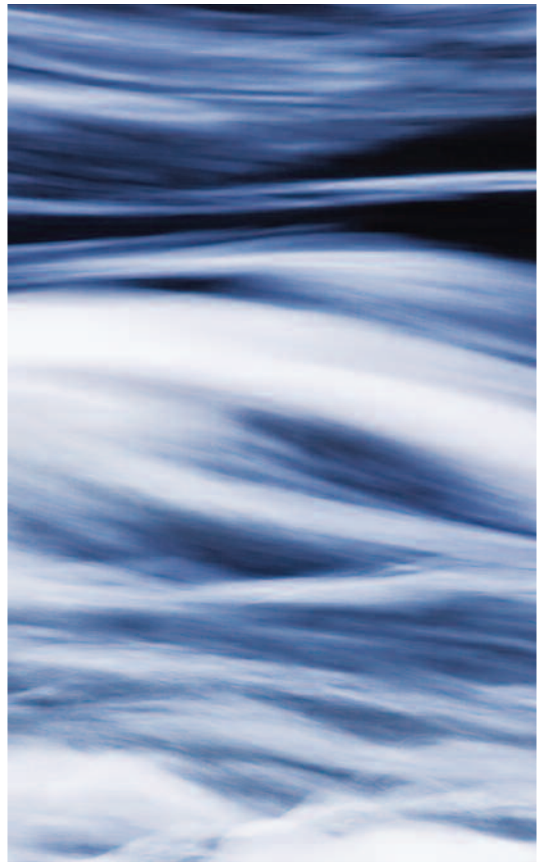
STRATEGIC OUTCOMES PRACTICE
TECHNICAL ADVISORY BULLETIN

December 2011 www.willis.com

FLOOD RISK MITIGATION: PLANNING IS KEY



When you see the water rising, it's too late to plan for a flood. In order to effectively manage the hazards associated with floods, it is imperative that you have in place a thorough flood risk mitigation strategy that you can implement before, during and after the event. This paper explores several issues relating to property risk control and preparation as they pertain to floods, including pre-emergency planning, structure and site mitigation strategies, utility protection and business continuity management.

Pre-emergency planning allows for the immediate implementation of policies and procedures – practiced and understood by everyone on site. A detailed and well-established flood loss prevention plan has these advantages:

- Personnel respond more rapidly and effectively than if no planning had taken place
- Promotes an understanding of the issues involved in responding to a dangerous situation
- Ensures development of complex responses to complex situations
- Provides for a complete examination of difficult and controversial issues (e.g., who is in charge?)
- Identifies information that must be gathered to properly respond to the flood
- Recognizes preparations that must be made for a response (acquiring and maintaining equipment, records, funding, materials, etc.)
- Promotes a sense of ownership and buy-in to the plan among personnel who participate in the planning process and who will be impacted by the plan
- Ensures a clear assignment of tasks and responsibilities, helping to avoid important things being left undone or unnecessarily duplicated
- Produces a plan that can serve as a baseline or starting point for modification should other emergencies arise
- Identifies training and resource needs; personnel should be oriented to the plan and trained in the skills necessary to enable them to fulfill their assigned responsibilities

To assist you with a flood emergency plan, **click here** to access our *Technical Advisory Bulletin*.

The importance of pre-planning cannot be overstated, and there are permanent flood mitigation strategies you can implement to protect your property and business. These strategies often include significant capital expenditure, long-term project management and the need to involve several engineering disciplines, such as mechanical, structural, electrical and fire protection. The next section addresses this aspect of flood emergency planning.

BUILDING AND SITE FLOOD MITIGATION STRATEGIES

Ideally, the best approach to flood risk mitigation is to simply not build in a flood zone or occupy an existing structure in a flood-prone area. Certainly, this may be easier said than done. At a minimum, you want to select a site at least two feet above the 500-year flood[1] elevation. You may want to determine if access routes to the site (e.g., highways, railroads, marine terminals) are at least two feet above the 500-year flood elevation as well. When choosing a site, consider the effects a flood may have on site egress, utilities (water, gas and electrical) and communication systems. If the area is protected by levees and/or other man-made flood control devices, ensure that they are properly designed, maintained and operated.

