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I. INTRODUCTION

A. BACKGROUND

Many water utilities in Tennessee could face significant operational and supply-related problems during droughts or other emergencies. These problems are caused by the combined effects of less water available from the source, increased demands for water from customers, and stress on system equipment. Even water quality degradation is a potential problem in a drought.

Industry is expanding in many areas of Tennessee, and Tennessee's population is continuing to increase. As water supply conditions change and demand increases, temporary shortages in water supply are likely. An emergency or an extended drought can severely diminish or limit the use of stream, reservoir, and groundwater supplies. In many emergencies, the final phases of a drought management plan can be used to deal with power outages, hazardous materials spills, line breaks or other emergencies having a severe impact. An emergency operations plan (or EOP) is required by the Division of Water Supply under its Rules.

Water utilities that have experienced serious and costly water shortages stemming from changing conditions in water supply and demand should include drought management in their emergency management plan. In addition, public water systems which may be impacted by a drought were identified in the study, "Drought-Related Impacts on Municipal and Major Self-Supplied Industrial Water Withdrawals in Tennessee" (Parts A and B) by Alexander, Keck, Conn and Wentz, 1984.

A local drought management plan outlines the actions a public water supplier will take in order to limit adverse effects during a drought. The possible issues, rationale and responses which should be considered in developing a local drought management plan are the subject of this Guide.

B. PURPOSE

This Guide has been prepared to help public water supply managers (1) assess their situation, (2) develop a drought management plan, (3) identify and monitor drought stages, and (4) effectively manage system supply and demand during a drought. It focuses on developing a drought management plan for public water supplies. This Guide should serve as a basic reference document to the "Summary." The materials in this Guide are drawn heavily from the sources listed on page , "Literature Cited". Another document, "Guidelines for Emergency Operations Planning for Community Water Systems," (to be printed) provides details on developing emergency operations procedures (EOPs), which are needed to meet the State's minimal emergency planning requirements.

This Guide does not address detailed planning for developing water supplies nor other responses requiring a considerable expenditure of time or money. Such planning and system expansion or renovation should be handled as a part of normal operations and maintenance. Where a system or source of water fails to meet the most essential demands, that supplier may choose to embark on a program for improving the system's capacity through development of alternative supplies of water, overall demand reduction, leakage control, etc.

Rather than focus on source development, this Guide emphasizes the development of a plan **(1) to manage available supplies and uses during a drought** and (2) to identify alternative sources which could be used on a short-term, interim basis to alleviate a water shortage. Auxiliary sources which are not already owned take time to acquire and develop. The Guide accepts as given, situations that cannot be altered without considerable money or time. Where a water system finds it cannot tolerate the restrictions that would accompany potential water supply shortages, the plan may indicate to the system its need to develop alternative water supplies and/or reduce overall demand. These considerations, however, do not negate the fact that all users face some risk.

Drought management planning can be invaluable in determining what chances are going to be taken and what consequences exist for water users. Acceptable levels of service must be established for various uses and the available water resources managed accordingly. For example, priorities should be established for essential needs such as hospitals, nursing homes, emergency shelters, decontamination of lines, and firefighting over such uses as lawn watering and street cleaning. This Guide will help water suppliers to establish priorities.

II. OVERVIEW OF GUIDE ELEMENTS

This Guide begins by clarifying the roles of local, state, regional and federal agencies. It identifies possible goals and objectives for plans containing phase responses as well as the need for public participation in their development. It also discusses the need for an accurate and timely assessment of source supplies and distribution capability, potential water quality problems, assessing current and peak demand, and the development of a phased program of balancing the supply and demand of water in an equitable and acceptable manner. Many optional local responses to water shortages are identified, with each having a different set of potential benefits. Finally, the Guide addresses the administrative and enforcement needs of drought management, as well as the need for an ordinance or by-law enabling the system to exercise these management prerogatives, and the need to educate the public concerning plan implementation.

The steps taken by this Guide develop a plan as shown in Figure 1, "Developing a Local Drought Management Plan." Several of the steps detailed in the figure can be undertaken at the same time, i.e., assessing source capacity, identifying potential water quality problems, and estimating current and projected demand. Other steps are better developed in a progressive order, i.e., from identifying goals and objectives to assessing demands and water sources, and establishing water use priorities to adopting an ordinance enabling the system to implement its plan. Suppliers should use Figure 1 in developing a local plan. Public involvement should occur throughout the plan development process.

Figure 2, "Balancing the Water System's Supply and Demand," focuses on the collective purpose of all the steps, i.e., to develop an acceptable plan to balance the system's demand for water with its supply of water at three levels of availability. Figure 2, part A shows a water system in crisis as a result of unmanaged water use. Under wet and normal conditions water demands are met by the system. The capacity of the source and the capacity to treat and deliver water is far from being stressed. Average daily use (demand) is near 80 percent of deliverable capacity. As conditions become dry and the source's capacity begins to decline, water demand increases due to lawn watering, additional bathing and laundering, etc. Water demand may approach the system's deliverable capacity. In a drought a source's capacity may decline to its 3Q20, minimum reservoir level, etc., or even decline below its safe yield. When the water system's deliverable capacity is insufficient to meet total demand, the system will be in crisis and many critical needs will not be met by the system.

Figure 2, part B shows a water system meeting critical needs though supplies are deteriorating and demand is increasing. As drought conditions persist, source capacity declines and/or total water demand continues to increase. The system begins a program for managing water use in keeping with its deliverable supply. The system has defined three levels of service in response to increasingly severe drought conditions. These phases are called "Conservation," "Restrictions," and "Emergency." Under its "Conservation" phase, water demand is designed to be reduced by 15-20 percent. Water service to meet First, Second and Third Class Essential uses are maintained. Under the "Restrictions" phase water demand is reduced a total of 30-40 percent.

Figure 1
Developing a Local Drought Management Plan

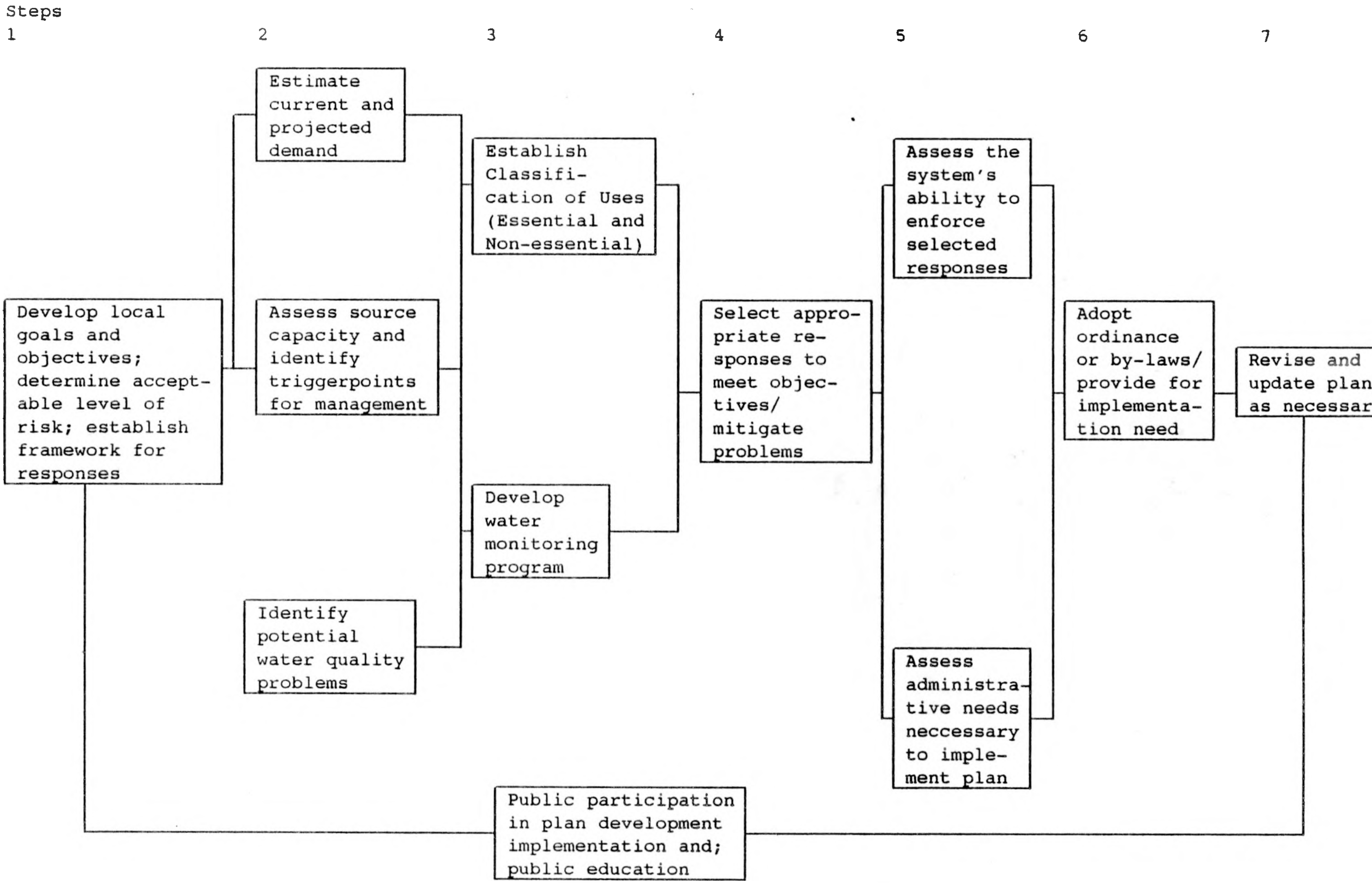
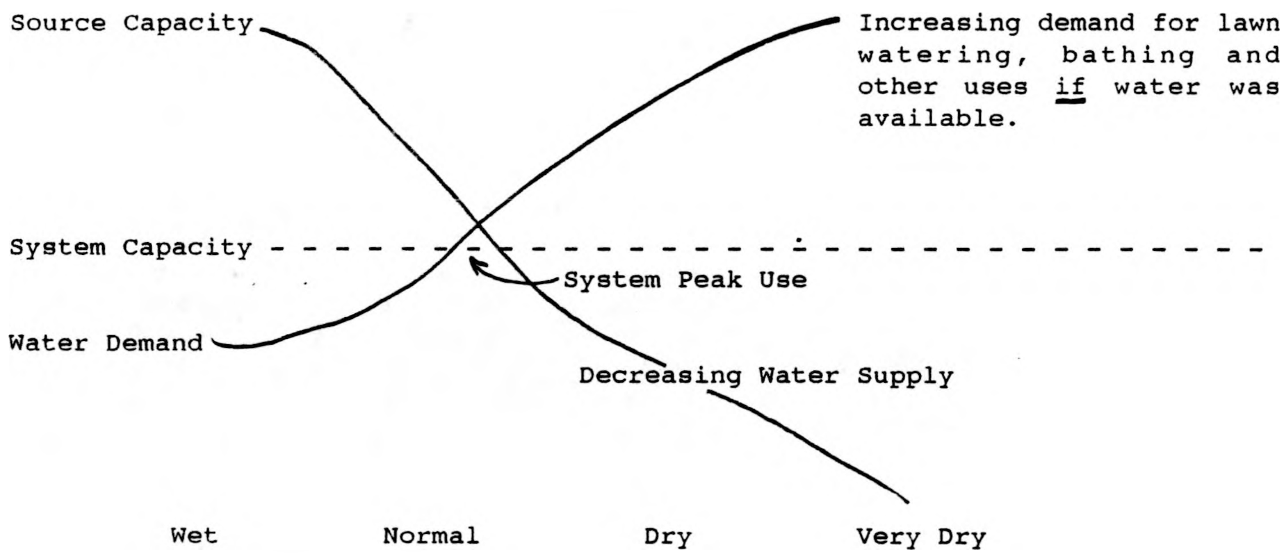


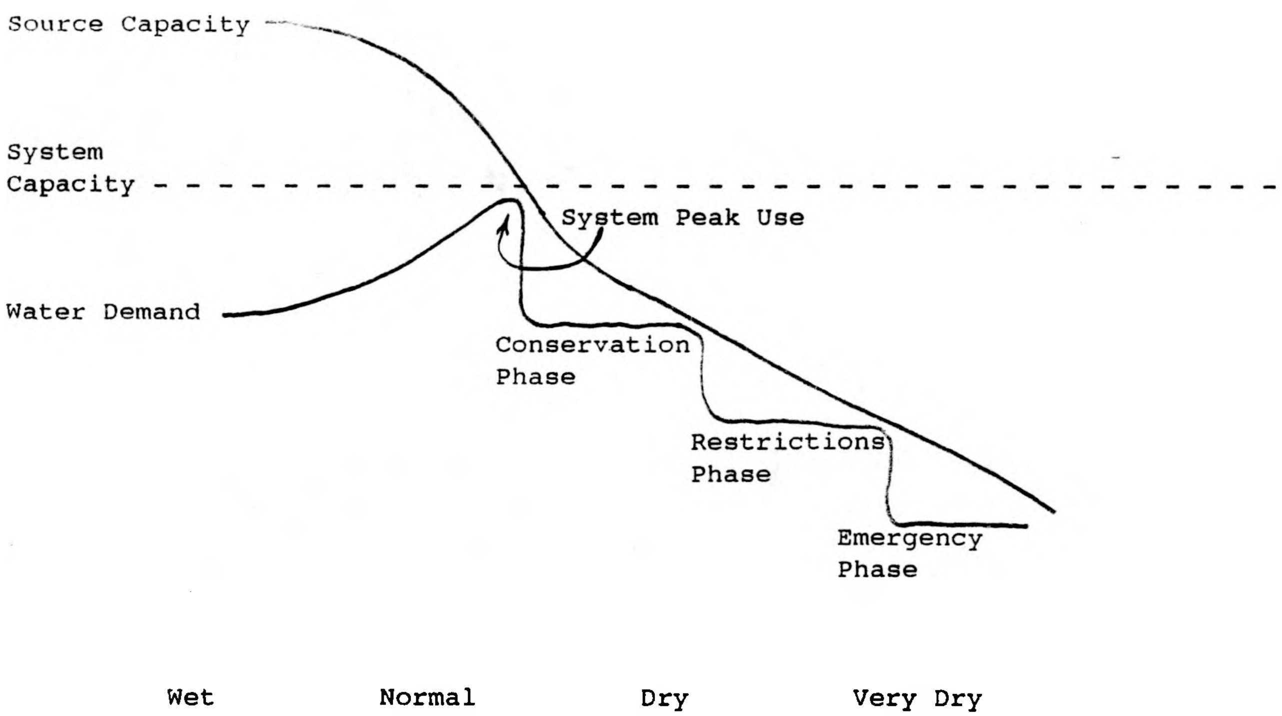
Figure 2

Balancing the Water System's Supply and Demand

A. Unmanaged Water Use



B. Managed Water Use



Non-essential, Third Class and possibly Second Class Essential uses should be curtailed. Under the "Emergency" phase water demand is reduced a total of 60 percent or more. Throughout the three phases water demand is balanced with the system's available water supply. Water use does not exceed the system's deliverable capacity.

As an aid to developing a drought management plan, this Guide recommends that the three levels of service defined above be incorporated in the system's drought management plan. Other, additional phases may be developed by the water supplier as appropriate. In particular, water suppliers may want to develop additional management phases which would apply to various emergency situations.

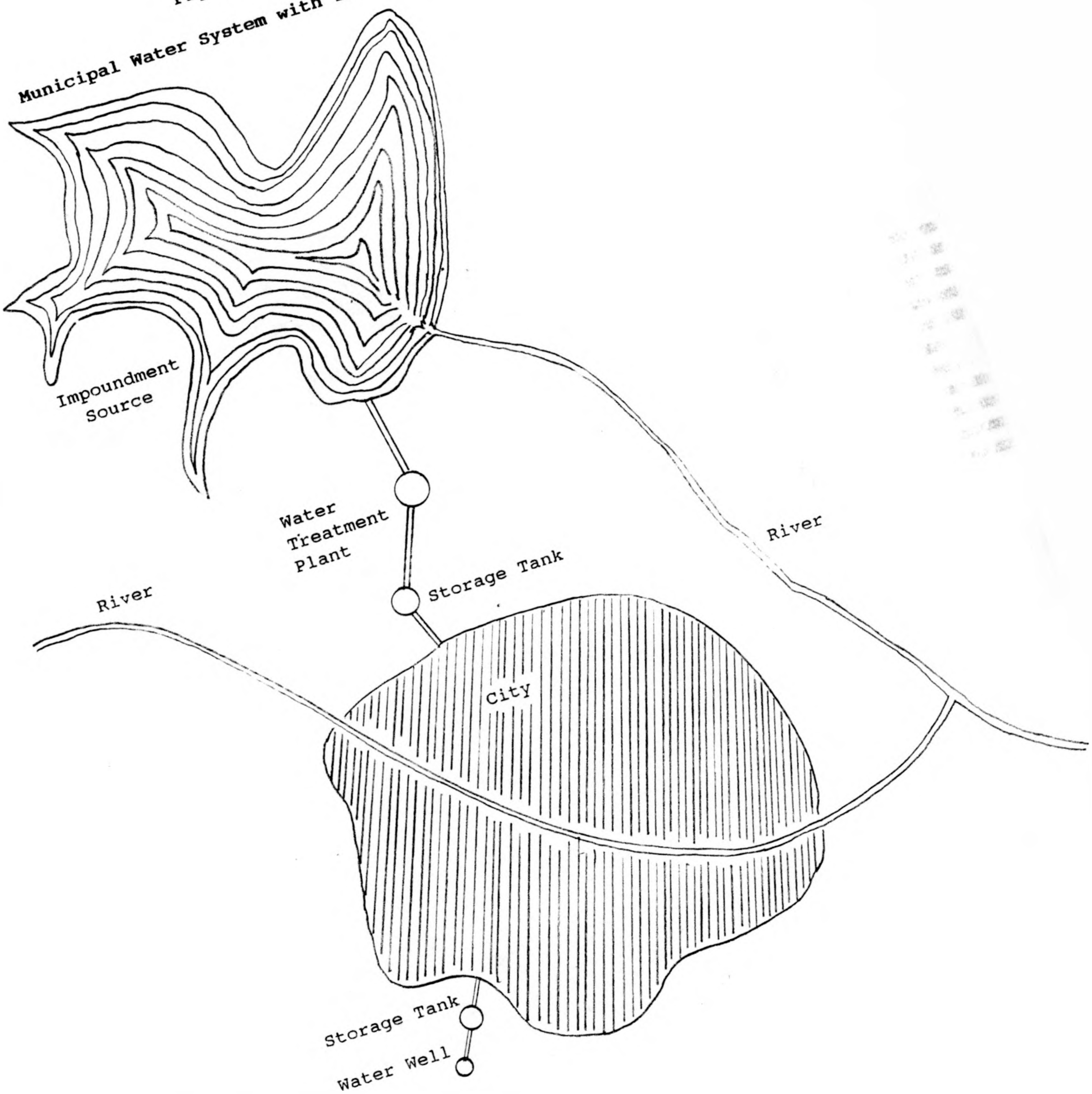
All suppliers need to plan for all three drought management phases and assign an appropriate triggerpoint to signal the implementation of each phase. Reductions in supply are possible for all suppliers, even those who consider themselves to be "drought-proof." Instead of a drought, supply reductions may result from a toxic spill preventing withdrawal of water from a reservoir or river, or because of a major fire, linebreak, power outage, treatment plant or storage problem. A supplier's drought management plan should provide an excellent basis for continued emergency management planning. In addition to drought, a local or county comprehensive emergency management plan will consider the effects of all potential emergencies on many services and for each of their components, recognizing that each disaster or emergency, e.g., earthquake, snowstorm, etc., has its own characteristics. Identifying the effects produced by particular disasters should help water system managers better anticipate their management responses, although many disasters will have the same result. However, a system with a resultant water supply loss must consider the cause in light of its overall extent, specific impacts on other services and need for coordination with other agencies. The local emergency planning committee (or county emergency management agency) should develop plans and procedures for handling multiple service needs.

Some public water suppliers may have several treatment plants, reservoirs, or sources of supply. The service areas for each of these may need to be considered independently when evaluating delivering capacity, identifying priorities, potential reductions in usage, health and safety considerations, and management phase. Figure 3, "Municipal Water System With Two Sources," shows a system with major two components. A supplier, like that shown in Figure 3, can subdivide its plan measures dealing with the critical components, e.g., water treatment facilities, distribution system, transmission system, trained personnel, or sources. Important components of each section of the system should be identified. Although components can be planned for subdivided sections separately, the planned measures can be undertaken systemwide as circumstances dictate. Plans should provide a clear breakdown of each subsystem and the emergency operations procedures (EOPs) that should be used under each phase.

A drought management plan should be developed in response to clearly defined objectives. The better these broad objectives are defined by a public water supplier, the greater the possibility that planned responses will be appropriate for the circumstances. Systems may include additional phases and detail beyond what is described in this Guide.

Figure 3

Municipal Water System with Two Sources



Because a water supplier serving almost exclusively domestic users is so nearly uniform, its foremost objective may be to provide adequate supplies to its elderly and handicapped residents. The system may use a pricing structure which prices excess use above an established "lifeline" minimum at a significantly higher rate. Another system with a vulnerable source may be more concerned about prolonged industrial layoffs as a result of drought. That community may want to keep as many of its labor intensive businesses and industrial users operating as long as possible. Identifying the system's objectives helps develop a phased management plan to balance the supply and demand of water.

A water supplier can begin identifying its possible health, economic, and social objectives, system components, opportunities for reducing use, etc., by completing Appendix A, "Drought Management Planning Inventory For Public Supply Systems," in this Guide. For the sake of simplicity and consistency concerning objectives, this Guide will deal primarily with the minimal three phases suggested by the Office of Water Management.

III. AGENCY ROLES AND RESPONSIBILITIES

The "Interim State Drought Management Plan" is the Department of Health and Environment's interim plan for the management of water under drought conditions. The Plan was developed based on several related mandates in Tennessee statutes. These are the Water Resources Division Act of 1957, which authorizes the Department of Health and Environment to provide general direction in all matters pertaining to the conservation, protection, and development of Tennessee's waters, including development and implementation of a basic, long-range water resources policy; the Tennessee Safe Drinking Water Act of 1983, which requires development of a plan for the provision of safe drinking water under emergency circumstances; and the Tennessee Water Quality Control Act of 1977 as amended, under which the Water Quality Control Board has adopted a plan for the protection and preservation of the state's waters. The Interim State Drought Management Plan also serves in part as the emergency water management plan authorized under the Tennessee Safe Drinking Water Act (T.C.A., Section 68-13-710), (Keck, 1987).

The Rules of the Tennessee Department of Health and Environment, Chapter 1200-5-.17(7), require that "...all community water systems shall prepare an emergency operations plan in order to safeguard the water supply and to alert the public of unsafe drinking water in the event of natural or man-made disasters." The Interim State Drought Management Plan outlines in broad terms the procedures and roles to be taken by water users and managers during a drought.

In the State's plan, the Commissioner of the Department of Health and Environment advises public water suppliers and other local users to develop their own emergency response plans. The responsibility to develop and implement a local drought management plan is local. Local plans insure that local circumstances are recognized and that critical local needs are met. The plan should detail "phased" responses to address increasingly severe drought conditions. Recommended phases include a "Conservation" phase, a "Restrictions" phase, and an "Emergency" phase (Keck, 1987).

Furthermore, the Commissioner recommends that every plan consider source capacity, hydraulic limitations of the facility, how water is used, and possible water quality problems due to low flow. Specific actions included in the plan under each phase should be based on local circumstances and needs, and the acceptability of remedies to the public. Each user or system has a unique set of demands that must be considered in context.

Because all users are potentially subject to decreases in water availability due either to a source or facility limitation, development of an emergency management plan is essential. Source and facilities planning should make sense and be cost effective. This planning Guide is directed toward drought management. However, many of the principles that are utilized in managing water supplies in a drought also apply to other emergency situations where the water supply to the public is cut back or cut off. Storage tank failures, sudden contamination of supply, treatment plant failures, and pump failures are water supply problems that should be addressed and made part of the plan's emergency operations procedures (refer to Chapter XI, "Planning for Implementation" and the Division of Water Supply's "Guidelines for Emergency Operations Planning for Community Water Systems.")

Water suppliers will need to distinguish among emergencies the roles and assignments that are appropriate for other agencies and individuals. (Chapter VIII, "Identifying Management Triggerpoints," characterizes the various degrees of drought as well as types of emergencies.)

Problems and needs that are regional or statewide should be addressed by agencies having a state or regional water management responsibility. The Interim State Drought Management Plan also recognizes that some problems may be beyond the state's authority or ability to manage. Figure 4, "Drought Responses," identifies not only the scope of this Guide but also the roles of other agencies under various drought scenarios. Because circumstances and needs differ locally, State and Federal roles primarily consist of data collection, information dissemination, technical assistance, and regulatory oversight (Keck, 1987).

Where conflicts over water rights and water quality problems emerge or local situations become emergency situations, the Tennessee Office of Water Management, the Tennessee Emergency Management Agency, and the Governor can enter the situation. Once a situation is declared an emergency, special actions can be taken under the Commissioner's or Governor's emergency powers authority. Conflicts involving water rights will be handled on an emergency, case-by-case basis (Keck, 1987).

Within this framework, public water suppliers are afforded considerable flexibility to meet the needs of their situation. The management strategies developed by local suppliers are extremely important in lessening impacts and delaying or averting further water use restrictions.

Figure 4

Drought Responses

Condition and Management Phase*	State and Federal Actions	Local Actions: Public Water Suppliers	Local Actions: Industrial	Local Actions: Agricultural, Self-Supplied, Environmenta
Normal Conditions Water supply is adequate; water quality is acceptable under normal management	.Develop precipitation, streamflow, ground water, and water quality monitoring programs .Conduct state and regional water studies and coordinate recommended actions .Assist public water suppliers and local government in developing Emergency Water Management plans .Establish public education program	.Develop local drought management plan .Develop additional storage and treatment facilities; evaluate distribution system .Adopt standby rates, other necessary ordinances and codes, and establish mutual aid agreements, interconnections, conservation education, etc.	.Develop local drought management plan .Develop additional wastewater storage .Develop alternative water supplies, water storage and conservation measures .Purchase standby equipment and install permanent equipment as necessary for recycling	.Develop local drought management plan .Evaluate need for irrigation .Enlarge pond, purchase tanks, drill wells, install conservation devices and livestock watering tanks .Evaluate agricultural water use and find where conservation could be used, including use of "drip" irrigation .Evaluate domestic water use and install water-saving devices, etc. to reduce stress on supply source
Drought Alert Lower than normal precipitation, declining streamflows, reservoir levels, and groundwater levels; greater than normal demand	.State issues Drought Alert to media and notifies targeted water users (Alerts may be regional or local) .Intensify selected monitoring activities .State initiates an awareness program	.Monitor water sources and daily water use for specific purposes and anticipate user demand .Monitor potential conflicts and problems	.Monitor water sources and daily water use for specific purposes and anticipate demand .Monitor water quality	.Monitor water sources and daily water use for specific purposes and anticipate demand

Figure 4

Drought Responses (continued)

Condition and Management Phase*	State and Federal Actions	Local Actions		
		Public Water Suppliers	Industrial	Agricultural, Self-Supplied, Environment
Conservation Phase Water supplies/ water quality deteriorating or conflicts among users	.Disseminate water supply and water quality data .Monitor systems and users having past problems and monitor plan implementation .Coordinate state and federal supply and water quality actions .Respond to local and individual appeals for assistance ."Post" streams where water quality standards are not met .Commissioner issues orders to water suppliers and/or dischargers	.Implement "conservation" phase at plan triggering point. Potential conservation measures include curtailment of outside uses, education, and pricing .If conservation goal is not obtained, implement restrictions .Notify OWM of sources conflicts	.Institute recycling, cutback production, store wastewater, alter production schedule per industrial water management plan during a drought .If goals are not met, implement additional measures .Notify OWM of source conflicts	.If assessed source is capable, irrigate crops .Provide tanks, maintain streamflows, etc., to meet supply needs of livestock, fish, and aquatic life .Continue conservation of domestic supplies .Notify OWM of source conflicts
Restrictions Phase Continued decline in water supply and/or water quality	.Same responses as in Conservation Phase	.Implement "restrictions" phase at plan triggering point. Restrictions could include banning of some outdoor water uses, per capita quotas, cut-backs to non-residential users .Notify OWM of source conflicts	.Institute additional cut-backs in production, storage of wastewater, or changes in production schedule, etc., per industrial water management plan .Notify OWM of source conflicts	.Same responses as in Conservation Phase

Figure 4

Drought Responses (continued)

Condition and Management Phase*	State and Federal Actions	Local Actions		
		Public Water Suppliers	Industrial	Agricultural, Self-Supplied, Environmenta
Emergency Phase Severe water supply or water quality problems due to very limited resource availability	.Governor responds to critical situations by declaring an emergency .TEMA takes action .OWM mediates in conflicts of source utilization under emergency powers	.Notify TEMA and request emergency declaration .Provide bottled water and sanitation supplies to users .Make hospitals, fire-fighting, etc., priority .Initiate hauling of water .Comply with Commissioner's Orders	.Request emergency declaration of Governor .Comply with Commissioner's Orders .Request assistance from local government .Implement hauling water for sanitation, domestic uses	.Local government assistance in obtain-taining water for domestic purposes, and in supporting livestock .Implement hauling water, etc.

*Each phase would be marked by some event or percent of water supply deficit (triggerpoint) as defined locally.

IV. GOALS AND OBJECTIVES

In order to effectively accomodate the public interest, efforts should be made to identify practical water-related goals and objectives needed during times of water shortage.

The goals of a local public water supplier's drought and emergency management plan may include:

1) equitable distribution of available water supplies among all water users during times of drought, or other water shortage, consistent with goals of minimizing adverse economic, social, environmental, and health related impacts;
2) a basis for management decisions related to the use of water under varying water shortage conditions; and
3) advance knowledge of actions that will be taken during times of water shortage to facilitate implementation in a timely and orderly manner and promote greater security among water users.

More specific goals relating to levels of service under each management phase may be included in a drought management plan depending on the circumstances of the system.

Good management must know the dependable capacity of a water source, the capability of equipment to deliver water, and understand the demand. Assessing risk for water shortage is uncertain because forecasting is imperfect. Some risk will always be present, and the tolerance of risk among users will vary. Where users have a low tolerance for risk, severe drought conditions make sure water availability possible only after considerable source and facility development.

The dependable capacity of a supply source is simply the maintained output of a source during a severe and extended drought. Where a system's capacity to treat and deliver water determines the deliverable capacity of a system, monitoring the system's source may not be necessary. Managers must then monitor water use demand. If water users have a low tolerance for water use restrictions, the system may also need to undertake a long-term investment strategy to reduce the risk of short supplies.

A long-term water development plan to meet growing water needs over an extended period should be part of the supplier's normal planning for growth. Such strategies may involve cooperative agreements or the regionalization of systems to develop a source which is otherwise economically unattainable. Another long-term strategy is to reduce overall demand through non-voluntary water conservation. These long-term plans reduce risk and improve the margin of safety.

Recommended criteria (several exceeding State minimum standards) for evaluating a system's resistance to water shortage include:

1) Pump-tested wells and/or 3Q20 flows sufficient to meet the capacity of the system;
2) impoundments totalling 90-days or more storage of raw water;

3) minimum 3-day or longer storage capacity for finished water;
4) less than 10 to 12 percent losses of treated water through leaks;
5) treatment plant capacity that exceeds previous 12 month average daily use by 30 or more percent; and
6) a minimum water pressure of 60 psi (pounds per square inch of pressure) in all distribution lines.

Water systems that do not meet most of these criteria might have difficulty satisfying water demands during a peak use period exceeding 4 to 6 weeks. A system that meets or exceeds these criteria reduces the risk of shortage to its customers. Developing facilities and sources that meet these criteria depends on whether more frequent water shortages are acceptable to users given the developmental costs.

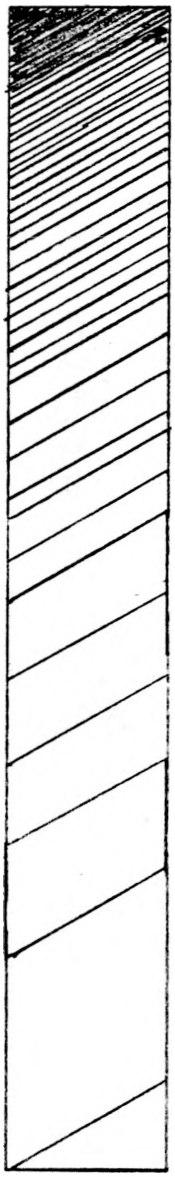
Risk involves both the probability of a water shortage and its subsequent impacts. Risk factors include the source availability of water; the extent of population at risk; the degree to which the system serves critical, non-deferrable needs; the diversity of source types and/or number of sources utilized by the system; capacity and condition of system infrastructure; the diversity of uses (industrial, commercial, institutional, residential, etc.); the vulnerability of sources to contamination, etc. A local drought management plan should contain all the information requested in Appendix A, "Drought Management Planning Inventory for Public Water Supply Systems." It should also contain maps showing the layout of the water system in relation to important area features, such as power facilities, highways, railroads, streams, chemical plants, aviation routes, and other landmarks. Systems serving many users with little tolerance for risk likewise cannot tolerate a great deal of risk. Figure 5, "Factors in Evaluating Risk," provides a checklist for evaluating a system and identifying possible goals and objectives.

Facilities with large sources and those which are willing and/or able to accept extensive restrictions and cut backs over long periods need a drought management plan to be orderly and equitable in the event of a shortage. A really good management plan will deal with unexpected emergency shortages as well as drought. It will address shortages whatever the cause. A good plan reduces the system's vulnerability. It could suggest additional plant security or acquiring auxiliary equipment, as well as temporary conservation actions that focus on reducing water demand during the shortage, and actions to increase supplies. Plans for restrictions and obtaining other sources of water are most essential, in effectively dealing with supply shortages. Controlling risk with a short-term water management plan requires knowing what your priorities or service goals are under various degrees of diminished supply.

Figure 5

Factors in Evaluating Risk

High Risk



Low Risk

Limited or no storage for finished water
Unknown source capacity of streams and/or wells
3Q20 flow less than average daily demand
No interruptable service contracts
History of many linebreaks and shortages
Single source of water, no interconnections with other systems
Poor infrastructure capacity or condition (leakage exceeds 15 percent)
Large number of users with critical non-deferrable needs (concerning public health and safety)
Vulnerable to hazardous materials spills or other contamination
No drought and emergency management plan
No emergency power source(s) supporting system components (booster stations, well pumps, etc.)
Minimum water pressure less than 60 psi in areas of the system
No facility security
No emergency personnel

Adopted drought and emergency management plan and ordinance
Diversity of water user groups
3Q20 which exceeds treatment capacity
History of linebreaks and shortages
Diversity of sources and/or source types
Average daily use 70 percent or less of treatment capacity
10 percent or less leakage of treated water
3-day or longer storage of finished water
90-day or more storage of raw water
An emergency power source
Secured facility
Low vulnerability to hazardous materials spills or other contamination
Minimum water pressure of 60 psi in all distribution lines
Trained emergency personnel available

V. PUBLIC INVOLVEMENT IN PLAN DEVELOPMENT

While the responsibility of developing a local drought management plan rests with local water officials (or their staff assigned to develop a management plan), the creation of an advisory group to be involved in developing a drought management plan may be critical to the plan's usefulness. Who should be involved depends on the institutional characteristics of the system, whether it is a municipal department, a utility district or an investor-owned system.

If the system serves a small community, an advisory group or task force can provide meaningful input and feedback needed to analyze and shape a plan. If the system serves a large urban area, a formalized board may be needed which presents proposals to the public for ratification. The advisory group should consult interest groups and/or major users with a large stake in water management. When other emergencies are considered, many other groups, and public agencies may have a vital interest in coordinating their actions with the actions of the system. Where alternative responses are identified public meetings and other means of exposure may be planned to allow for public discussion. An advisory group or task force helps insure appropriate and effective community response.

Consider involving representatives from the following (Wood and others, 1986):

- County Emergency Management Agency (Civil Defense)
- County Health Department Official
- Hospital Administrators/Nursing Home Operators
- Chamber of Commerce
- County Executive or Official
- Churches
- Mayor(s), City Manager(s) or Other City Official(s)
- Fire Chief
- Legal Representative
- Division of Water Supply, Office of Water Management
- Businesses and Industries (which purchase from the system)
- Media Representatives (TV, radio and newspapers)
- Professional Groups
- PTA/School Officials
- Water System or District Personnel
- Residential Groups

The advisory group can provide some direction to water system officials in gathering information related to sources, demand and system capability. Members might make a list of essential uses and evaluate the amounts of water used by hospitals, jails, and nursing homes. They may suggest which options are more suitable for reducing demand and explore potential auxilary sources of supply, including lakes, quarries, additional wells, etc. They are most valuable in identifying potential exceptions to rules and developing policies and approaches which address special needs (Wood and others, 1986).

The major task of an advisory group is to advise and assist system officials in formulating the plan. Group members should anticipate impacts, identify service areas having a priority, suggest appropriate responses and measures, and promote the plan among their constituents. After the plan has been activated, they should consider the effectiveness of the plan in insuring adequate water supplies (Wood and others, 1986).

The advisory group can provide much needed support where difficult decisions must be made by water system managers. They should represent community perspectives in evaluating conditions and activating or de-activating specific management phases. They can assist in public education, promote adoption of the plan, organize and oversee its implementation. The group may also oversee interagency coordination, and serve an appeals role, for granting variances where circumstances are unique. They should serve as a consensus-building group so that local decisions have general political and community support.

The first role of the advisory group should be to assist development of a drought management plan which can be adopted by the city, commissioners of the district system, or on record with the investor company. An official ordinance authorizing powers necessary for the implementation of the plan, or the adoption of plan itself, may be necessary before the plan can be activated.

VI. ASSESSING SOURCE CAPACITY

In Tennessee, there are extreme variations in types and character of water sources. The capacity of each source and its contribution to the system is important in understanding potentials for water shortage. Systems with a limited source may expect to impose conservation and restriction measures more frequently than systems with almost limitless source capacity. Consequently, each situation must be analyzed to determine how a local municipality or water utility manager is to respond to a state declaration of "Drought Alert."

Assessing a source's capacity during drought is essential to a management plan. Current supply, especially for wells and streams, should be compared to historical records if available. Records for drought years are especially helpful. Besides the dry period 1985-1987, other years of moderate to severe drought conditions in Tennessee include 1981, 1969-70, 1966, 1959, 1953-54, 1940-42, 1930-31, 1925-26, 1914, 1910, 1904, 1894-96, 1885 and 1877-78.

A. GROUND WATER

"Water wells rely on ground water, which is drawn from underground aquifers. The available supply is measured in **specific capacity.**" Specific capacity of a well can be measured by dividing the volume of water withdrawn (gallons per minute), by the drawdown (the distance the water level falls in a well when the well is pumped) (Wood and others, 1986).

$$\underset{\text{(gpm/ft.)}}{\text{Specific Capacity}} = \frac{\text{volume withdrawn in gallons per minute (gpm)}}{\text{feet of drawdown}}$$

If there are past records of specific capacity, or if the original specific capacity of a well is known, they can be used to determine the decrease of available water in the well. Current specific capacity can also be expressed as a percent of specific capacity under normal conditions by dividing the specific capacity under present hydrologic conditions by the specific capacity under normal conditions and multiplying by 100 (Wood and others, 1986).

$$\text{Percent of Original Capacity} = \frac{\text{specific capacity (present conditions)} \times 100}{\text{specific capacity (normal conditions)}}$$

If specific capacity drops below 80 percent of normal specific capacity, a hydrologist should be consulted. There may be some cases if specific capacity under "normal" conditions is not known. In those cases if the specific capacity decreases 6 percent or more over a two month period, a hydrologist should be consulted (Wood and others, 1986).

Where historic records are not available, data collection should be initiated. If a facility has a maintenance contract for its wells, the maintenance company should have calculated the change in specific capacity. Many large well drilling companies have resident hydrologists who can analyze well data (Wood and others, 1986).

All public suppliers should routinely measure static water level (the water level when not pumping) and drawdown of their wells. These measurements should be made on a daily basis during supply shortages and weekly during normal conditions. Static ground water levels tend to fall during dry periods and rise during wet periods. Drawdown and static water levels can be plotted on graphs like those in Figure 6, "Static Water Level" and Figure 7, "Water Drawdown Level," (Wood and others, 1986). When static water levels or drawdown approach the well screen or pump or when other problems are encountered, a hydrologist should be consulted. In West Tennessee, a declining static water level may provide a good basis on which to base water management. Wells which cannot be measured for drawdown or static water level should be modified so that measurements can be made (Wood and others, 1986).

"Ground water aquifers are usually an excellent source of water because they have high storage capacity, constant temperature, and very little evaporation. However, they can be overdrawn" (Wood and others, 1986). If further information is needed on ground water resources, contact the Office of Water Management, Division of Ground Water Protection, 615/741-0690.

Measuring Water Levels and Depths

Daily or weekly measurements of the depth of static water level (the level when no pumping is occurring) indicate trends in the amount of ground water available for use. These readings should be taken when the pump is off and the water level has stabilized. Static water level should be measured just before the well enters a pumping cycle" (Wood and others, 1986).

Another useful well measurement is drawdown level (the reduction in water level while the pump is running). Drawdown is measured after the pump has been operating long enough for the water level to stabilize at a constant or nearly constant level. Comparison of drawdown and static water level measurements over time allows an operator to recognize drops in well efficiency caused by incrustation of screens or decreases in aquifer water levels (Wood and others, 1986).

Methods for measuring depth include:

Chalked Tape Method (see Figure 8, "Chalked Tape Method for Well Water Level Measurements")

A steel or fiberglass surveying tape long enough to reach the water and carpenter's chalkline chalk are needed. The tape should have a weight on the end to help prevent it from sticking to the side of the casing. Bolts securely fastened to the end of the tape can be used. The first ten feet of the tape should be chalked. The chalk on the tape is used to establish a water mark on the tape, when it is completely lowered (Wood and others, 1986).

The tape should be lowered in short quick drops (one foot at a time). A splash will be made by the weight when it hits the water. The tape should be lowered until it reaches the bottom. The tape should then be pulled out, the number at the water mark noted and subtracted from the previous number. The result is the depth to water. The chalked tape method cannot be used in wells with cascading water (Wood and others, 1986).

