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LESSONS LEARNED FROM THE 1986 DROUGHT

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Prepared for
Institute for Water Resources
Water Resources Support Center
U.S. Army Corps of Engineers
Fort Belvoir, Virginia

Prepared by
The Hydrologic Engineering Center
Water Resources Support Center
U.S. Army Corps of Engineers
Davis, California

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Contents

INTRODUCTION

Authority and Purpose

Research reported in this document was authorized as part of the fiscal year 1987 policy studies program of the Institute for Water Resources, Corps of Engineers. Its objective is to determine whether there is a need to modify current Corps drought policy based on lessons learned during the 1985-86 drought in the southeastern United States. That policy is described in Engineering Regulation 1110-2-1941, 15 September 1980, "Drought Contingency Plans".

Method of Investigation

Research on the 1986 drought in the southeastern United States used a variety of information from a variety of sources. Information was drawn from field trips, existing drought plans, interviews, correspondence and published literature.

An initial visit was made to the South Atlantic Division (SAD) office, Atlanta, to speak firsthand with engineers directly involved in the drought. In addition, division and district correspondence and documentation on the Corp's role during the water shortage were reviewed. As part of the initial information gathering trip, a drought contingency planning workshop for Corps districts was attended in Cincinnati, Ohio. These visits provided the initial information for this study.

Visits with faculty members at Colorado State University and the University of Nebraska provided information on drought and drought contingency planning research. The North Carolina Water Resources Research Institute provided information on a conference held on the southeastern drought. Finally, the libraries of the University of California at Davis and Berkeley proved to be good sources of information on drought planning.

Federal, state and regional offices were contacted for drought plans. In all, ten state drought plans, a regional plan and three Corps plans were obtained. The section "Content of a Drought Plan" in this report is based on a review of these drought plans together with the lessons learned.

A second trip to the South Atlantic Division office and the Mobile, and Wilmington districts helped to answer more in-depth questions on the Corp's role during the drought. Due to flight cancellations and schedules the Savannah and Charleston districts were not visited but were contacted by telephone. All the district contacts proved to be valuable in understanding the nature and management of the drought.

A meeting with the Federal Emergency Management Agency (FEMA), Atlanta Regional Office, was arranged to discuss their role in the 1986 drought and in drought disasters generally. This was followed by a meeting with Brig. General Edgar, Commander, South Atlantic Division, on the Corp's role in water management and emergency response. Valuable insight on how the Corps responded to the drought and the measures taken to mitigate impacts and prepare for disaster was obtained. The meetings with FEMA, Brig. General Edgar, and the Corps' emergency management offices, together with review of related documents, are the basis for the section "Emergency Activities and Assistance During Drought".

The Atlanta Regional Commission (ARC) and the State of Georgia were visited to understand their perspective on the drought. The ARC is a commission which regulates water supply for the city of Atlanta and several surrounding counties. At the State of Georgia, a visit to the Environmental Protection Division, Water Resources Unit, helped to understand the State's involvement in the drought. These visits were valuable in determining a non-federal agency's view of drought operations.

By gathering information from a variety of agencies and interests, a comprehensive view of the 1986 drought was gained. This information, both personal interviews and review of correspondence and documents, forms the content of this report.

Principal Findings

Three principal findings have been derived from this investigation.

1. Corps offices, in all regions of the country, could benefit from a revision of ER 1110-2-1941 which would reflect the lessons learned from the 1985-86 southeast drought and which provides guidance for developing drought contingency plans which are responsive to those lessons.

   This study investigated the major aspects of the southeast drought as it affected Corps operations. Drought is clearly a management problem and requires preparation for a variety of management tasks from establishment of a drought management committee to examination of reservoir rule curves. This report documents these important tasks as they were carried out by Corps offices during the 1986 southeast drought. Drawing from this experience, and a number of state drought plans, the report identifies and describes the essential content of a drought contingency plan. This

information should be of benefit to Corps offices as they prepare drought plans for their operations. Engineering Regulation 1110-2-1941 is an appropriate document to communicate this information.

2. Corps authorities, responsibilities and assistance, including that related to Federal Emergency Management Agency (FEMA), need to be more clearly described for the time when a drought progresses from a matter of concern to a disaster and possible Presidential declaration. Consideration should be given to establishing, as part of drought management, a federal interagency advisory group.

   Emergency operations in the Corps are a unique activity carried out through the Corps Emergency Management/Operations offices. It is distinguished from water control operations. Policy guidance is available in Engineering Regulation 500-1-1 "National Disaster Procedures" and other documents. As the title describes, emergency operations is about operations during disasters. It is when an event becomes a disaster that many emergency operations begin. At this time special assistance becomes available and the Federal Emergency Management Agency and other federal agencies become actively involved. When does a drought become a disaster? What assistance can be provided by the Corps before a disaster, during a disaster, following a disaster? How are the unique tasks of water control/operations and emergency management/ operations combined during a disaster? What is the responsibility of the Corps, FEMA and other federal agencies prior to, during and after a disaster? At present there is no clear guidance on these questions, questions which were asked during the southeast drought and which are appropriate during any drought. Establishment of a federal interagency adisory group to respond to state and local governments on matters of federal drought assistance could be an effective way of consolidating the variety of federal authorties.

3. A Corps sponsored two-day workshop during 1988 on "Preparation of Drought Contingency Plans" would be a quick and effective way to transfer information on the lessons learned from the southeast drought to Corps district and division offices in other regions.

   Floods and droughts are natural hazards which involve the Corps. The Corps technical and management skill in responding to floods is well known. Its expertise in drought management less so. In the past, drought and water supply have not received the attention in the Corps that floods have. In the southeast drought, without exception, everyone interviewed felt the Corps

did an excellent job of providing leadership and responding to needs during the drought. Even so, having gone through the drought, many valuable lessons were learned and the Corps offices in the southeast are currently seeking ways to be even more effective should another drought occur. This experience should be passed on to other offices outside of the southeast. A workshop on preparation of drought contingency plans can be an effective way to do this. It could bring Corps engineers and planners charged with drought planning in contact with one another; it could bring them in contact with Corps personnel in the southeast who carried out different tasks during the 1985-86 drought to learn from their experience; and it could provide written technical and policy information on drought planning.

Acknowledgements

Many professionals, in many different organizations, with quite different responsibilities for drought management, provided their time, information, observations and hospitality during this study. Their help is greatly appreciated. Mike Deas, civil engineer with the Hydrologic Engineering Center (HEC) during the summer of 1987 participated in the interviews, corresponded with federal and state offices, researched literature and prepared the draft report. Bill Johnson HEC provided supervision and final editing. The study was conducted under the general supervision of Darryl Davis, Chief, Planning Division and Bill S. Eichert, Director, The Hydrologic Engineering Center. Funding was provided by the Institute for Water Resources, Corps of Engineers, Kyle Schilling, Chief, Policy Division and Randy Hanchey, Director.

LESSONS LEARNED FROM THE 1986 DROUGHT

Introduction

During the 1986 drought in the southeast, the South Atlantic Division (SAD) and its districts learned many lessons on drought management and response. After the drought, the lessons were summarized by the division as "lessons learned." There were six lessons. These are expanded upon and extended in this document.

The final choice of lessons was arrived at following the field visits and review of correspondence and documentation. This latter information included monthly water control management reports and drought status reports from the districts, the minutes of drought management meetings, drought bulletins and other literature. In draft form, the lessons were sent to the SAD, Mobile, Savannah and Wilmington districts to receive comments and suggestions.

The lessons addressed include:

- Need for a Drought Contingency Plan
- Importance of a Drought Management Committee
- Value of Water Supply and Use Data
- Have Up-to-date Water Control Manuals and Reservoir Rule Curves for Low-Flow Operations
- Use a Simulation Model for Assessing Impacts
- Open Communication and Public Information
- Develop Memoranda of Agreement Between Corps and Other Institutions
- Have a Drought Monitoring and Response Plan
- Value of Division and District Drought Coordination

The format used for each lesson includes: title, a description of the lesson, and specific background information describing the circumstances and conditions which led to the lesson.

Need For A Drought Contingency Plan

Lesson:

It was found during the 1986 drought that having a drought contingency plan in hand before the onset of such an event was invaluable. Early in the drought, the South Atlantic Division (SAD) found, in general, their emergency management plans for drought were not as well defined as those for floods. As a result, they developed more detailed drought management plans to address their current conditions and to serve as a baseline for future situations.

Background:

The Mobile District developed an Interim Drought Management Plan (IDMP) for the Apalachicola-Chattahoochee-Flint (A-C-F) River Basin, which was published in April, 1985, several months prior to the beginning of the 1986 drought (U.S. Army Corps of Engineers, 1985). This plan was developed as part of a memorandum of agreement between the states of Alabama, Florida, Georgia and the Mobile District to address the long term solution to the basin's complex water problems.

Some of the information contained in the plan includes:

. Basin Characteristics - description of area, physiography and land use, climate, major streams, impoundments, and navigation projects.

. Water Use and Availability Problems - addresses surface water use, groundwater use and associated availability problems in the Chattahoochee, Flint, and Apalachicola subbasins.