If the site selection process leaves you with no alternative other than to use a location prone to flooding, you may want to consider elevating the site by building up land levels so they are least two feet above the 500-year flood elevation. This may require a civil or structural engineer familiar with flood-related design and land or soil conditions. Since the topography of the land is being changed, storm water runoff and terrain management is needed to ensure that a greater hazard is not being created.

Another engineering approach regarding flood mitigation is to elevate the existing buildings and equipment and/or incorporate flood mitigation strategies into the original design. We will examine structures first and then utility systems.

STRUCTURES

Section 2.2.4.5 of FM Global Property Loss Prevention Data Sheet 1-40, "Flood," suggests you "design and build structures to adequately resist all flood-related loads and conditions, including hydrostatic loads, hydrodynamic loads, breaking wave action, debris impact, ice floes, ice and debris jams, rapid rise and drawdown of floodwaters, prolonged inundation, soil liquefaction, soil consolidation and subsistence, sediment deposition, mud slides and wave-induced and flood-related erosion and scour. Consider long-term erosion over the design life of the structure when determining the effects of flooding on building and foundation design."

In most cases, employing a civil and/or structural engineer to design buildings, structures and other protection features, such as dams, channels, culverts and diversions, is necessary.

When designing the interior and exterior walls of the building, certain materials will expedite cleanup and reduce damage. Specifically, choose items that you can easily clean, dry and sanitize. For example, cement walls are easier to restore than walls that use porous materials or are easily susceptible to water damage, such as gypsum board and wood. Ceramic floors and metal or glass doors are easier to clean than those constructed of wood.

The importance of pre-planning cannot be overstated, and there are permanent flood mitigation strategies you can implement to protect your property and business. These strategies often include significant capital expenditure, long-term project management and the need to involve several engineering disciplines, such as mechanical, structural, electrical and fire protection.

When designing the interior and exterior walls of the building, certain materials will expedite cleanup and reduce damage. Specifically, choose items that you can easily clean, dry and sanitize. For example, cement walls are easier to restore than walls that use porous materials or are easily susceptible to water damage, such as gypsum board and wood.

Finally, some building improvements that may help reduce water from seeping into a building include flood shields, flood gates and watertight doors. Since closing these must be done manually, include the procedures for doing so in your flood loss prevention plan.

UTILITIES

Flood water often contains dissolved chemicals and other hazardous materials, mud and floating debris that can consist of any type of material. Flood water also exerts tremendous pressure on equipment, storage tanks and all types of mechanical equipment.

The degree of damage to mechanical or electrical equipment is often not immediately apparent. A quick check of such equipment as transformers, compressors and electric motors may not reveal much damage. But damages can go far beyond those expected. Equipment can be impaired progressively, keeping the plant out of production for many months.

Examples of damage that may not be readily observed after a flood:

- Compressor intakes filled with water
- Water-contaminated oil in transformers
- Electric motors with water-soaked and debris-filled windings
- Large machines misaligned due to undetected damage in the building structure
- Foundations of buildings and machines damaged from water washout
- Other problems can limit the activity restart, such as loss of potable water and power supply
- Destruction of telephone lines and roads going to the plant

The Federal Emergency Management Agency (FEMA) provides guidance for incorporating flood damage-resistant techniques in the design and construction of building utilities. The following information examines the primary protection methods that apply to residential and non-residential building utilities and meet the minimum requirements of the National Flood Insurance Program.[2] These requirements include:

- The elevation of equipment and system components above the Design Flood Elevation (DFE)[3] of pedestals, platforms or fill, suspending them from structural elements or moving them to upper floors or attics

- The protection of system components that exist below the DFE by employing watertight enclosures, protective utility shafts and anchoring systems

Now, we will examine these techniques for the following building utilities: heating, ventilating and air conditioning (HVAC) systems, fuel systems, electrical systems, sewage management systems and potable water systems.

HVAC SYSTEMS

We can divide these components into main equipment (compressor/condenser/heat pump/evaporator cooler units, furnace, boiler and air handler) and the supporting distribution system (storage tanks, fuel, supply lines, electrical supply lines, duct work, refrigerator lines, pumps and piping). These components may be located indoors or outdoors, and flood mitigation methods include both elevation and component protection. Guidelines include:

- Strapping or bolting equipment onto a platform above the DFE. The strapping or bolting mechanism must be designed to withstand wind, earthquake and other forces specified in local building codes and ordinances.