Electric Tape Method (see Figure 9, "Electric Tape Method For Well Water Land Measurements")

STATIC WATER LEVEL

Month ______________

Well No. ________

19 ___

F
E
E
T

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 23 24 25 26 27 28 29 30 31

DAYS

Figure 6

WATER DRAWDOWN LEVEL **Well No.** ____________

Month ________________ **19**___

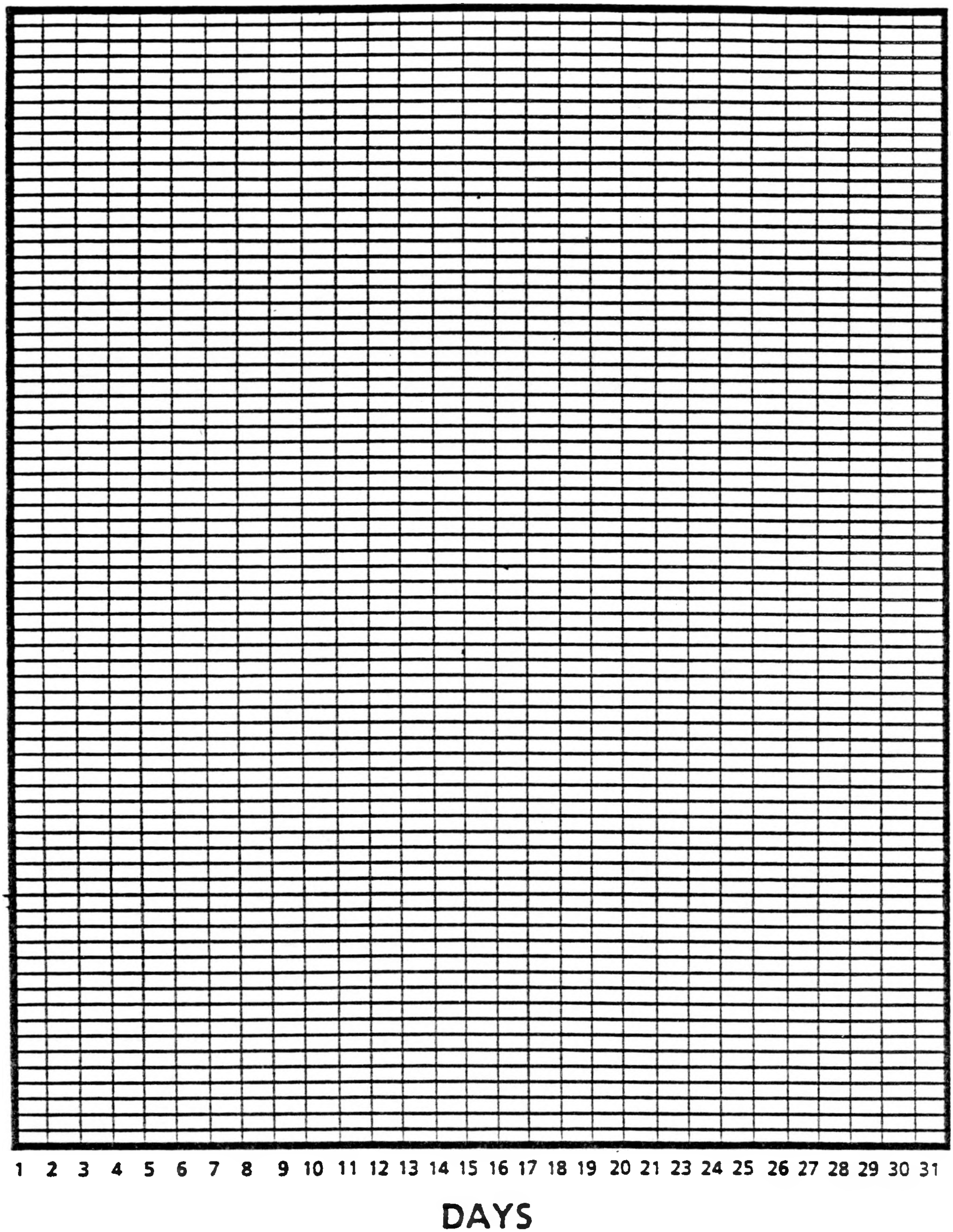
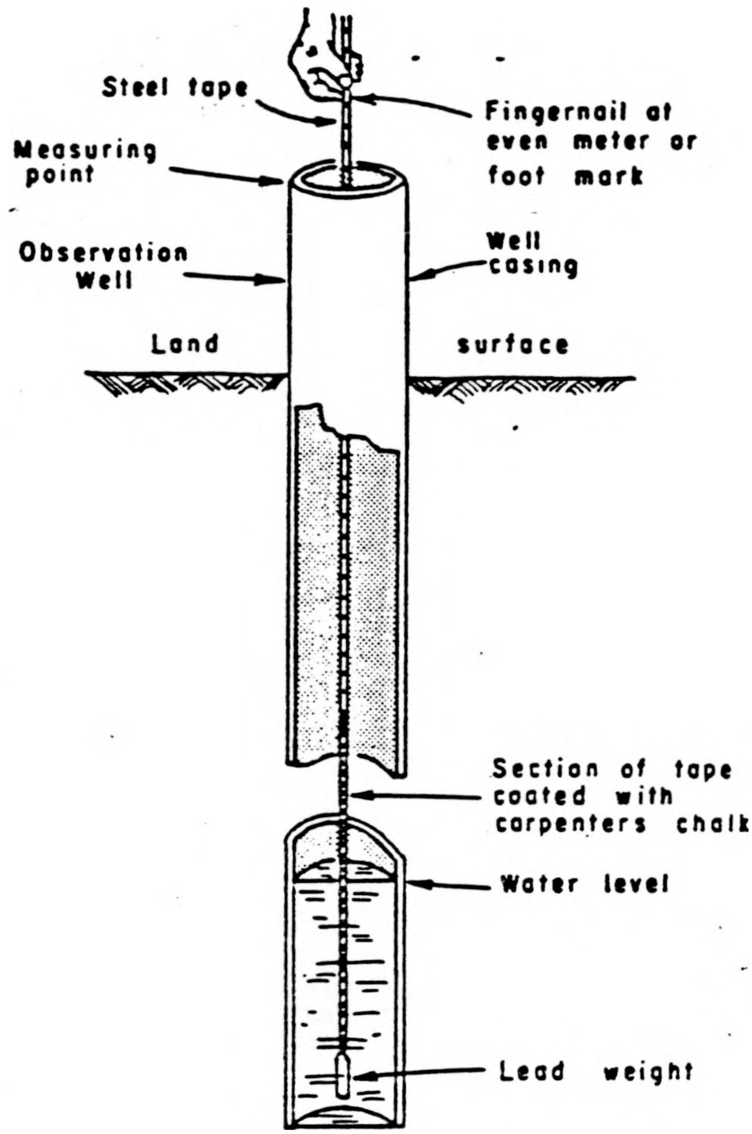


Figure 7

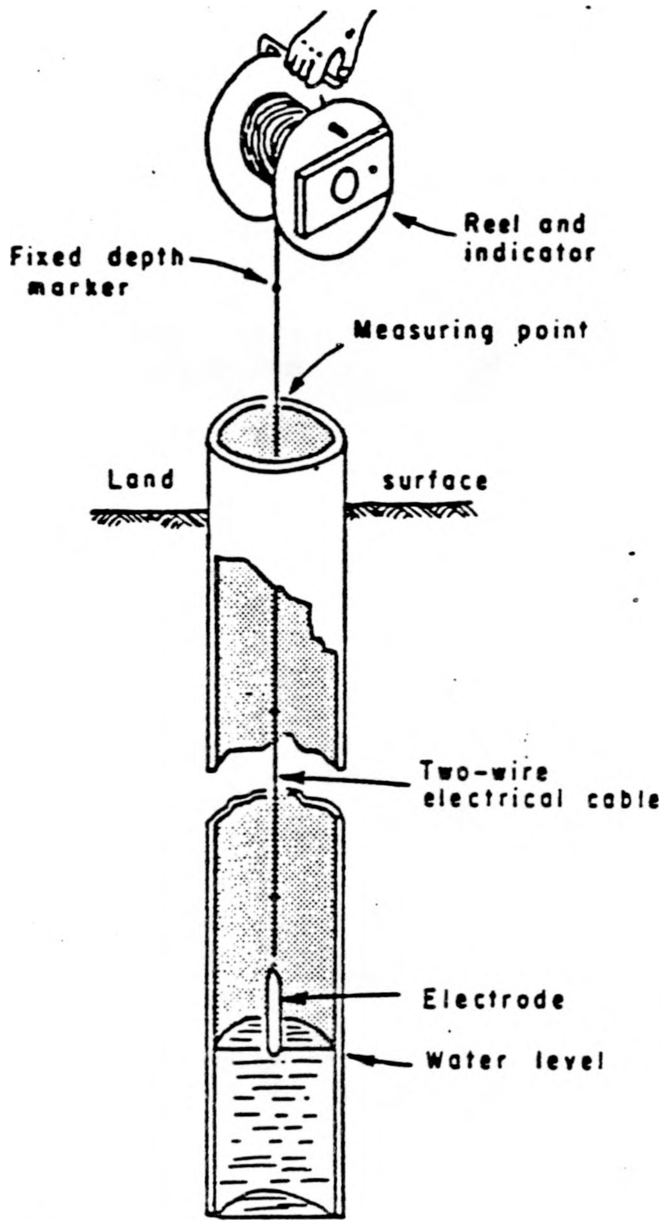
CHALKED TAPE Method for Well Water Level Measurements



From "Basic Elements of Ground-Water Hydrology with Reference to Conditions in North Carolina"; 1980; U.S.G.S. Open file Report 80-44

Figure 8

ELECTRIC TAPE Method for Well Water Level Measurements



From "Basic Elements of Ground-Water Hydrology with Reference to Conditions in North Carolina"; 1980; U.S.G.S. Open file Report 80-44

Figure 9

"An electric well measuring tape is basically a measuring tape with an electrode at the end." Lower it into the well and when the electrode touches water, the control will give a signal (a bell buzzer, light, or meter reading) (Wood and others, 1986).

Other methods for measuring water levels include pressure transducers and sonar devices.

Recording Water Levels

Plotting daily or weekly static water levels on a graph (Figure 6) will show trends in the amount of available ground water. Ground water levels will normally rise in winter and spring and drop in summer and fall. Keeping records of precipitation may provide information about the amount of ground water being recharged (Wood and others, 1986).

Plotting daily or weekly drawdown levels (Figure 7) will indicate when problems are developing with the well. When static water level stays constant but drawdown level drops, it indicates clogging or incrustation of the well screen or gravel pack which increases pumping costs and can reduce production. An abnormal drop in static water levels and specific capacity indicates a decreasing water supply and need for water conservation or restriction measures (Wood and others, 1986).

B. FREE FLOWING STREAMS AND SPRINGS

The measurement of springs and streamflows over a long period provides a statistical basis from which to predict flows and yields. The most frequently used low-flow statistic for unregulated streams and springs is a low flow which can be expected to occur over a three-day period once in twenty years. This streamflow value is referred to as a "3Q20." In Tennessee water management, the 3Q20 is recognized as a drought low flow. Wastewater permits are issued to users based on the 3Q20 low flow. It is the recognized standard by which managers measure risk, since water suppliers withdrawing amounts exceeding the 3Q20 for a stream are considered exposed to a level of risk which is unacceptable. It is also significant from an environmental standpoint. It is the stream flow value in Tennessee where water withdrawers must be alert to their potential impacts on fish and aquatic life habitat (Keck, 1987).

Determining Flow

If there is a flow gage near the system's intake, determine the flow at the gage in millions of gallons per day (mgd). To find mgd from cubic feet per second (cfs), multiply cfs x 0.646 (Wood and others, 1986):

Million gallons per day (mgd) = cubic feet per second (cfs) x 0.646

If a stream or discharge adds flow between the intake and the gage, or user removes water from the stream, figures must be adjusted accordingly. If the gage is downstream of the intake, adjustments must be made for discharges (a sewage treatment plant, for example) and for the system's withdrawal (Wood and others, 1986).

If a gage is not present, flow measurements should be made. Because of user patterns, it is important that flow measurements be made at the same time of day and same day of each week (generally on a week day). The measurements will require two people, sufficient line to cross the stream twice, an orange or a bottle partly filled with water, stakes, tape measure, stopwatch, paper, and pencil (Wood and others, 1986).

The measurement area should have well-defined banks. The stream bed should be fairly straight, easily accessible, with a flow having as little turbulence or riffle as possible. Often a site at or near the water supply intake is best. The site should not be in the pool area of a dam (Wood and others, 1986).

Two lines should be strung from bank to bank, at least 10 feet apart. The distance should be such that an object takes at least 20 seconds to float from one line to the other. After the stream's width has been measured between the two lines several depth measurements along the midway line should be made (see Figure 10, "Diagram of Physical Stream Measurements"). The average of the depth measurements should be computed. For example, if three depth measurements are taken (Wood and others, 1986):

$$\text{Average depth} = \frac{(\text{depth 1} + \text{depth 2} + \text{depth 3})}{3}$$

Multiply the average by the stream width to find the area of the cross-section of the stream.

Average depth (ft) x width (ft) = cross-section in square feet (sq. ft)

NOTE: The stream width should be broken into subsections if the stream is very wide or if the rate is not uniform across the section. Figure the cross-sectional area for each subsection separately.

An orange or partially filled water bottle should be dropped far enough upstream that it has settled into the streamflow when it gets to the first line, its "starting point." Measure the object's travel time from one line to the next. Determine rate of flow by dividing the distance between lines (in feet) by the travel time (in seconds) (Wood and others, 1986):

$$\text{Rate in feet per second (fps)} = \frac{\text{distance (ft)}}{\text{time in seconds}}$$

To obtain the best results, the object should be floated from three locations. The average speed should then be used. If subsections are used, get average rates for each subsection.

The discharge rate, in cubic feet per second (cfs), is calculated by multiplying the rate by the area.

Discharge rate in cubic feet per second (cfs) = rate (fps) x area (sq. ft.)

The discharge rate should then be multiplied by 0.85. This is a standard correction for the non-linear nature of flow in streambeds (Wood and others, 1986).

Diagram of Physical Stream Measurements

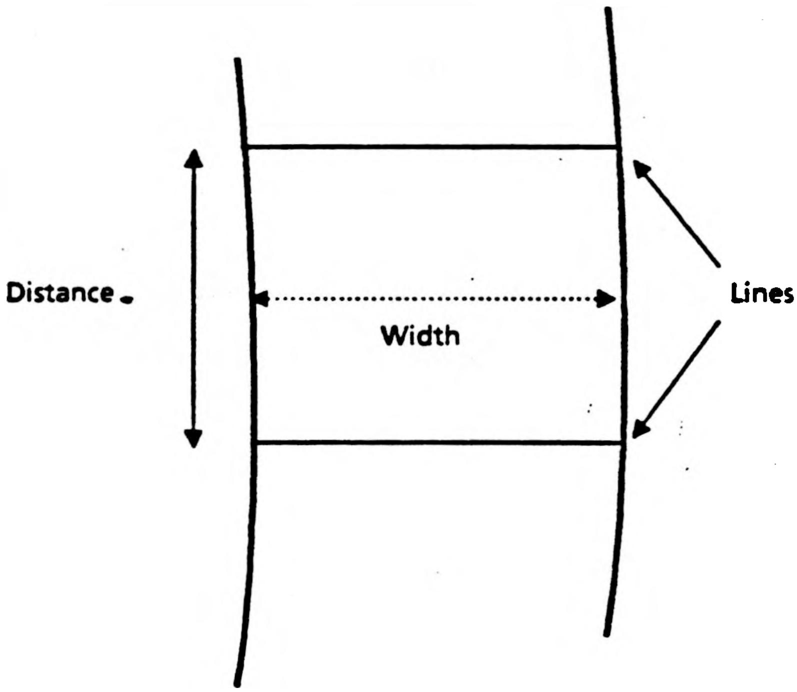


Figure 10

Adjusted cfs = cubic feet per second (cfs) x 0.85.

The system's available source supply in million gallons per day (mgd) can be obtained by multiplying the adjusted cfs by 0.646:

Rate of flow of the stream (mgd) = adjusted cfs x 0.646

If subsections are used, flow rates in each subsection can be added together to obtain total stream flow (Wood and others, 1986).

Recording Flow

An individual measurement as has been described above is of value only for a period of hours, or a few days, after it is made. Individual measurements are not useless; however, if properly recorded to establish a flow record. A long-term record can reduce the total number of measurements which have to be made at a later date (Wood and others, 1986).

The first step in developing a flow record is to establish a permanent fixed gage (often called a staff gage) at the site where the measurements are to be made. A gage may be on a bridge abutment or the intake structure. It should be rigidly fixed and treated to withstand exposure to water. The gage should be marked as shown in Figure 11, "Staff Gage for Measuring Streamflow Level" and extend below the intake. The water level on the gage should be read to the nearest tenth of a foot. The values should be plotted on graph paper as shown in Figure 12, "Example of Graph of Streamflow Record" (Wood and others, 1986).

C. FLOW-REGULATED STREAMS

A flow-regulated stream is a stream that depends on the water released from an upstream reservoir or impoundment.

Determining Flow

If a flow gage is not located near the intake, estimate flow by using the methods explained in "Free-Flowing Streams and Springs" section of this guide. If a gage is present, determine the flow at the gage in million of gallons per day (mgd). To calculate mgd from cubic feet per second (cfs), multiply cfs x 0.646:

million gallons per day (mgd) = cubic feet per second (cfs) x 0.646.

If another stream or discharge adds flow between the intake and the gage, or another user removes water from the stream adjust streamflow figures by estimating the amount of water usually withdrawn between the upstream reservoir and the system's intake. Some users (farmers, for example) will be using larger amounts of water under dry conditions. Also, adjustments must be made for streams adding to the source between the dam and the system's intake. If there is a gage downstream of the intake, adjustments must be made for all discharges (a sewer plant, for example) and all withdrawals between the two. (Wood and others, 1986)

Staff Gage for Measuring Streamflow Level

(1) Alternate colors from orange or red to white at one-foot (1′) intervals.

(2) Add black squares alternating sides at three-inch (3″) increments.

(3) Mark the distance in feet above the bottom of the gage just above where each color change is made.

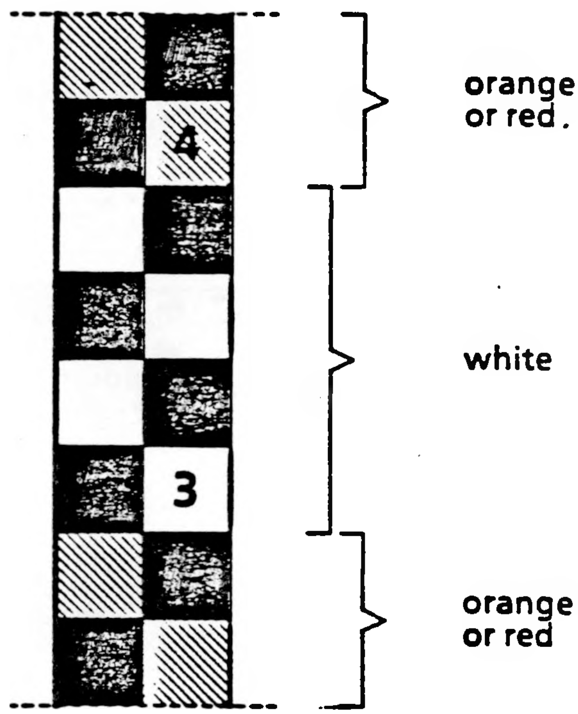


Figure 11

This diagram shows a section of a sample staff gage. Installing a staff gage can save much time and trouble once a flow record has been graphed from flow measurements and staff gage readings.

Example of Graph of Streamflow Record

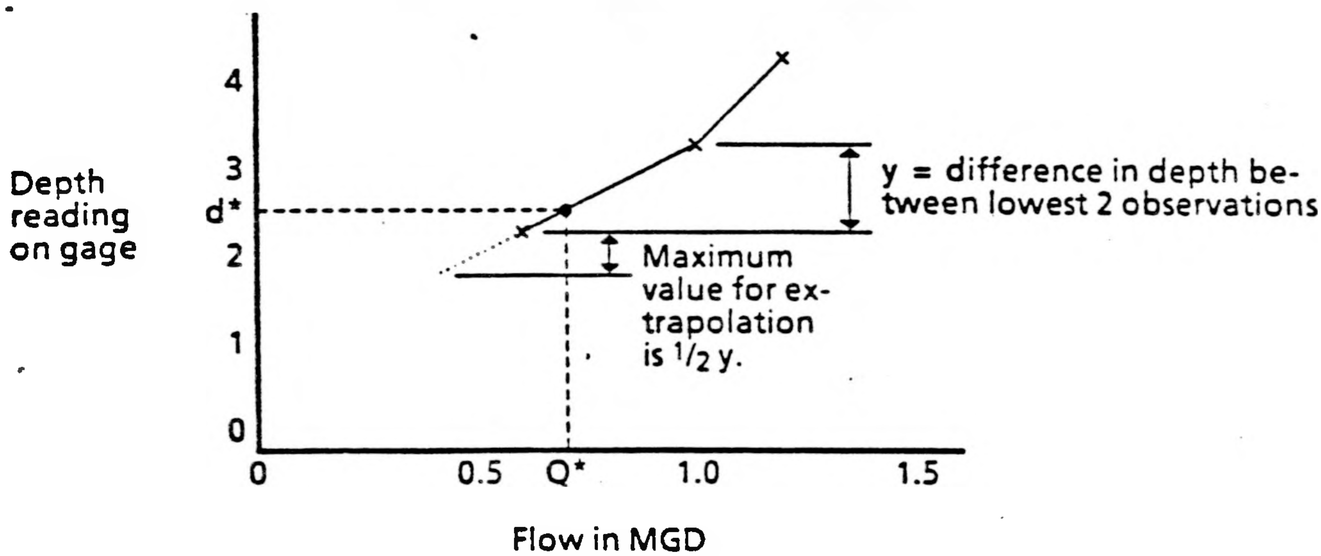


Figure 12

Only a few points have been graphed in this example; nevertheless, when the gage reading (d* in the example) is between previously plotted points, a new value of flow (Q*) is revealed, without further measurements, by a straight line relationship between the two known points. After a number of measurements have been made, the points may form a curve (Wood and others, 1986).

Increasing Flow Releases

The Army Corps of Engineers and Tennessee Valley Authority control the water releases affecting many streams in Tennessee. If potentially affected, water users shoud contact the appropriate agency or the Tennessee Office of Water Management to obtain information on their policy on low-flow releases. Users adversely affected should consult with the Tennessee Office of Water Management on changing the amount of water released during shortage conditions. In some instances, the volume of water released can be increased accomodate downstream users (Wood and others, 1986).

D. RESERVOIRS AND IN-STREAM IMPOUNDMENTS

Determining Volume of Available Storage

The number of gallons of **available** water in a reservoir can be estimated; the amount should take into account the fact that water below the level of intake pipes is not immediately available, and that sediment decreases volume. If information is not available on the volume lost to sedimentation, one-half of one percent of the design volume for each year since its construction should be subtracted (Wood and others, 1986).

The Tennessee Office of Water Management may be able to provide information on the original volume of the reservoir. Where a system obtains water from a Tennessee Valley Authority or Army Corps of Engineer reservoir, the water system manager should contact the Federal agency responsible for its operation. Although water below the level of a system's intake is not immediately available, it may be made available with intake modifications, auxiliary pumps and pipelines, etc. These actions should follow all the proper legal and institutional arrangements.

Monitoring Flow Out of the Reservoir

The amount of water flowing over the dam or spillway should be compared with normal seasonal flows. Flows should be monitored and recorded on a regular basis. The volume of water flowing into a reservoir less that being spilled should indicate any needed reservoir water management with respect to inflows, withdrawals, evaporation, and other factors (Wood and others, 1986).

Monitoring Flow Into the Reservoir

If the reservoir is estimated to hold more than a 30 day available supply, monitor upstream flow regularly. If the capacity of the reservoir is less than a 30-day supply or has receded to less than a 30 day supply, measure the amount of upstream flow on a regular basis using the methods described in the "Free Flowing Streams and Springs" section of this Guide (Wood and others, 1986).

The volume of water available should be divided by the projected daily demand to determine the number of days of supply left.

$$\text{Supply (days)} = \frac{\text{volume of available water stored (mgd)}}{\text{projected use (mgd)}}$$

Adjusting Supply Days with Incoming Streamflow

If the reservoir is holding less than a 30 day supply, the supply figure should be adjusted to account for springs below water level or by incoming streamflow.

The first step in adjusting supply days is to determine percent of demand being met by incoming flow. Divide inflow by projected use and multiply times 100.

$$\text{Percent of demand met by inflow} = \frac{\text{streamflow (mgd)}}{\text{projected use (mgd)}} \times 100$$

Secondly, determine the percent of demand met by water held in the reservoir.

Percent of demand met by reservoir = 100-percent of demand met by inflow (%).

Thirdly, determine what this means in gallons:

$$\begin{array}{l}\text{Amount of demand met} \\ \text{by reservoir (mgd)}\end{array} = \text{demand (mgd)} \times \begin{array}{l}\text{percent demand met} \\ \text{by reservoir (\%)}\end{array}$$

Finally, divide the volume of water stored by the demand being met by the reservoir to determine supply days left.

$$\text{Supply (days)} = \frac{\text{Volume of available water stored (mg)}}{\text{Amount of demand met by reservoir (mgd)}}$$

For example, if reservoir has 60 mg available, and the system expects to use 2 mgd, there is 30 days stored. If daily stream inflow is 0.60 mgd, the system is replenishing 30 percent of its supply daily. Therefore, the reservoir will recede at the rate of 70 percent of the daily demand, or 1.4 mgd. The adjusted available supply is then 60 mg divided by 1.4 mgd or 42 days (Wood and others, 1986).

Allowance must also be made for evaporation. Evaporation losses from a reservoir during drought depend on surface area, wind speed, air temperature, relative humidity, and sunlight. Because of the variableness of these factors, the evaporative rate is not a constant figure; it is generally lower in winter and greater in summer. The annual average amount of precipitation lost by evapotranspiration in Tennessee is about 60 percent. The daily loss from a reservoir by evaporation may be calculated by taking 75 percent of pan evaporation (Class A Land Pan) over any given period (Kazmann, 1965). On an annual basis evaporation losses from reservoirs are 28 to 30 inches in East Tennessee, and 30 to 35 inches in Middle and West Tennessee. Unfortunately, the largest losses from reservoirs occur when supplies are needed most.

E. INTERCONNECTIONS WITH OTHER UTILITIES

One of the best means of insuring adequacy of water supplies is to interconnect with other utilities, either for untreated or treated water. Interconnections allow a utility with water to help a system that is experiencing shortages. Primary considerations are the distance between the systems, the amount of water that would have to be transferred, the price paid for water that is transferred, sharing costs for the water line connecting the systems and pertinent legal and institutional considerations. It is far better to have the line in place prior to a drought or an emergency than attempt hurried construction when the need is greatest (Smith and Lampe, 1982).

The first step in developing an interconnection is to identify a nearby utility with water supply capabilities beyond its own needs. Contact the utility to see whether an agreement can be reached on sharing water during shortages. "A formal contract should be negotiated that specifies how much water each utility can use and the price that must be paid for the water." The utility with the need for extra supplies should pay for construction of the interconnection line and any additional pumping facilities. Plan design for the interconnection must be submitted to and approved by the Division of Water Supply before construction is begun. Such approval will be given high priority and should not take more than a couple of weeks in an emergency situation. If possible, interconnections should be built prior to the onset of drought, but, if necessary, can be built when the need arises. The design and construction of the line will probably take several months so practical use of this option depends on action being taken before the drought or other emergency occurs (Smith and Lampe, 1982).

Probably the greatest obstacle to interconnections is political in nature. Many utilities have difficulties negotiating agreements with other utilities. It is often difficult to agree on sharing water during shortages, price to be paid under these circumstances, and distribution of costs for new pipelines and pumping facilities (Smith and Lampe, 1982).

F. MONITORING WATER SOURCES

Once source capacities are known from collected data, continued monitoring of sources may be necessary, though not on an intensive, on-going basis. Regular monthly or weekly measurements are adequate most of the time. Once a drought alert is issued, or source conditions approach critical levels, more frequent monitoring of sources should be initiated. Depending on the source, its assessed capacity, and the "triggerpoints" identified by the system for initiating particular actions, the source may be measured weekly, daily, or even hourly. The monitoring program utilized by the water supplier will depend on the source and the extent to which it fluctuates.

VII. ASSESSING DEMAND

During drought, many utilities experience problems related to overall system balance. A common problem is shortage of raw water due to source inadequacy or significantly greater water demands. A system must estimate essential, average, and peak water supply needs to assess its management potential. Common problems resulting from unchecked peak demands include low distribution pressures caused by small distribution mains and inadequate elevated storage, and well deterioration from overpumping (Smith and Lampe, 1982).

Other potential problems resulting from excess demand include bad tastes and odors from algae growths at low reservoir levels, shortages of treatment chemicals, and increased mineral content of water. Calculating a potential demand for water determines the criteria necessary for sizing water supply facilities. It is also used to predict what components of the system are likely to fail (Smith and Lampe, 1982).

Most systems should be capable of meeting short-term peak demands. Some systems may be capable of meeting longer term peak demands without imposing conservation or restriction measures. Analyzing a system's demand by user groups and sub-components and knowing each subsystem's capacity to deliver water are important in understanding a system's potential under certain restrictive measures.

When water supply systems are being designed, the sizes of various components of the system are based on the peak demands expected to be exerted on the system for a particular situation or time periods. Components sized to meet maximum daily demands include water intakes, raw water pumps, wells, raw water pipelines, and treatment plants. Distribution lines are designed to supply the maximum hourly demands or fire fighting flows, whichever are greater. Distribution pumps and system storage, both elevated and ground, are sized on the basis of the most severe combination of normal maximum demands and fire flows (Smith and Lampe, 1982).

Design engineers usually estimate future water demands by finding the persistent demand patterns.

- First, systems should calculate past average annual per capita demands for water and project them forward to the desired date. They should then estimate the population to be served by the utility in the future. Average annual demand to be met by the utility is the product of the estimated per capita demand and the projected population served (Smith and Lampe, 1982).

  The estimated per capita demand should be analyzed carefully. Local water usage practices vary with the use of garbage disposals and diswashers, percentage of homes with swimming pools, number of bathrooms per home, the importance of landscaping and water conservation, rate structures, etc. Current usage should be compared with historical usage and if trends are applicable, future estimates of per capita use may be used.

- Maximum daily and hourly demands are determined by multiplying the predicted average annual demands by appropriate maximum demand ratios (Smith and Lampe, 1982).

Where historical demand data for a utility are adequate, these maximum demand ratios are usually based on past demand patterns. If the historical demand data is not adequate to assess maximum demand patterns, standard maximum demand ratios are used (Smith and Lampe, 1982). The drought of 1985-86 may be used to determine the potential impact of a future drought.

Standard peak demand ratios (the ratio of peak demand to average demand) used by consultants in Kansas are also shown in Table 1, "Comparison of Maximum Demand Ratios." For periods of one day or longer, maximum demands experienced in 1980 for several surveyed cities in Kansas were actually somewhat higher than those predicted in Table 1. Water supply systems may be underdesigned where demand assumptions were not correct. Theoretical predictions of demand can be wrong (Smith and Lampe, 1982).

Table 1. Comparison of Maximum Demand Ratios*

Period	Maximum Demand Ratios (Peak/Average Annual) From 1980 Data	From Consultants
1-hour	3.11	3.3
1-day	2.31	2.1
7-days	2.06	1.7
1-month	1.83	1.4
2-months	1.60	---

*(Smith and Lampe, 1982.)

To project a system's average daily demand, demand data should be assembled for the utility to determine per capita demand. Table 2, "Average Per Capita Demands, 1977-1981" summarizes average per capita demands data from various utilities in Kansas.

Table 2. Average Per Capita Demands, 1977-1981*

Period	Year 1977 (gpcd)**	1978 (gpcd)	1979 (gpcd)	1980 (gpcd)	1981 (gpcd)
1-hour	482	513	475	592	458
1-day	296	316	285	374	302
7-days	270	278	245	348	251
1-month	225	245	208	302	214
2-months	193	207	191	260	197
Annual	157	168	168	180	---

*(Smith and Lampe, 1982)
**GPD per capita

Note that for this hypothetical city, demand was approximately 12 percent higher in 1980 than in the previous 3 years. The increased demands during the 1980 dry spell were probably caused by large uses of water for lawn, shrub, and garden watering. As seen in this table, demand can radically increase when the weather is dry.

Demand should be projected from past records and adjusted for new development. With an estimate of population growth, utilities can project average daily demand and maximum demand (using the maximum ratio). However, a utility should recognize that large industrial uses can cause per capita demand values to be higher than they would otherwise be.

Where industrial demands are a large percentage of total use, projected demand ratios are often too low, because most industrial demands are relatively constant. The projected data assume that the future percentage of manufacturing employees served by the utility would be the same as the current percentage. But this depends on the degree and type of industry attached and served. Planners need to consider what local industries are presentand how they use their water to see if corrections should be made to their projections of demand.

- A third calculation that should be made is essential water use needs. Average water use demand in Tennessee ranges from about 60 gallons per capita per day to over 250 gallons per capita per day (gpcd). Average daily domestic water use in 1975 in the United States equaled 118 gpcd - 87 gallons inside the home and 31 gallons outside. This varies from system to system depending on local water usage practices, i.e., the use of appliances and fixtures using water, etc.

An effort should be made to determine what the minimum per capita usage will be where uses are curtailed. During brief emergencies, commercial and industrial demands can be severely restricted or eliminated, leaving the system only domestic requirements. For example, the knowledge that 40 gallons per capita per day is reasonable usage for a particular system during a brief emergency provides a basis for managing the water supply. For prolonged water shortage, utilities might plan for essential water use needs equaling 50 gallons per capita per day (Smith and Lampe, 1982).

If absolutely necessary, water use can be restricted to much less than 50 gallons per person per day, perhaps as little as five to ten gallons per capita per day. This is the amount of potable water needed for drinking, cooking, and minimal sanitation. The system should also estimate the amount of water needed to serve hospitals, nursing homes, to decontaminate lines, and to fight fires. These extreme measures are sometimes justified for sudden, severe emergencies such as tornadoes and floods (Smith and Lampe, 1982).

Since droughts develop over long periods of time and utility managers can observe water levels falling in reservoirs or wells, there should be time to implement conservation andrestriction phases (Smith and Lampe, 1982). Sudden implementation of drastic measures should not apply to droughts as they do to other emergency situations.

VIII. IDENTIFYING MANAGEMENT TRIGGERPOINTS

Droughts and other emergencies as well affect systems and users differently, depending on their source, system design, extent of the drought or emergency, and other factors. What constitutes a drought for one system may not be a drought for another. It will relate to a system's specific source or sources, degree to which facilities are developed, patterns of water use, water quality, water rights, economic and envrionmental considerations, and other factors.

Each supplier must evaluate his own source(s), treatment, delivery capacities, and uses. Following the evalution, each must identify appropriate triggerpoints for the various phases of drought management, including monitoring of drought conditions and water demand patterns. A triggerpoint is a preset condition at which point particular action is taken. Triggerpoints are based on some measure of water shortage, such as deficiencies in rainfall and runoff, decline in soil moisture, reduction in ground water levels, increase in daily demand, reduced storage, or some other appropriate condition. A triggerpoint should correspond to some measure of the system's delivering capability. It should be based on an assessment of the system's ability to meet continuing demand, given deteriorating resources and the potential for serious consequences if demand is not further managed.

For example, it may be determined that "Conservation" should begin when raw water storage is insufficient to meet the anticipated sixty-day demand at the current rate of usage. The plan might impose "Restrictions" when water use under "Conservation" exceeds the anticipated thirty-day supply and might call for "Emergency" measures when restricted water use exceeds the five-day supply. These actions, based on appropriate triggerpoints are responses which can be taken by a system to avert or prevent more severe cutbacks in deliveries to customers should the system's long-term expectations concerning supplies hold true.

Figure 2, "Balancing the Water System's Supply and Demand," summarizes those factors which should be considered in establishing a system's triggerpoints. When the system and not the source is at capacity the triggerpoints must be based on demand. However, where deliverable capacity is limited due to source considerations, appropriate triggerpoints will be based on source factors. Most triggerpoints will involve both. Various indices may be appropriate.

Using a rainfall based index may not be practical where water supplies appear to be adequate, unless usage is directly related to rainfall and supplies are threatened. In essence, the water supplier and its users must consider what constitutes a drought, the conditions in a drought, where more intensive management is needed, and the point at which it becomes an "emergency." There must be a definition of "emergency" that applies whether supply difficulties occur suddenly, or whether they occur slowly over time. Some managers may call anything from a break in the water main to a nuclear holocaust an "emergency." Obviously, emergencies differ in seriousness and scope and may also be classified.

A local water supplier may want to classify emergencies according to situations that demand different levels of response. Suppliers may distinguish between emergencies by first looking at their scope. What is the nature of the problem? Are the impacts confined and local, or are they regional? Can the problem be addressed at the local level or does its resolution involve others?

Emergencies might be further classified into three types: Class I, II and III. A "Class 1 Emergency" might be an emergency that can be handled on the local level and is a temporary crisis. It may include such "routine emergencies" as a break in a water main, a chemical spill, or loss of a pumping station. It may involve only a limited area. It may require some outside assistance, but the local system is able to control the situation.

A "Class 2 Emergency" might address the shortage of chemicals, or loss of water to a service area or a disaster affecting larger areas and greater lengths of time. This situation may be any that lasts 2 days to a week. It would include those situations clearly beyond the ability of the local system to relieve within a reasonable period of time without considerable outside aid. A "Class 2 Emergency" may require coordinated responses from a regional or larger framework. Local resources will have been expended.

A "Class 3 Emergency" may include more restrictive measures for truly extreme situations. Water supplies are cut off to most customers. Outside help is needed to restore water supply. System wide reductions of over 80 percent are required.

Responses to linebreaks, floods, chemical spills, power outages, etc. should be developed and included in the "Emergency Operations Procedures" portion of the water system's drought and emergency management plan.

When planning for the management of emergencies, it is essential to identify resources for which there is a potential need. Once needs are identified, the plan should also identify potential providers, i.e., trucking companies, nearby cities, industries, etc. In some instances, contractual arrangements may be developed for implementation during emergencies.

Responses to each class of emergency should be planned by management similar to "phases" of a drought management plan. These considerations should be addressed at the local level, by the local water supplier. Each management phase or class distinction should be based on an appropriate set of criteria suited to the circumstances of the water supplier. Estimate probable levels of supply in the short-term and compare the supply forecasts to short-term forecasts of restricted and unrestricted water demand (Planning and Management Consultants, Ltd., 1986).

The unrestricted peak demand during a shortage situation may be different from "normal" conditions. Demand forecasting models for specific service areas can be taken from historical data on water use and weather conditions. Both the supply and demand forecasts should be statistical (Planning and Management Consultants, Ltd., 1986).

A. SYSTEM HYDRAULICS

The hydraulic capacity of various system components should provide excellent indices that may be used to trigger management activities. Obvious component failures, such as linebreak, or pump failure, caused by a landslide, earthquake, power outage, accident, etc. should prompt the immediate implementation of appropriate emergency operations procedures (EOPs). (Refer to the Division of Water Supply's "Guidelines for Emergency Operations Planning for Community Water Systems.") In drought management, the capacity of system components including the treatment plant, a booster pump serving an area, and water storage facilities provide other triggerpoints.

For example, certain restrictive measures may be necessary when the capacity of a system subarea is extended beyond its capacity to deliver due to major firefighting requirements. Other hydraulic limitations may be suggested by diminishing finished water supplies in storage.

Figure 13, "The Effect of Water Use on Storage," illustrates the relationship between forecasted supply and demand for a system having an impoundment. In this illustration, both the system's peak demand and average daily demand exceed the 3Q20 inflow. Forecasting water demand under these two levels of use and forecasted supply reveals very different outlooks. Instead, the impoundment could be the system's 3-day storage and the 3Q20 could be the treatment plant capacity. Management, then, might need to be triggered on the basis of system hydraulics. Where a system's hydraulics are under stress to deliver or maintain deliveries over a foreseeable period, a triggerpoint based on water demand would be appropriate. If targeted reductions were not achieved, the next more restrictive phase would be triggered. It is essential that water supply systems balance source supplies and manage water demand looking at the future implications of their decisions.

B. RAINFALL AND EVAPORATION

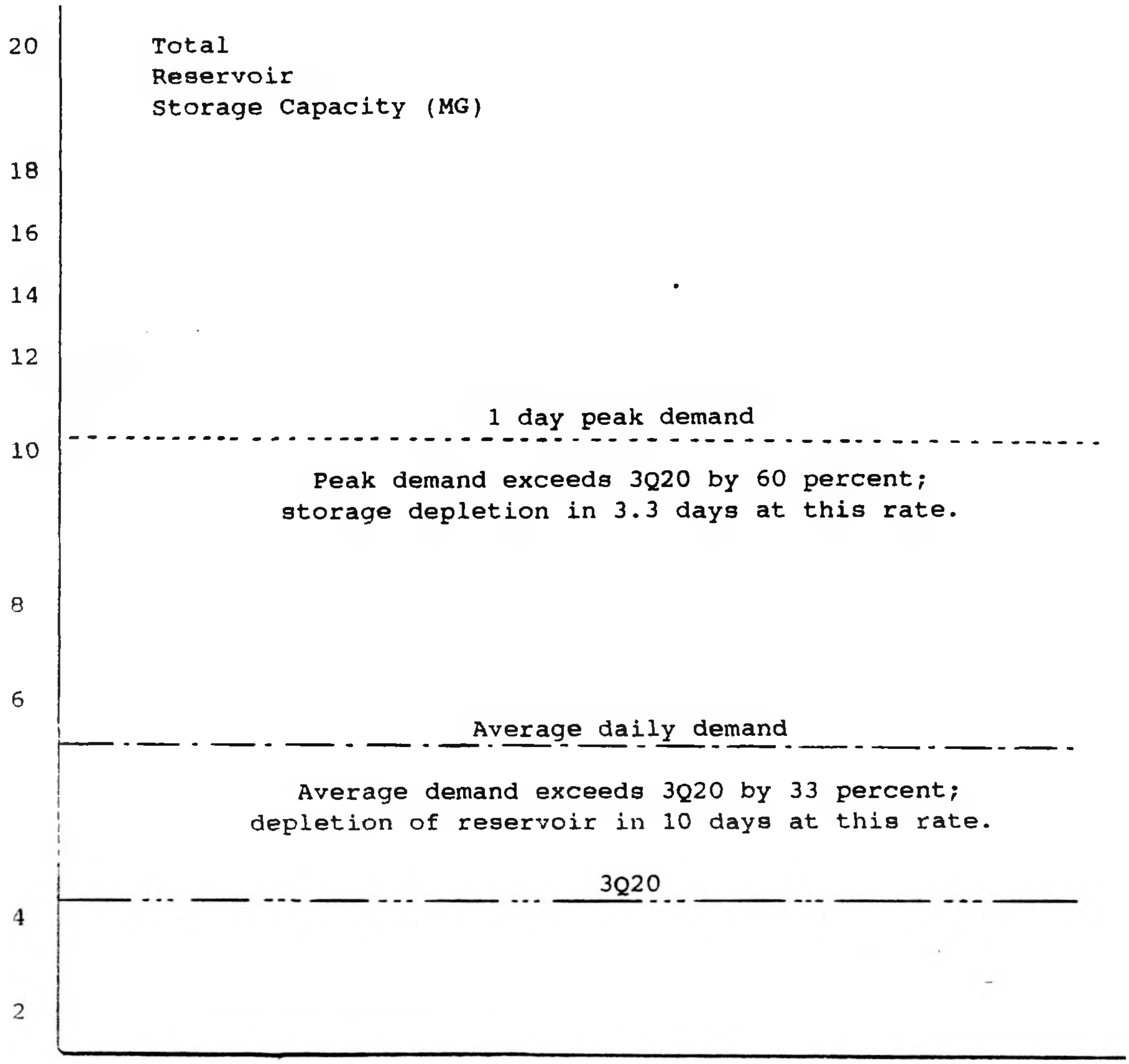
Various rainfall-evaporation related indices may be used by the state, a county, or local water supplier to trigger activities of a water management phase. They may not be suitable as a triggering mechanism for many water suppliers. On the other hand, a rainfall-related indice may correspond to increased outdoor demand. These drought indices are frequently based on water supply variables such as precipitation, temperature, wind velocity, radiation exposure, streamflow, soil moisture, ground-water levels, etc. either in individual or combined form, or combined with water-demand variables. Many different factors may be included in analysis of drought phases.

