLY CONSTRUCTED FLOOD CONTROL WORKS

COE GUIDANCE On The Web

http://www.nwk.usace.army.mil/Missions/EngineeringDivision/GeotechnicalBranch/GeotechnicalDesignandDamSafety.aspx



SECTION 3

WHERE TO GO FOR WEB BASED

WEATHER, RIVER GAGE AND

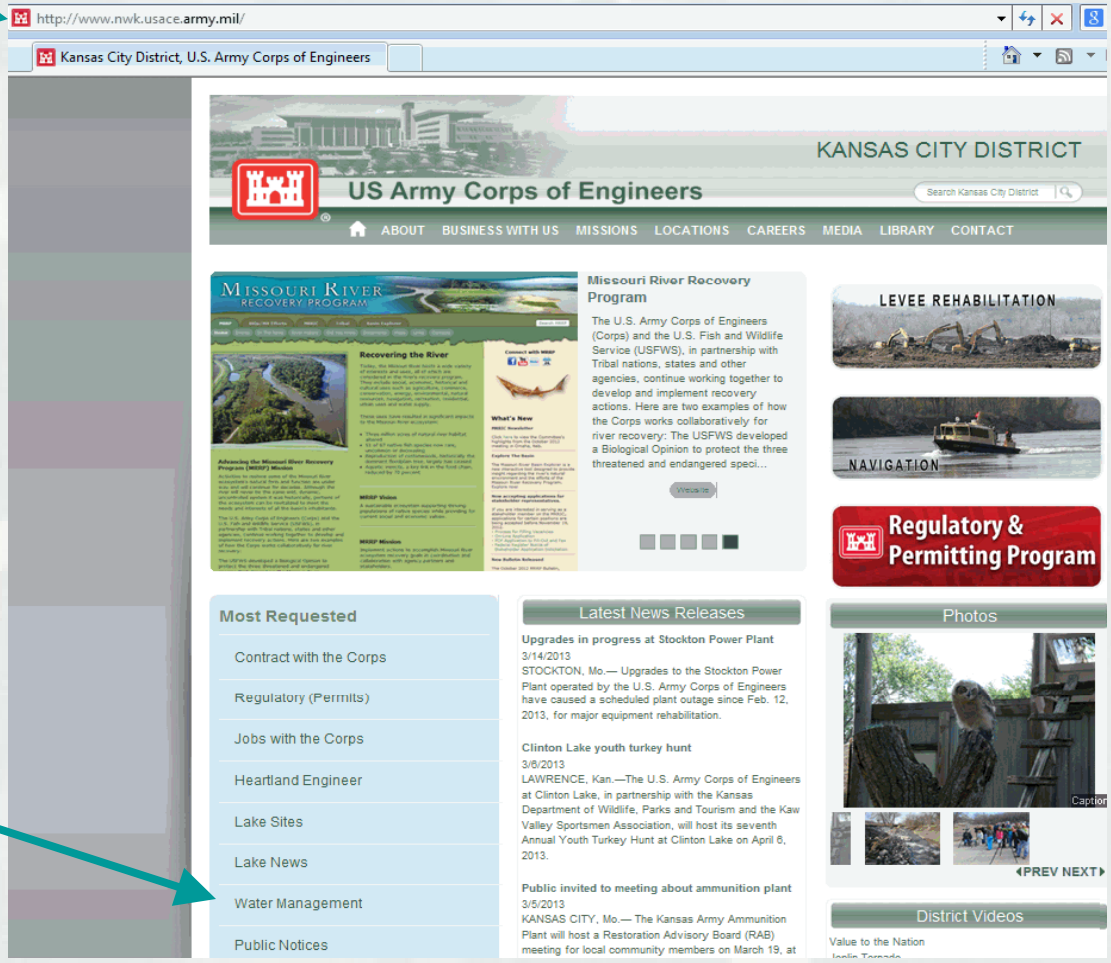
RIVER FORECAST INFORMATION

INTERNET ADDRESSES

http://www.nwk.usace.army.mil/

Click

“Water Management”



INTERNET ADDRESSES

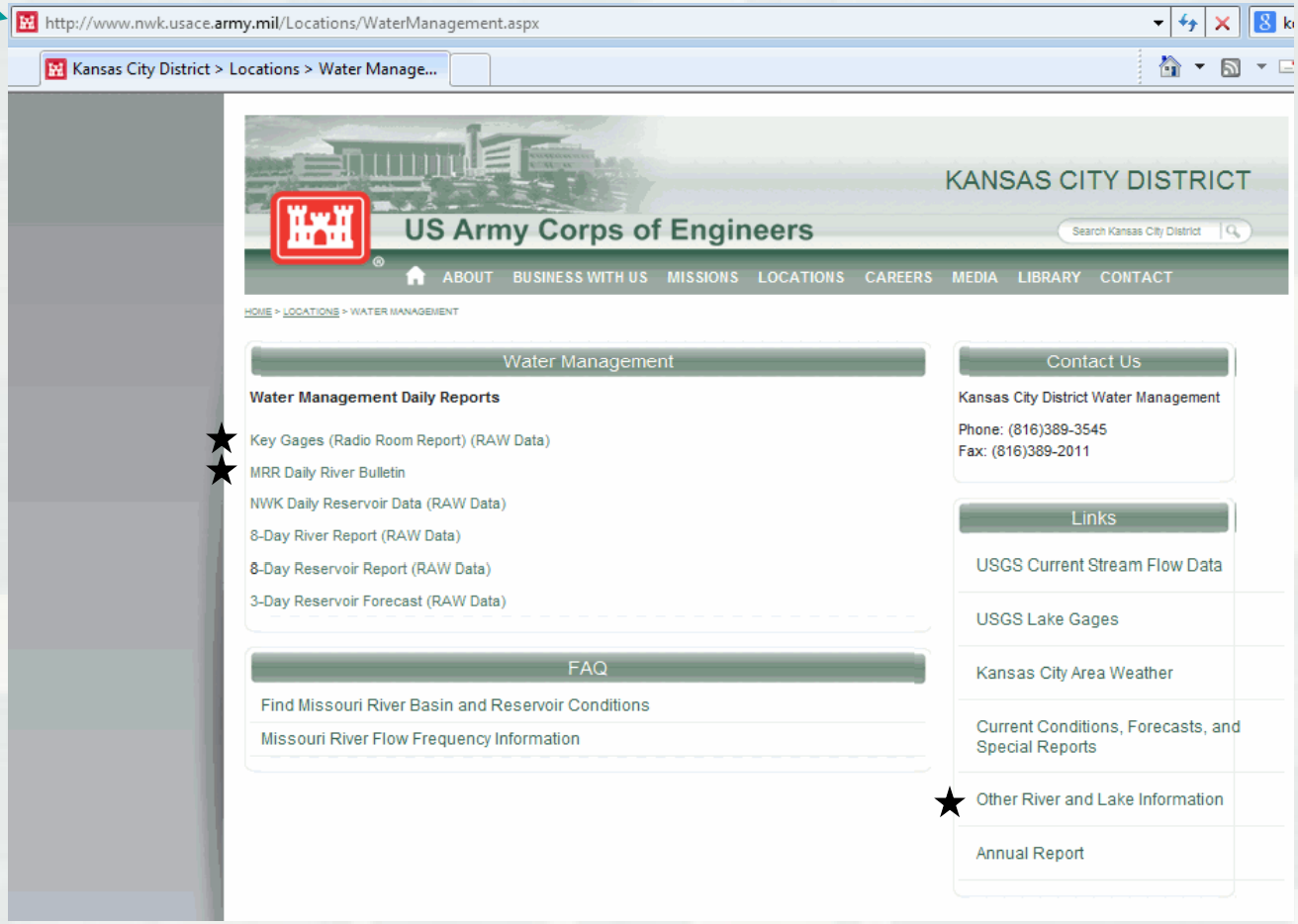
This Screen will link you to various pages and web sites; some of most useful include:

Key Gages

MRR Daily River Bulletin

Other River and Lake Information:

- Missouri River Forecast Center
- NWS Kansas River Forecasts



SECTION 4

ENGINEERING AND MAINTENANCE

STANDARDS FOR FLOOD CONTROL WORKS

EXAMPLE CHECKLISTS

(EXHIBITS 2-11)

CHECKLIST

LEVEE

Inspected by _____ Title _____ DATE _____

Inspection covers: Station _____ to _____

Report condition requiring maintenance in "Remarks" column or on separate sheet and attach to original.

Item	Location: Station	Condition	Remarks
1. Settlement, Sloughing, or loss of grade.			
2. Caving (either side of levee).			
3. Seepage, saturated areas, or sand boils.			
4. Riprap slope protection.			
5. Sod.			
6. Access roads and ramps.			
7. Unauthorized traffic.			
8. Unauthorized encroachment on right-of-way.			
9. Accumulation of drift, trash, or debris.			
10. Weeds or undesirable vegetation.			

EXHIBIT 2

Item	Station	Condition	Remarks
11. Miscellaneous pipe crossings.			
12. Unauthorized excavation and loose backfill.			
13. Unauthorized excavation within 500' landward and 200' riverward of the levee centerline.			
14. Burrowing animals.			
15. Freeboard gauges.			
16. Levee surfacing, access roads, ramps, and gates.			
17. Ponding area.			

EXHIBIT 2

CHECKLIST

IMPROVED CHANNEL AND DRAINAGE DITCHES

Inspected by _____ Title _____ DATE _____

Inspection covers: Station _____ to _____

Report condition requiring maintenance in "Remarks" column or on separate sheet and attach to original.

Item	Location: Station	Condition	Remarks
1. Debris, weeds, and willows in channel			
2. Channel restriction by waste deposits or unauthorized structures			
3. Shoals or silt deposits forming in channel			
4. Erosion of banks			
5. Approach and outlet channels			
6. Bank carving or sloughing			
7. Unauthorized excavation			
8. Seepage (from cutoff to old channel)			
9. Unauthorized encroachment on right-of-way			

Additional remarks:

EXHIBIT 3

CHECKLIST

DRAINAGE STRUCTURES

Inspected by Title _____ DATE

Gates lubricated:

Item	Location Station	Condition	Remarks
1. 10' x 10' RGB w/sluice			
2. 24" CMP w/flap & sluice			
3. 42" CMP w/flap & sluice			
4. 60" CMP w/flap & sluice			
5. 60" CMP w/flap & sluice			
6. 6' x 5' RGB w/flap & sluice			
7. 24" CMP w/flap & sluice			
8. 24" CMP w/flap & sluice			
9. 42" CMP w/flap & sluice			
10. 36" CMP w/flap & sluice			
11. 72" CMP w/flap			

Exhibit 4

CHECKLIST CULVERTS

Inspected by _____ Title _____

DATE

Item	Location Station	Condition	Remarks
1. 18" CMP w/flap gate, drains thru tieback levee			
2. 24" RCP, drains away from highway 45			
3. 12" CMP, drains to structure at station 596+00			
4. 18" CMP w/flap gate, drains through tieback levee			

Exhibit 5

CHECKLIST

CLOSURE STRUCTURES

Inspected by _____ Title _____ DATE _____

Location of closure inspected_____

Report condition requiring maintenance in "Remarks" column or on separate sheet and attach to original.

Item	Location: Station	Condition	Remarks
1. Materials are on hand or easily available			
2. Gap has not been widened or deepened			
3. Tools for closure are available			
4. Obstructions have not been placed in the gap to prevent closure			

Additional Remarks:

EXHIBIT C

CHECKLIST

PUMPING PLANT

Inspected by _____ Title _____ DATE _____

Pumping Plant Name: _____. Tests, etc., required annually or semiannually _____ only, are so indicated.

Location

Item	Condition	Recommended Maintenance
A. Grounds, buildings, & discharge structure		
1. Grounds		
(a) Surfacing		
(b) Access roads		
(c) Locks		
2. Buildings		
(a) Roof		
(b) Doors, Locks		
(c) Plant cleanliness		
(d) Lights		
(e) Painting		
3. Discharge structure		
(a) Obstructions		
(b) *Sluice gate		
(c) Floorstands - painting		
(d) Floorstand - electric wrench & waterproof receptacle		
(e) Floorstand - manual operation		
(f) Floorstand - locks		

*See lubrication schedule

EXHIBIT 7

CHECKLIST

PUMPING PLANT

Pumping Plant Name: _____ cont.

Item	Condition	Recommended Maintenance
4. Outside discharge - piping		
(a) Leaks		
(b) Siphon breakers		
B. Inlet Structures		
1. General - cracks, grating, locks		
2. Sluice gate		
3. Floorstand - general		
(a) Painting		
(b) Electric wrench waterproof receptacle		
(c) Locks		
(d) Trashracks		
C. Pump Pit		
1. General condition (cleanliness)		
2. Ladder and access		
3. Float well and float switch		
D. Interior Electrical System		
1. Secondary circuits		
(a) General		
(b) 480-volts Megger test (annual) _____Megohms		
(c) 120-volts Megger test (annual) _____Megohms		

EXHIBIT 7

CHECKLIST

PUMPING PLANT

Pumping Plant Name: _____ cont.

Item	Condition	Recommended Maintenance
2. Equipment ground connections		
Pump house test (annual)	_____Ohms	
3. Motor No. 1		
(a) General		
(b) Stator-Megger test, cold (annual)	_____Temp _____Meg.	
(c) Stator-Megger test, hot (annual)	_____Temp _____Meg.	
(d) Grease change*	_____Date	
4. Motor No. 2		
(a) General		
(b) Stator-Megger test, cold (annual)	_____Temp _____Meg.	
(c) Stator-Megger test, hot (annual)	_____Temp _____Meg.	
(d) Grease change*	_____Date	
5. Motor No. 3		
(a) General		
(b) Stator-Megger test, cold (annual)	_____Temp _____Meg.	
(c) Stator-Megger test, hot (annual)	_____Temp _____Meg.	
(d) Grease change*	_____Date	
6. Float switch assemblies		
(a) General		
(b) Float		
(c) Gage dial		

EXHIBIT 7

CHECKLIST

PUMPING PLANT

Pumping Plant Name: _____ cont.

Item	Condition	Recommended Maintenance
7. Lighting panel		
8. Lighting transformer		
9. Lighting fixtures-lamps, etc.		
10. Wall switches		
11. Receptacles and covers		
E. Pumps		
1. Pump No. 1		
(a) General		
(b) Greased*	_____Date	
(c) Lubricators and connections		
(d) Test run (submit log of operation)		
2. Pump No. 2		
(a) General		
(b) Greased*	_____Date	
(c) Test run (submit log of operation)		
3. Pump No. 3		
(a) General		
(b) Greased*	_____Date	
(c) Test run (submit log of operation)		

*See lubrication schedule

EXHIBIT 7

CHECKLIST

PUMPING PLANT

Pumping Plant Name: _____ cont.

Item	Condition	Recommended Maintenance
4. Pump No. 4		
(a) General		
(b) Greased*	_____Date	
(c) Test run (submit log of operation)		
F. Valves		
1. Flap valves		
2. Butterfly valves		
3. Ball valves		
4. Check valves		
G. Electrical or other failure since last inspection (explain, giving cause, date, and corrective action)		
H. Tool box		
1. Lock		
2. Tools		
3. Service manual		
4. Electric wrench and adapters		
5. Grease gun		
6. Sluice gate cranks		

EXHIBIT 7

CHECKLIST

FLOODWALLS

Inspected by _____ Title _____ DATE _____

Inspection covers: Stations _____ to _____

Report condition requiring maintenance in "Remarks" column or on separate sheet and attach to original.

Item	Location: Station	Condition	Remarks
1. Seepage, saturated areas, or sand boils			
2. Settlement			
3. Possibility of tree roots under wall			
4. Concrete (cracking, spalling or breaking)			
5. Accumulated trash or debris			
6. Evidence of fires being built near wall			
7. Riprap and slope protection			
8. Bank caving or sloughing			
9. Excavations near or under the wall for pipelines or other installations			
10. Poor backfill for excavations adjacent to or under the walls			
11. Unauthorized fill adjacent to wall (on either side)			
12. Holes cut in sheet pile walls under floodwalls			
13. Toe drain system			

EXHIBIT 8

CHECKLIST

FLOODWALLS

Inspected by _____ Title _____ DATE _____

Inspection covers: Stations _____ to _____

Report condition requiring maintenance in "Remarks" column or on separate sheet and attach to original.

ADDITIONAL REMARKS: _____

EXHIBIT 8

CHECKLIST

UNDERSEEPAGE CONTROL, FACILITIES

MAINTENANCE OF PIEZOMETERS & COLLECTOR SYSTEM

Project: _____

Date: _____

Piez. No.	Is Tube Open?	Depth of tube		Remarks - List any special conditions that require more space on the reverse side of this report
		Original	Sounded	
P-1				
P-2				
P-3				
P-4				
P-5				
P-6				
P-7				
P-8				
P-9				
P-10				
P-11				
P-12				
P-13				
P-14				

Seepage Collector System

Item	Station	Condition	Remarks
1. No burning of trash or other material within 10 feet of the system.			
2. Condition of any excavation.			

EXHIBIT 9

Date _____

CHECKLIST

UNDERSEEPAGE CONTROL FACILITIES - MAINTENANCE OF WELLS

Well number	Disch. el. to cap: Original (when new)	Disch. el. to cap: Sounded (this date)	Sediment record: Found (date)	Sediment record: Removed (date)	Discharge Data: Drawdown Orig tested	Discharge Data: Yield gpm Orig tested	Sand in well after pumping: Depth to sand	Sand in well after pumping: Removed after pumping	Well condition visual check: Screen	Well condition visual check: Riser	Well condition visual check: Flange
W-1											
W-2											
W-3											
W-4											
W-5											
W-6											
W-7											
W-8											
W-9											
W-10											
W-11											
W-12											
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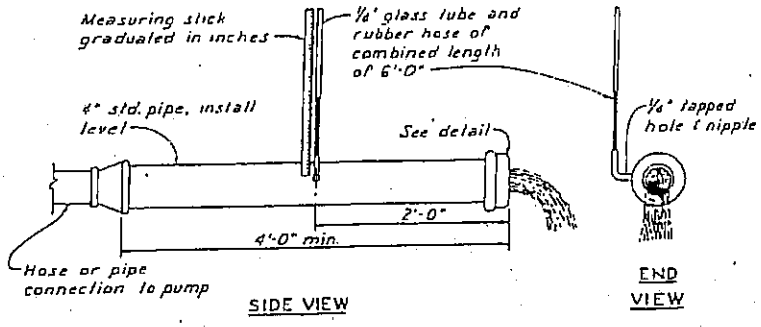
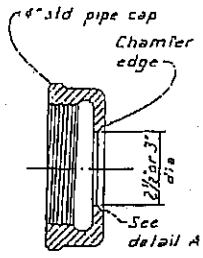
W-27											

EXHIBIT 10

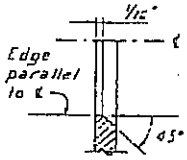


SIDE VIEW

END VIEW



DETAIL OF ORIFICE MADE FROM ST'D. PIPE CAP



DETAIL A

NOTES FOR CONSTRUCTION AND OPERATION OF ORIFICE METER

1. *The inside of the orifice shall be cut square with the pipe cap, free from burrs, and edges not rounded.*
2. *Any error in the diameter of the orifice opening will reflect greatly in erroneous discharge readings.*
3. *Where the pipe is tapped for the nipple, rubber hose, and glass tube, care must be exercised against burrs, and to make certain the nipple does not extend past the inside surface of the 4" pipe.*
4. *The discharge from the orifice must fall free.*
5. *The amount of water must be sufficient to produce an even flow with the orifice flowing full at all times. A very low head will cause a "broomy" flow which results in an error in measurment.*
6. *Grease on the interior of the orifice pipe will change the rate of flow at low heads, and make the discharge calculations uncertain.*
7. *The pipe or hose back of the orifice meter must be full of water at all times.*
8. *The glass tube and hose must be free of all air bubbles.*
9. *The height the water rises in the glass tube is measured in inches from the outlet of the 4" pipe. The rate of discharge in gallons per minute (G.P.M.) is then taken from the table for a corresponding height in inches.*

DETAILS OF ORIFICE METER

DISCHARGE TABLE

DISCHARGE IN G.P.M. FOR 2½" & 3" ORIFICES

HEAD IN INCHES	ORIFICES		HEAD IN INCHES	ORIFICES		HEAD IN INCHES	ORIFICES	
	2½"	3"		2½"	3"		2½"	3"
3	52	—	29	136	226	55	186	310
4	56	—	30	138	230	56	188	313
5	60	100	31	140	235	57	189	315
6	65	108	32	143	239	58	191	317
7	69	115	33	145	242	59	193	320
8	73	122	34	147	246	60	195	323
9	77	128	35	149	250	61	196	325
10	80	133	36	151	254	62	197	328
11	84	140	37	153	257	63	199	330
12	87	146	38	155	260	64	200	333
13	91	151	39	157	263	65	202	335
14	94	157	40	159	266	66	204	338
15	97	162	41	161	269	67	205	340
16	100	167	42	163	272	68	207	343
17	103	172	43	165	275	69	208	346
18	106	178	44	167	278	70	209	349
19	109	183	45	169	281			
20	112	187	46	171	284			
21	115	192	47	172	287			
22	118	197	48	174	290			
23	121	201	49	176	293			
24	124	205	50	177	296			
25	126	210	51	179	300			
26	129	214	52	181	302			
27	131	219	53	183	304			
28	133	222	54	185	307			

ORIFICE METER
FOR MEASURING RATE OF
DISCHARGE

CORPS OF ENGINEERS
KANSAS CITY DISTRICT
FILE NO. K-1-202

EXHIBIT 11

SECTION 5

CANTON, MISSOURI FLOOD FIGHT PRESENTATION 2008

FLOOD FIGHTING ORGANIZATION

(EXHIBITS 13-17)

EOC Notes
FLOOD 2008

Jeff McReynolds
EMD, City of Canton
Fire Chief, Canton R-V Fire Protection District

Canton, MO

Monday, June 9, 2008 morning

- Current River Level 8am 15.25'
- Current Crest Prediction 21.1'
  - For Tuesday, June 17th, 2008
- Canton Flood Stage 14.0'
- Action Stage 20.0'
- Levee Design 24.5'
- Top of Levee 27.5'
- Record Flood 1993 27.88'

Monday, June 9th, 2008 evening

- Current River Level 8pm 15.75' up .5'
- Current Crest Prediction 26.6' up 5.5'
  - For Tuesday, June 17th, 2008
- Canton Flood Stage 14.0'
- Action Stage 20.0'
- Levee Design 24.5'
- Top of Levee 27.5'
- Record Flood 1993 27.88'

Tuesday, June 10, 2008

- Met with Mayor, Admin, & Contractors
- Set Emergency City Council Meeting
- Negotiated Sand Hauling Contracts

Wednesday, June 11, 2008

- Held emergency council meeting.
- Authorization to spend city funds for floodfighting effort.
- Bid and ordered needed construction supplies.
- Met with local contractors - agreements

Thursday, June 12th, 2008

- Contractors begin batter board construction
- City Crews begin Gate installation
- Set up EOC at CSC campus
- Start Hauling Sand

Friday, June 13th, 2008

- EOC begins 24/7 operation

Friday, June 13th, 2008

- Begin daily contractor meeting 6:30 am
- Begin daily EOC staff meeting 8:00 am


Friday, June 13th, 2008

- Contractors start batterboard installation



Friday, June 13th, 2008

- Sandbagging Operations begin



Friday, June 13th, 2008

- Request Health Dept for shots
- Plan for volunteer registration

Friday, June 13th, 2008

- Plan for food and water services
- (we fed and provided water for 2150 different volunteers over 6 days)

Saturday, June 14th

- Crest prediction changed to 28.0' for Tuesday, June 17th
- Task ahead of us!
  - Raise 3 miles of levee 2'
  - 14,500 TONS of sand hauled (29 million lbs)
  - Sand was moved at least 5 times by hand
    - **145,000,000 pounds moved by hand!**
  - 725,000 sandbags filled and placed
  - 1980 ea 2' x 8' batterboard form installed
  - 2000 wood posts driven
  - 6000 steel fence post driven

Saturday, June 14th

- Request Additional Resources from state (Manpower)
  - National Guard
  - Department of Corrections
  - Region C Swift water team
  - Additional EOC staff

Weekend, June 14 th – 15 th

Saturday, June 14th

- Request Additional Resources from state (Materials)
  - Sandbags
  - Water
  - Ice
  - Straw

Weekend, June 14 th – 15 th

- Volunteerism at its best
  - Saturday 600-700
  - Sunday 1200+
  - Over 21,000 logged manhours
- Now we have to take care of them!
- CSC involvement.

Sunday, June 15th, 2008

- Notify Public of involuntary evacuation
- Met with local clergy
- TV conference
- Educated the public and media

Sunday, June 15th, 2008

- Moving out and Moving in
  - About 250 homes requested to move
  - 80 unit SR Housing
  - K-12 School
  - Fire Department
  - City Hall
  - All of Downtown business district

Monday and Tuesday 16th-17th

- Volunteer numbers drop
- Use the media to request workers
- Must be complete by Tuesday night
- Levee showing signs of stress
- Levee must be patrolled 24/7

Monday and Tuesday 16th-17th

North Levee
swellhead adds 1.3'

Wednesday, June 18th 2:00am

- River Level - goes above 24.5 at Midnight on Sunday
- Climbs to 27+ Tuesday
- Meyer breaks @ 2am river @ 27.3
- Still climbs to 27.73 before drop
- North Levee with swellhead = ~29.0'
  1.5' above existing levee

Thurs June 18th – Friday June 27th

- Rivers crests second @ 27.0 on Sat – 20th
- Remains above 24.5 till June 27th
- EOC closes June 27th 6pm

CONDUCTING FLOOD FIGHTING OPERATIONS

1. Preparation: Preparing to undertake a flood fighting event requires prior planning and an understanding of basic flood fighting techniques. Each flood event is different, but is similar to past events. Time, weather conditions, river stages/conditions, resources, hours of darkness, and lack of trained personnel will all impact your flood fighting effort. The KEYS to every flood fighting effort is:

- Development of a site specific plan that outlines the WHO, WHAT, WHERE, WHEN, and HOW of flood fighting.
- Key personnel training in the "ART" of flood fighting.
- Early warning, recognition, and identification of a flood event.
- Command, control, and communications within you flood fighting team.
- Traffic control and traffic patterns to and from the work site(s).
- Sandbag filling operations should be staged away from the work site but close enough to reduce transportation requirements and cycle times.

2. Concept of Operations:

a. Primary and Alternate Assembly Areas:

- Assembly area should have adequate parking.
- Volunteers should report to a designated assembly area.
- Request volunteers bring their own flash light, work gloves, rain gear, shovel, and snack.
- Alternate assembly area should also be identified.
- Sign in roster for volunteers - personnel accountability (name, home phone number, address, work group assignment).
- Recommend that volunteers be transported from assembly areas to staging areas.

b. Staging Areas:

- As close to flood fight location as possible, but must also have good access and egress and good trafficability.
- Recommend that 4 X 4 pick-up trucks be used to transport filled sandbags.
- Site layout of staging area:
  - sandbag filling
  - carrying and loading
  - materials stockpile
  - rest/break area
  - first aid area

c. Work Site:

Plan the Work Site: The work site is where the sandbagging operations occur. The traffic pattern again is extremely important and must be will planned. It is recommended that if conditions permit that one way traffic patterns be established. This is extremely important on the levee system. Remember, the higher the sandbag levee the wider the base will be. All Federal levee systems within the Kansas City District were constructed with a 10 foot levee crown. Consequently, this may require backing the vehicle up or down stream to the laying party.

Rules of Thumb: It is extremely important that the work site is well supervised by a trained individual. Labor and resource requirement can be decreased and efficiency increased by following some simple "rules of thumb":

- Construct on a firm foundation
- Sandbags should be filled 1/2 to 2/3 full
- Sandbags should not be tied, but folded
- Always have the butt of the bag facing up stream
- Each bag should be placed with 1/3 overlap and be well mauled into place

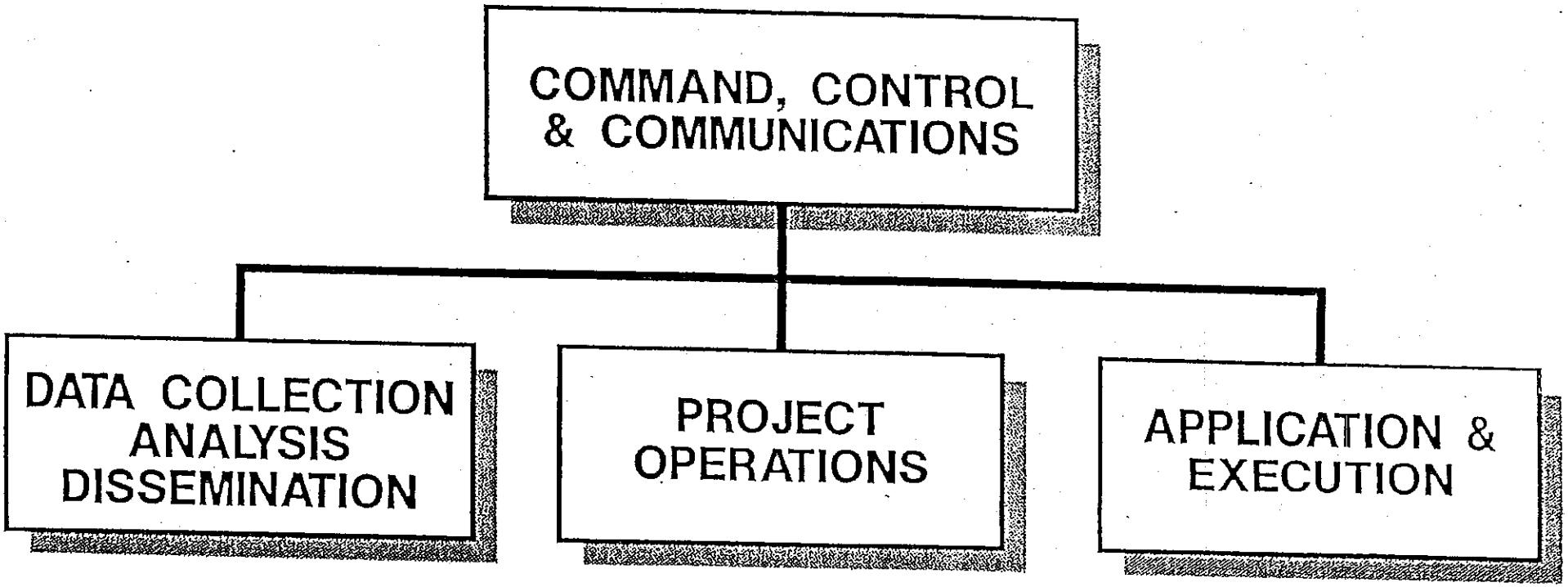
Command & Control at the Work Site: How do you control a flood fighting effort? First someone has to be in charge of the operation. Since coordination between many agencies is a must, it is recommended that an Emergency Operations Center be established and operated 24 hours daily until the emergency is over. When operating the EOC, consider the following:

- Radio and telephone communications systems
- Television and/or radio monitor weather and river forecasts.
- Emergency generator in case of power outages
- Administrative supplies
- Levee Operations and Maintenance Manuals
- State, County, and local maps
- Flash lights, telephone books, emergency phone rosters
- Listing of local contractors, Red Cross, Salvation Army, hospitals, polices, State/County Emergency Operations center, etc.

Common Misconceptions In Flood Fighting: The efficiency of undertaking a flood fight can be increased by avoiding some of the common mistakes and misunderstanding about the process. Many people think that sandbagging is a mindless endeavor; just fill the bags and throw them in place. Yet nothing could be further from the truth. Sandbagging operation is an "art" that requires understanding and thought. Remember *time, weather conditions, hours of darkness, and limited resources* are your enemy.

Plan Development: In the development of your flood fighting plans, you must consider the characteristics of the adjacent river or stream. Flashing streams and rivers require rapid response, while moderately rising streams and rivers allow greater reaction and warning time. Therefore, it is essential that you flood fighting plans are based on the available "reaction time".

FLOOD FIGHTING ORGANIZATION



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LOG OF OPERATIONS - HOURLY RIVER STAGES

Date _____

STATIONS	FB-1	FB-2	FB-3	FB-4	FB-5	FB-6	FB-7	FB-8	FB-9	FB-10	FB-11	FB-12	FB-13	FB-14
FLOODSTAGE														
1:00 am														
2:00														
3:00														
4:00														
5:00														
6:00														
7:00														
8:00														
9:00														
10:00														
11:00														
12 noon														
1:00 pm														
2:00														
3:00														
4:00														
5:00														
6:00														
7:00														
8:00														
9:00														
10:00														
11:00														
12:00														

LOG OF OPERATIONS

DRAINAGE STRUCTURE

Location of Drainage Structure _____

_____

ACTION	DATE	HOUR	RIVER STAGE F.B. GAGE
1. Water reached elevation of bottom of flap gate or sluice gate			
2. Closure of sluice gate initiated			
3. Closure of sluice gate completed			
4. Maximum elevation of water surface			

Remarks:

Signed _____ Date _____

Note: Do not close sluice gate when the water from the landward side is flowing to the river by gravity.

LOG OF OPERATIONS

CLOSURE STRUCTURE

Location of Structure _____

_____

ACTION	DATE	HOUR	RIVER STAGE F.B. GAGE
1. Water reached elevation requiring notification of anticipated closure to railroad or highway authorities			
2. Closure of gap initiated			
3. Closure of gap completed			
4. Maximum elevation of water surface			

Remarks:

Signed _____ Date _____

LOG OF OPERATIONS

PUMPING PLANT

Pumping Plant Name _____ Date _____ am _____ pm _____

Operators: _____ from _____ to _____. _____ from _____ to _____
Name Name

Signed: _____ (Sup't) Date _____

Time	Float Gage Reading	Remarks	Pump No. 1 Hrs. & Mins. Start	Pump No. 1 Hrs. & Mins. Stop	Pump No. 2 Hrs. & Mins. Start	Pump No. 2 Hrs. & Mins. Stop	Pump No. 3 Hrs. & Mins. Start	Pump No. 3 Hrs. & Mins. Stop
am _____								
pm _____								

ndicate test runs and manual or automatic control for operation, and electrical or other failures.
ecord maintenance duties performed and time of oiling and greasing pumps and motors.

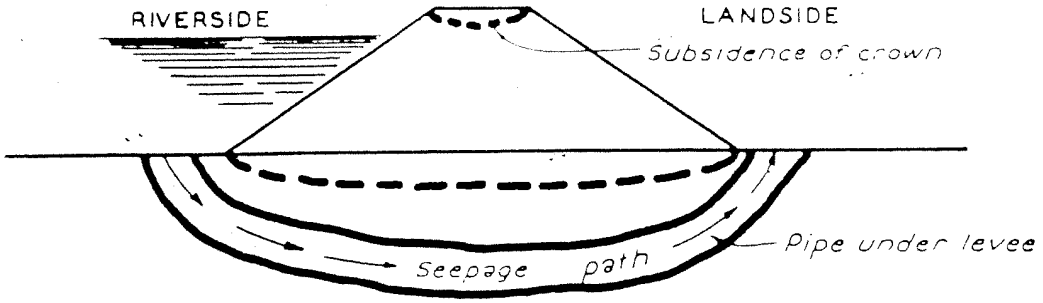
EXHIBIT 17

SECTION 6

FLOOD FIGHTING TECHNIQUES

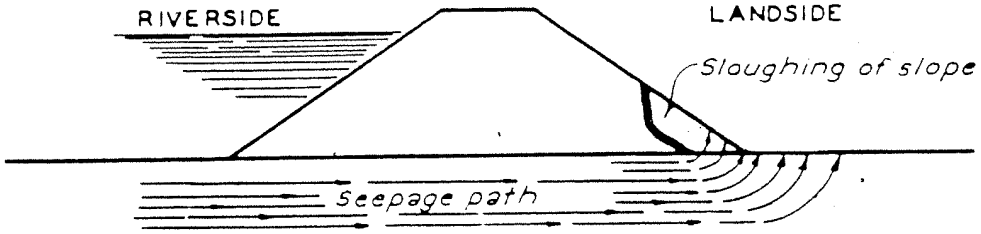
AND

RESOURCE REQUIREMENTS



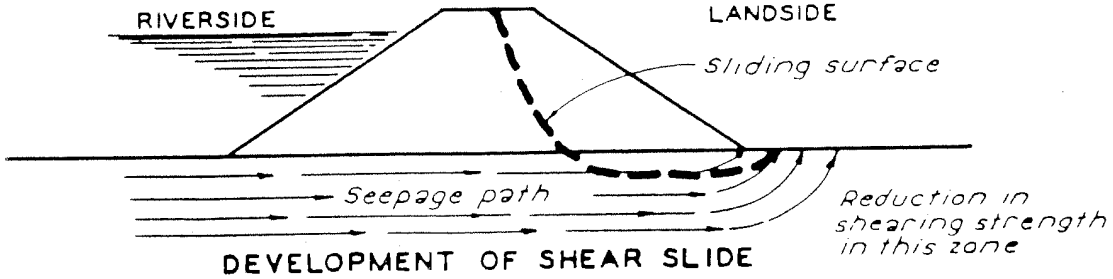
DEVELOPMENT OF PIPE UNDER LEVEE

FIG. 1



SLOUGHING OF LANDSLIDE SLOPE DUE TO RAVELLING AND UNDERCUTTING OF TOE

FIG. 2

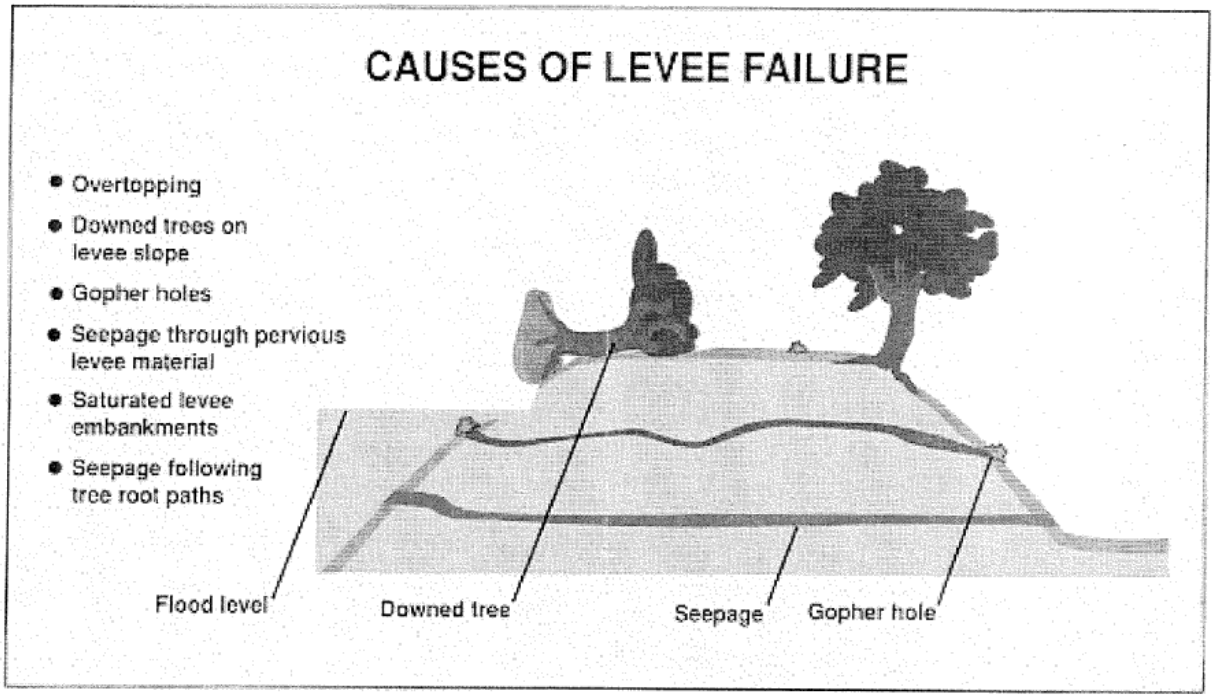


DEVELOPMENT OF SHEAR SLIDE

FIG. 3

EFFECTS OF SAND BOILS ON LEVEE

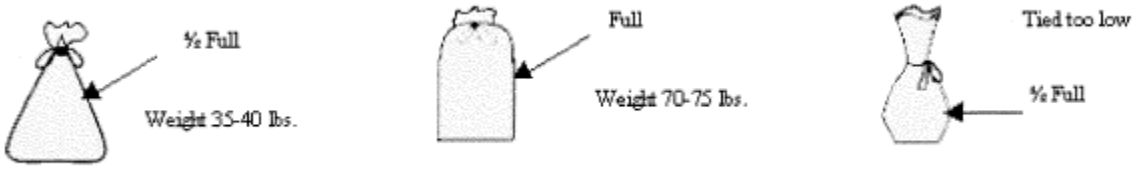
Figure 1



http://www.sandbagcentral.com/levee.asp

How to Fill

Fill sandbag ½ to 2/3 full, tie at top so bag will lay flat when put in place. (Overfilled bags leave gaps in the levee allowing water to seep through).



Placing Sandbags

Sandbags should be placed flat on the ground, overlapped, tamped into place, and stairstepped.

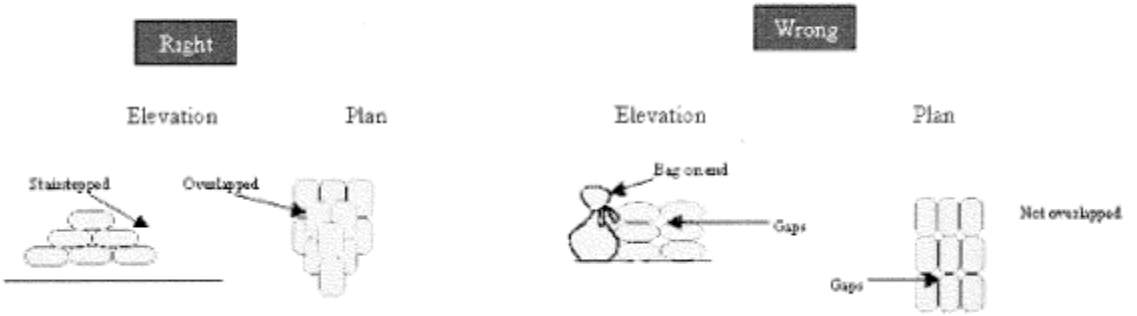
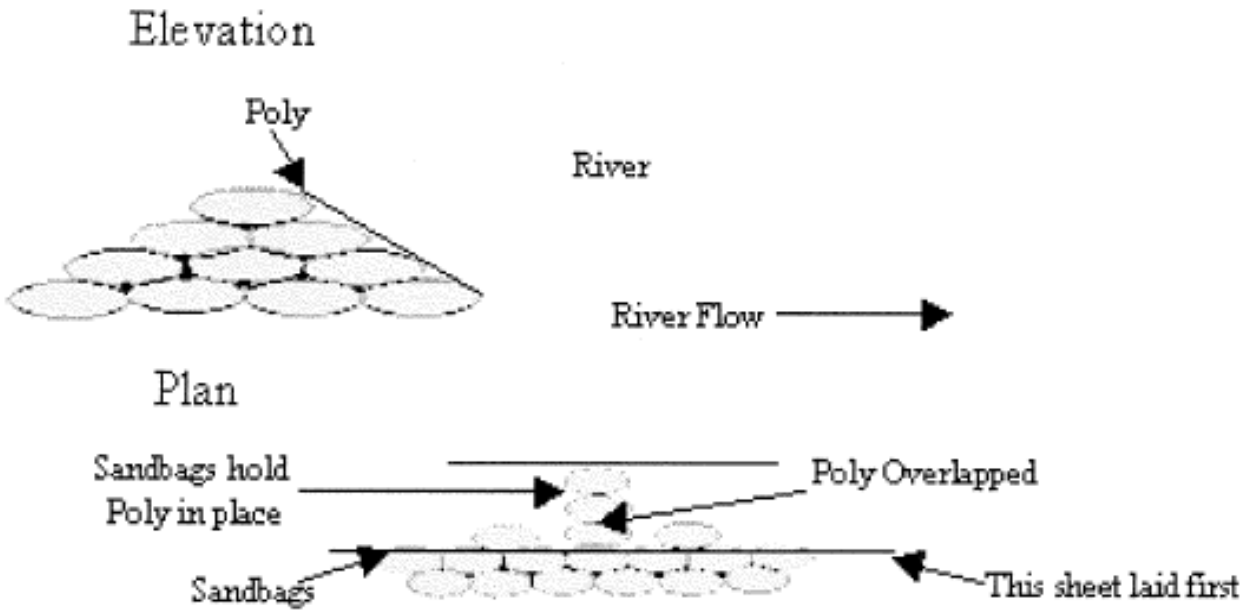


Figure 2

Polyethylene

Polyethylene (poly) comes in rolls 20 ft. wide and 100 ft. long. It's used to wrap sandbag levees to prevent seepage. Poly should be placed on downstream portion of levee first, then worked upstream with a two-to three-foot overlap. Poly is held in place with sandbags.



Estimated number of sandbags per linear foot of wall.

Height in Feet	Bags required
1	5
2	10
3	21
4	36
5	55

Five feet is the practical limit of a sandbag levee. If a higher levee is needed, alternative means of construction should be considered.

Note: Preferred levee limit is 3 feet high.

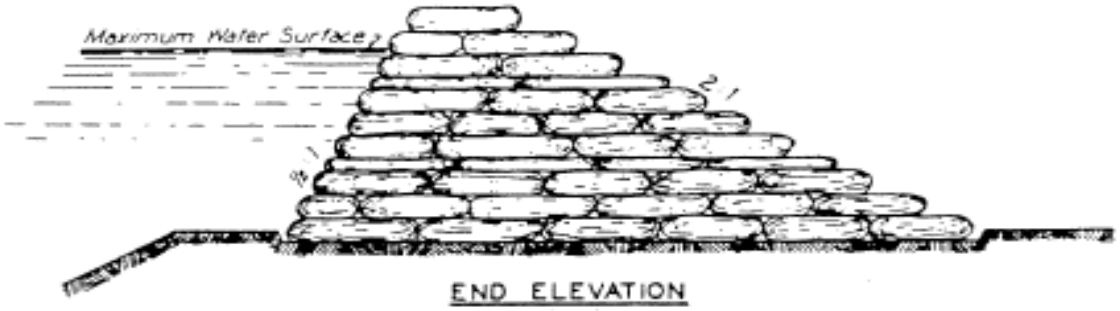
Figure 3

Fold the open end of the bag under the filled portion. Place succeeding bags with the bottom of the bag tightly and partially overlapping the previous bag. Offset adjacent rows or layers by one-half bag length to avoid continuous joints. To eliminate voids and form a tight seal, compact and shape each bag by walking on it and continue the process as each layer is placed. This flattens the top of the bag and prevents slippage between succeeding layers.

Place each succeeding bag tightly against and partially overlapping the previous one. Compact and shape each bag by walking on it.

Figure 4

RIVERWARD SLOPE ELEVATION



END ELEVATION

BAGS REQUIRED FOR 100 LINEAR FEET OF LEVEE	
ELEVATION	BAGS REQUIRED
1 Foot	650
2 Feet	1800
3 "	3450
4 "	5600
5 "	8250

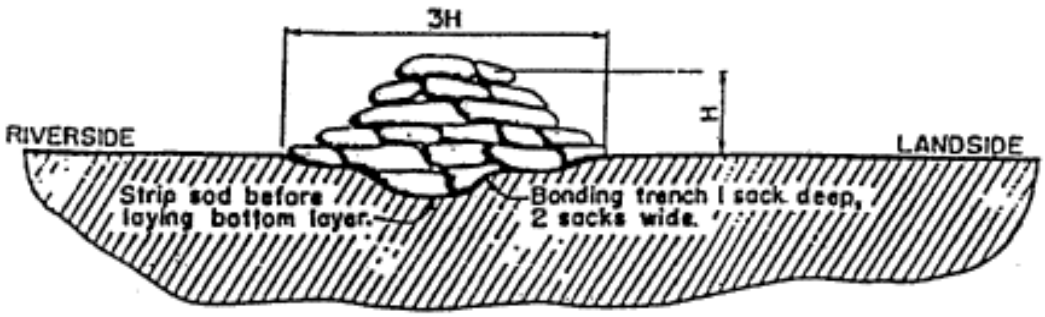
NOTES

Bags shall be approximately ½ full of clay or sand. They shall be placed lengthwise along the staked alignment. They shall be placed in the levee with ⅓ overlap and be well mauled into place.

A binding strip shall be placed at every 4th course. The bags for this strip shall be flattened and laid transverse to the staked alignment.