. Existing Drought Planning Efforts - calls for the consideration and incorporation of drought planning efforts, at private, local, regional, state and federal levels, into the Interim Drought Management Plan.

. Institutional Constraints - addresses constraints such as, legal statutes and established organizational structures, within which the IDMP must be developed.

. Drought Management Committee (DMC) - outlines a committee, consisting of two Corps officials, one from the division and one from the district, and a person from each of the states involved, to coordinate and develop management recommendations for approval by their respective agency heads.

. Drought Recognition - describes drought recognition tools, the importance of early recognition of conditions that may lead to drought, and initiating management actions to minimize adverse effects of prolonged water shortage.

. Project Purpose Measures - addresses project purposes, such as water supply, hydropower, navigation and recreation, and drought management measures associated with each.

. Emergency Assistance Measures - discusses emergency actions which may be taken by the Corps and the triggers for their implementation.

. Public Information Program - included to insure the frequent dissemination of information to the appropriate interests, through news releases, drought bulletins and navigation bulletins.

The IDMP provided the overall initial strategy for coping with the 1986 drought and proved to be the most valuable single contribution to drought management. In addition, the implementation of the DMC provided a structure for state and federal collaboration and cooperation. It provided a valuable channel for input from those affected to express their thoughts on releases from Corps reservoirs.

Corps offices, as well as other agencies (states, regional commissions, etc.), expressed support for the Mobile District Interim Drought Management Plan. The plan provided structure which gave the Corps direction, but also retained flexibility by avoiding fixed priorities or rigid operational commitments. Another valuable asset to the plan was that other districts, either without a plan or in the process of formulating one, used the Mobile plan for assistance in their drought management.

In response to worsening water shortage conditions within the basin during July and August of 1986, a drought task force was formed to develop a drought emergency water control plan. This plan, Drought Water Management Strategy for the Apalachicola-Chattahoochee-Flint (A-C-F) Basin, was published by the Mobile District, Corps of Engineers, in August 1986 to complement the IDMP (U.S. Army Corps of Engineers, 1986). The purpose of this plan was to develop a strategy to help manage the remaining available storage at Corps reservoirs until the drought was over.

To insure the many interests affected by the drought were addressed, a multi-disciplinary task force was formed. Representatives from the Mobile District's sections, branches and divisions were pulled together to represent the following tasks:

- Policy
- Project resource management
- Reservoir regulation and water supply
- Engineering
- Hydropower
- Navigation
- Information dissemination
- Environmental considerations
- Economic considerations

Representatives from the Savannah District and South Atlantic Division also participated.

A strategy calling for reservoir operations, providing minimum water supply and water quality releases through the end of 1986, was implemented. The strategy also established a public information program, increased monitoring efforts and tracked environmental considerations.

The Interim Drought Management Plan and the reassessment and updated document, Drought Water Management Strategy, illustrate the value of not only having a drought plan, but also keeping such plans up-to-date with current conditions.

Importance of a Drought Management Committee

Lesson:

Establishment of a drought management committee was found to be an essential element of a drought contingency plan. The committee, which consisted of representatives from the states involved and the Corps, was effective in balancing water needs and minimizing disputes among project users. The committee helped assure all users that their concerns were considered in decisions and provided increased support for Corps' operating decisions.

Background:

In accord with the Interim Drought Management Plan for the Apalachicola-Chattahoochee-Flint (A-C-F) basin, a drought management committee (DMC) was established. The five person committee consisted of:

Mobile District	Chief, Water Management Section
South Atlantic Division	Chief, Engineering Division
State of Alabama	Director, Department of Economic and Community Affairs
State of Florida	Executive Director, Northwest Florida Water Management Dist.
State of Georgia	Assistant Director, Environmental Protection Division

The committee was responsible for gathering information on water conditions and water management actions within the A-C-F basin and the southeast, appraising conditions of water supplies in the basin, and issuing and rescinding drought alerts and warnings. In addition, the committee coordinated individuals, agencies, organizations, industries and others affected by the drought for the exchange of information (water supply and use, and operations) and the notification of impending water management operations. Those involved included: power interests, such as Southeastern Power Administration (SEPA); industrial interests, like St. Joe Paper Co.; environmental interests, including Georgia Game and Fish Division; and recreation interests, such as the marinas at Lake Lanier and West Point Reservoir. Although the persons responsible for arriving at final committee recommendations were the five appointed members, all meetings were open to affected or concerned parties. The attendance averaged approximately twenty-five persons, including hydropower interests, Save the Lake (Lanier) Committee, and Corps districts' representatives. Most water control actions in the A-C-F basin during the drought were based upon recommendations of the drought management committee.

The A-C-F drought management committee operated under bylaws adopted by the committee. In non-drought periods, the committee agreed to meet twice per year, after the winter and spring flood period (late April - early May) and at the beginning of the traditional fall low-water period (October). These were thought to be appropriate times to appraise the water conditions within the basin. If a significantly dry situation was identified, a "water shortage appraisal meeting" would be held. Subsequent meetings were to be held as conditions warranted.

In 1986, the DMC met eight times from March to December. On March 21, the committee issued a water shortage alert. This alert meant that conditions in the Lake Lanier portion of the basin were dry enough to begin causing concern for the entire basin. At a May 9 meeting, the water shortage alert was replaced by a drought alert. This alert meant that the water shortage conditions in the basin were trending toward a possible severe drought. These decisions were based on the monitoring of hydrologic indicators, dry conditions of the basin, and the water shortage situation in the basin at that time.

To keep the users, general public and media informed of Corps actions, the DMC used press releases, navigation bulletins, forecasts of lake levels and streamflows, and public meetings. Occasionally, press conferences were held after the committee meetings. During the week of August 18, 1986, the DMC sponsored six drought information meetings throughout the basin to discuss water management strategies and to ask for public input on needs of water users for implementing future overall basin water management operations.

Value of Water Supply and Use Data

Lesson:

Information available on water supply and use was inadequate during the 1986 drought. Among the recognized needs were: an accurate inventory of users, their water supply intake locations and elevations, their water requirements, and instream flow needs, low river profiles and discharges. This information is important for effectively managing water control projects.

Background:

Water supply and use data are important in assisting the Corps in assessing impacts on users due to changes in reservoir operation. A supply and use data inventory should include: public supplies, such as cities and counties; industrial self-supplied users, such as hospitals; thermoelectric and hydroelectric users; navigation users; irrigation supplies; and various other users being supplied by the managed water.

Prior to and during the 1986 drought, water supply and use information was obtained from states, reservoir operators and users. Some information was incomplete or unavailable at the onset of the drought. Valuable time and manpower were required to gather such information during the drought. Obtaining or knowing where to obtain the information prior to a water shortage was found to be important.

A water supply and use data structure should consist of the following:

User:
- name - water withdrawal facility
- location - state, county, hydrologic unit
- contact - address and telephone of appropriate person

Water Supply Intake:
- location - on river, lake, etc.
- intake elevation - lowest withdrawal elevation; National Geodetic Vertical Datum (NGVD)

Water Supply:
- source - lake, river, etc.
- requirement - cfs or mgd; seasonal variation
- instream flow needs - minimum flow requirement; low river profiles; seasonal variation
- discharges - cfs or mgd; seasonal variation

Corps' districts found that having a person to contact when planning operational strategy was invaluable. It was vital to communicate with users on releases and obtain responses on possible impacts. If sufficient time were available, most users could respond to lower lake elevations and reduced streamflows. Savannah District, for example, delayed reduction of discharge from Clarks Hill Dam to allow downstream water users time to modify their intake canals and structures. As a result, the Corps now has a more precise definition of the instream flow needs for water supply, and the users have a better understanding of the need for continuing maintenance on their intake canals and structures.

The Mobile District specifically addressed water supply and use data for environmental, power, industrial, water supply, recreational and navigation interests in the Drought Water Management Strategy for the Apalachicola-Chattahoochee-Flint Basin. They included 7Q10 flows and low-flows from the droughts of 1954 and 1981 to assess possible impacts on these various users during an extended drought period under varying flow and lake level conditions.

Have Up-to-date Water Control Manuals and Reservoir Rule Curves for Low-Flow Operations

Lesson:

The 1986 drought reaffirmed the importance of having up-to-date water control manuals, and drought responsive reservoir rule curves and water control plans. This should include information on methods to conserve water during drought and alternative low-flow release schedules.

Background:

Prior to the 1986 drought many of the water control manuals for the South Atlantic Division (SAD) had not been updated since the project was constructed. SAD has since called for a review of water control manuals for all Corps reservoirs within the division.

The Apalachicola-Chattahoochee-Flint (A-C-F) Basin contains five Corps operated reservoirs. The regulation manuals for two of the reservoirs (Lake Lanier, Walter F. George) are due to be revised during the 1987 fiscal year. The other three regulation manuals have not been revised. The table below summarizes the present situation (October 1987).

Reservoir	Status of Regulation Manual
Lake Seminole (Jim Woodruff L/D)	Approved August 1958
Lake Lanier	Approved April 1960 (Revision Expected FY 87)
W.F. George	Approved April 1965 (Revision Expected FY 87)
George W. Andrews	Approved March 1965
West Point	Approved May 1975

The Savannah River Basin contains three Corps operated reservoirs. A single manual, dated December 1974, covers the Savannah River Basin. An interim report completed in 1984, revised the conditions and operations Regulation Schedule to include the newly constructed Russell Dam. A revised regulation manual is planned and will coincide with the installation of pumpback units at Russell Dam.