"In Texas, for example, periodic map analyses of rainfall distributions are used to identify abnormally dry areas during the previous 30-day and 60-day periods by comparing these data with normal rainfall patterns. In Texas, the degree of drought is determined as follows" (Rouse and others, 1984):

> Partial meteorological drought--a condition characterized by a rainfall amount less than 50 percent of normal for a 30 day period (normal is the 30-year average ending last decade year, i.e., 1980).
>
> Meteorological drought--a condition characterized by a rainfall amount less than 50 percent of normal for a 60-day period.

Figure 13

The Effect of Water Use on Storage



Storage depletion schedule varies according to management of use at a 3Q20 flow.

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"In South Dakota, the Drought Analysis and Assistance Office is activated when a substantial portion of the state has received less than 50 percent of normal rainfall in the previous 30 days, or if within the last 60 days, a substantial portion of the state has received less than 75 percent of normal rainfall" (Missouri River Basin Commission, 1981). Other rainfall related indices, "such as the National Fire Danger Rating System and the drought index used by the U.S. Department of Agriculture (1968) in forest fire control, may also be utilized for verification purposes or as supplemental information" (Rouse and others, 1984).

In Tennessee, data collection consists of general indicator data. The Tennessee Office of Water Management monitors selected streams for flow data (obtained from the United States Geological Survey through its cooperative program). Stream flow data collected on a regular basis include: average mean monthly flow for the period of record, mean monthly flow for the current year, the maximum and minimum daily discharge for the month, and the calculated 3Q20. (A 3Q20 is the estimated low flow for a stream or spring which can be expected to occur over a three-day period once in twenty years.) Reservoir water level (obtained from the Tennessee Valley Authority and the U.S. Army Corps of Engineers) and ground water level data (collected by the United States Geological Survey) are also monitored. In addition, precipitation data (collected by the National Weather Service) is monitored by the Office of Water Management (Keck, 1987).

During a drought, precipitation, streamflow and groundwater data are collected and made available to the public on a regular basis by the Office of Water Management. When drought is regional in nature, the release of management information is targeted on a multi-county or regional basis.

When appropriate, the Office of Water Management issues a local, regional or statewide "Drought Alert." The alert is designed to call attention to users and suppliers of the need to evaluate hydraulic or source stress and the possible need to curtail water demand. During a "Drought Alert" the Office of Water Management through its regional field offices contacts weekly those water supply systems and industries in the targeted area considered "drought sensitive" or "having a potential for a shortage." Their status is monitored and technical assistance given to the extent possible, including the identification of alternative supplies.

At the local level, a county or water supplier may issue a "Drought Alert" based on similar, localized considerations. A local "Drought Alert" can be issued calling attention to the need for possibly more intensive management of suppliers at the local scale. Self-supplied domestic users, farmers, industries, and others may want to monitor their sources in particular.

When a "Drought Alert" is issued locally, the Office of Water Management should be informed. Where shortages, water quality problems, or other conflicts appear in source use, users should immediately notify the Office of Water Management for assistance. Alerts should signal the need to regularly evaluate a specific source or sources and the demands placed on those sources.

More sophisticated drought indices useful in issuing a "Drought Alert" or providing a basis on which to base management phases include: the Palmer Drought Index, the Crop Moisture Index, and various historical comparisons.

C. PALMER DROUGHT INDEX

The Palmer Drought Index (Palmer, 1965), the most commonly used rainfall-related index, "utilizes a supply/demand water balance accounting procedure in conjunction with climatic weighting factors to produce a drought severity indexing system. This index reflects the abnormality of moisture deficiency or surplus." Within this water balance, supply is represented by precipitation and stored soil moisture; while demand is expressed as potential evapotranspiration, soil moisture recharge, and normal surface runoff (Rouse and others, 1984).

"According to the Palmer method, drought is an interval of time during which the actual moisture supply at a given location falls short of the climatologically expected moisture supply. The drought is a function of both the duration and magnitude of the moisture deficiency. Specific index numbers of the Palmer system are as follows" (Rouse and others, 1984):

+4.0 or above	Extreme Moist Spell
+3.0 to +3.9	Very Moist Spell
+2.0 to +2.9	Unusual Moist Spell
+1.0 to +1.9	Moist Spell
+ .5 to + .9	Incipient Moist Spell
+ .4 to - .4	Near Normal
- .5 to - .9	Incipient Drought
-1.0 to -1.9	Mild Drought
-2.0 to -2.9	Moderate Drought
-3.0 to -3.9	Severe Drought
-4.0 or Below	Extreme Drought

Palmer Drought Index data is published weekly in the "Crop and Weather Bulletin" by the Climate Analysis Center, National Weather Service (NWS). Subscriptions to the "Crop and Weather Bulletin" are available at a nominal cost.

D. CROP MOISTURE INDEX

The Crop Moisture Index (CMI) adjusts computations produced by the Palmer Index to reflect moisture conditions which affect growing vegetation and field operations. "It is designed to respond quickly to changes in the upper layer soil moisture situation. The CMI is therefore an index of agricultural drought" (Rouse and others, 1984).

"The CMI can be used as an indicator of real-time agricultural conditions as well as a verification tool to supplement the Palmer Index" (Rouse and others, 1984). In Tennessee, soil moisture conditions are reported weekly during the growing season by the Agricultural Statistics Service, Tennessee Department of Agriculture. These data, although reliable, do not utilize the CMI. However, like the CMI, they take into account fieldwork conditions and crop yield prospects.

E. HISTORICAL COMPARISONS

A low soil moisture content is not always the first indication of events leading to a drought situation. If an area is receiving just enough precipitation to satisfy evapotranspirational needs of crops and vegetation, almost all moisture will be used to satisfy these demands. "During this situation, crops and agricultural activities might be progressing at near normal levels." However, very little water would run off to rivers and streams. This condition could be classified as "hydrologic drought" (Rouse and others, 1984).

The local water supplier can consider this kind of drought as a supplement to the Palmer Index. Recording gages located on unregulated streams accurately reflect precipitation runoff within a basin. During the verification procedure for a drought alert phase, real-time data from a stream gage network can be compared to historical data (Rouse and others, 1984).

Similarly, records of observations of ground water levels can be followed to see if such data are related to drought severity. Few records may be available for past water-use data, but water-use reporting for those using 50,000 gallons or more of water per day was initiated in 1972 by the Office of Water Management.

F. STREAMFLOW AND SPRINGS

Instead of using miscellaneous drought indices to base water management phases, a water supplier may choose to monitor the specific sources utilized by the system. Sources for most include unregulated streamflows, springs, impoundments, regulated streamflows, water wells, and connections to other systems. Each source will have its own unique triggerpoints.

"During droughts, run-of-river flows (unregulated streams) are more affected than surface impoundments or groundwater supplies." The supplier should assess the ability of a source stream to maintain flow during droughts. Signs of abnormally low supply from a free-flowing stream or spring can be determined by comparisons to historical records with adjustments for changes in use. If these are unavailable, a "Drought Alert" should be issued as demand approaches 40 percent of flow and conservation measures should be implemented when demand is 40 to 65 percent of available flow. Measurements should be made twice weekly. Once in effect, conservation measures should not be removed until demand is less than 40 percent of flow for a four week period. If demand is 65 to 75 percent of flow on a free-flowing stream or spring, a water shortage "Restrictions" phase should be declared. Once in effect, the "Restrictions" phase should not be lifted until demand is less than 65 percent of available flow for a four week period. Flows should be measured daily (Wood and others, 1986).

An "Emergency" should be declared when demand is 75 percent or more of available flow on a free-flowing stream. Flow should be measured daily. Once in effect, the "Emergency" phase should continue until demand is less than 75 percent of available flow for a four week period (Wood and others, 1986).

Systems on flow-regulated streams should activate a conservation phase when dam releases are cut or when demand is 65 to 75 percent of available flow. If dam releases are diminished further or demand is more than 75 percent of available flow, a "Restrictions" phase should begin (Wood and others, 1986).

The need for activation of the "Emergency" phase for systems on flow-regulated streams depends on the operational characteristics of the upstream reservoir (Wood and others, 1986). In activating this management phase, percentages might be considerably lower as the 3Q20 is exceeded.

G. IMPOUNDMENTS

The volume of water in storage at a given time may be used as the determining factor for a drought phase. Depending on this volume, storage may be normal in a "Drought Alert." Volumes of water in storage may be expected to change depending on the time of year (supply/demand relationships) (Pennsylvania Gas and Water Company, undated).

To indicate the stage of its storage, a water supplier could utilize a pictogram such as in Figure 14, "Reservoir Operation Curve," to illustrate the conditions of its storage. Figure 13 indicates a hypothetical utility's storage capacity in 1980-81 relative to the drought stages. Reservoir storage level reports are monitored on a regular basis (Pennsylvania Gas and Water Company, undated).

"During extended periods of below normal rainfall, storage volumes may be plotted on pictograms" as in Figure 14. This data, together with short- and long-range weather forecasts and other information, could be utilized by management to determine the stage of drought condition (Pennsylvania Gas and Water Company, undated).

Other factors which may need to be considered in an impoundment situation include intake elevation and water quality. Possible triggerpoints for systems relying on an impoundment should relate to the number of days supply remaining. Figure 13, "The Affect of Water Use on Storage," illustrates the benefits of water use management.

A potential shortage would exist when there are less than 60 but more than 45 supply days left. In some systems, a water shortage "Alert" might be warranted with an even larger supply. Supply should be reassessed weekly (Wood and others, 1986).

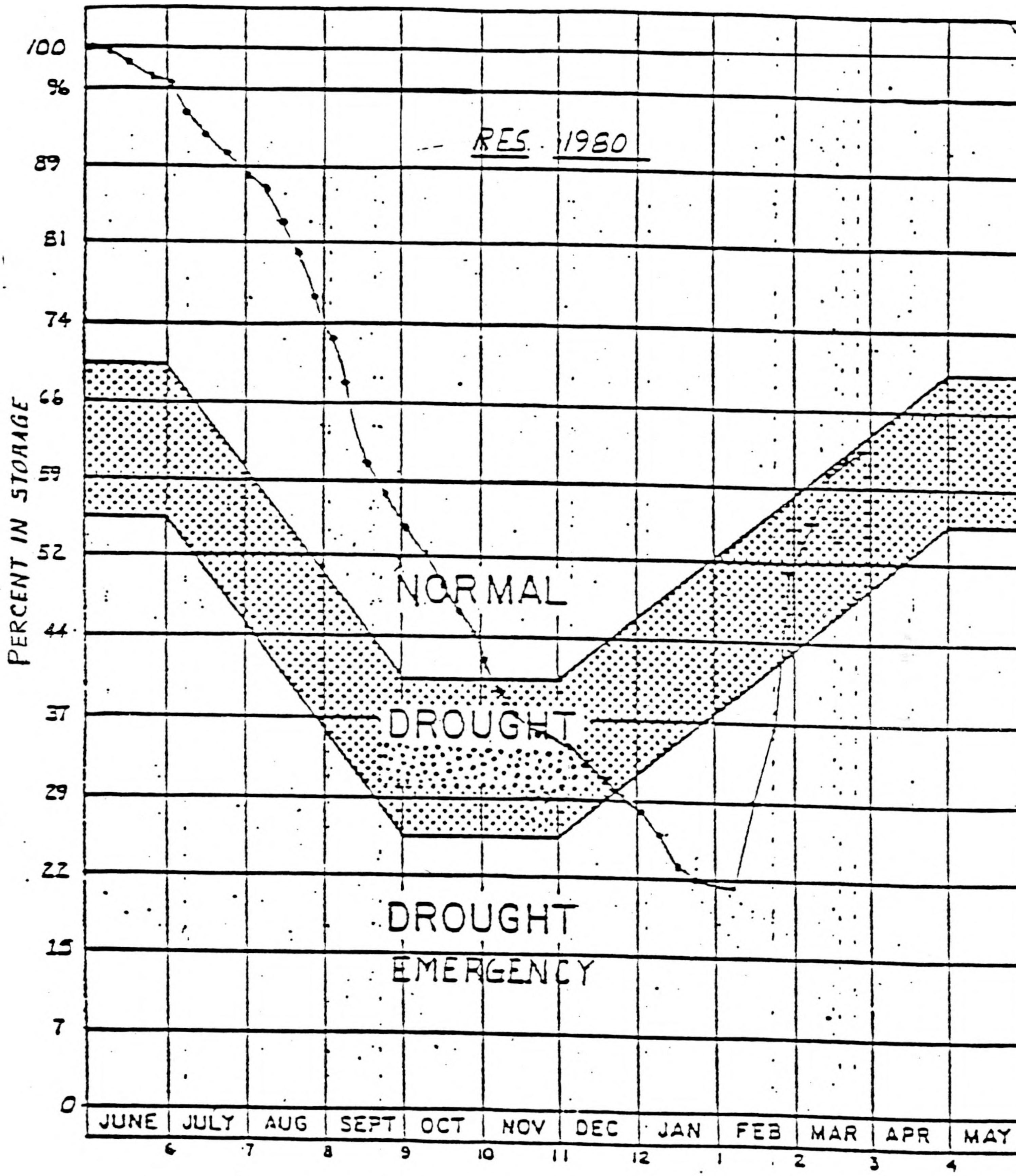
Activation of the "Conservation" phase should be declared when there are less than 60 but more than 30 days in a reservoir. Include incoming flow when making calculations, as explained in Chapter IV, "Assessing Source Capacity." Supply should be reassessed every few days (Wood and others, 1986).

Water "Restrictions" should be declared when there are less than 30 but more than 7 days available supply. Include incoming flow when making calculations, as explained in "Assessing Source Capacity." Supply should be reassessed daily. An "Emergency" should be declared when less than five days of supply is available. Include incoming flow when making calculations, as explained in "Assessing Source Capacity" (Wood and others, 1986).

H. WATER WELLS

Pump tests are used to measure water well capacities. These tests involve detailed analysis of area geology and other factors. In instances where a public water supplier obtains water from a well, an appropriate triggering mechanism can be the water level. Well measurements should be made at least weekly under normal conditions.

FIGURE 14



Reservoir Operation Curve

A potential shortage in a well would be suspected when water supply conditions in the area are especially low, or when another well which draws from the same aquifer is showing signs of reduced supply. It is also of concern when the static water level is decreasing faster than usual or when drawdown is (1) increasing faster than historically normal for the season, (2) increasing when it would normally decrease, or (3) changing quickly. In West Tennessee, in particular, a declining static water level may indicate the need for water conservation measures (Wood and others, 1986).

Signs of a shortage in a well would be an abnormally large or rapid increase in drawdown or a large decrease in static water level. This may indicate the need for restrictions. Measurements should be made daily (Wood and others, 1986).

I. INTERCONNECTIONS

The triggering mechanism for water suppliers with an interconnection to another system should be contained in the contract or agreement between the entities. Some contracts/agreements include requirements relating to the sharing of a water shortage or they may specify purchase limits and price levels under certain conditions. If a supplier obtains all of the system's water from another supplier and shortages are shared, the activation of the various management phases should coincide. Where a purchasing system is limited to specific amounts of water by agreement, independent triggerpoints may be required. Systems must develop their own triggerpoints based on a thorough evaluation of their circumstances.

J. MULTIPLE SOURCES

Water supply systems having multiple sources of water should also be evaluated. Systems with multiple sources must evaluate the capacity of each source, and weigh the impact of that source's failure on the remainder of the system. Each source must be considered for its contribution to meet the demands on the system. It would be inaccurate to tie water management to one source. Systems having a mix of sources, especially different types of sources (surface and ground water) which are also both reliable, may have advantages over single source systems.

K. WATER QUALITY

Where a water system experiences a linebreak, a loss of pressure, or a chemical spill occurs, potential water quality problems are obvious. The first steps in these instances are for the system to isolate the problem area, initiate a clean-up of spilled substances, if appropriate, or make repairs and implement temporary services, if necessary. The specific steps taken will depend on the emergency and should be outlined in the plan's emergency operations procedures (EOPs).

During a drought, water quality problems are also probable, particularly in streams and reservoirs. Streamflow is reduced, causing reservoirs to be maintained at lower levels. Reservoirs on tributaries to the Tennessee and Cumberland Rivers will be at lower levels than the mainstem reservoirs. Water users which withdraw from tributary reservoirs and smaller streams will be hardest hit by decreased amounts of water. Small, unregulated streams could stop flowing entirely due to decreasing water levels and runoff.

When streamflow is reduced, possible water quality problems are (1) higher temperatures, (2) lower dissolved oxygen, (3) higher algae production, (4) decreased assimilative capacities for industrial and municipal discharges, (5) taste and odor problems, (6) increased mineral concentrations, (7) and increased potential for biological pollution. In areas where water quality is already a problem, impacts of a drought will make problems more pronounced.

Although Tennessee is fortunate to have many reservoirs which are a tremendous help in times of water shortage, reservoir releases may be one source of water quality problems. Natural stratification in reservoirs causes different dissolved oxygen concentrations in different depths of the reservoir. During summer, dissolved oxygen at the bottom is normally at very low levels.

When low water levels in the reservoirs during summer combine with reduced inflow from runoff and increased retention time, dissolved oxygen concentrations become even lower than normal. When this water is released through low level turbines, downstream water quality suffers.

The low dissolved oxygen levels cause a chemical conversion of insoluble iron and manganese to more soluble forms. Releases of lower level water increase concentrations of manganese and iron in the water found downstream. These concentrations can cause an unpleasant color and taste in the water in public water supplies. In addition, both iron and manganese are undesirable in some industrial processes.

Dissolved oxygen in water is necessary for fish and other aquatic life. It is also essential to the stream's assimilative capacity, which is the ability of the stream to accept natural or man-made wastes and cleanse itself. Many types of bacteria use dissolved oxgyen in the decaying process. As more wastes are discharged, the limited amount of oxygen becomes even more depleted. With a decreased dilution capability for industrial and municipal discharges, higher concentrations of sewage bacteria will be found below the discharges of sewage treatment plants.

Deterioration of water quality usually increases the costs of treating raw water for drinking water purposes and water-based recreational opportunities are often reduced. More nuisance growths of algae and aquatic weeds occur because of nutrient enrichment, which lead to additional taste and odor problems. Fish kills may occur due to oxygen depletion and concentration of toxic substances.

Public water suppliers and the public need to be made aware of the water quality problems associated with a drought and identify those with a potential to impact their water supply. Public water suppliers should be prepared for the added treatment necessary to keep their supply in compliance with existing regulations.

Simiarly, up-stream discharges should be identified. Discharge sources having a potential for a chemical spill also should be considered in local plan preparation. Low-flows accentuate water quality problems. A more thourgh listing of responses to identified potential water quality problems is contained in Chapter X, "Dealing with Shortages and Water Quality Problems."

IX. CLASSIFICATION OF WATER USES

Public water suppliers should develop a classification system of water uses to reflect water priorities. A classification system clarifies issues of fairness, hardship and, ultimately, management effectiveness. Some water uses are important only socially or economically. Some water uses are essential and some are non-essential.

These classes may be different from place to place based on differences in local priorities. Each water supply system must decide the degree to which they support these general classes under varying situations. These classes are useful in identifying goals, priorities, and strategies, as well as weaknesses of a drought management plan.

A public water supplier's plan should classify water uses, while considering all the water management options available; i.e., pricing, conservation, supplemental supplies, bans, etc. An effective drought management plan would emphasize or focus on curtailing one class of uses before strong measures are implemented to significantly cut the next higher water use classification. Classifying uses and analyzing their contribution to the system's overall demand may reveal a plan weakness. First Class Essential Water uses should always be provided for. Essential uses are further classified into Second and Third Class Essential Water uses. Non-essential Water uses should also be identified. The following are **recommended** water use classifications.

First Class Essential Water Uses (Wood and others, 1986)

Domestic Use:
- water necessary to sustain human life and the lives of domestic animals and to maintain minimum standards of hygiene and sanitation (sink only use, excludes laundry, commode, bath and shower uses),
- emergency shelters.

Health Care Facilities:
- patient care and rehabilitation including related pool make-up water (requiring less than 25 percent filling).

Public Use:
- firefighting,
- health and public protection purposes, if specifically approved by health officials and the municipal governing body, including line flushing on an emergency basis.

Second Class Essential Water Uses

All Domestic Uses Not Included in First Class:
- personal home water use includes water used in the kitchen for food preparation, commode, bath, shower, laundry, and landscape watering (handheld hose watering of shrubs before 8:00 a.m. and after 6:00 p.m.).

Agricultural Watering (which is publicly supplied):*
- agricultural irrigation at a minimum level for the production of truckcrops, the maintenance of livestock, and all drip irrigation;
- watering by commercial nurseries at a minimum level necessary to maintain stock, to the extent that sources of water other than fresh water are not available or feasible to use;

- water use by arboretums and public gardens of national, state, or regional significance where necessary to preserve specimens, to the extent that recycled water is not available or feasible to use;
- landscape (shrubs) and vegetable garden irrigation (handheld only);
- minimum watering of golf course greens.

Industrial Water Use (publicly supplied):
- industrial processes
- refer to industrial air conditioning below

Commercial and Public Water Use (publicly supplied):
- office, retail, entertainment, schools and churches
- laundromats, unrestricted hours of operation
- restaurants, clubs and eating establishments, unrestricted hours of operation
- motels, hotels and similar commercial establishments, unrestricted hours of operation.

Office and Industrial Air Conditioning (water cooled):
- refilling for startup at the beginning of the cooling season,
- make-up of water during the cooling season to maintain temperature no cooler than 78°F.
- refilling specifically approved by health officials and the municipal governing body, where the system has been drained for health protection or repair purposes.

*very little publicly supplied water actually may be used for agricultural purposes

Third Class Essential Water Uses

Schools and Other Institutions:
- showering facilities

Filling and Operation of Swimming Pools:
- residential pools which serve more than 25 dwelling units,
- municipal pools,
- pools used by health care facilities for patient care and rehabilitation requiring 75 percent or more filling.

Washing of Motor Vehicles:
- commercial car and truck washes.

Non-Essential Water Uses

Ornamental Purposes:
- fountains, reflecting pools, and artificial waterfalls.

Outdoor Non-Commercial Watering (publicly supplied):
- irrigating gardens (except handheld), lawns, parks, golf courses (except greens), playing fields, and other recreational areas;
- street, driveway, and sidewalk washing.

exceptions:
- agricultural irrigation at a minimum level for the production of truck crops or the maintenance of livestock, and all drip irrigation;
- watering by commercial nurseries at a minimum level necessary to maintain stock, to the extent that sources of water other than fresh water are not available or feasible to use;
- water use by arboretums and public gardens of national, state, or regional significance where necessary to preserve specimens, to the extent that recycled water is not available or feasible to use;
- landscape (shrubs) and vegetable garden irrigation (handheld).

Filling and Operation of Swimming Pools:

exceptions:

- residential pools which serve more than 25 dwelling units,
- pools used by health care facilities for patient care and rehabilitation,
- municipal pools.

Washing of Motor Vehicles:

- automobiles, trucks, boats and trailers.

exceptions:

- commercial car and truck washes.

Serving Water in Restaurants, Clubs, or Eating Places:

exceptions:

- specific request by a customer.

Fire Hydrants:

- any purpose, including use of sprinkler caps and testing fire apparatus and for fire department drills.

exceptions:

- firefighting,
- health protection purposes, if specifically approved by the health officials of the municipality,
- certain testing and drills by the fire department, if it is in the interest of public safety, and is approved by the municipal governing body.

Flushing of Sewers and Hydrants:

exceptions:

- as needed to ensure public health and safety, and approved by health officials and the municipal governing body.

Air Conditioning:

- refilling cooling towers after draining.

exceptions:

- refilling for startup at the beginning of the cooling season,
- make-up of water during the cooling season,
- refilling specifically approved by health officials and the municipal governing body, where the system has been drained for health protection or repair purposes.

The class of use targeted for actions may vary. One water supply system may only need to ban non-essential water uses and require cutbacks in other uses of water to meet its conservation objective. Another system may need to impose cutbacks only on its non-essential uses. Figure 15, "Recommended Water Use Classes and Class Restrictions," shows a typical scenario. Defining class restrictions insures consistent policies in the development of an emergency water management plan. To simply pick and choose among responses and policies without regard to potential benefits runs the risk of inadvertently cutting back on a high priority water use or allowing some lower priority use to continue as if there were not a water shortage.

Figure 15
Recommended Water Use Classes and Class Restrictions
(Wood and others, 1986)

General Water Use Class / **Program Phase**	**Conservation**	**Restrictions**	**Emergency**
Essential, First Class	Voluntary Cutbacks	Voluntary Cutbacks	Mandatory or Voluntary Cutbacks
Essential, Second Class	Voluntary Cutbacks	Mandatory or Voluntary Cutbacks	Mandatory Bans
Essential, Third Class	Voluntary Cutbacks	Mandatory Bans	Mandatory Bans
Non-Essential	Mandatory Cutbacks or Bans	Mandatory Bans	Mandatory Bans

The scheme shown does not reflect other drought mitigative measures that may be utilized in addition to the general conservation and restriction measures suggested here. The purpose of this scheme is primarily to establish basic priorities for water use within which to implement a water conservation or restriction program. Optional local responses dealing with water use management and water quality problems are discussed in the next chapter, "Dealing with Shortages and Water Quality Problems," by water management phase.

X. DEALING WITH SHORTAGES AND WATER QUALITY PROBLEMS

The most effective responses to a potential water shortage depend heavily on prior resource planning and development. Most industries have facilities located where adequate supplies are known to exist and other risks appear acceptable. Cities have often built reservoirs, negotiated mutual aid arrangements with other water suppliers, or located other back-up supplies. Responses have generally related to improving "raw" water availability. Source-related problems brought on by a short-term drought would not be acceptable to most communities. Such droughts which readily produce inconveniences only seem to suggest that more serious problems lie ahead. On the other hand, infrequent source-related problems produced by an extended drought might constitute an acceptable risk most users are willing to assume (Keck, 1986).

Typically, short-term actions in response to drought involve development of a "phased" drought and emergency management plan. A drought management plan should sequence management responses to increasingly severe drought conditions and possibly de-activate phases as conditions improve. Local officials should plan public education, enforcement, monitoring procedures, conservation objectives, and other actions necessary to achieve plan goals. Three phases are recommended: "Conservation," "Restrictions," and "Emergency" (Keck, 1987). See Figure 4, "Drought Responses."

The responses in the various phases of this water management guide tend to be demand reduction oriented. Options involving supply augmentation are often economically unattractive. Consequently, most systems focus on water conservation, rather than on improving water supplies. This guide identifies those options, both supply and demand-side oriented, which are most appropriate in response to the three recommended phases. Some responses may not be appropriate for every system. After an appropriate analysis and selection of options, the resulting plan should balance the system's demand with its supply (Figure 2) at three different levels of water availability.

Recognizing that demand-side responses are possible no matter what the system's sources, this Guide suggests that responses specified in the "Conservation" phase reduce water use by 15 to 20 percent; that "Restrictions" phase responses reduce water use by 30 to 40 percent; and that "Emergency" phase responses target a reduction in use of 60 percent or more.

A. OPTIONS FOR DEALING WITH SHORTAGES

"Normal" Conditions

Under normal conditions utility district and municipal actions can promote water conservation, detect and repair system leaks, and replace inefficient water using equipment. Actions may involve developing a city reservoir, construction of storage tanks, expanding treatment plant capacity, and establishing mutual aid agreements with neighboring water suppliers. Another long-term action is adoption of a plumbing code encouraging water saving fixtures (Keck, 1987).

Although some remedies appear to be spontaneous responses, emergency water supply management plans and adoption of ordinances to implement plans in times of drought or emergency should be pursued in advance. These activities include making an equipment inventory, identifying potential water haulers, suppliers of equipment, preparing educational and media materials, and developing contingency contracts with bottled water suppliers. Preparation for drought will be more desirable and effective than remedies enacted in haste (Keck, 1987).

Long-term objectives affect the responses considered and planned over the short-term. Physical and capital improvements were briefly discussed in the section of Chapter IV, "Goals and Objectives," dealing with the criteria used to evaluate supply dependability. This Guide will not attempt to describe those options in any further detail. Following this section are options of water conservation education, pricing, metering, pressure reduction, reservoir evaporation suppression, detection and repair of system leaks, water reuse, and water saving plumbing codes.

Water Conservation

Water conservation reduces water use. Reduced per capita water use is especially helpful in deferring the need for new or expanded water treatment facilities, and in effect reduces per capita cost of providing water. Water conservation, however, does not eliminate the need for a drought management plan especially where the system continues to rely on a source having a shortage-related risk. Systems also need to develop plans which address the system's ability to maintain supplies to those already practicing conservation and having few opportunities for reducing demand.

When water conservation is not pursued under normal conditions, it can be an effective response to a temporary water shortage or emergency. When conservation is practiced routinely, water may be difficult to conserve beyond what has already been accomplished (Matthai, 1979).

In addition it should be noted that water users who conserve water should also be informed of the potential health-related concerns resulting from use of "first-draw" water from taps. That is, turning on the tap and using water immediately without running it for a minute or so to flush out the water which has been standing in water lines for an extended period of time. This concern applies particularly to homes constructed within the last five years using copper plumbing with lead/tin solder. Because the lead can be leached out, and protective deposits in lines are not yet in place, water users should be encouraged to run the water line enough to flush out water lines prior to any water use for drinking or cooking purposes.

Water Conservation Education. The objective of a conservation program is to reduce the quantity of water required for each activity through more efficient water use practices. These practices may apply to the residential, industrial, commercial, agricultural, recreational, and public sectors.

Appendix B, "Obtainable or Adaptable Water Conservation Education Materials," contains a list of brochures, fact sheets, pamphlets, and other materials available to the public, promoting conservation measures. These brochures and pamphlets are often inexpensive and can be purchased by a water supplier to mail to customers. Or a supplier may develop its own materials. More recent health-related concerns resulting from water conservation may need to be addressed at the same time. Users who want to conserve water but are concerned about higher concentrations of lead and other contaminants should beinstructed to fill drinking water containers for ther refrigerator, etc., after lines have been flushed out through other uses. The effectiveness of a conservation education program may depend on overcoming this and similar user concerns.

Figure 16, "Opportunities to Reduce Water Use," shows a hypothetical system's breakdown of water use into sectors. In this scenario, single family water use predominates over multi-family, commercial, and institutional uses.

Figure 16

Opportunities to Reduce Water Use (East Bay Municipal Utility District, 1985)

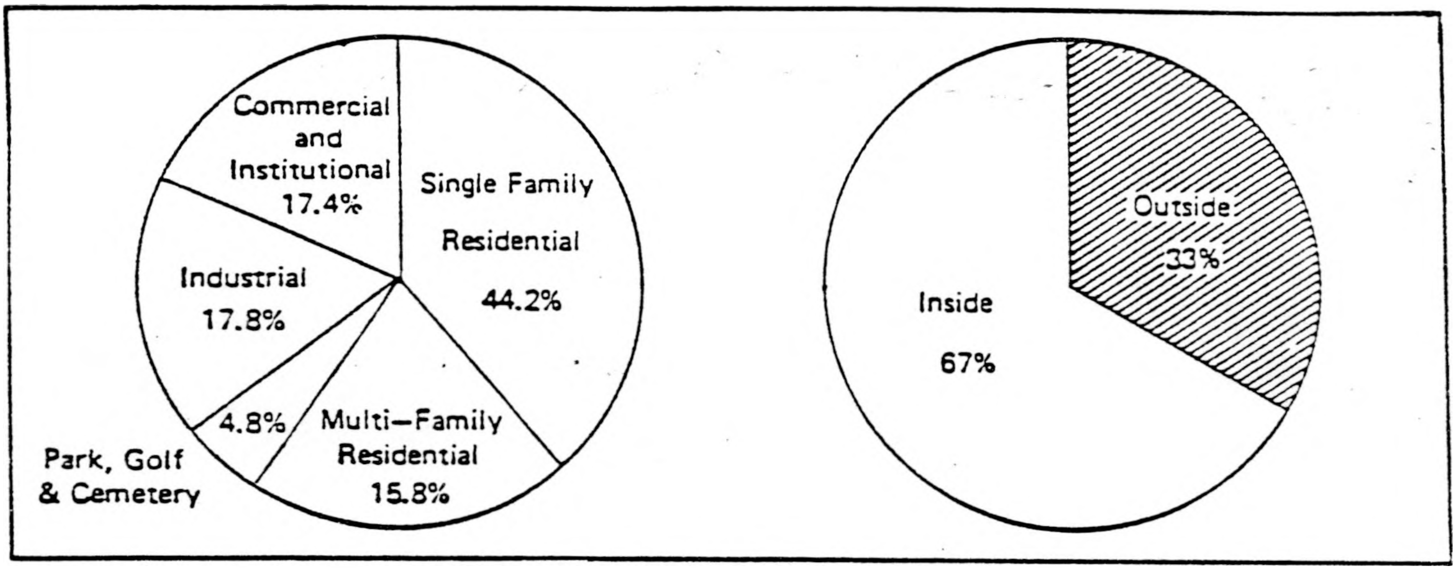
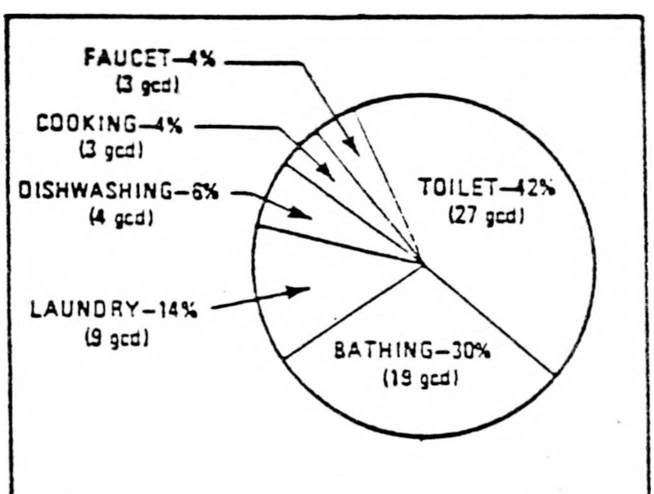


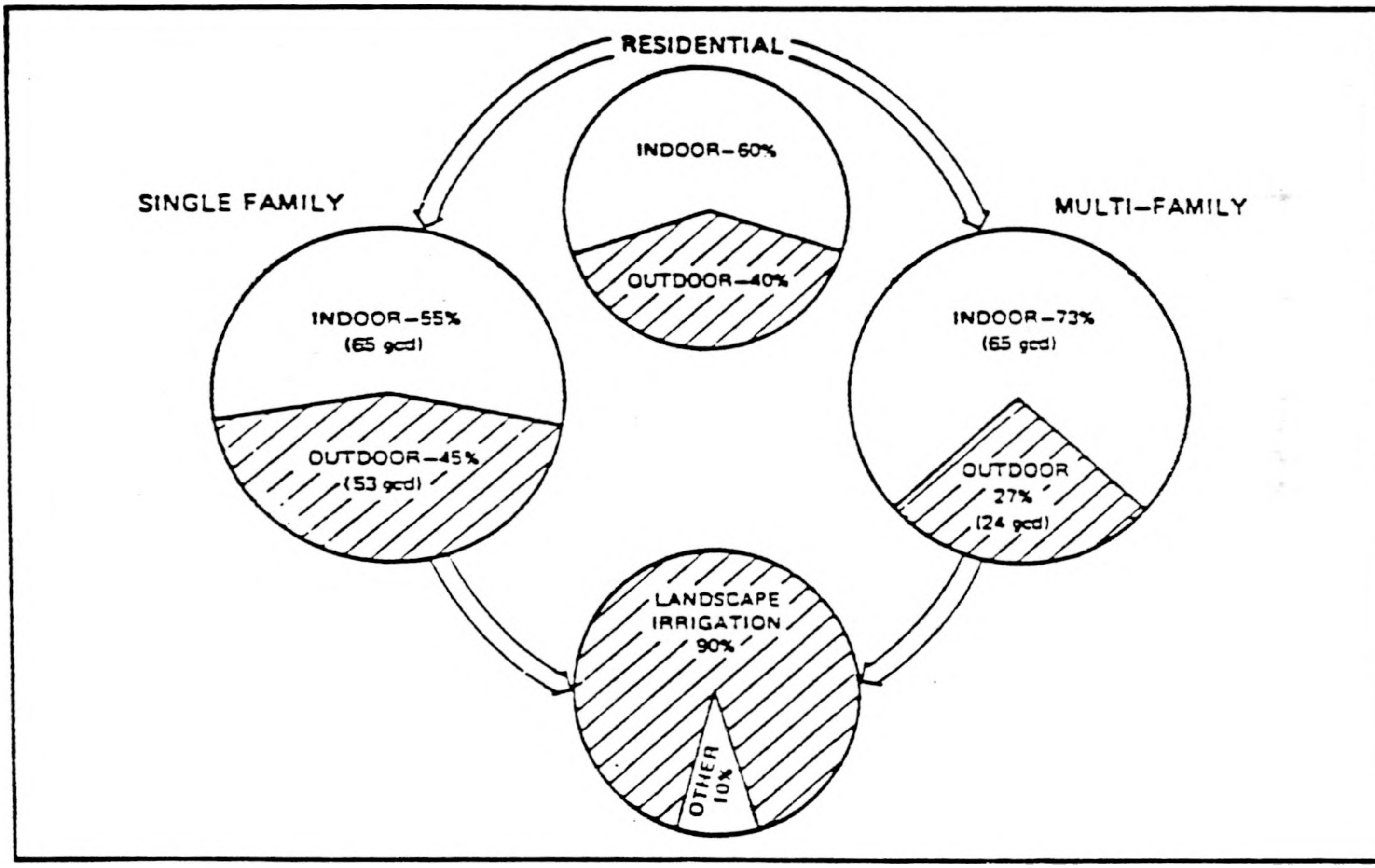
Figure 17, "Single and Multi-family Residential Indoor Water Use," shows a breakdown of multi-family and single-family indoor water use which averages 65 gallons per capita per day (gpcd) for this hypothetical system. Clearly a water conservation education program aimed at reducing water used to flush toilets and bathing is needed. Another conservation opportunity, as shown in Figure 18, "Single and Multi-Family Residental Water Use," is to reduce the amount of water used in landscape irrigation. A water supplier may also wish to conduct home or office water audits and recommend practices to improve water use efficiency.

Figure 17
Single and Multi-Family Residential
Indoor Water Use (East Bay Municipal Utility District, 1985)



Depending on the specific measures used, the potential water savings in toilet and bathing could approach 40 percent of an average family's use. For instance, significant reductions in water use can be realized if shower times are shortened. If consumers can be persuaded to reduce shower times by 25 percent, a savings of 5 gallons per person per day would result. An even more effective measure is turning the shower on to allow an initial soaking, turning it off for lathering and washing, and then turning it back on again for rinsing. Water conservation education used in connection with other water conservation measures such as leak detection, pressure reduction, etc., might exceed 50 percent of some system's water use (Smith and Lampe, 1982).

Figure 18
Single and Multi-Family Residental Water Use
(East Bay Municipal Utility District, 1985)



Many commercial and industrial establishments use large volumes of water and can give considerable assistance to conservation programs by reducing their water use. Examples of the types of commercial and industrial establishments which use large quantities of water from public supplies are car washes, ready-mix concrete plants, greenhouses and nurseries, meat-packing plants, laundries, food processing plants, and certain chemical or petroleum processing facilities. Many of these establishments can achieve considerable reductions in water use merely by instituting a program to conscientiously monitor and reduce water use to the minimum amount consistent with the requirements for producing their product or service.

Reductions may be possible where water is used for spraying or rinsing products and general plant cleanup. In some cases, increased treatment of water by the industry may allow them to reduce water use. For example, cooling water may be cycled through cooling towers more times if the water is softened or if certain corrosion and scale inhibitors are added to the water.

Since the water-use patterns of each industry are different and significant differences can occur even between similar plants in the same industry, water conservation can be accomplished only by consulting with the management of each industry and cooperatively developing a water conservation program suitable for their operation (Smith and Lampe, 1982).

Water Saving Devices. Closely related to changing water use habits is the installation of water saving devices. Voluntary programs encouraging these "retrofit devices" are a major component of many conservation education programs. A brochure is provided in Appendix B, "Obtainable or Adaptable Water Conservation Education Materials," showing many of these devices.

Water suppliers can make information available on these devices to plumbers and customers to use when they purchase or install plumbing fixtures, lawn watering equipment, or water using appliances. Information regarding pipe insulation and retrofit devices such as low-flow shower heads or toilet dams that reduce water use by replacing or modifying existing fixtures or appliances should be a part of this program. A water supplier may also promote conservation by providing certain devices (toilet dams, insulation of hot water pipes, low flow showerheads, flow restrictors, etc.) free or at a reduced cost to the customer. Plumbing codes may make these devices mandatory in some areas.

Repair of Household Leaks. Many residences have small leaks in the plumbing systems, particularly at faucets and toilets. Customers should be encouraged to repair all leaking faucets and toilets. Leaky faucets can usually be repaired by replacing the worn washer or O-ring in the faucet valve with a new one. Leakage from toilets is usually caused by a worn ballcock valve or faulty flapper. It can be detected by the sound of flowing water or by the use of leak detection tablets or food coloring placed in the water in the tank of the toilet. Fifteen to 20 percent of the toilets in service are likely to be leaking at any given time (Smith and Lampe, 1982).

Pricing. Pricing may be the most effective means to reduce residential peak use and commercial/industrial use. In addition, a pricing program may also provide extra revenues even as water use decreases. Sometimes, however, revenues decrease to the system as a result of user conservation.

Pricing or rate structures can be permanently employed by a public supplier to encourage water conservaton over the long-term or stand-by rate structures can be developed and implemented when the system is confronted by a water shortage. The major obstacle to a long-term pricing program is user opposition.

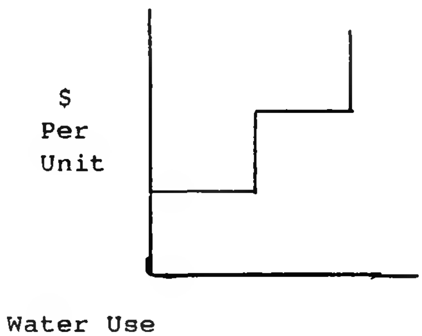
Local governments encourage low rates to attract industry. Estimating reductions in water use from pricing changes is complicated for two reasons: water is a basic necessity of life and, therefore, a minimum usage is necessary; and the price of water is normally so low that many consumers do not consider the economics of water supply. Nevertheless, various pricing schemes have been employed in attempts to decrease water usage for periods of time. Traditional water pricing methods have included:

- a set fee, which disregards volume used; or
- declining block rates where the pre-unit cost decreases as volume increases.