- In coastal areas, the platform can often be cantilevered out from the structure at an elevation above the DFE. If this is not possible, then the platform can often be supported on piles, posts or columns that are embedded in the soil below the expected depth of erosion, scour and frost.
- If necessary, cross-bracing of piles and posts, together with concrete footings, should be used to increase the resistance of the platform to wind, velocity flow and seismic forces (cross-bracing should only be installed parallel to the direction of flow to permit free passage of debris and floodwaters).
- The platform should be located on the landward side (in coastal areas) or the downstream side (in riverine areas) of the structure to protect against velocity flows and debris impact.
- A furnace boiler or water heater can be located in the attic to protect it from floodwater inundation. Use a lateral or in-line furnace that fits into the ductwork.
- Hang ducts from the bottom of the lowest floor or the crawl space ceiling so that the bottom of the duct is above the DFE.
- Locate the ducts in the attic of the structure. This method minimizes the risk of inundation.
- Place the ducts above a suspended ceiling.
- Put the ducts within the habitable areas, concealing them with a bulkhead.

FUEL SYSTEMS

We can classify fuel systems into two categories which include fuel storage tanks and fuel lines, meters and control panels. The four major concerns when considering the protection of these systems are buoyancy, impact loads, scour of lines and movement of connection.

Specific flood mitigation methods related to both elevation and component protection include:

- The tank should be anchored to the platform with straps, which would constrain the tank in wind, earthquake and other applicable forces.
- In coastal zones, the straps should be made of non-corrosive material to prevent rusting.
- In velocity flow areas, the platform should be supported by posts or columns adequately designed for all loads, including flood and wind loads.
- The posts or columns should have deep concrete footings embedded below expected erosion and scour lines.
- The piles, posts or columns should be cross-braced to withstand the forces of velocity flow, wave action, wind, and earthquakes; cross-bracing should be parallel to the direction of flow to allow for free flow of debris.
- In non-velocity flow floodplains, elevation can also be achieved by using compacted fill to raise the level of the ground above the DFE and by strapping the tank onto a concrete slab at the top of the raised ground.

- A fuel tank located below ground in a flood-prone area can be anchored to a counterweight in order to counteract the buoyancy force that is exerted by saturated soil during a flood. One effective method is to anchor the fuel tank to a concrete slab with (non-corrosive) hold-down straps. The straps must also be engineered to bear the tensile stress applied by the buoyancy force. The maximum buoyancy force is equal to the weight of floodwaters required to fill the tank minus the weight of the tank.

Hazards associated with fuel lines, gas meters and control panels include breaking of unprotected pipes (especially at the entry point through walls or fuel tank structures), leaking fuel causing an environmental and fire hazard and the inability of pressure relief devices to operate properly if submerged during a flood.

Ideally each piece of equipment should be kept above the DFE, placed in protected shafts and have some flexibility.

ELECTRICAL EQUIPMENT

Generally speaking, the best approach to minimizing the flood damage to the electrical system of a building is to raise all of the electrical components above the DFE. If the larger components of the structure cannot be relocated to higher elevations, measures can be taken to protect them in place. As a last resort, if some of the smaller components of the system cannot be elevated above the DFE due to local code requirements, design methods can be employed to minimize the flood damage to the electrical systems of the building so that it can be reoccupied as quickly as possible.