The Wilmington District had modified rule curves at John H. Kerr and Philpott reservoirs in 1973 to increase power generation and to serve recreation more effectively. As a consequence, at the end of the 1986 drought (November 28, 1986), John H. Kerr Reservoir was 12.9 feet higher than if the rule curves had not been revised. Philpott Reservoir, on the same date, was 42.2 feet higher than if the operation had not been changed.

In 1982 the water control plans for W. Kerr Scott Dam and Reservoir (Wilmington District) were updated. Under old operation, the reservoir would have had a minimum elevation 26 feet below normal pool with only 10% of the conservation pool storage remaining. Due to a change in the water control plans, the reservoir had a minimum elevation of 7 feet below normal with 72% of the conservation pool storage remaining during the drought.

Such positive results show that restudying reservoir rule curves and having up-to-date water control manuals is important in preserving reservoir levels during periods of drought.

Recently, Falls Lake (Wilmington District) had its rule curve elevation raised from elevation 250.1 to elevation 251.0 on an interim basis during the summer and early fall. This additional storage is non-dependable and would be dumped at the first sign of tropical moisture. Still, it increases the amount of storage available during dry periods.

Use a Simulation Model for Assessing Impacts

Lesson:

The drought identified a need for a simulation model to assess impacts on users of alternative operating plans. A model can assist in the development of water control management strategies for drought operations, as well as for real-time hydropower capabilities.

Background:

The purpose of a simulation model is to simulate alternative operating decisions at Corps projects and determine the impacts on project purposes, such as environmental, recreation, navigation, hydropower, water supply, water quality, fish and wildlife and recreation.

Model outputs identified by the Division as important include reservoir levels, surface areas and releases, and corresponding flows at specific points along the river. These outputs would be compared to the water use needs of identified resources and activities on reservoirs and along streams. This process would help the districts in making operating decisions during a drought.

An additional use for a simulation model would be in aiding the Corps in coordinating operations with other agencies. An example of this was the need by the Division to evaluate the Southeastern Power Administration (SEPA) requests for hydropower contract declarations. SEPA has a computer model which it used to prepare its energy and capacity contract commitments. It is important that the division have the capability to evaluate both hydropower generation and other conservation needs under drought conditions.

The accuracy of a simulation model is important, because reservoir releases are essential in meeting users demands. The results of an incomplete or inaccurate model can lead to a loss of Corps credibility, which is vital, especially in times of water shortage.

Open Communication and Public Information

Lesson:

Public affairs participation was important in drought management. Open and frank communications with the news media, river and lake users, and the general public throughout the 1986 drought resulted in excellent public relations for the Corps, and minimized "second guessing" of Corps decisions.

Background:

The value of open communications and public affairs during the 1986 drought could not be overemphasized. Communication, at the district and division levels, kept people informed of Corps actions and why such actions were being carried out. In addition, it opened channels for feedback on reservoir operations and assisted in balancing user needs. Equitable treatment of users was imperative.

Several methods of communications were employed by the Corps:

- In the Wilmington District, drought updates, including rainfall, lake levels, streamflows, groundwater levels, and names of cities adopting mandatory water conservation, were published in newspapers.

- In the Savannah District, public information meetings were held to discuss the impacts of the drought on the Savannah River and the Corps water conservation plan. Comment periods following the meetings provided the opportunity for public participation.

- The Mobile District, with the help of the drought management committee, not only held regular press briefings, but also forecast lake and stream levels, future changes in operations, and their impacts. As a result, users could take appropriate actions to prepare for any measures which may have affected them.

- At the division level, meetings between the Corps and affected parties addressed special interest cases. Examples of this included the meetings between SEPA and Corps staffs to discuss hydropower operations at the SAD projects during the current drought.

- Interdepartmental correspondence was important during the drought. Many questions were repeatedly asked about the water shortage situation. The Corps sought to answer them effectively and consistently throughout the districts involved in reservoir regulation.

It was imperative for the districts to realize the need to identify and involve affected parties early. Contacting them before they contacted the Corps made for more effective relations. Common sense coupled with good public affairs made such actions successful. The Corps' openness during the drought earned them respect and support from the users, public, and media.

Develop Memoranda of Agreement Between Corps and Other Institutions

Lesson:

The value of having prior agreements between the Corps and other institutions, which describes actions to be taken during a drought, were recognized during the 1986 drought. Such agreements enable both parties to reach an understanding in an atmosphere of less pressure and urgency.

Background:

Several short-term contracts and agreements were made during the 1986 drought. The arrangements ranged from hydropower agreements to emergency water supply contracts. These took time and energy to complete. Although the districts managed the situation, prior agreements stating the purpose and terms of the agreement, as well as each agency's responsibilities, could have more effectively implemented emergency measures and led to a more efficient use of water.

Memoranda of agreement for operation during periods of drought should contain:

- .the purpose of the agreement
- .the terms of the agreement
- .the responsibility of the Corps and the other organizations involved

Prior to the drought, the Southeastern Power Administration (SEPA) had no formal memorandum of agreement with the Corps concerning water shortages, reservoir operations and hydropower production. During the drought, SEPA stated that not only was the Corps obliged to operate the reservoirs according to Congressionally authorized purposes, but also that SEPA had authority to market power so long as pools were within authorized conservation zones. The Corps managed the problems by working with SEPA, while maintaining its position of equity with all users of the system.

Following the drought, in April 1987, SAD and SEPA were working on a draft of an operating agreement between the Corps of Engineers, U.S. Army and the Southeastern Power Administration, U.S. Department of Energy. The agreement covers thirteen projects in three districts and addresses operations during water shortage situations.

Have a Drought Monitoring and Response Plan

Lesson:

The 1986 drought illustrated the need for reliable and accurate monitoring measures to determine the beginning, severity and end of such an event. In addition, identification of an appropriate response to different severities of drought are needed.

Background:

The Mobile District drought management committee (DMC) used a variety of information to assess the drought. This included:

- Climatic conditions
- Lake Lanier Water Availability Index (WAI)
- Extended Streamflow Prediction (ESP) Model
- Probability of Lanier's pool elevations returning to normal
- Total available energy in storage
- Groundwater table levels

Climatic condition indicators primarily involved rainfall deficits, amount of rain needed to reach normal seasonal levels, and forecasts of weather conditions. The Palmer Index, a climatological index calculated every two weeks by the National Weather Service, was also used. The Palmer Index is useful to assess general climatic conditions.

The Lake Lanier WAI, an index created specifically for the basin above Buford Dam (Lake Lanier), was also employed. During April and May, the index, in which a zero indicates normal conditions and a "10" refers to a severe drought, ranged around "18" or "19".

The Mobile District reported the WAI in their weekly reservoir forecast. If the index reached a certain value (WAI = 2), DMC members were notified and a meeting was held if a member felt it was necessary. Unfortunately, the WAI was found to be too sensitive and is currently being restudied. The Mobile District also noted an interest in classifying drought severity. Using an array of indicators, different stages of drought could be defined and appropriate responses at each stage identified.

Savannah District is adapting the WAI developed by Mobile District for use in their Long-Range Drought Contingency Plan which is currently being prepared.

The Extended Streamflow Prediction model (ESP), run by the Southeast River Forecast Center (SERFC), also emphasized the severity of the drought. The model is a long-range prediction tool which develops probabilistic forecasts of streamflow parameters and reservoir stages for any future period, and is limited to the same area as the WAI (soon to be updated to include the Flint River basin).

The probability that Lake Lanier would return to normal pool elevation was one of the more valuable drought monitoring tools. The percent chance of recovery was plotted with normal lake elevation versus time of year. Thus, knowing the time of year and the lake elevation, percent chance of recovery could be determined. The curves developed in 1981, using historical data, are due to be updated through the use of streamflow frequency data.

Another drought indicator was the total available energy in storage. The Southeastern Power Administration (SEPA) reported the total available energy in storage for the multiple-basin system of Federal projects (this included the A-C-F Basin). Energy in storage levels were monitored and compared with 1981 values to determine the severity of the situation.

The U.S. Geological Survey (USGS) reported groundwater level information on aquifers in the southeast. The downward trend of groundwater levels as the drought progressed illustrated a worsening water shortage condition.

In the Wilmington District, the Palmer Index was reported in the monthly drought status reports. The Palmer Index was calculated every two weeks for the seven geographic regions of North Carolina. The change in the Index from the previous two weeks, degree of drought severity and rain needed to end the drought were also given. Other parameters reported were the percent below normal inflows for each reservoir, percent of power pool remaining, inches of runoff needed to refill reservoirs and feet below normal.