The rationale for declining block rates is that the per-unit cost of serving large water users is less than that for small water users. Declining block rates can be an incentive to waste water (New York State Senate Research Service, 1986).

The most common strategies are listed in Figure 19, "Common Price Structures." Adopting a particular price structure may depend on the number and influence of large-volume water uses served.

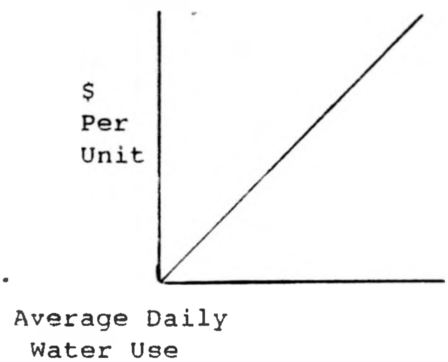
Figure 19
Common Price Structures (New England River Basin Commissioner, 1980)



Structure: Increasing block
Price per block increases as water use increases.

Best Used For: Reducing average (and sometimes peak) use.

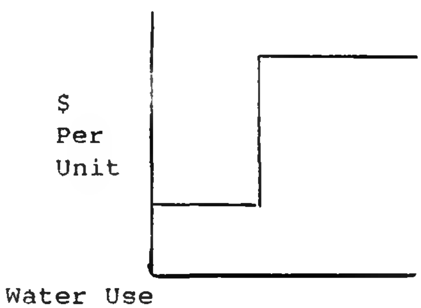
Considerations: Large volume users consider inequitable.



Structure: Sliding scale
Price level per unit for all water used increases based on average daily water use.

Best Used For: Reducing average (and sometimes peak) use.

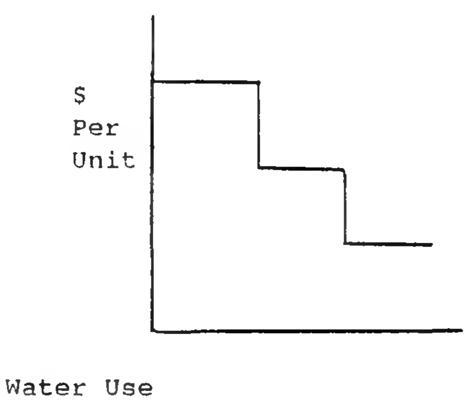
Considerations: Large volume users consider inequitable.



Structure: Lifeline Rate
Price for "necessary" water use is kept low.

Best Used For: Reducing average use.

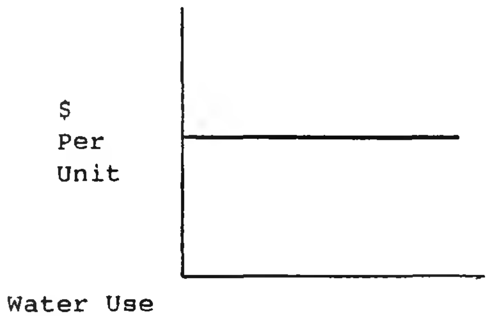
Considerations: Usually used to insure that low income users are not unduly burdened by high prices.



Structure: Decreasing block rate
Price per unit decreases as water use increases.

Best Used For: Reducing either peak or average use.

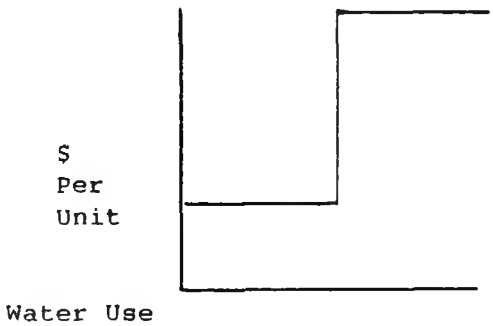
Considerations: Large volume users perfer this structure.
When there is sufficient supply, costs of supplying water will probably decrease as water use increases.



Structure: Uniform rate
Price per unit is constant as water use increases.

Best Used For: May be somewhat effective in reducing.

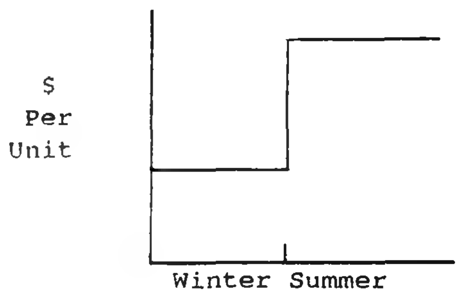
Considerations: Large volume users consider this structure equitable.



Structure: Excess use or Surcharge
Price level is significantly higher for all water used above average, usually determined by winter use.

Best Used For: Reducing peak volume.

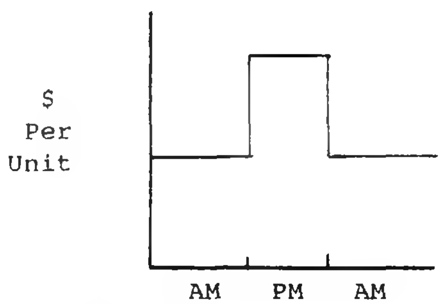
Considerations: Large volume users consider equitable.



Structure: Seasonally Adjusted Rate
Price level during season at peak use (summer) is higher than level during winter.

Best Used For: Reducing peak use.

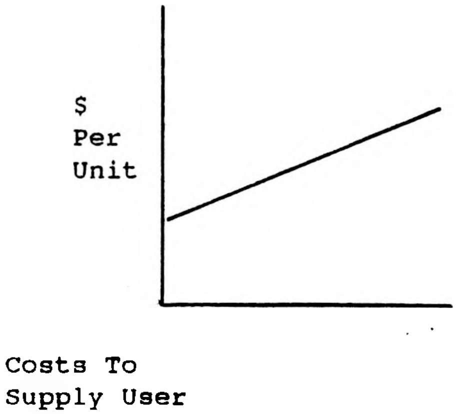
Considerations: Large volume users consider equitable.
Effective for summer tourist community.



Structure: Daily peak load
Price level is higher during hours of peak use.

Best Used For: Reducing peak use.

Considerations: Expensive to implement since sophisticated meter reading system would be necessary.



Structure: Spatial pricing
User pays for actual costs of supplying water to his establishment.

Best Used For: Discouraging new or difficult to serve connections.

Considerations: Used in areas where distribution system is being expanded rapidly and being expanded in difficult to serve areas (long mains, pumps, etc.).

It is difficult to determine the many different impacts pricing may bring on, or how much water can be saved by implementing a specific pricing strategy. Reduced water usage can not only effect revenues, but also sewer treatment needs if rate structures are permanent. Virginia Beach, Virginia, for example, went from a decreasing block rate structure to a uniform rate structure, reducing its water use; and Dallas, Texas reduced its summer usage of water by nearly 12 percent when it instituted a seasonably Adjusted Rate Structure (Reed, 1982).

<u>Universal Metering</u>. Some water suppliers do not meter all water use. Metering helps the conservation of water and insures equity in customer charges for water. Metering makes water use accounting and leak detection easier. Metering provides consumers with feedback on their water use and makes consumers more aware of water as a commodity.

A problem encountered by systems submitting to metering is that reductions in water usage frequently decrease revenue. An advantage is that long-term capital expenses can be reduced. Frequent reading of meters can also facilitate conservation efforts. Technology exists for meters to be remotely read by computers through telephone line connections quickly and efficiently, once the equipment is in place (New York State Senate Research Service, 1986).

<u>Pressure Adjustment</u>. One measure used to improve supplies or reduce use is to adjust pressures in an entire water system, in part of a system, or in individual services. "Decreasing water pressure diminishes the amount of water flowing through open faucets. While 50 pounds per square inch (PSI) is considered sufficient for residential use, pressures exceeding 80 PSI are common." Under emergency conditions, reductions to 20 PSI may be acceptable. Recommended pressure is 60 PSI (New York State Senate Research Service, 1986).

In other instances, areas served by a public water supply need additional pumping capacity at booster stations, etc. Improvements in the distribution system may correct water shortages within some systems.

"Water pressure also has an effect on system leakage. High pressure is one cause of pipe joint leaks and it generally causes water facilities to wear out more rapidly. High pressure also produces greater losses through existing leaks: A pressure of 100 PSI, for instance, will discharge approximately 40 percent more water from a leak or outlet than will a pressure of 50 PSI" (New York State Senate Research Service, 1986).

"Household pressure-reducing valves are cost-effective where system pressures exceed 60 PSI, and savings can be achieved with little or no customer inconvenience. Peak water use reductions can be particularly significant" (New York State Senate Research Service, 1986).

"Consumers are likely to accept pressure reductions as long as sufficient pressure remains for household purposes and personal comfort. Household flow restrictor valves attach at the water meter to reduce pressure throughout the house. The fixtures are probably too expensive to warrant free distribution, but household savings can justify consumer purchase in high-pressure areas. System pressure reductions necessarily are the responsibility of the water supplier. Because many water systems have various pressure zones, system pressure reductions require close monitoring." Pressure reduction by many systems has produced reductions in use from 5 to 30 percent, depending on previous pressure levels (New England River Basin Commission, 1982).

Leak Detection.

"Substantial savings can be obtained by locating and repairing leaky pipes and pipe fittings in water systems and within buildings. Many water supply systems repair leaky and broken pipes only when a problem becomes obvious--water flows out to the ground surface, the pavement collapses or an area suffers a severe loss of water pressure. Available techniques, however, enable trained operators to detect underground leaks before they cause obvious damage or disrupt service" (New York State Senate Research Service, 1986).

The costs of detection will of course vary from system to system, depending on the detection techniques used. If large amounts of water are being lost due to leakage, a scan of the system using a listening technique might be appropriate. The most widely used equipment includes the aquaphone, the geophone, and electrosonic instruments. In some instances a water audit or a detailed survey of the distribution system may need to be conducted.

Estimates developed by the Pittsburgh Equitable Meter Company indicate that at 60 pounds of pressure, 400,000 gallons of water will be lost through a 1/4-inch hole in one month, 100,000 gallons through a 1/8-inch hole, and over 6,000 gallons through a 1/32-inch hole (Wentz and others, 1986). Although, some leaks may be so small that it is uneconomical to repair them, water saved through a leak detection program can result in considerable savings. Unaccounted-for water (leaked water, plus water used for municipal use and fire fighting, plus water unaccounted for by underregistering meters or other unmetered uses) may vary from 10 to 15 percent in a well-operated system (New York State Senate Research Service, 1986).

In almost all systems, most of the unaccounted-for water is lost through leaks. Average water system leakage in the United States is estimated at 12 percent, but leakage is known to exceed 40 or 50 percent in some systems. Even efficient systems can gain from leak detection, with obvious benefits to systems with over 15 percent leakage (New York State Senate Research Service, 1986).

"Leak detection should be a regular activity of every water supply system. Periodic checks should be made on valves, hydrants, and services to locate obvious underground leaks. The first step in a leak detection program is a leakage survey. The survey involves (New York State Senate Research Service, 1986):

- examining water distribution system records to locate mains, valves and hydrants and determine pipe sizes (good record-keeping is an essential part of leakage surveys);
- checking conditions of valves and hydrants;
- inspecting storm drainage systems during dry weather for evidence of leaks;
- dividing distribution systems into test districts;
- plotting the locations of all water users;
- investigating nighttime use of large water users;
- calculating predicted nighttime use for each zone; and
- determining realistic figures for acceptable leakage in each zone.

A leak detection program can be a valuable conservation program in reducing water loss during a water shortage. Nevertheless, the cost of a leak detection survey should be compared to the potential benefits of the water saved.

Reservoir Evaporation Suppression.

The only way to suppress reservoir evaporation is to cover an open storage reservoir. It should be considered if losses due to evaporation are 10 percent or more or a system's total supply. It may not be a cost effective means to reduce losses, unless it is done to protect water quality also.

Water Saving Plumbing Codes.

Local governments may adopt ordinances or plumbing codes that require the installation of water conserving devices in all new construction. At present, Tennessee codes do not require low flow fixtures or water conserving devices. A local water conservation example ordinance is included in Appendix C, "DuPage County Plumbing Code Amendment."

Where a local code requiring water conservation is not adopted, a water supplier can elect to distribute information to their customers to encourage them to purchase and install water saving plumbing devices. These devices include pressure reducing valves, faucet aerators, water saving toilets, flow limiting faucets and showerheads, and insulated hot water lines. New swimming pools should have recirculating filtration equipment as part of the system. The standards for residential and commercial fixtures should be:

Tank-type toilets	-	No more than 3.5 gallons per flush
Flush valve toilets	-	No more than 3.0 gallons per flush
Tank-type urinals	-	No more than 3.0 gallons per flush
Flush valve urinals	-	No more than 1.5 gallons per flush
Shower heads	-	No more than 3.0 gallons per minute
Lavatory and kitchen faucets	-	No more than 3.0 gallons per minute
All hot water lines	-	Insulated
Swimming pools	-	New pools must have recirculating filtration equipment

"These standards are recommended because they represent readily available products and technology and do not involve additional costs when compared to standard fixtures (Texas Water Development Board, 1986)."

Analysis has shown that the use of water saving devices presently available from manufacturers could reduce residential use from 15 to 35 percent. Current technology coupled with conservation practices could produce a 30 percent reduction in total water demand (Reed, 1982). Jurisdictions that have adopted water conservation standards have had few problems in enforcing the codes where adequate advance notice of code revisions were given to plumbing suppliers and contractors (Georgia Department of Natural Resources, 1983).

Reuse.

Water reuse is not a popular measure due to its higher costs and user reluctance to reuse water for potable purposes. Nevertheless, in some cases it should be considered for some non-potable purposes. For home purposes, it may be reasonable to design plumbing which utilizes "grey water" (sink and shower wastewater) for toilet flushing.

Reuse is good where the use of treated effluent can replace an existing use that currently requires fresh water from a public supplier. Recycled water may be useful for landscaping or irrigation use by some industries. Problems occur primarily on water quality/health-related issues (New York State Senate Research Service, 1986).

Under "Alert" Conditions

Under "Drought Alert" conditions, water suppliers should intensify their monitoring for potential conflicts or problems. Potential conflicts and problems are those situations which have appeared under previous water shortage conditions or have the potential for occurring.

Under "Conservation" Conditions

During a drought, municipalities and utility districts can experience both raw water supply and treatment facility problems. Water use curtailment can alleviate both types of problems. **Most of the measures applicable under "Normal" conditions are effective in reducing water use under "Conservation" conditions.** Municipalities and utility districts can activate conservation water pricing structures which encourage reduced use. Municipalities and utility districts could institute public education programs aimed at reducing water use. Conservation brochures, radio and TV announcements, newspaper releases, and public meetings could inform customers on ways to save water in domestic, landscaping and recreational uses. Municipalities and utility districts could distribute (at public meetings) and/or install toilet tank displacement devices, shower flow restrictors, and replace leaking faucet washers and flappers in commodes in a door-to-door program (Keck, 1986).

Indoor measures considered under a "Conservation" phase should include flushing the toilet fewer times, shorter showers and shallower baths, using washing machines and dishwashers only with full loads or washing by hand, turning the shower off while soaping or shampooing and keeping a bottle of drinking water in the refrigerator (Keck, 1987).

Non-essential outside uses of water could be banned under a "Conservation" phase. Outside uses of water may account for as much as half to two-thirds of total residential water use in the summer. The outside uses of water that are generally restricted include watering lawns, gardens, trees and shrubs, filling swimming pools, and washing cars. Since water shortages are usually most severe during the hot, dry days of summer when outside uses of water are greatest, restrictions on outside water uses are often effective in reducing total water use (Smith and Lampe, 1982).

The advantage of restrictions on outside uses is that total water use can be decreased significantly. Enforcement of the restriction is relatively easy since violations are usually apparent to utility officials, police, or other residents. Disadvantages are that the appearance of lawns, flowers, and shrubbery in a community will decline, unfilled swimming pools will be unused, and vehicles will remain unwashed (Smith and Lampe, 1982).

It is particularly important to enforce bans on all public uses of water, such as watering parks and golf courses and street-washing. An exception to this ban might be filling a municipal swimming pool. Three types of restrictions on outside use are commonly employed: time-of-day restrictions, alternate day restrictions, or a complete ban (Smith and Lampe, 1982).

Time-of-day restrictions allow outside uses of water only during specified hours of the day. Outside uses are usually forbidden during the portion of the day that is the hottest and during which water losses from evaporation will be the greatest. Also, by reducing the number of hours in the day that customers can use water outside their houses, it becomes less convenient to use the water (Smith and Lampe, 1982).

"Since time-of-day restrictions are imposed during peak use periods of the day, the stress on distribution facilities is reduced." The effectiveness of time-of-day restrictions in reducing water use depends largely on the times of day for which outside uses are prohibited and the enforcement of the restrictions. Time-of-day restrictions should restrict outside uses between 8:00 a.m. and 6:00 p.m. in the evening (Smith and Lampe, 1982).

"Another option is to allow outside water use only on alternate days or every third day. To equalize the load on treatment and distribution facilities, residential service areas are divided into two or three equally sized groups and each group of customers is allowed to use water for outside uses on specified days." The use of house numbers is a popular method for dividing customers into groups, but other methods may work as well. Other methods include dividing the service area into sections or using different sides of streets to indicate when outside uses were permitted or prohibited (Smith and Lampe, 1982).

Advantages of time-of-day or alternate day restrictions are that water use can be reduced while customers are still given an opportunity to continue outside uses on which they place high priorities. A disadvantage is that, depending on the schedule selected for restrictions, water use reductions may not be more than five to ten percent of total water use. Enforcement of the program is often difficult due to confusion concerning the hours or days when certain customers are allowed to use water (Smith and Lampe, 1982).

Because outside water uses often make up a significant percentage of total residential water use, a complete ban on non-essential uses can reduce total water use considerably. "The amount of water saved will be much higher in the summer than in the winter. Reductions in water use achieved through complete bans on non-essential outside uses can approach fifty percent of total water use during the summer for some systems." A complete ban on non-essential outside uses is equitable by residents since no group is favored over another (Smith and Lampe, 1982).

Once a "Conservation" phase is activated, conservation actions (in addition to those pursued under normal conditions) must be implemented by water users if goals are to be reached. If a water supplier has had an active water conservation program to reduce overall water use under normal conditions, additional measures or restrictions will need to be implemented.

In some instances, many existing measures may remain as voluntary while other uses are cut back or even banned. The water supplier's classification scheme like the one shown in Figure 15, "Recommended Water Use Classes and Class Restrictions," should serve as a guide in designing a conservation program.

The imposition of restrictions and/or bans must be practical for enforcement. In other words, restrictions should be imposed which are enforceable. Where lawn watering bans are required, the supplier should have a plan for enforcing the ban. The activation of a "Conservation" phase should enable a water supplier to meet its pre-established objectives.

Where objectives are not met, the water supply system must consider implementation of the next most restrictive phase. This was the situation in the case of Virginia Beach, Virginia, in response to the 1980-81 drought. Requests for voluntary reductions in the consumption of water and a ban on non-essential uses did not significantly reduce the city's total daily consumption of water. However, the establishment of a water-allotment (rationing) program with surcharges based on a maximum-use allowance was quite effective in reducing water use.

A water conservation plan, if not carefully designed, can actually increase use. Many people may overwater, sprinkling the lawn whether or not it needs it. Research by the Virginia Water Resources Research Center revealed that the success of a conservation program depends on (1) the public perception of the program's fairness and (2) a thorough public information and education program to inform water users of the drought's seriousness and delineation of water-saving practices (Alexander and others, 1984).

Under "Restrictions" Conditions

The effectiveness of a "Restrictions" phase also depends on the public's perception of crisis. If imposed too frequently over extended periods of time, regulators risk losing credibility.

<u>Conservation Measures</u> (including rationing, bans and shut-offs).

Response options under "Restrictions" conditions include mandatory conservation rather than voluntary. Figure 15, "Recommended Water Use Classes and Class Restrictions," should serve as a guide in designing a "Restrictions" phase. Under a "Restrictions" phase, municipalities and utility districts could mandate reductions on a weekly basis to consumers.

A "Restrictions" phase could begin when projected water use exceeds the anticipated thirty-day supply, system hydraulic problems are encountered, or the system's "Conservation" phase goal of a given percent reduction (for example 20 percent) is not being met (Keck, 1987). Mandated conservation could be tied to a percentage reduction in use based on the previous year's usage for the same period (often referred to as the "base-period").

In addition, all outdoor water uses might be banned, or perhaps watering of lawns might be prohibited, but allowing the hand-held application of water to shrubs. Utility districts and municipalities could also restrict the time of operations for some industries or require percentage cut-backs from previously established levels of use. Restaurants, hospitals and nursing homes might be required to use disposable paper cups and plates in food service and to serve water only on request. Enforcement of conservation might be based on service shut-offs and penalties for non-compliance (Keck, 1987).

Rationing.

Rationing measures can be formulated with the objective of producing a specific reduction in water use. Because the percentage reduction in water use attributable to various types of restrictions on outside uses are generally not well defined, a percentage reduction based on a seasonal increase in use might be considered. During the summer, when the water usage for lawn and garden watering is great, systems might expect restrictions on outside uses to result in a significant percentage reduction in use. "If outside uses are completely banned, this reduction may be as great as fifty percent, but is more likely to be about thirty percent. Partial restrictions on outside uses, as with time-of-day or alternate day restrictions, result in lesser reductions in water use than the complete bans on outside uses" (Smith and Lampe, 1982).

The effectiveness of rationing will largely depend on how strictly the measure is enforced and the severity of penalties imposed on violators. For water rationing plans to be effective, the user must suffer a severe penalty for excess water use or plan non-compliance. "It is advisable from a public relations standpoint to use escalating penalties for noncompliance, rather than an across-the-board severe penalty" (Smith and Lampe, 1982). After two violations customers could have service cut-off for five-days.

For example, the first violation of the rationing plan by a customer would result in issuance of a written warning to the customer. The second violation would result in assessment of a small fine, such as $100.00. The response to the third violation would be either a more severe fine, such as $200.00, or installation of a flow restriction device in the customer's service line. "The fourth violation would then lead to discontinuation of service to the customer." The management of each utility must decide which penalties are best their situation (Smith and Lampe, 1982).

A second form of rationing is the allocation of water to customers as a constant percentage of their normal use. Normal use is based on average use per billing period or use in the same billing period the previous year. This rationing plan can be used if the percentage of the normal water supply available for the foreseeable future can be determined (Smith and Lampe, 1982).

"The principal advantage of a rationing plan based on percentage of normal use is that all customers have to restrict their water use to the same degree, and those customers that have established higher water use requirements than other customers can still maintain their proportionately higher water use. This same aspect of the plan also serves as its primary disadvantage, since those customers who have previously wasted large amounts of water are allowed to use more water than other water users, thereby rewarding those customers who have habitually used water inefficiently" (Smith and Lampe, 1982).

Finally, a third form of rationing involves allocation of available water on an equal basis to each connection. This scheme is easily administered and is generally perceived as equitable, since each customer is allowed the same amount of water to use. However, it does not account for differences in water needs between different customers, particularly due to differences in family sizes (Smith and Lampe, 1982).

"A modification of this plan that somewhat overcomes the obstacle of varying water needs for different family sizes is the rationing of water on a per capita basis. With this type of rationing, water is allocated to residential customers on the basis of the number of occupants of a household" (generally 50 gallons per person per day). "However, this latter method is difficult to administer because determination of the actual number of occupants in a given residence is often uncertain." One way it can be done is to once a year, have customers indicate on their bill payment the number of occupants living at that address (Smith and Lampe, 1982).

Service Interruptions.

Water service interruption agreements with large water users should be considered by public suppliers. Special water rates established by a supplier for industries and other users may contain conditions in their contracts to shut-off or reduce water use during specified periods. When necessary, the system can valve off tanks and/or lines to extend supplies.

Mutual Aid Agreements.

In addition to imposing mandatory conservation measures or rationing, a system may also consider a variety of other measures to increase the system's available water supplies.

Establishing a mutual aid agreement is one of the best means of insuring the adequacy of water supplies during an extended drought. An interconnection with another utility, either for treated or untreated water can be made with nearby systems. Mutual aid may also include loaning of pumps, portable treatment plants, and other available equipment. Mutual aid, like other actions, is best executed when agreements, inventories, and contacts are made and periodically reviewed prior to a water shortage or emergency.

In planning for interconnections, the primary factors to be considered are the distance between the systems, the amount of water that would have to be transferred, the price paid for water and sharing costs for the water line connecting the systems. It is better to have the line in place prior to the drought than to attempt construction when the need is greatest (Smith and Lampe, 1982).

"The first step in developing an interconnection is to identify a nearby utility with water supply capabilities that are in excess of its own needs. The utility must then be contacted to determine whether an agreement can be reached . . . ." A formal contract should be negotiated that specifies how much water each utility can use and the price that must be paid for the water and under what conditions. Systems agreeing to assist adjacent systems must evaluate each other's vulnerability because they are committing themselves to sharing their resources. The utility having the greater potential need for will probably have to pay for construction of the interconnection line and any additional pumping facilities (Smith and Lampe, 1982).

"If possible, the interconnection should be built prior to the onset of drought, but, if necessary, it can be built when the need arises. However, design and construction of the line will probably take several months" (Smith and Lampe, 1982).

Temporary Pipelines and Sources.

If another source of water is reasonably close, and the public supplier has an agreement or rights to obtain water, "it may be possible to run a temporary pipeline to the treatment plant or the distribution system." Ideally, an auxiliary source would be a developed system with treated water, such as a nearby municipality, an unused groundwater source or an industrial supply with surplus potable water. It might also be a surface supply such as a quarry, lake, pond, river, or even a creek. While a surface water supply can be "discharged readily into an existing reservoir for untreated water, it is not readily adaptable to a system utilizing a ground water source" (Alexander and others, 1984).

In situations where surface water and groundwater supplies are to be used conjunctively and mixed together, the potential exists for some water quality-related problems to occur. Essentially, these problems manifest themselves through the (1) release of scaly deposits in the system's water distribution lines and (2) discoloration of the water delivered to users. Because of difference in pH between conjunctively used surface water and groundwater supplies, previous deposits in water distribution lines are frequently released resulting in stained laundry and residue in wash basins.

Also some existing groundwater supplies contain ferrous oxide. When this water enters the water system and is exposed to air, carbon dioxide is released and ferrous iron is changed to ferric iron, which then precipitates out of solution causing the water to become reddish in color.

In extreme situations of treatment plant failure or where a system normally uses a ground water source, untreated water may be introduced into a system, however untreated water cannot be used for human consumption. Nor can untreated water of unsuitable quality be used for any body contact purposes. Systems supplying untreated water must issue a "Boil Water Notice" and only after all water is treated and distribution lines disinfected can the "Boil Water Notice" be discontinued. Systems supplying untreated water may also need to haul water or provide bottled drinking water to their customers.

All sources and modifications to a system must be approved by the Office of Water Management, Division of Water Supply prior to their use as established under the Tennessee Safe Drinking Water Act.

Additional Wells and Reactivation of Abandoned Wells.

Drilling additional wells may not be feasible if the well field has not been investigated and water rights obtained. In addition, a well field may not be a suitable location for additional wells if existing wells have fully developed the aquifer. If this is the case, it may be necessary to go some distance to another aquifer.

An alternative might be to deepen the existing well(s) to obtain a greater quantity of water by tapping a deeper aquifer or reactivating an abandoned well. Well logs in some areas indicate that substantial yields of good water can be found at greater depths than those usually drilled. But highly mineralized water may be encountered by drilling deeper (Alexander and others, 1984). Again, all wells or other modifications to a system must be approved by the Office of Water Management, Division of Water Supply prior to their use as established under the Tennessee Safe Drinking Water Act.

Temporary Impoundments.

Public suppliers on streams might consider constructing a temporary impoundment. Guidance should be obtained concerning its feasibility and costs from consulting engineers (Smith and Lampe, 1982). Any temporary impoundment or other modifications to a system must be approved by the Office of Water Management, Division of Water Supply prior to their use. In addition, it will be necessary to obtain a permit for the construction of an impoundment structure from the Office of Water Management, Division of Water Pollution Control.

Water Recycling.

"The recycling of water intended for human consumption is a process which must be approached with caution." It is used only in extreme situations. "However, the reuse or recycling of water used exclusively in some commercial or industrial operations is common and should be considered by firms experiencing water shortage." Any community which is considering the recycling of water as an alternative water source should seek guidance and assistance from the appropriate State agencies with statutorily mandated water quantity and quality responsibilities (Alexander and others, 1984).

"The most conspicuous opposition to recycling for domestic use is likely to be that of uninformed individuals who object on general principles." However, most water suppliers on the downstream reaches of streams are treating water that has been reused repeatedly. The most serious technical problem associated with recycling is that treatment processes do not remove all dissolved minerals. Therefore, the several cycles may make the water too salty for further domestic use. "Other objections involve the resistance of viruses to chlorination and the concentration of heavy metals" (Alexander and others, 1984).

Modify Reservoir Management.

The State of Tennessee, through either the Office of Water Management or the Tennessee Emergency Management Agency, will work with the Tennessee Valley Authority and the U.S. Army Corps of Engineers to modify the operation of reservoirs where deemed necessary to satisfy critical needs. Availability of water on a regional scale impacts local water supply operations and environmental quality. Statutorily mandated objectives and responsibilities must be recognized to the greatest extent possible. Changing the operation of a reservoir system may be possible under some circumstances, provided the balance between different statutory objectives can be adjusted. Probable reservoir uses which would be effected include navigation and in-lake recreation.

Where reservoir releases are increased to meet downstream water supply needs, water quality impacts from a discharger are likely to lessen due to increased assimalative capacity. Increased releases also help protect critical habitat. Where reservoir management is changed to meet downstream needs, recreational users of reservoir pools should be informed of reservoir hazards due to poor water quality and/or low water level elevation (Keck, 1987).

Dredging to Improve Intake Capability.

"Another alternative for increasing available water supplies is to remove excessive deposits of silt and debris from the area surrounding community surface-water supply intake facilities. This is particularly true for those communities who get their water from small, unregulated streams or small surface-water impoundments." Communities sometimes have problems with siltation and clogging of water intake facilities as a result of excessive sedimentation and debris. Because environmental resources such as fisheries and other aquatic and waterfowl-wildlife habitat areas may be impacted, a state or federal water quality permit must also be obtained (Alexander and others, 1984).

Under "Emergency" Conditions

Under "Emergency" conditions, public systems will attempt to restore a system's integrity and must manage water to satisfy priority uses, such as hospitals and nursing homes, firefighting, and domestic drinking water. They may have in place contracts with vendors of bottled water to provide drinking water to homes without potable water. In addition, systems should furnish information dealing with sanitation and shutting down home water heating systems should these emergency actions be necessary. Procedures for dealing with non-drought emergencies will include not only priorities for water delivery, and starting up auxiliary equipment, but in addition, responses focusing on restoration of the system, and clean-up of a spill. The emphasis may be on restoring the system and protecting lives and property. "Emergency operation procedures" for every possible emergency should be developed for each water system depending on the class of emergency and based on available equipment, personnel, etc., listed in Appendix A, "Drought Management Planning Inventory For Public Water Supply Systems" (Keck, 1987).

For drought induced water shortages, **many of the responses appropriate under the "Restrictions" phase also apply under "emergency" conditions.** In some cases, rationing or other actions may be made more restrictive, reducing per capita allocations even further. Additional water management remedies include running a temporary pipeline to another source, and/or drilling an auxiliary water well. Suppliers should also consider the need to haul water to homes temporarily without service.

Hauling Water.

If all other water shortage responses fail to provide for First Class Essential water use needs, hauling water (by "water buffalo," etc.) may be necessary to protect the community and individuals from serious health, sanitary, and safety-related consequences. "However, the decision to haul water should be made only after all other responses fail because hauling water is expensive, time consuming, and unlikely to supply all of the water-related needs." Should the hauling of water be initiated, every possible conservation measure must be utilized, since hauled water can only satisfy essential water needs. Suppliers planning for this action must identify potentially needed equipment, vendors or lessors of equipment, potential water needs, and a corresponding capability (Alexander and others, 1984).

Because of the cost and difficulty of obtaining emergency supplies in this manner, the utility must establish measures to insure that the emergency water is used only for drinking, cooking, body washing, and other defined essential needs, not for general cleaning or outside use. This will insure that quantities of hauled water are minimized (Smith and Lampe, 1982).

Either raw or finished water can be hauled, but it is preferable to obtain finished water so that treatment of the water is not needed. "If raw water is hauled, the water must be treated in the utility's treatment plant, or, if the utility uses ground water and treats only with chlorination, the raw water must be treated in a portable treatment plant. If finished water is hauled, it should be emptied into the wet well for the finished water pumping facilities of the utility." If the utility normally obtains water pumped directly from wells into the distribution system, emergency pumps should be used for pumping the hauled water into the system (Smith and Lampe, 1982).

The equipment to haul water to the distribution point can frequently be obtained from local dairies, milk processors, road contractors, private water haulers, city public works departments, fire departments, and U.S. military bases or through the Tennessee Emergency Management Agency or Tennessee Adjutant General's Office. "Prior to use, the water tanks on the trucks should be cleaned and disinfected, and the water delivered should be chlorinated to a free chlorine residual of at least 2 mg/l" (Smith and others, 1982).

Total truck capacities required to meet basic water supply needs during an emergency must be estimated. For example, if emergency supplies were hauled to a community of 1,500 persons from a city 30 miles away, assuming a 24-hour per day operation, 3 trucks with a total capacity of 12,500 gallons would be needed to provide 50 gallons per person per day to the community.

(1,500 population x 50 gpcd) = 75,000 gallons per day
(24 hours   4 hour round trips) = 6 trips can be made per day
75,000   6 = 12,500 gallons per trip

Thus, two 5,000-gallon tank trucks and one 2,500-gallon tank truck would be adequate (Smith and others, 1982).

Bottled Water.

Similar to the option of hauling water is the option of providing bottled drinking water to customers of a system experiencing a water outage or being supplied with undrinkable water. Water systems planning this action must identify potential vendors, develop policies for distribution, and possibly establish a contigency contract with a vendor. Also, bottled water should be available at fallout and other emergency shelters.

Sanitation Measures.

Under the "Emergency" phase, water supply systems without water need to publicize sanitation needs, especially the safe disposal of human waste. Plastic bags and bucket-type containers need to be available at fallout and other emergency shelters, and homes for when water for sanitation is not available.

Each emergency, however, will be dealt with on a case-by-case basis. Where the emergency cannot be resolved by the local water system, the state will consider remedies present within the watershed including the allocation of water between competing users, changes in reservoir management, obtaining necessary equipment, and assistance from nearby systems or communities. Although most water supply shortages need to be handled locally to the largest extent possible, state agencies may become involved in coordinating efforts necessary to alleviate the water crisis on request to TEMA. Efforts may be directed toward water hauling, laying of temporary pipe, reallocation of water or any other actions necessary for mitigating the emergency. Funding of these emergency actions would be borne by the local community, to the greatest extent possible (Keck, 1987).

B. DEALING WITH WATER QUALITY PROBLEMS

Water suppliers may not actually experience a water shortage. But, because diminished supplies may affect surface water quality, taste, odor, and other problems may be anticipated. Drought can also lead to pressure losses within a system, resulting in an in-flow contamination of treated water. In addition to drought, systems should also plan for possible contamination due to earthquakes (linebreaks), sabotage, flood, hazardous materials spills, etc. Responses to these various water quality scenarios should be identified. Although various disasters may have common effects on a system, the water supplier must consider the system's water loss problems in light of impacts to other services and the need for coordination with many agencies. Remedies of water quality problems will depend on the degree of severity, available resources and other factors.

Where water quality problems result from reservoir management, public suppliers may request that the Office of Water Management approach the Tennessee Valley Authority and/or U.S. Army Corps of Engineers to modify the operation of a reservoir to maintain a water level or establish a flow necessary to maintain water quality or serve other purposes. It must be recognized that pursuing this alternative could adversely affect other uses for which the reservoir is normally maintained. Where reservoir releases are increased, downstream water quality is likely to improve. Where reservoir management is changed to meet downstream needs, in-lake water quality is likely to deteriorate.

In circumstances where streamflows cannot be altered or sufficiently improved on a regional scale, the Department could "post" stream segments not meeting standards. On federal reservoirs, the Department of Health and Envrionment could post those beaches which are unsuitable for body contact, reducing in effect the priority given to aquatic life and recreation (Keck, 1987).

Where a toxic or hazardous materials spill occurs, the Tennessee Office of Water Management (OWM) and the Tennessee Emergency Management Agency (TEMA) should be involved with cleanup efforts. Their involvement in coordinating emergency situations is well established in the Civilian Defense Act, the Water Quality Control Act, the Safe Drinking Water Act, and various Executive Orders.

Most water suppliers experiencing typical low-flow water quality problems, will have to provide additional treatment. Actions include changing the level of the raw water intake; adjusting the chlorine dosage; treating water with activated carbon, potassium permanganate, or ozone; a Boil Water Notice recommending physical or chemical disinfection; or supplying bottled water for drinking.

Most taste and odor problems occurring as a result of low flows are caused by the growth and decay of algae. Algal byproducts create a "musty" taste. The treatment to control algae tastes and odors consists of an alternate preliminary disinfectant and treatment with activated carbon.

The addition of chlorine to a raw water containing decaying algae may intensify taste and odor problems. Modifying the preliminary chlorine dosage or changing to another oxidant such as potassium permanganate, ozone, or chlorine-dioxide may decrease the effect of the algal byproducts released by the algae.

Treating the water with activated carbon will reduce taste and odor problems from algae growth. Activated carbon has a porous structure containing many sites for the adsorption of chemical compounds which cause taste and odor complaints. Activated carbon is added in a powdered form to the water for the removal of these chemical compounds. The carbon is removed from the water by settling or by filtration.

Aeration will help to increase dissolved oxygen, and oxidize iron and manganese. When organic matter is high, increasing normal treatment helps.

Where the taste and odor of water are unacceptable, systems may continue to supply water for most uses, and encourage bottled water for drinking. In cases of spills, where a water system must shut down an intake or take other drastic measures, bottled drinking water may be necessary. Water suppliers should include in their emergency plans arrangements for the distribution of bottled drinking water, or provisions for hauling water to customers. Water suppliers encountering water quality problems can obtain technical assistance from the Office of Water Management Fleming Training Center, Murfreesboro, Tennessee (615/470-8090).

Where excess water use causes reduced pressure, resulting in inflows of untreated water, systems may need to valve-off tanks and lines, make repairs if necessary, and decontaminate lines before restoring service. A good cross-connection program may help to avoid some of these problems.

Where a local/regional response to a water quality problem is inadequate, the Office of Water Management has authority, under the Commissioner's or the Governor's emergency powers, to mediate or resolve water use conflicts between competing users, in order to protect the environment (Water Quality Control

Act, T.C.A. Section 69-3-109(b)). In a declared water shortage emergency the Office of Water Management could allocate water among competing users. The authority for this power can be found under the Civilian Defense Act (T.C.A. Sections 58-2-101 through 58-2-518) and Executive Order No. 4. Where minimum standards are not being met in the provision of safe drinking water or where compliance with a locally adopted water emergency management plan is inadequate, the supplier could be subject to Orders issued by the Commissioner of the Department of Health and Environment, the Safe Drinking Water Act (T.C.A. Section 68-13-710) (Keck, 1987).

Where water quality problems are the result of a loss of pressure, linebreak, flood, major fire or other hazard, the critical factors must first be identified and established procedures for that emergency followed. These should be developed and included in the "Emergency Operations Procedures" portion of the water system's drought and emergency management plan. Where water service has been restored following a linebreak, or "in-flow" water quality problem, systems may need to have additional water quality analyses made by a laboratory certified by the Department of Health and Environment.

C. SURVEILLANCE SYSTEM

When conditions are conducive to drought, a close watch should be kept on water supplies and uses by suppliers. An increased use or abuse of water, including the contamination of supplies, can signal activation of a phase. Refer to chapters VI and VIII "Assessing Source Capacity" and "Identifying Management Triggerpoints" for what should be monitored.

Utility districts and municipal systems are responsible for monitoring impoundment levels, streamflows, and water levels in production wells. In addition, suppliers must prepare for treating water quality problems induced by drought. In some instances, sub-components of the system may need to be monitored, such as monitoring supply and demand on a weekly basis or more frequently as conditions warrant.

Monitoring supply and demand is the basis for changing response levels and deciding how to allocate existing supplies. At a minimum, the community should prepare water availability estimates, evaluate remaining supplies at various usage levels and consider their ability to monitor fluctuations in water supply (Wood and others, 1986). Where water supply data is provided by others, data reporting arrangements must be made. Arrangements would also be needed if existing staff are to be used to gather data in addition to the normal duties.

In addition, systems should check for progress in reducing water use. It may simply involve more frequent reading of meters in selected areas of the distribution system. A system surveillance should be more detailed and encompassing with each progressive stage.

Surveillance is therefore important not only for phase activitation, but enforcement. The means for achieving the end-result must be both practical and appropriate. Each required response in a phase must be enforceable.

Planning the surveillance and enforcement elements of a drought water management plan avoids uncertainty and last minute, crisis-moment decisions. It is wise for a supplier to choose to establish an advisory group to assist in plan development and to validate implemented actions.

XI. PLANNING FOR IMPLEMENTATION

Once all other plan elements have been dealt with (i.e., the capacity of the source assessed, demand projected, uses classified according to some priority, local actions in response to various drought phases balanced, impacts identified, and the community served by the system satisfied by the strategy and plan) water system public officials must evaluate each measure for reduced water use and enforceability.

If each plan element seems viable, the system must then develop an ordinance or by-law enabling it to implement its drought management plan. The adoption of an ordinance legally defining and authorizing the plan is essential to implementation. Also, essential is development of a program to educate users about water conservation and the planned responses under the various phases of water management. A plan should also be developed for notifying customers of phase activitation due to a drought.

A. ASSESSING THE ABILITY TO ENFORCE

Enforcing the measures prescribed under each water management phase deserves attention. Where measures are voluntary or tied to pricing structures, enforcement procedures are not applicable. However, where measures are mandatory, the water supplier should determine what management actions and resources are needed to enforce the provisions of the plan.

The local water system (alone or in cooperation with other area systems) is responsible for informing customers of conservation measures to be taken. Also, each system is responsible for the costs associated with mandatory restrictions and bans. Additional costs are likely to result from overtime pay to system employees and temporary help to make more frequent meter readings, additional treatment costs, water purchases, make repairs, clean-up a spill, haul water from other systems, or other actions.

Additional financial burden to a utility may come from reduced income where water conservation measures are effective. However, this problem may be irrelevant where the system is operating at its maximum. Revenues may be maintained or even improved where a pricing program is used to reduce water consumption. Standby rate structures can help off-set enforcement costs. Where the supplier is a local unit of government, the police department and other agencies of government may be able to assist in enforcement.