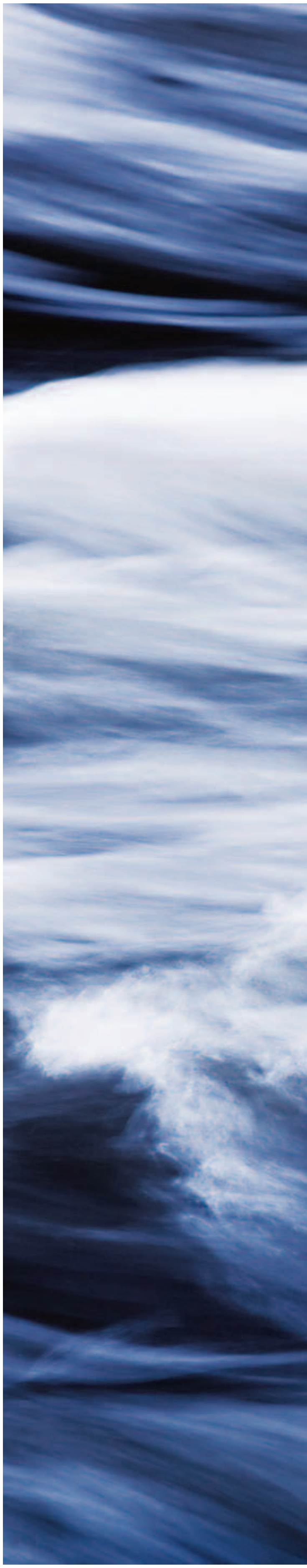
If electrical equipment must be continuously submerged, it should have an Ingress Protection (IP) rating[4] of IPX-8 (protected against water submersion, the equipment is suitable for continual submersion in water under conditions identified by the manufacturer).

SEWAGE MANAGEMENT SYSTEMS

Flood waters present three main concerns to sewer management systems, including back-up of sewage into buildings, physical system component damage (such as pipes, septic tanks, distribution boxes and piping) and health hazards associated with contamination. Therefore, you want to prevent sewer back-up into buildings and prevent physical damage to system components.

A practical strategy for protecting components of sewage treatment and disposal systems from damage by velocity flow and wave action involves designing the components that are to be located below the DFE to ensure stability and sturdiness. In V Zones (an area of special flood hazard designated Zone V, VE, or V1-V30 on a FIRM that extends offshore to the inland limit of a primary frontal dune along an open coast, and any other area subject to high-velocity wave action from storms or seismic sources) especially, erosion and scour of sandy soils by velocity flow during a storm are practically impossible to stop. Effort is therefore best applied to designing the system to withstand the forces of velocity flow and debris impact without incurring much, if any, damage. Due to the nature of treatment/disposal components that rely on gravity flow, it is usually impossible to elevate the system. In most systems, a method of component protection must be developed that can protect the system in place.

For the best protection against sewage backup, you may want to consider installing a combination of a check valve and a gate valve. A check valve allows flow in only one direction. Flow from the opposite direction automatically shuts the valve. A gate valve must be operated either manually or electrically. When open, a gate valve allows flow in either direction; when closed, a gate valve prevents flow in either direction.



POTABLE WATER SYSTEMS

Water supply systems usually include a source of potable water and transport of the water to the property on the surface of the ground. The two types most common are public utility system and on-site system, such as an on-site well. In addition, distribution components usually include a usage meter, a service feed pipe, water heater and a distribution system. The two main concerns to water supply systems are damage to equipment and water supply contamination.

The best protection for outdoor items, such as faucets and showerheads, is to raise them above the DFE. Water meters are usually located below grade to protect from freezing. If possible, locate the water meter in an area of the property above the DFE. If a hot water heater or pressure tank is located in a Zone A flood zone and not above the DFE, it is suggested that a waterproof wall be constructed around them and the equipment secured to the floor or wall. Pipes should be protected from debris impact, velocity flow and wave action and properly embedded or placed in a debris impact resistant chase adjacent to a permanent building member.

The best time to implement a strategy for protecting building utilities from flood damage is during the design and development stage of new buildings and equipment. For existing buildings, the most realistic time is during renovation or repair. Basic options when repairing the building include:

- Implementing low-cost retrofits – includes such measures as elevation and relocation of equipment and components and making items flood damage resistant and water resistant during periods of flooding within the structure (e.g., flood enclosures)

- Mitigating future damage using the methods previously described, which will provide a permanent, long-term solution

Finally, always refer to local building codes, flood plain management regulations and other applicable requirements to ensure compliance with local and state laws.

BUSINESS CONTINUITY MANAGEMENT

What if, after all these precautions are implemented, a flood still impacts my business?