In the Savannah District, the monthly water control management activities reports covered the effects of the drought. Monthly rainfall and deficits were tabulated for each reservoir. Summaries of reservoir levels, reduced inflows and outflows, and percent normal of power generated were also given. Using this information, reservoir operations for the coming month were proposed. In addition, operational impacts due to the water shortage were reported for recreation, fish management, hydropower, water supply, and water quality. A significant aspect of water quality monitoring was the salinity level in the Savannah River estuary. Decreased outflows from Clarks Hill Dam caused the salt water wedge to move upstream threatening the fresh water supply of the Savannah National Wildlife Refuge. As

a result, a more sophisticated monitoring system is being installed, which in turn should provide more data for improved calibration of an existing numerical water quality model.

Although monitoring was used during the drought, it was limited and did not provide for corresponding responses. Some offices felt that it was difficult to determine the onset of the drought. Guidelines to report drought monitoring efforts on a regular basis and appropriate responses to different drought conditions could ıve assisted both in determining the onset of water shortage c ıitions and aided in managing it.

Value of Division and District Drought Coordination

Lesson:

Coordination between the district and division, within the districts, and between districts is an essential part of effective drought management. The 1986 drought demonstrated the importance of having and developing good communication channels.

Background:

Telephone conversations, meetings in the districts or division, and written status reports were used throughout the drought as means of communication and coordination. Several examples are cited below to briefly describe some of these efforts and their content.

Concerns regarding the needs of the many users of water stored in Corps reservoirs were addressed at a division meeting. As an example the Corps contract with the Southeastern Power Administration (SEPA) included thirteen reservoirs in three districts. When addressing such concerns within the Corps, it was important to coordinate the Corps decisions/operations with the users' expectations/needs. Some users felt they were not involved early enough and this led to tensions between the users and the Corps.

Another important aspect of division and district coordination was obtaining and disseminating information. An example of such coordination was the Emergency Activity Summaries. These summaries were published weekly during the drought. They covered district actions (all five districts in SAD), state and local actions, and Division emergency actions. Inventories of available supplies, towns and cities implementing conservation measures, water releases, media contacts, as well as other information were reported. These summaries were sent to the districts, state and local agencies, FEMA and other organizations. More coordination with organizations meant more knowledge, skill and cooperation were available to manage the water shortage situation.

As an example of interdistrict coordination the Savannah District attended the drought management committee meetings for the Apalachicola-Chattahoochee-Flint basin. This resulted in, not only coordinating information, but also coordinating plans of action.

In September 1986, the South Atlantic Division (SAD) held a drought management meeting hosting the three districts most affected by the drought (Mobile, Savannah, Wilmington). The purpose of this meeting was to inform the Division on drought conditions in each district and also to keep the districts informed of each others' actions.

EMERGENCY ACTIVITIES AND ASSISTANCE

1986 Drought Emergency Assistance and Activities

The 1986 drought in the southeast began with low rainfall and runoff in the winter 1985-86. The Corps, through its water control management, became involved from the beginning. As the drought continued during the year and became more severe, the Corps became increasingly involved and was called upon to provide leadership and coordination. Its involvement was through its reservoir operations, drought management committee (a cooperative effort with the states), drought management plan, and technical assistance program. Because of its multiple-purpose authority in managing water, the Corps worked with levels of government and with the private sector. This included state and local authorities in navigation, hydroelectric power, recreation, water quality, fish and wildlife, and M&I water supply. The Corps management during the 1986 drought received praise from all agencies.

Corps Emergency Activities: Emergency activities carried out by the Corps during the 1986 drought included the gathering of information and dissemination of drought emergency activity summaries. From July 2 through October 2, 1986, the South Atlantic Division (SAD) published twelve emergency activities summaries on approximately a weekly basis. These summaries, averaging three to five pages, addressed the drought situation. In addition, an inventory of emergency equipment available (drilling rigs, pumps, etc.) was listed. Table 1 describes the content of the SAD emergency activities summaries. The emergency management office forwarded emergency activities summaries to whomever needed the information: Corps districts, state emergency agencies and FEMA. The Corps also maintained contact via telephone. A good working relationship between the Corps and emergency organizations is important as considerable authority and responsibility is delegated over the telephone in emergency situations.

FEMA's Role: In contrast, FEMA's role was quite different. They received and monitored drought reports from various federal agencies and initiated two information meetings on federal drought assistance because of the concern and interest of state and local governments. However, without exception, no one at the local, state or federal level felt FEMA played an active role in drought management for M&I water supply. At an information meeting on federal drought assistance FEMA representatives pointed out that there had never been a Presidentially declared disaster for drought. Such a declaration is required for them to get actively involved. FEMA did not participate in any of the nine drought management committee meetings held in the Apalachicola-Chattahoochee-Flint River Basin (which includes Atlanta). This lack of direct involvement by FEMA in drought management is consistent with their understanding of their role

during drought. It is pointed out here to illustrate the contrasting roles of the two federal agencies and to make the important distinction between water control management and emergency activities and assistance.

FEMA only becomes directly involved when a drought reaches a disaster/emergency/ catastrophic level. The Corps, however, is involved before the drought begins and maintains and increases its involvement as the drought increases in severity. As a drought approaches a disaster, the Corps is constrained in what it can do in response, and there is no federal agency with the authority to actively coordinate federal assistance to prevent a disaster. It is important in preparing a drought contingency plan to describe the emergency activities and assistance authority available through the Corps and to consider establishing an advisory group of federal agencies. Such a group could serve to coordinate federal activity prior to a Presidential declaration.

Table 1. Content of SAD Emergency Activities Summaries

A. District

1. General situation summary: rainfall, rainfall deficits, severity and extent of drought.

2. State and local efforts: communities on mandatory and voluntary water use restrictions, issuance of permits, emergency response activities, State National Guard activities.

3. Other non-federal efforts: Red Cross and Salvation Army assistance in hay distribution.

4. Military efforts: none throughout drought.

5. Other federal efforts: U.S. Dept of Agriculture through Operation Hay provided farmers with hay and financing.

6. Corps efforts: drought monitoring, public meetings, drought management committee meetings, coordinated with state and local emergency organizations, Corps reservoir operations, public affairs.

7. Inventory of existing emergency equipment.

B. Division

Coordination of district drought activities, work with regional agencies, present scheduled drought related events (drought management meetings), coordinate with state and FEMA.

Corps Authorities

The Corps has a variety of emergency authorities to respond to natural disasters. These are described in National Disaster Procedures (ER 500-1-1, 1983). However, the Corps' authority to provide drought assistance is quite limited. During drought it is important that state and local jurisdictions clearly understand the limits of this authority. It is a responsibility of Corps offices to let others know what they can and cannot do. As part of this investigation of the 1986 drought a number of authorities were discussed by field personnel. They are identified here to make others aware of their existence. Only one related directly to drought assistance, the others dealt with water supply and related emergencies. Each is briefly mentioned below. Additional details are presented in Appendix A, Selected Corps Emergency Authorities.

Drought Assistance: The Chief of Engineers, acting for the Secretary of the Army, has the authority under certain statutory conditions to construct wells and to transport water to farmers, ranchers and political subdivisions within areas he determines to be drought-distressed. This authority was added to Public Law 84-99 by Public Law 95-51. The general policy which guides this authority (ER 500-1-1) states,

"The responsibility for providing an adequate supply of water to inhabitants of any area is basically non-Federal. Corps assistance to provide emergency water supplies will only be considered when non-Federal interests have exhausted reasonable means for securing necessary water supplies, including assistance and support from other Federal agencies."

Specific guidelines for assisting with well construction and transport of water are described in Appendix A. Together with the general policy stated above, they describe the authority the Corps has for drought assistance.

Water Supply and Emergency Related Authorities: Several other authorities related to water supply and emergency response are:

- Clean Water Supplies
- National Emergency Preparedness Planning
- Federal Emergency Management Agency (FEMA) Authority
- Assistance Prior to a Presidential Determination of Disaster

The Clean Water Supplies authority is directed toward providing emergency supplies of clean water to a location which has a contaminated source of water. The national Emergency Preparedness Plan authority focuses on preparedness planning of our nation's water resources for national security during a national emergency. The FEMA authority discusses the authority

of FEMA and other federal agencies, such as the Corps, during Presidential Declaration disasters. Assistance prior to a Presidential Declaration, the so called gap authority, is authorized by Section 917 of Public Law 99-662. Each of these authorities are described in greater detail in Appendix A.

CONTENT OF A DROUGHT CONTINGENCY PLAN

Introduction

The Corps' role in responding to drought varies in different regions of the country and locally within those regions. In some regions such as the southeast, reported in this study, the Corps played a role through its reservoir operations. In other regions, for example the West, where there are major state and Bureau of Reclamation reservoirs providing water supply, the Corps role is likely to be complimentary and secondary. Even within a major geographic region the Corps role can vary. The importance of that role will depend upon the place of Corps facilities in the supply system, and the legal and institutional arrangements governing reservoir operation. Because of this variation, drought contingency plans developed by Corps offices will vary in content reflecting the actual degree of Corps involvement in providing storage for different purposes. In what follows the description of the content of a drought contingency plan was developed based upon the 1986 southeast drought where Corps involvement was heavy. In adapting this description to other regions, consideration should be given to the Corps' local and regional role.