Systems must be prepared to enforce restriction and bans with fines and penalties. These must be built in appropriate ordinances if the water supplier is a local government. A utility district may issue warnings, impose surcharges, and suspend service for various periods of time if measures are not taken by a customer. A mechanism must also be established within the ordinance for granting variances (relief from compliance). There will be unique circumstances and hardships which must be allowed some flexibility.

Where penalties and other payments are not made, suppliers might consider disconnecting that customer until payments are received. Without tough provisions for enforcement, a water supplier cannot expect to achieve its planned goals and objectives. Systems unable to achieve adopted plan goals and objectives under any phase of implementation would be subject to enforcement by the Commissioner of the Department of Health and Environment.

Plans should include personnel assignments given the various management situations and detailed procedures for the well-being of personnel. Personnel may need to be reassigned to duties they do not normally perform depending on the nature of the emergency. This means that management and personnel must be familiar with tasks they might have to perform under drought conditions. Periodic "dry runs" through these procedures will train the personnel and give them the expertise that may be called upon during a drought or other emergency.

B. ADMINISTERING MANAGEMENT PHASES

The primary reasons for developing a drought management plan is to have management guidance when the need arises. Procedures for implementing the plan must be outlined by the management plan, as well as provided for in an ordinance or by-law.

Where an emergency arises which is not the result of a drought, many additional responses may be necessary. These will vary according to the emergency, and the actions outlined by the system to address the emergency given their resources. Developing "emergency operations procedures" (EOPs) is discussed in detail in the Division of Water Supply's "Guidelines for Emergency Operations Planning for Community Water Systems."

The "Drought Alert" phase is important to initiate drought management responses because customers, other utilities, and government entities need to be informed in advance that water supply/use conditions are conducive to a water shortage. Procedures necessary for activating and de-activating a drought response must be clearly established. A water supplier must have a plan for notifying its customers in a timely manner about emergencies or other necessary responses. A list of media contacts, containing names and phone numbers for radio and television stations, and newspapers should include in the management plan. Implementation plans should also include (Texas Water Development Board, 1986):

1. automatic regulatory provisions;
2. prearranged media notification or press release procedures;
3. communications procedures including paging of emergency personnel, and means of public notification (telephone, police car public address, leaflets left door-to-door, etc);
4. prearranged contract procedures to obtain emergency water supplies from other sources if needed;
5. emergency checklists, personnel assignments and established operating procedures, as necessary; and
6. procedures and forms for documenting management actions taken.

In addition to these, several legal or regulatory components may be necessary for implementing phases of the plan. These may include (Texas Water Development Board, 1986):

- Ordinances, bylaws, or other implementing legal documents;
- Changes in plumbing codes;
- New or revised contracts with potential water suppliers;
- Conditions in contracts tied to drought phases with industries or commercial water users who may have water supplies cut off or curtailed; and
- Changes in contracts with current water suppliers.

The decision to terminate a drought management phase must be based on sound judgement by proper city or utility authorities. In some instances the stepping-down of phases may be appropriate. The city or utility should also have a written procedure to inform customers that a particular phase is no longer in effect or that drought management is being discontinued or terminated (Texas Water Development Board, 1986). Actions leading to the activation and de-activation of phases should be clearly specified and based on triggerpoints established in the drought management plan. Water suppliers are encouraged to consider deactivating plan phases in the reverse order of their implementation.

Copies of the drought management plan and/or EOPs should be on file with local law enforcement officials, the local emergency planning agency, fire department, appropriate state agencies, adjacent water systems and others who may have a need for the information during an emergency. A list of those with a copy of the plan should also be kept and updates sent to them as revisions to the plan are made. In addition, multiple copies of records, maps and engineering plans kept at locations remote to the plant should be considered.

C. ADOPTING THE ORDINANCE

A water department must have legal authority for the implementation of a drought management plan. They must have the authority to affect or alter existing plumbing codes, establish a leak detection program, or commit the water system to a mutual aid agreement with another system. A model water shortage ordinance is contained in Appendix D, "Water Shortage Ordinance."

This representative ordinance reflects a municipal water supply system utilizing a city reservoir. Other systems might utilize some other triggering mechanism. Appendix D also contains a classification system involving industry and institutions. (This component may not be applicable inasmuch as many utility districts in Tennessee do not serve industry or large institutional users. The ordinance also contains other features which may not be applicable.)

A system may not wish to adopt a stand-by rate structure, opting for rationing instead. An effective drought management ordinance should address all of the actions selected to respond to water shortage conditions.

D. OPERATIONAL CHANGES

In addition to prioritorizing water uses, establishing a drought management price structure, and establishing mutual aid agreements, water systems may need to purchase bullhorns, or put 500 feet of line in place to a neighboring system in order to effect a mutual aid agreement if it were needed. Other water systems may have determined that reducing their vulnerability to risk requires that they also invest in a number of "harder" solutions. They may have identified a number of measures they could implement with existing financial resources. They may have identified the lack of an emergency power source, or insufficient accessable records. Reducing some risks in many instances may not necessarily require the construction of a finished water storage tank, plant expansion, or other major capital improvement but merely acquiring equipment to isolate parts of the system, or having printed leaflets available.

Systems should review their plans and EOPs for those operational changes which are necessary to make valid the management measures outlined in their plans.

Operational changes may involve:

- additional pumps, valves, and other equipment, chemicals, or supplies;
- copies of records, maps and engineering plans at additional locations;
- identification of spokesman;
- fences around water system facilities;
- maintaining emergency placards, loudspeakers, and mobile communications equipment;
- trained emergency personnel;
- emergency shelters for water treatment personnel;
- monitoring and detecting equipment;
- portable power supplies; and
- other operational changes as may be needed to implement any of the management phases detailed in the plan, including any of its emergency operations procedures (Agardy and Ray, 1973).

E. PUBLIC EDUCATION

Education is the key to the success of a conservation/drought management program because it can help users understand why water conservation is needed and how to conserve water. "It can also successfully minimize opposition to water conservation programs and can improve water supply planning coordination among community officials." The public should be informed of what will be expected during a drought or water emergency (New England River Basin Commission, 1980).

"Education is most effective during a water crisis when user awareness of water is high. At other times, users need constant reminders of the need to conserve." Therefore, educational programs should be on-going (New England River Basin Commission, 1980). Table 3, "Suggested Audiences, Messages, and Communication Techniques For A Public Information Program" provides a list of approaches a water supplier might use.

"It is questionable that a particular public education campaign will result in a certain amount of water savings; often public education works only in conjunction with more direct conservation efforts, such as plumbing retrofit programs. Public education is effective on its own mainly during obvious emergencies, and the behaviors it induces are usually short-lived." School programs can teach children water-saving habits, and can possibly teach parents as well (New York State Senate Research Service, 1986).

There are many methods of public education, including (New York State Senate Research Service, 1986):

- developing citizen involvement through public interest groups;
- establishing speaker's bureaus to make presentations to schools, businesses, and service organizations;
- newspaper articles, public service announcements, and news stories;
- developing and distributing films or slide shows;
- radio and TV talk shows and interviews;
- promotion conferences, symposia or seminars;
- distributing pamphlets, brochures, leaflets, and posters promoting conservation;

- encouraging board of education involvement;
- bumper stickers, buttons, and decals
- conducting public demonstrations, displays and distribution at malls and shopping centers, schools, and booths at fairs;
- encouraging restaurant tri-folds which explain water use, for instance, for ice making and filling and washing of drinking glasses;
- enclosing water bill inserts and distributing newsletters to non-customer water users such as apartment dwellers; and
- free distribution of inexpensive flow restriction devices on doorknobs.

Educational material should make direct connections between conservation activities and monetary savings, from the points of view of both consumers and water suppliers.

Give as much information as possible and be specific about what you want the public to do. A water conservation program should be individualized to meet the needs of the community. Customers cannot be expected to cooperate until they are informed. This is particulary important when regulatory and/or pricing measures are being implemented.

Specific voluntary and regulatory measures being promoted will depend on the responses selected by the system as appropriate. An exhaustive list of optional responses is contained in Chapter X, "Dealing with Shortages and Water Quality Problems." Examples of direct mail fact sheets, bill inserts and articles are contained in Appendix B, "Obtainable or Adaptable Water Conservation Education Materials."

Public education should be an integral part of any system's water supply management program. A water system should develop a strategy and plan for educating its customers. The strategy should be appropriate to the community it serves. It may not be practical to develop TV public service announcements where the system is small and serves few of the TV station's viewers.

Developing presentations for school-age children geared to convey information about "restrictions" and/or "emergency" responses initiated during the summer are not likely to be effective. However, programs that teach water conservation practices to school children may be more permanently successful. Typical press releases are contained in Appendix E, "Sample Press Releases and Declarations."

F. PLAN UPDATES AND REVISIONS

The need to update a local drought management plan may be self-evident after the plan has been activated by a water supplier. Needs which were not addressed, inappropriate triggerpoints, or unsuitable responses may be identified. Other factors which require a drought management plan to be updated include population or industrial growth served by the public water supplier, changes in industrial mix, infrastructure condition, lower risk requirements of users served, major equipment changes, or any other condition altering the public supplier's circumstances. To insure that local drought management plans are evaluated and updated, public suppliers should review and modify adopted plans within three (3) months of deactivating any of its drought management phases or every two (2) years.

Table 3

SUGGESTED AUDIENCES, MESSAGES, AND COMMUNICATION TECHNIQUES FOR A PUBLIC INFORMATION PROGRAM (INTASA, INC., 1982)

Key Audience	Key Motivating Message(s)	Particularly Appropriate Techniques
Home owners/ apartment renters	. Flow reduction measures save water, energy, and dollars with minimal cost, little effort and no inconvenience. . Flow reduction saves tax dollars by decreasing community expenditures for building and operating treatment facilities.	. Water bill inserts. . Media public service announcements. . Presentations. . Exhibits of devices and cost saving information. . Treatment facility tours.
Apartment owners	. Retrofitting rental units save money at minimal cost and with no tenant dissatisfaction.	. Information flyers mailed to landlords.
Civic groups, public interest groups (e.g. Lions Club, Sierra Club, League of Women Voters	. As concerned community leaders, they can ignite the program.	. Presentations at meeting to encourage active support and suggest activities they can do.
Homebuilders Association	. Water-saving features can enchance the attractiveness of homes to potential buyers. . The program represents an opporunity to enhance public visibility and improve their image.	. Workshops or meetings of member representatives. . Information flyers.
Hardware and plumbing supply store owners and managers	. Increased sales revenues can be obtained if they advertise, display and stock water-saving devices.	. Workshops or meetings. . Information flyers.
School children	. Saving water is fun. . Saving water is something they and the family can do at home.	. Puzzles about conservation. . Math problems showing water, energy savings. . Essay/poster contests. . Take-home class assignments on reading water, gas meters.
Scout troops and youth groups	. Flow reduction activities can be fun and help the community.	. Activities to earn a water-saving badge or certificate. . Presentations at club meetings. . Contests of exhibits for display at fairs or or shopping centers.

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GLOSSARY

The following terms are defined as they are used in this guide.

"3Q20" is the low flow for a stream or spring which can be expected to occur over a three-day period once in twenty years on the average. In Tennessee the 3Q20 is used in planning for the discharge and assimilation of liquid wastes into a stream.

"Activated carbon" is a highly adsorbent powdered or granular material used for purifying water. Also called activated charcoal.

"Aerator" is a device that exposes water to additional air.

"Aesthetic water use" means the use of water for fountains, waterfalls, and landscape lakes and ponds where such uses are primarily ornamental.

"Agricultural drought" generally involves soil moisture and plant behavior. It occurs when the amount of water needed for transpiration and direct evaporation for a particular crop exceeds the amount of water available in the root zone of that crop.

"Agriculture water use" or "irrigation" refers to the use of water for the production of crops and for freeze protection.

"Alert" refers to "Drought Alert."

"Allotment" is used to mean the maximum quantity of water allowed for each customer over any applicable period as established in the water rationing provisions of an ordinance.

"Any water" is used to mean any type of water, including fresh water, brackish water, wastewater, or reclaimed water.

"Aquifer" is a geologic formation that stores, transmits, and yields significant quantities of water to wells and springs.

"Atmospheric drought" involves precipitation and possibly temperature, humidity, wind speed, or sunshine.

"Average Daily (Water) Use" is the average amount of water withdrawn for processing and distribution by a public water supply system to meet users' daily water demands. This amount is usually based on the system's average monthly use over a 12 month period.

"Average Streamflow" is the average of all the mean daily flows for a stream or river. The average flow characterizes the yield of water from a particular basin.

"Backflow" is a reversal of normal water flow direction.

"Base-period" refers to a a specified period during which water use is calculated.

"Blue-green algae" is a type of algae typically responsible for creating taste and odor problems in finished water.

"Boil Water Notice" is a public announcement to the customers of a water system that conditions indicate bacteriological contamination of the water may have occurred and that water should be strained through a clean cloth to remove any sediment and vigorously boiled for 2 minutes before being used for human consumption. Where contamination involves heavy metals, organic compounds, etc., boiling is not effective.

"cfs " (cubic feet per second) is a measure of the amount of water passing a given point. A cubic foot of water equals approximately 7.5 gallons.

"Commercial/industrial water use" refers to the use of water for the production of goods and/or services by an establishment having financial profit as the primary aim.

"Component" is a discrete part of a system capable of operating independently but operated as an integral part of a system.

"Conservation" means a reduction in usage of a resource to prevent its depletion or waste. It is the efficient use of available water.

"Conservation device" is a mechanical device used to reduce water use.

"Conservation measure" is a change in the behavior of people that results in a reduction of water use.

"Conservation phase" is the term used to refer to a period of below normal water supply and/or inadequate water quality conditions.

"Consumption" refers to that water withdrawn from a source that is used and not returned to that source because of evaporation or product incorporation.

"Customer" is a term which means any person, company, or organization using water for any purpose supplied from the system's water distribution system and for which a charge is made.

"Deliverable capacity" of a system is the lesser of either the source capacity or the system's capacity.

"Design capacity" is the maximum amount of water a treatment or wastewater plant was built to treat.

"Design volume" is the amount of water a reservoir was originally designed to hold.

"Diffused surface water" means waters lying, or running on the surface of the earth but not in definite courses, streams, or waterbodies.

"Domestic water use" means any use of water for personal needs or for household purposes; such as drinking, bathing, heating, cooking, sanitation, or cleaning, whether the use occurs in a residence or in a business, industrial, or institutional establishments.

"Drainage basin" is the land area that contributes water by runoff or underground flow to a surface body of water.

"Drawdown", usually measured in feet, is the distance that the water level in a well falls from the static water level to the level at which it stabilizes when the pump is running.

"Drought" is an extended period of dry weather conditions (prolonged and abnormal moisture deficiency) which results in declining streamflows (generally flows near or below a 3Q20), depressed reservoir pool levels, depleted soil moisture, and/or lower groundwater levels. A drought may be of one or more of several types: agricultural, hydrologic, meteorological, atmospheric, etc.

"Drought Alert" is a term used to publicize a need to evaluate water use. It is used to advise an area that it is experiencing lower than normal precipitation, declining streamflows, reservoir levels or groundwater levels, and that if these conditions continue to decline, water supplies may not be adequate to meet normal needs. Users should monitor for source quantity and quality problems as well as for hydraulic stress and the possible need for water conservation measures.

"Drought emergency" exists as declared by an official or administrative head when the safety, security, health, or welfare of citizens are threatened. It may not necessarily mean the implementation of measures outlined in a plan's "emergency phase."

"Emergency" from a water supply standpoint is used to mean a period during which water supplies are below the level necessary to meet essential needs within the system or a sub-area of the system, requiring the implementation of emergency measures. It also includes supplies where water quality poses serious risk to water users. In addition to drought induced, a water supply emergency may be caused by a tornado, storm, flood, wind, earthquake, landslide, snowstorm, fire, explosion, civil disorder, dam failure, hazardous materials spill, power failure, nuclear attack or other catastrophe.

"Emergency Operations Procedures" or "EOPs" refer to sets or lists of actions which are used as guidelines during a drought or other emergency in assessing its extent, and then in obtaining, commiting, and applying resources to alleviate the identified needs. They should prescribe in sequential order: who, what and under what conditions, existing resources are utilized. Emergency Operations Procedures may prevent costly and potentially dangerous spur-of-the-moment decisions from being made.

"Essential water use" is a classification of water uses to be part of a drought or emergency management plan. Essential water uses are priortized further into First, Second and Third Classes.

"Evapotranspiration" is the loss of water through transpiration from plants and evaporation from land and water surfaces.

"Even numbered address" means the street address, box number, or rural route ending in the numbers 0, 2, 4, 6, 8, or the letters A-M; and locations with no addresses.

"Even numbered days" means the days whose dates end in the number 0, 2, 4, 6, or 8.

"Excess use" is a term used to mean the usage of water by a water customer in excess of the water allotment provided under water rationing provisions over any applicable period.

"FEMA" refers to the Federal Emergency Management Agency.

"Finished water" means water withdrawn from a surface or groundwater source which has been treated and is potable.

"Fish kill" is an event during which large numbers of fish in a water body are killed by toxic substances, oxygen depletion, high water temperatures, etc.

"Float valve" is a device that controls how much water is allowed to enter the tank of a toilet.

"Flow-regulated stream" is a stream or river in which the amount of flowing water is controlled by releases from the dam of an upstream reservoir or impoundment.

"Flow-restricting device" is a device by which the amount of flow in a pipe, conduit, showerhead, etc. is reduced.

"gpd (gallons per day)" is a measure of water use, streamflow, etc. To convert gpd to million gallons per day (mgd), divide gpd by 1,000,000.

"Hydraulic problems" refer to water system problems resulting from inadequate pump capacity, distribution mains, low pressure, limited treatment capacity, etc.

"Hydrologic Drought" is characterized by a reduction in streamflows, lake or reservoir levels and lower than normal groundwater levels.

"Hydrology" is the science of (or study of) the origin, properties, distribution, and circulation of waters of the earth including precipitation, streamflow, infiltration, groundwater storage, and evaporation.

"Impoundment" is a body of water, such as a pond or lake, confined by a dam, dike, floodgate, or other barrier.

"Institutional water user" refers to water used in activities and facilities for such diverse entities as, but not limited to, hospitals, nursing homes, government, public or private schools or universities, prisons, churches and places of worship, etc.

"Instream water use" takes place within the stream for such purposes as fish and wildlife habitat, recreation, navigation, waste assimilation, and hydropower generation.

"Lagoon" in wasterwater treatment, is a shallow pond usually manmade where sunlight, bacterial action, and oxygen interact to restore wastewater to a reasonable state of purity.

"Landscape water use" includes water used to maintain gardens, trees, lawns, shrubs, flowers, athletic fields, rights of way and medians, but excludes nurseries and golf courses.

"Low-volume hand-held watering" means the low-volume irrigation of plants and crops with one hose, fitted with a self cancelling or automatic shutoff nozzle attended by one person.

"Mandatory allocation" is the rationing of available water supplies by a governing body among the various water uses.

"Meterological drought" is a prolonged and abnormal deficiency in precipitation for a given area, over a period of months or years, from that which is climatically expected.

"mgd (million gallons per day)" is a measure of water use, streamflow, etc. To convert mgd to gallons per day (gpd), multiply mgd by 1,000,000.

"Monitoring" is the process of regularly measuring and analyzing water supplies for quality and/or quantity.

"NOAA" refers to the National Oceanic Atmospheric Administration, United States Weather Office.

"Non-essential water use" is a classification of water uses to be part of a drought or emergency management plan. Typically, it will refer to water used for fountains, law watering, irrigation of recreation areas, filling of swimming pools, and the washing of streets and sidewalks.

"NWS" refers to the National Weather Service.

"NWSFO" refers to the National Weather Service Forecast Office.

"Odd numbered address" means the street address, box number, or rural route ending in the numbers 1, 3, 5, 7, 9 or the letters N-Z.

"OWM" refers to the Tennessee Office of Water Management, Department of Health and Environment.

"Oxygen depletion" is the process of removing oxygen from the water, often associated with the decomposition (breakdown) of plant or animal remains in the lower levels of lakes or in slow moving rivers during times of elevated temperatures.

"Palmer Index" is a measure of the severity of a drought or a wet spell in an area's soil moisture. Dry conditions are associated with negative values, wet conditions with positive values, and normal conditions have a value of zero.

"Percent reduction in overall demand" means the weight average reduction of all water uses within a source class regardless of the type of use or method of withdrawal, which is necessary to reduce estimated present and future demand to estimated present and future available water supply.

"Per Capita Water Use" is the amount of water used by one person per day.

"Person" means any and all persons including individuals, firms, partnerships, associations, public or private institutions, municipalities, political subdivisions, governmental agencies, or private and public corporations organized under the laws of this state or any other state or country.

"pH" is an expression of acidity or alkalinity of water on a scale of 0 to 14. A pH of less than 7 indicates acidic water, and a pH above 7 indicates alkaline water.

"Potential Water Shortage" is a situation in which the "source capacity" of a specific system's source of water is less than, or equal to the system's peak capacity.

"Precipitation" is the fall of water in any form upon the earth's surface. It includes rainfall, snow, sleet, hail, and dew.

"PSI" refers to pound per square inch of pressure.

"Public Water Supplier" refers to municipal water systems, departments, water commissions, utility districts and investor-owned systems serving at least 15 connections and/or 25 people at least 60 days per year. The supplier's primary mission in any emergency is to maintain or restore delivery of potable water. Other services or relief, such as providing emergency shelters, etc., may or may not the responsibility of a public water water supplier. Disasters that are more extensive will require the coordinated management action of many agencies having different missions. The local emergency planning committee (or county emergency management agency) should develop plans and procedures for handling multi-service coordination.

"Rationing" is the restriction of water usage in order to insure equitable distribution of critically-limited water supplies, in order to balance demand and limited supplies, and to assure that sufficent water is available in the future to preserve public health and safety.

"Reclaimed water" is wastewater which has been treated to allow reuse.

"Reservoir" is a pond, lake, tank, or basin, natural or manmade, used for the storage, regulation, and control of water.

"Runoff" is water from precipitation that eventually enters a stream or reservoir; especially water flowing over the earth's surface.

"Raw water" is water that has not been through any treatment process.

"Residential customer" is used to mean any customer who receives water service for a single or multi-family dwelling unit. The term residential customer does not include educational or other institutions, hotels, motels, or similar commercial establishments.

"Residential use" refers to any water for personal needs or for household purposes such as drinking, bathing, heating, cooking, sanitation, cleaning, outside watering, or sprinkling, and water used for private swimming and wading pools.

"Restrictions phase" is the term used to refer to actions affecting water users in responding to specified continued declines in water supply, possibly due to water quality.

"Riparian rights" are the common law rights of a land owner to the water on or bordering his property, including the right to prevent diversion or misuse of upstream water.

"Risk" is vulnerability to a hazard, in this case a water shortage. The degree of exposure to risk will depend on how likely the various situations are that can cause a water shortage. Some events are not very probable and are not worth worrying about, others are likely. Risk also must consider all potential impacts resulting from a water shortage, i.e, social, economic and environmental. An "acceptable level of risk" is generally determined by those who must pay the additional cost necessary to improve the reliability of their supply.

"Runoff" is the portion of rainfall, melted snow that flows across ground surface and eventually is returned to streams. Runoff can pick up pollutants from the land or air and carry them to the receiving waters.

"Sediment" is soil that erodes from the land and is carried by runoff; it travels in water producing a turbid, brown appearance or settles to the bottom of a reservoir or other slow-moving body of water.

"Safe yield" is the available amount of water that can be expected from a reservoir, stream, or groundwater source during a critical dry period. It is generally the 3Q20 for a non-regulated stream, the pump tested yield of a well, the average daily flow in a regulated stream, or the 90 day sustainable yield of a reservoir. Optimally, the safe yield of a source should equal or exceed the system's capacity to deliver water. Greater risk is assumed when the safe yield of a water source in drought can only meet the water demands of either the "Restrictions" or "Emergency" phase.

"S.A.R.A." refers to the "Superfund Amendments and Reauthorization Act of 1982." "Emergency Planning and Community Right-to-Know" is Title III of S.A.R.A.

"Service interruption" refers to the temporary suspension of water supply or reduction of pressure below that required for adequate supply to any customer, portion of a water supply, or the entire system.

"Sonar device" is an instrument used to measure drawdown in wells by the use of sound waves.

"Source capacity" is the water yield of a particular surface-water or groundwater source. The safe yield of a source is generally the 3Q20 flow of an unregulated stream, the pump tested yield of a well, or the minimum average daily flow of a regulated stream.

"Specific capacity" is an index of the efficiency of a well, measured in gallons per minute per foot of drawdown (gpm/ft).

"Static water level" is the level of the water in a well before pumping begins.

"System capacity" is the maximum amount of water a treatment plant can effectively process and deliver. When a system's average daily use reaches 80 percent of the system's design capacity, the manager of the system should consider expanding the system's treatment plant capacity. The system's capacity should not exceed the safe yield of the source.

"TEMA" (Tennessee Emergency Management Agency) is the state agency responsible for coordinating emergency assistance to supplement local efforts.

"Toilet tank displacement insert" is a device placed in a toilet tank to reduce the volume of water held in the tank.

"Toxic substances" are chemicals that can produce sickness, death, or abnormalities if consumed or, in some cased, contacted.

"Triggerpoint" is a predetermined condition at which point particular action is taken, such as a declaration of a "Conservation" phase requesting users to utilize water conservation measures.

"TVA" is an abbreviation for the Tennessee Valley Authority.

"Use class" means the category describing the purpose for which the user is utilizing water. Four classes are recommended: Essential, First Class; Essential, Second Class; Essential, Third Class; and Non-essential.

"User" means any person, individual, firm, association, organization, partnership, business trust, corporation, company, agent, employee or other entity, municipality, or public agency, thereof, which directly or indirectly takes water from a specified water resource.

"USGS" refers to the United States Department of the Interior, Geological Survey.

"Waste of water" refers to water use exceeding the generally accepted normal water use for each individual water use category. It may also include water escaping down a ditch, or other surface drain, or lost by a leak due to defective plumbing.

"Wastewater" refers to water which has been previously used for industrial, municipal, domestic, or other purpose and must be treated prior to its return to a surface or groundwater source. It is waste carried by water.

"Water" refers to the water available to the city or utility district for treatment by virtue of its water rights or any treated water introduced into its water distribution system, including water offered for sale.

"Water conservation" means the short- or long-term reduction in water use, whether by mechanical device or human behavior, to prevent its depletion or waste. It can be accomplished by reducing the overall demand for water, improving water use efficiency, recycling and reusing existing water, and reducing water losses through leak detection and repair.

"Water Management Advisory Group" or "Drought Response Committee" refers to the committe of local representation whose purpose should be to advise and oversee drought responses by a management agency.

"Water resource" means any and all water on or beneath the surface of the ground, including natural or artificial water courses, lakes or ponds, and water percolating, standing, or flowing beneath the surface of the ground.

"Water shortage" refers to inadequate amounts of water to meet the present or anticipated needs of a water user or users. A water shortage requires temporary reductions in total use within a particular area to protect water resources from being seriously depleted. A water shortage may stem from drought, but may also result from broken water mains, distribution lines, inadequate treatment capacity, and other causes.

"Water shortage emergency" means a situation when powers are exercised to protect the public health, safety, or welfare; the health of animals, fish, or aquatic life; a public water supply; or commercial, industrial, agricultural, recreational, or other reasonable uses.

"Water withdrawal" refers to water withdrawn or diverted from a surface-water or groundwater source for a specific purpose.

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APPENDIX A

DROUGHT MANAGEMENT PLANNING INVENTORY

FOR

PUBLIC WATER SUPPLY SYSTEMS[1]

1. Name and address of the water supply system:

   System name ______________________________

   Mailing address ______________________________

   City ______________ State ______________ Zip code ______________

2. Name and position of person(s) to contact for further information (plant manager, operator, owner, etc.):

   Name ______________ Position ______________ Phone ______________

3. Operation location and general description of the system's service area.[2]

   City ______________ County ______________

   Service area (a map showing the service area would be helpful):

   ____

   ____

   ____

4. Time period for which water use data are being provided:

   12-month period beginning: Month ______________ Year ______________
   Seasonal use beginning: Month ______________ Year ______________ to
   Month ______________ Year ______________

5. Source(s) and amount of supply:

Source of Supply by Name or Number	Water Supply Intake Location	Average Daily Amount Withdrawn or Purchased on Operating Days (Gallons Per Day)	Percent of Total	3Q20 of Pump Test Yield if Known
Streams[3]:				
Wells[3]				
Springs[3]				
Lakes or Ponds[3]:				
Other Supplies[4]:				
Total			100	

Describe the contractual agreements your system may have with other suppliers, specifying the amount to be supplied under various conditions and system contracts.

____

____

6. What percentage of the total average daily withdrawal shown above is metered?__________ Estimated?__________

7. Normally, this system operates __________ hours per day, __________ days per week and __________ weeks per year.

8. Average amount of water reused or recirculated in gallons per day (GPD) on normal operating days: __________ GPD

9. Total water use (average daily withdrawal plus reuse): __________ GPD

10. Historical peak water use: __________ GPD

Frequency of near peak water use:

____

Approximate time(s) of peak water use (hours of day, days of week, month, and season of year): ____

____

11. Specify the location of treatment plant(s) and describe the type of treatment including major processes and the maximum design treatment plant capacity in gallons per day[2]: ______________________________

____

____

12. Describe distribution facilitie[2]:

Diameter of distribution lines:	__________	Average Age:	__________
Diameter of high service lines:	__________	Average Age:	__________
Number of pumps:	__________	Pump sizes:	__________

13. What percentage of the distributed water is metered? ________________ Estimated? ________________

14. Total storage capacity for treated water by type of storage[2]:

Type	Amount of Storage (Gallons)	Overflow Elevation
Tanks	__________	__________
Clear wells	__________	__________
Reservoirs	__________	__________
Distribution lines and mains	__________	__________
Other	__________	__________

15. Describe how and where records on the location of water lines, system valves and hydrants, storage facilities and pumping facilities are kept (i.e., map, computerized, etc.)

____

____

16. Number of connections by type: residential ____________________, commercial ________________, and industrial ____________________. Number of people served by this system: __________.

17. Describe the water use records maintained by the system, i.e., basic data maintained, categories of use, and if computerized.

____

____

____

18. Number of multiple units with only one meter: ____________

Name	Address	Units

19. Average daily amount of water in gallons per day supplied by this system for each of the following purposes:

Sale to other towns and utility districts	________
Industrial	________
Commerical	________
Residental	________
Public supply[5]	________
System losses[6]	________

Estimated Monthly Water <u>Sales</u> by User Category in Gallons (Use latest typical year)

	Residential	Commercial	Industrial	Towns
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				

20A. Identify below all other towns or utility districts, if any, purchasing water from this system:

20B. Specify the contractual conditions contained in each agreement:

Name and Address of the Purchasing System	Average Amount of Water Purchased Per Month (GPD)	Contact Point Name and Telephone Number

21. Identify below all industrial and commercial customers purchasing more than 2,000 gallons of water per day from system.

Customer's Name and Telephone Number	Amount of Water Purchased (GPD)

MAJOR INDUSTRIAL CUSTOMERS

Customer's Name and Telephone Number	Amount of Water Purchased (GPD)

MAJOR COMMERCIAL CUSTOMERS

Specify whatever contractual conditions may exist between any large water user and the utility, i.e. interrupable service, etc.

____
____
____

22. Has the system experienced any major changes(s) in its water supply source during the past 5 years? ______________ if so, explain:

____
____
____

Do you anticipate any major change(s) in the system's water supply source during the next 2 to 5 years? ______________ If so, explain:

____
____
____

23. Have you recently made or do you plan to make any major changes in the system's facilities (treatment plant expansion, extension of the system's service lines, installation of new and/or larger water mains and distribution lines, etc.) during the next 2 to 5 years? __________
If so, describe these changes and provide the completion date or estimated completion date for all completed and ongoing or anticipated system changes: ______________________________

____
____
____
____
____
____

24. What percent change (increase or decrease) in this system's average monthly water withdrawal, if any, has occurred over the past 5 years?

Explain the reason for this change: ______________________

____
____

Do you foresee any significant increase or decrease in the system's average monthly water withdrawal during the next 2 to 5 years and, if so, by what percentage?

Explain the reason for this anticipated change: ______________

____
____

25. What water supply problems, if any, has this system experienced during the past 5 to 15 years? For example, these problems could include water supply shortages resulting from either inadequate supplies due to low streamflows and groundwater levels or inadequate system pumping and distribution capacity, pump failures, leaking water mains and distribution lines, etc.; water quality problems including taste and odor, excessive iron and manganese concentrations, etc.; turbidity after heavy rainfall and flooding; etc. Describe each problem briefly and indicate its frequency and years(s) of occurrence.

26. Describe the general effects of those water supply shortages and water quality problems, if any, experienced by this system and its users during the 1985-1987 drought on the area's economy, its environment, and the social well-being of its residents.

Economic: ______

Environment: ______

Social: ______

27. Describe the specific measures (public information/education, conservation, use restrictions, rate increase, etc.) utilized by your system to deal with any water supply shortages and quality related problems experienced by your system during the 1985-1986 drought period.

28. Describe the public's response to specific measures used by your system to deal with water supply shortages and quality-related problems, if any, experienced during 1985-1986 drought period. ______________________________

29. Describe how and what chemical supply records are maintained for this system. Where are the records located and what records are computerized. Also, what basic information is contained in these records?

30. What chemicals (alum, chlorine, line, etc.) and/or other supplies does your system use in treating its water and what quantity of each is used in a day. Also, how many days supply of each do you normally maintain?

Chemicals/Supplies	Average Daily Use	Normal Supply in days

31. What companies supply these chemicals in your area? Provide names, addresses and telephone numbers of back-up sources as well.

Chemicals	Supplier	Address	Phone

32. Describe how and what equipment supply records are maintained for this system. Where are the records located and what records are computerized. Also, what basic information is contained in the records.

33. Specify the location of all major pieces of equipment and supplies owned by the water system which may be needed to repair the system (including pipes, pumps, hydrants, blowoffs, valves, etc.).

34. List area suppliers of pipe and other major equipment, including portable filters, pumps, and valves.

Items	Supplier	Equipment	Phone

35. Does your system prepare an annual water management and operations report? Yes ____________ No ____________ Where are these kept? ____________

List the names, addresses and phone numbers (or other means of communication) of those individuals who may be able to assist the water system in an emergency. This list should include the plant manager and other current employees, retired personnel, others knowledgeable of water system operations, EPA emergency personnel, Tennessee Office of Water Management Emergency personnel, United States Coast Guard, Tennessee Emergency Management Agency, Food and Drug Administration Poison Control Center, Area Sheriff, Police and Fire Departments, Tennessee Bureau of Investigation, Tennessee Department of Transportation, Chemtrek, Corps of Engineers, Tennessee Valley Authority, and others.

Person	Address	Phone(s)	Means of Communication	Expertize

36. Identify your system's governing body by checking one of the following: Local government__________ Private, reports to local government_________ Private, separate from local government__________ Other (specify) ______

____

____

37. What is the source of your system's operating revenue? ________________

____

____

____

38. What is your system's average cost of water withdrawal? ________________ per ________________

39. Indicate your system's present rate structure by checking one of the following. Uniform ___________ Declining block ____________ Increasing block ___________ Varies by user ____________ Other (specify) __________

____

40. Under your system's present rate structure, what is the minimum cost per 1,000 gallons of water for each of the following user groups? Residential ____________ Industrial ____________ Commercial ____________ Other (specify) ____

____

41. What plumbing code, conservation measures and/or other ordinances, if any, are currently in effect in your system's service area?

____

____

____

____

____

42A. Does your system have an active, ongoing public information and education program to inform water users about the relative merits of water conservation and emergency plans in the event of water supply shortages? Yes ________ No ________ If yes, describe the program briefly.

____
____
____
____
____
____

42B. Describe the communication resources available for use in notifying customers and the public of a water shortage or emergency (list newspapers, radio-tv stations, and other means such as automobile public address, etc.):

____
____
____
____
____
____

43A. Does your system have an active leak detection program? Yes ________
No ________

43B. Does your system have a cross-connection program? Yes ______ No ______

44. Identify any alternative sources of water which your system has used in past years to alleviate water supply shortages. For each alternate source identified, indicate the years and amount of water used; the length of time over which the alternative source was utilized; the name, address, and telephone number of the water utility district or owner supplying the water; and any problems encountered in utilizing this source. ________________________________

____
____
____
____
____
____
____

45. Identify any alternative sources of water which your system might potentially be able to utilize to alleviate future water supply shortages. For each potential alternate source identified, indicate the type of source and name, address, and telephone number of the water supply district or owner of the water. ______________________________

____

____

____

____

____

46. List, to the extent the data are available, the latest test results and date of the test for each of the following water quality parameters for your system's raw water supply.

Contaminant	Level	Date
Barium	mg/l	
Chloride	mg/l	
Chromium	mg/l	
Copper	mg/l	
Fecal Coliform	mi	
Fluoride	mg/l	
Iron	mg/l	
Lead	mg/l	
Magnesium	mg/l	
Maganese	mg/l	
Methylene Blue Active Substances	mg/l	
Mercury	mg/l	
Nitrate	mg/l	
Selenium	mg/l	
Silver	mg/l	
Sulfate	mg/l	
Total Dissolved Solids	mg/l	
Zinc	mg/l	

47. What percent of your customers use septic fields? ________% Sewer service?______% Other? ______% Please specify what "other" includes.

____

____

48. Average amount of water returned to a public wastewater treatment system in gallons per day. ______________________________

49. Do your sewer and water supply systems have combined billing? Yes ______ No _______

50. Describe and list any contractual arrangements that have been made with other towns, water systems, private supplies, etc. for water, bottled water, water tank truck hauling, pumping equipment, etc. in the event of any emergency. Also, note contact person and phone number(s) where contact can be reached.

____

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____

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SURVEY FORM FOOTNOTES

1. In completing this inventory, please feel free to call the Tennessee Office of Water Management.

2. Please describe the system's service area in geographic terms including the names of specific communities and/or urban areas, or parts thereof, as well as any rural areas which are served by the system. Also indicate the names of the counties in which the service area lies. Indicate the location of maps showing the areas served, population served, location of treatment and storage facilities, water mains, valves and hydrants, pumping facilities, and large water users, i.e. industries, etc.

3. The location of all supply wells and intakes should be mapped. If the source of supply is a surface water source, also identify the source's intake location by river mile, where possible, or latitude and longitude. Groundwater supplies should be located by latitude and longitude. Specify intake elevation in reservoir.

4. Other suppliers include both private and public water supply systems from which water is purchased either on a regular basis or occasionally for emergency or backup water supply purposes.

5. Water supplies for carrying out public services include water used in fire fighting, street washing, and the maintenance and operation of municipal parks and swimming pools.

6. Water losses in the system include losses due to deteriorating water mains and distribution lines.

APPENDIX B

OBTAINABLE AND ADAPTABLE WATER CONSERVATION EDUCATION MATERIALS

Bill Insert

PIPE LINES

Metropolitan Department of Water & Sewerage Services

SPRING 1987

The miracle of Mother Nature is visible all around us as plants prepair for another season of growth in the bright sunshine of Summer in Nashville. People are also getting ready for the outdoor activities of Summer. Boats are being cleaned and polished, fishing gear is being oiled and readied for use, gardens are being nutured, shrubs are being planted... the list goes on and on. Summer is a time for recreation and fun but it is also a time when we all need to remember not to waste our valuable drinking water.

Past Summers have been unusually dry and we are entering this Summer with rainfall still below average. Because of this and the many questions asked in the past Summers, we are dedicating this entire newsletter to helpful hints and reminders in the use of WATER... OUR MOST VALUABLE RESOURCE.

DON'T WATER THE GUTTER: Position the sprinkler so water lands on the lawn.... not the driveway or sidewalk. Avoid watering on windy days and you'll avoid having most of the water go where you don't want it or evaporate before the soil gets it. Let water sink in slowly. Lots of water applied fast mostly runs off. This also helps establish deeper roots. A kitchen timer is a handy reminder for turning off sprinklers.

LANDSCAPE WITH DROUGH-RESISTANT TREES AND PLANTS: Many beautiful trees and plants thrive with far less water than other species. Get to know your plant's needs.

PUT A LAYER OF MULCH AROUND TREES AND PLANTS: Mulch will slow evaporation of moisture and discourage moisture robbing weeds.

USE A BROOM, NOT A HOSE, TO CLEAN DRIVEWAYS AND SIDEWALKS

DON'T RUN THE HOSE WHILE WASHING YOUR CAR: Clean the car with a pail of soapy water. Use the hose just to rinse it off.

TELL YOUR CHILDREN NOT TO PLAY WITH THE HOSE AND SPRINKLERS. Remember a garden hose can pour out 600 gallons of water in just a short time.

WATERING LANDSCAPE PLANTS

What to water	Comments	How to Water When Water is Necessary
Established lawns:	Healthy lawns in Davidson County generally do not need extra water. Cool season grasses such as fescue and bluegrass enter a period of dormancy during the hot days of summer. Healthy grass may turn brown during periods of moderate drought without damage. A clipping height of 2½ to 3 inches for cool season grasses and 1½ to 2 inches for bermudagrass will encourage deeper root development. Over fertilization increases water demand and may encourage disease problems.	Watering should begin only after two weeks without rainfall. Apply enough water at each application (usually once per week) to soak the ground to a depth of 6-8 inches. Water mid-morning if possible. Late evening watering may encourage fungus.

Meeting the needs of tomorrow. . .Today!

Back page of insert

What to water	Comments	How to Water When Water is Necessary
	Newly planted trees and shrubs (first year). A two inch layer of mulch helps to hold moisture in the root zone. Over watering or watering too frequently will likely result in root decay. Some plants, such as yew, are extremely sensitive to over watering or poor soil drainage. Check soil drainage before planting.	Thoroughly soak root zone with a slow running hose or soaker hose once every 7-10 days in the absence of rainfall.
	Water thoroughly immediatley after transplanting.	Soil should go into the winter moist. Large transplanted trees (three inch trunk diameter or more) may require supplemental watering the second yr.
	Established Trees and Shrubs: The root zone generally extends just past the "drip line" of the branches with the majority of the feeder roots located around the perimeter. Most healthy mature trees and shrubs can withstand moderate drought (three weeks without significant rainfall) without harm.	Thoroughly soak root zone to a depth of 8 to 10 inches with a single application every two weeks. Certain shallow rooted shrubs such as azaleas may require more frequent watering.
	New transplants (flowers, vegetable plants, etc.) soak the soil around each plant at transplanting. A two inch layer of mulch helps conserve moisture, prevents weed seed germination and may reduce disease problems.	Water new transplants every 2 to 3 days in the morning for one week or until leaves do not wilt during the day. Thereafter, water to a depth of 6 to 8 inches once per week in the absence of rainfall. More frequent watering may promote crown rot on certain plants.
	Vegetable Gardens: Individual vegetables have critical growth periods when water is essential. With most heavy yielding plants such as tomato, this period is usually from flowering through fruit-fill. Soaker hoses or drip irrigation provide more efficient use of water and help reduce Foliar disease problems.	For maximum yield the root zone should remain moist (not wet or water-logged especially during the critical growth period. Generally, one to two applications per week.