The answer is: Be prepared with a strategy that allows you to minimize the extent of disruption, establish alternative means of operation, minimize the impact of economic losses, and provides for a smooth and rapid transition of services.

The foundation of any business continuity plan is the Business Impact Analysis (BIA). This is the process of determining the impact on an organization should a potential loss identified by the risk analysis actually occur. The BIA extends the risk analysis to provide information on the effects of a disruption or interruption on revenues, contractual requirements, regulatory requirements and more.

The BIA should also identify the **maximum time frame** before interruption or disruption of a function or process causes significant harm to the operation and

Generally speaking, the best approach to minimizing the flood damage to the electrical system of a building is to raise all of the electrical components above the DFE. If the larger components of the structure cannot be relocated to higherelevations, measures can be taken to protect them in place.

dependent resources. This time frame is known as the Recovery Time Objective. The RTO is comprised of two components: the time before a disaster is declared and the time to perform the tasks, as documented in the business continuity plan, to the point of business resumption.

For example, an organization with property in a flood-prone area decides to use sandbags to mitigate a potential flood. Furthermore, the time required to prepare the facility for this event is 24 hours. Is enough material on hand to meet this time frame? Materials include such items as sand, bags, protective equipment (e.g., work gloves and shoes) and the necessary manpower required to complete this project. Filling sandbags is normally a two- or three-person operation and proper placement and stacking is necessary to ensure they work properly.[5] Furthermore, employees are going to be concerned about preparing their own property if affected, so it may be necessary to prepare the facility 48 or 72 hours ahead of time.

When conducting a business impact analysis, common practice includes a review of critical systems that are needed to perform the business functions, additional staffing requirements, key suppliers and how frequently the business function is performed. Call trees or automated message systems for providing instructions to employees are essential.

Lastly, additional sections of a business continuity plan you should include are timetables for completing regular exercises to ensure all personnel are familiar with their assigned roles and responsibilities, public relations and crisis communication procedures (both internal and external) and information on coordinating with other agencies. Also, a section that includes a list of equipment inventory and vendors, spare parts, and diagrams of the building, utilities, fire protection systems and other infrastructure is extremely valuable. For the contents of your plan, you should implement a formal change procedure for any updates that are made. For example, have copies of the old information returned or a signature sheet distributed for people to sign when they receive their new copy of the plan. You should update your business continuity plans whenever any changes are made within the organization.

SUMMARY

A flood mitigation program that addresses loss prevention, risk mitigation and business continuity planning has to become an advanced strategic plan designed to be an integral component of an organizations corporate culture. It must enhance the bottom line by protecting share value and an organization's competitiveness. This program should look at the impact a flood will have on the entire organization so that disruptions and breakdowns can be reduced or mitigated. Remember, it is better to have a strategy in place that you don't use, than to need a strategy that you don't have.

GLOSSARY OF FLOOD TERMINOLOGY

100-year flood: The flood having a 1% or greater annual probability of occurring.

500-year flood: The flood having a 0.2% or greater annual probability of occurring.

Base Flood: Defined by FEMA as the flood having a 1% probability of being equaled or exceeded in any given year; also referred to as the 100-year flood.

Base Flood Elevation (BFE): Defined by FEMA as the height of the base (100-year) flood in relation to a specified datum, usually the National Geodetic Vertical Datum of 1929 or North American Vertical Datum of 1988. Generally speaking, this is the elevation of the 100-year flood waters relative to "mean sea level." BFE is not depth of flooding. To determine depth of flooding, you would need to subtract the lowest elevation of a particular property from the BFE. For example, if the property's foundation was at an elevation of 125 feet and the BFE was 131 feet, then one might infer that the 100-year depth of flooding would be approximately 6 feet.

ANNUAL PROBABILITY OF FLOODING OF 1% OR GREATER

A – Subject to 100-year flood. Base flood elevation undetermined.

AE or A1-A30 – Both AE and A1-A30 represent areas subject to 100-year flood with base flood elevation determined.

AH – Subject to 100-year shallow flooding (usually areas of ponding) with average depth of 1-3 feet. Base flood elevation determined.

AO – Subject to 100-year shallow flooding (usually sheet flow on sloping terrain) with average depth of 1-3 feet. Base flood elevation undetermined.