SAND BAG LEVEE
CONSTRUCTION DETAILS

Figure 5

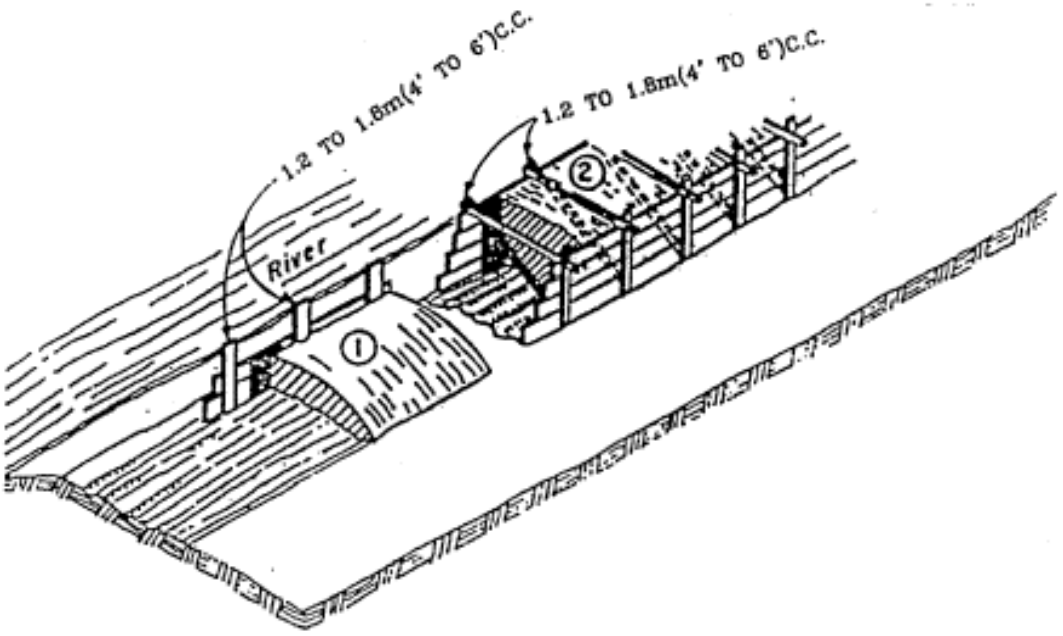


SECTION

NOTE:
Alternate direction of sacks with bottom layer parallel to flow, next layer perpendicular to flow, etc.
Lap unfilled portion under next sack.
Tying or sewing sacks not necessary.
Tamp thoroughly in place.
Sacks should be approximately 1/2 full of sand.

METHOD OF LAPPING SACKS

Figure 6



TYPES OF WOOD AND EARTH LEVEES

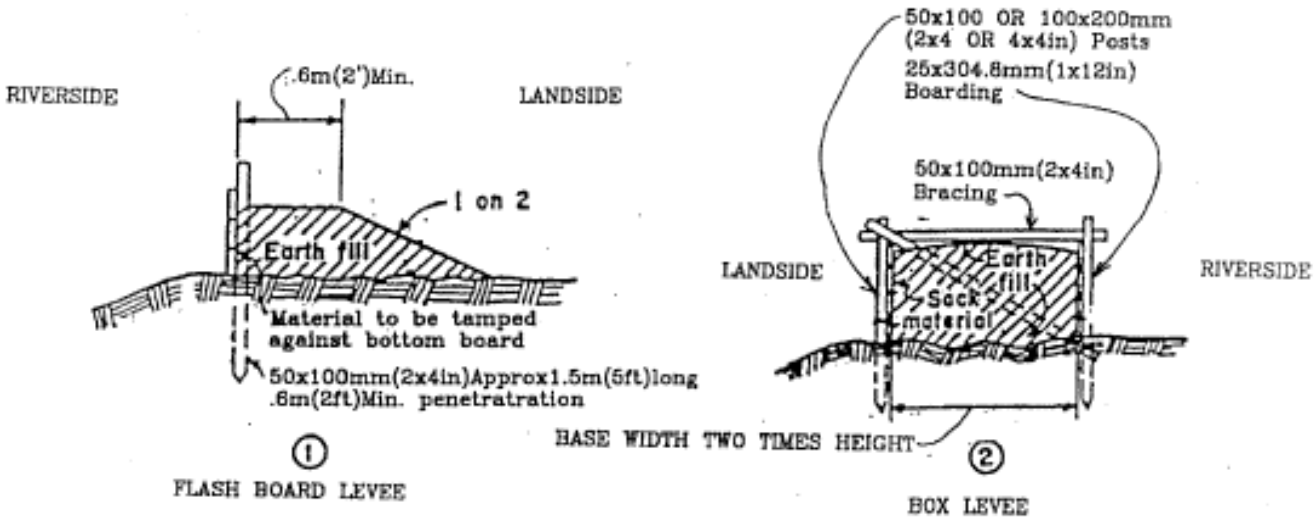
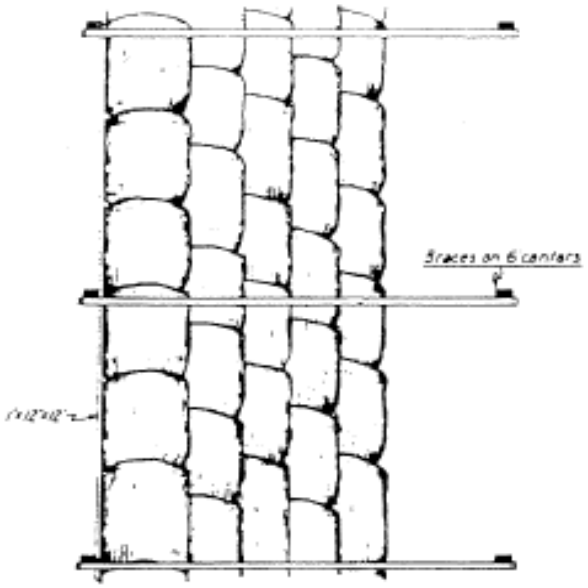
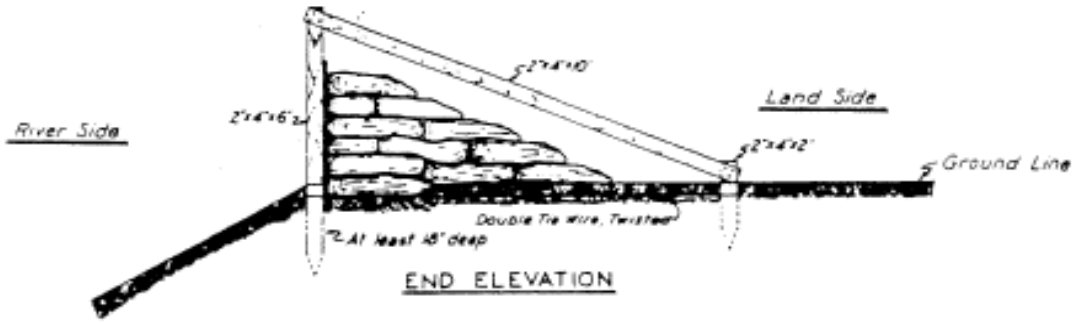


Figure 7





MATERIAL REQUIRED FOR 100 LINEAR FEET OF LEVEE		
LUMBER	SAND BAGS	NAILS
25 Pieces 1"x12"x12'	1100 Bags	6 lbs 10d nails
17 " 2"x4"x10'		6 lbs 20d nails
#17 " 2"x4"x6'		WIRE
#17 " 2"x4"x12'		15 lbs Wire #12 gage
# Sharpened		

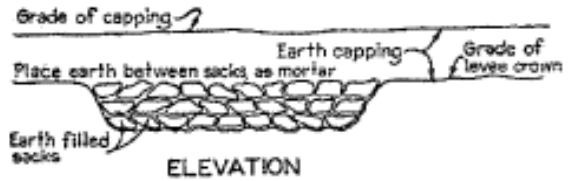
Total lumber 504 Board Feet

NOTES

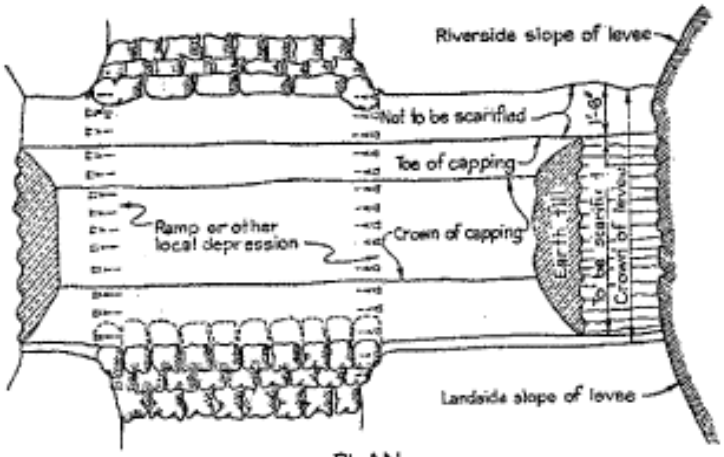
Bags shall be approximately ½ full of clay or sand. They shall be placed lengthwise along the staked alignment. They shall be placed in the levee with ⅓ overlap and be well mauled into place.

3 FT. LUMBER & SANDBAG LEVEE CONSTRUCTION DETAILS

Figure 8



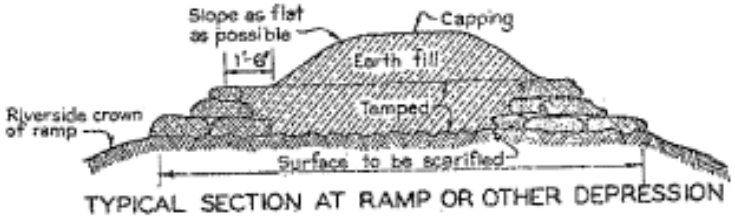
ELEVATION



PLAN

TYPICAL SECTION LEVEE CAPPING

NOTE: This type of capping not to be used on levees with crown less than 10' wide or on levees exposed to wave wash.



TYPICAL SECTION AT RAMP OR OTHER DEPRESSION

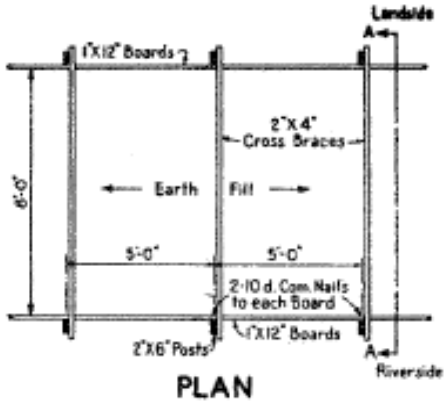
EMERGENCY FLOOD FIGHTING

EARTH CAPPING

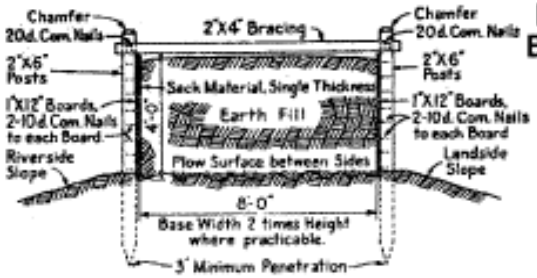
FOR RAISING DEPRESSIONS AND LEVEE CAPPING

(THIS DESIGN IS ADEQUATE FOR HEIGHTS UP TO 1½')

Figure 9



PLAN



SECTION A-A

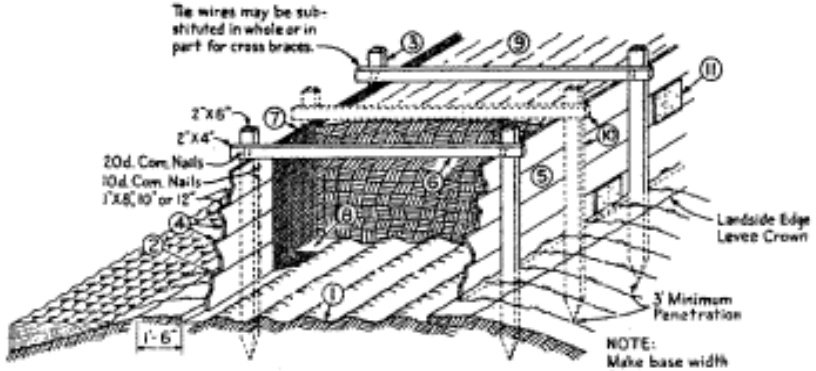
MUD BOX LEVEE CAPPING — 4 FEET HIGH
BILL OF MATERIALS FOR 1000 LINEAR FEET

402 Posts	2"X6"X8'-0"	=	3216 Bd. Ft.
201 Ties	2"X4"X10'-0"	=	1340 Bd. Ft.
Boards	1"X12"X8000 L.F.	=	8000 Bd. Ft.
		Total	12,556 Bd. Ft.

100 Lbs. 10d. Common Nails
80 Lbs. 20d. Common Nails
1700 Sacks
Actual quantities. No allowance made for waste.

4500 Sq.Ft. Visqueen 2-1/2' X 1000'

*NOTE: Dimensions based on rough cut lumber.



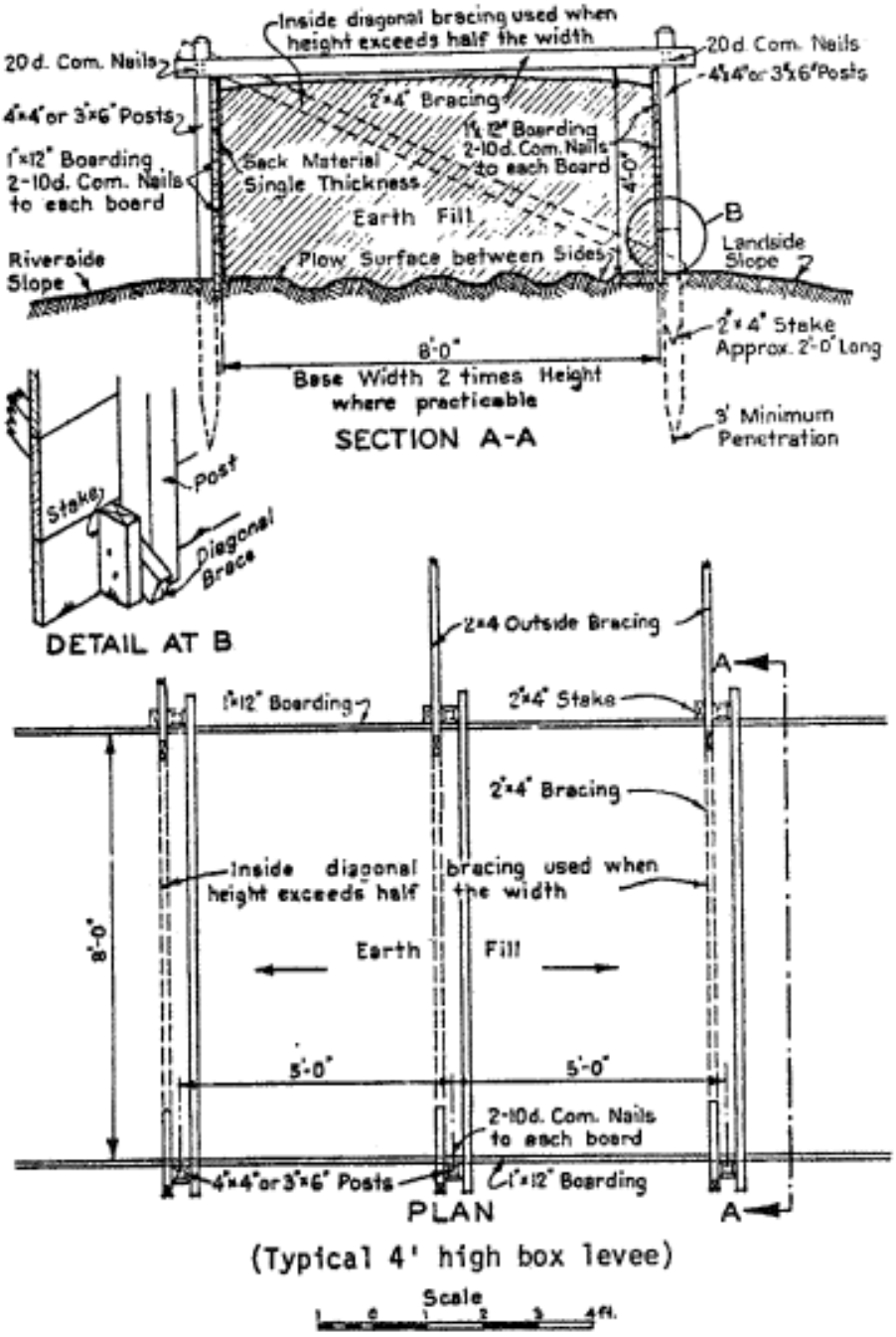
METHOD OF CONSTRUCTION

SEQUENCE OF OPERATIONS

1. Plow crown of levee (2" minimum depth) beginning 1'-6" from riverside edge.
2. Place bottom board.
3. Place and drive posts at 4' to 6' C.C. so ends of boards will meet on posts.
4. Place additional boards and nail.
5. Construct landside fence.
6. Brace fences together.
7. Place and nail sack material.
8. Refill furrow and tamp on both sides of bottom board.
9. Place earth fill between fences.
10. Drive and brace additional posts if earth fill exceeds 3 ft. in height.
11. Break joints any place. If joints butt, use scab.

EMERGENCY FLOOD FIGHTING
MUD BOX LEVEE CAPPING
(FOR CAPPING IN EXCESS OF 3' IN HEIGHT OF NARROW CROWN LEVEE CAPPING)

Figure 10



BILL OF MATERIALS FOR 1000 LINEAR FEET
FOR BOX LEVEE WITH DIAGONAL BRACING

201 Stakes	2"X4"X2'-0"	= 268 Bd.Ft.
201 Diagonal Braces	2"X4"X10'	= 1340 Bd.Ft.
402 Posts	4"X4"X8'	= 4288 Bd.Ft.
201 Bracing	2"X4"X8'	= 1072 Bd.Ft.
Boarding	1"X12"X8000'	= 8000 Bd.Ft.
		14,968 Bd.Ft.

Dimensions based on rough cut lumber.
60 lb. 20d. Common Nails
60 lb. 10d. Common Nails

EMERGENCY FLOOD FIGHTING
MUD BOX LEVEE WITH DIAGONAL BRACING

U.S. ARMY ENGINEER DISTRICT, OMAHA

Figure 11

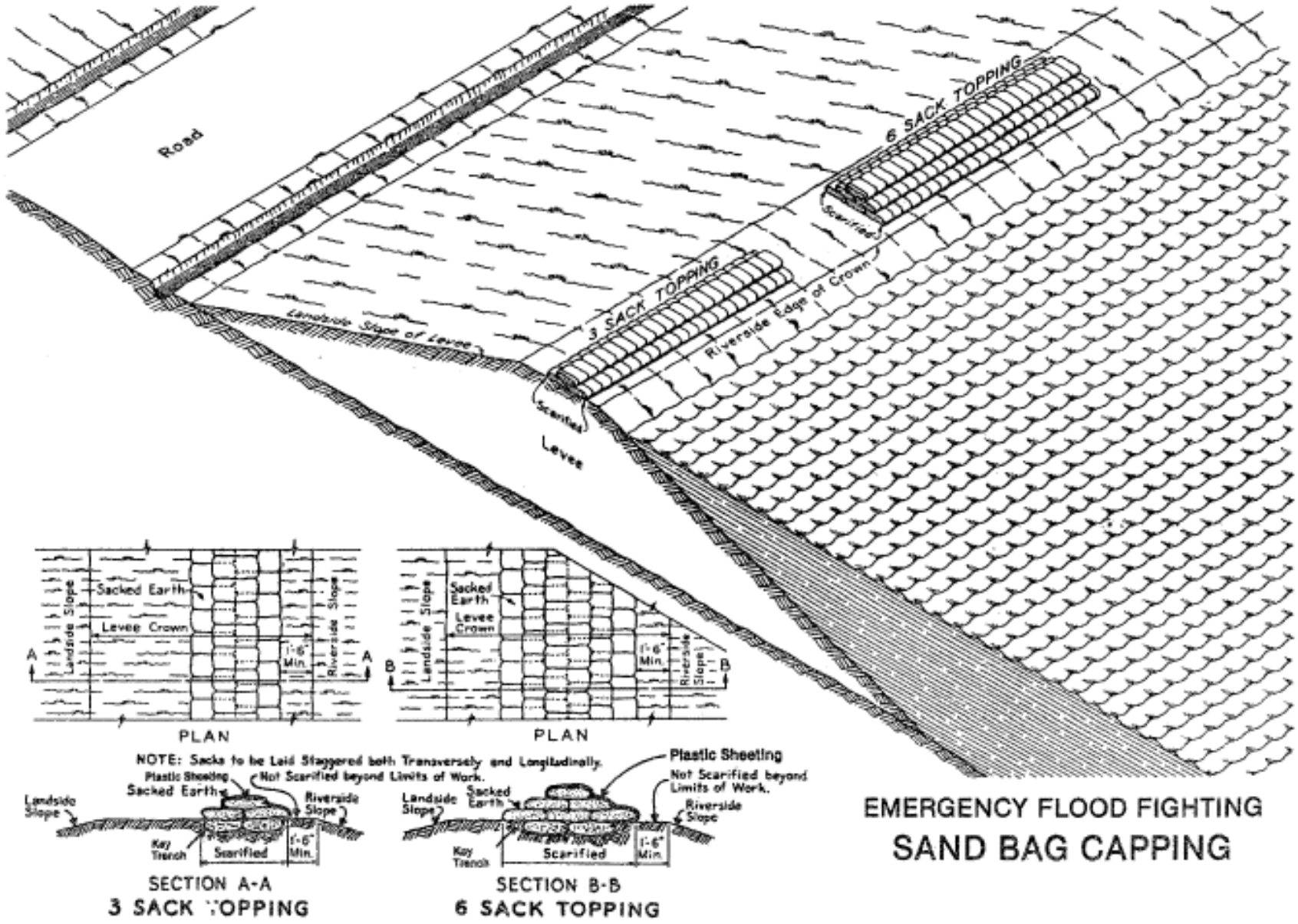

Road
6 SACK TOPPING
Scarified
3 SACK TOPPING
Riverside Edge of Crown
Landside Slope of Levee
Scarified
Levee
Landside Slope
Sacked Earth
Levee Crown
Riverside Slope
1'-6" Min.
A
A
PLAN
Landside Slope
Sacked Earth
Levee Crown
Riverside Slope
1'-6" Min.
B
B
PLAN
NOTE: Sacks to be Laid Staggered both Transversely and Longitudinally.
Plastic Sheeting
Not Scarified beyond Limits of Work.
Sacked Earth
Landside Slope
Riverside Slope
Key Trench
Scarified
1'-6" Min.
SECTION A-A
3 SACK TOPPING
Plastic Sheeting
Not Scarified beyond Limits of Work.
Sacked Earth
Landside Slope
Riverside Slope
Key Trench
Scarified
1'-6" Min.
SECTION B-B
6 SACK TOPPING
EMERGENCY FLOOD FIGHTING
SAND BAG CAPPING

Figure 12

SEQUENCE OF OPERATIONS

① Plow crown of levee (2" minimum depth) beginning 1'-6" from riverside edge.

② Place bottom flashboards on edge of plowed furrow, break joints any place.

③ Place and drive 2"x4" posts from 4' to 6' C.C., nail flashboards to posts.

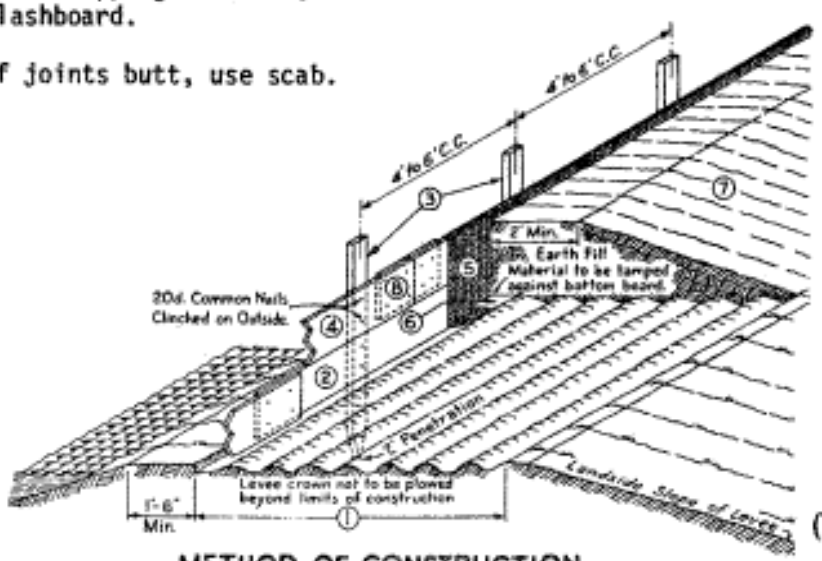
④ Place top flashboards and nail; break joints any place.

⑤ Place and nail Visqueen or other material.

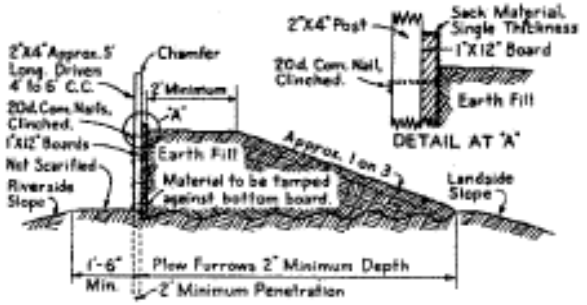
⑥ Refill plowed furrow and tamp on both sides of bottom boards.

⑦ Place capping material, landside of flashboard.

⑧ If joints butt, use scab.



METHOD OF CONSTRUCTION



SECTION

TWO BOARD LEVEE CAPPING
BILL OF MATERIALS FOR 1000 LINEAR FEET

201 Posts	2" x 4" x 5'-0"	= 670 bd.ft.
Boards	1" x 12" x 2000 L.F.	= 2000 bd.ft.
		2670 bd.ft.
50 lbs.	20d Common Nails	= 1450 Nails
Visqueen	2-1/2' x 1000'	= 2500 sq.ft.

Actual quantities. No allowance made for waste.

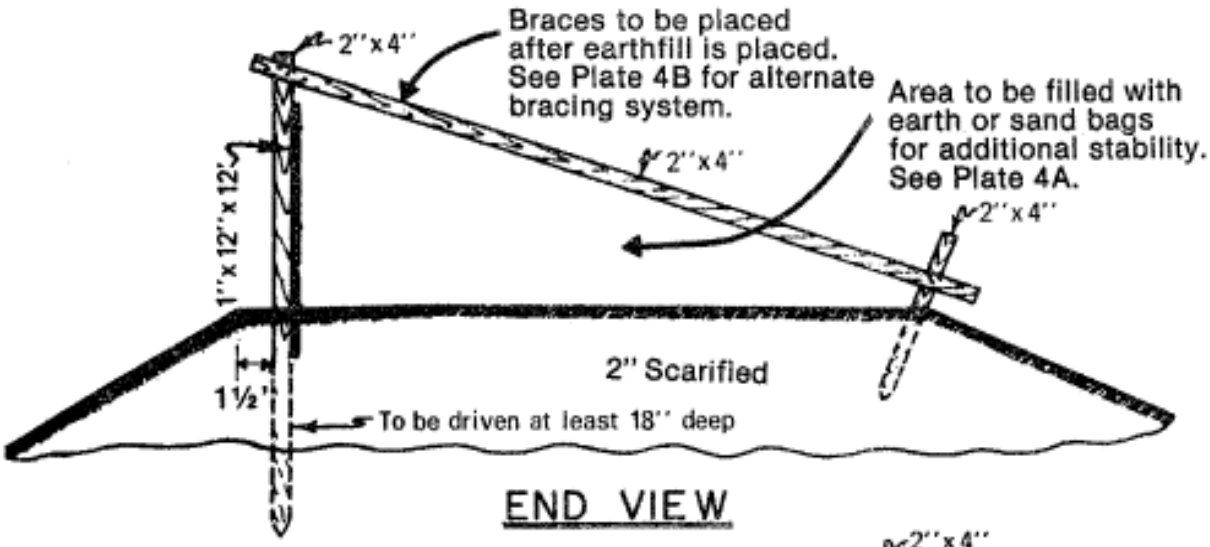
*NOTE: Dimensions based on rough cut lumber.

EMERGENCY FLOOD FIGHTING

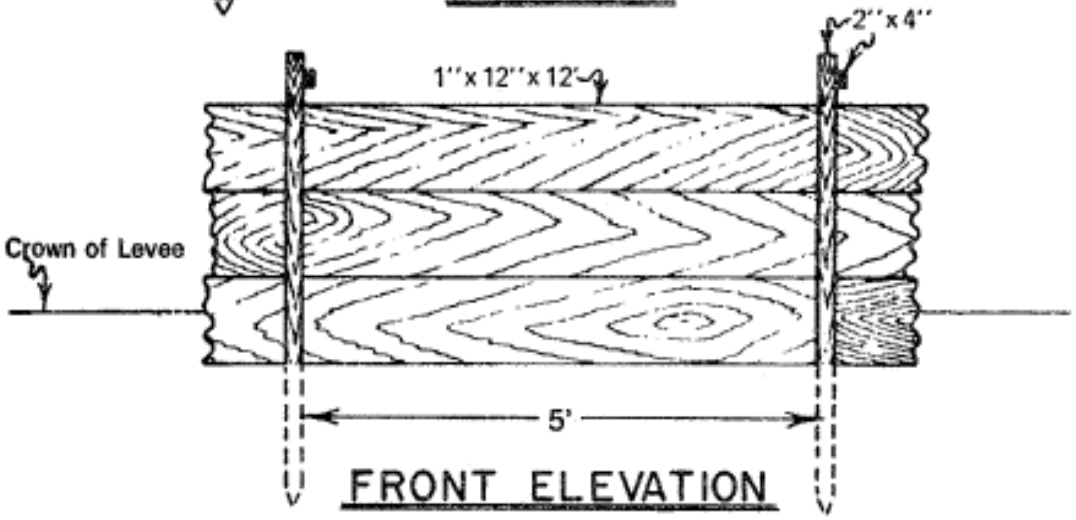
FLASHBOARD LEVEE CAPPING TWO BOARD TYPE

(THIS DESIGN IS ADEQUATE FOR HEIGHTS UP TO 2')

Figure 13



END VIEW



FRONT ELEVATION

THREE BOARD FLASHBOARD LEVEE CAPPING
BILL OF MATERIAL TO CONSTRUCT 100'

Boards 1"X12"X 300 L.F.	=	300 Bd.Ft.
17 Posts 2"X4"X 6'-0"	=	68 Bd.Ft.
17 Braces 2"X4"X10'-0"	=	114 Bd.Ft.
17 Anchors 2"X4"X2'-0"	=	23 Bd.Ft.
TOTAL		505 Bd.Ft.

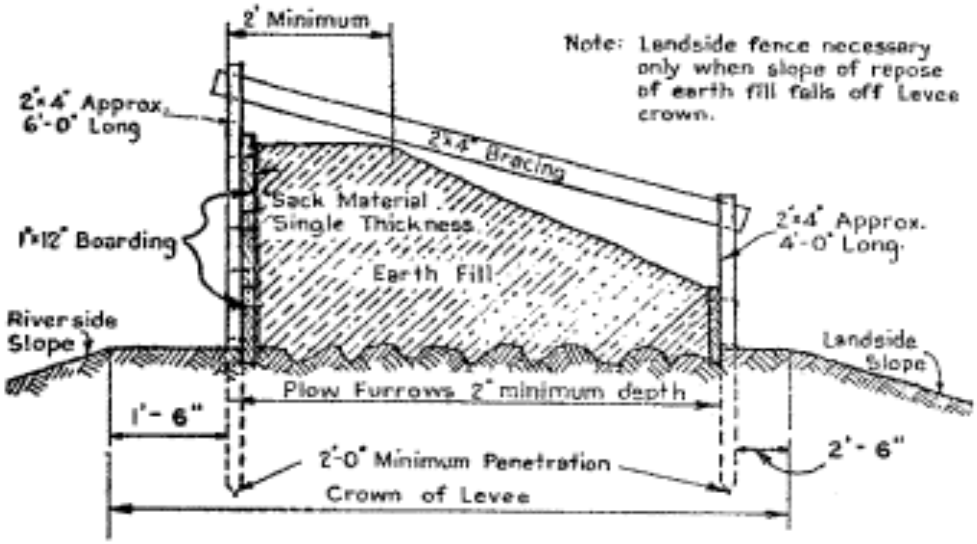
Dimensions based on rough cut lumber.
5 lbs. 10d Common Nail's

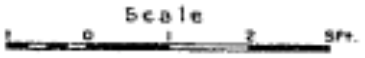
EMERGENCY FLOOD FIGHTING

FLASHBOARD LEVEE CAPPING THREE BOARD TYPE

(THIS DESIGN IS ADEQUATE FOR HEIGHTS UP TO 3')

Figure 14





BILL OF MATERIALS FOR 1000 LINEAR FEET
OF THREE BOARD CAPPING FOR NARROW
CROWN LEVEE (MAX. 3' HIGH)

201 Posts	2"X4" X 6'-0"	=	804 Bd.Ft.
201 Posts	2"X4" X 4'-0"	=	536 Bd.Ft.
*201 Braces	2"X4" X 14"=0"	=	943 Bd.Ft.
Boards	1"X12" X 2000 L.F.	=	4000 Bd.Ft.

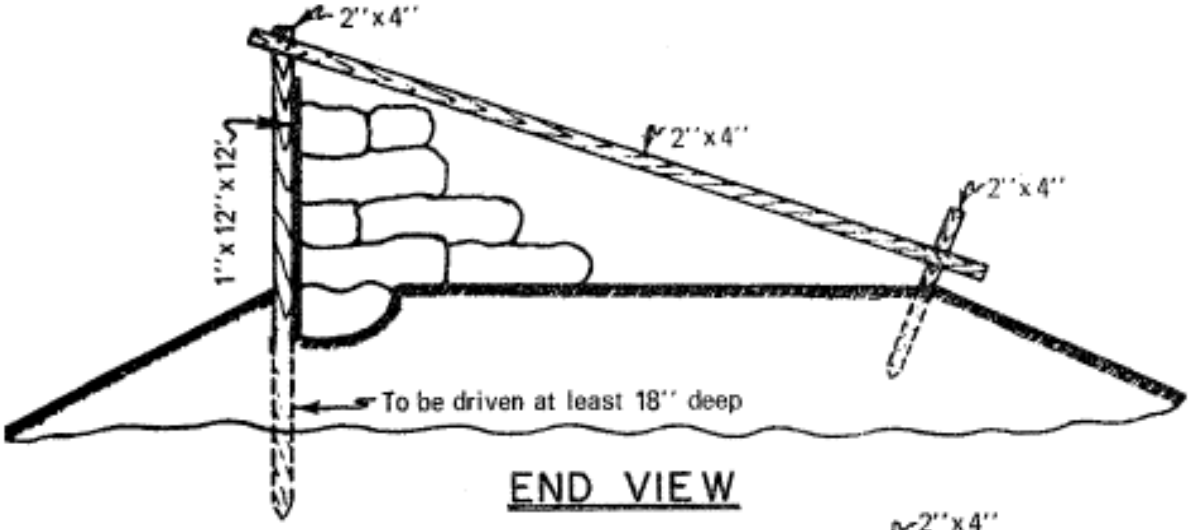
Dimensions based on rough cut lumber

50 lbs. 8d. Common Nails
30 lbs. 20d. Common Nails

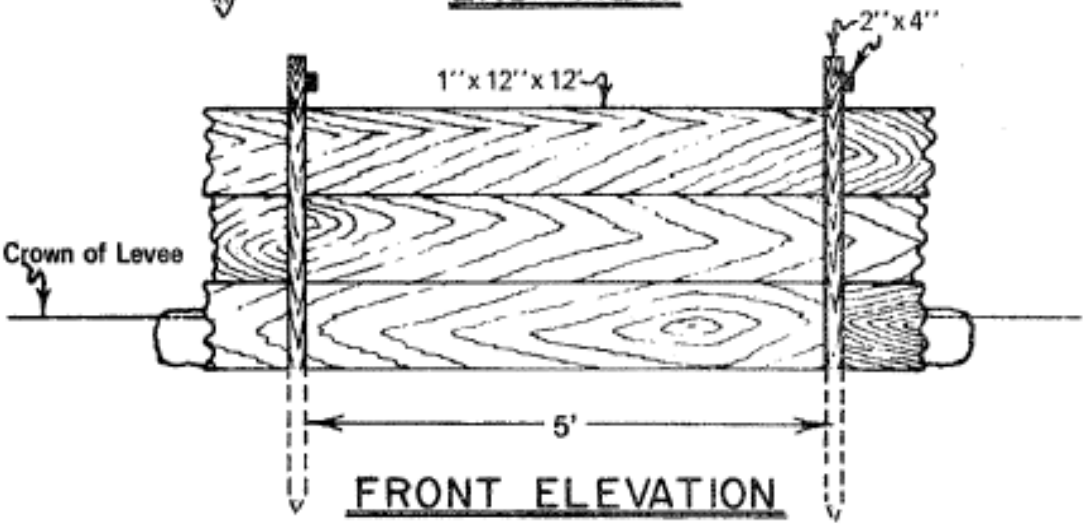
*NOTE: Should get two braces from each board.

EMERGENCY FLOOD FIGHTING
FLASHBOARD LEVEE CAPPING
THREE BOARD TYPE
(THIS DESIGN IS ADEQUATE FOR HEIGHTS UP TO 3')

Figure 15



END VIEW



FRONT ELEVATION

THREE BOARD LUMBER AND SACK TOPPING
BILL OF MATERIAL TO CONSTRUCT 100'

Boards 1"X12"X 300 L.F.	=	300 Bd.Ft.
17 Posts 2"X4"X 6'-0"	=	68 Bd.Ft.
17 Braces 2"X4"X10'-0"	=	114 Bd.Ft.
17 Anchors 2"X4"X2'-0"	=	23 Bd.Ft.
TOTAL		505 Bd.Ft.

Dimensions based on rough cut lumber.
5 lbs. 10d Common Nails
6 - 8 bags/L.F.
800 bags

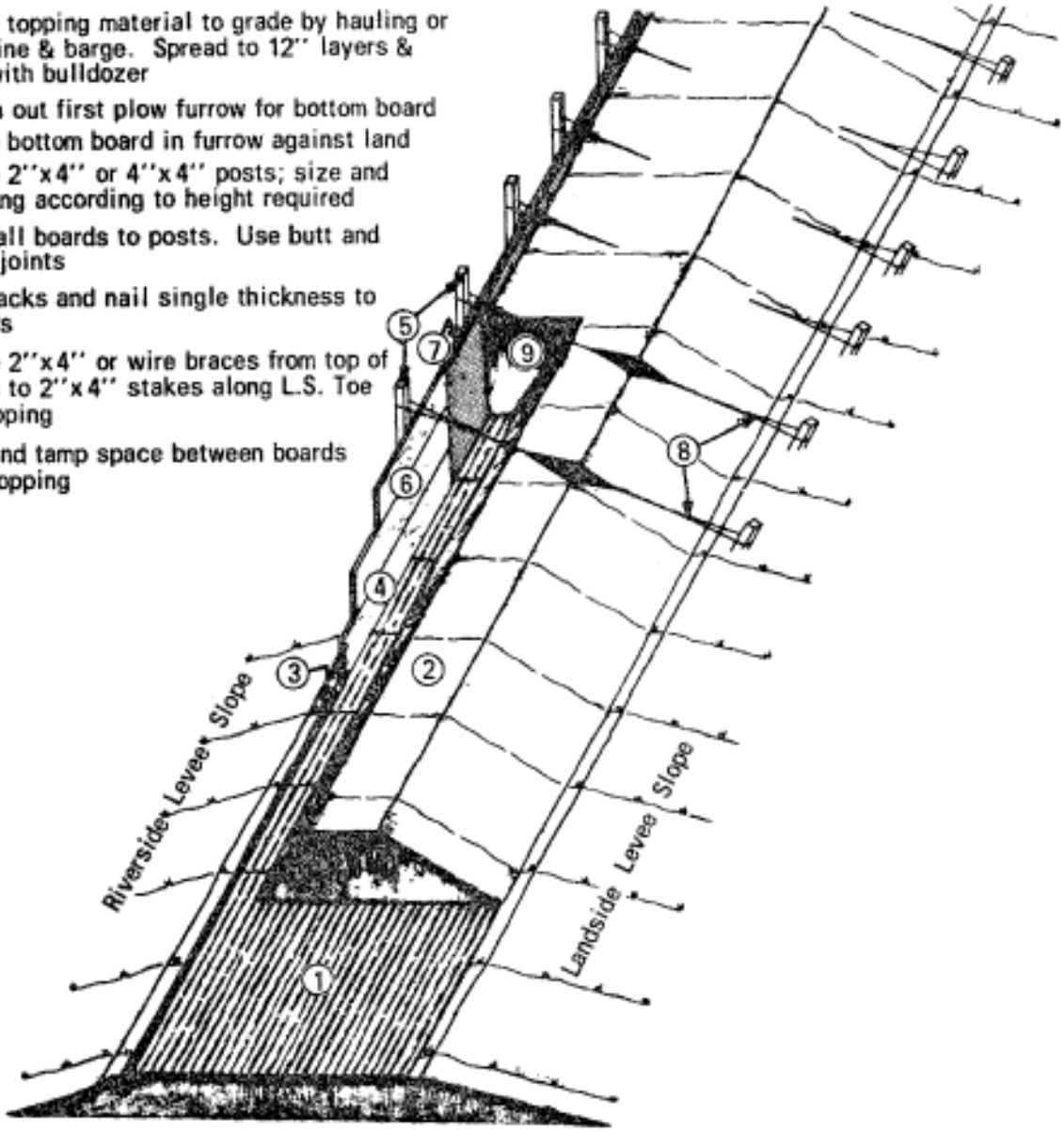
EMERGENCY FLOOD FIGHTING
LUMBER AND SACK TOPPING

Figure 16

Figure 17

SEQUENCE OF OPERATIONS

1. Plow crown of levee
2. Place topping material to grade by hauling or dragline & barge. Spread to 12" layers & roll with bulldozer
3. Clean out first plow furrow for bottom board
4. Place bottom board in furrow against land
5. Drive 2"x4" or 4"x4" posts; size and spacing according to height required
6. Nail all boards to posts. Use butt and scab joints
7. Rip sacks and nail single thickness to boards
8. Place 2"x4" or wire braces from top of posts to 2"x4" stakes along L.S. Toe of topping
9. Fill and tamp space between boards and topping

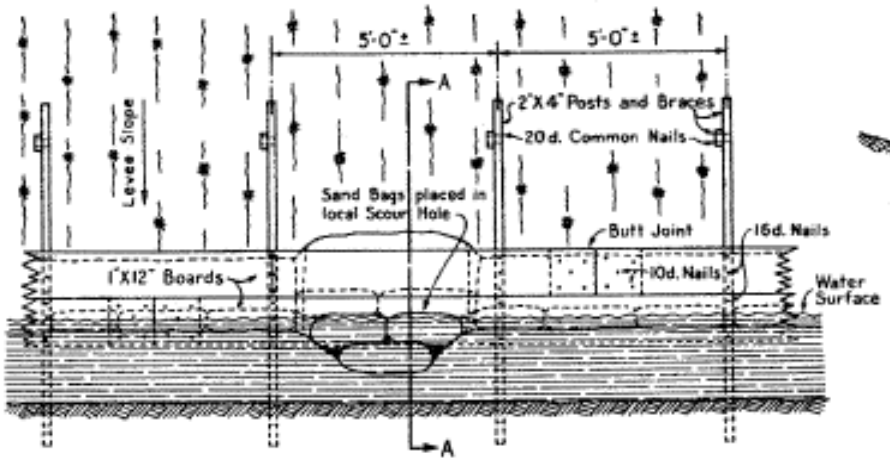


MATERIAL REQ. FOR 100' X 3'H

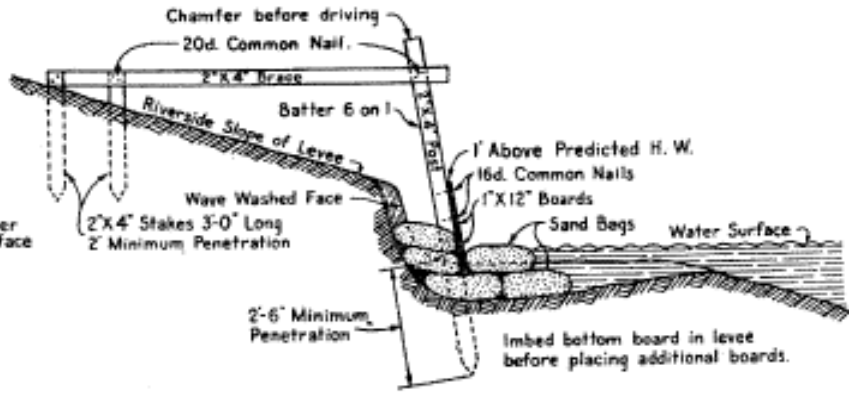
Posts - 17 pc's 2"x4"x12' Spaced 3' = 136 b.f.
or 13 pc's.4"x4"x12' Spaced 4' = 208 b.f.
Boards - 300 FBM 1"x12" x Any Length = 300 b.f.
3' Brace Stakes - 8 pc's 2"x4"x12' = 64 b.f.
300 Sq.Ft. Visqueen
5 lbs. 16d Common Nails
Braces - 1000 ft. (121 lbs.) 1/4" Strand

EMERGENCY FLOOD FIGHTING
BOARD & EARTH TOPPING MECHANICAL METHOD

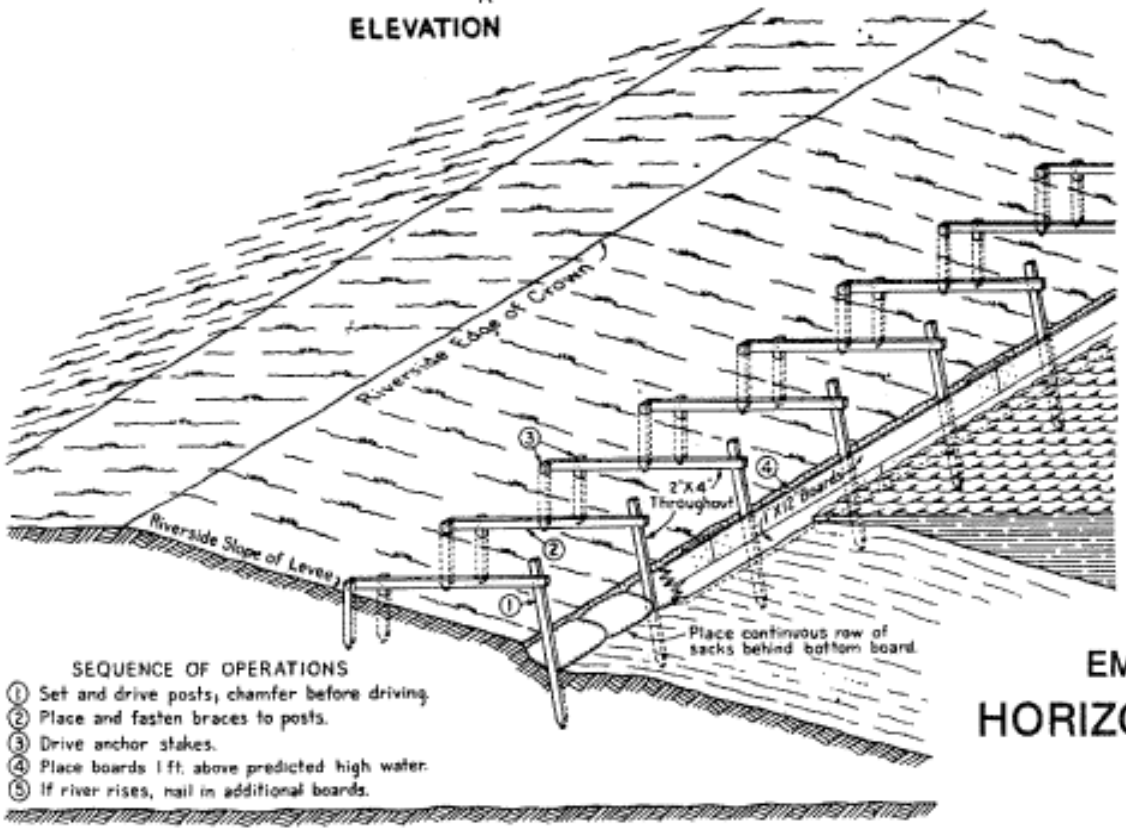
Figure 18



ELEVATION



SECTION A-A



SEQUENCE OF OPERATIONS

1. Set and drive posts, chamfer before driving.
2. Place and fasten braces to posts.
3. Drive anchor stakes.
4. Place boards 1 ft. above predicted high water.
5. If river rises, nail in additional boards.