The purpose of what follows is to present information to assist Corps offices in developing drought contingency plans. To do this, fourteen drought plans from state, Corps, and regional offices, were reviewed to identify topics useful to Corps water control operations. In addition, other sources, including the lessons learned during the 1986 drought, were examined to identify information which would be useful in a drought plan. As a result of this review nine subjects were identified as important to be addressed in a drought contingency plan:

- Drought Management Committee
- Drought Monitoring and Response
- Public Information Program
- Water Supply and Use Data
- Impact Evaluations
- Emergency Drought Assistance
- Memoranda of Agreement
- Legal and Institutional Supply Requirements
- Agency Responsibilities and Contacts

Each subject is described in the following sections. Together they provide a framework for preparing for and responding to drought. Such a framework is essential to effective management of drought operations. It is not a rigid set of instructions, but rather flexible guidance within which management decisions are made.

Drought Management Committee

The most important part of a drought plan is the formulation of a drought management committee. A drought management committee (DMC) is a coordinating body which implements the drought management plan. Its main purpose is to assist the Corps in making decisions for reservoir operations. The committee involves agencies, organizations, communities and industries affected by Corps water management decisions. The DMC is a focal point between the Corps and all concerned or affected parties. It gathers and disseminates information, and makes recommendations for implementation by Corps and State agency heads.

Formulating a Drought Management Committee: A DMC should represent water management interests within a basin or region served by Corps projects. For example, a representative from the district, one from the division, and a representative from the state(s) involved. Such a choice of representatives involves the important interests at the Corps and state level, yet keeps the committee small. Other interests are invited to participate by attending meetings and communicating in other ways. An example of DMC offices and agencies is given below.

Corps District	- Chief, Water Management Section
Corps Division	- Chief, Engineering Division
State Agencies	- State Department of Economics and Community Affairs
	- State Environmental Protection Division
	- State Water Management Director

The constituents of a committee may vary according to the divisions, districts, states involved in the operation of Corps water control projects.

A DMC should be an ongoing part of reservoir operations in addition to being a central part of a drought management plan. Working with agencies and organizations before the onset of a water shortage is invaluable. It creates the opportunity for relationships among members which enhances efficient and effective communication during normal periods as well as drought periods.

Responsibilities: Specific responsibilities of a drought management committee include:

- hold meetings
- appraise water supply in Corps projects
- coordinate with appropriate federal, state and local interests
- conduct water shortage appraisal meetings
- monitor drought conditions

- declare and rescind drought actions (alerts, warnings, etc.)
- recommend water management actions to those affected by the water shortage
- prepare and issue "drought bulletins" as necessary.

The district's responsibilities should include coordinating activities with federal and state agencies that can assist in drought management (U.S.G.S., National Weather Service, U.S. Coast Guard) as well as project purpose interests (navigation).

The division is responsible for interdistrict coordination, and dealing with multiple district organizations such as hydropower authorities.

DMC representatives from the states should coordinate with state and local governments, local water supply entities, industrial and agricultural interest, and other interest groups as well.

Meetings: Drought management committees should meet at least once per year. Some meet twice - once following the winter and spring flood season, and once during the fall low water period.

If a significantly dry situation has been determined to exist, the DMC may meet at the request of any one member. Some committees utilize drought indicators to determine when conditions warrant a special meeting. Once the DMC has come together in response to impending drought conditions, the frequency of the meetings will be based on the severity of the water shortage.

A DMC should invite affected users, agencies and organizations and other interests to drought meetings. By involving affected users, impacts due to the water shortage and Corps operations can be determined. Agencies and organizations such as U.S. Geological Survey and the National Weather Service can provide technical data. Notification lists, including the type of interest (environmental, navigation, hydropower, etc.) location, name of contact, municipality or organization, and a phone number should be compiled. When a water shortage situation is determined to exist and a drought management meeting called, the appropriate interests should be notified of the date, time and location. If other agencies/organizations show interest, they should be added to the notification list. Input from such interests is imperative in drought management decision making.

Appraise Water Supplies/Shortage: At the initial drought management meeting each year, the water supplies available in Corps water control projects should be appraised. As the drought progresses, or regresses, the water supply conditions should be continually appraised and appropriate responses taken.

Drought conditions should be monitored on a regular basis by the Corps throughout the year. An array of drought indicators can be used to assess the water supply conditions. When one or more indicators denote dry conditions warranting a drought management committee meeting, monitoring efforts should be stepped up and regularly reported. This may be done by a sub-committee of the DMC. The Nebraska Drought Assessment and Response System has a Moisture Situation Committee which is responsible for determining the severity of a water shortage and reporting it to the coordinating body (Nebraska Natural Resources Commission, 1986). By closely monitoring drought conditions, the committee can more effectively appraise water shortages.

Declare and Rescind Drought Severity Levels: The committee, after appraising the water shortage, should be empowered to issue drought alerts, warnings, and disaster notices. Utilizing a drought monitoring and response network can aid the DMC in recognizing and declaring levels of drought. In addition, certain prescriptive measures should be associated with each level of drought intensity. For example when a drought alert is issued, the committee automatically issues a news release. Keeping the public informed of changes in drought status is imperative. The release should include upcoming Corps drought management actions, changes in reservoir operations and a forecast of possible impacts.

Prepare and Issue Drought Bulletins: Once a declaration has been made, periodic drought bulletins should be prepared. The bulletins should be disseminated on a regular basis (for example every two weeks) and should fulfill the information needs of all affected or interested parties. A drought bulletin may contain information on inflows to and outflows from Corps projects, rainfall, navigation channel depths, reservoir operations, percent storage probability of refill, as well as other information that is deemed pertinent.

Recommend Water Management Actions: Recommendations on water management actions based upon existing and possible water shortage conditions are reached through consensus of the committee members. Some state drought committees have been empowered to impose water conservation measures.

Keeping Plan Updated: During drought periods, as well as before and after, additional information on drought management should be added to the drought contingency plan. This may include impact assessments, information on drought monitoring and response, water supply and use data, notification lists and any other aspects of the plan. When a drought has ended, the drought plan should be reviewed and updates or modifications made accordingly.

Drought Monitoring and Response

Determining the beginning, severity, and end of a drought, is often difficult. An effective drought monitoring and response program consists of drought indicators, drought monitoring and a drought response network. A reliable program to monitor and interpret drought indicators is essential for predicting drought conditions and eliciting responses.

Drought Indicators: Drought indicators are mechanisms which reflect drought conditions and severity. Drought indicators consist of hydrologic indicators such as decreasing streamflows, storage levels and groundwater levels. Human-activity indicators include navigation traffic cutbacks and reductions in hydropower generation.

Drought Monitoring: A monitoring program should report drought indicators and corresponding conditions on a regular basis (usually monthly or weekly). By regularly monitoring conditions, trends can be observed and steps taken to prepare for problems. When drought conditions exist, monitoring efforts can be increased and conditions reported more frequently. The Mobile District reports the water availability index, a drought indicator based on reservoir level and precipitation, in its weekly reservoir forecast.

To more effectively and accurately monitor conditions, some drought plans call for subdividing large regions into subregions. These subregions can be based on drainage basins, climatological zones, hydrologic units, population centers, source and type of water supply or a combination (Kentucky Water Shortage Response Plan, 1987). Subregions should reflect relatively consistent indices throughout and be covered by reliable and sufficient data collection points.

The Nebraska Drought Assessment and Response System has developed a Moisture Situation Committee to monitor and report drought conditions (Nebraska Drought Assessment and Response System, 1986). The committee is responsible for making assessments concerning precipitation, streamflow, reservoir levels, groundwater levels, and soil moisture conditions. Representatives from several disciplines and agencies including the U.S. Geological Survey, Soil Conservation Service, Nebraska Department of Water Resources, and National Weather Service, make up the committee. The committee meets at the same time the drought committee meets. It reports its findings to the drought committee for assessment and response.

Drought Response: A response network consists of trigger levels and appropriate responses. Triggers are predetermined standards reflecting drought intensity which induce responses. An example of triggers and responses would be: When a reservoir level drops (indicator) to where the percent chance of reservoir recovery is equal to or less than 75% (trigger), power companies

should be notified of impending hydropower reductions (response).

Since drought varies in intensity, several levels of response are usually defined. For example, the Pennsylvania Drought Contingency Plan for the Delaware River Basin (DRB) has three levels of drought severity: Drought watch, drought warning and drought emergency (Commonwealth of Pennsylvania, 1985). These phases are triggered when three of the five drought parameters (precipitation, groundwater levels, reservoir storage, streamflow, Palmer Index) indicate a given stage. Streamflow as a trigger is shown in Table 2. The lower the streamflow the greater the time it is equalled or exceeded. For example, a normal flow of 500 cfs might be exceeded 60 percent of the time, while a flow of 250 cfs could be equalled or exceeded 90 percent of the time and trigger a drought warning. Different regions have different climatic conditions, as well as social and economic pressures. As a result, setting trigger levels should be flexible.

Table 2. Streamflow Drought Triggers
(Commonwealth of Pennsylvania, 1985)

Stage	Percent Time that Flow is Equalled or Exceeded
Normal	up to 75%
Drought	75-90%
Drought Warning	90-95%
Drought Emergency	over 95%

As with drought indicators, drought responses will be unique for a given region. The number of water control projects, basin characteristics, as well as population density and other factors will affect responses. Clear definitions of prescriptive measures should be outlined for each drought stage.