More complete information concerning care of landscaping plants is available at the Davidson County Agricultural Extension Office. 701 Jefferson Street, Nashville, Tennessee 37208 - Phone: 259-6467.

Information compiled by the Department of Water & Sewerage Services and the Davidson County Agricultural Extension Office

Presented as a public service of the
Metropolitan Government of Nashville and Davidson County
Richard Fulton, Mayor

Metropolitan Department of Water & Sewerage Services
1700 Third Avenue North ● Nashville, Tennessee 37208

William B. Whitson, Associate Director

TIPS FOR PLUMBING PROTECTION FROM WINTER FREEZE

★ Prepare now before you forget!

★ **INSULATE PIPES** ★ Insulating pipes . . . especially those adjacent to outside walls, under the house, or in the attic . . . is the most effective method for avoiding frozen water pipes. Inexpensive insulation for water pipes can be found in most hardware stores or department stores with a hardware section.

★ **ATTIC ABOVE SHOWERS** ★ The attic area above showers is often left open in construction of the house. If yours is, block it off with material that can be secured to eliminate cold air penetration and add insulation.

★ **CRAWL SPACE VENTS** ★ These should be closed from mid-November to around the middle of March to keep out cold wind. Don't forget to open them in the Spring, the circulation of air in the Summer helps control moisture.

ACT IMMEDIATELY WHEN THE WEATHERMAN WARNS OF BITTER COLD!!!

When temperatures drop below 20° it's almost too late to take the precautions already listed. But, here are some steps you can take . . .

★ **VANITY DOORS** ★ Open the doors beneath your bathroom sink and kitchen sink to allow warmer air to circulate around the water pipes.

★ **GARAGE & UTILITY AREAS** ★ Leave doors closed as much as possible. Since these areas are often poorly insulated, it may be necessary to add supplemental heat such as:

- Electrical Heat Tape or a Light Bulb

If you select the heat tape be sure to read and follow the manufacture's instructions for use. **DO NOT USE OPEN FLAMES! ! !**

★ **FAUCETS** ★ When temperatures near zero, you may want to let the water trickle. The extra cost of water is much less than a plumbing repair bill.

★ **OUTSIDE FAUCETS** ★ Be sure the garden hose is disconnected.

IF LINES FREEZE: use a hair dryer or warm towels to thaw. **NEVER** risk a house fire by using a torch. In addition to the risk of a fire, using a torch can cause the water in the pipe to turn into steam, which can build enough pressure to split the pipe!

★ **MASTER VALVE** ★ Locate the cutoff valve for your house so that in the event of a burst line you can stop the flow of water. The cutoff valve is usually the first valve near where the water line comes into your house.

If a pipe in your home freezes and bursts, you must call a plumber. If you see water in the street or a yard, please contact **WATER & SEWERAGE SERVICE AT 259-6401.**

Presented as a public service of the

Metropolitan Government of Nashville and Davidson County

Richard H. Fulton, Mayor

Metropolitan Department of Water & Sewerage Services
1700 Third Avenue North ● Nashville, Tennessee 37208

Bill Insert

HELPFUL HINTS FOR CONSERVING WATER

CHANGE TO GOOD WATER USE HABITS. Most water users are unaware of the amount of water they use in an average day of ordinary living. Of the average 100 gallons per person per day used in a community, about 80 gallons involve home use. Most of this home use is in the bathroom — 33 gallons flushing the toilet and 30 gallons for bathing.

	NORMAL USE	CONSERVATION USE
Shower	water running 25 gal. (4 minutes)	wet down, soap up, rinse - 4 gal.
Toothbrushing	tap running 10 gal.	wet brush, rinse briefly - 0.5 gal.
Tub Bath	full 36 gal.	minimum water level 10-12 gal.
Shaving	tap running 20 gal.	fill basin 1 gal.
Dishwashing	tap running 30 gal.	wash & rinse in sink or pan - 5 gal.
Automatic Dishwasher	full cycle 16 gal.	short cycle 7 gal.

CONSERVATION MEASURES

Conservation Measures For Residential Users:

(1) Locate and repair all leaks in faucets, toilets, and water-using appliances.

(2) Adjust all water-using appliances to use the minimum amount of water in order to achieve the appliance's purpose.

(3) Use automatic washing machines and dishwashers only with full loads. Preferably, wash dishes by hand.

(4) Take shorter showers and shallower baths.

(5) Turn off faucets while brushing teeth, etc.

(6) Turn off shower while soaping up.

(7) Set temperature settings of hot water at least 10 degrees lower to discourage lengthy shower-taking.

(8) Where plumbing fixtures can accommodate them, install flow-restricting or other water-saving devices.

(9) Reduce the number of toilet flushes per day. Each flush uses about 5 gallons. Reduce water used per flush by installing toilet tank displacement inserts.

(10) Use sink and tub stoppers to avoid wasting water.

(11) Keep a bottle of chilled water in the refrigerator.

Conservation Measures For Non-Residential Users:

(1) Identify and repair all leaky fixtures and water-using equipment. Give special attention to equipment connected directly to water lines, such as processing machines, steam-using machines, washing machines, water-cooled air conditioners, and furnaces.

(2) Assure that valves and solenoids that control water flows are shut off completely when the water-using cycle is not engaged.

(3) Adjust water-using equipment to use the minimum amount of water required to achieve its stated purpose.

(4) Shorten rinse cycles for laundry machines as much as possible; implement lower water levels wherever possible.

Source: Kentucky Water Shortage Response Plan, 1986

(4) Shorten rinse cycles for laundry machines as much as possible; implement lower water levels wherever possible.

(5) For processing, cooling and other uses where possible, either reuse water or use water from sources that would not adversely affect public water supplies.

(6) Advise employees, students, patients, customers, and other users not to flush toilets after every use. Install toilet tank displacement inserts; place flow restrictors in shower heads and faucets; close down automatic flushes overnight.

(7) Install automatic flushing valves and/or adjust to cycle at longer intervals.

(8) Place water-saving posters and literature where employees, students, patients, customers, etc. will have access to them.

(9) Check meters on a frequent basis to determine consumption patterns.

(10) Review usage patterns to see where other savings can be made.

Direct Hospitals and Health Care Facilities to Adopt the Following Conservation Measures:

(1) Reduce laundry usage or services by changing bed linen, etc., only where necessary to preserve the health of patients or residents.

(2) Use disposable food service items.

(3) Eliminate, postpone, or reduce, as may be appropriate, elective surgical procedures during the period of the emergency.

WATER-SAVING DEVICES

Toilet Devices (Retrofit)

Note: Do not use a brick or other item which may crumble, causing damages and leaks.

- Water Bag*
- Plastic Bottle*
- Plastic Dam*
- Dual Flush Mechanism*
- Weighted Tank Ball
- Flap-Type Flush Valve*
- Improved Float Assembly*

Toilets (new installations)

- Shallow Trap Toilet
- Pressurized Toilet Tank
- Compressed Air Toilet
- Vacuum Toilet

Shower Devices

- Shower Flow Restrictor*
- Shower Shut-off or Control Valve*
- Flow Control Showerhead
- Automatic Shut-Off Valve
- Thermostatic Mixing Valve
- Pressure-Balancing Mixing Valve
- Air-Assisted Shower

Faucet Devices

- Flow Control Faucet
- Faucet Flow Control Valve
- Faucet Flow Restrictor
- Faucet Aerator*
- Spray Tap
- Thermostatic Mixing Valve
- Automatic Shut-Off Valve

ater-Saving Appliances

- Front Loading Washer
- Variable Water Level Control
- Suds-Saver Feature
- Cycle-Adjusted Dishwasher

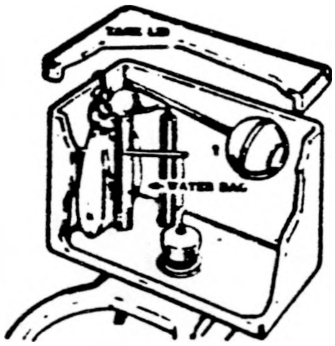
Miscellaneous Devices

- Hot Water Pipe Insulation
- Pressure-Reducing Valve

*See Pictures (following)

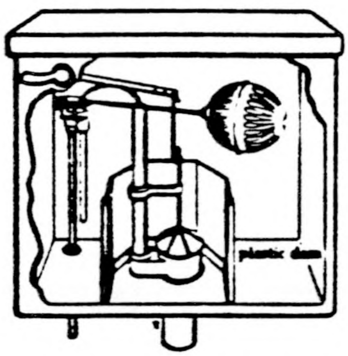
WATER-SAVING DEVICES FOR TOILETS

WATER BAG



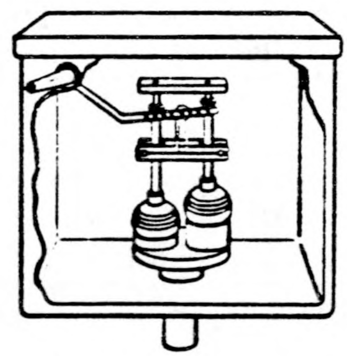
PLASTIC BOTTLE

PLASTIC DAM



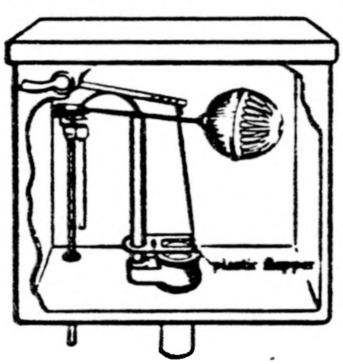
A small plastic dam installed around the flush valve reduces the amount of water flowing from the flush tank into the toilet bowl without reducing the force with which it flows.

DUAL FLUSH MECHANISM



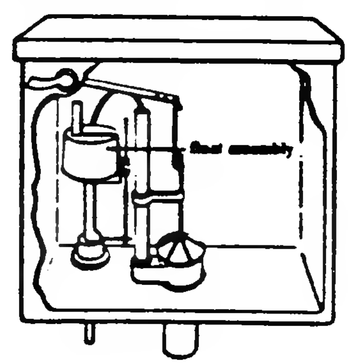
A dual flush mechanism permits a full flush to remove solids if the trip handle is moved in one direction, and a partial flush for liquid wastes if moved in the other direction.

FLAP-TYPE FLUSH VALVE



A "flap" type of flush valve replaces the flush ball and its system of wires and guides. Bent or binding guide wires are a major cause of flush ball leaks.

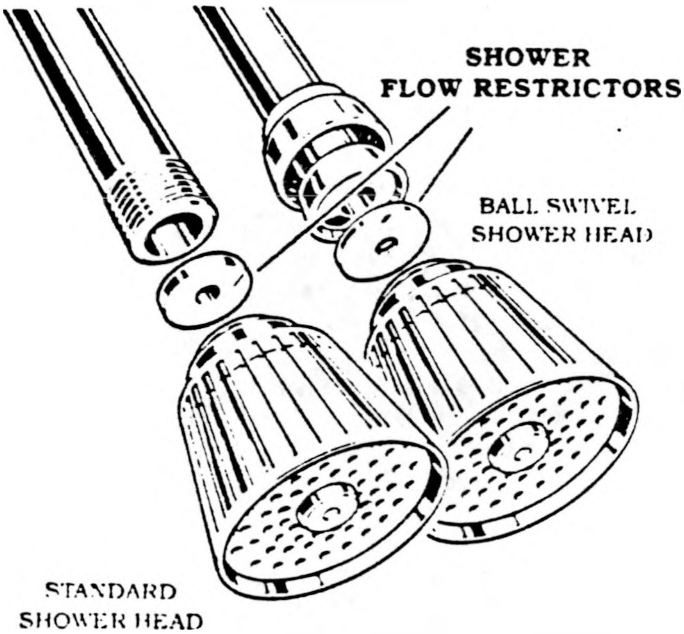
IMPROVED FLOAT ASSEMBLY



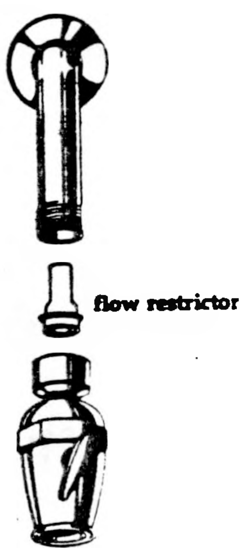
An improved float valve refills more rapidly and signals the presence of a leak at the flush ball.

SHOWER AND FAUCET WATER CONSERVATION DEVICES

SHOWER FLOW RESTRICTOR (example A)



SHOWER FLOW RESTRICTOR (example B)

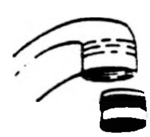


SHOWER CONTROL VALVE

- Chrome-plated brass shower control valve that cuts water useage by 60%.
- Fits all shower heads, including hand held-massaging units.

SHOWER SHUT-OFF VALVE

FAUCET AERATOR



- Chrome-plated brass aerator with stainless steel screen.
- Flow rate will not exceed 2.75 gpm at 80 psi.
- Saves up to 60% in energy and water.

Source: TVA, 1986

WATER CONSERVATION FACTSHEET NO. 1

WHAT IS WATER CONSERVATION?

Water conservation is the wisest and best use of available water resources—it is the act of protecting water from loss or contamination so it can be used for desired purposes. With both water usage and costs for treatment and distribution increasing, water is not always in the right place at the right time. Water conservation is a practical and necessary alternative to expansion of treatment and distribution systems for meeting our water needs. The increased demand placed on the available water has reached a point where we have to realize that our water resources are limited. The time has come for all of us to treat this renewable but limited resource with care. A clean and abundant supply of good quality water is a key resource to support public health and economic growth and development in the Valley and throughout our country.

WHAT ARE SOME REASONS FOR SAVING WATER?

ECONOMY—The cost of treating and delivering safe drinking water to your home is constantly increasing. Saving water will save money for you and your community. With less water usage, fewer chemicals are needed for purification, operating costs are lower for both water and sewage treatment plants, and expansion of these plants to provide adequate capacities is needed less frequently.

REDUCTION OF POLLUTION—Water used in homes and businesses eventually makes its way to wastewater treatment plants. When you cut down on your use of water, you automatically reduce the volume of wastewater reaching the treatment plant or your septic tank. This reduces the possibility of pollution from overloading these facilities.

SAVING OF ENERGY—Significant quanities of energy are used to heat water for residential and commercial use. Next to home heating, the greatest use of residential energy is heating water. Large amounts of energy are used to operate pumps to move water from place to place, to extract groundwater, to pressurize distribution systems and to pump and treat the resulting wastewater flows. Increased water-use efficiency can have significant impact on energy use.

WHAT ARE SOME WAYS TO SAVE WATER?

INSTALL WATER-SAVING DEVICES—The growing awareness and concern for water supply problems has prompted plumbing manufacturers to introduce new devices and redesign existing products for more efficient water use. These water-saving products help eliminate waste by allowing only the necessary amounts of water to be used at the plumbing fixture without seriously changing the user's comfort or satisfaction. Water conservation devices make it easy to conserve water because once installed they save water with little effort on the user's part.

CHECK YOUR PLUMBING. Start your water conservation habits at home with the following suggestions:

1. Repair all leaky faucets, and be certain they are turned off tight when not in use. Don't forget outside faucets as well.

2. Place laundry bluing or food coloring in the toilet tank reservoir after it is filled and watch for its appearance in the bowl to check for leaks. Do not flush while testing. Also, listen for the sound of running water.

3. When a hose is used and left connected to an outside faucet, don't depend on the hose nozzle to cut the water off—turn off the faucet instead.

4. If an underground leak is suspected, call the utilities department and request they send a representative to check the situation.

5. Excessive water pressure can cause leaking pipes, dripping faucets, appliance breakdown, and "pushes" more water than is necessary out of outlets and fixtures. If you suspect high water pressure, have the pressure checked by the utilities department or a plumber. For household purposes, 50-60 pounds per square inch pressure is adequate. If your pressure is excessive, get a plumber to install a pressure-reducing valve.

MEET YOUR WATER METER. Your water meter can help keep track of the amount of water you use and is also helpful in detecting leaks. To be able to do this, learn how to read your water meter.

CHANGE TO GOOD WATER USE HABITS. Most water users are unaware of the amount of water they use in an average day of ordinary living. Of the average 100 gallons per person per day used in a community, about 80 gallons involve home use. Most of this home use is in the bathroom—33 gallons for flushing the toilet and 30 gallons for bathing.

WATER CONSERVATION FACTSHEET NO.2

WHAT ARE SOME HELPFUL WATER SAVING TIPS FOR THE HOME?

BATHROOM

1. Showers—Limit showers to approximately four minutes. Take only seconds to wet your body—turn off the water, "soap up," then turn on the water for a good rinse. A four minute shower may use about 20 to 40 gallons. A longer shower could use 100 gallons or more.

2. Bathtub—Don't waste cold water—Stopper tub before turning on water. Initial cold water can be warmed by adding hot water later. Small kids can go in together. Consider recycling bath water (if not too dirty) for heavy cleaning jobs.

   Don't overfill tub—A full tub holds 50+ gallons. You can bathe adequately with one quarter as much. Clean tub while you are in it. Mark height of water with tape during bath. Next time, take shower with tub stoppered and compare water level.

3. Bathroom Sink—Shave and brush teeth the water-saving way—Clean razor and toothbrush with an occasional burst of water. For teeth, use cup to rinse. Try an electric razor—uses electricity but saves water, soap, laundry, and blades.

5. Toilet—Flush less often—Flush only feces, urine, and toilet paper. Use waste container for tissue, trash, hair, paper towels, paper diapers, etc. Be sure not to flush more often than necessary.

   Add bottles to tank—Use plastic bottles filled with water and weighted with pebbles to displace water in the tank. Be sure not to obstruct float. DO NOT USE BRICKS. They may flake and clog tubes and valves and, if dropped, could crack tank.

6. Hair Washing—Combine this chore with a shower or tub bath.

KITCHEN

1. Kitchen Sink—Clean vegetables and fruit efficiently—Use vegetable brush for fruits and vegetables. If you have a hand sprayer, use it sparingly with short bursts of water.

   Defrost without water—Plan ahead to thaw frozen foods and ice trays in the air when possible.

   Handwash efficiently—Scrape dishes with paper napkins from meal. Rinse all at once. Soak pots and pans overnight if very dirty. Cut down on cleanup by serving more single dish meals.

2. Dishwasher— Use it efficiently—Preclean dishes with paper napkins from meal. Soak pots and pans overnight if necessary. Wash only full loads. Experiment to discover the least possible detergent necessary. This will cut down suds residue.

3. Garbage Disposal—Use as little as possible—If you know a dog, cat, horse, hamster, pig, etc., your garbage can be their food. Start a compost pile. Use the garbage can.

4. Drinking Water—Promote water conservation at the table—Don't let the waiter bring water unless you request it. Discourage automatic refilling of empty water glasses. Use paper cups at drinking fountains whenever possible to avoid water waste.

   Keep a bottle of drinking water in refrigerator—Don't run the tap waiting for cold water without collecting for other use. Make only the amount of coffee or tea you are going to drink. Use ice cubes to cool water. Recycle leftover drinking water.

5. Household Cleaning—Use less water—Recycled water is great for heavy cleaning followed by clean rinse. Use least possible soap or cleaning agent. To cut down on rinse water, presoak.

LAWN AND GARDEN

1. Lawn—Make every watering count—Water slowly, thoroughly, and as infrequently as possible. Water at night to minimize evaporation. Keep a close watch on wind shifts while using sprinklers. "Aerate" the lawn. Avoid watering during hot windy days. Early morning is the best time for sprinkling.

2. Practice water-saving horticulture—Select hardy species that don't need as much water. (Try native plants.) Mulch heavily. Let grass grow higher in dry weather—saves burning and saves water.

WATER CONSERVATION FACTSHEET NO.3

SAVINGS FROM CHANGES IN PERSONAL HABITS

	NORMAL USE	CONSERVATION USE
shower	water running 25 gal. (4 minutes)	wet down, soap up, rinse - 4 gal.
toothbrushing	tap running 10 gal.	wet brush, rinse briefly - 0.5 gal.
tub bath	full 36 gal.	minimum water level 10-12 gal.
shaving	tap running 20 gal.	fill basin 1 gal.
dishwashing	tap running 30 gal.	wash & rinse in sink or pan - 5 gal.
automatic dishwasher	full cycle 16 gal.	short cycle 7 gal.

Additional Conservation Resource Materials

Channing, L. Bete, Inc., 1981. The ABC's of Water Conservation. South Deerfield, MA, pp. 15.

INTASA, Inc. 1981. Flow Reduction: Developing a Public Information Program. U.S. Environmental Protection Agency, Washington, D.C. pp. 41.

Milne, Murray. 1976. Residential Water Conservation, Report No. 35. California Water Resources Center, University of California. pp. 468.

Mitchell, S; R.L. Crowell and J. Herbert Snyder. 1977. What We Can Do Before The Well Runs Dry. California Water Resources Center, University of California. pp. 10.

New England River Basins Commission. 1980. Before The Well Runs Dry: A Handbook For Designing A Local Water Conservation Plan. Water Conservation Programs Report, Boston, Massachusetts. pp. 95.

Sikora, V. A. and C. S. Bishop. July/August 1980. "Simply Saving Water". The Tennessee Conservationist. Tennessee Department of Conservation. pp. 24-24.

U.S. Water Resources Council. 1980. Water Conservation Planning Guide (Draft). U.S. Water Resources Council, Washington, D.C.

Films:

Our Wealth of Waters. Available from the Tennessee Wildlife Resources Agency, Film Librarian, Ellington Agricultural Center, P.O. Box 40747, Nashville, Tennessee 37204. Film begins with a man dying of thirst, emphyzing the value of water and the problem resulting from its misuse. Junior High - Adult. 26 minutes.

Water Follies. Available from the Tennessee Department of Health and Environment, Health Services Film Librarian, 100 9th Avenue North, Nashville, Tennessee 37219. Film uses cartoon characters to humorously demonstrate uses and abuses of water supply with dishwashers, leaky faucets, lawn watering, showering, car washing, shaving, etc. Children. 7 minutes.

APPENDIX C

DuPage County Plumbing Code Amendment

AN ORDINANCE AMENDING THE DU PAGE COUNTY (ILLINOIS) PLUMBING ORDINANCE ADOPTED SEPTEMBER 14, 1948 AND SUBSEQUENTLY AMENDED

WHEREAS, the regulatory powers under the Building Ordinance of 1948, as amended, provide for building construction and material standards, including the regulation of plumbing materials and installations, and to provide requirements for the disposal of sanitary sewage and,

WHEREAS, from time to time, the County Board of DuPage County, Illinois deems it expedient and in the best interest of the general public to amend the DuPage County Building Ordinance aforesaid;

NOW THEREFORE, BE IT ORDAINED by the County Board of DuPage County, Illinois, that Article 400, DuPage County Plumbing Ordinance, adopted September 14, 1948, and subsequently amended, be amended as follows:

410 G. WATER CONSERVATION

1. Water Use
2. New plumbing fixtures and any replacement plumbing fixtures shall comply with the following standards of water use.
    a. Water Closet-tank type
    residential only--Maximum 3.5 gallons (13.2 liters)/flush.
    b. Water closet-flushometer
    any location--Maximum 3.0 gallons (11.4 liters) per flush.
    c. Urinal-tank type--Illegal
    d. Urinal-floor mounted--Illegal
    e. Urinal-flushometer--Maximum 1.5 gallons (5.7 liters) per flush.
    f. Shower heads--Maximum flow 3.0 gallons (11.4 liters) per minute.
    In all shower rooms intended for public use, the shower heads are to be serviced by metering self-closing control valves whose cycle is not to exceed 60 seconds. Thermostatically controlled water at a temperature not to exceed 105oF (40oC) is to be provided each shower head.
    g. Lavatory Sink Faucets--Maximum flow 3.0 gallons (11.4 liters) per minute.
    The maximum flow rate for lavatory faucets is measured with both hot and cold water supply fully opened. When installed for public use, these shall be metering self-closing type.
    h. Water Softeners
    No residential water softeners may use more than 75 gallons (285 liters) during the entire regeneration cycle, and size to cycle no more than 3 times per week.

i. Special Fixtures
Special purpose plumbing fixtures and appurtenances where necessary, may be exempt from these requirements upon request and approval of the Director of the Building Department.

j. Industrial and Business Uses
Technical information on water usage of other than the above noted plumbing fixtures shall be indicated including demand, rate of demand, amount lost and amount re-circulated.

FURTHER, all Ordinances or parts of Ordinances in conflict with this Ordinance are hereby repealed to the extent of such conflict.

BE IT FURTHER ORDAINED that this Ordinance shall be in full force and effect after ten (10) days of its passage and due publication.

Dated at Wheaton, Illinois, this 19th day of July, A.D., 1977.

APPENDIX D

WATER SHORTAGE ORDINANCE

WATER SHORTAGE ORDINANCE

SECTION I: DECLARATION OF POLICY, PURPOSE, AND INTENT

Purpose: To achieve the greatest public benefit from domestic water use, sanitation, and fire protection, and to provide water for other purposes in an equitable manner, (name of municipality) adopts the following regulations and restrictions on the delivery and consumption of water.

This Ordinance is hereby declared necessary for the preservation of public health, safety, and welfare and shall take effect upon its adoption by (name of municipality) .

Whenever, in the judgment of the governing body of (name of municipality) comes necessary to conserve water in the service area, due to drought, (name of municipality) is authorized to issue a Declaration that existing conditions prevent fulfillment of the usual water-use demands. The Declaration is an attempt to prevent depleting the water supply to the extent that water-use for human consumption, sanitation, fire protection, and other essential needs become endangered.

Immediately upon the issuance of such a Declaration, regulations and restrictions set forth under this Ordinance shall become effective and remain in effect until the water shortage is terminated and the Declaration rescinded.

Water uses, regulated or prohibited under this Ordinance are considered to be non-essential and continuation of such uses during times of water shortage are deemed to constitute a waste of water, subjecting the offender(s) to penalties (SECTION VIII).

The provisions of this Ordinance shall apply to customers of (name of municipality) .

SECTION II: DEFINITIONS

For the purposes of this Ordinance, the following definitions shall apply:

Conservation: reduction in water use to prevent depletion or waste of the resource.

Customer: any person, company, or organization using water supplied by the (name of municipality) .

Domestic water use: water use for personal needs or for household purposes such as drinking, bathing, heating, cooking, sanitation, including employees' use in business, industry, or institution.

Management Phases:

Conservation: A conservation phase exists when (specify the triggering condition) and has been verified by best available information.

Restrictions: A restrictions phase exists (specify the triggering condition) and has been verified by best available information.

Emergency: An emergency phase exists when (specify the triggering condition) and has been verified by best available information.

Even numbered address: street addresses, box numbers or rural route numbers ending in 0, 2, 4, 6, 8, or letters A-M; and locations without addresses.

Institutional water use: water used by government, public and private educational institutions, public medians and rights of way, churches and places of worship, water utilities, and other lands, buildings, and organizations.

Landscape water use: water used to maintain gardens, trees, lawns, shrubs, flowers, athletic fields, rights of way and medians.

Odd numbered address: street addresses, box numbers or rural route numbers ending in 1, 3, 5, 7, 9, or letters N-Z.

Water Management Advisory Group: a committee composed of local representatives, created for the purpose of coordinating responses to water shortages.

Water shortage: lack of adequate available water to meet normal demands due to lower than normal precipitation, reduced stream flows or soil moisture, water levels in wells which cause water supplies to be less than usual, major water line breaks, chemical spills, etc. resulting in reduced water supplies.

SECTION III: WATER USE CLASSIFICATION SYSTEM

First Class Essential Water Uses

("First Class Essential Water Uses" should correspond to the classification system established in the system's drought and emergency management plan.)

Second Class Essential Water Uses

("Second Class Essential Water Uses" should correspond to the classification system established in the system's drought and emergency management plan.)

Third Class Essential Water Uses

("Third Class Essential Water Uses" should correspond to the classification system established in the system's drought or emergency management plan.)

Non-Essential Water Uses

("Non-Essential Water Uses" should correspond to the classification system established in the system's drought and emergency management plan.)

SECTION IV: MANAGEMENT PHASES

Three levels of water management are established: "Conservation," "Restrictions," and "Emergency." Declarations issued by (name of municipality) shall specify the water management phase in effect and undertake the appropriate water management activities.

A. Drought Alert Provisions and Implementation

When a local, regional or statewide "Drought Alert" is issued by the Tennessee Office of Water Management, (name of municipality) will begin, if not already underway, regular monitoring of supply and demand conditions applicable to (name of municipality). Users of the system will be alerted to the activation possibility of the water shortage management plan. Notice will be made to a newspaper of general circulation within the affected community or area. In addition, (name of municipality) will encourage water users to assess their use of water.

B. Conservation Phase Provisions

If conditions indicate that a moderate water shortage condition is present and is expected to persist, (name of municipality) shall activate those requirements outlined in this section to reduce water use.

1. Goal:

(a) An overall water use reduction of fifteen (15) percent. Voluntary water use reductions would be requested for essential, economic, and social uses.

(b) Non-essential water uses would be banned.

2. General Response:

Issue a Declaration of Water Shortage in a newspaper of general circulation within the affected community and region. This statement shall specify that conservation phase measures are necessary and shall include the list of non-essential water uses.

3. Restrictions Applying to Non-Essential Uses:

(Specify the restrictions that apply to Non-Essential Uses.)

C. Restrictions Phase Provisions

If conditions indicate that a severe water shortage condition is present and is expected to persist (name of municipality) shall activate those requirements outlined in this section to curtail water uses.

1. Goal:

An overall water use reduction of thirty (30) percent. Voluntary water use reductions would be requested for essential uses. Non-essential water uses would be banned, resulting in a 100 percent overall class reduction. Curtailments in Second and Third Class Essential Water uses would be required resulting in a seventeen (17) percent combined class reduction.

2. General Responses:

(a) Issue a Declaration of Water Shortage in a newspaper of general circulation within the affected community and region. This statement shall specify that a Restrictions Phase is in effect and shall include the list of banned uses, and the list of restricted water uses.

(b) Require customers of ___(name of municipality)___ to comply with the listed water-use bans and restrictions in all categories while severe drought conditions exist.

3. Restrictions Applying to Second and Third Class Essential Water Uses:

(Specify the bans and restrictions that apply to Non-Essential, Second and Third Class Essential Water Uses.)

D. Emergency Phase Provisions

If conditions indicate that an extreme water shortage condition is present ___(name of municipality)___ shall activate the provisions outlined in this section to curtail water use.

Water-use restrictions imposed during extreme water shortage conditions are mandatory.

1. Goal:

(a) An overall water use reduction of sixty (60) percent; only First Class Essential water uses would be allowed.

(b) All other water uses would be prohibited.

2. General Responses:

(a) Issue a Declaration of Water Shortage in a newspaper of general circulation within the affected community and region. This statement shall specify that an Emergency Phase is in effect. It shall include the list of banned water uses.

(b) Require customers of (name of municipality) to comply with the listed water-use restrictions in all categories while extreme water shortage conditions exist.

3. Restrictions Applying To Second and Third Class Essential Water Uses:

(Specify the restrictions that apply to Non-Essential, Second and Third Class Essential water uses.)

SECTION V: WATER MANAGEMENT ADVISORY GROUP

The Water Management Advisory Group shall consist of five (5) members, representing various local interest groups. The representatives shall be appointed by administrative body and serve a term of five years. Terms should be staggered, beginning on October 1 of each year. Regular, annual meetings should be held to review the plan, meeting more frequently as necessary upon the onset of each drought.

The Water Management Advisory Group shall evaluate water supply conditions to determine if conditions satisfy water shortage management triggering points as identified in the local drought management plan. The Advisory Group shall consider:

1. the effectiveness of the local water shortage ordinance and plan in protecting and insuring adequate water supplies,
2. water supply conditions (existing and forecasted), and
3. other relevant information.

The Water Management Advisory Group shall consult with and invite participation by the general public affected, as well as with interest group representatives.

SECTION VI: SHORTAGE WATER RATES (STAND-BY RATES)

Upon the declaration of a water shortage, (name of municipality) shall utilize shortage water rates to water conservation of water supplies. (Such rates may provide for, but not be limited to: (a) higher charges per unit for increasing usage (increasing block rates); (b) uniform charges for water usage per unit of use (uniform unit rate); (c) extra charges for use in excess of a specified level (excess demand surcharge); or (d) discounts for conserving water beyond specified levels. This ordinance includes an example of an "excess use or surcharge" structure.)

In the event of a water shortage and activation of the "restrictions" phase, the (name of municipality) is hereby authorized to monitor water use and limit households to 70 gallons per household member per day. Domestic water use above this limit will be subject to a surcharge of $25.00 per 1000 gallons. The (name of municipality) is hereby authorized to monitor water use and limit households to 40 gallons per household member per day under an "emergency" phase. Domestic water use above this limit will be subject to a surcharge of $50.00 per 1000 gallons. Institutional, commercial, industrial, and recreational water users will be subject to water use surcharges of $100.00 per 1,000 gallons of water used if the (name of municipality) deems that adequate conservation measures have not been implemented.

SECTION VII: RATIONING

(Water Supply Systems relying on rationing to reduce water use will need to include a section in their ordinance dealing with rationing.)

In the event of a declared drought (name of municipality) issues a Declaration of Water Shortage specifying either a Restrictions phase or Emergency phase (name of municipality) is hereby authorized to ration water in accordance with the following conditions:

Residential Water Customers and Allotments

(1) The number of permanent residents in each dwelling unit (household) will determine the amount of water that each household will be allowed.

(2) Each dwelling unit (household) shall be allotted 70 gallons per day for each resident of the household under "restrictions" and 40 gallons per day for each resident of the household under "emergency" conditions. Households with only one permanent resident will have a daily allotment of 55 gallons per day under "emergency" conditions.

(3) Residential water customers are required to provide city utility personnel with reasonable access to read meters as necessary to this rationing declaration. Where access is not readily available, all reasonable efforts to contact customers in order to arrange for access to read meters shall be made. In the event a water customer does not allow entry to read the meter after reasonable efforts to arrange for such access, the dwelling unit (household) allotment will be reduced to 55 gallons per day.

(4) (i) Where the residential water allotment provided under this section would create an "extraordinary hardship," as in the case of special health-related requirements, the water customer may apply to the water system for an exemption or variance from these requirements. If it is found that the allotment provided in this section would impose an extraordinary hardship, a revised allotment for the particular customer may be established.

(ii) Any person aggrieved by a decision relating to such an exemption or variance rendered by the municipality rendering water service, may file a complaint with the (name the appropriate body). (The procedures for such a complaint may be described here).

Non-Residential Water Customers and Allotments

Non-residential customers include commercial, industrial, institutional, public and all other such users, with the exception of hospitals and health care facilities.

Non-residential water customers shall further reduce their water usage to fifty (50) percent of use levels of (specify month and year) .

It is the primary responsibility of each non-residential water customer to meet its mandated water use reduction goal in whatever manner possible.

The (name of municipality) will establish a water allotment for each non-residential water customer, based upon a required further reduction of water usage from the rate of water used by the customer in effect on (date), or the last recorded use level if no meter readings record the rate of the customer's use on (date).

Each non-residential water user shall provide access to water system personnel for purposes of meter reading and monitoring of compliance with this ordinance. All reasonable efforts will be made to contact customers to arrange for access.

If the mandated further reduction in water usage cannot be obtained without imposing extraordinary hardship which threatens health and safety, the non- residential customer may apply to the water system for a variance. For these purposes "extraordinary hardship" means a permanent damage to property or economic loss which is substantially more severe than the sacrifices borne by other water users subject to this water rationing ordinance. If the further reduction would cause an extraordinary hardship or threaten health or safety, a variance may be granted and a revised water use reduction requirement for the particular customer may be established.

(The municipality may need to specify in its ordinance that any person aggrieved by a decision relating to such a variance rendered by a public utility may need to file a complaint with the appropriate body. The procedures for such a complaint may be described here.)

Water Use Rationing for Hospitals and Health Care Facilities

Hospitals and health care facilities shall comply with all restrictions imposed on residential and non-residential water customers as may be applicable to each individual institution, to the extent compliance will not endanger the health of the patients or residents of the institution.

Each hospital or health care facility shall survey its water usage patterns and requirements and implement such additional conservation measures as may be possible without endangering the health of its patients or residents to achieve a further reduction in the institution's water usage.

SECTION VIII: FINES AND PENALTIES (FAILURE TO COMPLY)

Except as otherwise stated herein, violators of any provision of this Ordinance shall be penalized. The penalty for a person's first offense shall be $100. The penalty for a person's second offense shall be $200. Persons violating this ordinance a third or more times within the same drought period will have water service disconnected for a period of five (5) days with a $300 reconnection fee.

The aforementioned fines and penalties may be in lieu of, or in addition to, any other penalty provided by law.

Services disconnected under such circumstances shall be restored only upon payment of a reconnection charge.

SECTION IX: MONITORING AND ENFORCEMENT

Law officers of the (name of municipality) police force shall, in addition to duties imposed by law, diligently enforce the provisions of this Ordinance.

Employees of (name of municipality), Department of Public Works, and fire department have the duty, and are hereby authorized to enforce the provisions of this Ordinance and shall have the power and authority to issue citations when violations of this Ordinance occur during any declared drought.

SECTION X: VARIANCES (RELIEF FROM COMPLIANCE)

Customers not capable of reducing water use immediately, because of equipment damage or other extreme circumstances, shall reduce water use within twenty-four hours of a declaration of a water shortage, where provisions of this ordinance apply to them and shall apply for a variance from curtailment.

Customers requesting exemption from the provisions of this Ordinance shall file a petition for variance with (name of body) within three (3) days after such curtailment becomes effective.

When the Ordinance has been invoked by the (name of position), all petitions for variances shall be reviewed by the (name of body). When the Ordinance has been invoked by the (name of position), persons using less than 25,000 gallons of water per day shall file a petition for variance with the (name of body), and persons using in excess of 25,000 gallons of water per day shall file a petition for variance with the (name of appropriate body) within three (3) days of the effective date of water use curtailment or reduction. The (name of appropriate body) shall respond to requests for variance within five days of receipt of information or within twenty days of declarations of the curtailment, whichever comes first. Petitions shall contain the following:

A. Name and address of the petitioner(s).
B. Purpose of water use.

C. Specific provision from which the petitioner is requesting relief.
D. Detailed statement as to how the declaration adversely affects the petitioner.
E. Description of the relief desired.
F. Period of time for which the variance is sought.
G. Economic value of the water use.
H. Damage or harm to the petitioner or others if petitioner complies with Ordinance.
I. Restrictions with which the petitioner is expected to comply and the compliance date.
J. Steps the petitioner is taking to meet the restrictions from which variance is sought and the expected date of compliance.
K. Other pertinent information.

In order for a variance to be granted, petitioner must show one or more of the following conditions:

A. Compliance with the Ordinance cannot be technically accomplished during the duration of the water shortage.
B. Alternative methods can be implemented which will achieve the same level ofreduction in water use.
C. An extraordinary hardship can be shown.

The (name of municipality) may, in writing, grant temporary variances for existing water uses otherwise prohibited under the Ordinance if it is a condition adversely affecting health, sanitation, or fire protection for the public or the petitioner and if one or more of the aforementioned conditions is met. The governing body of (name of municipality) shall ratify or revoke any such variance at their next scheduled meeting. Any such variance so ratified may be revoked by later action of the governing body of (name of municipality).

No variance shall be retroactive or otherwise justify any violation of this Ordinance occurring prior to the issuance of the variance.

Variances granted by (name of appropriate body) shall be subject to the following conditions, unless waived or modified by (name of appropriate body).

A. Variances granted shall include a timetable for compliance.
B. Variances granted shall expire when the water shortage no longer exists.

SECTION XI: ACTIVATION AND DEACTIVATION OF MANAGEMENT PHASES

Declaration of a Drought. Whenever the (name of municipality) finds that a potential shortage of water supply is indicated, it shall be empowered to declare a drought exists, and that the water superintendent shall, (specify daily or other basis), monitor the supply and demands upon that supply. In addition, the mayor (or his/her agent) is authorized to specify the management phase in effect and the measures to be employed by the system's customers. This Declaration shall be published in an official city newspaper, and may be publicized through the general news media or any other appropriate method for making such resolutions public.

Termination of Drought Phases. Whenever (name of municipality) finds that water supplies have returned to normal, it shall be empowered to replace or declare as ended by resolution any phase enacted. Such a declaration shall follow the same guidelines used for declaring a drought.

SECTION XII: STATUS OF THE ORDINANCE (ADOPTION, SEVERABILITY AND EFFECTIVE PERIOD)

Severability. If any provision of this ordinance is declared unconstitutional, or the application thereof to any person or circumstance is held invalid, the constitutionality or validity of the remainder of the ordinance and its applicability to other persons and circumstances shall not be affected thereby.

Effective Date. This ordinance shall take effect immediately upon adoption by (name of municipality) .

Effective Period. This ordinance will remain in effect until terminated by action of (name of municipality) .

Passed by the City (council or commission) this ________________ day of __________________________, 19 _____.

____
(Mayor's Signature)

ATTEST:

____
(City Clerk's Signature)

APPENDIX E

SAMPLE PRESS RELEASE AND DECLARATIONS

SAMPLE DECLARATION FOR ACTIVATING DROUGHT MANAGEMENT

WHEREAS, the (city/town/utility district/etc.) has not received any appreciable precipitation during the past ___________ consecutive days; and

WHEREAS, the (city/town/etc.) is now experiencing (severe/extreme) drought conditions; and

WHEREAS, there is every indication that the present drought situation will not abate in the near future; and

WHEREAS, these conditions may in fact become even more (severe/extreme); and

WHEREAS, extraordinary cooperation and support are necessary to insure public safety, protect the general welfare and mitigate the impact of the drough situation.

NOW, THEREFORE, (I/we), ______________________________ do hereby proclaim a state of drought to exist. Further, I/we fully support the water conservation measures (recommended/imposed) by the ________________________________ and encourage local acceptance and compliance. Further, I/we have authorized the use of all agencies, personnel and facilities within my/our authority to address the needs of those affected by the drought and to mitigate its effect.

Note: Signing a proclamation, such as that above, or other such endorsement by the mayor or county commissioners lends official local support to the Drought Management Plan.

SAMPLE

PRESS RELEASE

Mayor ______________________________ today called upon (city, county, etc.) residents to conserve water as drought conditions continue.

"It is time for residents to avoid unnecessary use of water--sprinkling lawns, washing cars and other optional uses that are not essential," Mayor ________________________ said. "There is not yet a water emergency, but without substantial improvement in supplies soon we are not far away from it."

"Intelligent, careful use of our water resources will help the system to maintain sufficient supplies to meet essential needs."

SAMPLE

PRESS RELEASE

CONTACT: ______________________
Name

TELEPHONE: ______________________

(Community Name), Tennessee--Due to the recent abnormally dry weather conditions and little indication of significant rainfall in the foreseeable future, (resident's or customers) of ________________ (community or system's name) should begin conserving water, according to ______________________ (appropriate local or water official). For the month(s) of _______________, (community or area name) received only __________ percent of normal rainfall for the comparable period. The 30-day outlook from the National Weather Service calls for more abnormally dry weather (modify to reflect actual outlook).