BILL OF MATERIALS FOR 100 LINEAR FEET OF REVETMENT WITH BRACES ON 5'-0" CENTERS
(Using Posts 8 Feet Long) *

21 Posts	2"X 4"X 8'-0"	= 112 Bd. Ft.
21 Braces	2"X 4"X 9'-0"	= 126 Bd. Ft.
42 Anchors	2"X 4"X 3'-0"	= 84 Bd. Ft.
Horizontal Boards	1"X12"X 240 Lin. Ft.	= 240 Bd. Ft.
		Total 562 Bd. Ft.

3 Lbs. 10d. Common Nails
3 Lbs. 16d. Common Nails
5 Lbs. 20d. Common Nails

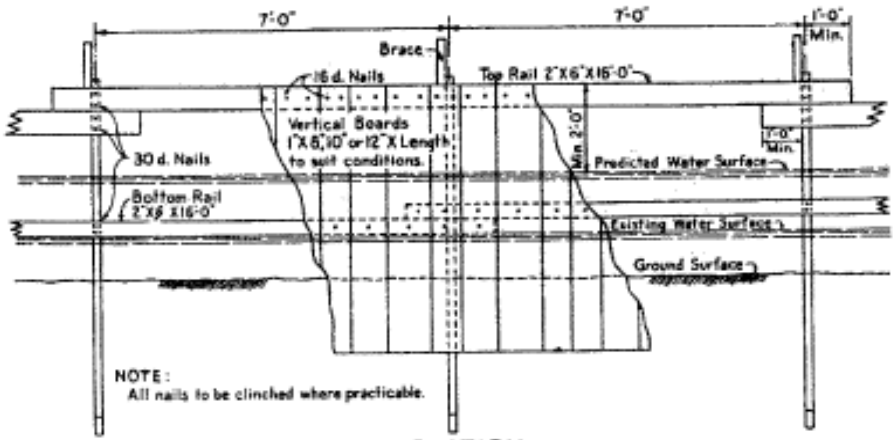
Actual quantities. No allowance made for waste.

NOTE:
Use this method only in localities subject to light attack. Use vertical board fence for all other cases.

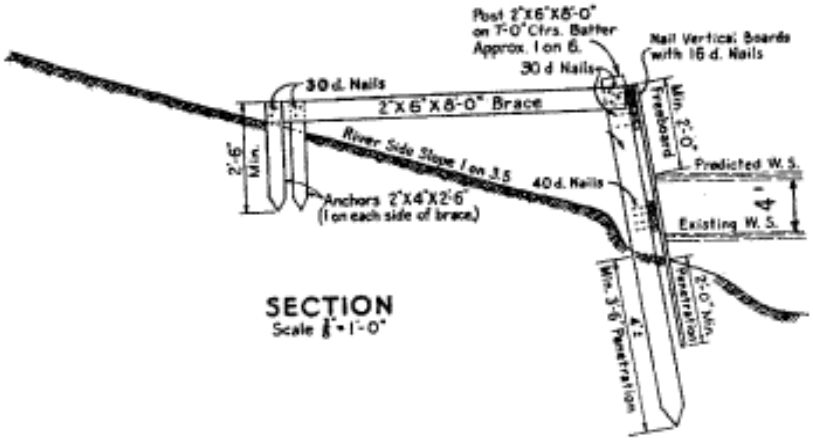
*Dimensions based on rough cut lumber

EMERGENCY FLOOD FIGHTING
HORIZONTAL BOARD REVETMENT

Figure 19



ELEVATION
Scale $\frac{1}{8}$"=1'-0"



SECTION
Scale $\frac{1}{8}$"=1'-0"

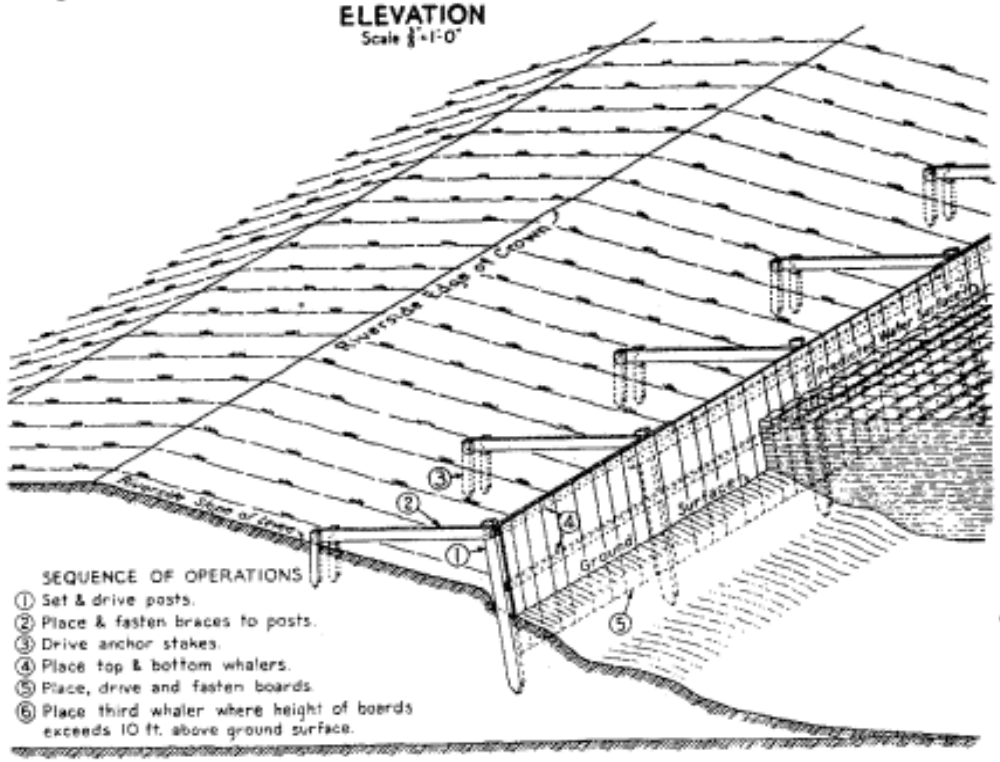
BILL OF MATERIALS FOR 100 LINEAR FEET OF REVETMENT WITH BRACES ON 7'-0" CENTERS
(Using Boards 6 Feet Long)

14.5	Posts	2"X6"X 8'-0"	= 116 Bd. Ft.
14.5	Braces	2"X6"X 8'-0"	= 116 Bd. Ft.
29	Anchors	2"X4"X 2'-6"	= 49 Bd. Ft.
7	Rails	2"X6"X 16'-0"	= 112 Bd. Ft.
7	Rails	2"X4"X 16'-0"	= 75 Bd. Ft.
Vertical Boards		1"X8",10"or 12"X 6'-0"	= 600 Bd. Ft.
			Total 1068 Bd. Ft. (Net)

6 Lbs. 30d. Common Nails
6 Lbs. 16d. Common Nails
Actual quantities. No allowance made for waste.

Dimensions based on rough cut lumber

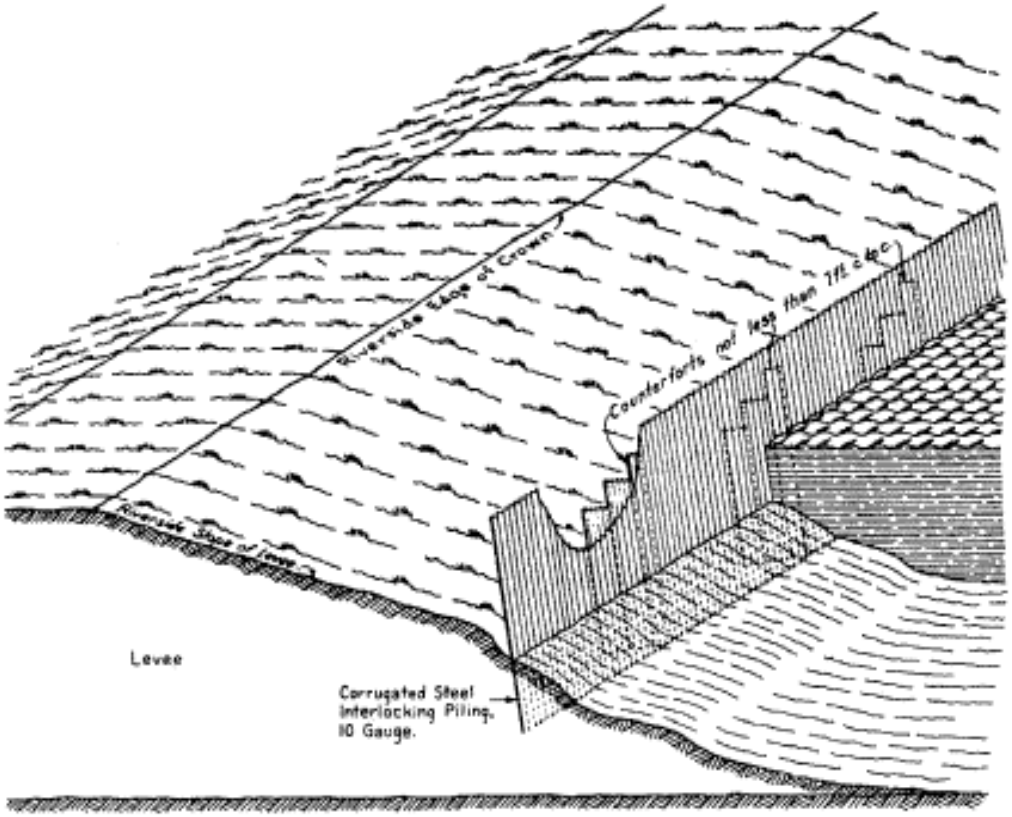
NOTE: When horizontal brace span is greater than 10' diagonal bracing and strongback is required. (Plate 7A)

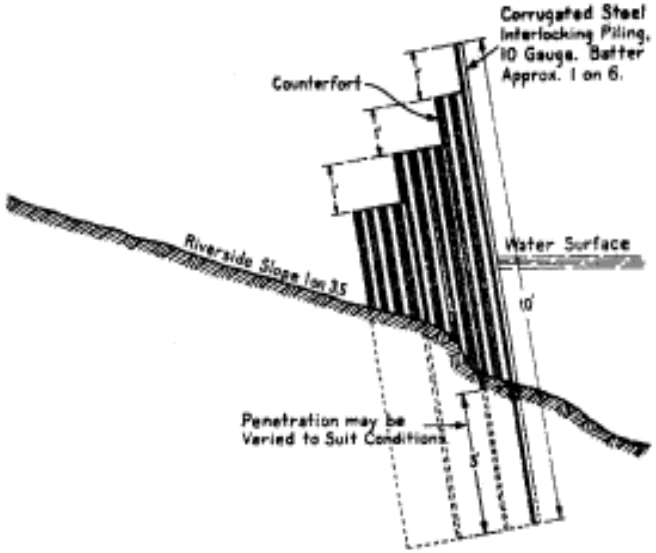


SEQUENCE OF OPERATIONS
① Set & drive posts.
② Place & fasten braces to posts.
③ Drive anchor stakes.
④ Place top & bottom whalers.
⑤ Place, drive and fasten boards.
⑥ Place third whaler where height of boards exceeds 10 ft. above ground surface.

EMERGENCY FLOOD FIGHTING
VERTICAL BOARD REVETMENT

Figure 20





SECTION

EMERGENCY FLOOD FIGHTING

STEEL PILING REVETMENT

Figure 21

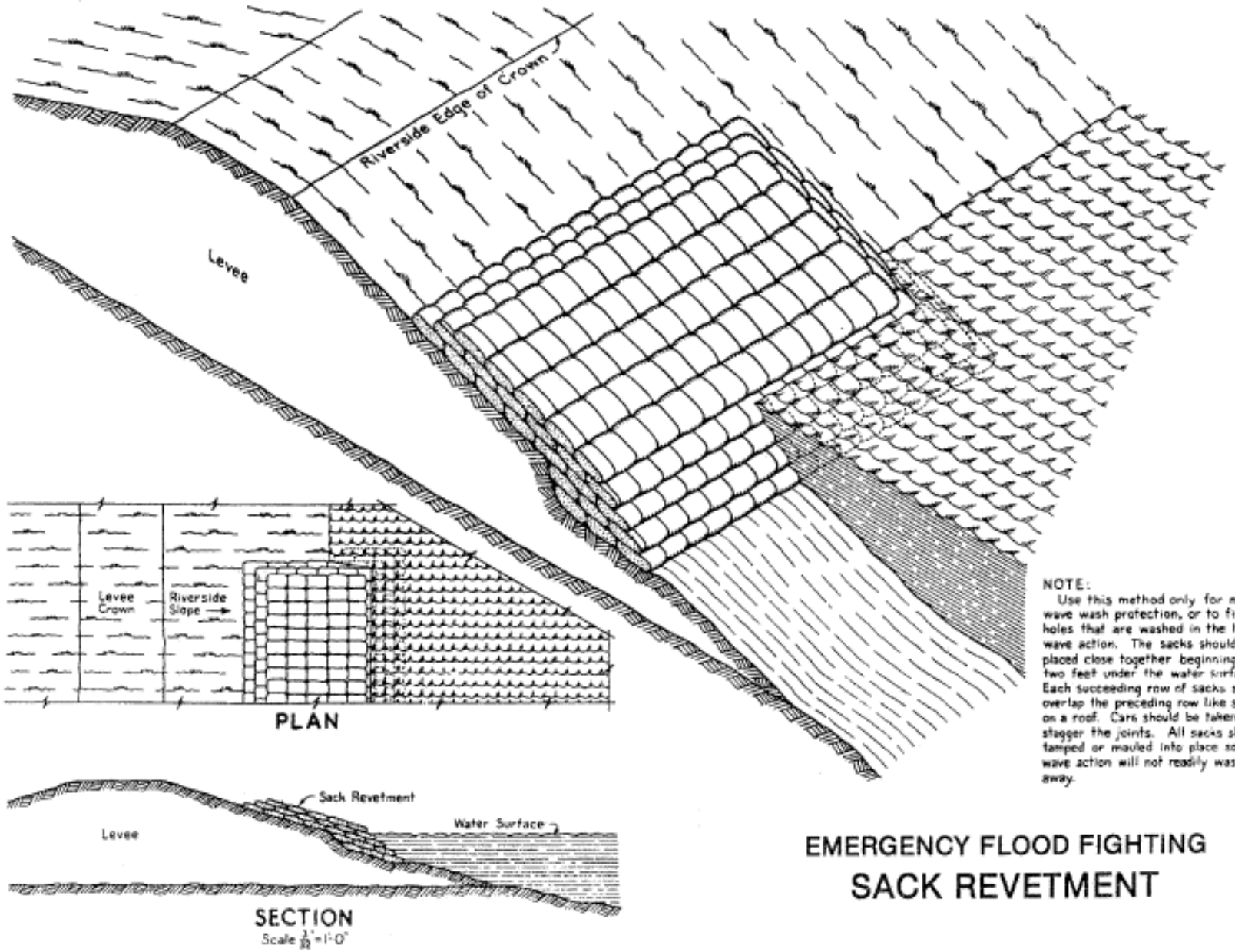
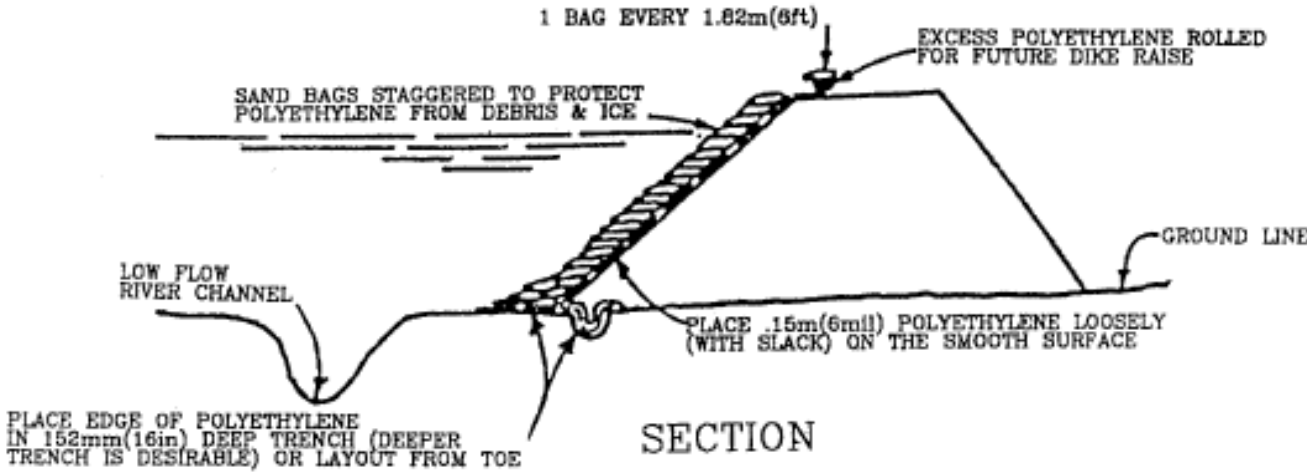
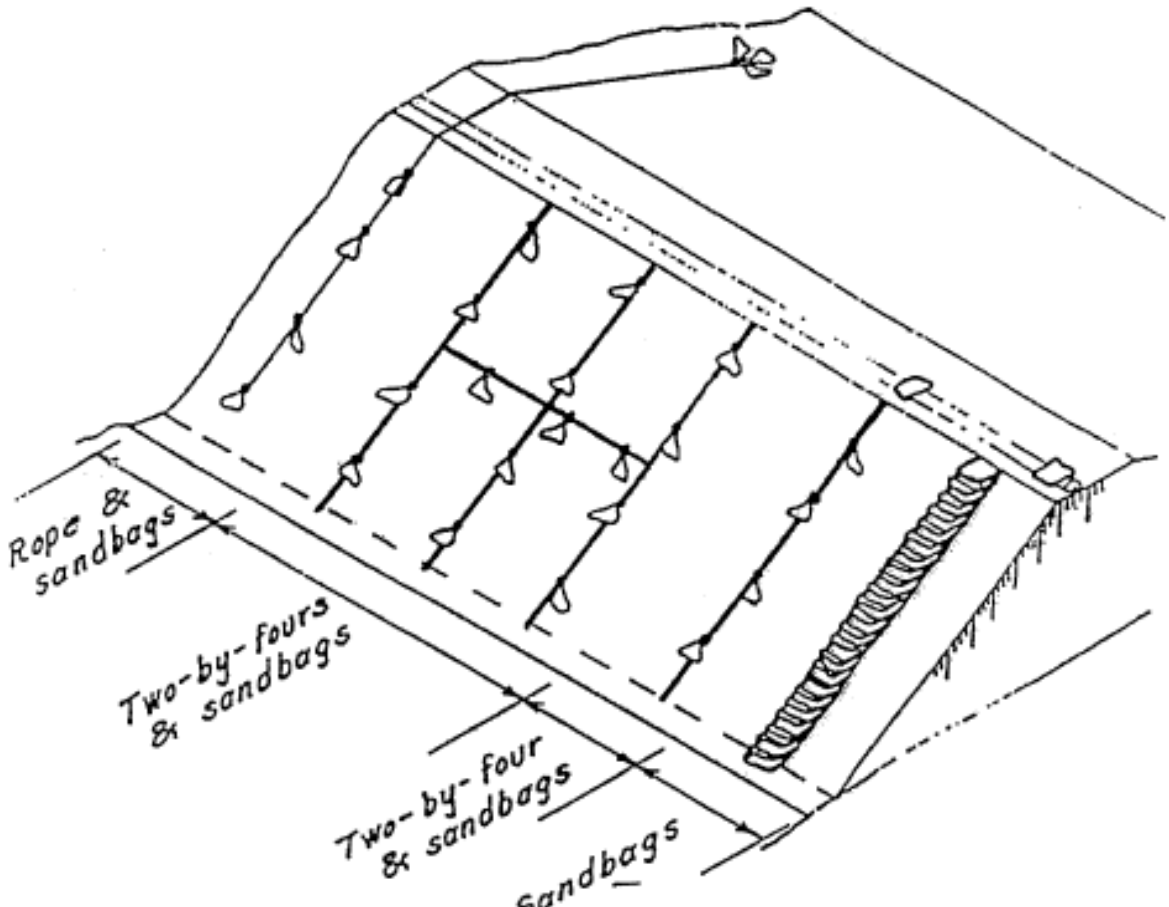

Riverside Edge of Crown
Levee
Levee Crown
Riverside Slope
PLAN
Sack Revetment
Water Surface
Levee
SECTION
Scale 1/10" = 1'-0"
NOTE:
Use this method only for minor wave wash protection, or to fill local holes that are washed in the levee by wave action. The sacks should be placed close together beginning about two feet under the water surface. Each succeeding row of sacks should overlap the preceding row like shingles on a roof. Cars should be taken to stagger the joints. All sacks should be tamped or mauled into place so that wave action will not readily wash them away.
EMERGENCY FLOOD FIGHTING
SACK REVETMENT

Figure 22





METHODS OF ANCHORING POLYETHYLENE

.15mm(6mil) BLACK POLYETHYLENE IS THE MOST DESIRABLE, .15mm(6mil) CLEAR SECOND, .10mm(4mil) BLACK THIRD, .10mm(4mil) CLEAR FOURTH & .05mm(2mil) POLYETHYLENE SHOULD ONLY BE USED AS A LAST RESORT.

Figure 23

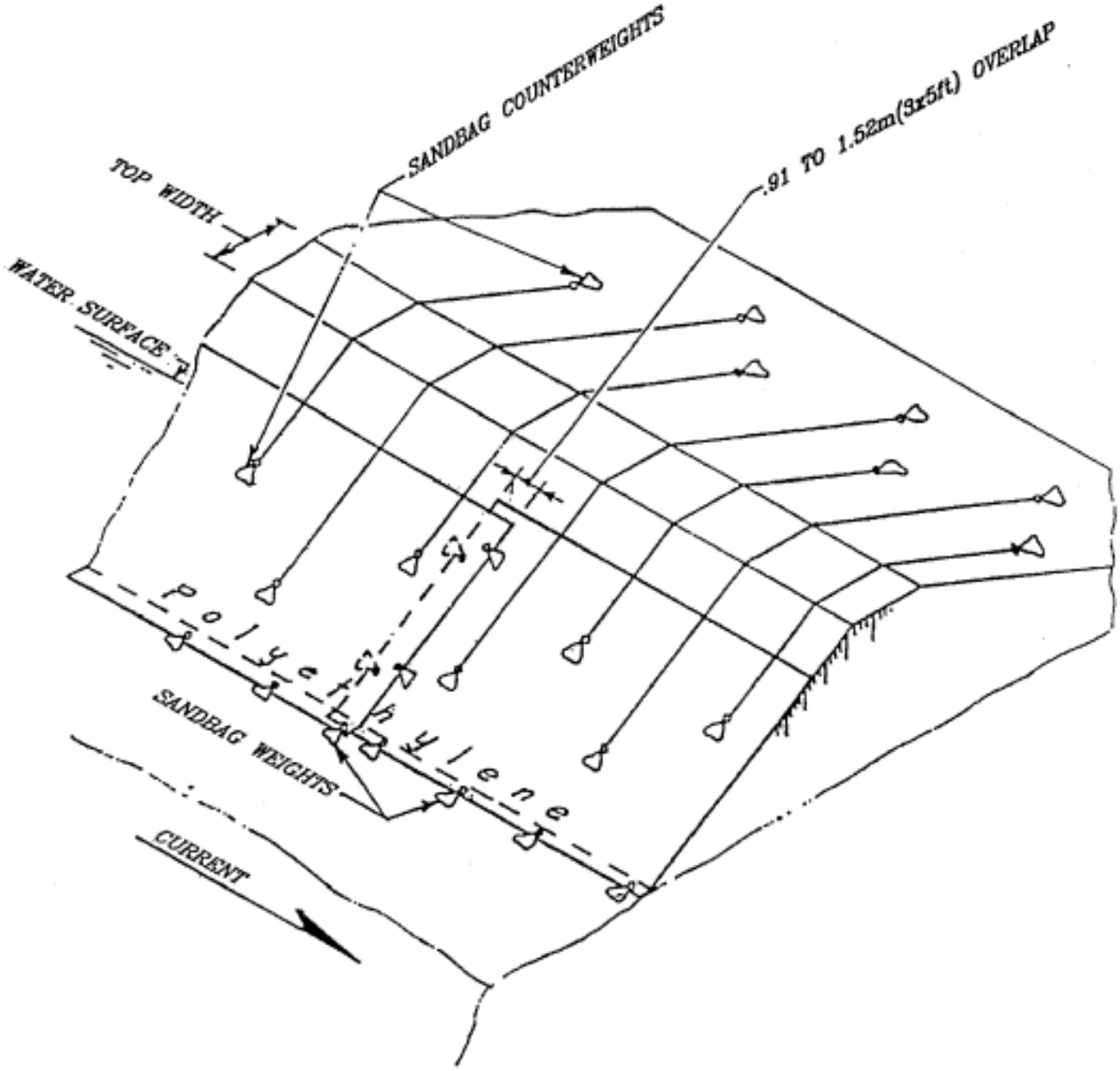
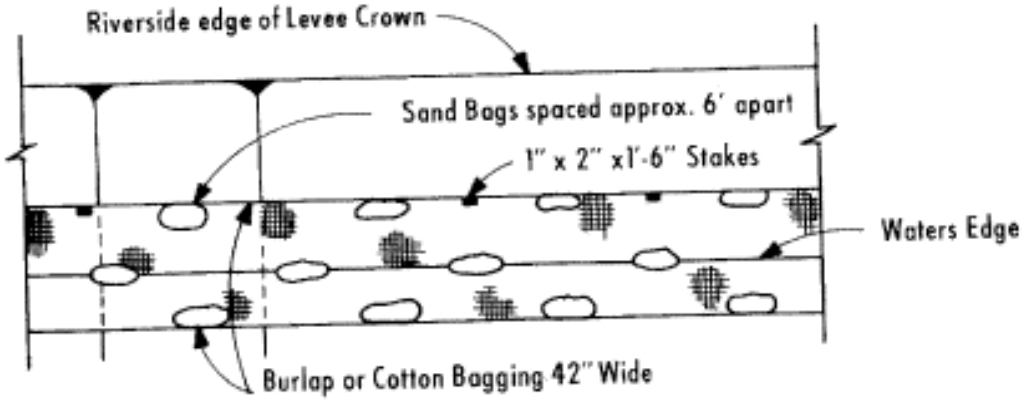
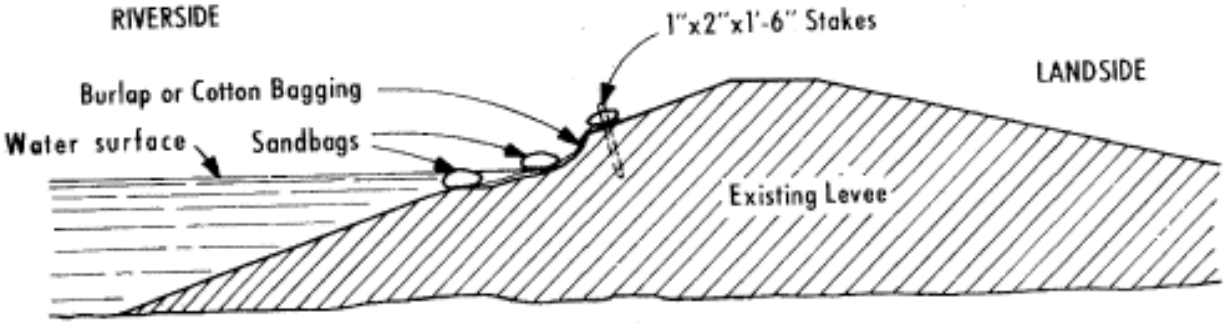

SANDBAG COUNTERWEIGHTS
.91 TO 1.52m(3x5ft) OVERLAP
TOP WIDTH
WATER SURFACE
SANDBAG WEIGHTS
CURRENT

Figure 24



PLAN



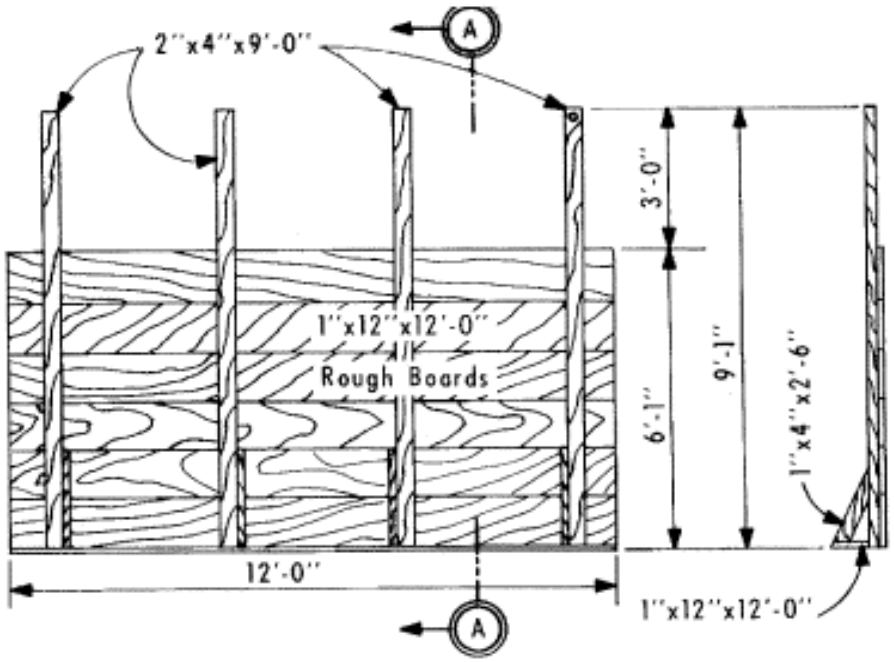
SECTION

NOTE:
Lay 42"wide burlap or cotton bagging longitudinally along levee slope and across damaged area. Weight with filled sandbags as shown. Drive stakes alternately between sandbags located along upper edge of bagging. If regular 42" width bagging is not sufficient in width to provide adequate protection, two or more widths may be laced together and laid as desired.

BILL OF MATERIAL FOR 100FT.
LUMBER 20 Stakes 1"x2"x1'-6"
BAGGING 100 Ft. 42" Wide 60 Filled Sandbags

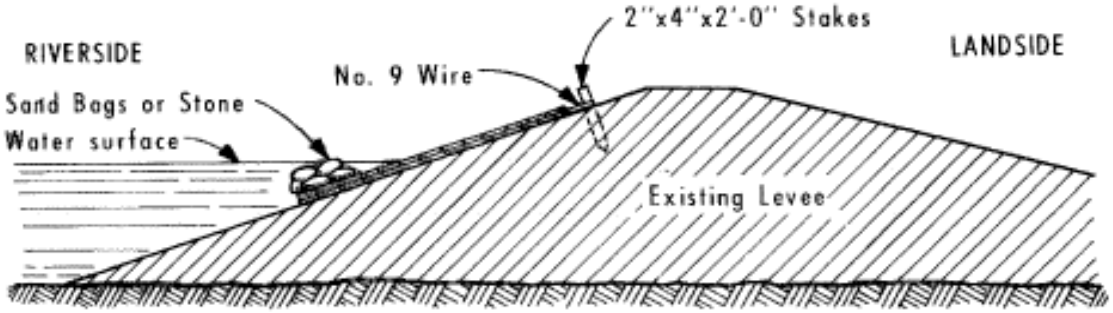
CONSTRUCTION METHODS
FOR
HIGH WATER
WAVE WASH PROTECTION
BURLAP AND SANDBAG

Figure 25



PLAN

SECTION A-A



SECTION

BILL OF MATERIAL FOR 100 FT.
LUMBER 55 Pieces 1"x12"x12'-0" 32 Pieces 1"x4"x2'-6" 32 Pieces 2"x4"x9'-0" 32 Pieces 2"x4"x2'-0"
WIRE 100 Ft. No. 9
NAILS 6lbs. 8d Common

CONSTRUCTION METHODS FOR HIGH WATER WAVE WASH PROTECTION MOVABLE

Figure 26

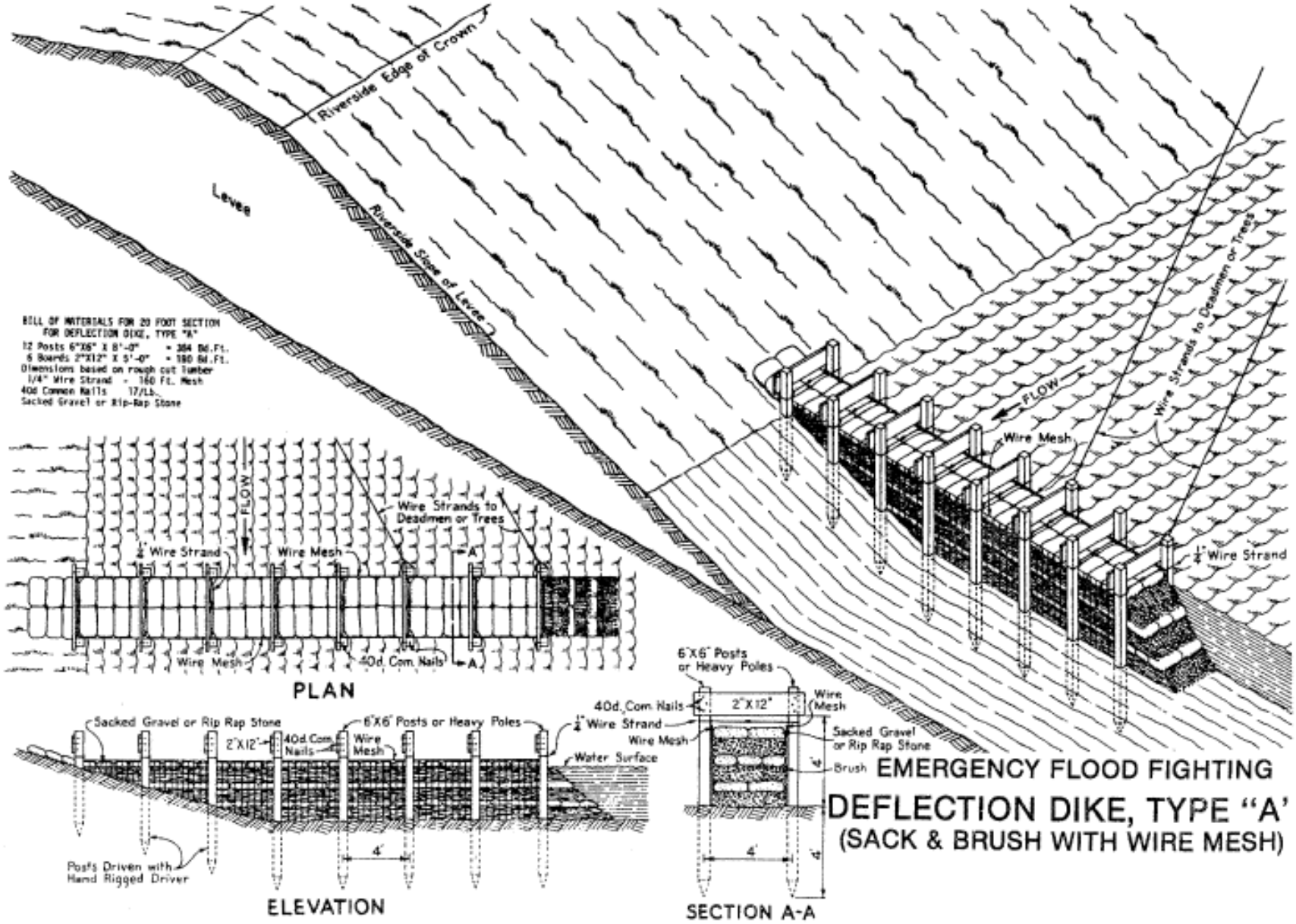

Riverside Edge of Crown
Levee
Riverside Slope of Levee
BILL OF MATERIALS FOR 20 FOOT SECTION FOR DEFLECTION DIKE, TYPE "A"
12 Posts 6"X6" X 8'-0" = 384 Bd.Ft.
6 Boards 2"X12" X 5'-0" = 180 Bd.Ft.
Dimensions based on rough cut lumber
1/4" Wire Strand - 160 Ft. Mesh
40d Common Nails 17/Lb.
Sacked Gravel or Rip-Rap Stone
FLOW
Wire Strands to Deadmen or Trees
1/4" Wire Strand
Wire Mesh
A
Wire Mesh
40d. Com. Nails
A
PLAN
Sacked Gravel or Rip Rap Stone
2"X12"
40d. Com. Nails
Wire Mesh
6"X6" Posts or Heavy Poles
1/4" Wire Strand
Water Surface
4'
Posts Driven with Hand Rigged Driver
ELEVATION
6"X6" Posts or Heavy Poles
40d. Com. Nails
2"X12"
Wire Mesh
1/4" Wire Strand
Wire Mesh
Sacked Gravel or Rip Rap Stone
Brush
4'
SECTION A-A
EMERGENCY FLOOD FIGHTING
DEFLECTION DIKE, TYPE "A'
(SACK & BRUSH WITH WIRE MESH)

Figure 27

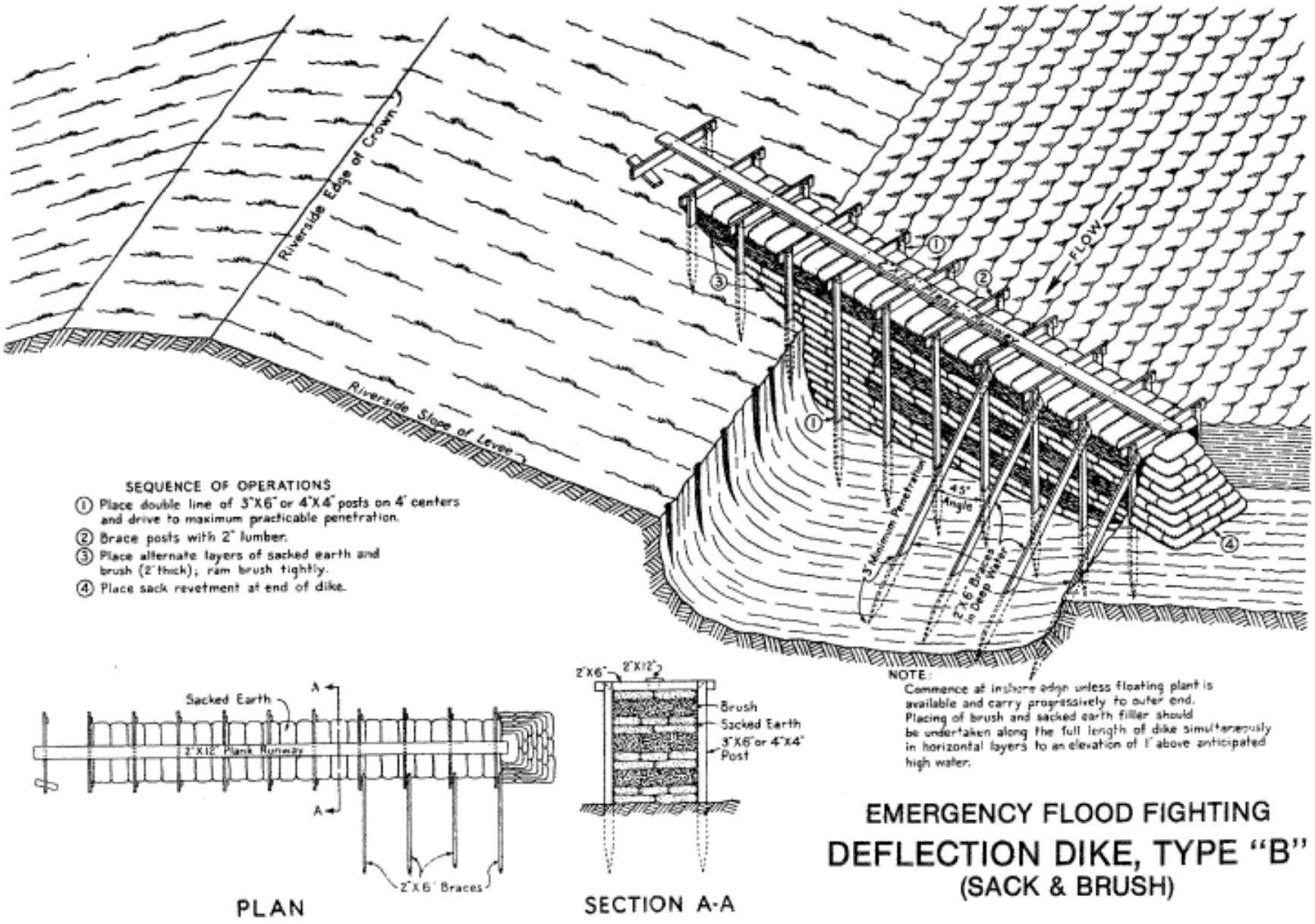
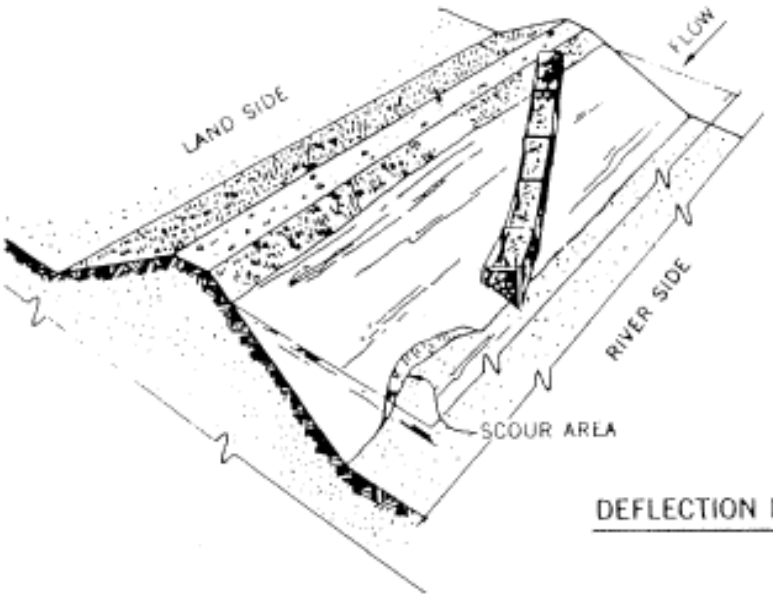
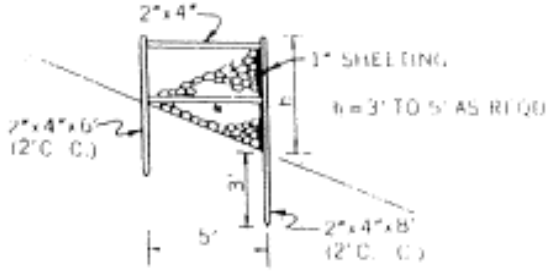

Riverside Edge of Crown
Riverside Slope of Levee
FLOW
SEQUENCE OF OPERATIONS
① Place double line of 3"X6" or 4"X4" posts on 4' centers and drive to maximum practicable penetration.
② Brace posts with 2" lumber.
③ Place alternate layers of sacked earth and brush (2' thick); ram brush tightly.
④ Place sack revetment at end of dike.
3' Minimum Penetration
45° Angle
2"X6" Braces in Deep Water
NOTE:
Commence at inshore edge unless floating plant is available and carry progressively to outer end. Placing of brush and sacked earth filler should be undertaken along the full length of dike simultaneously in horizontal layers to an elevation of 1' above anticipated high water.
Sacked Earth
2"X12" Plank Runway
A
2"X6" Braces
PLAN
2"X6"
2"X12"
Brush
Sacked Earth
3"X6" or 4"X4" Post
SECTION A-A
EMERGENCY FLOOD FIGHTING
DEFLECTION DIKE, TYPE "B"
(SACK & BRUSH)

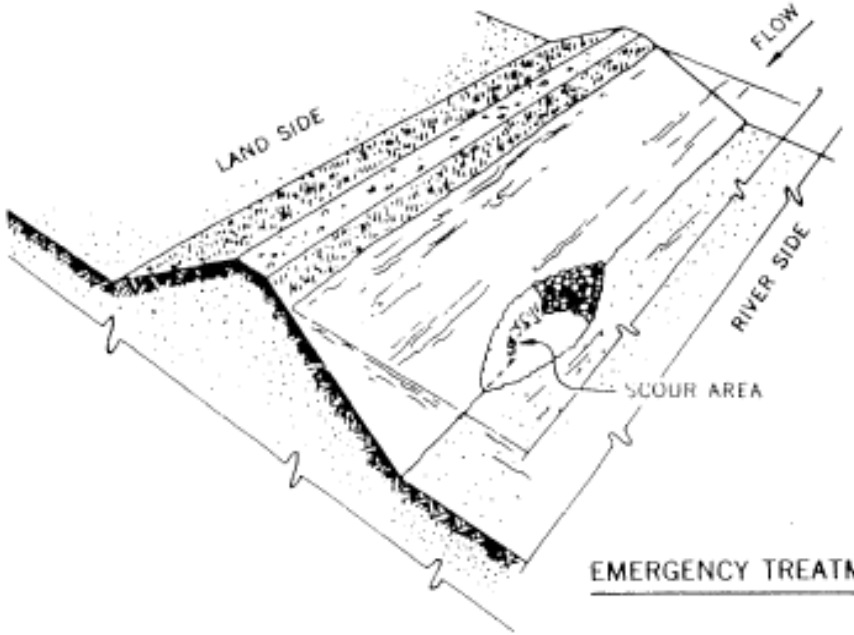
Figure 28



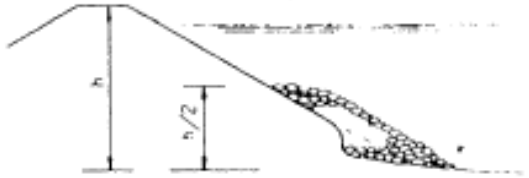
DEFLECTION DIKES



* BACK WITH SANDBAGS, ROCK OR EARTH AS REQUIRED, OR FILL COMPLETELY BY SHEETING THE LANDSIDE BRACING.



EMERGENCY TREATMENT



* BEGIN BERM AS FAR RIVERWARD AS IS PRACTICAL.

NOTE.
BERM MAY BE CONSTRUCTED OF SAND BAGS, ROCK, SLAG OR OTHER AVAILABLE, DURABLE MATERIAL.