Measures that can be addressed are:

- Alerting government agencies, public water supply agencies and the public of impending drought;
- Drought management committee duties;
- Emergency assistance implementation;
- Coordination with federal, state and other agencies;
- Advising users of drought conditions and possible impacts;
- Updating drought strategy;
- Special issues and actions unique to water control projects.

Public Information Program

Specifications for a public information program are an essential part of a drought contingency plan. For water management measures to be effectively implemented during a drought, the required information must be made available to those concerned with, or affected by, low-water conditions. In addition, being open with information and straight forward in communications gains support and credibility for the managing agencies.

A public information program which disseminates information frequently can be implemented by a drought management committee or sub-committee. Such a program should release regular drought status reports, issue news releases and drought bulletins, formulate mailing lists, make contacts, and have an active public affairs official.

Drought Status Reports: A drought status report is a statement of drought conditions prepared by a Corps district. It contains an assessment of the effects and magnitude of the water shortage and is reported regularly (monthly) to the Corps Division office. The following items can be addressed in a drought status report:

- reservoir status
- current operations
- current elevation
- percent power pool remaining
- pool elevation change since last report
- inflow (monthly, cumulative, percent normal)
- summary of conditions at reservoirs
- drought monitoring efforts and level of drought
- proposed reservoir operations
- operational impacts

News Releases: The public should initially be notified of possible drought conditions at the same time a drought declaration is made. The news media is an appropriate channel for such a notice. A news release should include information on the water shortage conditions of the region and the need to be alert of potential Corps management measures to conserve water.

In addition, news releases should follow each drought management committee meeting during drought conditions. These releases should update the current status of the water shortage conditions, important findings of the committee and describe possible future management measures.

Close coordination is necessary in working with the media when the district office is not in the same city as one affected by drought. Geographical factors can be compounded when the media from drought affected metropolitan areas become involved. Some prior agreements and plan for coordination between the district and the division can increase the effectiveness of public affairs in this situation.

It is important to develop a public information program in advance of a drought. An effective information dissemination program enhances the work of those organizations involved and insures that the public and appropriate interests receive timely information necessary to carry out water management measures.

Drought Bulletins: To reach the diverse group of project interests in Corps' basins, drought bulletins can be issued. These bulletins should address the potential water shortage problems which specific interest groups can expect to experience and water measures needed to cope with these problems. Examples of typical information are given in Table 3.

Table 3. Information for Drought Bulletins

Interest	Information Needs
Industrial	- reduced streamflows, lowered reservoir elevations
Environmental	- reduced streamflows, velocity, sedimentation
Navigation	- reduced streamflows, channel depths
Power	- reduced hydropower releases

Water Supply and Use Data

Having a database of water supply and use information prior to the onset of drought can aid in managing and responding effectively. Knowing the users of Corps stored water, their supply demand and withdrawal data can aid in being responsive to specific user needs. By making prior contact with users, the Corps creates a channel of communication important in drought operations and updating and maintaining supply and use data. Users can be notified of impending changes in reservoir releases due to Corps drought operations.

General information needs when formulating a water supply and use inventory include:

- who the user is
- an address and telephone number
- a person to contact

Most important is having a person to contact who is responsible for directing operations during drought.

Water Supply Data: Water supply data should be collected for each user. The low flow season is of special interest. The information needed includes:

- source of the water supply: stream, reservoir or groundwater
- location of intake along stream, or reservoir, and intake elevation (MSL) (National Geodetic Vertical Datum (NGVD))
- minimum streamflows (cfs) and stream elevation (MSL) for water supply intake to be operational.

Surface water as well as groundwater should be taken into account because groundwater often makes significant contributions to surface water during low flows and is an important backup supply source.

Additional information that can be helpful are historic low flows, 7Q10 flows, and seasonal low flows from previous droughts.

Water Use Data: Water use data for water supply users should also be placed in a database. Again, the seasonal variation of withdrawals should be recognized. Water use information needs include:

- type of use: industrial, public,irrigation, thermoelectric, etc.

- withdrawals and discharges: in million gallons per day (MGD), cubic feet per second (CFS), or some other appropriate unit.

In water supply and use inventories the units applied should be consistent throughout.

In addition to assessing impacts due to drought operation, a supply and use inventory can aid a drought management committee in addressing the question of equity. During drought many users are impacted due to the water shortage and the drought operations of Corps water control projects. As drought conditions persist the problem of supplying all interest in an equitable manner becomes more difficult. Knowing water supply user requirements and limitations can aid in drought management decision-making.

Obtaining Information: Water supply and use information can be obtained from several sources. State permit systems often have information on user, type of use, location of intake and withdrawal amount. The U. S. Geological Survey maintains an extensive network of stream and groundwater gaging stations throughout the United States. Up-to-date streamflow and groundwater data as well as historical data are available for most major streams. Water supply users themselves can also supply information on intakes and withdrawal amounts.

Organization and Maintenance: Water supply and use data should be accessible, organized, and up-to-date. It should be entered into a computer database for easy access, organization and management. As part of a drought contingency plan the maintenance of such inventory is imperative. Keeping data up-to-date as well as keeping in contact with users is important. Through past drought experience, it has found that developing contacts with users before water shortages, resulted in good working relationships during a drought.

Impact Evaluation

Multiple-purpose Corps reservoirs involve a wide variety of users. During drought periods, it may become necessary to evaluate tradeoffs between water control project uses. Providing a timely and systematic tool for assessing drought impacts and corresponding impacts due to Corps operations is necessary to assist users in drought management decision making.

Implementing Impact Assessment: An effective way to implement impact assessment in a drought plan is through a subcommittee of the drought management committee (DMC). An Impact Assessment Committee could gather information, evaluate impacts and report them to the DMC. A subcommittee should consist of people with technical expertise in the area of impact evaluation. Possible impact categories applicable to Corps reservoir operations are identified in Table 4.

Table 4. Impact Categories Evaluated
(adapted from U.S. Army Corps of Engineers, 1986)

Category	Factors to be Evaluated
water supply	- reservoir and river supplies
hydropower	- capacity available and energy production; loss of revenue
environment	- stream and reservoir water quality; wildlife refuges and fishery losses
recreation	- marina visitation; lake and river safety; facility closures boat launching ramps
navigation	- towing companies, shippers flow requirements
engineering	- structural integrity of dams, locks, turbines

The state of Nebraska has a permanent impact assessment framework made up of three task forces; water systems and health (water supplies, reserve capacity), agriculture and wildlife (fish and wildlife losses), economics and energy (energy production and availability). Each task force has a designated lead agency, participating agencies and certain assessment responsibilities. These task forces provide information to the system coordination group for consideration.

Another way to implement impact assessment is to let those impacted contact the Corps through drought management committee meetings. This channel allows feedback from drought impacted parties to be utilized by the committee in making drought management strategy decisions. This method of assessing impacts can be effective in determining concerns that the Corps was unaware of, but may not be as effective as an impact subcommittee. User feedback may be incomplete, incorrect or biased, while an impact assessment committee, using technical specialists, can examine decision impacts in-depth and more objectively.

An analytical tool which can aid in impact evaluation is a simulation model. Utilizing different reservoir operation plans and various water management alternatives, a simulation model can analyze operations for low flow. This information can then be utilized to determine which users would be affected and to what extent. To be useful such a model would need to be developed before a water shortage situation begins.

Emergency Drought Assistance

Drought often occurs over an extended period of time and its severity is not perceived until conditions reach the disaster/emergency level. It is important, therefore, to address emergency drought assistance in a drought contingency plan. Emergency actions should be distinguished from operations management and other actions which are taken during the course of a drought. Emergency actions are taken when a drought approaches a more severe level.

Effective Assistance: Emergency drought assistance is directed through the Corps' emergency management offices. For emergency assistance to be effective during a drought, several tasks must be performed. Emergency management offices formulate a drought response framework for emergency actions. The important aspects include: involving the emergency management services early in the drought, having a representative involved with the drought management committee, maintain open channels of communications within Corps offices, between Corps offices and with agencies such as FEMA, and identify the tasks to be done during emergencies.

By involving emergency assistance early in a drought, conditions and impacts can be monitored and emergency efforts augmented if the water shortage becomes more severe. If the drought reaches a disaster stage, emergency operations is familiar with the conditions and should be prepared to take the appropriate actions.

To effectively communicate within the Corps as well as with agencies, organizations, and interested and affected users, the emergency management office should have a representative attend the drought management committee (DMC) meetings. The existing situation as well as actions can be reported at these meetings. In addition, some Corps emergency management offices issue weekly "Emergency Activity Summaries" during drought conditions. These reports reflect the drought situation and activities in the division. These reports are sent to the division, each district office, the state(s) involved, Federal Emergency Management Agency (FEMA), as well as other agencies.

Special pamphlets describing the Corps' authorities in responding to natural disasters and national emergencies can be made available to assist state and local governments. Following the 1986 drought the South Atlantic Division prepared such a document.

Responsibilities: The emergency management offices, have several responsibilities to mitigate effects of, and respond to, drought emergency.