AOVEL – Alluvial fan subject to 100-year shallow flooding (usually sheet flow on sloping terrain) for which average flood depths and velocities have been determined. Average flood depth of 1-3 feet.

A99 – Subject to 100-year flood, with federal flood protection system (levee/dam) under construction. Base flood elevation undetermined.

AR – Previously accredited flood protection system has been decertified and is in the process of being restored to provide a 100-year or greater level of flood protection.

V – Subject to 100-year flood and additional velocity hazard (wave action). Base flood elevation undetermined.

VE or V1-V30 – Both VE and V1-V30 represent areas subject to 100-year flood and additional velocity hazard (wave action). Base flood elevation determined.

In SFHA – Areas in a "Special Flood Hazard Area" (or 100-year flood plain). Subject to 1% annual chance flooding. No distinctions have been made between the different flood hazard zones that may be included within the SFHA.

Flood Prone Area – An area designated as a "Flood Prone Area" on a map prepared by USGS and the Federal Insurance Administration. This area has been delineated based on available information on past floods. This is an area inundated by 1% annual chance flooding for which no base flood elevations have been determined.

ANNUAL PROBABILITY OF FLOODING OF 0.2% – 1%

B or X500 – Both B and X500 represent areas between the limits of the 100-year and 500-year flood, or certain areas subject to 100-year flood with average depths less than 1 foot or where the contributing drainage area is less than 1 square mile, or areas protected by levees from the 100-year flood.

ANNUAL PROBABILITY OF FLOODING OF LESS THAN 0.2%

C or X – Both C and X represent areas outside the 500-year flood plain with less than 0.2% annual probability of flooding.

ANNUAL PROBABILITY OF FLOODING OF LESS THAN 1%

No SFHA – Areas outside a "Special Flood Hazard Area" (or 100-year flood plain); can include areas inundated by 0.2% annual chance flooding, areas inundated by 1% annual chance flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile, areas protected by levees from 1% annual chance flooding, or areas outside the 1% and 0.2% annual chance floodplains.

UNDETERMINED

D – Unstudied areas. Flood hazards are undetermined.

CONTACTS

If you would like additional information on this or other risk control topics, contact your local Willis Property Risk Control representative or:

David H. Gluckman, ARM, CBCP, CFPS
Senior Risk Control Consultant
Willis Strategic Outcomes Practice
973 829 2920
david.gluckman@willis.com

Joe Stavish, P.E.
National Technical Director
Property Risk Control
Strategic Outcomes Practice
973 829 2955
joe.stavish@willis.com

You may also visit our **website** at willis.com.

The objective of our publication is to provide a general overview and discussion of issues relevant to loss control. The comments and suggestions presented should not be taken as a substitute for advice about any specific situation.

---

[1] A flood having a 0.2% or greater annual probability of occurring.

[2] FEMA, *Principles and Practices for the Design and Construction of Flood Resistant Building Utility Systems (FEMA 348)*, Jessup, MD, 1999, pp. 3.0-2 – 3.5-9.

[3] The Design Flood Elevation (DFE) is a regulatory flood elevation adopted by a community that is the Base Flood Elevation (elevation of the 100-year flood. It is determined by statistical analysis for each local area and is designated on the Flood Insurance Rate Map. This elevation is the basis of the insurance and floodplain management requirements of the National Flood Insurance Program.), at a minimum, and may include freeboard (additional amount of height incorporated into the DFE to account for uncertainties in the determination of flood elevations) as adopted by the community.

[4] Ingress Protection (IP) ratings are developed by the European Committee for Electro Technical Standardization (CENELEC) (NEMA IEC 60529 Degrees of Protection Provided by Enclosures - IP Code), specifying the environmental protection the enclosure provides. The IP rating normally has two (or three) numbers: 1. Protection from solid objects or materials; 2. Protection from liquids (water); 3. Protection against mechanical impacts (commonly omitted, the third number is not a part of IEC 60529). The IP ratings are from IPX-0 (no special protection) to IPX-8.

[5] Proper sandbagging techniques are discussed in a pamphlet prepared by the Northwestern Division of the US Army Corps of Engineers available by **clicking here**.