EMERGENCY DEFLECTION DIKES
CORPS OF ENGINEERS
KANSAS CITY DISTRICT
FILE NO. K-1-533
REVISED JULY 1971

Figure 29

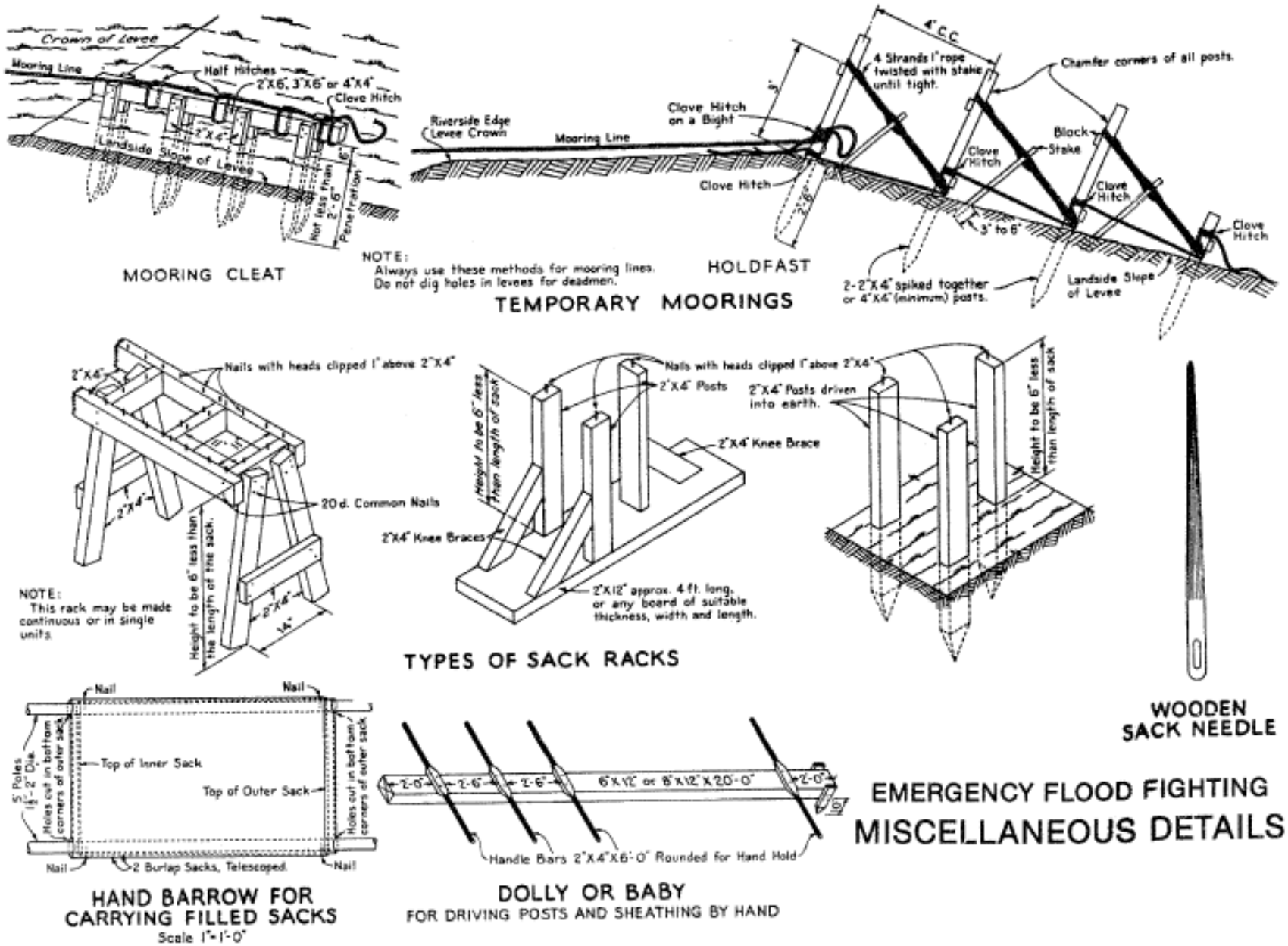
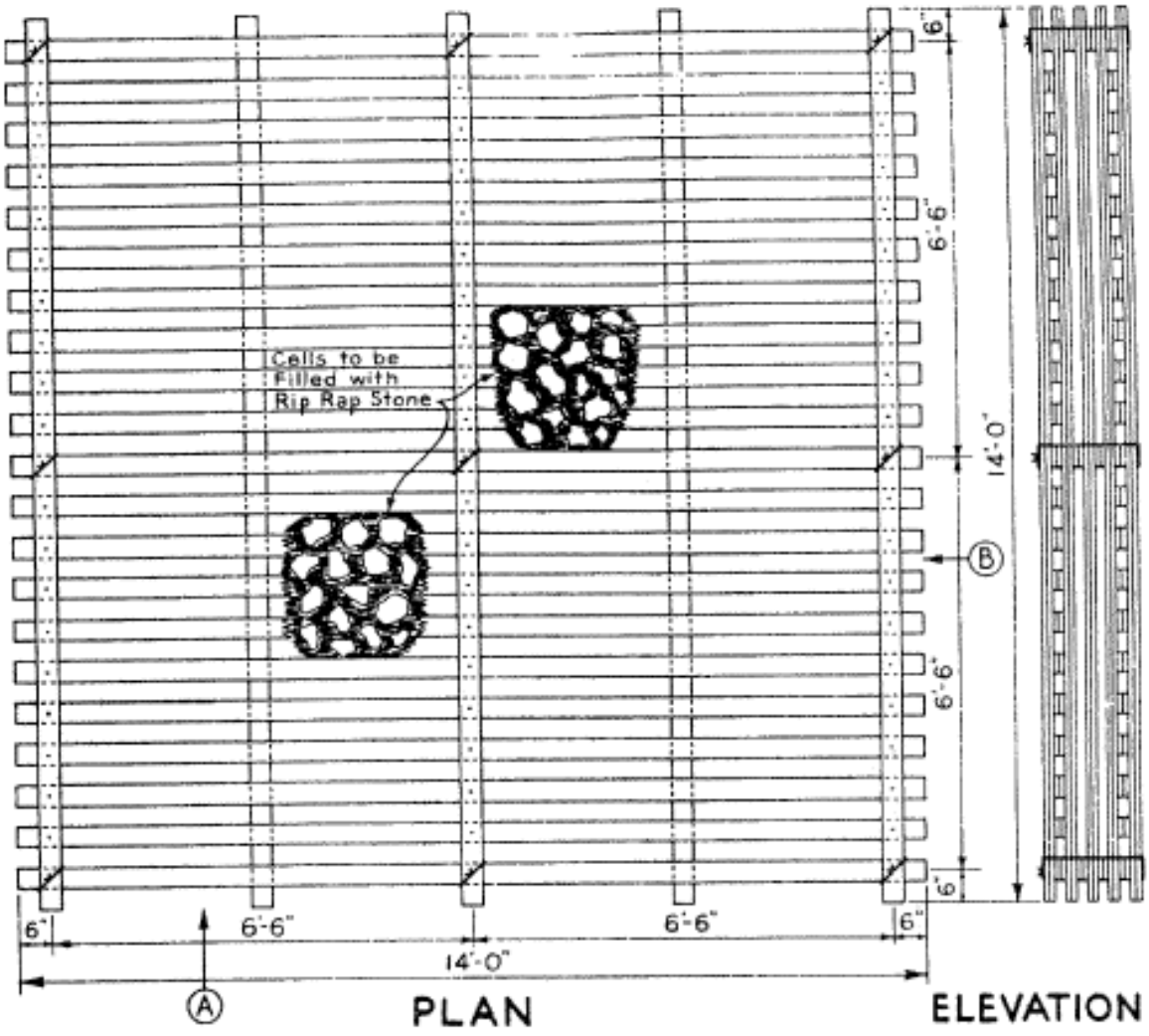
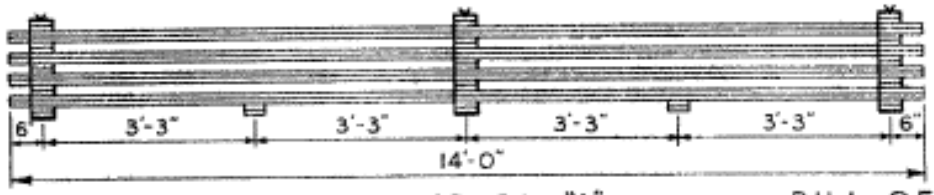

Crown of Levee
Mooring Line
Half Hitches
2"X6", 3"X6" or 4"X4"
Clove Hitch
2"X4"
Landside Slope of Levee
Not less than 2'-6" Penetration
MOORING CLEAT
NOTE:
Always use these methods for mooring lines.
Do not dig holes in levees for deadmen.
Riverside Edge Levee Crown
Mooring Line
Clove Hitch on a Bight
4'C.C.
4 Strands 1" rope twisted with stake until tight.
Chamfer corners of all posts.
Block
Stake
Clove Hitch
Clove Hitch
Clove Hitch
Clove Hitch
3' to 6'
2'-6"
2-2"X4" spiked together or 4"X4" (minimum) posts.
Landside Slope of Levee
HOLDFAST
TEMPORARY MOORINGS
2"X4"
Nails with heads clipped 1" above 2"X4"
20d. Common Nails
2"X4"
Height to be 6" less than the length of the sack.
2"X6"
14"
NOTE:
This rack may be made continuous or in single units.
Nails with heads clipped 1" above 2"X4"
2"X4" Posts
Height to be 6" less than length of sack
2"X4" Knee Braces
2"X12" approx. 4 ft. long, or any board of suitable thickness, width and length.
2"X4" Posts driven into earth.
2"X4" Knee Brace
Height to be 6" less than length of sack
TYPES OF SACK RACKS
WOODEN SACK NEEDLE
Nail
Nail
5' Poles 1½"-2" Dia.
Holes cut in bottom corners of outer sack
Top of Inner Sack
Top of Outer Sack
Holes cut in bottom corners of outer sack
Nail
Nail
2 Burlap Sacks, Telescoped.
HAND BARROW FOR CARRYING FILLED SACKS
Scale 1"=1'-0"
2'-0"
2'-6"
2'-6"
6"X12" or 8"X12"X20'-0"
2'-0"
Handle Bars 2"X4"X6'-0" Rounded for Hand Hold
DOLLY OR BABY
FOR DRIVING POSTS AND SHEATHING BY HAND
EMERGENCY FLOOD FIGHTING
MISCELLANEOUS DETAILS

Figure 30





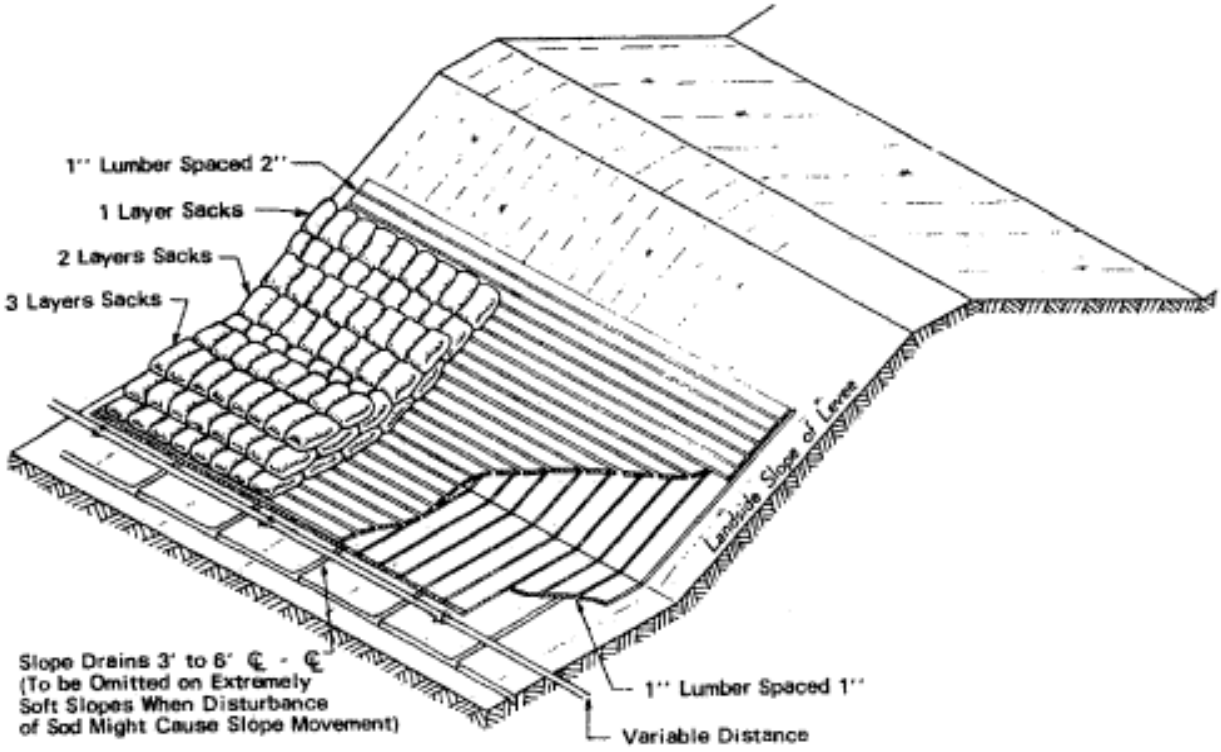
ELEVATION "A"

BILL OF MATERIALS
Dimensions based on
rough cut lumber
140 Pcs. 1"X4"X14" = 653 Bd. Ft.
12 Lbs. 20d. Common Nails
60 Ft. $\frac{1}{4}$" Strand
1$\frac{1}{2}$ Cu. Yds. Rip Rap Stone
Actual quantities. No allowance for waste.

NOTE:
Cribs constructed of double thicknesses of 1"X4"X14' lumber. Nail all intersections with 1-20d. nail. Each intersection of walls securely fastened by a loop of $\frac{1}{4}$" strand, tightly twisted. If rock or concrete blocks are unobtainable, sacks filled with gravel or soil cement may be used.

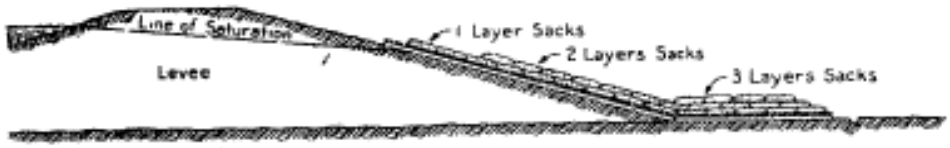
EMERGENCY FLOOD FIGHTING
STONE CRIB
CAVING BANK PROTECTION

Figure 31



PLAN

Material Required for 100 Sq. Ft.
180 F.B.M. 1" x 6" or 1" x 8" Lumber
1 Lb. 8d Common Nails
Dimensions based on rough cut lumber



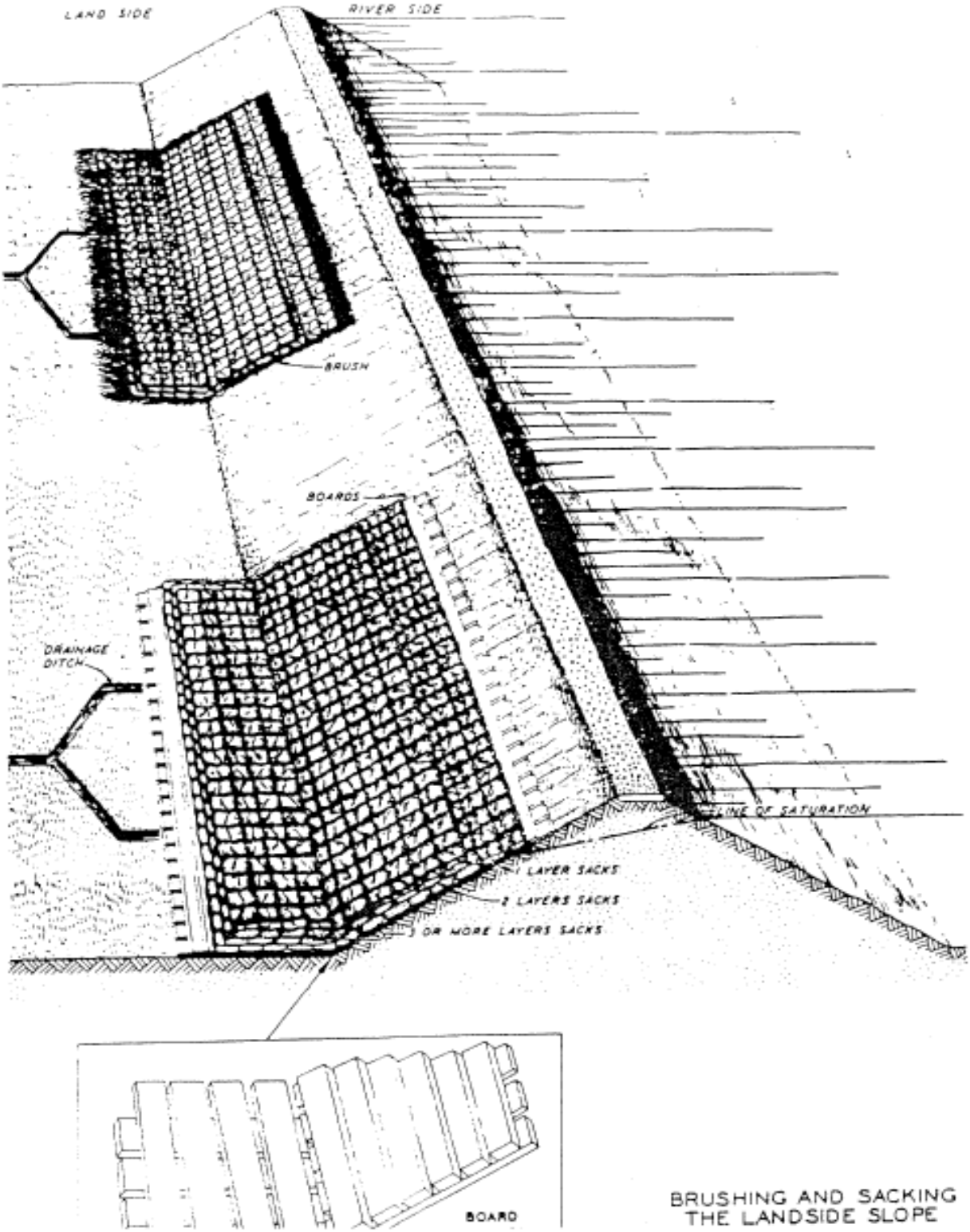
SECTION

EMERGENCY FLOOD FIGHTING

BOARD MATTRESS-STANDARD TYPE

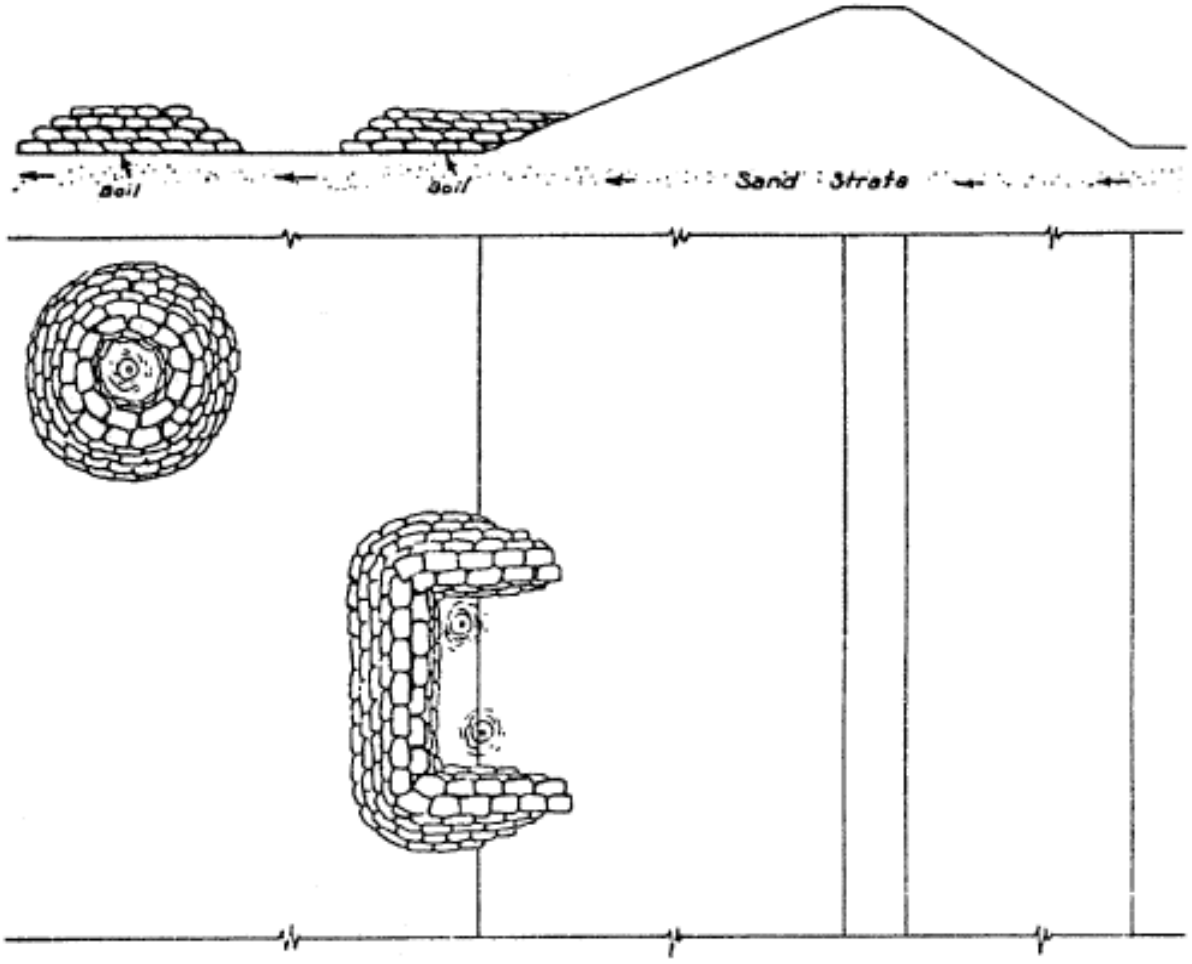
(FOR TREATMENT OF LEVEE SLOUGHS)

Figure 32



BRUSHING AND SACKING THE LANDSIDE SLOPE

Figure 33



Notes:

Do not stop flow of clear water.

Build ring to height only suficient to stop discharge of material.

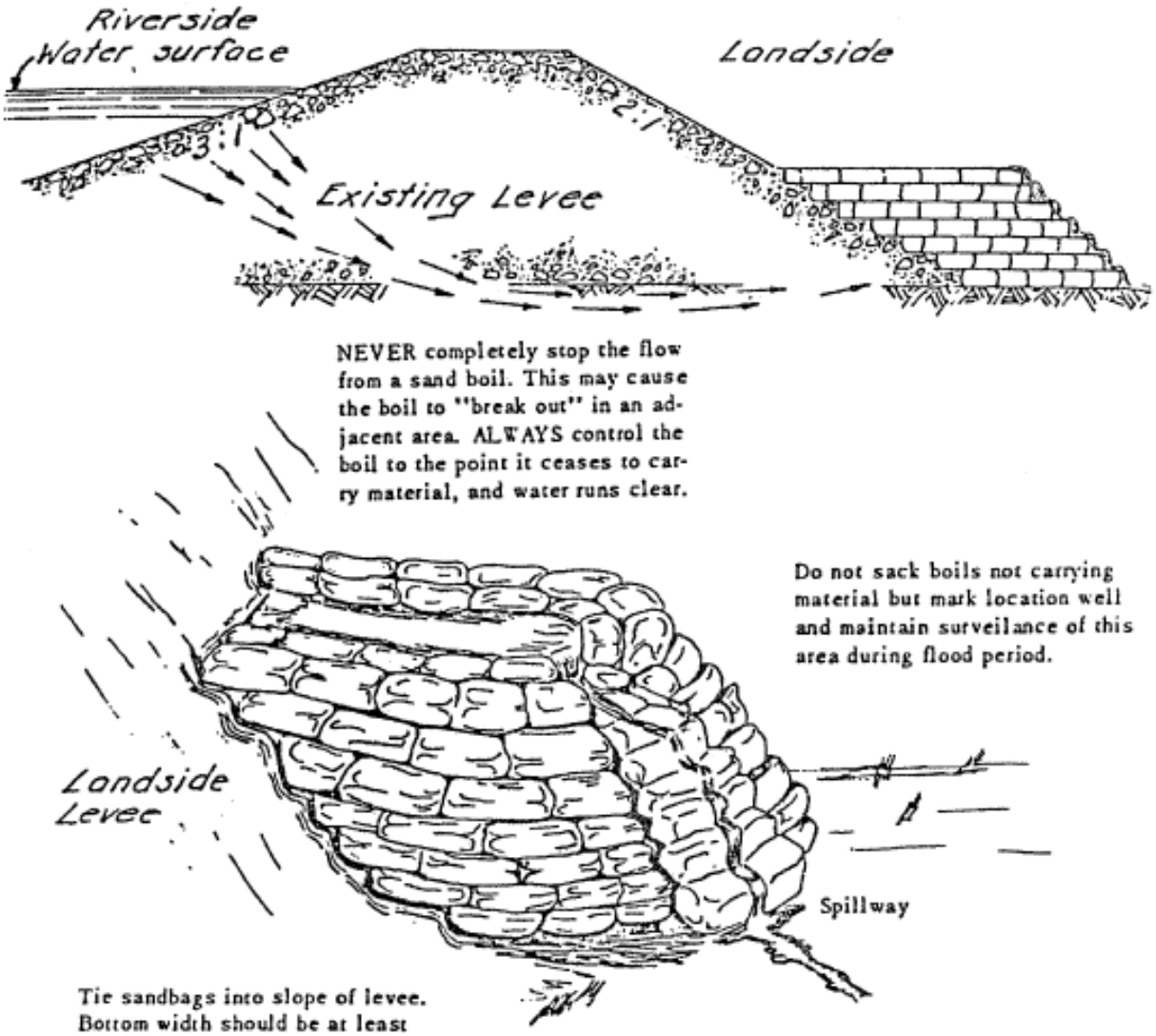
Leave a low place in top of ring for a spillway – on side nearest to natural drainage.

Leave sufficient room around boil to allow for caving and to get sacks on solid material to prevent seepage.

EMERGENCY FLOOD FIGHTING

METHODS OF SACKING SAND BOILS

Figure 34



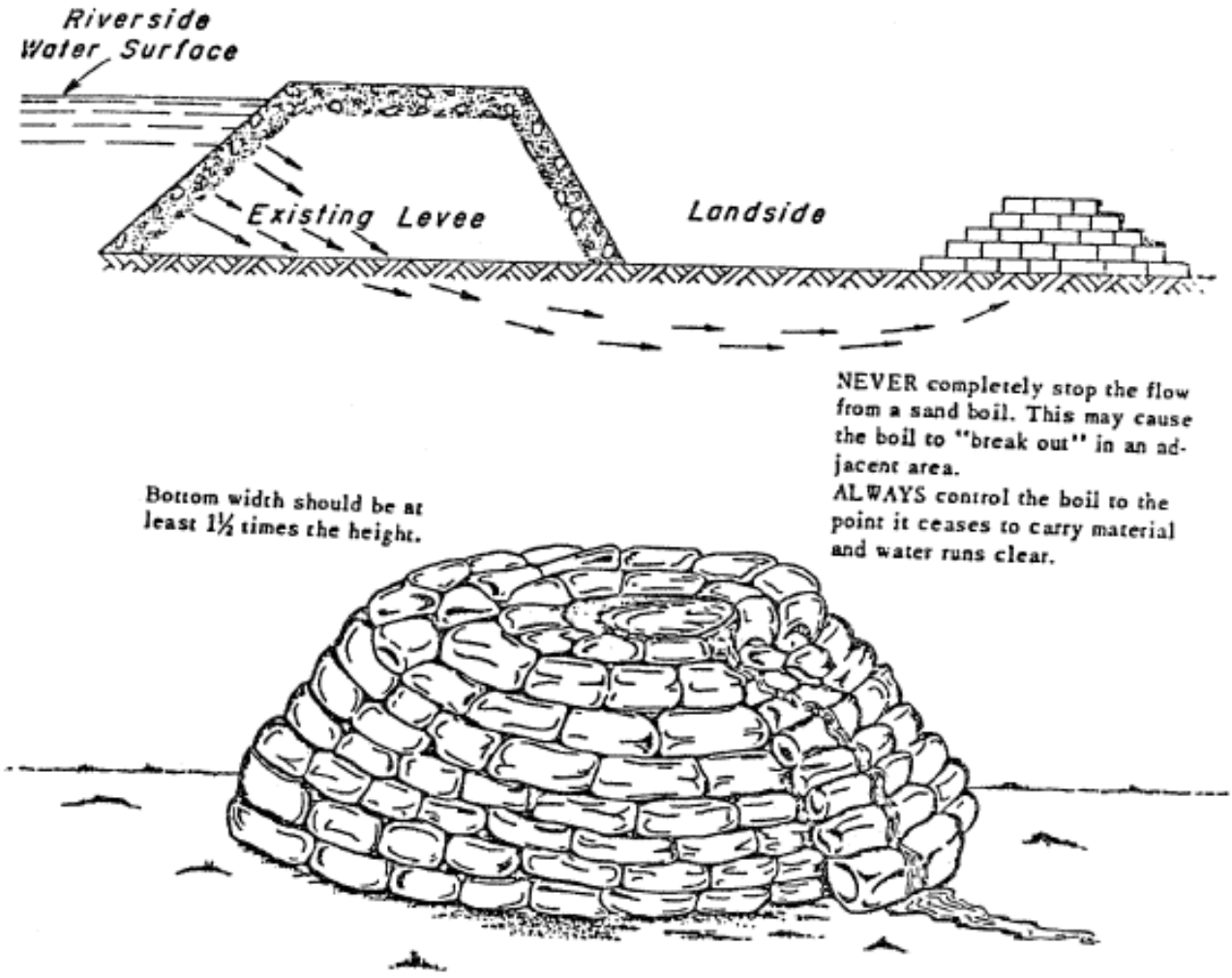
EMERGENCY FLOOD FIGHTING

CONTROL OF SAND BOILS

(NEAR LEVEE)

TRICT, OMAHA

Figure 35



EMERGENCY FLOOD FIGHTING

CONTROL OF SAND BOILS

(AWAY FROM LEVEE)

Figure 36

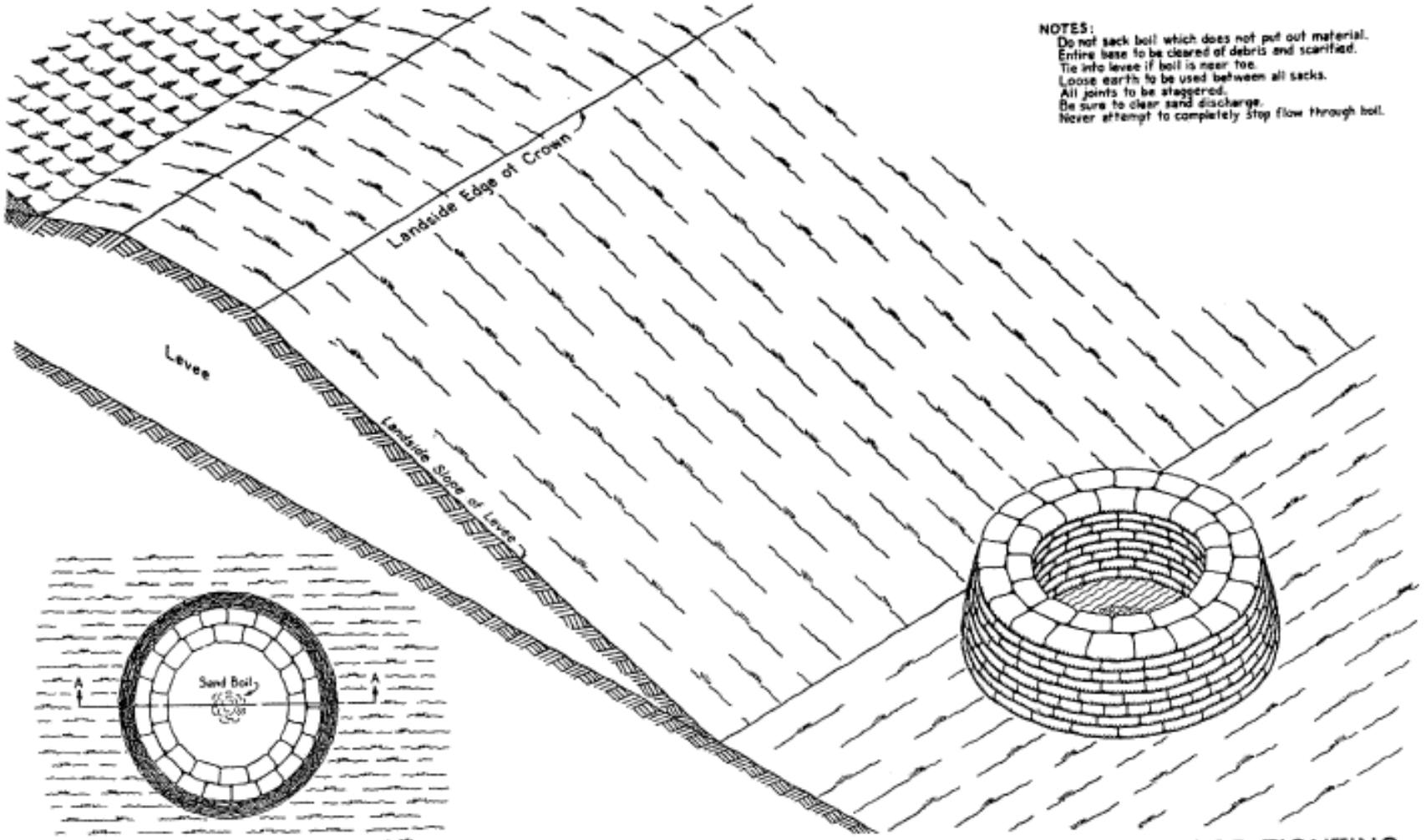
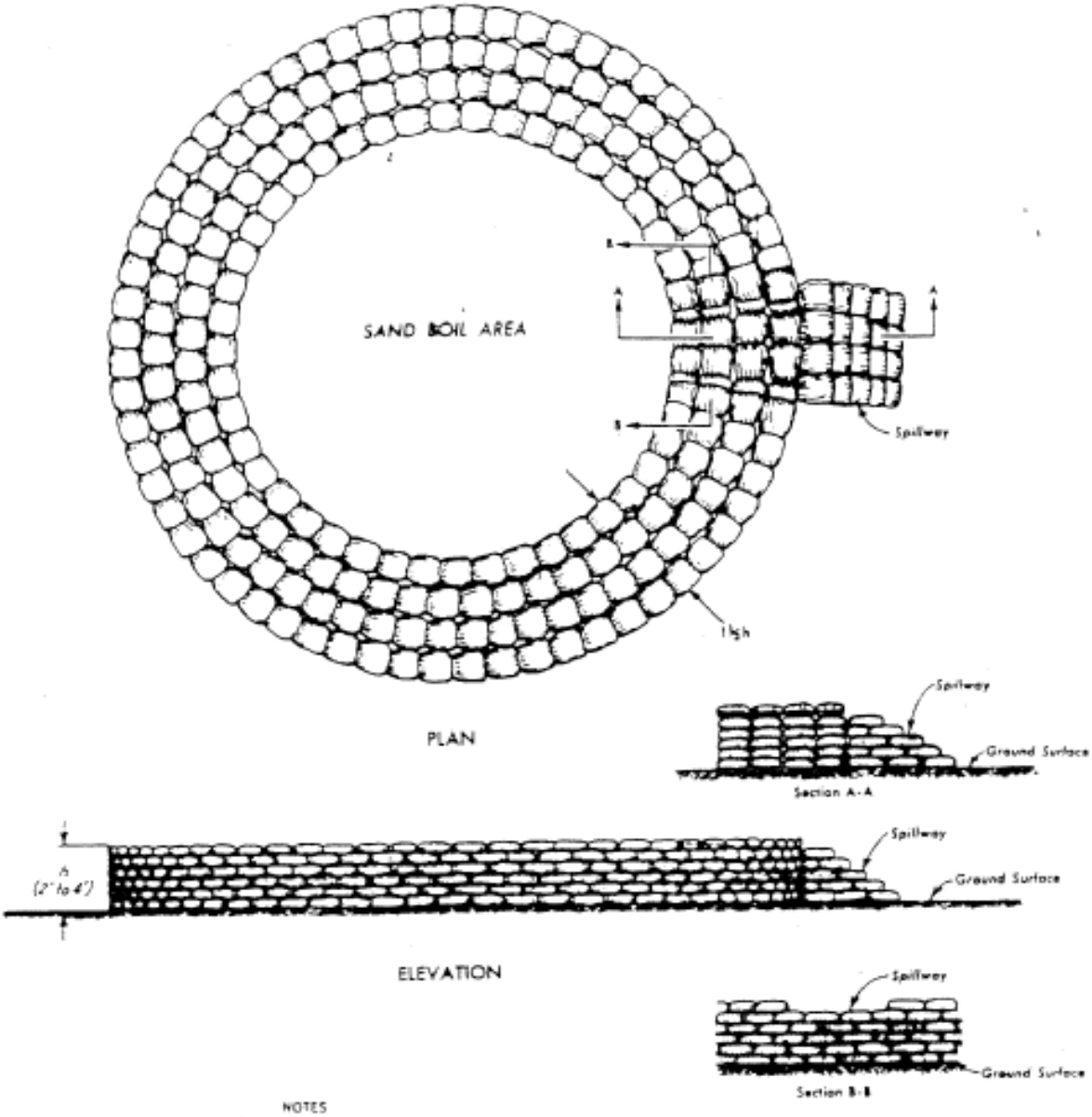

NOTES:
Do not sack boil which does not put out material.
Entire base to be cleared of debris and scarified.
Tie into levee if boil is near toe.
Loose earth to be used between all sacks.
All joints to be staggered.
Be sure to clear sand discharge.
Never attempt to completely stop flow through boil.
Landside Edge of Crown
Levee
Landside Slope of Levee
Sand Boil
A
A
PLAN
Height should be only sufficient to create enough head to slow down flow through boil so that no more material is displaced and boil runs clear
SECTION A-A
EMERGENCY FLOOD FIGHTING
RINGING SAND BOILS
WITH SACKED EARTH

Figure 37



NOTES

This method is to be used for ringing sand boils behind levees.

The sand bag ring should be on a firm foundation, clear of sand discharge. The ring should be constructed to a height sufficient to create a head which will bring the displacement of material to a stop. No attempt should be made to fully stop the clear water discharge.

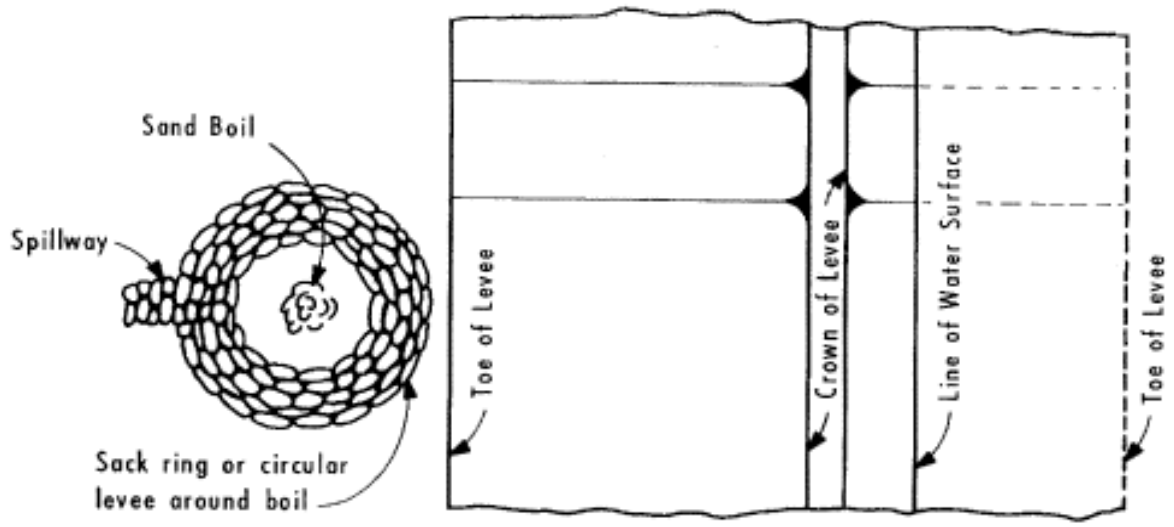
In general, boils which discharge clear water will not have to be ringed. However, if the flow is large and there is reason to believe material could be displaced, a clear water boil should be ringed.

The width of the base of the ring should be at least 1½ times the maximum height (h) of the ring.

Bags should be approximately ½ full of sand. They should be placed in the levee with ½ overlap and be well mauled into place. If sand is unavailable, clay may be used, however, clay filled bags are not as reliable as sand filled and will require close observation.

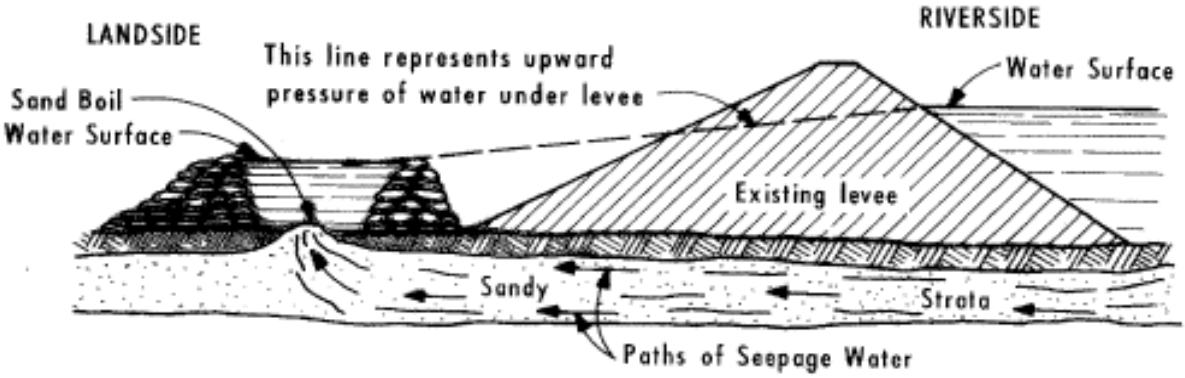
SAND BAG RING
CONSTRUCTION DETAILS

Figure 38



Tie into levee if boil is near toe

PLAN OF LEVEE

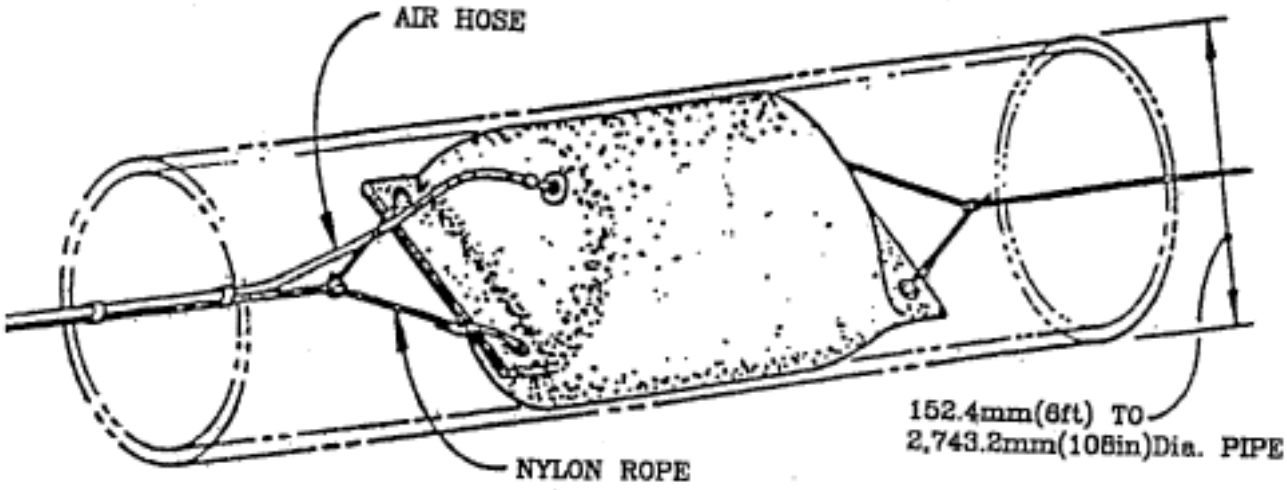


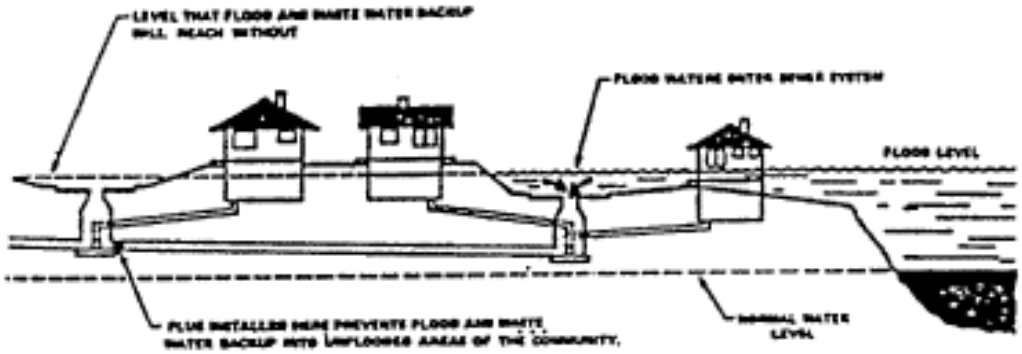
SECTION OF LEVEE

NOTE:
Do not sack boil which runs clear. Height of sack hoop or ring should be only sufficient to create enough pressure to slow down flow through boil so that no more material is displaced. Do not try to stop all flow thru boil. Sand bags should be filled only two-thirds full.