These include:

- coordinate with other federal, state and local emergency programs for exchange of information, including funding, personnel assistance, equipment

- form assignments of specific emergency tasks and responsibilities prior to drought to alleviate communication problems during such an event

- develop effective communication channels to eliminate potential misunderstandings and to enhance public involvement in mitigation measures

- monitor water sources and systems, collect data and report this information on a regular basis (for example, weekly) to Corps offices, state and federal agencies, etc.

- assist the DMC in formulating drought bulletins

Emergency Activities Bulletin: An emergency activities summary should address the division as a whole and each district individually. Appropriate topics for a bulletin include,

District: Typical district topics are: areas in district affected by drought; district actions; actions by state and local governments. Areas affected can cover the status of Corps projects in the district, drought conditions, any existing water availability problems, requests for emergency assistance and projected emergency problems. District actions include monitoring efforts, drought meetings, available emergency equipment (drilling rigs, pumps etc.), and special operations or work done by the Corps. Actions by state and local governments can cover the actions of other emergency organizations, the number of communities implementing water use restrictions, emergency permit information, what emergency measures are being taken by state, National Guard and local agencies.

Division: Division emergency activities include: coordinating with other divisions to identify pumps, generators, water tanks and other drought assistance equipment; providing a liaison between the districts; meeting with multi-district agencies such as power administrations, keeping the media and other interests informed.

Federal Interagency Advisory Group. As a drought becomes more severe, state and local governments look to federal agencies for assistance. The types of assistance available from federal agencies and the conditions necessary for providing that assistance vary with each agency. To assist state and local governments it would be helpful to consolidate and coordinate the role of federal assistance. This could be done through an advisory group of federal agency representatives. Such a group

would work with state and local governments to insure that they understand the assistance programs, their conditions and the federal agency responsible. Establishing such a group, their purpose and responsibilities can be addressed in a drought contingency plan.

Memoranda of Agreement

A memorandum of agreement which addresses operations responsibilities, obligations and expectations between the Corps and other agencies provides the opportunity of forming agreements about drought operations prior to a drought. Such an agreement is an agreement between the Corps and another non-federal agency which establishes a cooperative partnership to achieve the greatest benefits from Corps operated reservoirs. It should summarize the background of the agreement, explain why such an agreement is appropriate and discuss the purpose, operations responsibilities and conditions of each agency. The purpose should address agency roles and potential problems during drought operations. The operations section should describe the operational procedures to be taken during a drought to alleviate the potential problems. In addition, the intentions of each party in the sequence of events leading to and including drought operations should be outlined. The responsibility of the Corps and agency should be clearly defined. Responsibilities may include carrying out studies, monitoring river and Corps reservoir conditions, and providing comprehensive management of water resources for the public interest, as well as Congressionally authorized project purposes.

Specific conditions including the effective date, date of termination and special items can be included. An example of a special item could be the preparation of a drought contingency plan by the cooperating agency.

A draft operating agreement (1987) between the Corps, and the Southeastern Power Administration (SEPA) illustrates some of the principal features of a memorandum of agreement. It covers Corps reservoir operations with respect to hydropower production with drought operation being only one aspect of the agreement.

The purpose of this agreement is to define:

> "areas of responsibility and to assist the project operator and those involved in the marketing of hydropower at federal projects within the South Atlantic division to better understand the total mission of these project."

The responsibilities and conditions of the agreement are divided among the districts, the South Atlantic Division, and SEPA. The responsibilities of the districts include: managing their projects for authorized purposes, monitoring river and reservoir conditions of all systems within the district, and determining what actions are required to continually meet Congressionally authorized project purposes as well as provide comprehensive water management in the public interest.

The division's responsibilities are to coordinate the districts and SEPA on all releases from the projects within the SAD and to monitor the operation of projects for the most efficient operation consistent with project purposes.

The responsibility of the SEPA is to market electric power and energy not required in the operation of the multiple purpose projects with hydropower to preference customers and private utilities in accordance with the law.

Drought operations, are described in paragraphs 7. Drought and 17. Purchase Power.

"7. DROUGHT:

If conditions within the SAD area are such that inflows have decreased or are projected to decrease to the level that other project purposes will be compromised, or the water for the most vital needs is being depleted, the Corps, after consultation with others involved, will take action to reduce discharge from affected projects. These reduced discharges may result in reduced hydropower generation, and SEPA will take action to supplement the remaining generation with generation from alternative sources in accordance with paragraph 17 "Purchase Power."

17. PURCHASE POWER:

All parties recognize that during extreme water shortages or other adverse conditions, it may not be desirable or possible to generate the full contract amounts. Accordingly, a provision is included in the SEPA hydropower contracts to address this condition. This clause is referred to as the "Purchase provision". Before implementation of the "purchase provision" of the contracts SEPA will exhaust all efforts with the Power Companies to "store" energy in order that water can be conserved. Energy is "stored" by the Power Companies agreeing not to "take" the energy they are entitled at the time they are entitled according to the contract provisions. A record of the quantity of the "stored" energy will be maintained in an account from which the Power Companies can "take" when water becomes more abundant within the basins."

Legal and Institutional Supply Requirements

Due to the Constitutional commitments and the variety of public interests in Corps multiple-purpose reservoirs, legal and institutional supply requirements should be addressed in drought contingency plans.

The most important aspect of these requirements is Congressionally authorized project purposes. These commitments delineate the manner in which Corps projects are operated. Non-project purposes utilize Corps projects as well and the question of equity arises when water shortage conditions exist. Not only must the Corps meet Congressionally authorized project purposes, but it must also manage projects in the public interest. When preparing a drought contingency plan it is important that both requirements be recognized and addressed. Possible conflicts should be anticipated and resolved, and the range of legal authority for management decisions in the public interest clarified.

Some municipal and industrial water users, who have no contract for water stored in Corps reservoirs, have need for such water during drought conditions. The stored water becomes a source of supply, a backup, during drought conditions when the user cannot meet requirements with their own supplies. A drought contingency plan should recognize this potential need and negotiate price agreements for the water. Such agreements developed during normal conditions are preferred to trying to reach them in the midst of a drought.

Agency Responsibilities and Contacts

During water shortage situations the Corps is often seen as the lead agency in water management. Having contact information on federal, state and local agencies, and water users, can be a valuable part of a drought contingency plan. Such organizations can provide an array of assistance, ranging from emergency loans to technical information. Contacting these agencies prior to a water shortage condition allows them to become familiar with their role in the Corps drought operations. In addition, it opens a channel of communication between the Corps and the agency which is valuable during water shortage periods as well as normal periods.

To effectively implement this need, a list of available agencies, their responsibilities, a contact person, address and telephone should be compiled. The agencies can be subdivided into federal, state, local and private organizations. They can also be divided into interest groups, such as navigation, irrigation, water supply, recreation, hydropower, fish and wildlife. The responsibilities and capabilities of each agency should be defined in a way that the Corps or interested parties can contact the agency for assistance or information. Successful response to drought is primarily accomplished by people working together. Cooperation between all levels of government and the private sector will lead to better drought management.

APPENDIX A

Selected Corps Emergency Authorities

SELECTED CORPS EMERGENCY AUTHROITIES

Corps Authority for Drought Assistance

The Corps authority for Drought Assistance is contained in Chapter 6, "Emergency Water Supplies and Drought Assistance" of Engineering Regulation 500-1-1 Natural Disaster Procedures (1983). Under this authority the Chief of Engineers, acting for the Secretary of the Army, can construct wells and transport water to farmers, ranchers and political subdivisions within areas he determines to be drought-distressed.

Well Construction: Well construction may be provided by the Corps on a cost reimbursable basis. The guidelines for exercising this authority are described below.

> "a. Assistance to an eligible applicant by the construction of a well may be provided on a cost-reimbursable basis if:
>
> (1) It is in response to a written request to District Engineer by a farmer, rancher or political subdivision for construction of a well under PL 84-99 (amended).
>
> (2) The applicant is located within an area which has been determined by the Secretary of the Army to be drought-distressed.
>
> (3) The Secretary of the Army has made a determination that:
>
> (a) The applicant, as a result of the drought, has an inadequate supply of water.
>
> (b) An adequate supply of water can be made available to the applicant through the construction of a well.
>
> (c) As a result of the drought, the well could not be constructed by a private business within a reasonable time.
>
> (4) The applicant has secured the necessary funding for well construction from commercial or other sources and has entered an agreement to pay to the United States the reasonable cost of such construction, or has entered into an agreement to

pay to the United States the reasonable cost of such construction with interest over a period of years, not to exceed 30, as the Chief of Engineers deems appropriate.

(5) The applicant has obtained all necessary Federal, state and local permits.

b. The financing of the cost of construction of a well by the Corps under this authority should be secured by the project applicant. In cases where the applicant cannot secure the necessary funding from commercial or other sources, the Corps may enter into an agreement requiring the applicant to pay the United States the reasonable cost of such construction, with interest, over a number of years, not to exceed 30, as the CDR USACE deems appropriate. The rate of interest shall be that rate which would apply if the amount to be repaid was a loan pursuant to Section 7(b)(2) of the Small Business Act, PL 85-536 (15 U.S.C. 636). Eligibility criteria for a loan will be in accordance with the practices of the Small Business Administration.

c. The project applicant will provide the necessary assurances of local cooperation, to include the normal a-b-c provisions, prior to the start of Corps work under this authority.

d. Equipment owned by the United States will be utilized to the maximum extent possible in exercising the authority to drill wells. Federally-owned well drilling equipment can only be used when commercial firms cannot provide comparable service within the time needed to prevent the applicant from suffering increased hardship for the effects of an inadequate water supply. Use of equipment owned by non-Federal interests would only be appropriate in the unusual circumstance when both of the above conditions can be met."