At this time, there is an immediate need to begin conservation phase measures by those served by the ______________ water system. (List measures having greatest benefit to the community.) All non-essential uses of water are banned. Non-essential uses include water-sprinkling lawns, non-commercial washing of cars, filling and/or making-up water in private swimming pools serving less than 25 dwelling units and make-up water to foundations and reflecting pools. (Residents or customers) are urged to cooperate.

SAMPLE

PRESS RELEASE

Mayor (City Manager, etc.) ______________ today called on residents to conserve water as drought conditions continue.

"It is time for residents to avoid unnecessary use of water-sprinkling lawns, washing cars and other optional uses that are not essential," Mayor ___ __________ said. A Water Restrictions phase is not yet necessary but without substantial improvement in supplies soon we are not far away from it."

"Intelligent, careful use of our water resources will help the system to maintain sufficient supplies to meet essential needs."

SAMPLE

PRESS RELEASE

The (Mayor or City Manager) of ________________ on ______________(date) declared a need for water use (name phase) for the (city/town/utility district/etc.) of _________________. The drought situation has continued to deteriorate. The (city/town/utility district/etc.) of _______________ is now experiencing (severe/extreme) drought conditions, and the drought situation could become critical if restrictions phase measures are not implemented:

(List water-use measures for appropriate drought phase.)

The following enforcement procedures will be utilized should they become necessary:

(List options available.)

SAMPLE

PRESS RELEASE

CONTACT: ______________________________
Name

TELEPHONE: ______________________________

.

____________________, Tennessee--Due to recent improvements in water supplies, ____________________ (appropriate local official) informed customers of ____________________ (community or system) that they can discontinue water (name of phase) today. ____________________ phase measures will remain in effect in order to prevent a recurrence of extreme shortage conditions and until water supplies return to normal.

__________________ (official) thanked residents for their cooperation in conserving water over the past _______ weeks.

SAMPLE

PRESS RELEASE

______________________ (name of town) is currently experiencing abnormally dry conditions, and relief to supplies during the next few (weeks/days) does not look favorable. Although the situation has not yet reached critical stage, the following water use (conservation) measures are (encouraged; must be taken).

(List water use measures for appropriate drought phase.)

Precautionary measures taken now may mean less drastic steps will be needed in the future should drought conditions continue unabated.

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Appendix F

TENNESSEE VALLEY AUTHORITY

Office of Natural Resources and Economic Development

LOCAL DROUGHT MANAGEMENT PLAN FOR NORRIS, TENNESSEE

May 1988

TENNESSEE VALLEY AUTHORITY

Office of Natural Resources and Economic Development

LOCAL DROUGHT MANAGEMENT PLAN FOR NORRIS, TENNESSEE

Prepared by the

Division of Air and Water Resources

With Assistance From the

Tennessee Office of Water Management

and

Norris Water Commission

May 1988

ACKNOWLEDGMENTS

This plan was prepared by Stanley J. Wentz of the Tennessee Valley Authority (TVA), Office of Natural Resources and Economic Development, Division of Air and Water Resources, Flood Protection Branch, through TVA's Regional Water Management Program with assistance from the Tennessee Office of Water Management (TOWM) and Norris Water Commission (NWC). Special appreciation is extended to TVA's Engineering Laboratory (James W. Ferrell, Sr., and J. B. Perry), TOWM's Knoxville Regional Office (Debbie Hines), and NWC's Superintendent (Benny Carden) for their cooperation and assistance in providing the basic information and data used in developing the plan. Also, a special thank you to the following entities who assisted in the editing and review of the plan: TOWM (James W. Haynes, Lee Keck, and Jack Tompkins) and TVA (Larry R. Clark and James H. French).

EMERGENCY OPERATIONS PROCEDURE FOR DROUGHT MANAGEMENT

This procedure was developed through a joint, cooperative effort involving the Tennessee Valley Authority, Tennessee Office of Water Management, and Norris Water Commission. Essentially, it outlines a plan of action to be followed by the Commission and system personnel in dealing with drought-related water supply shortages. Summarized below is a list of the basic steps or actions to be followed by the Norris Water Commission to monitor the system's potential for drought-related water supply shortages and negate or minimize the adverse effects of these shortages.

1. Assess and monitor the system's water supply/use relationship on a continuing basis including such factors as precipitation, temperature, reservoir and groundwater levels, daily and peak water use, etc.

2. Identify the conditions such as precipitation, reservoir and groundwater levels, temperature, etc., which would signify the existence of drought-like conditions and potential for drought-related water supply shortages in the area served by the system.

3. Analyze the system's infrastructure condition and determine its adequacy to meet existing and near-term water demands in light of existing and possible water supply/use conditions. This should be done from the standpoint of both quantity and quality.

4. Establish the appropriate mechanisms (public information/education, enforcement powers, ordinances, etc.) to (a) increase the public's awareness of Norris' water supply situation and the potential for drought and (b) facilitate implementation of the needed actions when supply shortages do occur, in a timely and orderly manner, with the public's full cooperation and support.

5. Identify and analyze alternative sources of supply and select one or more supply alternatives which could most readily be utilized by the system during a drought period. To the extent possible, the system should do everything it can in advance of any shortages to facilitate the utilization of those alternative sources of supply as quickly and efficiently as possible.

6. Implement, when appropriate, the actions specified below under each drought stage delineated in Norris' local drought management plan to reduce water use.

   - "Conservation Phase". This phase, requiring a 15 to 20 percent reduction in water use, would be implemented when the annual precipitation at Norris' water treatment plant dropped below 50 percent of normal for an average year or the overflow from Clear Creek Spring ceased entirely. Under the "conservation" phase, the Norris Water Commission would:

     a. Encourage homeowners to install water-saving devices and repair household leaks.

b. Reduce water sales to the Andersonville Utility District from 153,000 GPD (1987 average daily purchase) to 130,000 GPD.

c. Request all of its customers to conserve water voluntarily.

- "Restrictions" Phase. Assuming an average flow of 380 gallons per minute (GPM) for Clear Creek Spring, this phase, requiring a 30 to 40 percent reduction in water use, would be implemented when spring flows decreased to 235 GPM. Under the "restrictions" phase, the Commission would:

a. Require mandatory water conservation for all nonessential and "second and third class" essential water uses.

b. Reduce water sales to the Andersonville Utility District from about 153,000 GPD (1987 average daily purchase) to 100,000 GPD.

c. Install pressure-reducing devices in the system's main lines and enforce the levying of fines or penalties for excessive water use.

- "Emergency" Phase. This phase, requiring a 60 percent or greater reduction in water use, would be implemented when spring flows fall to 150 GPM or less. Under the "emergency" phase, the Commission would:

a. Expand mandatory water conservation to include all "first class" essential water uses and continue enforcement measures to reduce water use.

b. Reduce water sales to the Andersonville Utility District from about 153,000 GPD (1987 average daily purchase) to 75,000 GPD.

c. Install an emergency water intake in the Clinch River at mile 78.11 to supplement the available supply from Clear Creek Spring.

LOCAL DROUGHT MANAGEMENT PLAN FOR NORRIS, TENNESSEE

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INTRODUCTION

During the summer of 1986, the town of Norris experienced serious water supply concerns due to a decrease in flow from Clear Creek Spring, its only source of supply, from an estimated average flow of 380 to 230 gallons per minute (GPM). This flow was one of the spring's lowest since the 1953-1954 drought. Although serious water supply shortages were averted, the Norris Water Commission did find it necessary to (1) reduce the amount of water sold to the Andersonville Utility District and (2) issue notices to all of its customers requesting their voluntary cooperation in the conservation of available water supplies by not watering lawns or washing cars.

In view of the continuing drought-like conditions, which extend back to the summer of 1984, the Commission, with assistance from the Tennessee Office of Water Management and the Tennessee Valley Authority, has developed a local drought management plan for Norris' public water supply system. This plan was developed in accordance with the general guidance and direction provided in Tennessee's Interim State Drought Management Plan published in January 1987 and the Local Drought Management Planning Guide for Public Water Suppliers published in 1988 by the Tennessee Department of Health and Environment, Office of Water Management. More specifically, the development of drought management plans for local communities is mandated in Tennessee's Safe Drinking Water Act, Tennessee Code Annotated (T.C.A.), Section 68-13-710; Water Quality Control Act, T.C.A., Section 69-3-109(b); Civilian Defense Act, T.C.A., Sections 58-2-101 through 58-2-518; and Executive Order No. 4 (Keck, January 1987).

PLAN PURPOSE AND GOALS

The purpose of this plan is to delineate a course of action to be followed by the Norris Water Commission and system superintendent in dealing with drought-related water supply shortages to limit the adverse effects of drought on the system's customers. More specifically, the plan will help system personnel to:

1. Assess the system's situation relative to the source capacity of its source of supply, hydraulic limitations of the system, average daily and peak water use by type of customer, potential water quality problems, and alternative sources of supply.

2. Delineate a procedure, including the identification of key "trigger" points or conditions, for monitoring local water use/supply relationships in the Norris public water supply system during drought periods.

3. Identify specific drought stages, i.e., percent reductions in available water supplies, at which certain actions will be taken.

4. Implement specific actions and measures at the appropriate time(s) to facilitate the system's timely and orderly resolution of drought-related water supply shortages.

The basic goals of this plan are to:

1. Provide for the equitable and fair distribution of water during drought conditions to minimize adverse economic, environmental, social, and health-related impacts and ensure that local circumstances are recognized and critical needs are met.

2. Establish a viable basis for the implementation of pertinent drought-related water supply management decisions.

3. Delineate specific actions and measures that will be taken to alleviate drought-related water supply shortages.

OVERVIEW OF PLAN ELEMENTS

This portion of the plan describes briefly the basic information and/or data contained in each of the plan's basic elements or sections.

1. Introduction. A brief description of the basic rationale for and authority under which Norris' local drought management plan was developed.

2. Plan Purpose and Goals. A brief statement describing the plan's overall purpose and its basic goals and objectives.

3. Overview of Plan Elements. An overview and description of the basic information and data contained in each section or plan element.

4. Agency Roles and Responsibilities in Plan Development and Implementation. This section delineates the roles and responsibilities of local, state, regional, and Federal agencies in dealing with drought-related water supply shortages.

5. Public Education and Involvement in Plan Maintenance and Implementation. This section of the plan describes the basic elements of an effective public education program and identifies alternative methods for use by Norris in educating and sharing drought-related information with the public.

6. Description of the Norris Public Water Supply System. A thorough description of Norris' public water supply system infrastructure, its source of supply and average daily and peak water use, and the quality of existing water supplies.

7. System to Monitor Available Water Supplies and Determine the Potential for Drought-Like Conditions to Occur. This portion of the plan describes the system and key environmental factors or conditions to be used by Norris in monitoring and evaluating the quantity and quality of existing water supplies to facilitate the declaration of a drought alert and potential water supply shortages during drought periods.

8. Phased Responses to Reductions in Supply. A description of the specific phases or levels of service, i.e., varying degrees of water supply shortages, at which selected program actions and measures are implemented to deal with supply shortages.

9. Water Use Priorities. This section of the plan establishes local priorities for water use by classifying local users into four basic groups: essential (first, second, and third class) and nonessential uses.

10. Identification and Evaluation of Alternative Sources of Supply. This part of the plan describes and evaluates the pros and cons of a number of water supply alternatives which the town of Norris could consider utilizing to alleviate water supply shortages.

11. Selected Drought Management Plan for Norris, Tennessee. This portion of the plan identifies a set of specific program actions that will be implemented by the town of Norris to deal effectively with local water supply shortages.

12. Plan Implementation Ordinance No. 359. This section of the plan contains a proposed ordinance which passed the first of three readings by the Norris Water Commission on May 9, 1988. This ordinance authorizes the Commission to implement specific program actions to resolve or mitigate water supply shortages.

13. Plan Enforcement. This part of the plan describes the procedure that will be used by the Norris public water supply system to enforce the implementation of specific program actions.

14. Plan Update and Revision. This portion of the plan indicates the need for periodic plan revision and update to reflect changes in existing water use/supply conditions.

15. Plan Recommendations. Summary compilation of the plan recommendations contained in the preceding sections of the plan.

16. Plan Glossary. This part of the plan contains the definition of key terms which are utilized in the plan.

17. Selected References List. This section includes a bibliographic listing for all reference and resource materials which were used in the preparation of Norris' local drought management plan.

AGENCY ROLES AND RESPONSIBILITIES IN PLAN DEVELOPMENT AND IMPLEMENTATION

Generally, water supply shortages can be addressed and resolved most effectively at the local and/or regional level of government. However, state and Federal agencies also have an important role to play in providing for the effective use of a community's available public water supplies, particularly during periods of severe and extended drought conditions. While specific agency roles and responsibilities relative to the development and implementation of Norris' local drought management plan, particularly the local role, are indicated in the various plan elements, a broad general overview of each governmental entity's role in drought management is presented below. (Keck, January 1987)

Local/Regional Role

The basic roles and responsibilities of local communities, such as the town of Norris, include the following:

1. Develop water shortage or drought management plans which address and are responsive to local problems and circumstances.

2. Evaluate the adequacy and ability of the system's existing infrastructure (distribution system and treatment and storage facilities) to meet existing and future needs and, if necessary, upgrade and/or expand existing infrastructure facilities or develop additional facilities to meet needs.

3. Monitor existing water supply sources and daily water use for specific purposes and anticipate user demands.

4. Identify and monitor potential water use problems and conflicts.

5. Identify and evaluate the pros and cons of a wide variety of alternatives, including other sources of supply, which the community could utilize to deal with potential water supply shortages.

6. Establish specific phases (conservation, restrictions, and emergency) reflecting different levels of water supply shortages at which pertinent program actions would be implemented to deal with the shortages.

7. Establish an effective mechanism for (a) educating and informing the public about drought and local water supply shortages and (b) acquiring public participation in and input to the local drought management planning and implementation process.

8. Adopt standby rates and pertinent ordinances and codes.

9. Establish mutual aid agreements, interconnections with other systems, and conservation education programs.

10. Notify the Tennessee Office of Water Management (TOWM) of all source conflicts and problems encountered in the implementation of local drought management plans.

State Role

Basically, the State's role in resolving and dealing with drought-related problems is to provide water management information, technical assistance, and regulatory oversight. More specifically, these duties would include the following activities.

1. In accordance with its delegated authority and legislative mandates, TOWM will serve as the State's focal point for the dissemination of hydrologic data.

2. When appropriate, TOWM may issue a local, regional, or statewide "drought alert" to alert users and suppliers of the (a) need to evaluate hydraulic or source stress and (b) possible need to reduce water demands through conservation.

3. During a "drought alert," TOWM would maintain weekly contact, through its regional field offices, with those water supply systems and industries considered to be "drought sensitive" or as "having a potential for a shortage."

4. Under Tennessee's "Interim State Drought Management Plan" issued in January 1987, TOWM's Division of Water Supply will solicit and review public water supply systems drought management plans.

5. The State will also work with the Tennessee Valley Authority (TVA) and U.S. Army Corps of Engineers (COE) to modify established reservoir operations and procedures, wherever possible within the existing statutory limitations, to provide the streamflows deemed necessary to maintain water quality and economic viability as well as serve other purposes.

6. In the event of an emergency water supply shortage situation, TOWM has the authority, either independently or through a concurring declaration of emergency by the Governor, the Tennessee Emergency Management Agency, and the Tennessee Department of Health and Environment, to mediate or resolve water use conflicts between competing users including protection of the environment.

<u>Federal Role</u>

The role of the Federal agencies during a drought will depend on the specific water-related resources under their management. Federal agencies having major water-related responsibilities in Tennessee including TVA, COE, U.S. Geological Survey, Environmental Protection Agency, Fish and Wildlife Service, and Soil Conservation Service. More specifically, these agencies responsibilities include the following:

1. Cooperate with the State of Tennessee by providing pertinent information and data relative to water quality conditions, reservoir and groundwater levels, and changes in reservoir management.

2. Cooperate with one another to protect critical habitat areas and maintain normal operations and programs.

3. Inform recreational users of reservoir hazards due to poor water quality or low water levels.

In addition, all Tennessee military units will provide, to the extent possible, needed water treatment and water hauling equipment when requested.

PUBLIC EDUCATION AND INVOLVEMENT IN PLAN MAINTENANCE AND IMPLEMENTATION

Public education will be the key to the success of Norris' plan for dealing with drought-related water supply shortages. In general, the public education program should be an ongoing, two-pronged effort: public education and information transfer.

1. Public Education. To inform and educate the general public about the area's water resources, existing water use/supply relationships, potential for water supply shortages to occur during prolonged periods of drought, and importance and means of conserving water.

2. Information Transfer. To distribute basic water supply-related information and data to the public. Under normal rainfall conditions, the program should provide the public with general information regarding the Norris water supply system's infrastructure (treatment plant and distribution system) and source of supply, potential for experiencing water supply shortages, and importance of water conservation. During periods of below-normal rainfall and/or other extenuating circumstances, the program should provide information describing existing water use/supply relationships, the nature and extent of existing or potential water supply shortages, and specific methods for conserving existing water supplies and reducing water use. The public should also be notified of any changes in the source of the system's water supply, unique quantity- and/or quality-related problems, and decisions to penalize those not following established conservation measures during a time of drought.

To ensure public credibility and cooperation in plan implementation, all information and data provided should be clear and concise, as accurate and current as possible, and specific about what action or response is desired from the public.

Public education and information transfer can best be accomplished through the use of a variety of methods including the following:

1. Presentations to schools, civic groups and service organizations, businesses, church groups, scout troops, etc.

2. Newspaper articles and public service announcements.

3. Development of video tapes or slide shows for use in public presentations.

4. Preparation and distribution of pamphlets, brochures, and posters promoting conservation to all water users.

5. Distribution of water conservation bumper stickers, buttons, and decals.

6. Public demonstrations and displays at shopping centers, schools, fairs, etc.

7. Enclosure of water bill inserts such as memorandums, brochures, etc.

8. Free distribution of inexpensive flow restriction devices.

While there are numerous methods which can be used to provide pertinent water supply related information and data to the public, the Norris Water Commission has successfully used memorandums to convey pertinent information to its customers. For example, in July 1986, the Commission issued a memorandum to all of its customers requesting voluntary restrictions on water use for all unnecessary water uses. Appendix I contains a copy of the Commission's July 1986 memorandum and several sample press releases which could be used by the Commission to inform the public of impending water supply shortages and the need to conserve water.

Analysis of the Commission's current public education program indicates that, to date, its primary function has been to request the Commission's customers to reduce their water use by temporarily eliminating unnecessary water uses such as lawn watering and car washing during dry periods. In light of the decrease in Clear Creek Spring's average flow from 380 to 230 GPM during the summer of 1986 and the continuing drought, it is recommended that the Commission give consideration to establishing and undertaking a program designed to inform and educate the public about the area's water resources, the potential for water supply shortages, and the importance of water conservation. Specific methods to be utilized in accomplishing these goals would be up to the discretion of the Commission and could be selected from the preceding list.

DESCRIPTION OF THE NORRIS PUBLIC WATER SUPPLY SYSTEM

This portion of the plan describes Norris' public water supply system infrastructure and operations organization, source of supply, average daily and peak water use, and water quality.

Basic Operations Organization and Infrastructure

Overall responsibility for overseeing the operation of the Norris Water and Wastewater System for Norris, Tennessee, belongs to the Norris Water Commission. The Commission consists of three members who are appointed by the Norris City Council for 6-year terms at staggered 2-year intervals. Day-to-day operation of the Norris Water and Wastewater System is conducted by the system superintendent and three employees who are responsible for the operation and maintenance of one water and two wastewater treatment plants, including the water distribution, metering, and sewer collection facilities. The water system is totally metered and excellently maintained and operated with very good records. All water processed by the system is approved by the Tennessee Department of Health and Environment (TDHE) based on inspections of the system's operation and maintenance during routine sanitary surveys with the system consistently rating in the high 90s out of a possible 100. The quality of the system's maintenance is also evidenced by the fact that (1) total water losses have decreased from 35 to 13 percent in recent years and (2) the system's average monthly, unaccounted-for water loss is only about

8 percent--one of the lowest in the State. The system has an ongoing leak detection and valve, fire hydrant, and meter change-out program. Billing for water and sewer charges is done by the town of Norris.

This system's water supply infrastructure consists of four basic parts: spring box and pump station, water treatment plant, storage system, and distribution system. Each of these components is described below. In addition, information is provided, where available, relative to any water supply problems experienced by the system's customers in recent years due to physical or infrastructure limitations.

1. Spring Box and Pump Station. These facilities are located at Clear Creek Spring about 3,000 feet from the system's water treatment plant. The spring box and pump station were built in 1933 as part of the Tennessee Valley Authority's (TVA) construction of Norris Dam and are in good condition. The pump station consists of five electrically operated pumps--three 150 GPM and two 350 GPM high service pumps--and one gasoline-powered 200 GPM stand-by pump for use if the electrically operated high service pumps fail. Normally, the pump station operates about 12 hours per day and up to 18 hours per day during periods of peak demand. Operation of the pump station for extended time periods to meet peak system demands causes accelerated wear on the pump station facilities resulting in their being more likely to break down.

   Several attempts have been made to measure the spring's flow capacity by capturing the spring's overflow in the spring box and using a weir to monitor the flow. However, to date, it has not been possible to keep all of the flow in the spring box.

2. Water Treatment Plant. This system's treatment plant was constructed in 1967 and has a design capacity of 432,000 gallons per day (GPD). By using the system's 350 GPM high service pumps, the plant's capacity can be increased to 520,000 GPD. The plant is equipped with pressure filters and pre- and post-chlorination, fluoridation, coagulation, and pH-adjustment facilities.

   During operation, water flows from Clear Creek Spring to the system's filter plant by gravity through an 8-inch pipe. At the filter plant, the water is pumped by three 150 GPM pumps through sand filters and is chemically treated by automatic systems. Chlorine is added for disinfection. Fluoride is added for dental health. Alum is introduced for turbidity removal and soda ash is introduced for pH-adjustment.

   While the system's treatment plant is in excellent condition, the fact that the treatment plant's maximum capacity of 520,000 GPD is being rapidly approached by the system's peak daily use of 519,000 GPD is an area of concern for the system. Although the system's average daily use is only about 75 percent of the system's designed treatment plant capacity, it should be noted that systems whose average daily water use exceeds 80 percent of the designed treatment plant capacity are likely to experience difficulties in meeting water demands if water use increases. Therefore, based on the relationship between the system's maximum treatment capacity and peak daily use as well as the limited cushion between average daily use and the system's designed treatment plant capacity, it is recommended that the Norris Water Commission should evaluate the potential for increases in both the average daily and peak water use and begin to plan for and implement, as appropriate, the expansion of the system's treatment plant capacity.

Any decision to increase the treatment capacity of Norris' water supply treatment plant should be closely coordinated with the system's analysis, identification, and development, if necessary, of additional or alternative water supply sources. This is particularly important because alternative sources of supply may require treatment which is beyond the capability of Norris' present treatment system. Thus, if the decision is made to expand the system's treatment plant capacity, it should also consider and provide, as appropriate, for making those system modifications needed to facilitate the plant's providing adequate treatment for any additional or alternative sources of supply (Clinch River, Norris Reservoir, etc.) which could be utilized by the system at some point in the future.

3. <u>Storage System</u>. Total storage for treated water equals 430,000 gallons. This includes one 100,000-gallon clearwell; one 250,000-gallon reinforced-concrete, underground reservoir; and 80,000 gallons of storage in the system's distribution lines and mains. The clearwell was constructed in 1967 and is located beside the treatment plant on Clear Creek. The underground reservoir is located on Reservoir Hill and was constructed in 1933 during TVA's construction of Norris Dam. This reservoir is in good condition and its overflow elevation is 1369.5 feet above mean sea level.

   Following treatment, the treated water is pumped from the treatment plant into the clearwell and from there into the underground reservoir. Present system storage of 350,000 gallons in the clearwell and underground reservoir complies with the TDHE's minimum standards, which call for systems to have sufficient treated water storage for one day's average daily use. At the present time, the system's average daily use amounts to about 320,000 gallons with peak daily use amounting to about 520,000 gallons. Currently, the Norris Water Commission is planning to construct a new 500,000-gallon steel reservoir by the year 1990 or shortly thereafter to reduce the risk of drought-related water supply shortages and accommodate anticipated system growth and expansion.

4. <u>Distribution System</u>. Norris' distribution system consists of an estimated 25 miles of pipeline with 650 meters and three major purchasers. Approximately 19 miles of pipeline in the system consists of cast-iron, cement-lined pipe of 6-, 8-, and 10-inch sizes. This pipe was installed in 1933 during construction of TVA's Norris Dam facilities. The remaining 6 miles of the distribution system consist of 6-inch ductile iron, 2- and 6-inch polyvinylchloride (PVC),

4- and 6-inch asbestos cement, and 2-inch galvanized steel. Most of the distribution system is in excellent condition with only one and one-fourth miles of galvanized steel pipe in bad condition. This bad pipe will probably be replaced with 6-inch PVC tubing by 1992. Two percent of all service lines are made of PVC tubing and galvanized steel, while the remainder of the lines are made of "type K" copper tubing. It should be noted that the TDHE no longer approves the use of galvanized steel pipelines due to complaints of rusty and "red" water problems associated with the use of such pipelines. Therefore, it is recommended that the Commission give consideration to replacing all service lines made of galvanized steel by PVC or "type K" copper tubing, as time and finances permit.

Water is fed by gravity from the underground reservoir at elevation 1359 feet throughout the distribution system in and around Norris. While problems are very limited, there are a few areas in Norris where the supply lines are too small to carry enough water for several customers to water lawns and gardens at the same time. When several customers on the same supply line are using large amounts of water at the same time, other customers on the same line may experience very low water pressure. Specifically, this problem has occurred several times along a portion of Reservoir Road east of Dairypond Road. To alleviate this problem of low water pressure, the town of Norris has established and implemented a program to replace, as funding and time permit, the small pipelines in the low pressure areas with larger lines. At present, Norris has less than 1,000 feet of small-sized pipeline which remains to be replaced.

Figure 1 is a topographic map of the Norris area depicting the relative location of key system facilities.

Source of Supply

Currently, the town of Norris gets all of its water from Clear Creek Spring which is located near the contact of the Chepultepec dolomite with the younger Longview dolomite of the Knox Group at elevation 925.3 feet (DeBuchananne and Richardson, 1956). Geologically, this area is karstic in nature with both of these formations being composed predominately of siliceous dolomite. Dolomite ($MgCO_3$) is not as subject to solution weathering as limestone ($CaCO_3$). Neither of these formations is, therefore, subject to extensive sinkhole development, except where beds of limestone may be present.

This spring is located in a forested area and is protected by both the town and the Norris Water Commission. Presently, Norris owns approximately 2,500 acres (about 4 square miles) of watershed area around the spring.

The actual flow capacity of this spring is unknown due to the loss of most of the spring's "early day" flow records in a fire some years ago. While it is difficult to obtain a direct measurement of the spring's flow because of its physical characteristics, i.e., the multiplicity of springs involved, a good estimate of Clear Creek Spring's flow could be obtained by determining the amount of water pumped from Clear Creek and adding to it an estimate of the creek's remaining flow. During wet seasons, the spring's peak flow is estimated to be about 700 GPM or 1,000,000 GPD. On the other hand, during the drought of 1953-54, summer 1986, and fall 1987, spring flow decreased to 230 GPM or about 330,000 GPD. This flow (230 GPM) equals the spring's 100-year minimum flow determined by the U.S. Geological Survey during the 1953-54 drought.

While the recharge area for Clear Creek Spring is generally assumed to be located almost entirely within the town of Norris, this has never been substantiated by detailed hydrogeologic studies. This area is heavily wooded, except for a narrow strip of development along the area's southern boundary. Since Norris owns a part of this area (2,500 acres) and controls the remainder through a lease agreement with TVA, it is not anticipated that this area will be extensively developed within the foreseeable future. Appendix II contains a copy of the lease agreement between the town of Norris and TVA.

Since the extent and precise location of Clear Creek Spring's recharge area is unknown, the potential for contamination of this spring cannot be clearly ascertained. While the spring's relative chemical stability does indicate that the spring is not as susceptible to contamination as other karst springs, the spring's variable turbidity, although not excessive, does indicate some potential for possible surface contamination. Therefore, it is recommended that the town of Norris undertake a program designed to (1) more accurately delineate Clear Creek Spring's recharge area through the conduct of groundwater tracer experiments and collection of pertinent hydrogeologic data, (2) identify and analyze the basic land uses occurring within the spring's defined recharge area, and (3) monitor the impacts, if any, of these land uses on the spring's water quality. Once the spring's recharge area has been accurately delineated and relative susceptibility to pollution determined, the Norris Water Commission should proceed to (1) identify and implement, as appropriate and feasible, those measures which would minimize, to the extent possible, the pollution potential from existing land uses in the recharge area to those land uses which would not adversely impact the spring.

In the event that Norris' present source of supply were to become inadequate due to periods of deep, continuing drought and/or increased system use through growth, the system would consider withdrawing water from either the Clinch River below Norris Dam at river mile 78.11 or Norris Reservoir. These points of withdrawal are located about 5,800 and 7,600 feet respectively from the system's water treatment plant. The quality of the water from both sources is good and would be compatible with the system's existing treatment facilities, thus posing no treatment problems for the town. To date, no facilities (pipelines, etc.) have been put in place to utilize water from either of these sources.

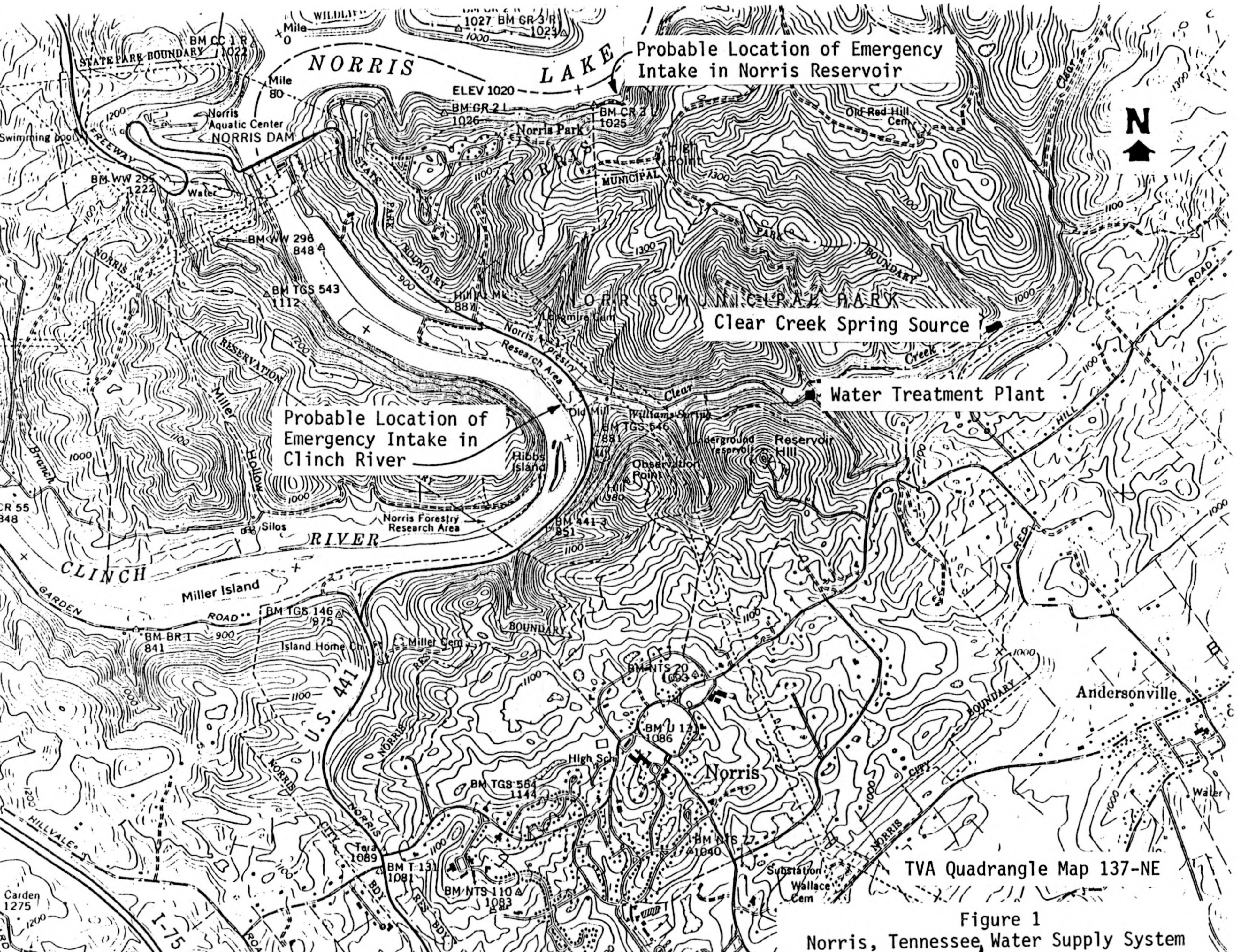

Figure 1
Norris, Tennessee Water Supply System

Average Daily and Peak Water Use

Average daily water use, i.e., water pumped by the Norris public water supply system, during the period from January 1986 to July 1987 equaled slightly over 322,000 GPD or about 9.821 million gallons per month (MGM). This water was sold to three major water users and about 615 residential and commercial customers, i.e., connections. Over 90 percent of these customers are residential water users. Assuming the Tennessee Office of Water Management's household factor of 2.70 people served per connection for Anderson County, the system serves approximately 1,660 people in the town of Norris. Major water users purchasing water and the average daily amount of water purchased during the first 7 months of 1987 are listed below.

1. Andersonville Utility District (153,000 GPD) to serve 500 customers or about 1,350 people. It should be noted that the Andersonville Utility District currently has a contract with the Clinton Utilities Board to provide its total daily water requirement. However, under normal conditions, Andersonville purchases approximately 50 percent of its normal daily use from the town of Norris for economical reasons and improved water flows and pressure.

2. Tennessee Valley Authority (12,000 GPD) for use at its Engineering Laboratory facilities.

3. State of Tennessee (5,000 GPD) for the operation of park and recreation facilities at Norris State Park.

Per capita water use among this system's users, including those served by the Andersonville Utility District, equals about 101 GPD. This compares to a national average of 100 GPD per capita which is used in the engineering design of public water supply systems.

Peak water use for this system generally occurs during the months of July, August, and September. In many years, May and October are also high water use months. Although the system's average daily water use equals about 322,000 GPD, peak daily use may reach as high as 519,000 GPD.

Analysis of this system's average monthly water use data for the 1972-87 time period provides some basic insights into the system's past growth and development. These insights are summarized below.

1. Average monthly water use during this period ranged from a low of 6.801 MGM during 1974-76 to a high of 9.840 MGM during 1985-87. Thus, average monthly water use during the 1972-87 period increased by 3.039 MGM or 45 percent. Except for minor fluctuations in some years, this increase occurred gradually and was distributed uniformly over the entire period.

2. Disregarding calendar years 1972-73 and 1987 for which only partial records are available, this system's peak water use during the

months of July-September ranged from a low of 7.401 MGM in 1974 to a high of 10.448 MGM in 1983. This represents an increase in peak water use of 3.047 MGM or 41 percent.

3. Total customers served by Norris' public water supply system ranged from a low of 440 customers in 1972 to a high of 672 customers in 1984. Over that time period, the system's growth rate averaged about 20 customers per year. Nonresidential (commercial) water users make up less than 10 percent of the system's total customers.

Based on the foregoing information and data regarding the system's growth and development, it is anticipated that the system will continue to grow at the same relative rate as in the past. More specifically, two basic conclusions are drawn regarding the system's future water use.

1. Assuming an average growth rate of 20 customers per year would result in an increase in water use of about 5,000 GPD. Thus, total average daily water use would increase to about 337,000 GPD by 1990 and 387,000 GPD by 2000.

2. While peak water use is expected to increase at the same relative rate as in the past, the continuing drought conditions could result in higher peak water use due to increased lawn and garden watering and air conditioning.

Water Quality

Chemical analyses are routinely performed on the finished or treated water produced by Norris' water treatment plant in accordance with State and Federal regulations. To date, the results of these analyses have never exceeded any of the maximum contaminant levels, i.e., standards set by existing regulations, for specific water quality parameters. Tables 1, 2, and 3 summarize the established maximum contaminant levels for inorganic (primary) chemicals, organic chemicals, and secondary chemicals and other pertinent factors, respectively, in community drinking water supplies under existing regulations (Tennessee Department of Health and Environment, July 1984).

Table 1

Maximum Contaminant Levels for Inorganic (Primary) Chemicals[1]

Contaminant	Maximum Contaminant Level (mg/l)[2]
Arsenic	0.05
Barium	1.0
Cadmium	0.010
Chromium	0.05
Fluoride	4.0
Lead	0.05
Mercury	0.002

Table 1 (Continued)

Maximum Contaminant Levels for Inorganic (Primary) Chemicals[1]

Contaminant	Maximum Contaminant Level (mg/l)[2]
Nitrate (as N)	10.0
Selenium	0.0
Silver	0.05

1. Primary chemicals are those which can pose health hazards for water consumers. Under existing regulations, public drinking water supplies must be analyzed for the presence of these chemicals once every 3 years. The Norris system's last analysis was done in February 1987.

2. Milligrams per liter - mg/l.

Table 2

Maximum Contaminant Levels for Organic Chemicals[1]

Contaminant	Maximum Contaminant Level (mg/l)
Chlorinated Hydrocarbons	
• Endrin (1,2,3,4,10,10-hexachloro-6, 7-epoxy 1,4,4a,5,6,7,8,8a-octahydro-1, 4-endo, endo-5, 8-di-methano naphthalene)	0.0002
• Lindane (1,2,3,4,5,6-hexachloro-cyclohexane, gamma isomer)	0.004
• Methoxychlor (1,1,1-trichloro-2, 2-bis p-methoxyphenol ethane)	0.1
• Toxaphene ($C_{10}H_{10}Cl_8$-technical chlorinated camphene, 67-69 percent chlorine)	0.005
Chlorophenoxys	
• 2,4-D (2,4-dichlorophenoxyacetic acid)	0.1
• 2,4,5-TP Silvex (2,4,5-trichlorophenoxy-propionic acid)	0.01

1. Norris' public drinking water supplies were analyzed for organic chemicals in November 1981 and none were detected. Therefore, under existing regulations, no further testing has been required by the State.

Table 3

Maximum Contaminant Levels for
Secondary Chemicals and Other Factors[1]

Contaminant	Maximum Contaminant Level (mg/l)
Chloride	250
Color (color units)	15
Copper	1
Methyl blue active substance	0.5
Iron	0.3
Manganese	0.05
Odor (threshold odor number)	3
pH	6.5-8.5
Total dissolved solids	500
Zinc	5
Fluoride	2.0

1. Secondary chemicals and other factors have a major influence on the aesthetic quality of a system's public drinking water supply. Under existing regulations, public drinking water supplies served by groundwater sources must be analyzed for the presence of these chemicals once every 3 years. The last analysis for the Norris system occurred in February 1987.

Past chemical analyses of Norris' public water supply have resulted in the detection of trace amounts of only two primary chemicals--barium and nitrate. Another primary chemical, fluoride, is added to Norris' public water supply for dental hygiene purposes. Existing regulations require all public water systems, which adjust the fluoride content of their water supply, to maintain the concentration of fluoride in the finished water between 0.9 and 1.3 mg/l on the average (Tennessee Department of Health and Environment, July 1984). Results of secondary chemical analyses indicate that the contaminant levels for these chemicals are well below the established maximum contaminant levels. Future amendments to existing State and Federal regulations will require the monitoring of volatile organic chemicals (VOC) starting in 1990. These will include eight regulated VOCs (benzene; carbon tetrachloride; para-dichlorobenzene; 1,2-dichloroethane; 1,1-dichloroethylene; 1,1,1-trichloroethane; trichloroethylene; and vinyl chloride) and 49 other unregulated VOCs including styrene, toluene, xylene, etc.

Existing regulations also require that radiochemicals (gross alpha, gross alpha-2 sigma, etc.) be analyzed once every 4 years. Past results of these analyses have been well below the established limits. The corrosivity of the system's water supply has been analyzed once, as required, (in August 1982) and the water was determined to be moderately aggressive, which is characteristic of groundwater in east Tennessee.

Essentially, the chemical composition of Norris' water supply is very stable and typical of groundwater in east Tennessee. The water is considered to be moderately hard. During the last 15 years, there has been no significant change in the chemistry of Clear Creek Spring's water indicating a reliable groundwater source with no intrusion from surface water sources. Generally, surface waters in Tennessee are less hard and have a lower alkalinity than groundwater. However, the pH, alkalinity, and hardness of surface water may change from day to day and typically does.

The following is a summary of Clear Creek Spring's existing raw water quality for several key water quality parameters based on information and data collected during the summer of 1987.

Parameter	Average Value
pH	7.3
Turbidity	1.0 Nephelometric Turbidity Units
Dissolved oxygen	11.1 mg/l
Alkalinity	140 mg/l
Temperature	15^{o}C

During the year, the pH of Clear Creek Spring's water varies from about 7.3 in the summer to about 7.5 or 7.6 in the winter. To prevent the dissolution of chemical deposits in the system's water distribution lines due to pH differences, the spring water's pH is tested on a daily basis and adjusted, when necessary, through treatment with soda ash in the system's treatment plant to avoid problems. During periods of excessive rainfall, turbidity levels in the spring may rise slightly, but generally they stay below 1.0 Nephelometric Turbidity Units (NTU). Whenever the water's turbidity exceeds two parts per million, alum is added to the water to coagulate the particles so that they can be filtered out by the system's water treatment plant. However, if the turbidity goes above 1.0 NTU, the system's pumps will automatically shut off.

Since this area's geology is karstic (dolomite) in nature, it is possible for surface water and other groundwater sources to intrude on Norris' groundwater supply. Thus, any changes in the chemical composition of Norris' water supply would indicate that something has happened and surface water may be entering Norris' aquifer or groundwater from a different source and is being drawn into Clear Creek Spring. In addition, during extended drought periods, it is possible that the surface of the water table would be lowered exposing previously submerged strata to oxidation which could result in slight increases in mineral concentrations, primarily iron and magnesium. However, it is not anticipated that these increases would pose a significant problem for the town of Norris.

Another potential source of pollution is some septic tanks, less than 10, being used by homes which are located along a road on a ridge about one-eighth mile above the spring. Due to the region's karstic nature, it might be possible for the flow from the septic tanks' drainfields to reach the spring due to a drop in the spring's water table. Although the Norris Water Commission routinely checks the bacteriological quality (total coliform bacteria) of the system's finished water, the raw water (before chlorination and filtration) is not normally checked.

Recognizing the potential for chemical and bacteriological contamination of the town's groundwater supply, it is recommended that the Norris Water Commission establish a program to test and analyze Clear Creek Spring's raw water supply on a quarterly or monthly basis to develop pertinent baseline information and data regarding the spring's chemical and bacteriological quality. During extended drought periods, beginning with the earliest evidence of the drought, it is further recommended that the frequency of the raw water testing and analysis should be done on a monthly or even a weekly basis. The establishment of this type of program would facilitate the Commission's monitoring of its raw water quality and identification of changes in water quality due to the possible intrusion of surface water or alien groundwater sources.