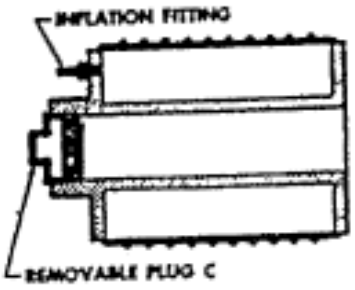
CONSTRUCTION METHODS
FOR
HIGH WATER
SAND BOIL

Figure 39





MUNI-BALL plug



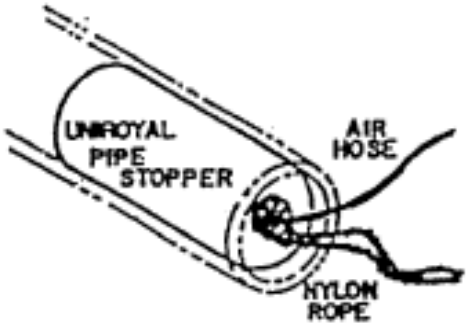
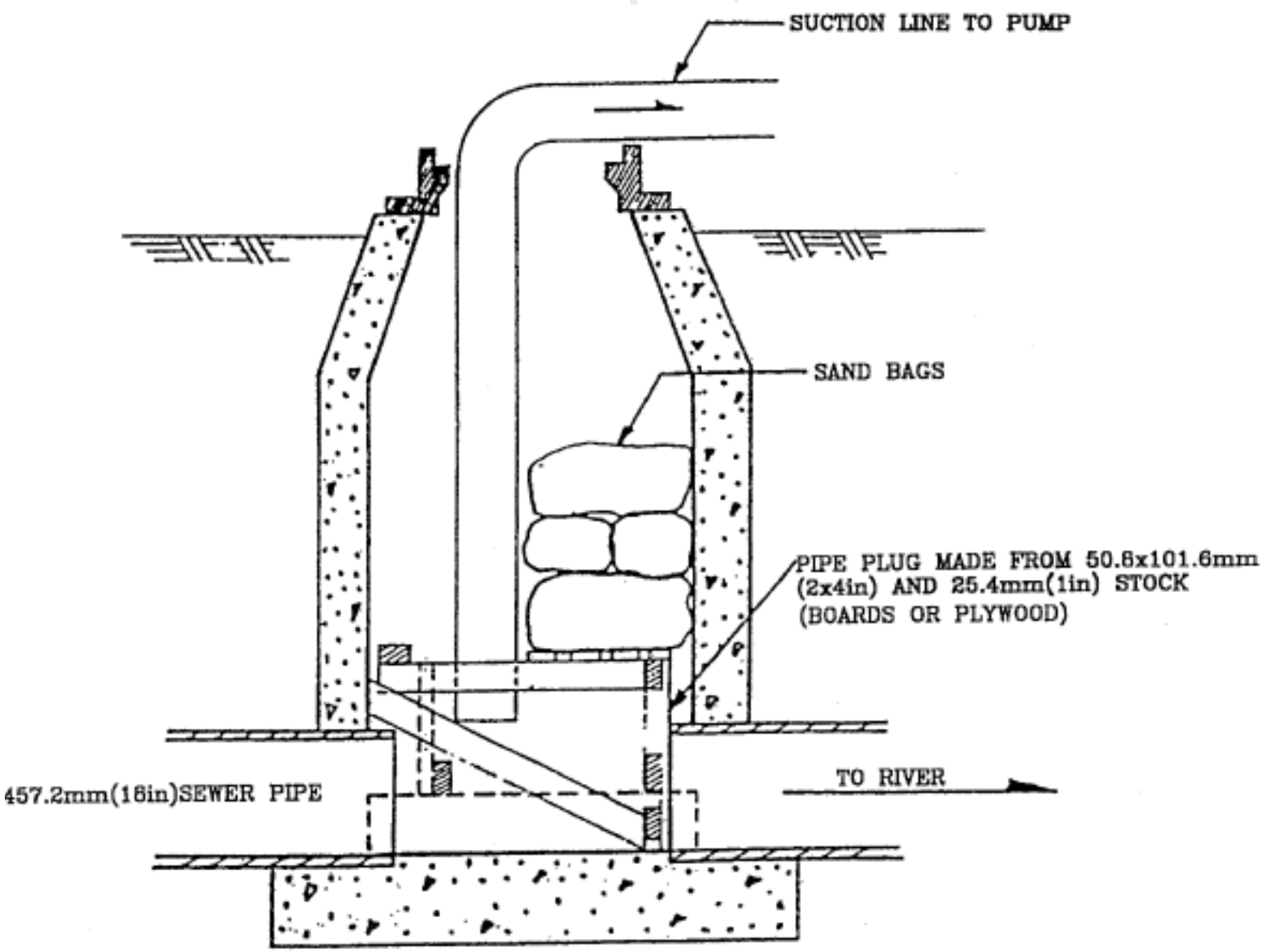
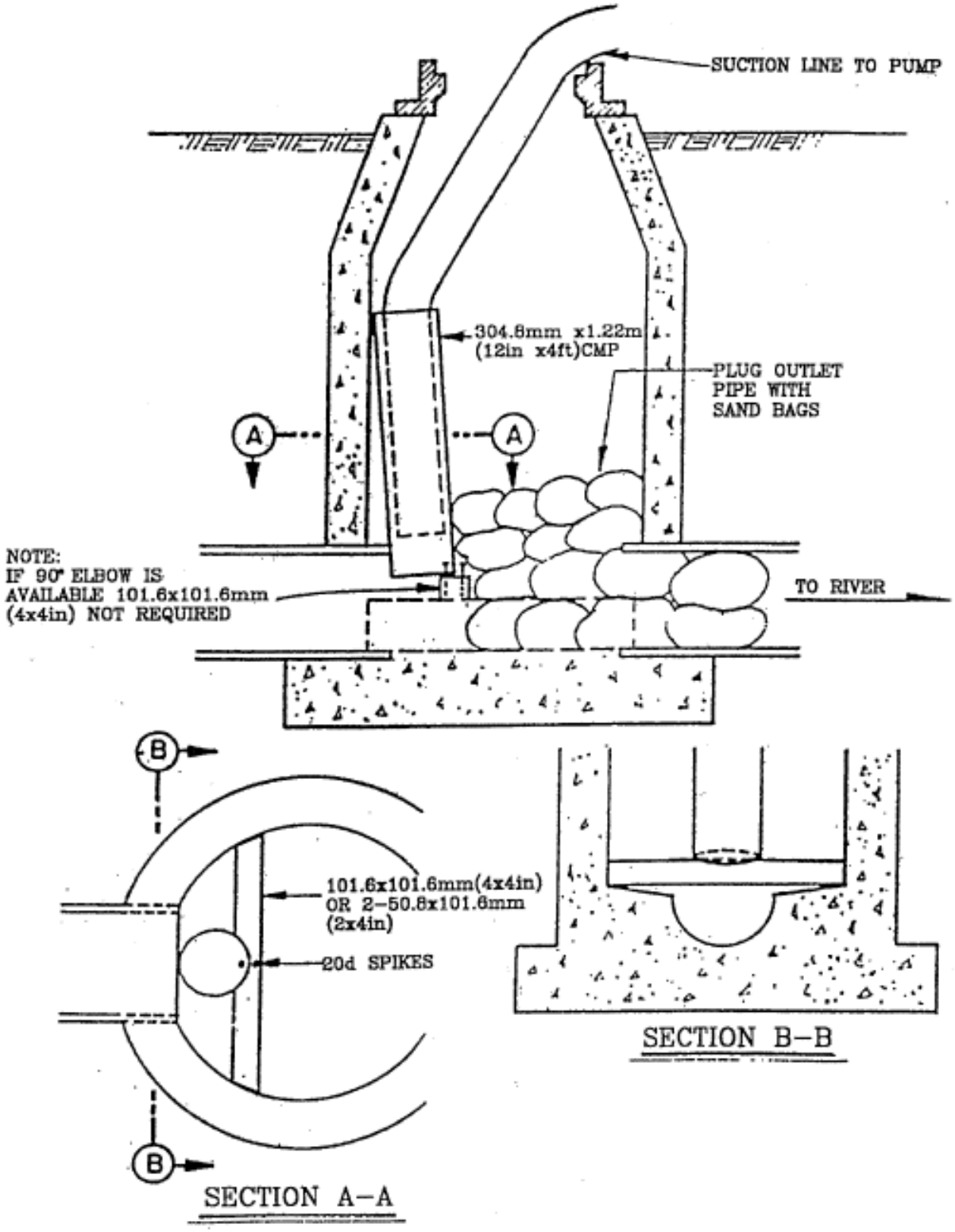


Figure 40

Figure 41



Adapting manhole for use as emergency pumping station



Suction line to pump from manhole

Figure 42

Figure 43

SECTION 7

SANDBAGGING TECHNIQUES BROCHURE

FLOODFIGHTER'S GUIDE TO

SANDBAGGING BROCHURE

SANDBAG VENDOR LIST

Portland District P.O. Box 2946
Portland, OR 97208-2946 (503)
808-4400

Seattle District P.O. Box
3755 Seattle, WA 98124-
3755 (206) 764-3406

Kansas City District
601 East 12th Street, Room 164
Kansas City, MO 64106-2896
(816) 426-6320

Omaha District 215 North 17th
Street Omaha, NE 68102-49978
(402) 221-4259

Walla Walla District 201 North
3rd Street Walla Walla, WA 99362-
1876 (509) 527-7144

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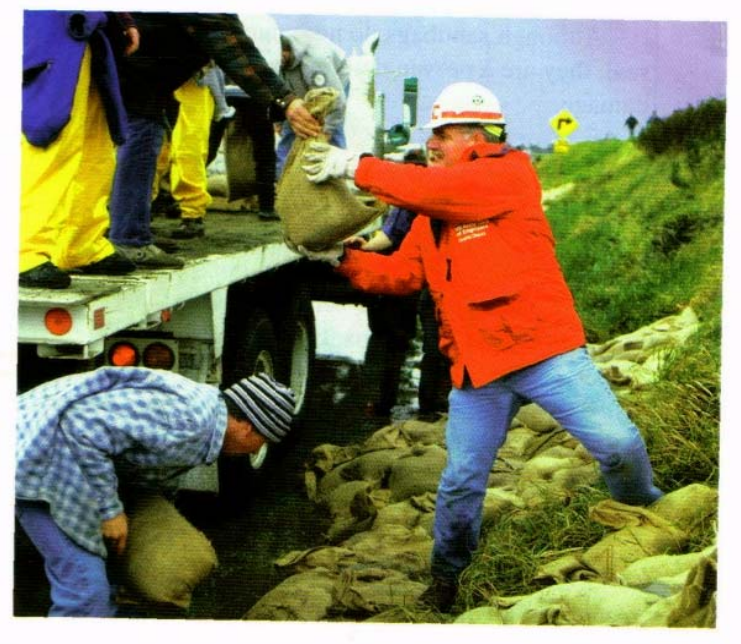
US Army Corps of Engineers
Northwestern Division



Sandbagging Techniques

The use of sandbags is *a* centuries old, tried and true method for flood fighting. See procedures and safety tips inside on efficient bagging operations.

Sandbags: a steadfast tool for flood fighting

Sandbagging is one of the most versatile of flood fighting tools and is a simple, effective way to prevent or reduce flood water damage.

Although sandbags do not guarantee a watertight seal, they are a proven deterrent to costly water damage.

Sandbags have been used to:

- prevent overtopping of levees,
- direct a river's current flow to specific areas,
- construct ring dikes around boils on levee back slopes, levee toes or behind levees,
- use as weight on back slopes of saturated levees,
- weigh down visquine and straw bales,
- build buttresses on back slopes and the toes of saturated levees and
- reduce seepage at closure structures.

Read this brochure to learn proper filling and placement methods aimed at increasing productivity of sandbagging operations. Included are hints, safety tips and correct procedures which will minimize work-related injuries and strain and will maximize essential time.

The first line of defense

Sandbag construction is a centuries old technique that has changed little. Bags are made from different materials including treated burlap and plastic. They measure approximately 14 inches wide and 24 inches long-Sandbags filled one-half to two-thirds full should generally be left untied. Tied bags, filled slightly fuller, have specific purposes: filling holes, holding visquine or straw bales in place, or forming barriers backed by supportive planks or aluminum sheet piles.

If access to the flood site is limited to boat, tractor or helicopter, then pallets and forklifts may be needed to load and off-load sandbags.

Unused empty bags can be stockpiled for emergency use and will be serviceable for years if kept dry and properly stored.

Fill materials

Sand is by far the easiest material for filling and shaping sandbags and becomes heavier when saturated from rain or moisture.

In emergencies, other materials such as silt, clay, gravel or a mixture of these may be used, but none work as well as sand.

When vehicle access is cut off to the flood site, and you have no other choice, use the back side of the levee or an adjacent field to find whatever material is available to fill sandbags.

Here are pros and cons on use of other materials:

- Silty soils get soft when wet and are more difficult to shape, and finer particles leak through the weave in the material.
- Clay materials are difficult to shape and to bag.
- Coarse-grained gravels are pervious and are also difficult to shape but can be used for redirecting the main stream flow while allowing seepage through bags.

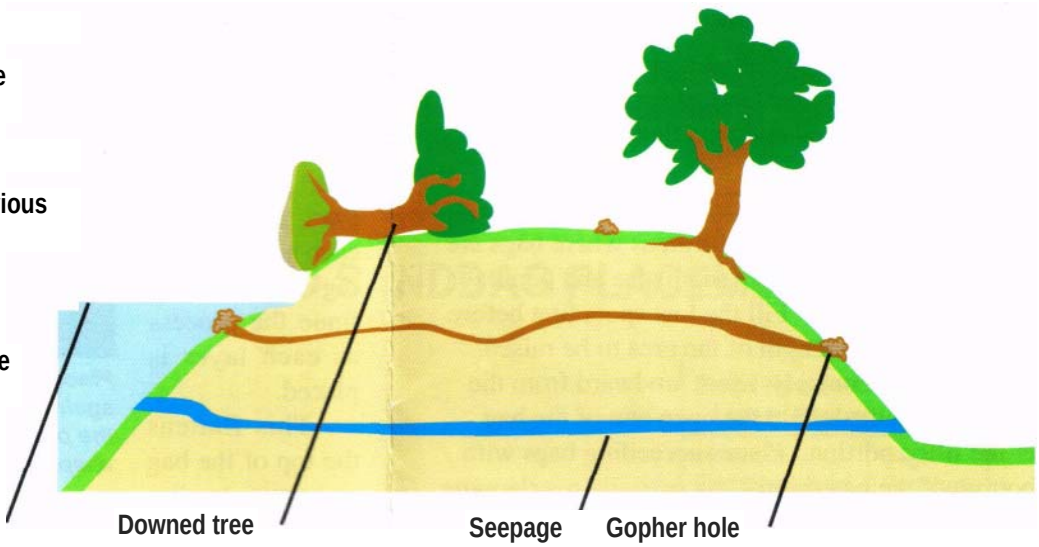
Alternatives

Other methods and remedies for flood fighting are as follows:

- Readily available, straw bales are an economical alternative. They range in size from 18 inches high by 30 inches long to 4 by 4 by 8 foot long blocks. Secure the bales by driving 4 to 10 foot stakes (or rebar) through the straw into the levee top, and weight down with andbags. Water swells the straw, making the bales heavier and watertight.
- Concrete Jersey Barriers or Econo Blocks can be used to divert water and can be cost effective solutions.
- Plastic sheeting can be used effectively by placing sand along a fold.

CAUSES OF LEVEE FAILURE

- Overtopping
- Downed trees on levee slope
- Gopher holes
- Seepage through pervious levee material
- Saturated levee embankments
- Seepage following tree root paths



Correct filling procedures

Filling sandbags is normally a two- or three-person operation. One member of the team—while crouching with feet apart and arms extended—should place the bottom of the empty bag on the ground.

The opening of the bag is folded outward about 1-1/2 inches to form a collar and held open to allow the second team member to empty a fully rounded No. 2 shovel of material into the open end of the bag.

Don't hurry. Haste can result in undue spillage and added work. The third team member stockpiles or stacks the open sacks. The three team members should rotate duties often to reduce job-specific muscle fatigue.

Untied bags should be filled approximately one-half to two-thirds full. Tied bags can be filled slightly more, but with enough room left at the top to tie the bag off properly. Always use gloves to protect your hands during the filling operation. After handling treated bags, avoid contact with your eyes and mouth.

Dress appropriately and layer clothing. Safety goggles should be used on dry and windy days.

Sandbag filling operations are done either near the actual placement site or at centrally located filling sites such as fire stations, diking districts or sand pits.

If the bags are filled at a distant location, vehicle

This two-member team uses correct positions for sandbag filling.

transportation and access to the flood site are primary planning considerations.

For large scale operations, a variety of specialized filling equipment—such as funnels on the back of dump trucks—is commercially available.

Such equipment is not always available during an emergency and may be best suited for a staging area where bags can be filled and then delivered to the site.

Proper placement

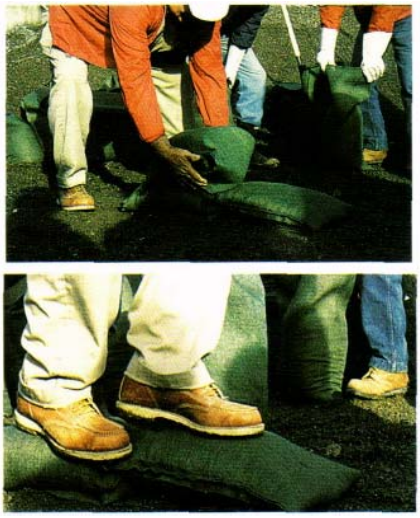
Remove any debris from the areas where bags are to be placed. Place the bags lengthwise and parallel to the direction of flow. Fill the low spots first before placing bags the full length of the area to be raised.

Start at approximately 1 foot landward from the river or levee's edge. Fold the open end of the bag under the filled portion. Place succeeding bags with the bottom of the bag tightly and partially overlapping the previous bag.

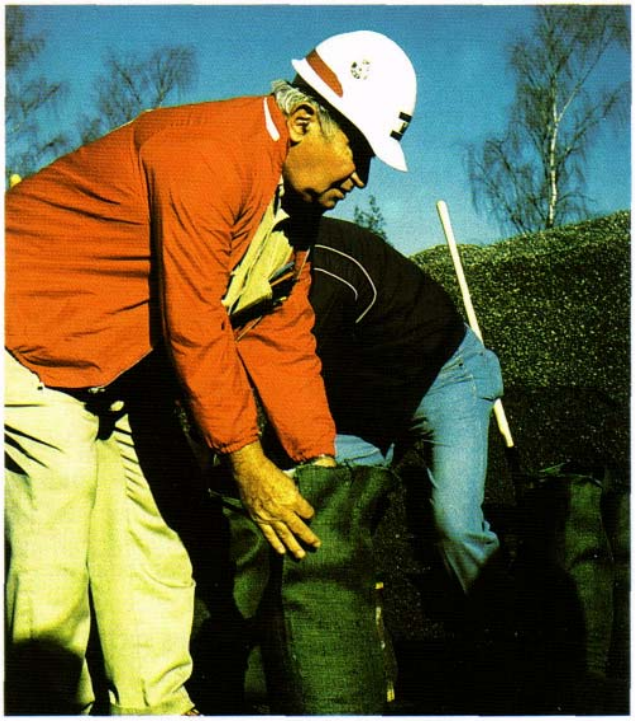
Offset adjacent rows or layers by one-half bag length to avoid continuous joints.

To eliminate voids and form a tight seal, compact and shape each bag by walking on it and continue the process as each layer is placed.

This flattens the top of the bag and prevents slippage between succeeding layers.



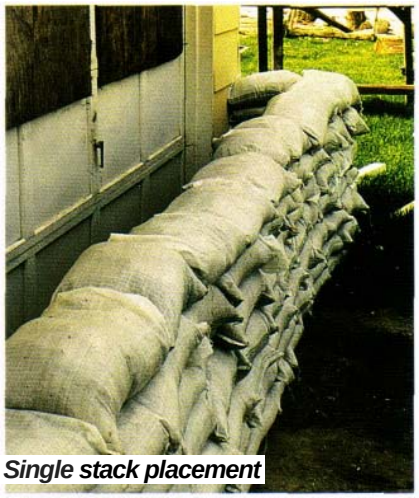
Place each succeeding bag tightly against and partially overlapping the previous one. Compact and shape each bag by walking on it.



Veteran flood engineer Ernie Sabo demonstrates that the sandbag should be two-thirds full, folded at the top.

Single stack placement

Sandbags stacked in a single row work well in flood areas where there is no streamflow velocity or danger from floating debris, such as logs and tree stumps, or from wave action which could topple the bags.



Single stack placement

Although generally not recommended to be above three courses or layers in height (approximately 1 foot), higher single stack placement can be effectively used as a barricade to protect structures from impending water damage as shown in the photo.

Pyramid placement method

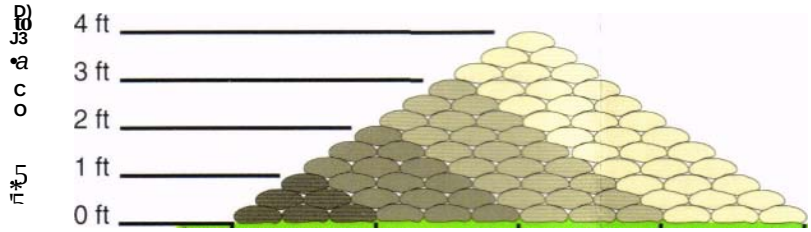
Use pyramid placement to increase the height of sandbag protection; however, use caution when raising the levee height. Determine the height of the sandbag raise by using the best available forecasts of flood conditions.

An example: When the water level is currently 1 foot below the top of the levee and is predicted to rise 3 more feet, construct a 2-1/2 foot sandbag operation which includes one-half foot of height as a safety factor.

It's important to compact each bag in place by walking on it, butting the ends of the sacks together, maintaining a staggered joint placement and folding under all loose ends.

Watch for flooding elsewhere, and watch for boils on the landward side of the levee due to the increased water elevation.

TYPICAL PYRAMID SANDBAG PLACEMENT



Bags Required Per 100 Linear Feet of Levee	
Height of Sandbag Levee	Bags Required
1 foot 2 feet 3 feet 4 feet	600* 2100 4500 7800

* Single width course 1 foot high requires 300 bags per 100 linear feet.

The pyramid placement method is used to increase the height of sandbag protection.

Use this rule of thumb in determining dimensions of the pyramid:

- **1 bag in length equals about 1 foot,**
- **3 bags in width equal about 2-1/2 feet,**
- **3 bags in height equal about 1 foot.**

Place the sandbags by laying an equal number of horizontal rows on the bottom as there are vertical layers.

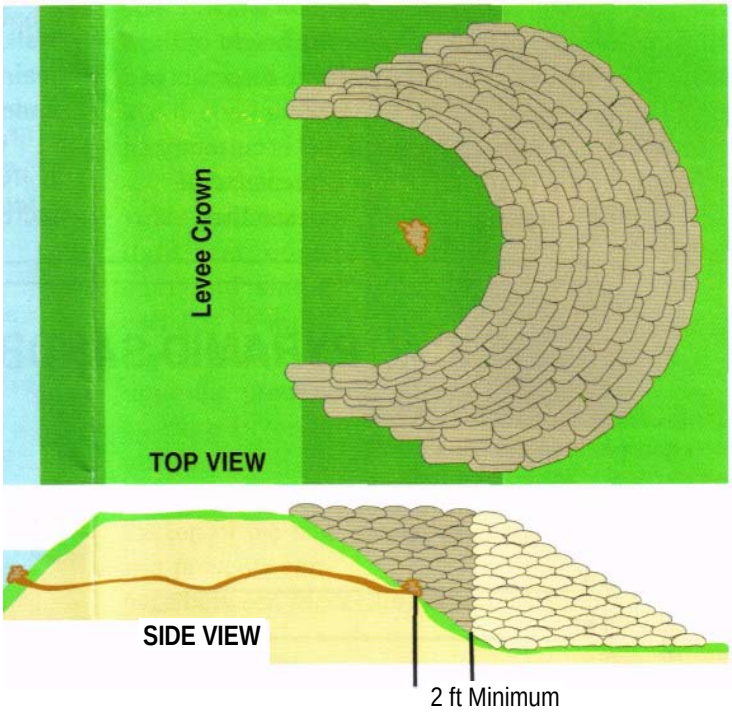
It's important to compact each bag in place by walking on it, butting the ends of the sacks together, maintaining a staggered joint placement and folding under loose ends.

RINGING SAND BOILS

Minimum 2 ft radius from center of boil to edge of ring dike.

Tie into levee if boil is near toe of levee.

Build half-moon shaped ring dike *if boil is on levee slope.



Ringing sand boil method

A sand boil is created by water seepage through the levee foundation or embankment. When that seepage transports dirty water, the levee's integrity is threatened.

Washington Conservation Corps members learn how to build a ring dike.

It's generally not necessary to build a ring dike around a boil that is not transporting soils, but monitor the boil for any change in condition.

Don't attempt to place sandbags directly on the boil. Pressure applied to plug the boil will cause water seeping through the levee to seek other avenues to follow and could cause levee failure.

As a minimum, there should be a 2 to 3 foot radius from the center of the boil to the inside edge of the ring dike. Take care to contain the entire area experiencing boils within the ring dike.

Build a spillway section in the dike so water runs out in a controlled manner. This diverts the overflow water away from the dike and reduces erosion on the levee slope. Once the spillway water runs clear, and is not transporting soils, then the ring dike is completed.

U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers is the nation's oldest engineering organization and one of its oldest military branches. It dates back to the Revolutionary War when, in 1775, George Washington appointed Col. Richard Gridley as Chief Engineer of the Continental Army.

The Corps' water resource program began in 1824 when Congress appropriated money for improving river navigation. In the following decade, the involvement in civil works mushroomed, including new roads, railroads and bridges, and assistance to local communities during flood disasters.

Annually Congress sets aside funds for disaster response flood work. This gives the Corps the ability

Safety First

Tip #1: Use proper lifting techniques to avoid injury and fatigue. Lift with your legs and bend at the knees to save your back.

Tip #2: Sandbags are treated to prevent deterioration when stored. Use work gloves and avoid contact with your eyes and mouth.

Tip #3: Stay in eye contact with heavy equipment operators and keep alert for truck backup alarms.

Tip #4: Flood waters can be polluted. Use rubber gloves and appropriate clothing if contact with water is unavoidable.

Tip #5: Wear adequate clothing in layers and watertight boots. Reflective material on outer clothing is essential for night work.

Tip #6: Rotate team members frequently to avoid fatique.

Clockwise from left: Watch for trucks and other heavy equipment frequently at flood sites; boots, clothing and other items are necessary for flood fighting; and heavy gloves are protection from treated burlap bags.

Tft/s ***classic shot shows conditions frequently are not even close to perfect. In the early '50s, flood fighters moved fast and furious to contain the swollen Snohomish River at Ebey Island—a major flood event.***

The Corps (continued)

to provide preparation, response and recovery measures concerned with flood fighting.

Public Law 84-99 today authorizes the Corps to engage in flood fighting and rescue operations if the emergency is beyond local and state capabilities. The Corps is there to perform a basic mandate as set down by the Corps' forefathers.

During a flood the Corps has the authority to:

• inspect and, if necessary, strengthen flood control structures,

• make temporary levee raises,

• provide supplies and 24-hour technical assistance, and

• assist in the evacuation of people and livestock.

The Army Corps of Engineers conducts flood fight training every year which includes sandbagging techniques. The Corps' districts maintain a limited supply of sandbags and other flood fighting materials intended to augment the stocks of state and local jurisdictions during actual flood emergency situations.

Local jurisdictions should first use their supplies and then request additional sandbags from the state.

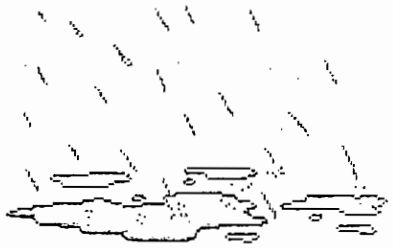
If the state supplies become depleted, then the Corps supplies are available for use when requested by state or local officials.

FLOOD FIGHTER'S

GUIDE TO SANDBAGGING

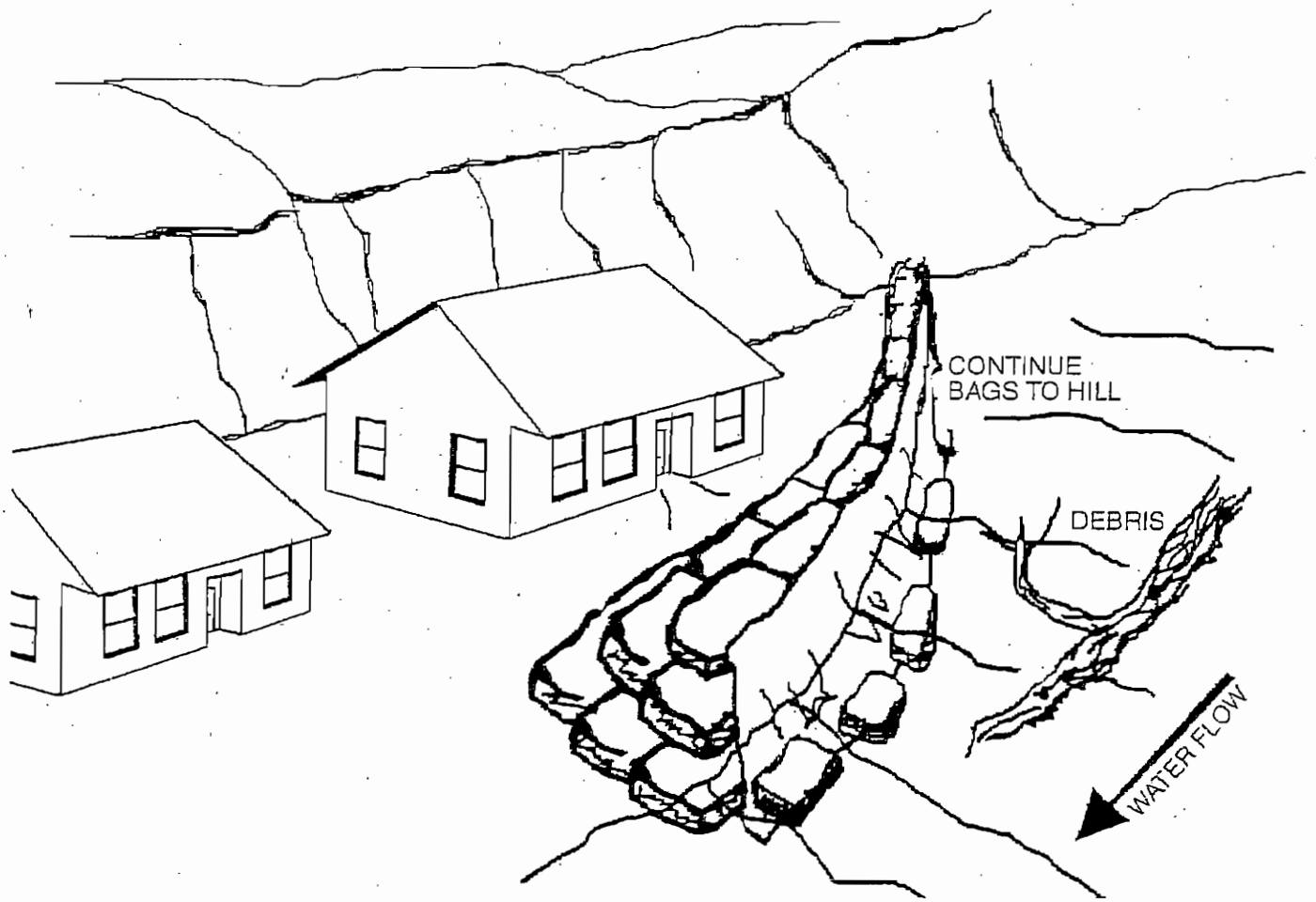
Prepared as part of the Innovative Technologies
for Flood Damage Reduction Program.

We would like to express appreciation to the U.S. Army Corps of Engineers, Seattle District, Emergency Management Branch, for their input to this manual.



Sandbagging Techniques

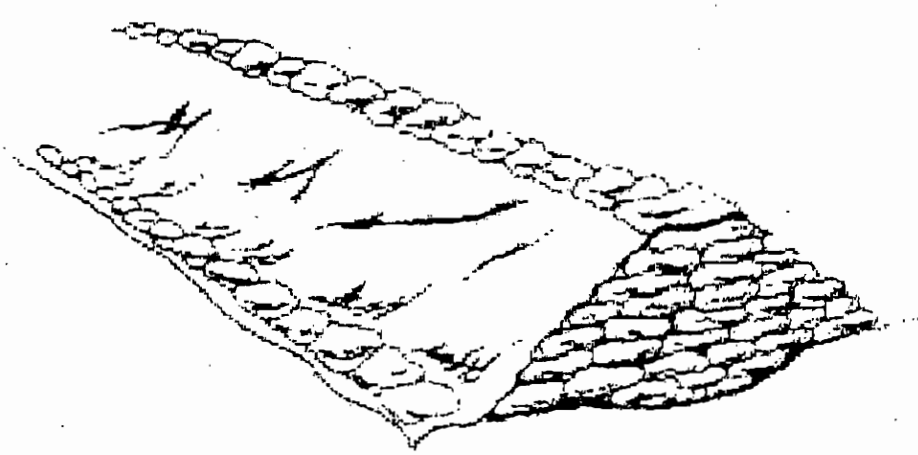
Sandbagging has been used for decades as a simple and effective tool to prevent flooding or reduce damage from floodwaters. This manual provides procedures and safety tips for efficient, successful bagging operations.



Purpose

Sandbags can be used to:

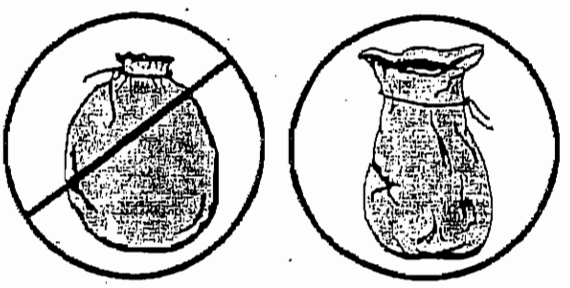
- Prevent overtopping of levees.
- Impound urban areas.
- Divert river flow to specific areas.
- Construct sandbag ring levees around sand boils near or landward of the landside levee toe.
- Close gaps in levees (i.e., railroad gap).
- Provide ballast on back slopes of saturated levees.
- Weigh down plastic sheeting or straw bales.
- Buttress the toe of saturated levees.



Materials

Bags

- Sandbags are typically made of burlap or polypropylene plastic.
- Standard sandbags measure 14 inches wide by 24 inches long. Untied sandbags, filled two-thirds full, with the loose flap folded under are used for most purposes.
- It is not recommended that tied sandbags be used to construct sandbag levees or sandbag ring levees. Tied bags are hard to bond together, and they leave a void (seepage path) between bags. If you elect to tie the bags, it is recommended the bag be filled slightly fuller than the untied bags. These bags can be used for filling holes, erosion rivulets, or holding materials (like visquine) in place.

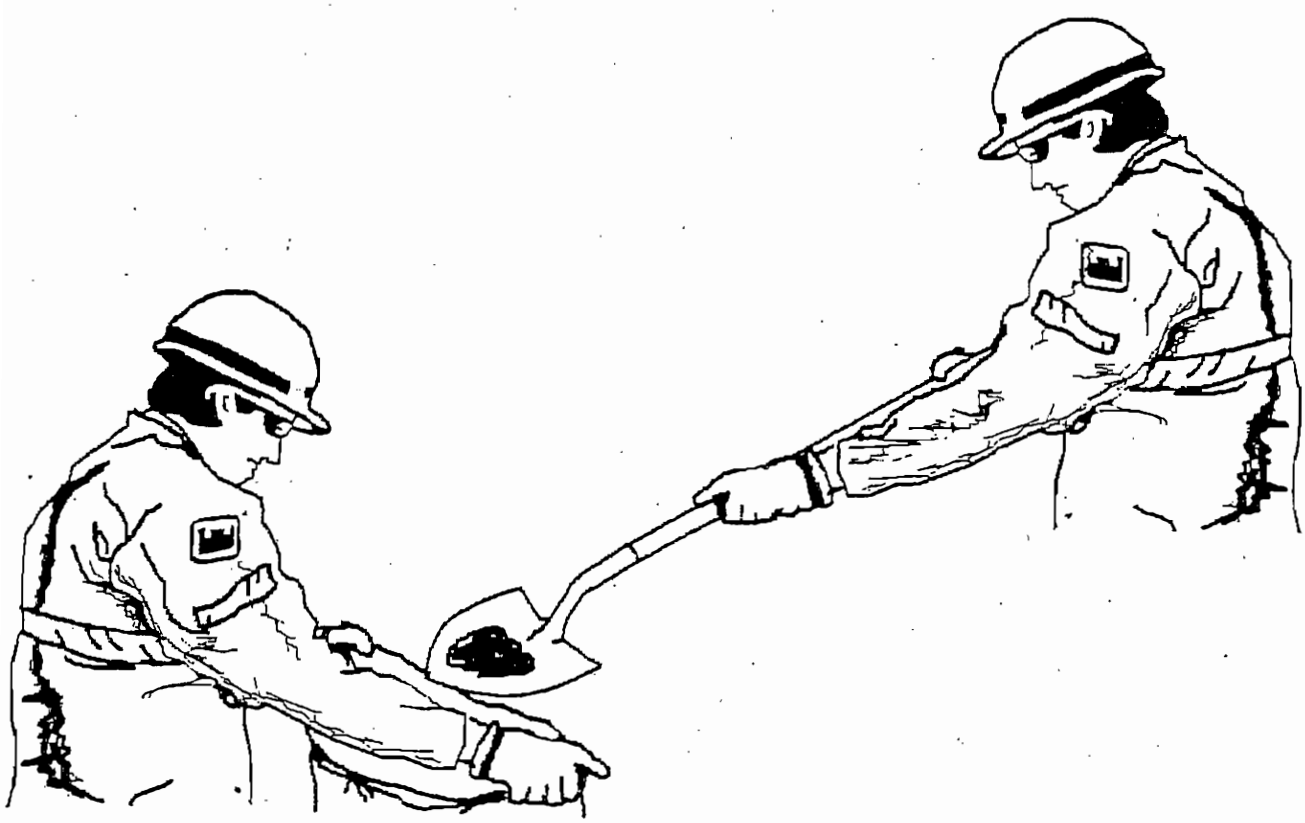


Fill Materials

- Sand is the preferred fill material.
- Silts, clays, and gravel are less desirable than sand, but can be used if sand is not available.

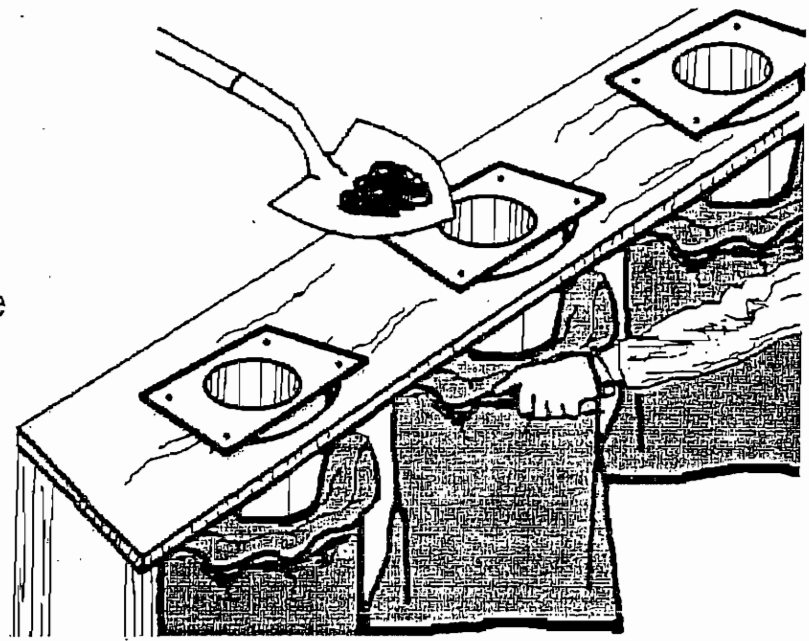
Filling Procedures

- Use at least two people to fill the bags, one to hold the bag and the other to shovel in the sand.
- Make sure everyone has gloves — even a minor cut can result in a serious infection.
- Fold the opening of the bag outward about 1-1/2 inches to form a collar and hold open.
- Empty a fully rounded shovel of sand into the opening. Normally it takes between 2-1/2 to 3 shovels of sand to fill a sandbag 2/3 full.
- Rotate duties often to reduce muscle fatigue.



Alternative Filling Methods:

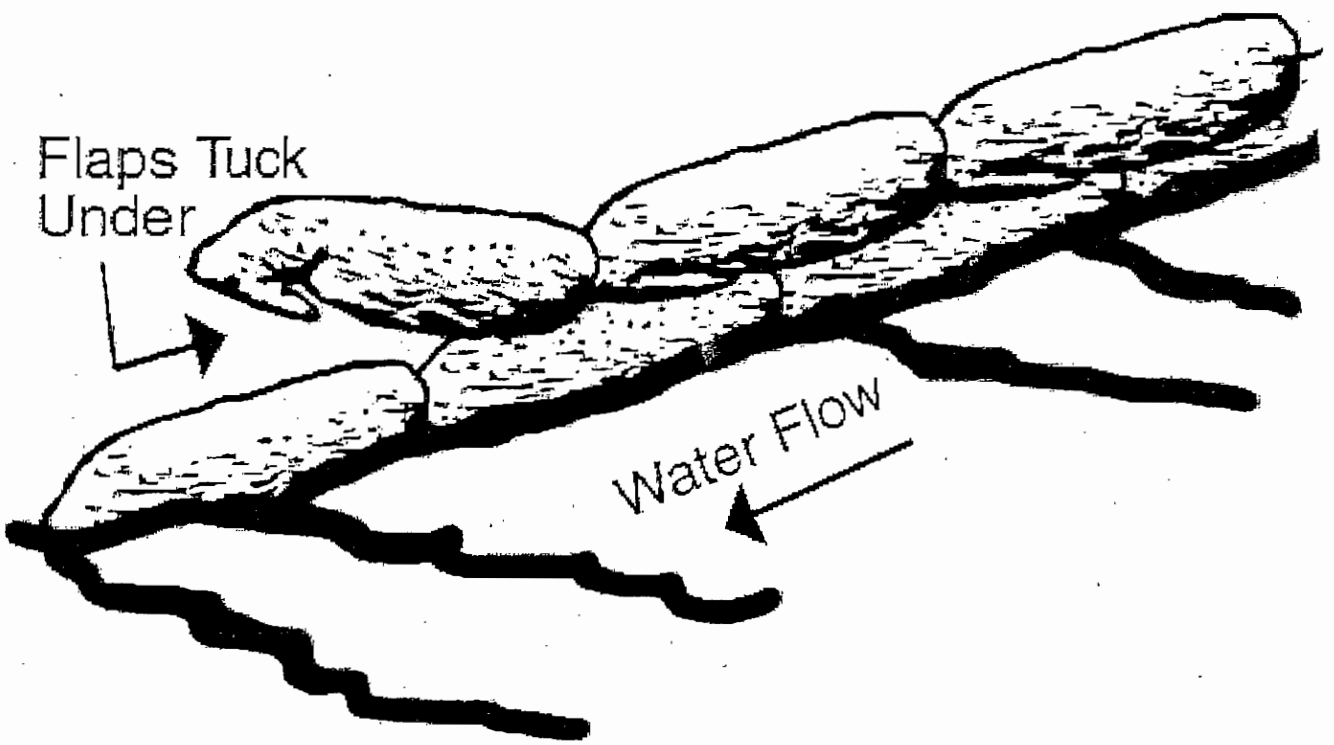
- Cut down a standard orange highway cone and use as a funnel to fill bags.
- Build a "filling table" out of plywood and 2 x 4's and place several highway cones set onto the top of the table to fill several bags simultaneously.



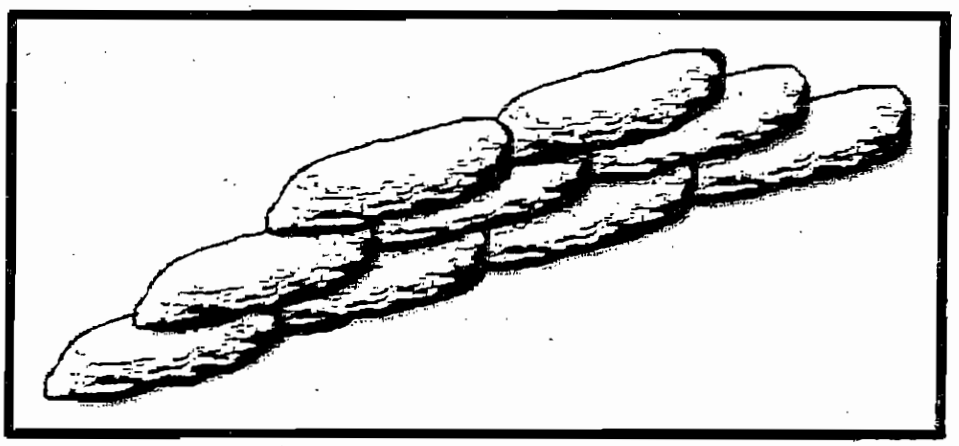
- Road sanding dump trucks are sometimes modified to fill sandbags. The chute allows a degree of metering so the same amount of sand is placed in each bag.
- There are various models of sandbag filling machines on the market today. Depending on the model and type, they can increase the numbers of sandbags that can be filled per hour.

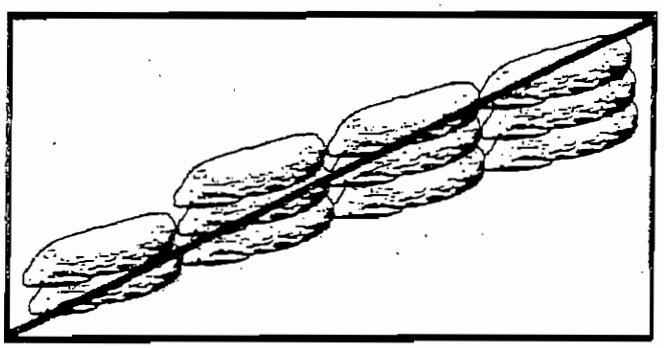
Placing the Bags

- Remove debris and loose material from areas where bags are to be placed.
- Place bags lengthwise and parallel to direction of flow, with untied ends facing downstream.
- Fill low spots first.
- Start at upstream end, at least 1 foot landward of the riverside levee shoulder, and work from upstream to downstream.



- Fold open end of bag under filled portion.
- Place each succeeding bag with bottom of bag tightly and partially (1/3) overlapping previous bag.
- Stagger adjacent rows or layers by one-half bag length to avoid continuous joints.
- Compact and shape each bag by walking on it to eliminate voids and to form a tight seal.
- Use a binding strip every fourth course. The bags should be flattened and laid transverse to the sandbag alignment. This will lock the sandbags in place.

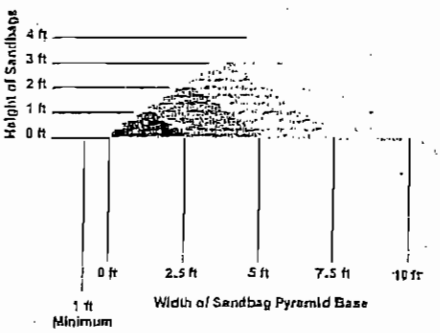




Types of Placement

Single Stack Placement (Normally Not Recommended)

- Single row placement can be used in backwater when stream-flow velocity or floating debris (logs, tree stumps, waves) is not a problem.
- Recommended height for single stack placement is approximately 4 to 8 inches (one or two bags high).

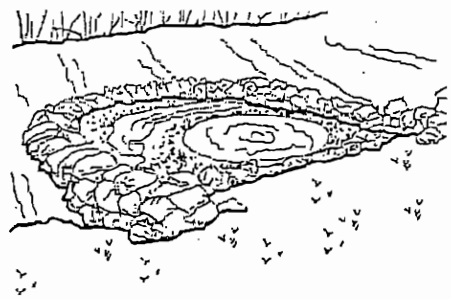


Pyramid Placement (Recommended for Sandbag Gaps)

- Use pyramid placement for closure of sandbag gaps. Can also be used to construct a sandbag levee.
- Most common construction of a sandbag levee is ½ on 1 on the riverside slope and 2 on 1 on back slope. Effective height is 4 feet. *Note: This may vary between regions.*
- Determine height of sandbagging needed based on available flood forecasts.

Example
Water = 1 foot below levee top
Flood prediction = 3 more feet
Allow 1/2-foot additional height for safety factor
Construct 2-1/2-foot sandbag operation

Ringing Sand Boils



Important: Watch for flooding elsewhere and for sand boils near the landed side and/or landward of the levee toe. Do not place bags directly on boils. If necessary, build a sandbag ring around the boil, with a 2- to 3-foot radius from the center of the boil. Be careful to contain the entire area within the ring levee. Build a spillway section to allow water to run out. Construct the ring levee to a height sufficient to create a head that will bring the displacement of material to a stop. No attempt should be made to fully stop the flow of water. In general, when sandboils discharge clear water, there is no need to ring the boil. However, if there is a reason to believe that material could be displaced, then construct the ring levee. There may be occasions when 2 or more sandboils are observed. In this case, you may construct a horseshoe ring levee using the landside levee slope as part of the ring levee. Using this method reduces construction time and resource requirements.

Mistakes To Avoid

Some common mistakes are:

- Overfilling bags.
  - "More is not better."
  - Results in bags that are too heavy. Bags should weigh about 35 to 45 pounds.
  - Causes difficulty in getting a good seal on the levee.
- Tying bags closed.
  - Causes one end to be bunched up.
  - Makes bags difficult to stack.
  - Does not allow a good seal.
- Stacking bags too steep.
  - Results in unstable structure that could topple and injure someone.
- Overhandling.
  - Results in unnecessary, extra effort.
  - Can cause sore backs and other injuries.
- Poor choice of transport vehicles.
- Failure to plan traffic patterns when undertaking sandbagging operations on levee crowns.
- Taking over flood fight of local sponsors unless they request the Corps to do so. The Corps' role is to supplement local sponsors' flood fight efforts.

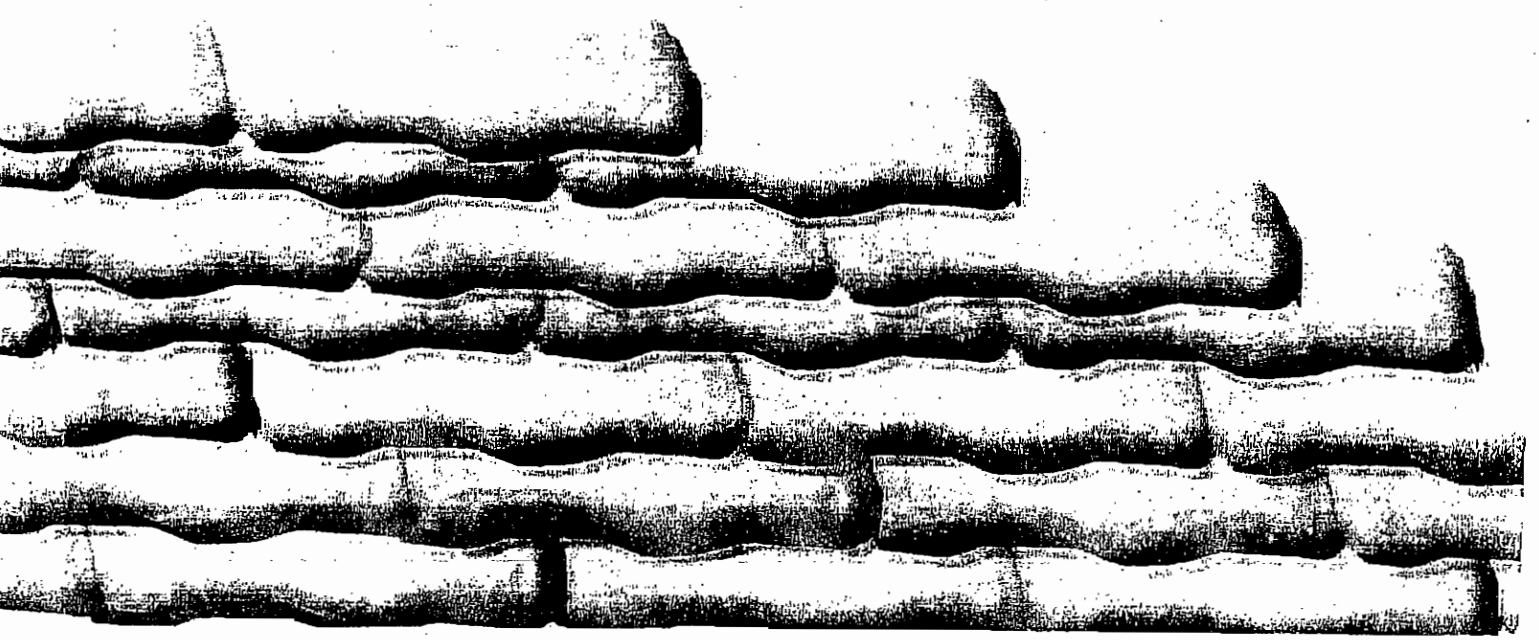
Remedies

- Mistake 1: Overfilling bags.
  - Fill only 1/2 to 2/3 full.
  - Bag should weigh about 30 lbs.
  - Rule-of-Thumb: "About 3 shovelfuls should do!"
- Mistake 2: Tying bags closed.
  - Just fold over the open end.
  - Sew the bag closed if time allows.
- Mistake 3: Stacking bags too steep.
  - "It is as easy to stack bags correctly as it is to stack them wrong — but a correctly built sandbag structure requires more bags."
  - The base width of the sandbag structure should be at least twice the height.
- Mistake 4: Overhandling bags.
  - "The shortest distance between two points is a straight line."
  - Plan, Plan, Plan.