Water Transport: For the Corps to transport water as assistance during drought the following guidance is provided.

"a. Assistance to an applicant in the transportation of water may be provided only if:

(1) It is in response to a written request by a farmer, rancher or political subdivision for transportation of water under PL 84-99 (amended).

(2) The applicant is located within an area which has been determined by the Secretary of the Army to be drought-distressed.

(3) The Secretary of the Army has made a determination that, as a result of the drought, the applicant has an inadequate supply of water for human and livestock consumption and water cannot be obtained by the applicant.

b. Transportation of water by vehicle, small diameter pipeline, or other means will be at 100 percent Federal cost.

c. Corps assistance in the transportation of emergency water supplies will be provided only in connection with water needed for human and livestock consumption. It will not be provided in connection with water needed for irrigation, recreation or other non-consumptive purposes.

d. Corps assistance will not include the purchase of any water nor the cost of loading or discharging the water into or from Government conveyance.

e. Equipment owned by the United States will be utilized to the maximum extent possible in exercising the authority to transport water. Transport of water under this authority cannot be undertaken until the Secretary of the Army has made a determination that water cannot be obtained by the applicant (for reasons other than lack of financial resources) within the time needed to prevent the applicant from suffering increased hardships from the effects of an inadequate water supply."

Water Supply and Emergency Related Authorities

Corps authorities in water supply and related emergencies are described below.

Clean Water Supplies: PL 84-99 as amended by PL 93-251 and PL 99-662 authorizes the Corps to provide emergency supplies of clean water to a location which has a contaminated source of water. Policies related to this authority are presented below and in ER 500-1-1.

"a. Any locality faced with a threat to public health and welfare from a contaminated source of water is eligible for assistance.

b. Assistance may be provided after the responsible Corps official has made a finding that the locality is confronted with a source of contaminated water causing or likely to cause a substantial threat to the public health and welfare of the inhabitants of the locality. The finding will be based on one or more of the following factors:

(1) The maximum contaminant levels established pursuant to the Safe Drinking Water Act are found to be exceeded.

(2) The water supply has been identified as a source of illness by a state or Federal public health official (the specific contaminant does not have to be identified).

(3) An emergency situation has either resulted in contaminants entering the source on a sufficient scale to endanger health, or has made inoperable the equipment necessary to remove known contaminants. Examples are flooding and chemical spills.

(4) The presence of a contaminant is indicated on the basis of other information available.

c. The contamination may be deliberate, accidental or natural.

d. The distribution system may be publicly or privately owned.

e. The assistance will be directed toward provision of water for personal hygiene, sanitation and drinking. However, the quantity of water and the means of distribution will be at the discretion of the responsible Corps official, who will consider both the needs of the individual situation and the cost effectiveness of providing various quantities of water.

f. Permanent work must be approved by HQUSACE and must be the most economical means of furnishing temporary water. This does not include minor modifications required to connect temporary supplies. Accomplishment of deferred or deficient maintenance is not authorized.

g. If a locality has multiple sources of water, assistance will be furnished only to the extent that the remaining sources, plus reasonable conservation measures, cannot provide adequate water.

h. Loss of supply cases are not eligible for assistance. However, if a locality with multiple supplies has one source contaminated and loses another source, it is eligible to the extent that the contamination reduces the total water supply after the loss.

i. Water will not be furnished to a business firm for use in its processes, except as incidental to the use of existing distribution systems. This does not prohibit the furnishing of water for drinking by employees and on-site customers. Also, water for preparing retail meals and similar personal needs may be provided to the extent it would be furnished to individuals.

j. The permanent restoration of safe water supplies is the responsibility of local interest.

k. Corps assistance is normally limited to 30 days or until FEMA undertakes the provision of emergency water under its own authorities, whichever is earlier. In unusual cases where either has justification as to how state and local governments cannot provide clean water within 30 days, assistance may be extended by HQUSACE. Such extension requires a formal agreement between the state and the Corps, covering specified services and providing a firm timetable for local interests to provide normal supplies.

l. State and local governments must make full use of their own resources, including National Guard capabilities.

m. Contamination due solely to a drought would be handled under the drought assistance authorization, Section II of this chapter.

n. Requests for assistance must be signed by the governor of the state. Exception: for Indian tribal lands, the Bureau of Indian Affairs will normally request assistance.

o. Cases involving deliberate or accidental contamination will be coordinated with the Environmental Protection Agency before determination of liability and possible legal action. However, the primary concern is protecting the public health and welfare. If necessary, the Corps will provide assistance and later seek recovery of costs through legal action.

p. Military bases and other Federal reservations are not eligible for assistance, except for cost-share participation in a project which assists adjacent areas."

National Emergency Preparedness Planning: The Corps of Engineers was designated the lead agency for national emergency preparedness planning for water resources in April 1983. The main thrust of this planning effort is to be able to meet the nation's water needs in the event of a national emergency, including a massive nuclear attack. The specific responsibilities are described in Executive Order 11490,

"Develop overall plans for the management, control, and allocation of the water resources of the nation in an emergency. Establish a system of priorities for the use of water in periods of emergency. Coordinate the emergency water planning efforts of those departments and agencies with statutory or delegated water responsibilities. Coordinate the overall plans with those developed by the Environmental Protection Agency to provide potable water for community needs. In developing any plans relating to water for use on farms and in food facilities, assure that those plans are in consonance with plans and programs of the Department of Agriculture. Provide national leadership and coordination for the development of Federal emergency plans for the management and allocation of water resources in the national interest during an emergency.

Coordinate emergency water resource planning at the State, interstate, and local levels throughout the appropriate Federal departments and agencies concerned with each area of planning."

The two major elements of this planning effort are water and water support resources. These are defined in EC 500-1-22 Emergency Water Planning. Water is defined as

"all usable waters, from all sources, within the jurisdiction of the United States, which can be managed, controlled, and allocated to meet emergency requirements."

Water support resources are the materials, chemicals and equipment needed to produce, distribute and use water. The principal focus of this preparedness planning effort is national security during a national emergency.

Federal Emergency Management Agency Authority: Under PL 93-288 FEMA has no authority to provide water for drought situations unless there is a Presidential Declaration made for that purpose. Once a Presidential Declaration of a disaster is made, FEMA directs and administers federal disaster assistance authorities. Corps activities for FEMA fall under the Disaster Relief Act Amendments of 1974 (PL 93-288). This legislation authorizes federal agencies to utilize or lend their resources to provide specific types of assistance. The Corps, when specifically authorized may undertake the following mission assignments by FEMA:

"(3) Providing Federal assistance in the following categories:

(a) Performing on public and private lands or waters any emergency work essential for the protection and preservation of life and property including channel clearance emergency shore protection.

(b) Clearing and removing debris and wreckage.

(c) Making repair to restore to service, or replacing, public facilities (including structures of all types) of state and local governments and of certain private non-profit organizations.

(4) Providing technical advice and engineering services.

(5) Providing temporary housing for disaster victims. This includes site selection, design and installation of mobile homes and the supervision of the minimal repair program." (ER 500-1-1)

The Corps may accept such mission assignments from FEMA and can be authorized "to utilize its available personnel, equipment, supplies, facilities and other resources" (PL 93-288) with or without reimbursement. In addition,

> "Action taken to manage the mission will be in accordance with existing policies, procedures, authorities, and available resources. Administration and management of Corps personnel, resources and equipment is the responsibility of the division commander. Missions from FEMA during emergency situations are beyond the Corps statutory authority and a mission assignment under PL 93-288 is required to conduct operations." (ER 500-1-1)

Assistance Prior to a Presidential Determination of Disaster: When flood and coastal storm emergency conditions reach a disaster condition and the Governor of a state requests the President declare that a disaster exists, Section 917, Emergency and Disaster Authority, PL 99-662 gives authority to the Corps to take limited action during the time between the governor's request and the President's determination.

> "In any case in which the Chief of Engineers is otherwise performing work under this section in an area for which the Governor of the affected State has requested a determination that an emergency exists or a declaration that a major disaster exists under the Disaster Relief Act of 1974, the Chief of Engineers is further authorized to perform on public and private lands and waters for a period of ten days following the Governor's request any emergency work made necessary by such emergency or disaster which is essential for the preservation of life and property." (Section 917, PL 99-662)

After ten days, the Corps is no longer authorized to continue such assistance. If a disaster is declared, the Federal Emergency Management Authority takes over responsibility.

Additional responsibilities of the Corps prior to a Presidential determination is to assist the Federal Emergency Management Agency (FEMA) in gathering information. This includes (ER 500-1-1):

"(1) Making damage assessments and investigations of request for Presidential declarations.

(2) Preparing Damage Survey Reports (DSR) and Final Inspection Reports (FIR)."

APPENDIX B

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