Safety Tips

- Wear gloves to protect hands from treated sandbags and polluted floodwaters.
- Avoid contact with eyes and mouth while handling bags.
- Wear safety goggles on dry and windy days.
- Use correct bending and lifting procedures. Lift with your legs and bend at the knees to save your back.
- Stay in eye contact with heavy equipment operators and keep alert for truck backup alarms.
- Wear adequate clothing in layers and watertight boots.
- Wear reflective material on outer clothing for night work.

US Army Corps
of Engineers®



NEMA Sandbag Vendor List

We are not soliciting business for these firms, only listing possible sources.

ALABAMA

Berry Small Enterprises, Inc.
3300 Pinson Valley Parkway
Birmingham, AL 35217
(205) 854^330 and (800) 329-7801
FAX: (205) 854-3677
CONTACT: Bill Lopez

Have (14" x 26") bags with attached tie strings for $.16 each. FOB Birmingham, AL. Delivery within 3-4 days.

ARIZONA

Arizona Bag Company, http://www.azbag.com
2530 W. Buckeye Road
Phoenix, AZ 85009
(602) 272-1333 and (800) 270-2247
FAX: (602) 278-7871
CONTACT: DonnaJWeese

Stocked in Phoenix. Have biodegradable burlap, polypropylene and cloth types for same-day shipment.

COLORADO

Fulton Denver Company
3500 Wynkoop Street
Denver, CO 80216
(303) 294-9292
FAX (303) 292-9470
CONTACT: Peter Ryan or Bill Merriman

Carries a large inventory of polypropylene bags. Polypropylene bags (14" x 26") are $.21 1/2 to $.28 each. (14" x 30") with tie string attached are $.23 1/2 to $.30 each. Has burlap or some other types of bags (bean) which are (22 1/2" x 36") at around $.52 each. Have (misprints) for $.35 each. Will ship immediately by common carrier or customer's own truck.

Central Bag and Burlap
2715 Blake Street
Denver, CO 80205
(303) 297-9955 or (800) 783-1224
FAX: (303) 297-9960
CONTACT: Elly or Morton Zussman
After Hours: Elly Zussman (303) 399-4130

They always have an inventory that they could ship immediately. Price will be approximately $.55 for burlap (20" x 36"). Ship FOB Denver, CO commercial carrier or customer's own truck. Quantity discounts.

IJJJNOJS

Alpha Bag Group, Corporation
1925 Elmwood Road
Rockford, IL 61103
(815) 963-9525 or (800) 758-8079
FAX: (815) 963-9585
CONTACT: Terresa K. Bryan

Have in stock 21" x 32" woven polypropylene bags priced at $0,245 FOB Rockforf IL. Can ship in 24 hours.

After Hours: Jim Williams (815) 519-6620

INDIANA

Max Katz Bag Co., Inc.
PO Box 1666
Indianapolis, IN 46206-1666
(317) 635-9561 and (800) 225-3729
FAX: (317) 635-3458
CONTACT: Morris Katz
After Hours: (317) 259-7270
Or: Stan Green (317) 873-9991

Have 2 million sandbags on hand for immediate shipment. Will receive invitations for bid quote on emergency or stocking needs. Woven polypropylene bags with tie strings (14" x 26") packed 1,000 per bale, pack 500,000 per trailer. Can furnish any quantity you may need with shipment same day of order. Plant is open 24 hours a day.

IOWA

Commercial Bag and Supply
1244 2nd Avenue
Des Moines, IA 50314
(515) 282-1248
FAX: (515) 282-7320
CONTACT: Jerry Bassman
After Hours: (515) 225-1739
Or: Rick Wells (515) 287-1337

Top of the line sandbags. Carries a large inventory of various sandbags. Polypropylene and burlap bags with ties are available. Prices range from $.23 to $.39 depending on quantity and type. Ship via commercial carriers to Nebraska. If rush, with order of 40,000-50,000 bags or more can deliver himself.

Farber Bag and Supply Company
8733 Kapp Drive
Peosta, IA 52068-0078
(800) 553-9068
After Hours: Jim Farber (319) 588-4591, Mobile (319) 580-2607 and (319) 580-5607

Carry approximately 2 million sandbags. Polypropylene and burlap available. Deliver within six hours. Small quantity will ship FOB. Large Quantity will deliver.

KANSAS

HUBCO Ina IHutohmscjLBagjnc)
PO Box 1286
215 South Poplar
Hutchinson, KS 67504-1286
(316) 663-8301
FAX: (316) 663-5053
CONTACT: Merlin Preheim
After Hours: (316) 663-4360
Or: Fred Moore (316) 663-3582

Several thousand polypropylene bags on hand. Polypropylene bags (14" x 26") $.15 to $.25 depending on quantity ordered. Flour bags are available, prices range from $.30 to $.45 each. Could ship other type of bag in an emergency situation. They could produce sandbags in a short amount of time to meet any need. Ship by commercial carrier or the customer's own truck.

Kansas City Bag Company
12920 Metcalf Avenue, Suite 180
Overland Park, KS 66213
(913) 681-3324
FAX: (913) 681-8034
CONTACT: Tom Sowden
After Hours Contact: Glenn Lebsack (913) 837-5769

Woven polypropylene (14" x 26"), $.18 each. Delivered in truckload quantities, packed 500/bale with ties.

MINNESOTA

Berg Bag Company
410 Third Avenue North
Minneapolis, MN 55401
(612) 332-8845 and (800) 658-7201
CONTACT: Richard Berg
After Hours: (612) 933-3897 and (800) 587-2040
Or: Bob Berg (612) 797-0303

Maintains a good supply of bags on hand, mostly poly. Could ship same day, if needed. Ship FOB Minneapolis, MN. Large quantities they fabricate as ordered. Prices range anywhere from $.15 to $.35 each depending on type and quantity. Government specification treated burlap bags are available for $.15 to $.35 each.

Jacobs Trading Company
13505 Industrial Park Boulevard
Plymouth, MN 55441
(763) 843-2000 or fax (763) 843-2101
CONTACT: Scott Armstrong

Maintains a very large supply of poly bags in Minnesota and many other locations. Bags sized 14" x 26".

Murphy Sales Company
Interchange West, Suite 345, 435 Ford Rd.
St. Louis Park, MN 55426
(612) 540-0755 and (800) 328-5876
FAX: (612) 540-0752
CONTACT: David Allen
After Hours: (612) 541-9855

Large stocks of treated sandbags currently on hand (14" x 27") 10 oz, burlap, government specification with tie cords. Prices as follows: 500-5,000 $.47 each; 5,500-15,000 $.42 each; 15,500-25,000 $.40 each; 25,500-50,000 $.38 each; 50,500-90,000 $.37 each. Buyer pays transportation cost under 50,000 bags. Also has woven poly bags (14" x 26") with ties. For woven poly prices, contact direct.

MISSOURI

Central Bag Company
1323 West 13th Street
Kansas City, MO 64102
(816)471-0388
CONTACT: Tom Simone
After Hours: (816) 941-7306

They could ship 100,000 burlap or approximately 40,000 to 50,000 polypropylene bags immediately. 120,000 to 240,000 within two days. Closed weave burlap bags (14" x 23") $.32 each; (14" x 26") call for quote. Ship FOB Kansas City, MO.

Columbia Burlap & Bag Company
999 Bedford Avenue
North Kansas City, MO 64116
(816) 421-4121 and (800) 523-4757
CONTACT: Walter March
After Hours: (816) 942-1792-Walter
Or: Dave Radasky (913) 381-3162
Joe Levy (913) 345-0861
Diane Bryon (913) 258-9017

Maintains normal supply of polypropylene and burlap bags. If an emergency arises they could put together enough bags of different types to fill any order. Prices range anywhere from $.25 to $.38 each depending on type and quantity ordered. Polypropylene bag with tie (14" x 26") $.38 each, price is less if ordered in large quantity. Will ship motor freight to Nebraska.

United Bag, Inc.
2508 North Broadway
St. Louis, MO 63102
(314) 421-3700
FAX: (314)421-0969
CONTACT: Jamie Holcman
After Hours: Todd Greenberg (314) 989-0999

One million bags on hand. Woven poly bags available. Two days to ship to Nebraska. 1-4,000 at $.33; 5-9,000 at $.32; 10-24,000 at $.31 1/2 delivered; over 50,000 special arrangements.

NEBRASKA

Frontier Bag Company
2420 Grant Street
Omaha, NE68111
(402) 342-0992
CONTACT: Judy Lee
After Hours: (402) 556-6959

Polypropylene (14" x 26") and burlap bags available. Price depends on type and quantity ordered. Could ship bags made for other purposes. Have 100# burlap potato bags at $.47 each. Will ship FOB Omaha, NE by commercial carrier. Or pick up with customer's own truck.

NEW JERSEY

NYP Corporation
805 East Grand Street
Elizabeth, NJ 07201
(908) 351-6550
FAX: (908) 351-0108
CONTACT: Jerry P. Labelle, Jr.

They maintain a large supply of sandbags on hand. Burlap, non-rot with tie strings (14" x 27") prices range from $.38 to $.50 each depending on quantity ordered. Burlap (18" x 30") with or without tie string $.24 each. Polypropylene bags available with or without tie strings (16" x 29") prices range from $.18 1/2 to $.29 each depending on quantity ordered. (18" x 30") (misprints) without tie strings, prices range from $.13 1/2 to $.18 each. Used poly bags (22" x 36") w/out tie string $.14 each. Ship FOB Elizabeth, NJ depending on quantity. 50,000 + freight paid.

NEW YORK

Amee Sales, Inc.
55 West 39th Street
New York, NY 10018
(212) 221-8515
FAX: (212) 221-8517
CONTACT: S. Kumar Shroff
After Hours: (516) 883-5805

Have polypropylene bags of all sizes, with or without tie strings. Prices range from $.12 to $.22 each depending on type and quantity ordered. Also carries burlap bags. Normally have over 200,000 bags on hand. Ship FOB Charleston, SC delivery within 2-3 days. Can also ship FOB Los Angeles, CA.

NORTH DAKOTA

Sandbags Warehouse
1338 3rd Avenue North
Fargo, ND 58102-4228
(701)237-9550
FAX: (701)237-9550
CONTACT: E John Carlson
After Hours: (701) 232-5400
Cellular (701)799-7283

Carries woven polypropylene (18" x 30") and (14" x 26") with ties. Prices are based on quantity needed and shipping mode. Special governmental purchase discounts are available.

OHIO

Dayton Bag and Burlap Company
322 Davis Avenue
Dayton, OH 45403
(937) 258-8000 and (800) 543-3400
CONTACT: Susan Spiegel
FAX: (937) 258-0029

Have 3 million bags on hand. Polypropylene bags (14" x 26") with tie string $.18 to $.21 each depending on quantity ordered. 1,000 per bale. FOB Dayton, OH.

TENNESSEE

Cady Industries, Inc.
2100 Troyer Ave., Bldg 330
Memphis, TN 38114
(800) 622-3695 and (901) 947-4977
FAX: (901)946-4987
CONTACT: Stephanie Dalton Lynch
E-Mail: Stephanie Lynch
Web: www.cadyindustries.com

Woven polypropylene bags with ties (14" x 26") 1,000 @ $.22 each, 2,000 at $.20 each, 3,000 at $.19 each, 5,000 at $.18 each and 10,000 at $.15 each. All prices are FOB Memphis, TN.

Langston Bag Company, Inc.
1760 South 3rd Street
Memphis, TN 38107
(901) 774^440 and (800) 627-5224
FAX: (901)942-5402
CONTACT: Steve Winston

Carries various polypropylene bags. Price depends on quantity ordered. Ship FOB Memphis, TN. Approximately 2-3 days for delivery.

WASHINGTON

Justus Bag Company, Inc.
East 11205 Trent Avenue
Spokane, WA 99206-4692
(509) 924-8353 and (800) 456-7878
FAX: (509) 926-2679
CONTACT: Duane Justus
After Hours: (509) 926-2853
Or: Darin Justus (509) 922-8305
Duane Justus (509) 927-8107

Call for pricing.

SECTION 8

Innovative Flood Fight Technologies

Rapidly Deployable Floodwall (RDFW)

Hesco Bastions

Portadam

Step 1

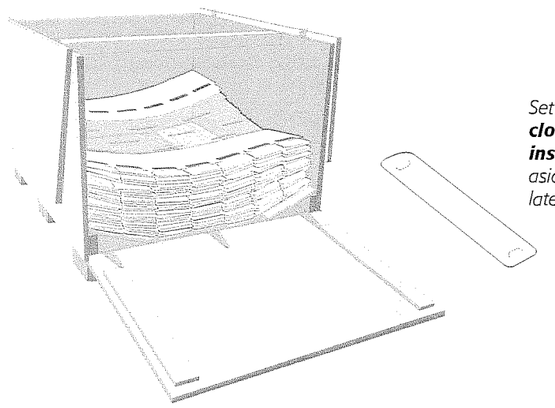
Unpacking the Crate

Your RDFW units arrive in crates of 100 units per crate.

Your RDFW crate may ship with pieces known as **End Closure inserts.** If so, set these units aside, as you may need them at the end of the construction process.

A team of two people is needed to lift each unit from the crate.

*A standard RDFW crate contains 100 RDFW units. The crate may or may not contain **end closure insert** pieces.*



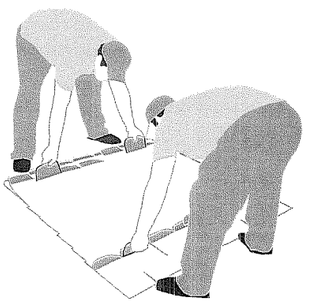
*Set **end closure inserts** aside for later.*

Step 2

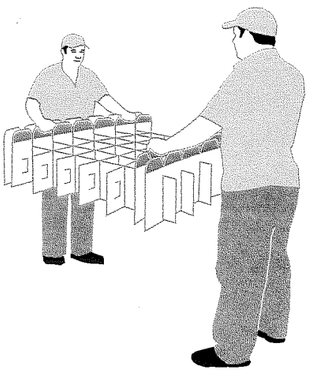
Expanding the RDFW Units

Having removed an RDFW unit from the crate, the unit is next expanded.

To expand the unit, two workers first grasp the GRIP HERE arrows. Then, together at the same time, both workers swing their hands in the direction of the arrows, allowing the grid to flip partially open. Both workers then swing their hands in the opposite direction, expanding the RDFW into a uniform, three-dimensional grid.



The collapsed RDFW sheet…



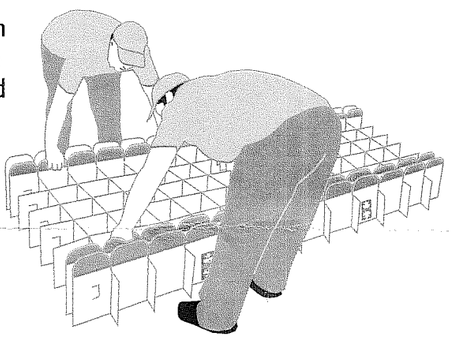
…expands into this.

Step 3

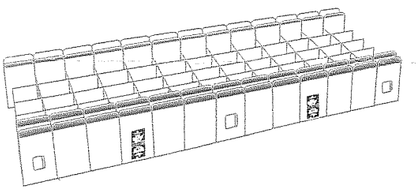
Laying Down the First Row

The workers next place the units on the ground where the wall is to be built. The big "RDFW" stickers should face away from the threat.

The units should be slid together snugly so that they overlap completely.



With your "RDFW" stickers facing away from the threat, slide your units together snugly…



…so that they overlap.

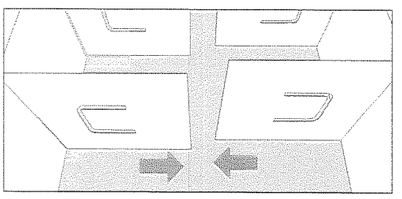
Step 4

Locking Side-to-Side

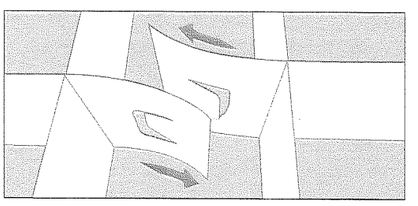
Locking together—or connecting—the RDFW units is critical when setting up your wall.

First, look at the difference between the locks. They should appear to be total opposites.

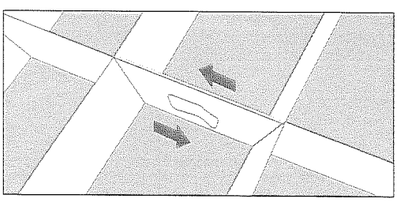
Bend the pieces slightly to allow the tabs to interlock.



The locks of your RDFW pieces should appear to be total opposites.



Bend the pieces slightly so that you can slide the tabs past each other, locking the units together.



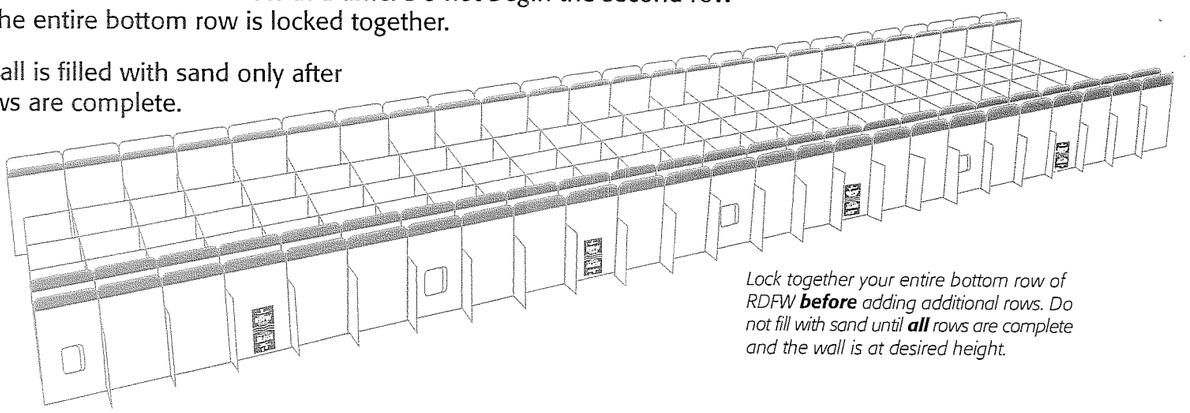
You RDFW pieces lock to each other side-to-side. Connect all the locks between your pieces.

Step 5

Completing the First Row

The RDFW wall is built one row at a time. Do not begin the second row until the entire bottom row is locked together.

The wall is filled with sand only after *all* rows are complete.



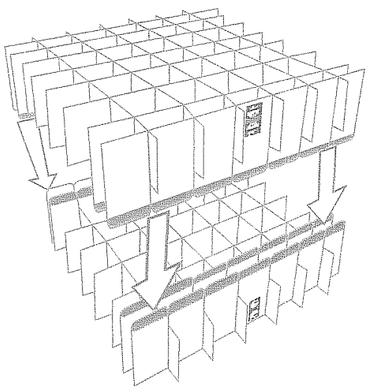
*Lock together your entire bottom row of RDFW **before** adding additional rows. Do not fill with sand until **all** rows are complete and the wall is at desired height.*

Step **6a**

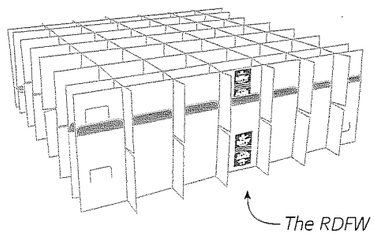
Adding Rows

Having completed the bottom row, the 2nd and any further rows should be added upside down, with each RDFW unit placed directly on top of the unit beneath it. The units should NOT be offset. A helpful guide is to make sure the large "RDFW" stickers line up.

Slide your RDFW units into the units beneath. After adding your units, lock them side-to-side, just as you did with the bottom row.



Starting with the 2nd row, each RDFW unit is added upside down.



The RDFW stickers should line up.

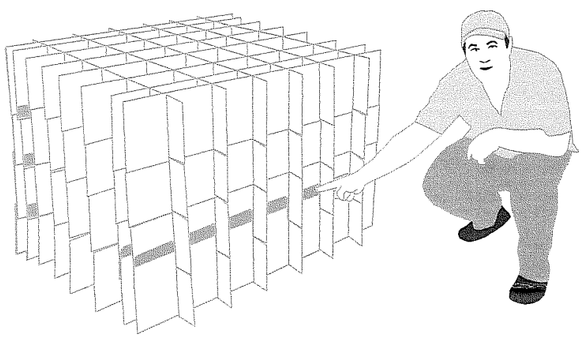
Step **6b**

Correct Inserting

When adding RDFW units, it is extremely important that the upper RDFW unit is correctly inserted into the unit beneath it. The colored tips of the upper RDFW unit should always be tucked towards the *inside* of the wall when slid into the unit beneath. This will prevent sand from leaking from the wall.

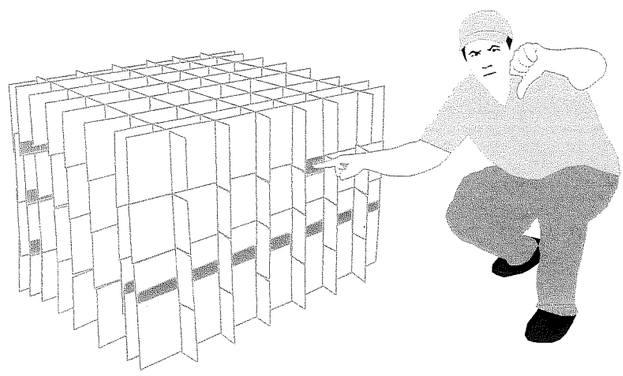
The colored tips provide an instant indicator of correct insertion. When a unit is correctly inserted into the unit below, the colored tip of the upper unit should always be hidden inside the wall. When all units are correctly inserted, you should see only a single colored stripe running 12 inches above the ground.

RIGHT!



If all units are correctly inserted, only a single colored strip running 12 inches above the ground will be visible on the outside faces of the wall.

WRONG!



If any unit is incorrectly inserted, its colored tips will provide an instant indicator. Remove the incorrectly inserted unit and insert it again correctly.

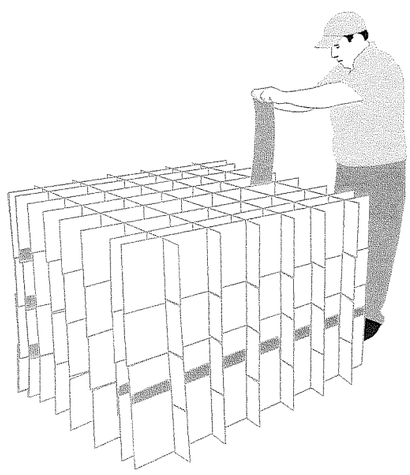
Step **7**

Sealing The Ends

Before filling your wall with sand, there is one final step in the construction process.

If your RDFW crates shipped with **End Closure Insert** pieces, they should be used to seal the ends of your wall. Slide the **End Closure Insert** pieces into the ends of your wall.

If your crate did not ship with **End Closure Insert** pieces, you may have to build a small stack of sandbags up against the end of your wall to prevent sand leakage from the end.



*To seal the ends of your RDFW wall, insert the **End Closure Inserts** into your wall and hang them from the edge. By covering the gap between the RDFW layers, the **End Closure Inserts** will help prevent sand leakage at the ends of your wall.*

*If your crate did not include **End Closure Inserts**, you may have to build a small stack of sandbags up against the end of your wall to prevent sand leakage.*

Step **8**

Filling With Sand

Your wall is now ready to be filled with sand. Dump sand into your wall using a loader, backhoe, or other heavy equipment.

Use a board or shovel to level the top of your wall, pushing uneven sand piles into any empty cells. Leaving a clean, level surface will greatly improve your ability to monitor your wall for leaks or settling.

When you fill your wall with sand, it is often easier to start at one end rather than in the middle.

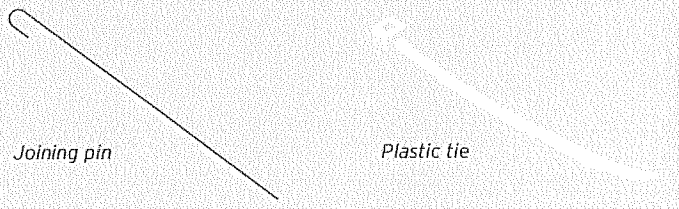
Technical specification sheet

Floodline™ units

A geotextile lined unit for use in flood protection applications. The design of these units reduces permeability of the wall when filled. Floodline units are designed for easy removal. Suitable for filling with earth, sand, or well graded gravel. Floodline units may also be used in other applications.

General specifications
Geotextile lined welded wire fabric gabion to ASTM A 974-97. The geotextile is a heavy-duty, non-woven, permeable, polypropylene fabric, available in either green or sand color.

Joining pins are supplied to join units together. Plastic ties are supplied to close the geotextile together at the top of unit ends. This prevents fill material from falling between unit joints.



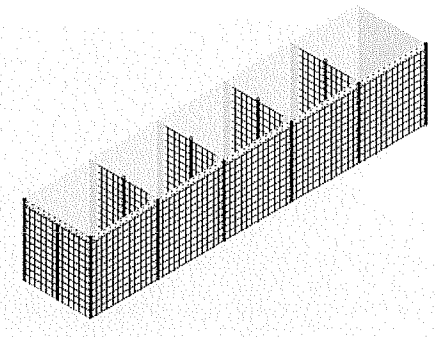
Welded wire mesh

Wire	
Wire gauge	8.5 American SWG, steel
Wire diameter[1]	0.155"/3.937mm
Tensile strength of wire	80 - 110 ksi 550 - 760 kPa
Corrosion Protection	Zn-5Al-MM to ASTM A 856A/A 856M-03 minimum coating weight 0.8oz/ft² / 240g/m²
Mesh	
Wire spacing	3" x 3"
Tolerance on line wire spacing	+/- ⅛"
Cross wire straightness across test panel	limit of deviation ¼" in 72"
Mesh strength	70% of wire tensile strength
Panels	
Squareness	in 4' diagonals shall not vary by more than ⅝"
Flatness	in 6' not more than 2" from plane

[1]Wire diameter is nominal

F-3-3-15

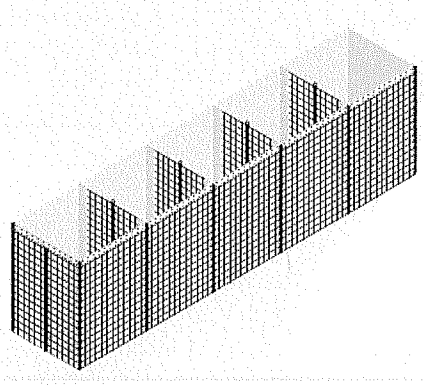
H-3' W-3' L-15' (5 cells)



Geotextile	Standard	Value
Mechanical Properties		
Grab Tensile Strength (Machine Direction)	ASTM D 4632	130lbs
Grab Tensile Strength (Cross Direction)	ASTM D 4632	160lbs
Grab Elongation (Machine Direction)	ASTM D 4632	50%
Grab Elongation (Cross Direction)	ASTM D 4632	55%
CBR Burst	ASTM D 6241	450lbs
Cone Drop Test	EN 918	24mm
Endurance Resistance		
UV Resistance (% retained after 500hrs)	ASTM D 4355	70%
Chemical Resistance	EN 14030	80%
Oxidation Resistance	EN 13438	80%
Hydraulic Properties		
Apparent Opening Size	ASTM D 4751	70 US Std. Sieve
Permittivity	ASTM D 4491	1.30sec⁻¹
Permeability	ASTM D 4491	0.24 cm/sec
Water Flow Rate	ASTM D 4491	100 gpm/ft²

F-4-3-15

H-4' W-3' L-15' (5 cells)



The values given are indicative and correspond to average results obtained in our suppliers' laboratories and in testing institutes. The right is reserved to make changes without notice at any time.

EP/T55/103/1.0/FEB09

HESCO Bastion USA 47152 Conrad E. Anderson Drive, Hammond, LA 70401
Email: info@hesco-usa.com Web: www.hesco-usa.com

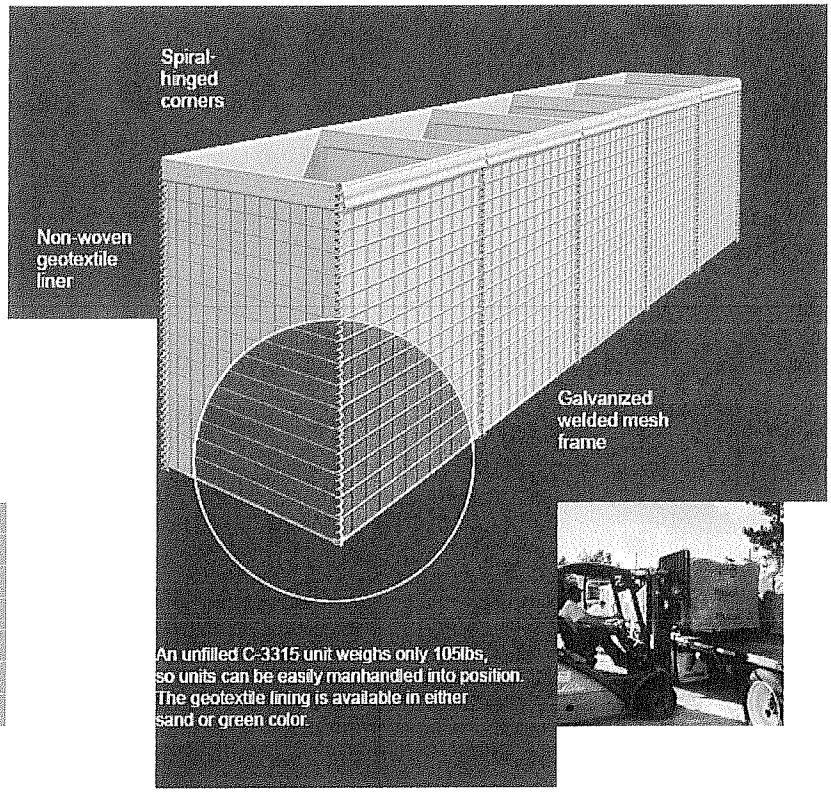
What is Concertainer?

One system, four products

The patented Concertainer design provides a cellular structure, using a welded mesh framework and geotextile lining. When joined and filled, the system can be used to create walls of exceptional strength and structural integrity. All products are pre-assembled and delivered packed flat, with joining pins to enable the connection of individual units.

The four products are the Concertainer unit; Floodline unit – a specialized flood-protection unit; Rockface – a part-lined gabion; Rockbox – an unlined cellular gabion. For more details, please use the links below.

Concertainer® unit
Concertainer Floodline™ unit
Concertainer Rockface™ unit
Concertainer Rockbox™ unit
Simple and efficient
Sandbags v Concertainer
Tested to the limit



News and archive Site map Legal disclaimer

Floodline

A geotextile-lined unit for use in flood-protection applications. The design of these units reduces permeability of the wall, when filled. Floodline units are designed for easy removal and are suitable for filling with earth, sand, or well-graded gravel. Floodline units may also be used in other applications.

There are two standard sizes of Floodline units: F-3315 and F-4315, as shown.

Joining pins are supplied to join units together. Plastic ties are supplied to close the geotextile together at the top of unit ends, which prevents fill material from falling between unit joints.

General specifications
Geotextile lined welded wire fabric gabion to ASTM A 974-97.

Welded Mesh, coils and pins
Hesco Concertainer units are manufactured with a Alu-Zinc coated welded wire mesh. The mesh has a spacing of 3" x 3" and a wire gauge of 8.5 American SWG, steel/diameter of 0.155"/3.937mm (nominal).

Geotextile
The geotextile is a heavy-duty, non-woven, permeable, polypropylene fabric, available in either green or sand color.

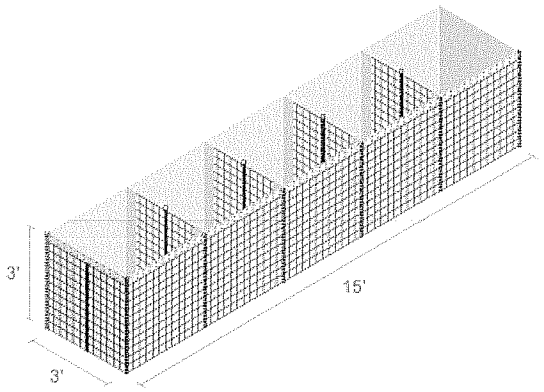
Detailed specifications
For detailed technical specifications on Floodline units, or all HESCO Bastion USA products, use the links below:

> Floodline Technical Specification Sheet

> All products Technical Specification Sheets

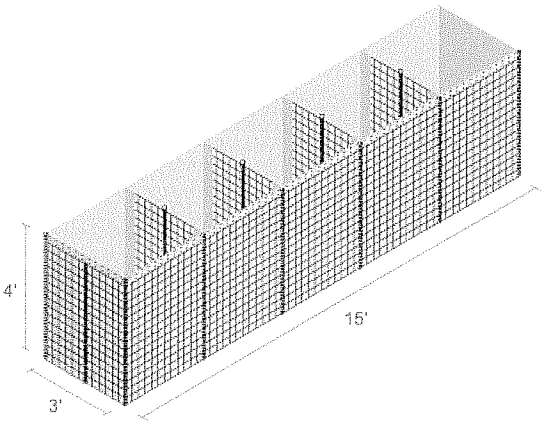
F-3315

H-3' W-3' L-15' (5 cells)



F-4315

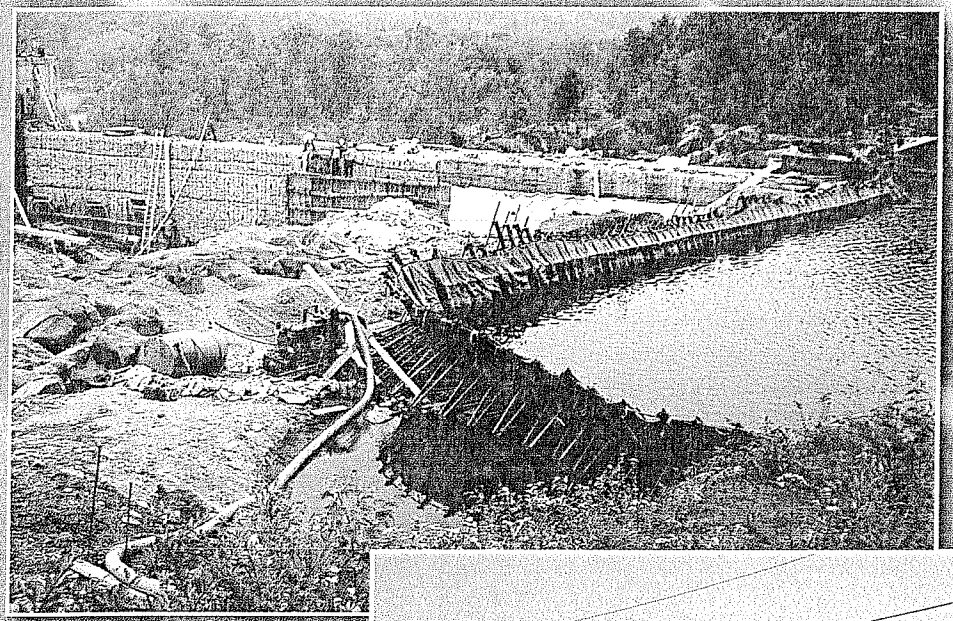
H-4' W-3' L-15' (5 cells)



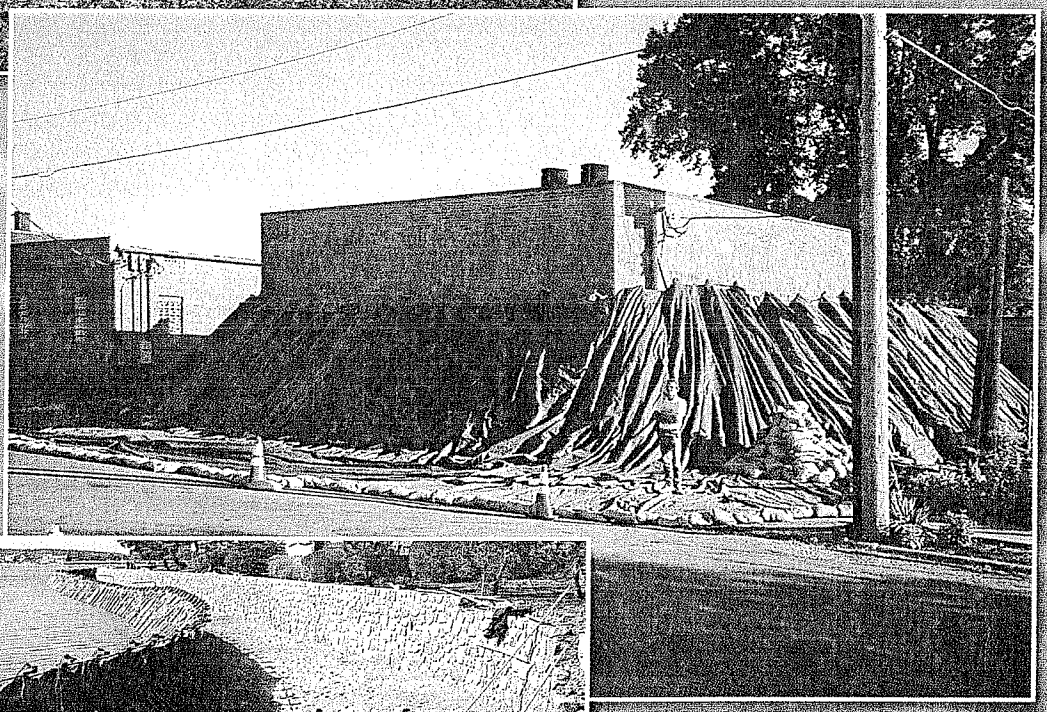
Back

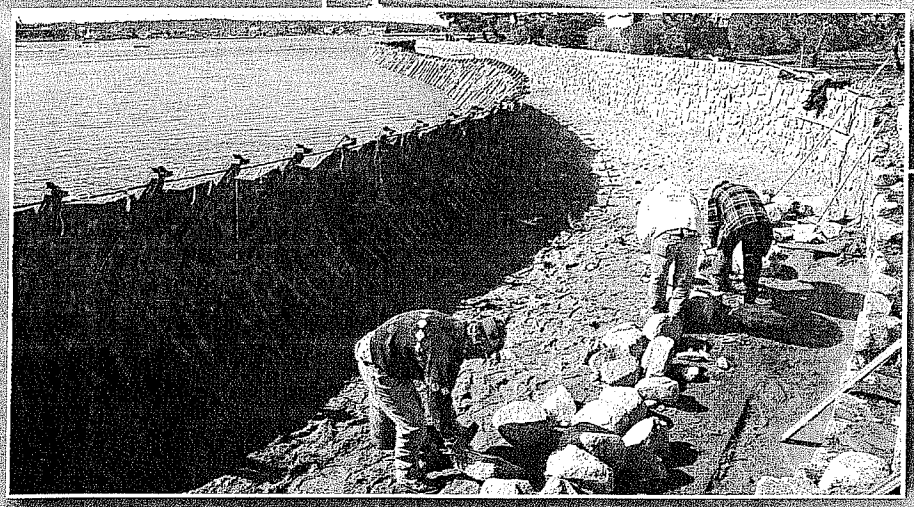
PORTADAM, INC.

FLOOD FIGHTING TECHNOLOGY FOR THE 21ST CENTURY

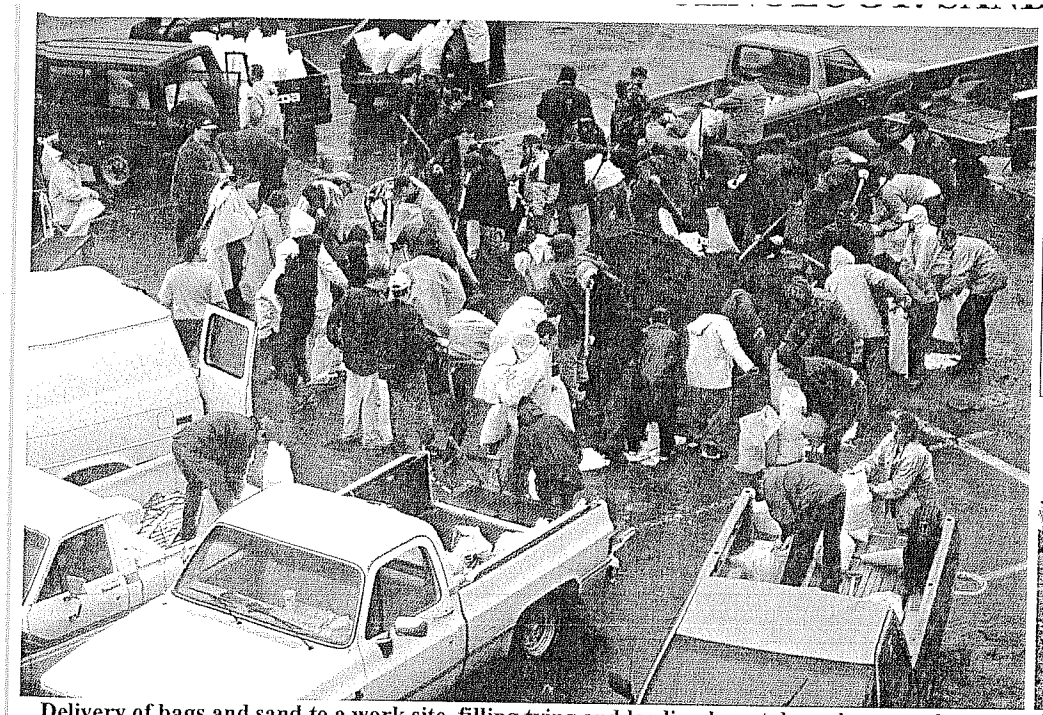


PORTADAM, INC. is equipped to provide you with approved technologies, recognized throughout the U.S. as the environmentally friendly alternative to water diversion & cofferdamming.

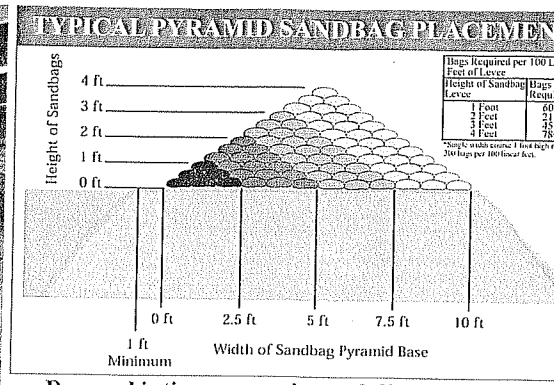




Builders of cofferdams and diversion structures for over 25 years.



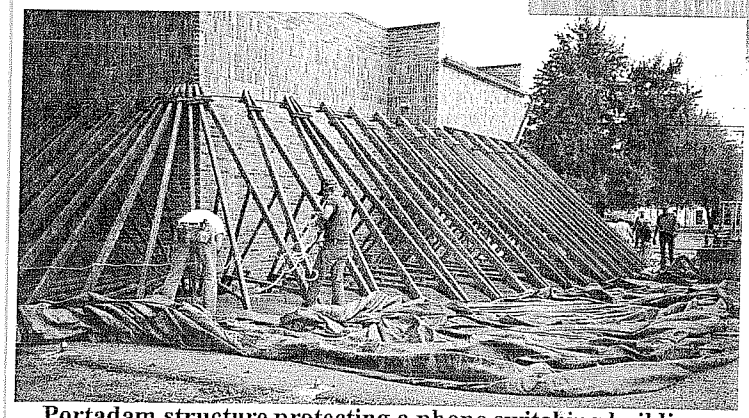
Delivery of bags and sand to a work site, filling tying and loading bags takes a large work area



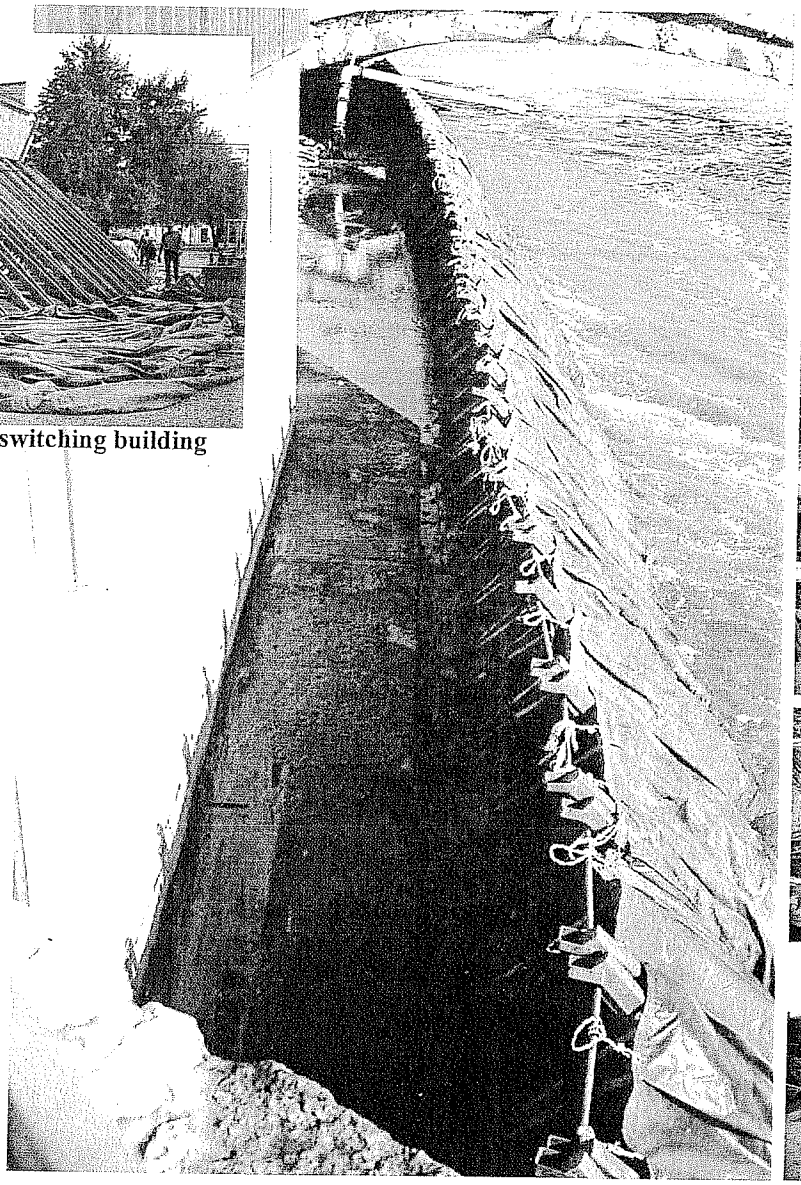
Removal is time consuming and disposal is messy

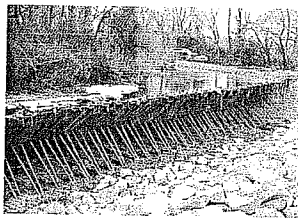
Requires extensive equipment and manpower to depl

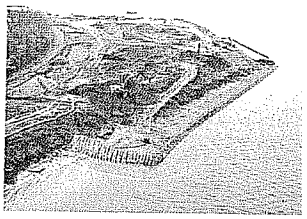
AVAILABLE TECHNOLOGY: PORTADAM SYSTEM

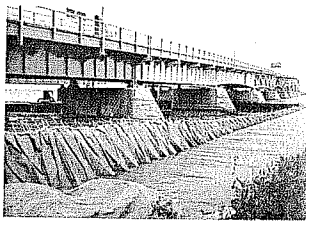


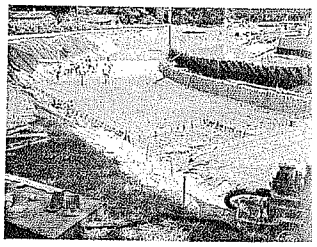
Portadam structure protecting a phone switching building

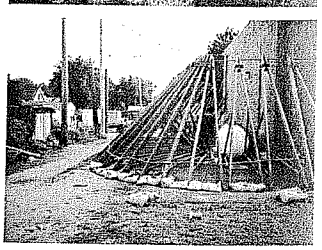












PORTADAM ADVANTAGES

- Ease of construction and removal
  - Time
  - Manpower
  - Equipment
- Low seepage rates
- No sand fill required
- High degree of reusability
- Conforms to varying terrains
- Available in multiple height configurations
- Environmentally safe
- Minimal storage requirements
- Cost effective
- Readily available

"USACE Districts are frequently contacted by vendors who market alternative flood-fighting products that they advertise as more efficient than sandbags while being cost competitive. As the nation's leader in flood fighting, the USACE is providing a scientific framework to enable evaluations of these various flood-fighting products. Initial research, testing, and evaluation of some flood-fighting technologies have been conducted at the U.S. Army Research and Development Center (ERDC). This effort provides performance, operational, and economic information on the tested flood fight technologies that will assist the flood fighting community in the selection of appropriate flood fighting products."

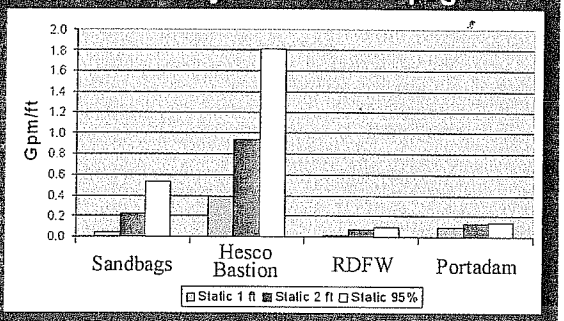

Portadam as delivered

Laboratory Results

Structure	Construction Effort (man hours)	Removal Effort (man hours)
Portadam	24.4	4.4
Hesco	20.8	13.4
Sandbags	205.1	9.0
RDFW	32.8	42.0

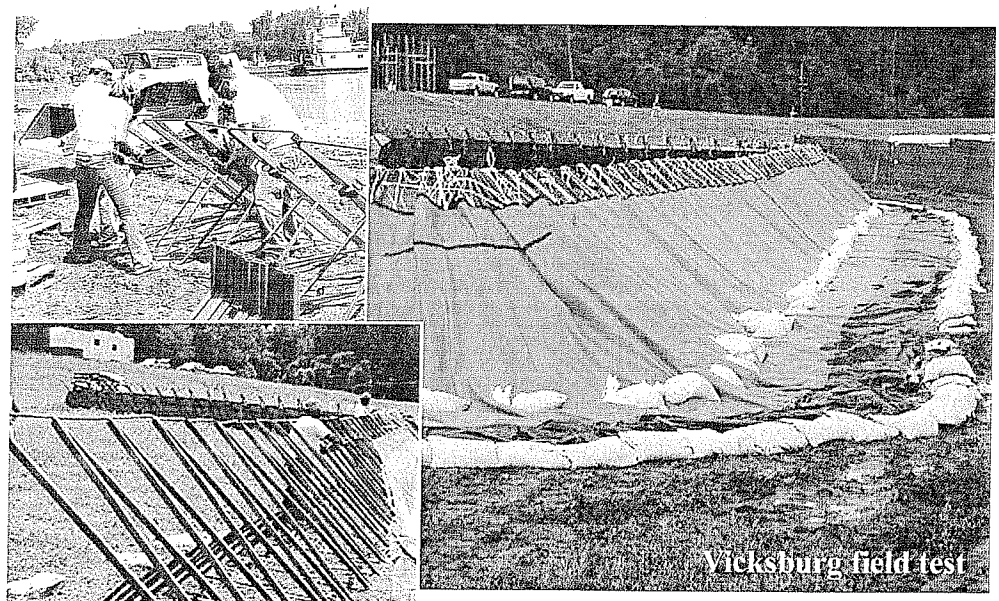
Information obtained from the ACOE Coastal and Hydraulics laboratory / Geotechnical and Structures Laboratroy website

Laboratory Results - Seepage



Information obtained from the ACOE Coastal and Hydraulics laboratory / Geotechnical and Structures Laboratroy website

All performance data contained herein has been retrieved directly from the ACOE website.


Vicksburg field test

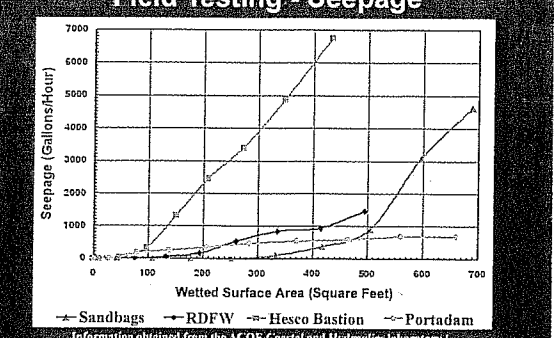
Field Testing
Construction and Removal

Structure	Construction Time (hours)	Construction Effort (man hours)	Removal Time (hours)	Removal Effort (man hours)
Portadam	5.1	26.2	2.9	12.6
Hesco Bastion	8.9	57.5	8.7	36.3
Sandbags	30.5	453.1	2.6	3.5
RDFW	7.5	48.4	17.3	113.4

Information obtained from the ACOE Coastal and Hydraulics laboratory / Geotechnical and Structures Laboratroy website


Wilkes-Barre, PA

Field Testing - Seepage



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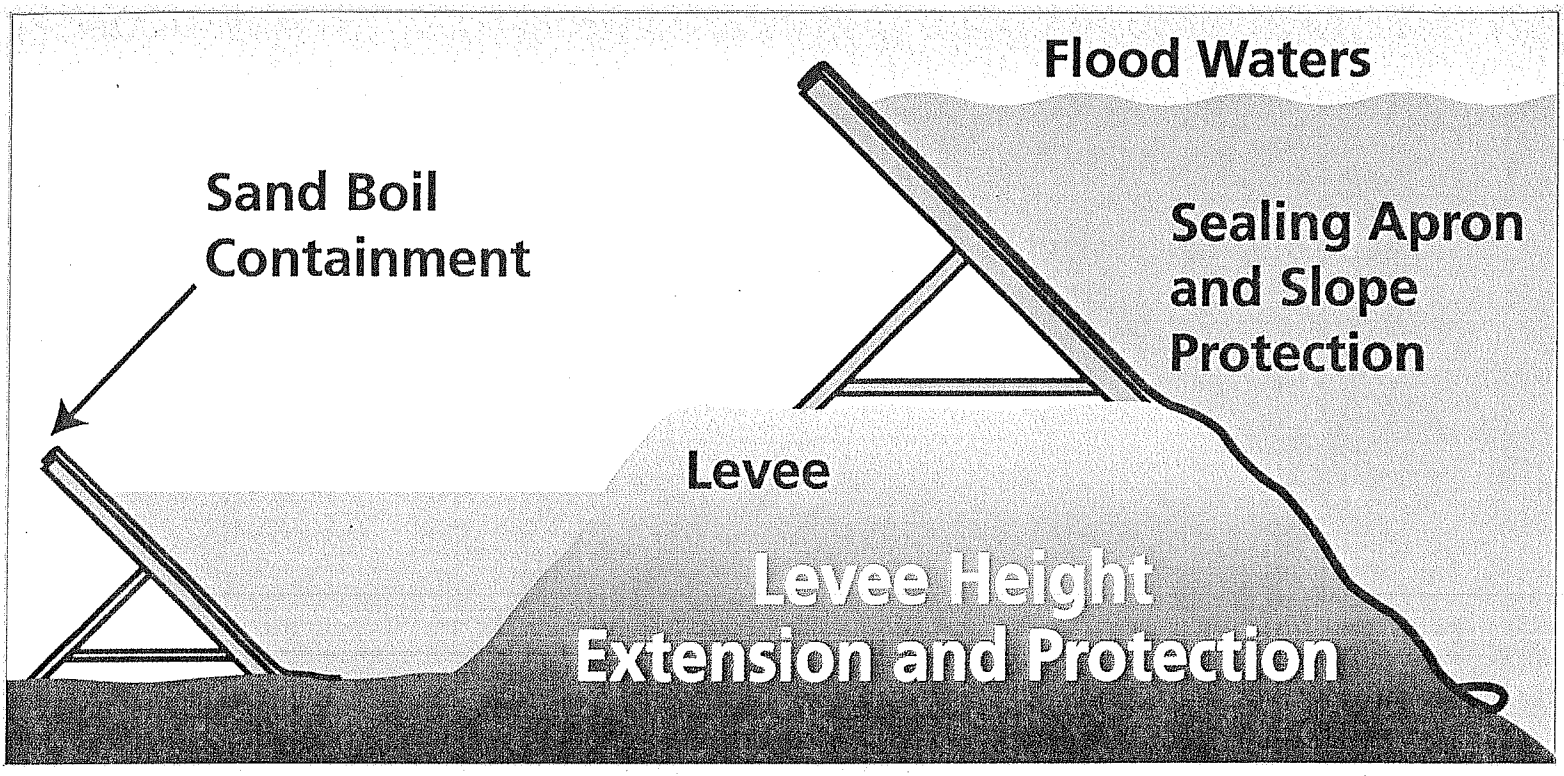

PORTADAM, INC.

DIVERSION AND COFFERDAM STRUCTURES

Corporate Office
3082 South Black Horse Pike
Williamstown, NJ 08094
856-740-0606 *phone*
856-740-0614 *fax*
800-346-4793 *toll free*

Southeast Region
154 Falcon Drive, Suite B
Forest Park, GA 30297
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92 Lincoln Street
Dover-Foxcroft, ME 04426
207-564-7878 *phone*

Southwest Region
2761 Oakland Avenue
Garland, TX 75041
972-278-1640 *phone*

Northwest Region
Warehouse
Vancouver, WA

Western Region
Coming Soon

www.portadam.com

Portadam, Inc. Portable Diversion and Cofferdam Structures

Portadam® is a time-proven temporary, portable cofferdam, water diversion or fluid retention system for use in open water up to 12 feet deep. Portadam is used for construction, remediation, rehabilitation, flood protection and inspection projects in rivers, streams, lakes, reservoirs and other retaining areas.

By utilizing a unique free standing steel support system and impervious fabric membrane, the Portadam® technique allows many types of in-water construction to be accomplished in a "dry condition" without the need for excavation or fill, costly pile driving equipment, or time consuming sandbag dikes.

The Portadam® system consists of two main components; a welded tubular steel framework support and a flexible waterproof membrane permitting easy installation in any configuration and over uneven bed contours.

The Portadam® system utilizes the mechanical, resistive and flexible properties of modern synthetic fabrics to provide both temporary and semi-permanent barriers for fluid impoundment and control.

The system support members are designed to transfer fluid loading to a near vertical downward load, thereby permitting installation on solid impenetrable foundations while eliminating the need for internal bracing which obstructs the work area. In contrast with driven sheet piling, this structure literally free-stands on the existing bed, eliminating the need for pile driving equipment, crossbracing and anchorage. Hydraulic loading on the membrane assists sealing and stability of the entire structure.

As the provider of a time-tested portable membrane cofferdam system, Portadam® possesses twenty-five years of experience in manufacturing, distributing and installing temporary cofferdam systems used for dewatering, water diversion and water retention. For more information, visit Portadam's website at www.portadam.com or contact us at our Williamstown, NJ Corporate Headquarters, 856-740-0606

PORTADAM, INC.

DIVERSION AND COFFERDAM STRUCTURES

Flood Fighting Equipment Installation Instructions

Portadam, Inc.
3082 South Black Horse Pike
Williamstown, NJ 08094

856/740-0606 **800/346-4793**

Atlanta, GA Dallas, TX Vancouver, WA Racine, WI
Dover-Foxcroft, ME Reno, NV

Portadam Flood Fighting System Installation Instructions

Page 1 Frame Hardware and Connections

1	Place 2 individual frames on the ground (as shown), aligning the tabs on cross beam.
2	Insert an 18" long bolt thru tab then thru ½" pvc sleeve and finally thru tab on adjacent frame.
3	Connect nut to long bolt as shown.
4	Perform same process on lower set of tabs (as shown).
5	Flip frames upright and insert link bar (as shown) in top opening of main beam.
6	Perform same process (pictures 1 – 5) again. This task forms a "pair of frames".
7	Insert 2nd long bolt on frame pair (as shown).
8	Stand 2nd pair of frames upright and place adjacent to 1st pair of frames (as shown).

Page 2 Clamps

9	Clamp pair top view
10	Clamp pair side view
11	Clamp pair bottom view. Tapered tabs always start at the top (narrow) to bottom (wide).
12	Clamp pair shows bolt placement thru front clamp half to back clamp half
13	3½" bolt screws into nut welded onto back clamp half
14	Turn clamp halves perpendicular to each other and insert between frame pairs (as shown).
15	After re-aligning clamp halves as shown, tighten with a ¾" ratchet wrench.
16	Tightened clamp ties one frame pair to another (as shown).

Page 3 Liner Connections ("Joiner").

17	Open all liners and lay them out end to end with joiners lined up as shown. (Also see photo 38)
18	Using an "R" clip, pull loop on one liner thru loop on adjacent liner
19	Loop has been pulled thru adjacent loop.
20	Insert "R" clip thru loop (as shown). Left "R" clip shows correct alignment, right shows incorrect alignment. (also see photo 21)
21	After all "R" clips are in place, pull two adjacent polyethylene panels together (as shown).
22	Roll both panels tightly together (as shown). Panels are white on one side black on the other.
23	Polyethylene panels rolled up will form a bundle approx 2¼ " in diameter.
24	Take the two flaps with opposing velcro strips attached and fold one over the other. This step locks the sealing panels tightly in and makes a watertight joint.

Page 4 Liner Sausaging

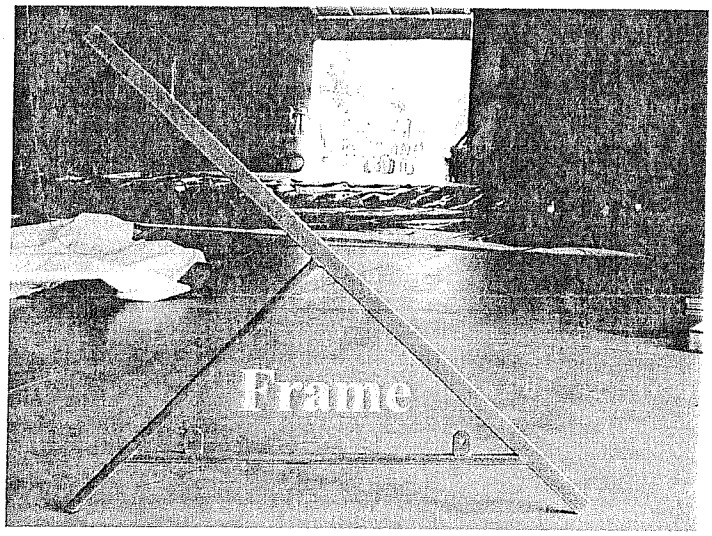
25	Liners have all been connected end to end. Note: Bottom section w chain is black, top is blue.
26	Take chain edge (bottom of black section) and pull to top edge of blue section
27	Liner shown folded in half.
28	Grasp bottom of black section and pull to top edge again.
29	Liner shown folded in quarters.
30	Grasp bottom of black section one last time and pull to top again.
31	Roll folded fabric into a workable bundle.
32	Tie fabric bundle with a slip-knot approx. every three feet.

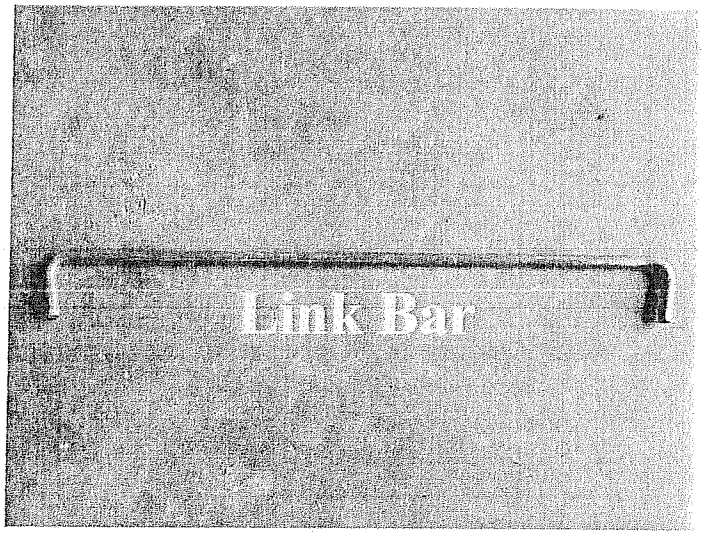
Page 5 Liner Attachment to Frames, Deployment and Sandbagging

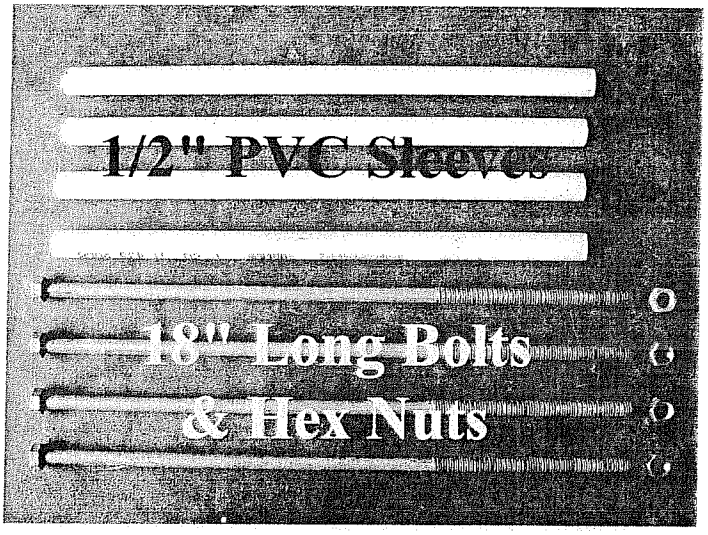
33	Place sausaged liner system at top of frames.
34	Attach liner to link bar at top of frames using a cable tie thru grommet (as shown).
35	Tighten cable tie.

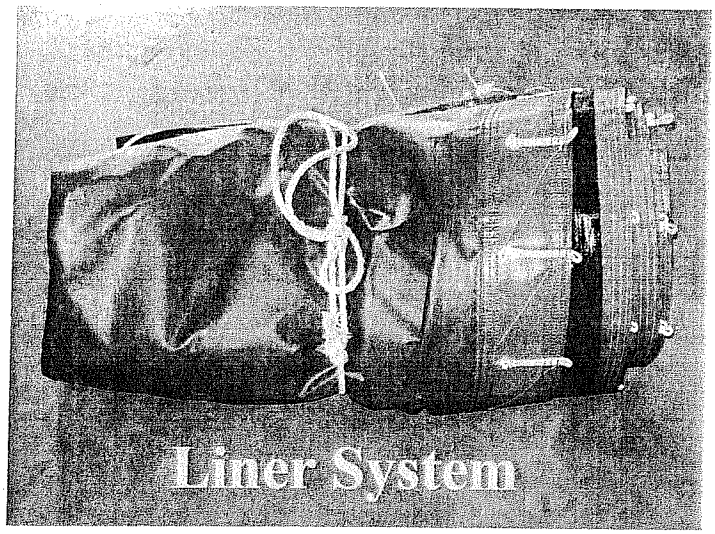
36	Take cable tie end and thread it back thru top slot in cable-tie lock block pulling it securely.
37	After entire liner has been attached to framework, deployment can begin by releasing the slip-knots tied around the sausaged fabric bundle.
38	Unwrap bundled liner pulling chain edge out and away from frames.
39	The chain edge of the liner system should be trenched into the ground, backfilled and sandbagged if a trenching machine is available.
40	Place a single line of sandbags over top of chain edge of fabric (entire length of dam).
Page 6 Installation Of Frames On An Incline	
41	Build frame pairs as described on page 1.
42	Place frame pairs on incline as shown keeping face (front) of frames aligned.
43	Attach clamp connecting two pairs of frames as described on page 2.
44	Clamp installation detail. Note: Remember to keep tapered tabs top (narrow) to bottom (large).
45	Note: Tighten clamp before placing next pair of frames.
46	Tighten detail showing clamps aligned properly.
47	Continue frame pair placement (steps 42 thru 45).
48	Tighten clamp showing frames aligned properly.
Page 7 90° Corners	
49	Building a 90° corner involves fanning out six individual frames (as shown).
50	Detail of frame and clamp placement. Note: Link bars are not used in corners.
51	It is important to have the frames in contact with tapered tabs on top clamp half (as shown). This assures proper spacing of the individual frames in the corner radius.
52	Open a straight liner section completely and pull the excess liner around and past the 90° corner frame assembly radius. This will cause the black sealing sheet/chain edge to pull in toward the frames. Pull and adjust the chain edge back to the normal distance (approx 12') from the frame toes, this will create a pile of excess fabric to form at the top of the frame radius (corner).
53	The excess liner will need to be "S" folded (as shown) starting on the side of the radius that has the pulled end of the liner. The "S" folds should be attached to the frames using cable ties thru the grommets as you go (see photo 55).
54	Continue making the "S" folds until all the excess liner fabric is neatly bundled (as shown).
55	Detail of cable tie attachment to "S" folded liner.
56	The "S" folded liner should look something like this after all the cable ties have been secured.

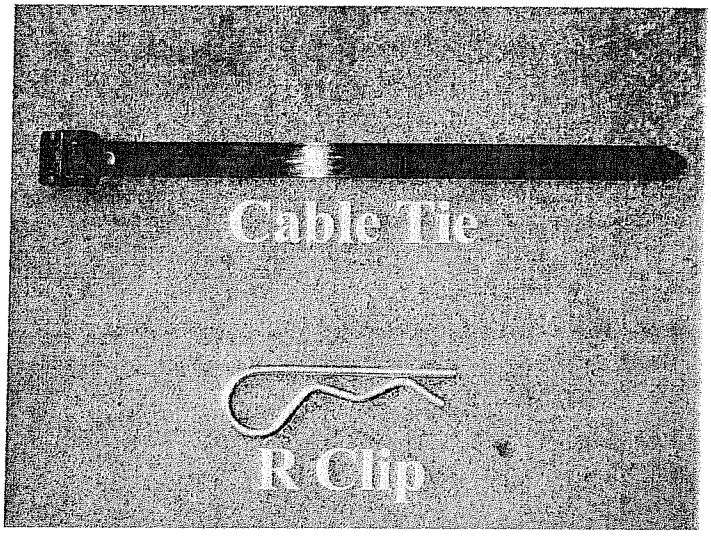
Portadam Flood Fighting System Component Identifier

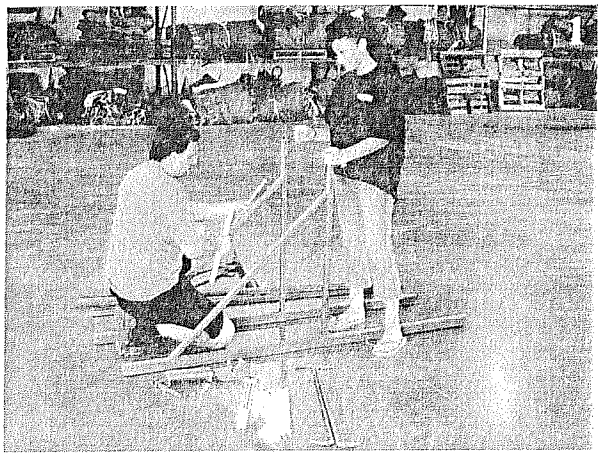








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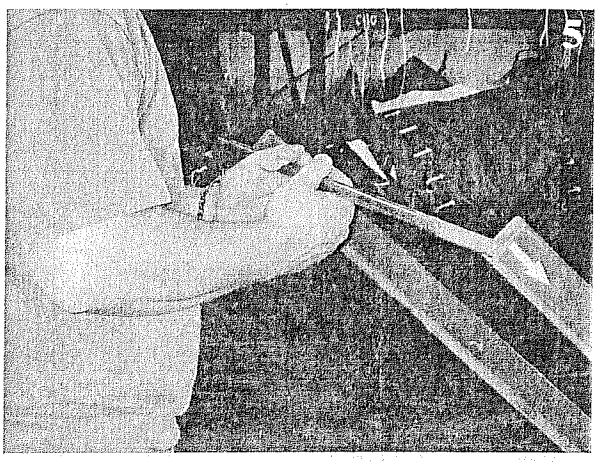
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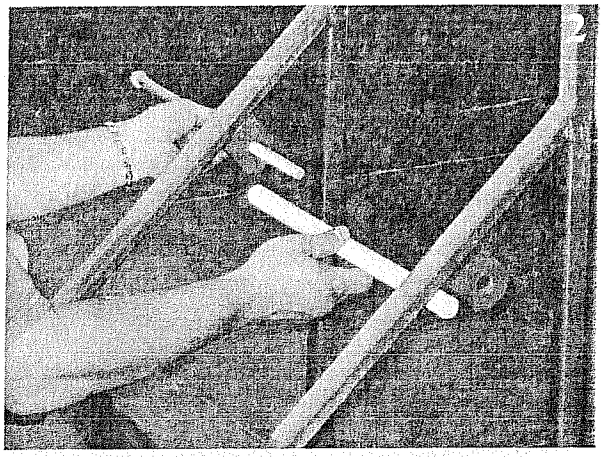
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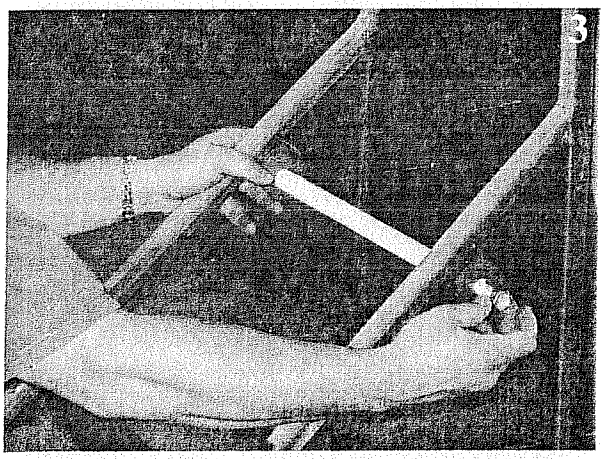
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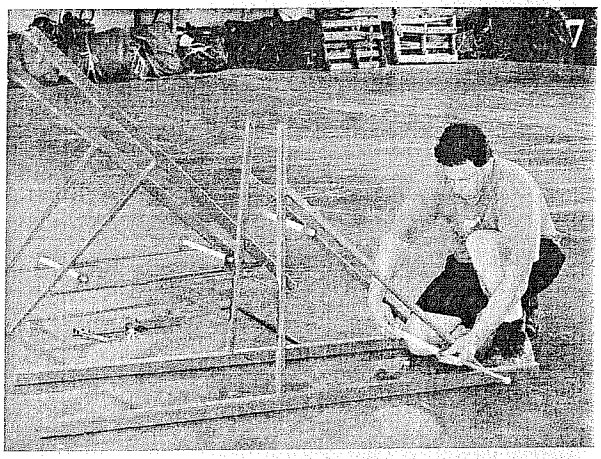
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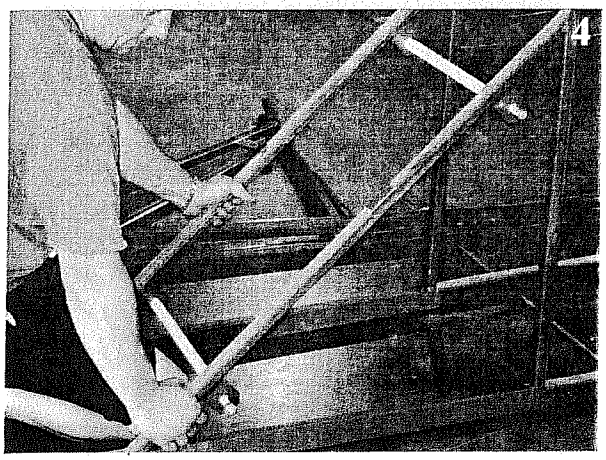
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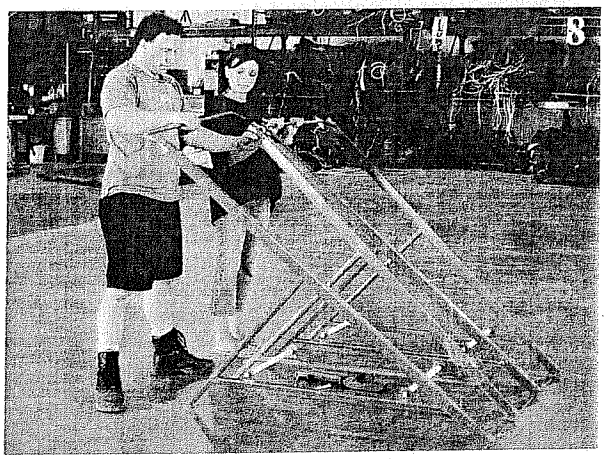
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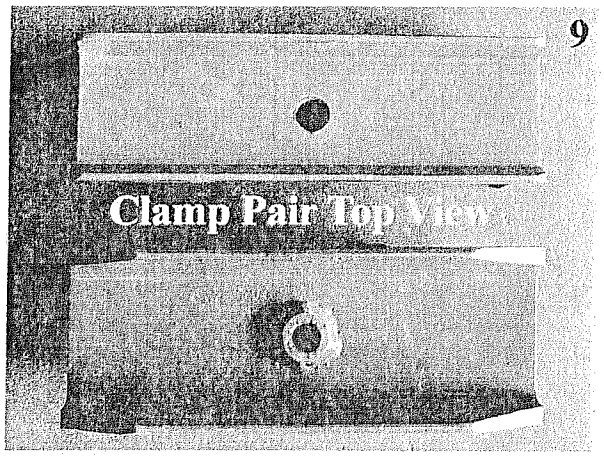
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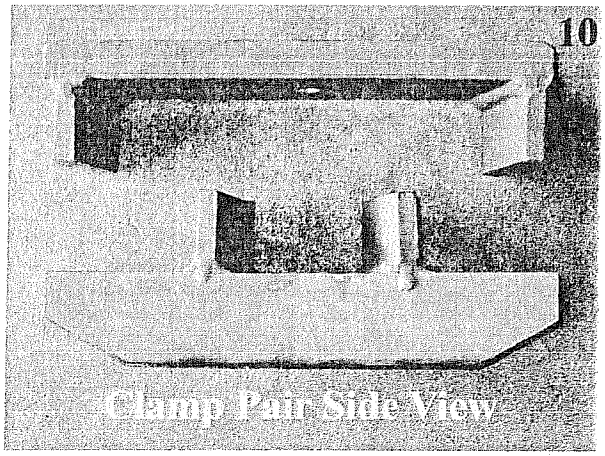
Clamp Pair Top View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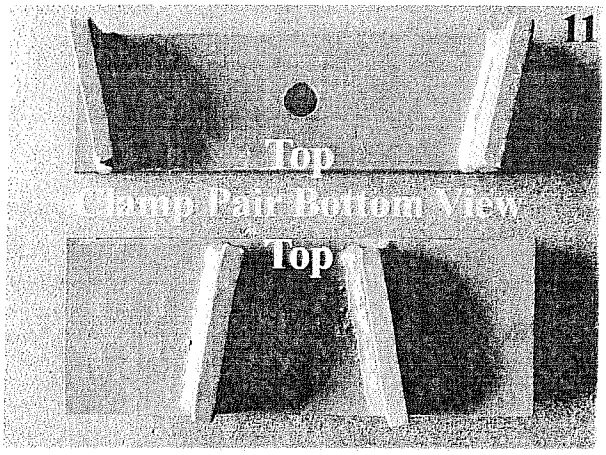
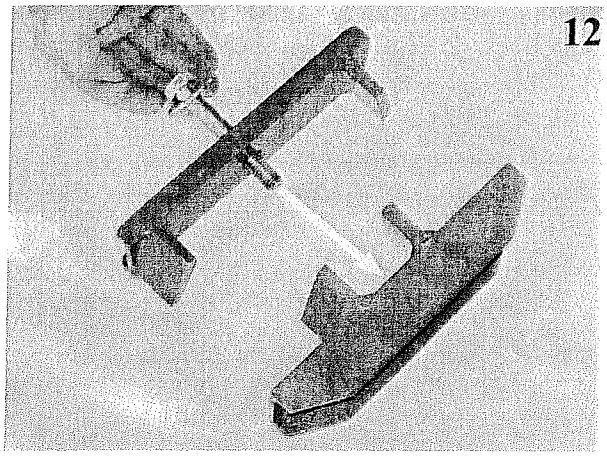
Clamp Pair Side View


11
Top
Clamp Pair Bottom View
Top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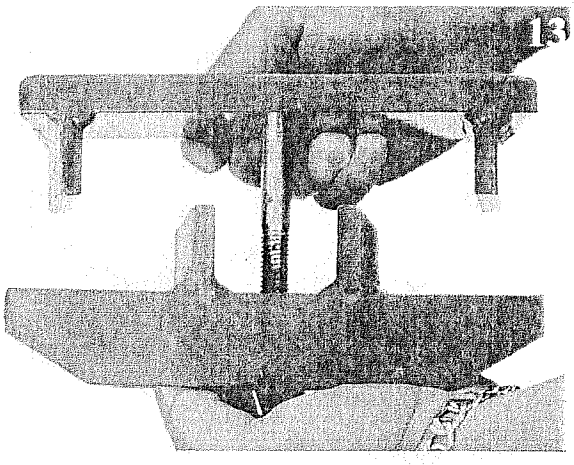
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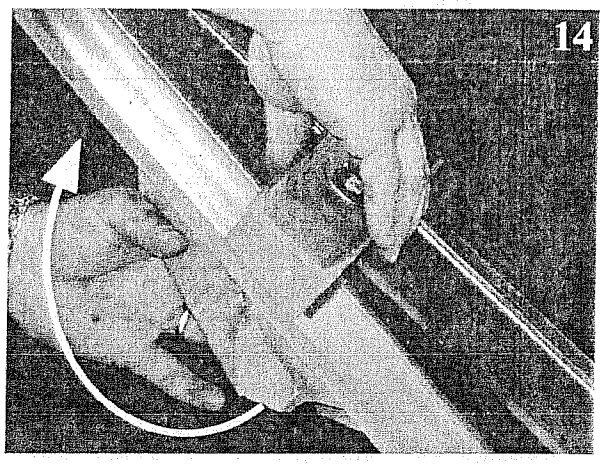
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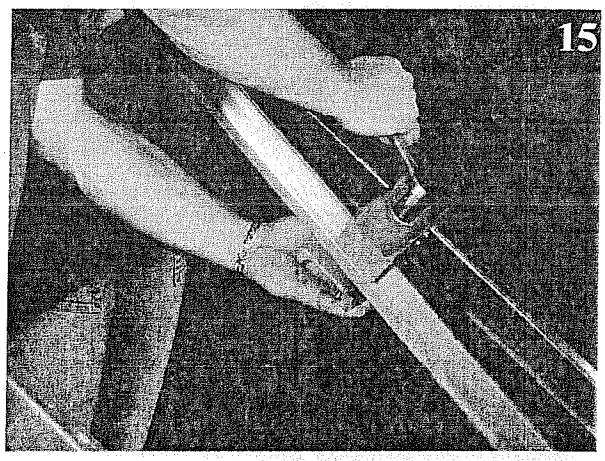
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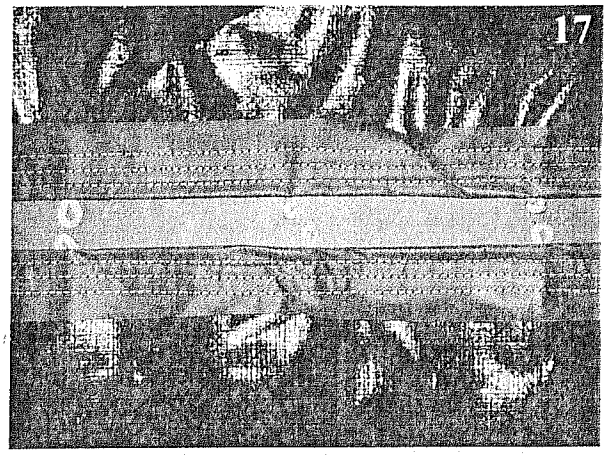
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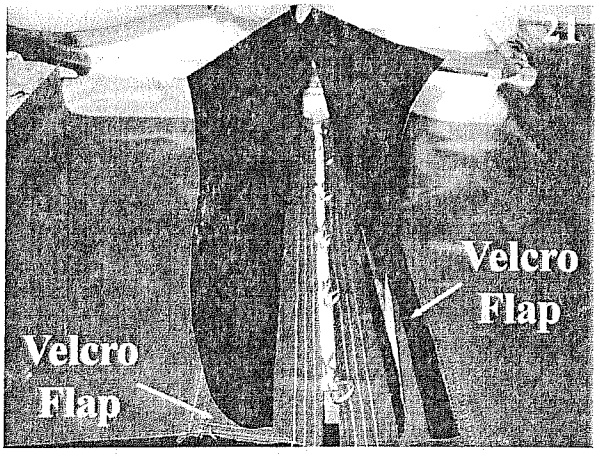
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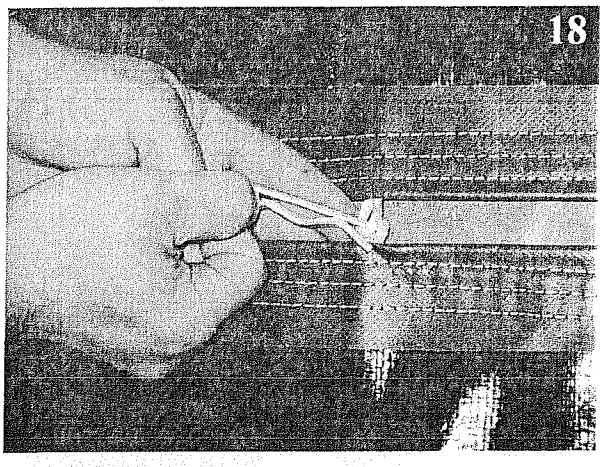
Velcro
Flap
Velcro
Flap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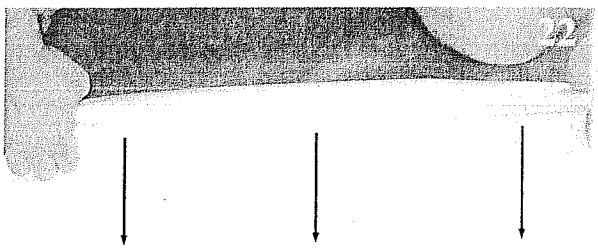
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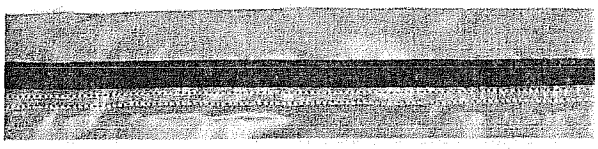

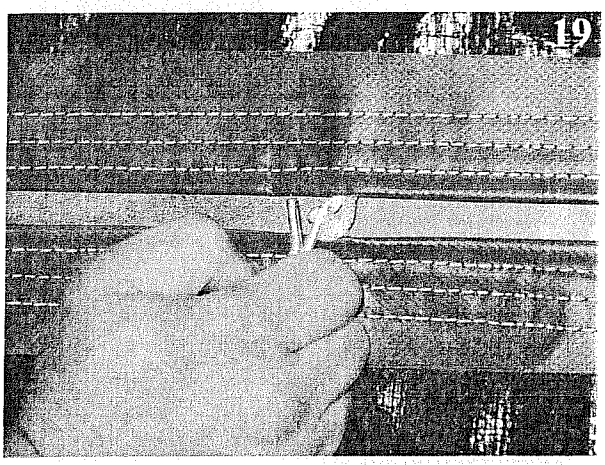
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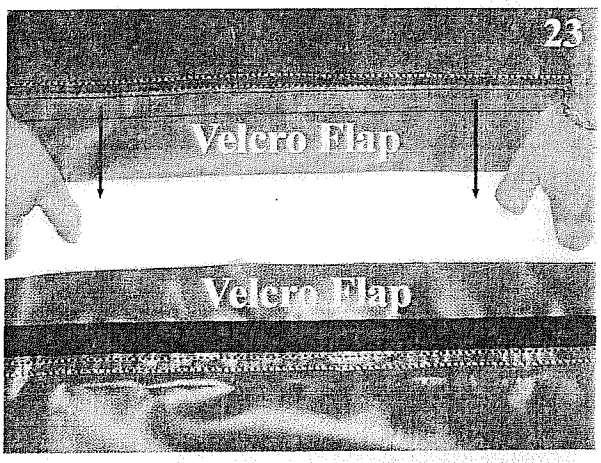
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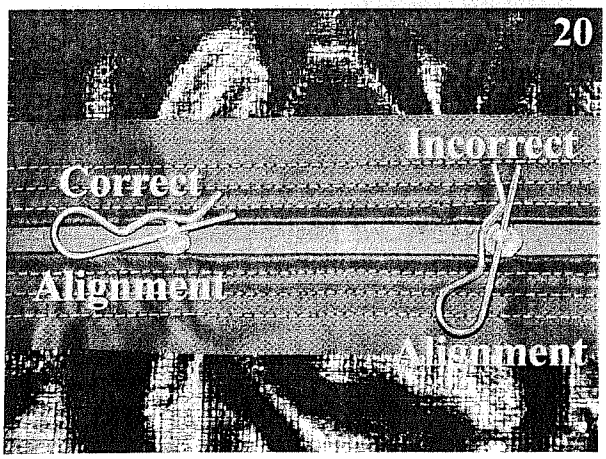
Velcro Flap
Velcro Flap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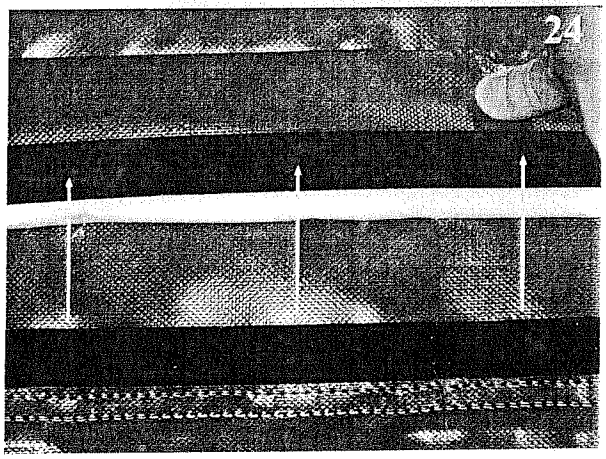
Incorrect
Correct
Alignment
Alignment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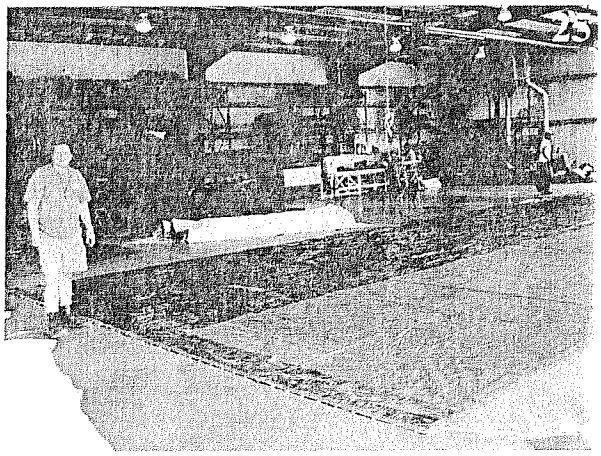
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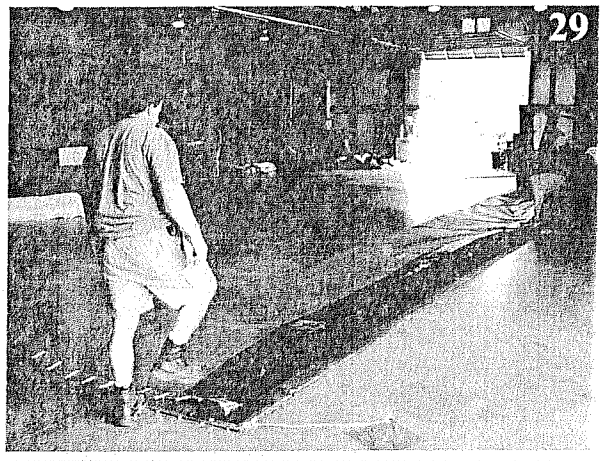
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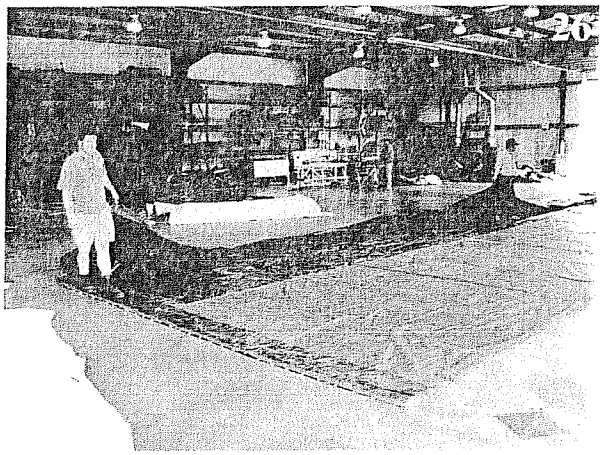
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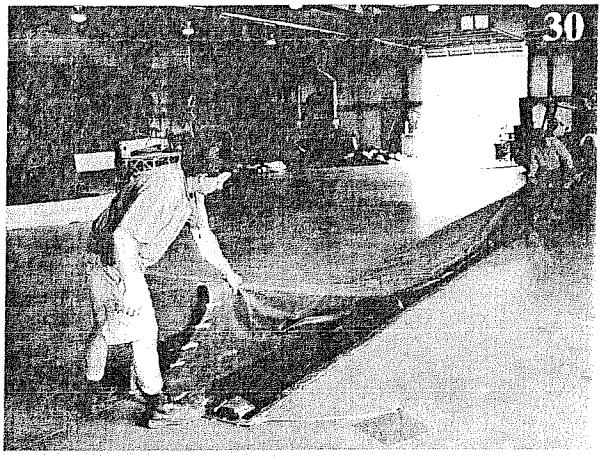
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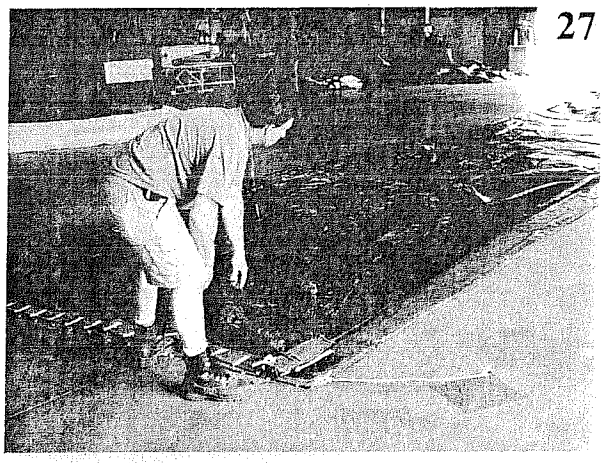
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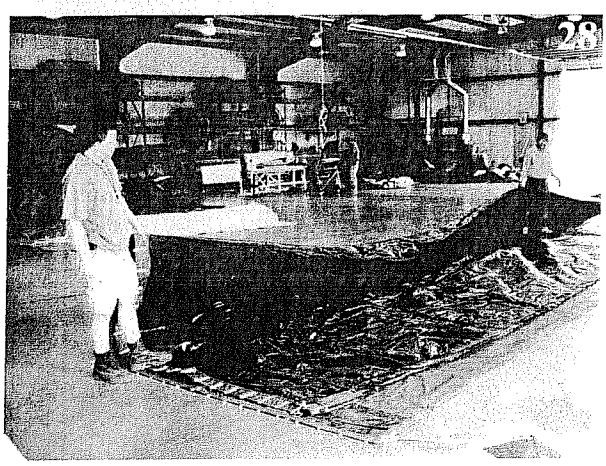
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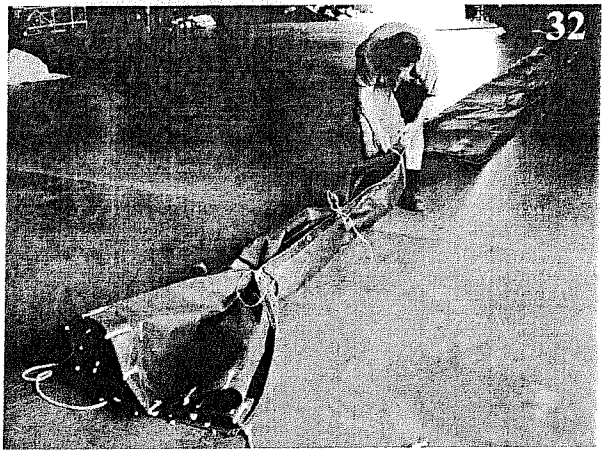
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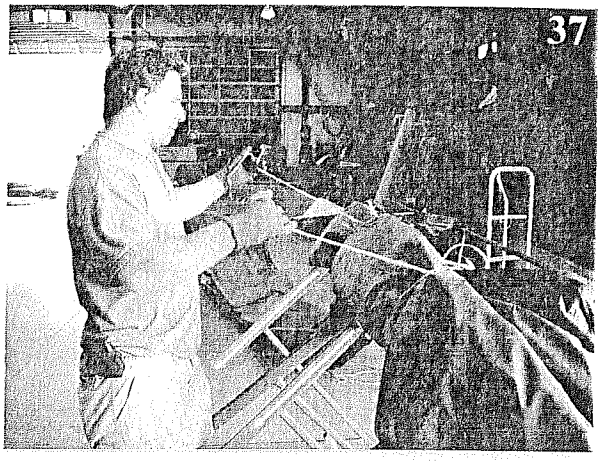
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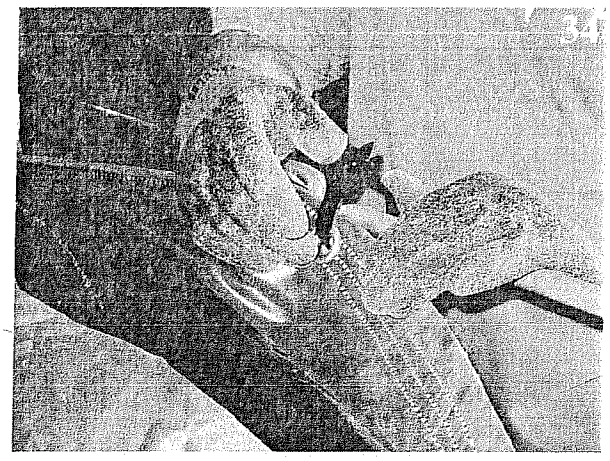
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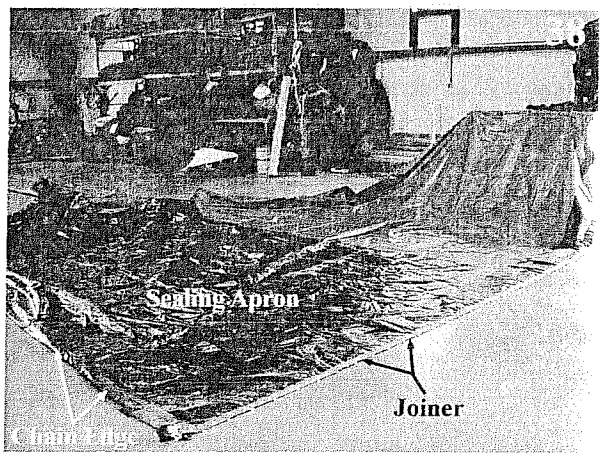
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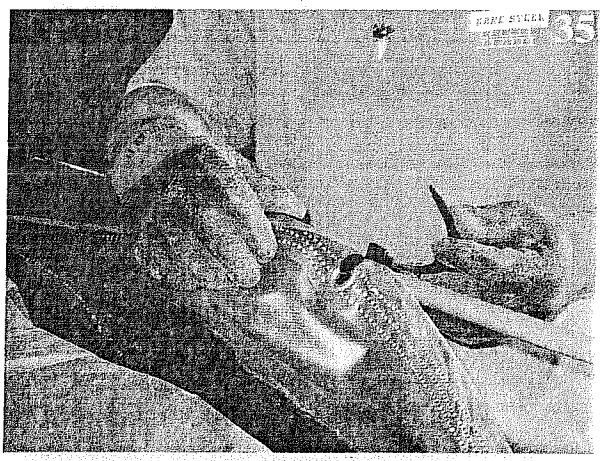
Sealing Apron
Joiner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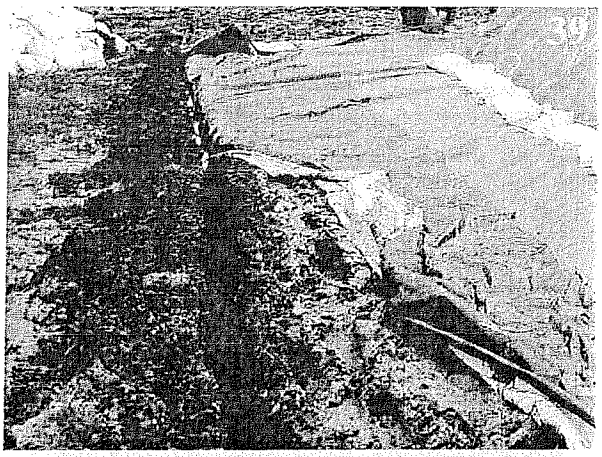
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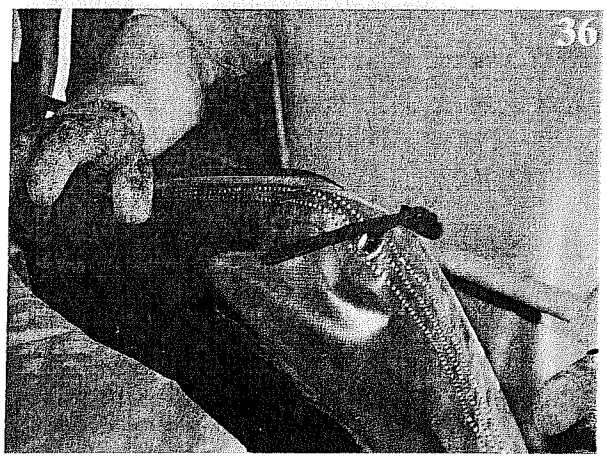
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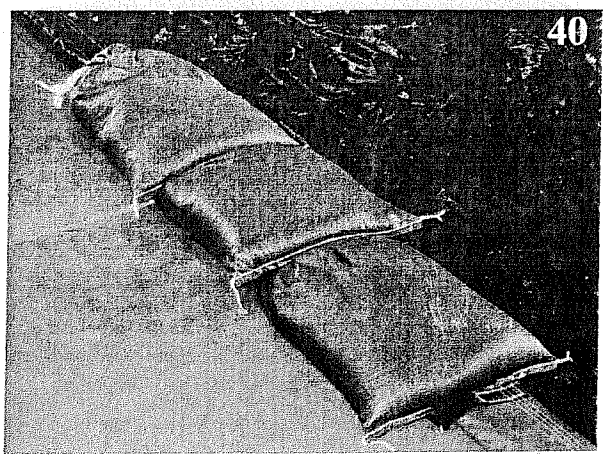
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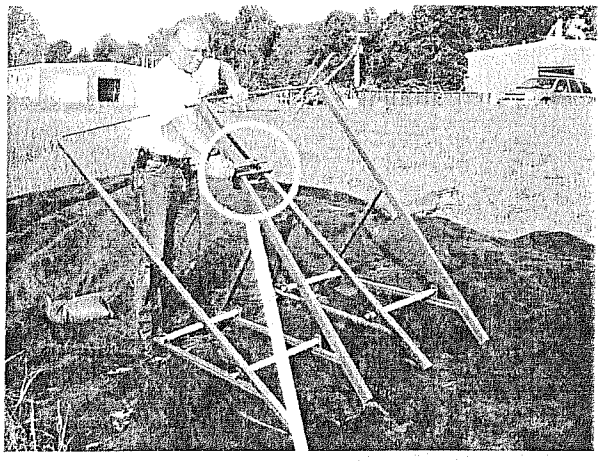
Incline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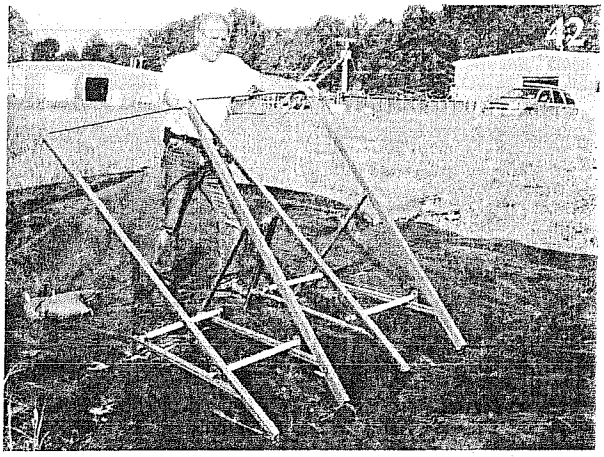
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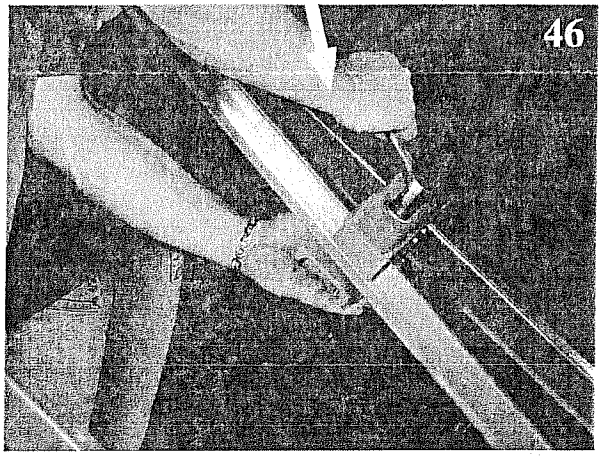
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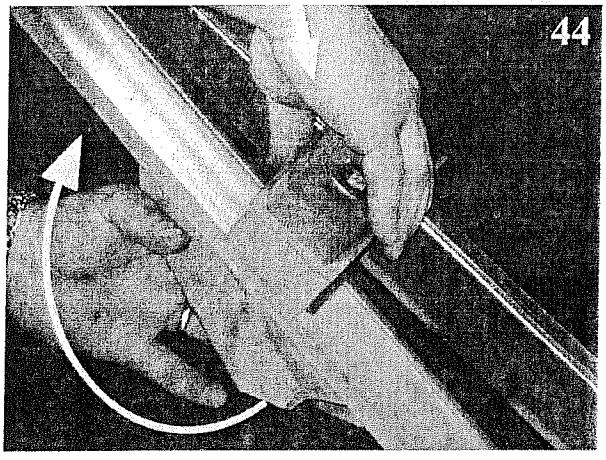
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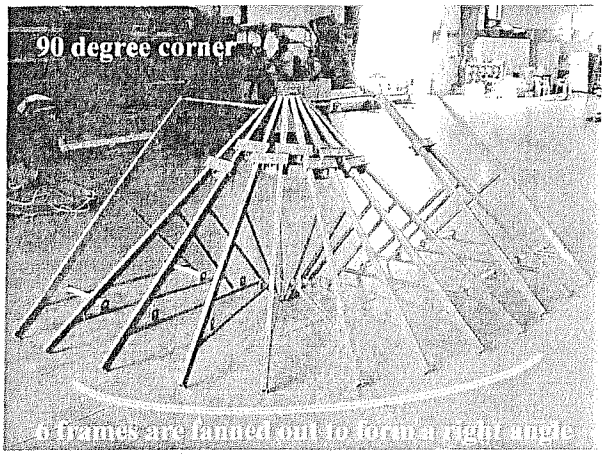
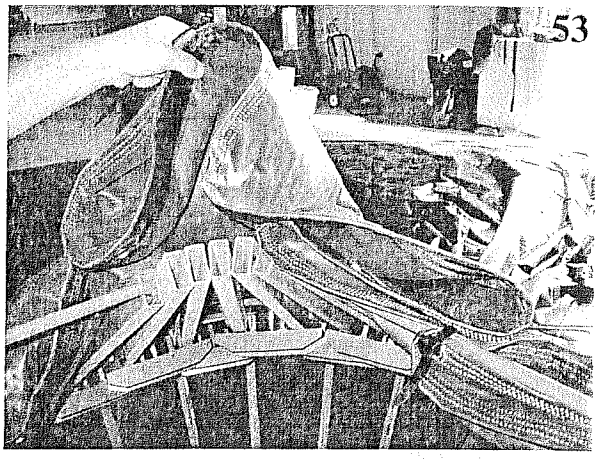

90 degree corner
6 frames are landed out to form a right angle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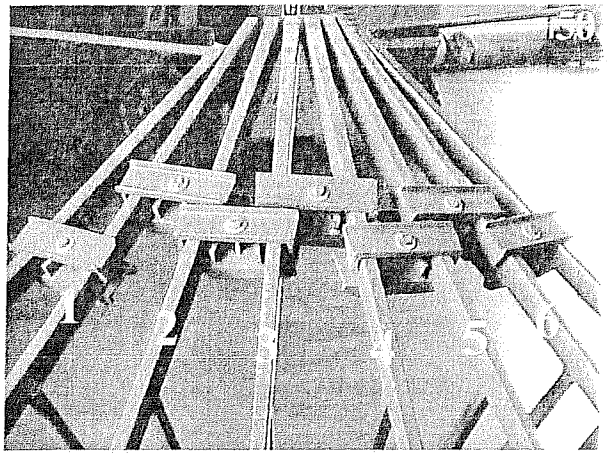
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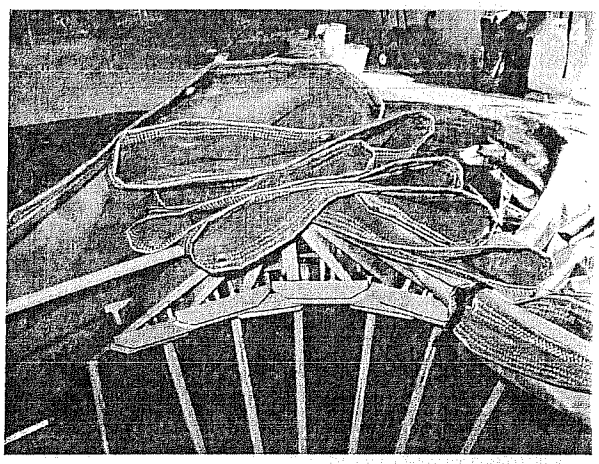

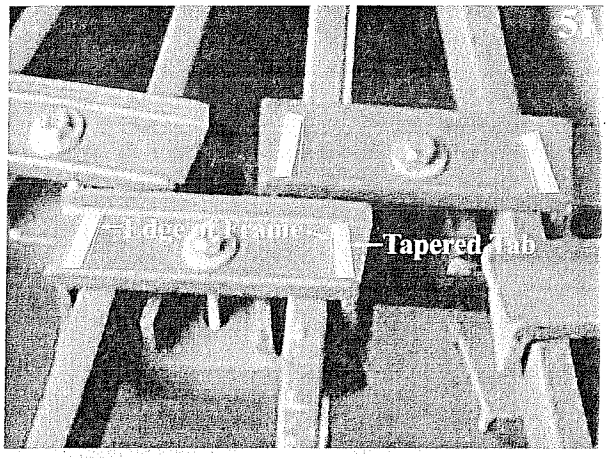
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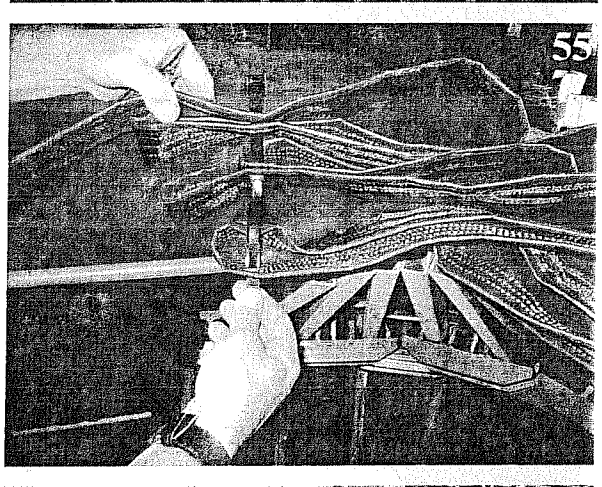
Edge of frame
Tapered Tab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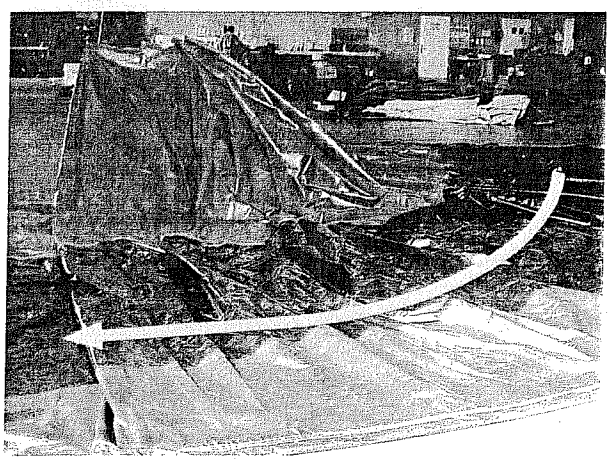

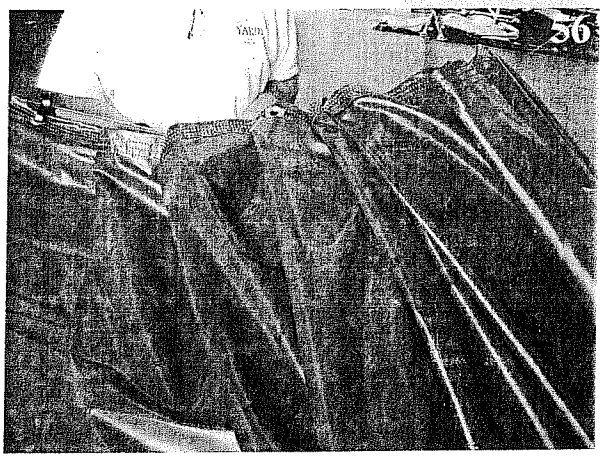
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FACT SHEET
Innovative Flood Fight Technology

Deployment Procedures:

Rapid Deployment Flood Wall (RDFW) product is shipped and stored in 50" X 60" X 40" crates containing 100 RDFW units per crate. The RDFW unit stands 48 inches wide and 8 inches tall. The units interlock horizontally and overlap to give a deployed width of 42 inches (3.5 ft) per unit. An Excel spreadsheet is available online (http://geocellsystems.com/estimator/) for calculating the amounts of materials required for barrier construction. To operate the spreadsheet, enter the length of the wall desired and the sheet will calculate the number of RDFW units and containers, and cubic yards of sand required, for various wall heights.

Hesco Bastion Concertainers are 4' high X 3' wide X 15' long and are shipped flat-packed on pallets. Each pallet contains 5-6 concertainers. Each pallet accommodates 75 to 90 LF of flood wall.

Portadam system consists of two main components: welded tubular steel framework supports and flexible waterproof membranes. The steel framework supports are packaged 20 per bundle and the flexible waterproof membranes come in 50- or 100-linear foot sections. Also included is the hardware (clamps, bolts, braces and ties) required for installation of the product. The hardware and installation instructions are containerized in pallets and will cover 100 LF of Portadam barrier. To construct a 100-linear foot Portadam barrier, 76 steel framework supports are required as well as one 100-linear foot membrane. To construct a 90-degree corner, an additional 6 steel framework supports and hardware will be required.

USACE GUIDANCE FOR DEPLOYMENT OF EXPEDIENT FLOOD FIGHT PRODUCTS

1. Deployment:
• Issuance of expedient flood fight products will be permitted only in emergencies declared by the District Engineer or designated representative and upon request from the State for assistance. Issue of these products should be focused on protection of critical infrastructure and key facilities.
• The supported district will coordinate directly with the Omaha District for delivery of products to the designated area. Provide the type of product preferred, barrier length in LF, destination of shipment, and on-site USACE POC contact information to the Omaha District.
• Supported districts will request Class 216 funds through the Division to fund technical assistance and supervision of the products issued to the local sponsor.
• Philadelphia District will request Class 216 funds through the Division to fund transportation of materials to the impacted district's designated location.
• The Supported district must provide and maintain a trained USACE representative on site with the public sponsor during the installation, operation, removal, and repackaging process, and provide
technical assistance to the public sponsor for the use of the products.

• Deployment of vendor technical support will be coordinated directly with the Rock Island District (MVR) EOC. The POC at MVR is Mark Clark at 309-794-5264. MVR will request Class 216 funding to provide vendor technical services.
• Transportation of products from other regional stockpiles will be coordinated with HQUSACE prior to movement of the products.

2. Corps of Engineers, Omaha District (Location of Regional Stockpile) Responsibilities:
• Proper storage and maintenance of products while in storage.
• Prepare and deliver products as requested by impacted districts.
• Transport products from the deployed location back to the stockpile.
• Inspect products for re-usability prior to returning to the stockpile.

3. Supported District Responsibilities:
• Coordinate with Omaha District for deployment of flood fight products.
• Hand receipt product to the public sponsor. The hand receipt must contain a statement similar to the recommended statement in EP 500-1-1, Paragraph 4-5c(1) with the addition that "*Subsequent to the flood threat or event, the sponsor agrees to disassemble, clean, and repalletize the product provided by the government*."
• Provide technical assistance to the public sponsor on the use of the product and manage and direct product vendor support if provided.
• Provide a trained USACE representative on site with the public sponsor during the installation, operation, removal and repackaging process.
• Coordinate the return shipment of the products to Omaha District after product use.

4. Public Sponsor Responsibilities:
• Provide labor to assemble, operate, disassemble and repackage material issued.
• Provide necessary equipment and fill material to assemble the flood fight products.
• Sign hand receipt for responsibility of issued products.

SECTION 9

LEVEE REHABILITATION

US Army Corps of Engineers ®
Kansas City District

Levee Rehabilitation Program Eligibility Requirements

Public Law 84-99 (33 U.S.C. 701n)
Flood Control and Coastal Emergencies

Union Township Overtop Levee Breach, 24July2010

General The U.S. Army Corps of Engineers may provide assistance in the rehabilitation of flood damage reduction projects only when repairs are clearly beyond the normal physical and financial capabilities of the project sponsor. The established Corps of Engineers eligibility criteria identified below must also be met. Structures built for channel alignment, navigation, recreation, fish and wildlife, land reclamation drainage, or to protect against land erosion are not flood control works and, therefore, are not eligible for assistance.

Eligibility For Corps of Engineers Assistance

- **Be Active In The Corps of Engineers Rehabilitation and Inspection Program**
  Only those Flood Damage Reduction projects in an "Active" status at the time of a flood or storm event may receive rehabilitation assistance under the authority of PL84-99. An "Active" project must have met USACE criteria for entry into the Corps of Engineers Rehabilitation and Inspection Program (RIP), must currently participate in the RIP program, and must have received an **Acceptable** or **Minimally Acceptable** inspection rating on the last continuing eligibility inspection performed by the Corps of Engineers.

- **Be A Primary Levee**
  A primary levee is a complete system, tied to high ground, designed for flood damage reduction and does not encroach on the flood plain.

- **Provide Required Minimum Level of Protection**
  Levee systems must provide a minimum 5-year level of protection for agriculture and a 10-year level of protection for urban area.

- **Have a Public Sponsor**
  A public sponsor is required for other than a public entity. The sponsor must be a public agency such as a legal subdivision of a State or State government, local unit government such as a county or city, a qualified Indian tribe or a state-chartered organization such as a levee board or district, drainage board or district. The sponsor will be required to co-sign any request for assistance.

- **Be Damaged By Flooding**
  The damages must exceed $15,000 (normal erosion is not eligible). Deliberate levee breaches will only be eligible for rehabilitation assistance if prior approval was received from the Corps of Engineers.

- **Be Properly Maintained**
  A properly maintained levee has a good grass cover, other vegetation is removed (trees), grass mowed not grazed, animal burrows controlled, erosion repaired, supporting drainage structures maintained, level of protection maintained, and pass a biennial inspection.

- **Repairs Must Meet Economic Criteria**
  The rehabilitation project must protect items of value and have a favorable benefit-cost-ration. The annual benefit must exceed the total annualized cost.

- **Provide Traditional A-B-C's**
  Corps policy requires the public sponsor to furnish the following items of cooperation and assurances (referred to as A-B-C's) prior to undertaking any work: (1) provide without cost to the United States all lands, easements, and rights-of-way necessary; (2) hold and save the United States free from damages due to the work, exclusive of damages due to negligence of the United States or its contractor; (3) removal of any temporary emergency protective measure; (4) maintain and operate, in a manner satisfactory to the Chief of Engineers, the entire project after completion.

- **Cost Share Repairs**
  Rehabilitation projects for non-Federal flood damage reduction projects will be cost shared at 80 percent Federal and 20 percent non-Federal. The non-Federal share may be provided with work-in-kind, cash, or a combination of both. Federal flood damage reduction projects will be repaired at 100 percent Federal cost.

Steps To Initiate Repairs After A Flood

Following a flood event, the Corps of Engineers will issue a public notice stating that requests for assistance for rehabilitation work must be submitted within 30 days after the flood waters recede to bank full. Local interests should request a rehabilitation investigation from the Corps of Engineers as soon as possible after the flood damage occurs. The process is as follows:

Baltimore Bend Levee, July 2010

- **Levee Owner/Sponsor Applies**
  The levee owner or sponsor will call, write, or visit a Corps of Engineers field or District office and identify the areas that have been damaged.

- **Investigation of Damages**
  A field investigation will be conducted by the Corps and will include an assessment of levee damage and acreage, crops and buildings involved. The sponsor will accompany the team as it identifies damages. The sponsor should provide proof of ownership or sponsorship authority. Necessary agreements will be signed.

- **Determination of Eligibility**
  The field report will be forwarded to the District Office where it will be reviewed. The Sponsor will be notified of the eligibility determination as soon as possible. Structures built for channel alignment, navigation, recreation, fish and wildlife, land reclamation, drainage diversion, or to protect against land or shoreline erosion or salt water intrusion are not considered flood damage reduction projects and are not eligible for rehabilitation assistance. Sediment removal from drainage ditches and debris removal are not eligible for rehabilitation assistance.

- **Forwarded for Approval and Funding**
  Project approval is made at the Division Office level. The sponsor will be notified when the project has either been approved or disapproved. Funding to complete the engineering and design; and funding to construct the rehabilitation project is made immediately upon notification that the project has been approved. Rehabilitation under PL84-99 is subject to the availability of funding.

- **Cost Share Details Resolved**
  If the local sponsor is providing cash for the 20% sponsor share, it must be received by the Corps prior to the contract being prepared. In-kind services must be accomplished before or during construction.

- **Start Contracting Procedures**

- **Award Contract, Start Construction**

- **Returned to Owner for Maintenance**

How Long Will It Take?

It Depends On—

- **When the Water Goes Down**
- **How Many Applications There Are**
- **How Extensive the Damages Are**
- **Availability of Contractors**
- **Availability of Funding**
- **Weather Conditions**

How to Obtain Help

If you would like to discuss the Corps of Engineers Flood Rehabilitation program, please contact the Kansas City District Emergency Management Office at 816-426-6320.

GLOSSARY

GLOSSARY OF TERMS

Acre-foot: An area of one acre covered with water to a depth of one foot. One acre-foot is equal to 43,560 cubic feet or 325,851 gallons. (1 cubic foot of water = 7.5 gallons)

Active: A status applied to FCW concerning participation in the Rehabilitation and Inspection Program under authority of PL 84-99. An Active project must have met USAGE criteria for entry and been entered into the RIP. Only Active projects may receive Rehabilitation Assistance to repair damages caused by a flood event or coastal storm.

Aeolian Deposits: Wind deposited material such as dune sands and loess deposits.

Agricultural Levee: A levee that provides at least a 5-yearflood protection to predominantly agricultural areas or agribusinesses. (Can be Federal or non-Federal)

Allowable Bearing Value (allowed soil pressure): The maximum press that can be permitted on foundation soil, giving consideration to all pertinent factors, with adequate safety against rupture of the soil mass or movement of the foundation of such magnitude that the structure is endangered.

Allowable Pile Bearing Load: The maximum load that can be permitted on a pile with adequate safety against movement of such magnitude that the structure is endangered.

Alluvium: Soil that has been transported in suspension by flowing water and subsequently deposited by sedimentation.

Angle of Repose: Angle between the horizontal and the maximum slope that a soil assumes through natural processes. For dry granular soils the effect of the height of slope is negligible; for cohesive soils the effect of height of slope is so great that the angle of repose is meaningless.

Anti-Seepage Collar: A projecting collar of concrete or other material built around the outside of a tunnel, pipe, or conduit, under an embankment dam or levee, to reduce the seepage potential along the outer surface of tunnel, pipe, or conduit.

Appurtenance/Appurtenant Feature: The associated works of a dam other than the embankment or main impoundment structure, such as inlet and outlet works, spillways, tunnels, or powerplants; Ancillary features of a levee such as pump plants, gatewell structures, flap gates, etc.

Aquifer: A water bearing formation that provides a ground-water reservoir.

Area of Influence of a Well: Area surrounding a well within which the piezometric surface has been lowered when the pumping has produced a maximum steady rate of flow.

As-Built Drawings: Plans or drawings portraying the actual dimension and conditions of a dam, dike, or levee as it was built. Field conditions and material availability during construction often require changes from the original design drawings.

Authorization: House and Senate Public Works Committee resolutions or specific legislation, which provides the legal basis for conduction studies or constructing projects. The money necessary for accomplishing the work is not a part of the authorization, but must come from an appropriation by Congress.

Bank and Channel Stabilization: The process of preventing bank erosion and channel degradation.

Base Course (Base): A layer of specified or selected material of planned thickness constructed on the subgrade or sub-base for the purpose of serving one or more functions such as distribution load, providing drainage, minimizing frost action, etc.

Basin: Drainage area of a lake or stream as in; (1) River basin, (2) a naturally or an artificially enclosed harbor for small craft, etc.

Beaching: The removal by wave action of a portion of the upstream (riverside) side of the embankment and the resultant deposition of this material further down the slope. Such deposition creates a very flat beach area.

Bearing Capacity (of a pile): The load per pile required to produce a condition of failure.

Bedrock (ledge): Rock of relatively great thickness and extent in its native location.

Bentonite Clay: clay with a high content of the mineral montmorillonite, usually characterized by high swelling on wetting.

Berm: A horizontal step or bench in the slope of an embankment.

Blanket Drain: A drainage layer placed directly over the foundation material.

Boil: A disturbance in the surface layer caused by water escaping under pressure from behind a water retaining structure such as a dam or a levee. The boil may be accompanied by deposition of soil particles (usually sand) in the form of a conical shaped mound (miniature volcano) around the area where the water escapes.

Borrow Area: The area from which material for a constructed embankment is excavated.

Boulder: A rock fragment, usually rounded by weathering or abrasion, with an average dimension of 12-inches or more.

Boulder Clay: A geological term used to designate glacial drift that has not been subjected to the sorting action of water, and therefore, contains particles from boulder to clay size.

Breach: A break, gap, or opening in a dam that results in loss of embankment integrity and the uncontrolled discharge of impounded water; a break, gap, or eroded opening in a levee that results in loss of embankment integrity and flooding of protected area. A controlled breach is a constructed opening.

Bulking: The increase in volume of a material due to manipulation. Rock bulks upon being excavated; damp sand bulks if loosely deposited, as by dumping, because the "apparent cohesion" prevents movement of the soil particles to form a reduced volume.

Cavitation: Water on hydraulic structures where a high hydraulic gradient is present. Cavitation is caused by the abrupt change in direction and velocity of the water so the pressure at some points is reduced to the vapor pressure and a vapor pocket is created. These pockets collapse with great impact when they enter areas of higher pressure, producing very high impact pressures over small areas, which eventually cause pits and holes in the surface. Noises and vibrations may be evident during high flows.

Channel: A general term for any natural or artificial facility for conveying water.

Clay (Clay Soil): Fine-graded portion of soil that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and which exhibits considerable strength when air-dry. The term has been used to designate the percentage finer than 0.002 mm (0.005 in some cases). It is strongly recommended that this usage be discontinued, since there is ample evidence that from an engineering standpoint the properties described in the above definition are many times more important.

Clay Size: That portion of the soil finer than 0.002 mm or 0.005 mm in some cases. See discussion under clay.

Cobble (Cobblestone): A rock fragment usually rounded or semi-rounded with an average dimension between 3 and 12 inches.

Cohesionless Soil: A soil when unconfined has little or no strength when air-dried, and that has little or no cohesion when submerged.

Cohesive Soil: A soil that when unconfined has considerable strength when air-dried, and that has significant cohesion when submerged.

Compaction: The densification of a soil by means of mechanical manipulation.

Compaction Curve (proctor curve) (moisture-density curve): The curve showing the relationship between the dry unit weight (density) and the water content of a soil for a given compactive effort.

Compaction Test (moisture-density test): A laboratory compacting procedure whereby a soil of known water content is placed in a specified manner into a mold of given dimensions, subjected to a compactive effort of controlled magnitude, and the resulting unit weight determined. The procedure is repeated for various water contents sufficient to establish a relation between water content and unit weight.

Compressibility: Property of a soil pertaining to its susceptibility to decrease in volume when subjected to load.

Compressive Strength (unconfined compressive strength): The load per unit area at which an unconfined prismatic or cylindrical specimen of soil will fail in a simple compression test.

Consistency: The relative ease with which a soil can be deformed.

Closure Structure: A structure built along low points of a levee or floodwall such as a street or railroad intersection to prevent floodwater from flooding the area protected by the levee or floodwall.

Conduit: A closed channel to convey the discharge through, around, or under a levee.

Confluence: The place where streams meet.

Construction Joint: The interface between two successive placements of concrete where bonding, not permanent separation, is intended.

Contraction Joint: A joint constructed such that shrinkage of the concrete would cause a crack.

Core: A zone of material of low permeability, the purpose of which is to reduce the quantity of seepage through the levee.

Corrosion: The chemical attack on a metal by its environment. Corrosion is a reaction in which metal is oxidized.

Creep: Slow movement of rock debris or soil usually imperceptible except to observations of long duration.

Critical Height: The maximum height at which a vertical or sloped bank of soil will stand unsupported under a given set of conditions.

Critical Slope: The maximum angle with the horizontal at which a sloped bank of soil will stand unsupported under a given set of conditions.

Cutoff: A relatively impervious barrier of soil, concrete, or steel constructed either to minimize the flow of water through pervious or weathered zones of the foundation, or to direct flow around such zones.

Cutoff Trench: The excavation later to be filled with impervious material so as to form the cutoff. Cutoff trench is sometimes used incorrectly to describe the cutoff itself.

C.F.S. (Cubic Feet per Second). Also cfs. The amount of flow passing a given point in a stream channel. One cubic foot per second is equivalent to approximately 7.5 gallons per second.

Dam: A barrier constructed across a valley or a watercourse for impounding water, creating a reservoir, or for diverting the flow of water.

Deliberate Levee Cut. A deliberate cut made in a levee, with the intention of either protecting the integrity of the structure (or an adjacent structure) from actual or forecasted river stages, or reducing the overall anticipated damages expected to occur to the existing structure by the current flood event. See also Dewatering Levee Cut.

Dewatering Levee Cut**.** A deliberate cut in a levee used as an engineering/construction method to dewater the area behind the levee when pumping this contained water is not considered a feasible, timely, or economical alternative. A dewatering levee cut is a type of deliberate levee cut that is never eligible for PL 84-99 assistance.

Draft: The vertical distance from the waterline to the bottom of a floating vessel.

Distress: A condition of severe stress, strain, or deterioration, indicating possible or potential failure.

Drainage Well or Relief Well: Vertical wells or boreholes landside of a levee to collect and control seepage through or under the levee to reduce water pressure. A line of such wells form a drainage curtain.

Dredged Material: The material removed in excavating or dredging canals, navigation channels, drainage ditches and lakes.

Eligible Levee. A levee categorized as "active" in the RIP, for which USAGE can provide assistance under authority of PL 84-99 to repair damage caused by a flood event.

Emergency. A situation involving a natural or technological disaster that would result in an unacceptable hazard to human life, a significant loss of property, or significant economic hardship.

Emergency Assistance. All USACE activities that assist a non-Federal entity that use FCCE funding from Category 200, 300, 400, and/or 500.

Emergency Preparedness. All those activities and measures designed or undertaken to prepare for or minimize the effects of a hazard upon the civilian population, to deal with the immediate emergency conditions that would be created by the hazard, and to effectuate emergency repairs to, or the emergency restoration of, vital utilities and facilities destroyed or damaged by the hazard.

Failure: An incident resulting from the uncontrolled release of water from a levee, floodwall, or closure structure.

Federally Authorized Projects/Federal Projects. An FCW project built by USAGE that was authorized for construction by Congress or by USAGE continuing authorities (e.g., Section 205.)

Federal FCW/Federal Levee/Federal Dam. A Federally authorized FCW, levee, levee system, or dam project. FCW constructed by non-Federal interests, or other (non-USACE) Federal agencies, and incorporated into a Federal system by specific Congressional action (i.e., United States law) are also designated as Federal FCW's. Construction by, or previous rehabilitation or reconstruction of a non-Federal FCW by a Federal Agency (to include USAGE, FEMA, NRCS, and EDA) does not make the levee a Federal levee. Levees constructed under the authority of the Works Progress Administration are not Federal levees. Section 14 projects constructed under authority of PL 79-526 are not Federal FCW's.

Fines: Portion of soil finer than a No. 200 United States standard sieve.

Flood. Abnormally high water flows or water level that overtops the natural or artificial confining boundaries of a waterway. A general and temporary condition of partial or complete inundation of normally dry land areas from the overflow of river and/or tidal waters and/or the unusual accumulations of waters from any sources.

1% Flood: This is the same as a 100-year flood and is a flood, which has a 1% chance of occurrence in any year.

Flood Capacity: The flow carried by a stream or floodway at bank-full water level. The storage capacity of the flood pool at a reservoir.

Flood Control Work(s) (FCW). Structures designed and constructed to have appreciable and dependable effects in preventing damages caused by irregular and unusual rises in water level. FCW may include levees, channels, floodwalls, dams, and Federally authorized and constructed hurricane or shore protective structures. Structures designed and constructed to protect against salt-water intrusion or tidal fluctuations, channel alignment, navigation, recreation, fish and wildlife, land reclamation, or to protect against land erosion are not considered to be FCW's. A riprap bank erosion control structure is not considered to be a flood control work.

Flood Crest: The highest or peak elevation of the water level during a flood.

Flood Plain: A plain bordering a river subject to flooding.

Flood Stage. The water surface elevation of a river, stream, or body of water, above which flooding and damages normally begin to occur, normally measured with respect to a specific reference gage. Flood stage is normally the level at which a river overflows its banks. Flood stage for any particular geographic area is unique to that geographic area.

Floodwall: A wall, usually built of reinforced concrete, utilized to prevent flooding.

Freeboard: (1) Vertical distance between the normal maximum level of the surface of the liquid in a conduit, reservoir, tank, canal, etc., and the top of the sides of the conduit, reservoir, canal, etc. (2) An allowance in protection above the design water surface level.

Gabion: A hollow cage or basket, usually of heavy wire, filled with stones or rock and used as a revetment or other protective device to sustain a wall or channel.

Gravity Drainage Outlets: (1) Outlets for gravity drains such as tiles, perforated conduits, etc., servicing an agricultural area and discharging into a drainage ditch. (2) Pipe, culvert, etc., used for dewatering ponded water by gravity.

Grout: A thin cement or chemical mortar used to fill voids, fractures, or joints in masonry, rock, sand, gravel, and other materials. As a verb, it refers to filling voids with grout.

Hardpan: Layer of extremely dense soil.

Heave: Upward movement of soil caused by expansion or displacement resulting from phenomena such as: moisture absorption, removal of overburden, driving of piles, and frost action.

Headwaters: (1) The upper reaches of a stream near its source. (2) The region where groundwater emerges to form a surface stream. (3) The reach of water upstream from a structure.

Hydrostatic Pressure: The pressure in a liquid under static conditions; the product of the unit weight of the liquid and the difference in elevation between the given point and the free water elevation.

Landslide (slide): The failure of a sloped bank of soil in which the movement of the soil mass takes place along a surface of sliding.

Leakage: Uncontrolled loss of water by flow through a hole or crack;

Left or Right Bank of River: The left-hand or right-hand bank of a stream when the observer faces downstream.

Levee: An embankment, generally constructed close to the banks of a stream, river, lake, or other body of water, intended to protect the landside from inundation or to confine the stream flow to its regular channel.

Liquefaction: Is a phenomenon, which takes place in a mass of saturated soil during flow slides. It is caused by a substantial reduction in shear strength of soil after the peak shear strength has been reached.

Mouth of River: The exit or point of discharge of a stream into another stream, lake, or ocean.

Non-Federal Levee/Non-Federal Project/Non-Federal FCW. A flood control work not authorized by Congress, or under other Federal agency authority. Works Progress Administration (WPA) projects are considered non-Federal FCW for the application of PL 84-99 authority.

Nonstructural Alternative Project. A type of project, authorized by an amendment to PL 84-99 contained in WRDA 96 that, in lieu of a structural rehabilitation effort, allows for restoration of floodways, flood plains, and/or the reduction of future flood damages and associated FCW rehabilitation costs.

Oxbow Lake: A lake formed in the meander of a stream, resulting from the abandonment of the meandering course due to the formation of a new channel course.

Phreatic Surface: The upper surface of seepage in an embankment. All the soil below this surface will be saturated when the steady-state seepage condition has been reached.

Pier: A structure, which extends from the shore out into the lake and serves primarily for mooring and landing of boats. Also, the term is sometimes used synonymously with jetty.

Piping: Progressive erosion and removal of soil by concentrated seepage flows through a dam, dike, or levee, its foundation, or its abutments. As material is eroded, the area of the pipe increases and the quantity and velocity of flow increase; these changes in turn result in the erosion of more material. The process continues at a progressively faster rate. Dam failure can result if the piping cannot be brought under control.

Piezometer: An instrument for measuring pressure head.

Potential Drop: The difference in pressure head between two equipotential lines.

Ponding Area: An area reserved for collecting excess runoff preparatory to being discharged whether by gravity or by pumping.

Pore Pressure: The internal cellular pressure of a fluid (air and/or water) within the voids of a mass of soil, rock, or concrete.

Progressive Failure: Failure in which the ultimate shear resistance is progressively mobilized along the failure surface.

Public Sponsor. A public sponsor must be a public entity that is a legally constituted public body with full authority and capability to perform the terms of its agreement as the non-Federal partner of the Corps for a project, and able to pay damages, if necessary, in the event of its failure to perform. A public sponsor may be a State, county, city, town, Federally recognized Indian Tribe or tribal organization, Alaska Native Corporation, or any political subpart of a State or group of states that has the legal and financial authority and capability to provide the necessary cash contributions and lands, easements, rights-of-way, relocations, and borrow and dredged or excavated material disposal areas (LERRD's) necessary for the project.

Quick Condition (quicksand): Condition in which water is flowing upward with sufficient velocity to reduce significantly the bearing capacity of the soil through a decrease in intergranular pressure.

Radius of Influence of a Well: Distance from the center of the well to the closest point at which the piezometric surface is not lowered when pumping has produced the maximum steady rate of flow.

Reach: A length, distance, or leg of a channel or other watercourse.

Recurrence Interval: The average time interval between actual occurrence of a flood of a given magnitude.

Rehabilitation and Inspection Program (RIP). A component of the Civil Emergency Management Program concerned with the inspection and rehabilitation of FCW's.

Rehabilitation Assistance. Repair and restoration under authority of PL 84-99 of an Active FCW damaged in a flood event.

Rehabilitation Project. An action or series of actions focused of the repair of an Active flood control work to return the FCW's level of protection to its pre-flood/pre-storm level.

Repair and Rehabilitation. The terms "repair", "rehabilitation", or "repair and rehabilitation" mean the repairer rebuilding of a flood control structure, after the structure has been damaged by a flood, hurricane, or coastal storm, to the level of protection provided by the structure prior to the flood, hurricane, or coastal storm. The terms do not include improvements (betterments) to the structure, nor does "repair and rehabilitation" include any repair, reconstruction, or rehabilitation activities of a flood control structure, which, in the normal course of usage, has become structurally unsound and is no longer fit to provide the level of protection for which it was designed.

Revetment: (1) A facing of stone, concrete, sandbags, etc., to protect a bank of earth from erosion. (2) A retaining wall

Riprap: A layer, facing, or protective mound of randomly placed stones to prevent erosion, scour, or sloughing of a structure or embankment. The stone used for this purpose is also called riprap.
River Basin: A water resource basin is a portion of a water resource region defined by a hydrological boundary, which is usually the drainage area of one of the lesser streams in the region.

Sandboil: The ejection of sand and water resulting from piping.

Scarp: The nearly vertical, exposed earth surface created at the upper edge of a slide or a beached area.

Secondary Levee**.** A levee that is riverward of the main or principal levee. The level of protection of a secondary levee is always less than the level of protection provided by the main levee.

Seepage: The slow percolation of water through or levee embankment, its foundation, or the abutment. A small amount of seepage will normally occur for any levee that retains water.

Sediment/Silt: Soil particles and debris in an impoundment.

Sediment Load: The total sediment composed of suspended load and bed load transported by a stream. The suspended load is composed of fine sediment transported in suspension while bed load is composed of relatively coarse material transported along or near the bottom.

Slide: The movement of a mass of earth or tailings down a slope.

Slope Protection: The protection of the embankment slope against wave action and erosion. Normally stone placed on riverside levee slope or on upstream face of a dam.

Slough: The separation from the surrounding material and downhill movement of a small portion of the slope. Usually a slough refers to a shallow earth slide.

Soil Stabilization: Chemical or mechanical treatment designed to increase or maintain the stability of a mass of soil or otherwise to improve its engineering properties.

Spalling: Breaking (or erosion) of small fragments from the surface of concrete, masonry, or stone, under the action of weather, or abrasive forces.

Stage: The elevation of the water surface above or below an arbitrary datum.

Standard Project Flood: A flood that may be expected from the most severe combination of meteorological and hydrological conditions that are reasonably characteristic of the geographical region involved, excluding extremely rare combinations.

Stoplogs: Large logs, timbers, or steel/aluminum beams placed on top of each other with their sides held in guides on each side of a channel or conduit, to provide an inexpensive and easily handled means of closure.

Structural Joint: A joint constructed where movement of part of a structure, due to temperature or moisture variations, settlement, or any other cause, would result in harmful displacement of adjoining structural components.

Subgrade: The soil prepared and compacted to support a structure or a pavement system.

Subsoil: (1) Soil below a subgrade or fill. (2) that part of a soil profile occurring below the horizon.

Training Berm: A berm built to confine or guide the flow of water.

Trashrack: A structure of metal or reinforced concrete bars located at the intake of a conduit inlet or waterway to prevent entrance of floating or submerged debris of a certain minimum size and larger.

Tributary: A stream or other body of water that contributes its water to another stream or body of water.

Unusual Flooding. For use with Advance Measures, a subjective determination of the potential level of flooding that considers potential to approach an area's flood of record, a catastrophic level of flooding, or a greater than 50-year level of flooding.

Uplift: The upward pressure in the pores of a material (internal cellular pressure) or on the base of a structure.

Urban areas. Cities, towns, or other incorporated or unincorporated political subdivisions of States that provide general local government for specific population concentrations, and occupy an essentially continuous area of developed land containing such structures as residences, public and commercial buildings, and industrial sites.

Urban Levee. A levee that provides a high degree of flood protection (10 year or greater) to a predominantly urban area.

Vertical or Sloping Filter: A filter placed more or less vertically that extends longitudinally through an embankment to intercept seepage flows and prevent them from getting the soils from the embankment. Filter often had vertical or sloping drainage

zones and is normally connected to the blanket drain. It is sometimes called a chimney drain.

Watershed: The whole surface drainage area that contributes water to a collecting river or lake.

Weir: A type of spillway in which flow is constricted and caused to fall over a crest. Sometimes specially designed weirs are used to measure flow amounts. Types of weirs include broad-chested weir, ogee weir, and v-notch weir.

Zoned Earthfill: An earthfill-type embankment, the cross-section of which is composed of zones of selected materials having different degrees of porosity, permeability, and density.