SYSTEM TO MONITOR AVAILABLE WATER SUPPLIES AND DETERMINE THE POTENTIAL FOR DROUGHT-LIKE CONDITIONS TO OCCUR

The basic cause of drought is a lack of sufficient precipitation. However, even if an area's water supply remains constant, increased use and abuse of water, such as the contamination of existing water supplies, can lead to a water supply shortage. This plan views drought basically within the concept of supply and demand. When supply exceeds demand, particularly during periods with above-normal precipitation, the need for water resources management is usually of little concern to the public. However, when drought occurs water management strategies become highly visible and increasingly important to water users. (Rouse)

The ability to determine or forecast when and where droughts are likely to occur is generally considered to be in its experimental stages. Nevertheless, a very important element of any viable drought management plan is the implementation of a process to monitor and analyze precipitation, maximum and minimum temperatures, lake levels, soil moisture (Palmer Drought Index), etc., in order to identify an occurring drought in a given area. Essentially, this procedure should (1) identify deteriorating water supply conditions as early as possible, (2) build governmental and public awareness of threatening, drought-like conditions and potential future problems, and (3) provide State and local decision-makers, as well as individuals, with the necessary information and adequate lead time needed to take the appropriate actions to deal with the drought in a timely and orderly manner. (Western States Water Council, October 1987) These actions might include the (1) issuance of a drought alert, (2) dissemination of pertinent drought-related information, (3) call for voluntary or mandatory water conservation, (4) institution of water use restrictions for certain nonessential water uses, (5) identification and evaluation of alternative water supplies, (6) implementation of higher water prices, etc. Currently, the town of Norris has no system or procedure to monitor the flow of Clear Creek Spring. While the Norris Water Commission has a weather station at its treatment plant which collects data on precipitation and daily maximum and minimum temperatures, the Commission has no established system or procedure for analyzing and utilizing this information to monitor available water supplies and determine potential drought conditions. Therefore, it is recommended that the Commission should review and summarize all precipitation and temperature data collected on at least a yearly basis; display it, as appropriate, in graphic form; and correlate it with pertinent information relative to the quantity and quality of water available from Clear Creek Spring in order to establish a data base on the area's environmental conditions and water supply availability. It is further recommended that the Commission collect data on soil moisture (Palmer Drought Index) conditions on at least a monthly basis and incorporate it, as appropriate, into the data base on area environmental conditions. To facilitate the establishment of a long-term (30 plus years) data base that would include the 1953-1954 drought, it is suggested that, to the extent possible, similar data should be collected for the 1950-1987 time period and incorporated into the data base. Essentially, all or most of this data would be available from the National Weather Service (precipitation, temperature, and Palmer Drought Index data). Establishment and maintenance of this data base would provide a basis for the Norris Water Commission to monitor available water supplies, determine potential drought conditions, and establish guidelines or "trigger points" for the implementation of specific measures to alleviate drought-related water supply shortages.

While it is recognized that the data base on environmental conditions will not provide the basic information needed to determine exactly how Clear Creek Spring's flow would be affected or the timing of that effect as a result of changing environmental conditions, it seems reasonable to assume that such data would provide some general guidance and direction to system personnel regarding general trends which could be anticipated in the spring's flow. However, to facilitate improved monitoring and management of the system's available water supply, it is recommended that the Norris Water Commission consider installing, if feasible, an observation well in Clear Creek Spring to monitor the spring's water table elevation.

PHASED RESPONSES TO REDUCTIONS IN SUPPLY

To respond effectively and appropriately to progressively worsening drought situations, Norris' local drought management plan provides for three basic levels of service or response phases under increasingly severe drought conditions. Specifically, these phases include the "conservation," "restrictions," and "emergency" water supply shortage phases. Essentially, each phase is a function of the percent reduction in overall water use for public supply purposes required to (1) reduce existing and future water use to the available water supply and (2) protect the water resource from serious or irreparable damage. Specific water use reductions required under each phase are "conservation" (15 to 20 percent), "restrictions" (30 to 40 percent), and "emergency" (60 percent or more).

For each water shortage phase, this plan identifies (1) a "trigger point" to alert system personnel that the drought is worsening and call for the implementation of the successive response phases to varying degrees of water supply shortage and (2) specific restrictions or measures that will be taken to achieve the required percent reduction in water use. Individual "trigger points" and water use restrictions identified for each response phase are summarized briefly below.

1. <u>"Conservation" Phase</u>. This phase calls for a 15 to 20 percent reduction in water use. Two occurrences would "trigger" the implementation of this phase's measures to reduce water use: (a) a drop in the annual precipitation recorded at the weather station at Norris' water treatment plant below 50 percent of normal for an average year and (b) the complete cessation of overflow from Clear Creek Spring. Either of these occurrences would result in the Norris Water Commission's request for voluntary conservation on the part of its customers to reduce water use and cut back water sales to the Andersonville Utility District from about 153,000 GPD (1987 average daily purchase) to 130,000 GPD. In addition, homeowners would be encouraged to install water-saving devices and repair household leaks.

2. <u>"Restrictions" Phase</u>. Reductions in water use required during this phase would equal 30 to 40 percent of normal water use. The implementation of this phase's measures to reduce water use would be "triggered" by a sudden drop in flow from Clear Creek Spring to 235 GPM. Under this phase, the Commission would implement several measures to reduce water use.

   - Mandatory water conservation measures would go into effect for all nonessential and "second and third class" essential water uses.

   - The sale of water to the Andersonville Utility District would be cut from about 153,000 GPD (1987 average daily purchase) to 100,000 GPD.

   - In addition, pressure-reducing devices would be installed in the system's main lines and measures would be established to enforce water conservation measures including fines and/or penalties for excessive water use.

3. <u>"Emergency" Phase</u>. During this phase, water use would be reduced by 60 percent or more. The "trigger point" for this phase would be a drop in Clear Creek Spring's flow to 150 GPM or less. Specific measures to be implemented during this phase to reduce water use and alleviate potential supply shortages include the following:

   - Expansion of mandatory water conservation to include all "first class" essential uses and the continuation of enforcement measures to reduce water use.

- Water sales to Andersonville Utility District would be cut from about 153,000 GPD (1987 average daily purchase) to 75,000 GPD.

- An emergency water intake would be located in the Clinch River at river mile 78.11. Water withdrawals from the Clinch River would either be pumped back to the system's original treatment plant and/or the Norris Water Commission would purchase a "package" type treatment unit and install it near the Clinch River intake or adjacent to the existing water treatment plant.

Normally, the Andersonville Utility District purchases about 150,000 GPD from the Norris Water Commission. Whenever the Commission reduces the sale of water to the District, the District makes up the difference by purchasing additional water from the Clinton Utilities Board.

One of the principal measures to be used under each of these phases to achieve the desired reduction in water use is that of conservation. Essentially, this involves voluntary and/or mandatory cutbacks in customers' water use for both indoor and outdoor water uses. Conservation measures which should be considered in reducing indoor water use include flushing the commode fewer times, taking shorter showers and shallower baths, using dishwashers and washing machines only with full loads, turning the shower off while soaping or shampooing, and keeping a bottle of chilled drinking water in the refrigerator. Outdoor water uses which can be reduced significantly through conservation include the watering of lawns, gardens, and trees and shrubs; filling of swimming pools; and washing of cars. Research by the Virginia Water Resources Research Center indicates that the success of a program to conserve water depends on (1) the public's perception of the program's fairness and (2) the existence of thorough public information and education programs to inform water users of the potential for drought and its seriousness and delinate viable water conservation measures. (Keck, June 1988)

Realizing the importance of public information and education in implementing an effective water conservation program, it is recomended that the Norris Water Commission review its present public information and education program from the standpoint of the program's usefulness in informing the system's customers of the potential for drought-related water supply shortages and describing alternative measures for conserving water. If necessary, the Commission should consider modifying or expanding its existing program, as appropriate, to facilitate its utilitarian value in dealing with drought-related water supply shortages in a timely and orderly manner.

WATER USE PRIORITIES

An important element of any drought management plan is the development of a classification system of water uses to reflect local water use priorities. A classification system is important because it clarifies issues of fairness, hardship, and, ultimately, management effectiveness.

In addition, the classification of water uses also facilitates the system's identification of (1) its water use goals, priorities, and strategies and (2) weaknesses of the drought management plan. In classifying water uses, the supplier should consider all available management options including increased water prices, water conservation, supplemental and/or backup water supplies, bans or restrictions on water use, etc. (Keck, June 1988)

Currently, the majority of customers served by the Norris Water Commission are residential water users. In addition, the Commission also sells water to the Andersonville Utility District (153,000 GPD), Tennessee Valley Authority (12,000 GPD), and State of Tennessee (5,000 GPD). At the present time, there is only one private business--a nursery--that would probably be affected by any reductions in water supply if mandatory water conservation measures were not successful in achieving the necessary reductions in water use.

Norris' local drought management plan has identified two basic classifications of water use--essential and nonessential--with essential water uses being broken down into "first," "second," and "third" class essential uses. Summarized below is a listing of the specific water uses included in each classification for the Norris public water supply system. Individual water use classes and the uses delineated within each class are listed in order of their relative use priority, i.e., the water uses are listed from highest to lowest priority.

1. Essential "First Class" Water Uses

   - Domestic. Water use to sustain human life and the lives of domestic animals and to maintain minimum standards of hygiene and sanitation, excluding laundry.

   - Health Care Facilities. Water use for patient care and rehabilitation, including related pool operation. Currently, the town of Norris has no health care facilities.

   - Public Supply. Water use for two basic purposes: firefighting and health and public protection purposes, including line flushing on an emergency basis.

2. Essential "Second Class" Water Uses

   - Domestic. All uses not included in "First Class."

   - Agricultural. Water use by commercial nurseries at the minimum level necessary to maintain stock, to the extent that sources of water other than fresh water are not available or feasible to use. Norris' public water supply currently serves only one nursery.

   - Industrial. Water use for industrial processes and industrial air conditioning. No industrial or manufacturing facilities are being served by Norris' water supply system at the present time.

- Commercial. Water use for offices, retail and entertainment facilities, restaurants, hotels and motels, laundromats, etc.

3. Essential "Third Class" Water Uses

- Schools and Churches. Water use for human and sanitary purposes.

- Motor Vehicle Washing. Water use for commercial car and truck washes. Currently, the town of Norris has no commercial car or truck washes.

- Swimming Pools. Water use for municipal and residential pools serving more than 25 dwelling units.

4. Nonessential Water Uses

- Outdoor Noncommercial. Water use for irrigating gardens (except handheld), lawns, parks, golf courses (except greens), playing fields and other recreation areas, and street washing.

- Ornamental. Water use for fountains, reflecting pools, and artificial waterfalls. Currently, Norris' public water supply system provides no water for ornamental purposes.

- Swimming Pools. Water use for private pools serving less than 25 dwelling units.

- Motor Vehicle Washing. Water use for the washing of privately owned cars and trucks.

Table 4 delineates the recommended water use classes and class restrictions for dealing with varying degrees or phases of water supply shortages through the implementation of various voluntary and/or mandatory cutbacks or bans on specific water use classifications (Wood and Others, May 1986). However, it does not reflect other drought mitigative measures (alternative or backup sources of supply, repair of leaking water mains and distribution lines, price increases, etc.) that might be considered for implementation by Norris' officials in addition to the general measures shown.

Table 4

Recommended Water Use Classes and Class Restrictions

General Water Use Class	Phased Responses to Water Supply Shortages		
	Conservation	Restrictions	Emergency
Essential "First Class"	Voluntary Cutbacks	Voluntary Cutbacks	Mandatory or Voluntary Cutbacks
Essential "Second Class"	Voluntary Cutbacks	Mandatory or Voluntary Cutbacks	Mandatory Bans

Table 4 (Continued)

Recommended Water Use Classes and Class Restrictions

General Water Use Class	Phased Responses to Water Supply Shortages		
	Conservation	Restrictions	Emergency
Essential "Third Class"	Voluntary Cutbacks	Mandatory Bans	Mandatory Bans
Nonessential	Mandatory Cutbacks or Bans	Mandatory Bans	Mandatory Bans

In the water "conservation" and "restrictions" programs, essential "first class" water uses should always be provided for. This drought management plan emphasizes curtailing one class of uses before strong measures are implemented to significantly cut the next higher water use classification.

IDENTIFICATION AND EVALUATION OF ALTERNATIVE SOURCES OF SUPPLY

An integral part in the process of developing this drought management plan was the identification and evaluation of specific measures, including alternative and/or backup sources of supply, which the system might consider for implementation in dealing with drought-related water supply shortages. This portion of the plan describes and evaluates a number of potentially appropriate measures which the Norris Water Commission might consider utilizing to alleviate water supply shortages. Basic information provided in this section is presented as food for thought to stimulate discussion and thinking about specific measures which have the potential to reduce existing and future water use and/or increase available water supplies to meet Norris' water-related demands.

Water Conservation

One effective and inexpensive way the town of Norris can deal with drought is through conservation. Conservation is a broad, general term which encompasses within its meaning a number of specific actions including public information and education, water-user ordinances, recycling, water-use rates, repair and maintenance of deteriorating water supply systems, and evaporation suppressants. However, conservation entails more than specific remedies. To be fully effective, water conservation techniques must be understood and accepted by the public.

When water shortages occur or drought conditions prevail, conservation of water should be the number one priority. Utilization of practical conservation measures can save an enormous amount of water, since most American families waste between 40 and 60 percent of their daily water demand through carelessness (Ferrell and Others, July 1984). However, bringing about a long-term change in people's water-using habits is difficult to effectuate and maintain, particularly during periods when water supplies are plentiful. This can be accomplished most effectively through the conscientious education of young people, beginning in the elementary grades, about water and its value, drought and its effects, and effective water conservation measures. Continuous education through the news media and conservation pamphlets, enclosed with monthly utility bills, is another way of increasing public awareness of the need for conserving water.

Another important step in conserving water is for local water officials to work closely with community leaders, particularly planners and developers, prior to drought periods to plan for and implement specific measures to reduce residential water use. Recent studies have indicated that showers utilize 30 percent of total household water, toilets about 40 percent, and faucets 10 percent, with the remaining 20 percent being used for nonessential or outdoor purposes (Ferrell and Others, July 1984). The use of conservation devices in the average household or commercial operation could result in a 50 percent savings of the total amount of water used for the foregoing purposes. In addition, the use of conservation devices provides a significant savings in the power costs associated with heating water and the cost of sewage treatment. This could be accomplished through the utilization of economic incentives, such as water pricing policies, that would encourage water conservation and enforcement of building code provisions that mandate the use of water saving devices.

It should be noted that whenever water users are encouraged to conserve water, they should also be informed of the potential health-related issues and concerns resulting from the direct utilization of water from the taps. That is, turning on the tap and beginning to use the water immediately without running it for a minute or so to flush out the water which has been standing in the water lines for an extended period of time. Most homes, especially those less than 5 years old that have copper plumbing and lead soldering, will experience some increase in lead concentrations in water which stands in the pipes for any extended period of time, even overnight. To minimize this potential, water users should be encouraged to run the water long enough to flush out the water lines prior to any water use for drinking or cooking purposes.

<u>Repair of System and Household Leaks</u>

Water systems can lose up to 50 percent or more of their treated water supply due to leaks in their service and distribution lines. Recent estimates, developed by the Pittsburgh Equitable Meter Company, indicate that at 60 pounds of pressure the water losses shown on the following page can be expected from system leaks over a 3-month period.

Ordinarily, a good tight water supply system will lose no more than 10 to 15 percent of its treated water and the Norris public water supply system almost always falls within this range. The low water loss from Norris' system is a direct result of the system's ongoing leak detection and repair program. Limited additional attention could be given to this activity.

Size of Hole (Inch)	Water Loss (Gallons)
1/4	1,200,000
3/16	675,000
1/8	300,000
1/16	75,000
1/32	19,000

Increasing Consumer Water Costs Through Rate Structure Modification

During recent years, water resources managers have come to recognize that water is an economic resource whose true value or worth must be recognized and priced accordingly. Consequently, Norris should (1) review its existing rate structure to determine if the full cost of providing and maintaining adequate water services is being recovered and (2) determine if the existing rate structure is conducive to promoting the wise use and efficient management of the system's source of supply. (Moreau, 1984)

Currently, the Norris public water supply system charges a fixed rate of $2.14 per 1,000 gallons of water used, with a minimum bill of $6.42 per month for the first 3,000 gallons used. Customers using more than 3,000 gallons per month are charged $2.14 for each additional 1,000 gallons of water used, with no limit on the total amount of water used. Since most of the system serves residential users, the Norris Water Commission feels that its fixed rate schedule, rather than the decreasing block rate, is more likely to encourage the system's customers to conserve water.

However, another rate structure which would offer even greater incentives to conserve water is the increasing block rate pricing structure. This represents the exact reverse of the decreasing block rate structure in that the unit rate increases with each succeeding block of water used. Generally, this type of rate structure offers the greatest incentive to reduce water use.

Metering

In accordance with good system management, Norris' public water supply system is completely metered. The meters are read on a regular basis and the meter boxes are kept clean and dry wherever possible. There seems to be no evidence of water theft by meters being bypassed or disconnected.

As water meters age, they begin to wear out and allow more water to pass through the meter than registers on the dial. Thus, the customer pays less for the water used resulting in a loss to the system. To prevent or minimize water losses of this nature, the Norris Water Commission has established a schedule for testing all meters on a regular basis and replacing those which are worn out.

Pressure Reduction

During periods of water supply shortages, be they drought induced or otherwise, one measure Norris can use to conserve water is to reduce the water pressure in the entire system, in part of the system, or to individual services. Decreasing the water pressure diminishes the amount of water flowing through open faucets. Normally, 50 pounds per square inch (PSI) is considered sufficient water pressure for residential purposes; however, pressures exceeding 80 PSI are not uncommon in many systems. Under normal conditions, Norris' water pressure ranges from 60 to 240 PSI.

Alternate Sources of Supply

Another option for dealing with periods of limited water availability or extended drought conditions is for the town of Norris to supplement its existing source of supply from other sources or find a new one. This would be particularly true during the period of peak water use from May through October which is often characterized by below normal precipitation and above average water use due to air conditioning, increased lawn and garden watering, etc. Recognizing that Norris' water use during dry periods is already approaching the capacity of Clear Creek Spring, its sole source of supply, an alternative or supplemental source of supply will be needed within the very near future. Basically, there are several alternatives that the Norris Water Commission might consider to supplement or replace its existing source of supply. Each of these alternatives is described briefly below.

1. Clinch River and Norris Reservoir. The most feasible alternative would be for the system to run a direct line to the Clinch River at river mile 78.11, a distance of about 5,800 feet, or to Norris Reservoir, a distance of about 7,600 feet. Either of these sources would provide Norris with a reliable source of good quality water that would not require additional water treatment facilities at the present treatment plant. Water from either of these sources is quite comparable and similar in quality to that from Clear Creek Spring.

2. Clinton Utilities Board. In the event that Clear Creek Spring should fail completely leaving the town of Norris without any water, a small portion of Norris' water demand could be supplied by the Clinton Utilities Board through its connection with the Andersonville Utility District, which currently receives a large part of its daily water supply from the Norris system. This water would come from Clinton's two million gallons per day treatment plant on the Clinch River and be transported to the Norris system through Andersonville's hookup with the Norris water system following renovation of a pumping station and water meters at Andersonville's connection with the Clinton Utilities Board to increase their capacity enough to allow water to be pumped from Clinton to Norris' water storage facilities. However, the connecting line sizes between Clinton and Andersonville and Andersonville and Norris are too small to supply all of the water needed by both the Andersonville Utility District

and the town of Norris. Essentially, this alternative could be used primarily to serve some of the system's smaller, low-lying areas. However, to facilitate the utilization of this alternative in a timely and orderly manner should the need arise, it is recommended that the town of Norris reach an agreement with the Andersonville Utility District and Clinton Utilities Board regarding the amount of water and circumstances under which that water would be provided to the town of Norris.

3. Expansion of the System's Treatment Plant and Storage Capacity. Although not an alternate source of supply, this option would enhance the system's overall dependability in terms of providing adequate water supplies during peak use periods and for a minimum period of time during severe and extended periods of drought. As noted earlier, the system's current maximum treatment plant capacity of 520,000 gallons per day barely exceeds the system's peak daily use of 519,000 gallons per day and the current treated water storage of 350,000 gallons exceeds the system's average daily use by less than 10 percent. Expansion of both of these facilities is badly needed to reduce the risk of water supply shortages and accommodate anticipated growth. However, any plans for system expansion should be closely coordinated with the system's search for alternative supply sources to ensure that the expanded treatment plant can provide adequate treatment for any alternative sources of supply. Currently, the Norris Water Commission is meeting with its consulting engineer to discuss plans for developing additional sources, expanding the system's treatment plant capacity, and increasing its storage capacity for treated water.

4. Additional Wells. Another potential source of water for the town of Norris lies in the area's potential for additional groundwater development. While the Norris public water supply system currently has no standby wells for emergency use, the possibility of locating and drilling additional wells to supplement Norris' existing supply is considered to be good. To facilitate the location and selection of the best possible well sites, it is recommended that a competent geohydrologist be hired by the town. Because of the time required to locate, construct, and develop a well, this should be done prior to an emergency.

Conjunctive Water Use

Conjunctive water use, i.e., the utilization of both surface water and groundwater resources to serve an area's water supply needs, poses a very real and viable option for the town of Norris to consider in planning for and dealing with water supply shortages should they occur. As has already been noted, one of Norris' most viable options for dealing with such shortages is to look to the Clinch River as an alternate source of water. However, in the interest of long-term dependability for Norris' water supply, Norris should continue to utilize its present source--Clear Clear Spring--to its maximum capacity and supplement it as necessary with water from the Clinch River.

As has been noted earlier, the quality of water available from both of these sources is good and should pose no problems in terms of Norris' present water treatment plant providing adequate treatment for the Clinch River water. While the water from the river will be colder and probably have less dissolved oxygen than the spring, it will also have less turbidity during the winter months. Both sources would probably experience sharp increases in turbidity levels during periods of heavy rainfall.

Whenever surface water and groundwater supplies are used conjunctively and mixed together, the potential exists for some water quality-related problems to occur. Essentially, these problems manifest themselves through the (1) release of scaly deposits in the system's water distribution lines and (2) discoloration of the water delivered to users. Neither of these is expected to pose a problem for the Norris public water supply system. The rationale for assuming this follows.

1. Release of Scaly Deposits in Distribution Lines. A difference in pH between conjunctively used surface water and groundwater supplies may cause earlier deposits in water distribution lines to be released resulting in serious problems such as stained laundry in customers' homes and residue in wash basins. Analysis indicates that the pH of Clear Creek Spring's water varies from about 7.3 in the summer to about 7.5 or 7.6 in the winter, while the pH of the Clinch River remains at about 7.4. Since there are no appreciable deposits in the distribution pipelines of the Norris system and the pH differential can be adjusted at the system's treatment plant via the introduction of soda ash, no problems of this nature would be anticipated as a result of the conjunctive use of available water supplies.

2. Water Discoloration. In some areas, existing groundwater supplies may contain ferrous oxide which is colorless. When this water enters the water system and is exposed to the air, carbon dioxide is released and ferrous iron is changed to ferric iron, which then precipitates out of solution causing the water to become reddish in color. However, this is not expected to pose a problem for the Norris system since its groundwater supply contains little or no ferrous oxide.

Water Reuse and Recycling

Water reuse is not a new concept. Most of the water available to users has been "used" over and over again for centuries. Whenever we use water in our daily activities, we are participating in water reuse. This stems from the fact that all of the water available to us today has been used and reused again and again thanks to the hydrologic cycle, nature's world-class and world-size reuse system. All of the water we drink, flush, or water our lawns with re-enters the water system sooner or later, cleaned either by nature or human processes, to be used again. (The Freshwater Society, 1986/87)

During periods of drought, planned water reuse should be considered. For Norris, the reuse of water may be particularly critical during a time of severe drought. Water users served by Norris' system could find it beneficial to use bath and laundry water to water lawns and shrubs, heavy cleaning jobs such as floors, and washing cars.

Considerable progress has been made in recent years in the development of specific products and equipment to make home water reuse more practical. For example, low-sudsing, biodegradable detergents are now available for many laundry and household cleaning jobs resulting in much cleaner rinsewater that could be used for the aforementioned purposes. In addition, there have been some research and demonstration projects for the development and use of home water recycling units. Generally, these demonstrations of home treatment units have been quite successful in recycling all home water use, except that used for sanitary purposes.

SELECTED DROUGHT MANAGEMENT PLAN FOR NORRIS, TENNESSEE

Basically, Norris' local drought management plan outlines the specific actions that the Norris Water Commission will take in order to deal with water supply shortages during a drought period, as quickly and effectively as possible. These actions are summarized briefly below.

1. Continuation of the system's program to (a) identify and repair leaking water mains and distribution lines and (b) replace old, worn out meters.

2. As in the past, conservation will continue to be the system's primary method for dealing with real or potential water supply shortages, be they drought-related or otherwise. Depending on the degree or magnitude of the shortage, sales of water to wholesale customers outside the town of Norris would be curtailed and system users would be requested to conserve water on either a voluntary or mandatory basis. In all cases, system users would be requested to curtail "non-essential" water uses first, followed by further conservation of "essential" water uses beginning with the "third class" uses and extending, if necessary, to the "first class" uses under emergency conditions. If necessary, mandatory conservation might be enforced by adding penalties to monthly water bills for excessive use.

3. Continuation and expansion of the system's public information program, as necessary, to inform the public about the status of the area's water resources, the potential for water supply shortages, and the need to conserve water during dry periods.

4. Recognizing the system's potential for serious supply shortages during dry conditions due to the decrease in Clear Creek Spring's flow, the Commission will review and evaluate the individual supply alternatives identified in the preceding section of the plan and utilize these, as appropriate, to supplement or take the place of Clear Creek Spring, thereby providing a more reliable or dependable source of supply.

5. The Commission will also consider all plan recommendations and implement those deemed pertinent to maintaining the Commission's ability to provide its customers with an adequate supply of good quality water.

As decisions are made by the Commission to utilize alternative sources of supply and/or implement specific plan recommendations, these decisions will be noted and incorporated, as appropriate, into Norris' selected drought management plan during future revisions and plan updates.

Under current circumstances, the following actions would be taken by the Commission, whenever Clear Creek Spring begins to show signs of reduced water flow, to conserve water for domestic, commercial, and fire protection purposes. The number of actions taken would depend on the seriousness of the condition. Specific actions are listed below in the probable order that they would be used.

1. Voluntary conservation and reduction of water sales to wholesale customers outside the town of Norris.

2. Restrictions on certain activities such as car washing and lawn sprinkling.

3. Mandatory conservation. This might be accomplished through the addition of penalty charges to monthly water bills for those users exceeding a prescribed monthly amount of water use.

4. Further reductions in water sales to wholesale customers.

5. Acquisition of additional water supplies via temporary supply lines to the Clinch River or to Norris Lake.

PLAN IMPLEMENTATION ORDINANCE NO. 359

To deal effectively with drought-related water supply shortages, the Norris Water Commission developed a proposed ordinance in February 1988 which formalizes the Commission's authority to implement certain basic actions during emergency water supply shortages to encourage water conservation and prohibit nonessential and some "second" and "third class" essential water uses. More specifically, this ordinance will, when approved and adopted, give the Commission the authority to encourage water users to conserve water, prohibit or regulate the use of water during a water supply emergency, provide for notice and penalties for water use violations, and repeal all ordinances or portions of ordinances which are in conflict with this ordinance. Appendix III contains a copy of the proposed ordinance which passed the first of three readings on May 9, 1988.

It is recommended that, as time passes, the Commission consider reviewing the ordinance with regard to incorporating into it (a) pertinent references to Norris' local drought management plan, (b) pertinent plan features, and (c) additional enabling authority, if necessary, to facilitate Norris' implementation of pertinent plan actions or recommendations to alleviate or resolve drought-related water supply shortages.

PLAN ENFORCEMENT

Depending on the degree or severity of the shortage--conservation, restrictions, or emergency phase--the need for an appropriate enforcement mechanism varies greatly. For example, when the measures being implemented are voluntary in nature, the need for an enforcement mechanism is not necessary. Under voluntary conservation requests, the Commission's customers are asked not to use water for lawn and garden watering, car washing, and other unnecessary purposes.

However, some form of enforcement mechanism is needed when existing water shortages necessitate the use of mandatory conservation, water restrictions, or emergency actions to achieve the desired reductions in water use. Section 1, Part 13-305; Enforcement; Ordinance No. 359; provides that mechanism:

> Every police officer of the City shall in connection with his duties imposed by law, diligently enforce the provisions of this Ordinance. The City Manager shall have the authority to enforce the provisions of this Ordinance by the discontinuance of water service in the event of violation hereof in addition to the penalties set out herein above.

During severe and extended drought periods, customers not complying with Commission requests for mandatory conservation may find an increase in their monthly water bill due to the addition of penalty charges for excessive use. Under "emergency" phase conditions, i.e., when water use must be reduced by 60 percent or more, water is to be used only for "first class" essential uses.

If, for some reason, Norris' response to severe and extended drought conditions and water supply shortages is inadequate, the Tennessee Office of Water Management would have the authority, either independently or through a concurring declaration of emergency by the Governor, the Tennessee Emergency Management Agency, and the Tennessee Department of Health and Environment, to (1) assist in the implementation of pertinent actions and (2) if necessary, mediate or resolve water use conflicts between competing users including the protection of the environment. In the event of a "declared" emergency, the Tennessee Office of Water Management might have to allocate water among the competing users. The authority for this power is found under various statutes and Executive Order including the Civilian Defense Act, T.C.A. Sections 58-2-101 through 58-2-518; the Water Quality Control Act, T.C.A. Section 69-3-109(b); the Safe Drinking Water Act, T.C.A. Section 68-13-710; and Executive Order No. 4. (Keck, January 1987)

LOCAL WATER SHORTAGE MANAGEMENT TASK FORCE

To date, no water shortage task force has been established by the town of Norris to participate in and provide input to the development of Norris' local drought management plan. The current plan was developed through a joint, cooperative effort involving the Norris Water Commission; Tennessee Department of Health and Environment, Office of Water Management (Nashville and Knoxville offices); and Tennessee Valley Authority, Office of Natural Resources and Economic Development. It should be noted, however, that the establishment and maintenance of such a group can be of invaluable assistance to local communities during periods of severe and extended drought, particularly communities that experience water supply shortages on a regular basis or communities whose available source of supply has decreased drastically.

Basically, the function of such a task force would be to (1) participate in the development and periodic revision and update of a community's basic plan for responding to drought-related water supply shortages and (2) assist system personnel in the implementation of specific plan actions and for recommendations to deal with water supply shortages when they occur. An important role played by the task force is that it serves as a consensus-building group so that the group's decisions will have the community's general support. Once decisions are made, task force members can also assist in program implementation including fund-raising for the distribution of conservation products, organizing volunteers to serve the elderly and handicapped in potential water cutoff areas, and enlisting volunteers to enforce any mandatory conservation measures which the city feels are necessary. The following is a list of potential sources for task force members.

City/County Health Department Officials
City Administration
Churches and Schools
Fire Chief
Local Media Representatives
Professional Groups
City Water Superintendent and Personnel
Commercial/Industrial/Institutional Water Users
Conservation Groups

Recognizing the many roles that a task force of this nature could play in terms of developing general support for a community's drought management plan and achieving the implementation of specific plan elements on a timely basis to alleviate water supply shortages, it is recommended that the Norris Water Commission give consideration to the establishment of such a task force to facilitate plan implementation, as appropriate, and future plan revisions and updates.

PLAN UPDATE AND REVISION

An integral element of any viable drought management planning process is the need to periodically update and revise the plan itself to reflect changing circumstances relative to both water availability and use. Current plans call for Norris' local drought management plan to be reviewed and revised, if necessary, at 2-year intervals, unless changes occur that would necessitate more frequent revision. Included among these factors or changes are population and/or industrial growth, changes in industrial mix, lower risk requirements of the users being served, infrastructure condition, etc. Other changes that might require revision of the plan would include the availability of additional quantity/quality information on Clear Creek Spring, major changes in the water system's basic facilities, and administrative and/or organizational changes in the structure of the Norris Water Commission. In addition, plans might need to be revised to address needs which were previously overlooked, delete inappropriate triggering points, etc.

Future annexations in the Norris area may drastically change the system's service area, thereby necessitating the need to update and revise Norris' local drought management plan. For example, Clinton may annex all areas up to I-75 which are currently being served by the Andersonville Utility District. If that happens then those areas would be served by the Clinton Utilities Board. There is also a possibility that the Norris Water Commission would then take over and serve those areas located closest to Norris which were previously served by the Andersonville Utility District.

PLAN RECOMMENDATIONS

Summarized below by major category or topic are the plan recommendations contained in the preceding sections of this plan.

Public Education

1. Recognizing the importance of public education in effective water supply management coupled with the 40 percent decrease in Clear Creek Spring's average flow in recent months and the continuing drought, it is recommended that the Norris Water Commission give consideration to establishing and undertaking a program designed to inform and educate the public about the area's water resources, the potential for water supply shortages, and the importance of water conservation.

Replacement of Galvanized Steel Pipelines

1. Recognizing that the Tennessee Department of Health and Environment no longer approves of the use of galvanized steel pipelines due to complaints of rusty and "red" water problems, it is recommended that the Commission give consideration to replacing lines made of galvanized steel by polyvinylchloride or "type K" copper tubing, as time and finances permit.

Expansion of the System's Water Treatment Plant

1. Since the system's average daily water use (320,000 GPD) is almost equal to 80 percent of the system's design treatment plant capacity (432,000 GPD) and the system's peak water use (519,000 GPD) is virtually equivalent to the system's maximum treatment plant capacity (520,000 GPD), it is recommended that the Norris Water Commission

evaluate the potential for increases in both the average daily and peak water use and begin to plan for and implement, as appropriate, the expansion of the system's treatment plant capacity. Any decision to expand the system's treatment plant capacity should also consider the system's current treatment capability and make any modifications necessary to facilitate the plant's ability to provide adequate treatment for any additional or alternative water supplies (Clinch River, Norris Reservoir, etc.) which the system might utilize at some point in the future to reduce the risk of water supply shortages and meet increasing demands.

Analysis of Clear Creek Spring's Pollution Potential

1. Since the extent and precise location of Clear Creek Spring's recharge area is unknown, it is recommended that the town of Norris undertake a program to (a) more accurately delineate Clear Creek Spring's recharge area through the conduct of groundwater tracer experiments and collection of pertinent hydrogeologic data, (2) identify and analyze the basic land uses occurring within the spring's defined recharge area, and (3) monitor the impacts, if any, of these land uses on the spring's water quality. Once the spring's recharge area has been clearly defined and its relative susceptibility to pollution determined, the Norris Water Commission should proceed to (1) identify and implement, as appropriate and feasible, those measures which would minimize, to the extent possible, the pollution potential from existing land uses in the recharge area and (2) limit future development in the recharge area to those land uses which would not adversely impact the spring.

Water Quality Analysis and Monitoring

1. In view of the potential for chemical and bacteriological contamination of the town's groundwater supply, it is recommended that the Norris Water Commission establish a program to test and analyze Clear Creek Spring's raw water supply on a quarterly or monthly basis to develop pertinent baseline information and data regarding the spring's chemical and bacteriological quality. During drought periods, it is further recommended that the frequency of the raw water testing and analysis should be done on a monthly or even a weekly basis to facilitate the identification of changes in water quality.

Monitoring Water Availability

1. Since the Norris Water Commission has no established system or procedure for monitoring available water from Clear Creek Spring, it is recommended that the Commission should review and summarize all precipitation and temperature data (maximum and minimum) being collected at the system's water treatment plant, display it in graphic form, and correlate it with pertinent information on the quantity and quality of water available from Clear Creek Spring to establish a data base on environmental conditions in the Norris area and water supply availability. In addition, it is recommended that the Commission collect data on soil moisture (Palmer Drought Index)

conditions on at least a monthly basis and incorporate it into the environmental data base. It is also suggested that similar environmental data should be collected for the 1950-1987 period and incorporated into the data base. Establishment and maintenance of this data base would facilitate the Commission's monitoring of available water supplies, determination of potential drought conditions, and establishment of guidelines or "trigger points" for the implementation of specific measures to mitigate against a potential water shortage.

2. Recognizing that a data base on environmental conditions will not enable the Norris Water Commission to determine exactly how changing environmental conditions would affect Clear Creek Spring's flow, it is recommended that Norris consider installing an observation well in Clear Creek Spring to monitor its water table elevation.

Water Conservation

1. Realizing the importance of public information and education in implementing an effective water conservation program, it is recommended that the Norris Water Commission review its present public information and education program from the standpoint of the program's usefulness in informing the system's customers of the potential for drought-related water supply shortages and describing alternative measures for conserving water. If necessary, the Commission should consider modifying or expanding its existing program, as appropriate, to facilitate its utilitarian value in dealing with drought-related water supply shortages in a timely and orderly manner.

Alternative Water Supplies

1. To facilitate the acquisition of water from the Clinton Utilities Board, it is recommended that the town of Norris reach an agreement with the Andersonville Utility District and Clinton Utilities Board regarding the amount of water and circumstances under which that water would be provided to the town of Norris.

2. To assure the location and selection of the best possible well sites for the development of additional or supplementary water supplies for the town of Norris, it is recommended that the town acquire the services of an experienced, knowledgeable geohydrologist.

Plan Implementation Ordinance No. 359

1. It is recommended that, as time passes, the Commission consider reviewing the ordinance with regard to incorporating into it (1) pertinent references to Norris' local drought management plan, (b) pertinent plan features, and (c) additional enabling authority, if necessary, to facilitate Norris' implementation of pertinent plan actions or recommendations to resolve or alleviate drought-related water supply shortages.

Local Water Shortage Management Task Force

1. Recognizing the many roles that a task force of this nature could play in terms of developing general support for the community's drought management plan and achieving the implementation of specific plan elements on a timely basis to alleviate water supply shortages, it is recommended that the Norris Water Commission give consideration to the establishment of such a task force to facilitate plan implementation, as appropriate, and future plan revisions and updates.

PLAN GLOSSARY

The following terms are defined as they are used in Norris' local drought management plan.

Alternate Sources of Supply--This refers to other sources of water supply (Clinch River, groundwater wells, etc.) and/or measures (water conservation, increased water rates, etc.) which could be utilized by the town of Norris to supplement or, if necessary, replace available water supplies from Clear Creek Spring.

Aquifer--A geologic formation, group of formations, or part of a formation that contains sufficient water-saturated permeable material to store, transport, and yield significant quantities of water to wells and springs.

Average Daily Water Use--The average amount of water withdrawn from Clear Creek Spring for processing and distribution through Norris' public water supply system to meet the system's daily water demands. This amount is usually based on the system average monthly use over a 12-month period and is recorded in gallons or millions of gallons per day.

Conservation Phase--This refers to a water supply shortage situation characterized by deteriorating water quality and possible conflicts among various water user groups. Alleviation of this situation in Norris' drought management plan would require a 15 to 20 percent reduction in water use.

Contaminant--Any physical, bacteriological, chemical, geological, or radiological substance or matter in water.

Drought--A period of time characterized by below normal or no precipitation (rain or snow) and one or more of such conditions as depleted soil moisture, decreased streamflow, reduced lake or reservoir storage, deteriorating water quality, and lowered groundwater levels. The longer this situation exists, the more serious the drought becomes.

Drought Alert--A term used to warn or advise an area that it is experiencing lower than normal precipitation, streamflows, and reservoir or groundwater levels and that, if these continue to decline, water supplies may not be adequate to meet normal needs.

Drought Emergency--A situation declared by an official or administrative head because of indications that the safety, security, health, and welfare of an area's citizens are threatened by drought-related water supply shortages.

Drought Susceptibility--The relative possibility that a particular water user, such as a public water supply system, will experience water supply shortages during drought conditions. Susceptibility is expressed as a percentage, which reflects the amount of the user's available water supply that would be used to meet the user's average daily water demand. As the percentage increases, the possibility of water supply shortages during drought conditions increases.

Emergency Phase--This refers to a water supply shortage situation characterized by severe water supply and water quality problems due to serious resource limitations which are well below the level needed to meet economically and socially important needs. Under Norris' drought management plan, water use would be reduced by 60 percent or more to alleviate these shortages.

Essential Water Use--Water used strictly for domestic and personal uses, firefighting purposes, health and medical purposes, industrial processes, agricultural uses, meeting streamflow requirements, and the use of water to satisfy Federal, state, and local public health and safety requirements. Norris' drought management plan prioritizes these uses into "first," "second," and "third" class uses.

"Trigger" Points--A "trigger" point is a predetermined condition at which a specific decision will be made, such as the issuance of a drought alert, or an action taken, such as a call for water users to conserve water. "Trigger" points are usually based on specific factors or conditions, such as deficiencies in rainfall and runoff, a decline in soil moisture, lower groundwater levels, increasing daily water demands, reduced storage, or some other appropriate condition.

Maximum Contaminant Level--This refers to the maximum permissible level of a contaminant in water which is delivered at the free-flowing outlet of the ultimate user of a public water system, except in the case of turbidity where the maximum permissible level is measured at the point of entry to the distribution system.

Nonessential Water Use--Water used strictly for lawn and garden watering, car washing, fountains, amusement (water slides), etc.

Palmer Drought Index--This index indicates prolonged abnormal moisture conditions (dryness or wetness). The index usually ranges from about -6 to +6 with negative values for dry spells and positive values for wet spells. This index usually returns to near normal (zero) levels within a few weeks after the onset of a spell of near-normal precipitation. The response is faster if unusually wet weather follows a dry period or unusually dry weather follows a wet period.

Per Capita Water Use--The average amount of water used per person per day.

pH--A Scale of water acidity or alkalinity which ranges from 0 to 14. A pH of less than 7 indicates acid water, a pH of 7 indicates "neutral" water, and a pH above 7 indicates alkaline water. A pH of 5 is 10 times as acidic as a pH of 6, and a pH of 9 is 10 times as alkalinic as a pH of 8.

Precipitation--The fall of water in any form (rain, snow, hail, or sleet) upon the earth's surface.

Public Water Supply--Water withdrawals by public and private water suppliers and delivery to a variety of users that do not supply their own water. These water uses include domestic, commercial, industrial, and public uses.

Public Water Supply System--Any municipal water system, department, water commission, utility district, or investor-owned system that serves at least 15 connections and/or 25 people at least 60 days per year.

Restrictions Phase--This refers to a water supply shortage situation characterized by a continued decline in available water supplies and water quality. Norris' local drought management plan calls for a 30 to 40 percent reduction in water use during this phase.

Safe Water Yield--The amount of water that can be withdrawn from a surface water (lake, reservoir, or stream) or groundwater source on an ongoing, long-term basis with an acceptably small risk of supply shortage. It is generally the 3-day, 20-year low flow for a nonregulated stream, the pump tested yield of a well, the average daily flow in a regulated stream, or the 90-day sustainable yield of a lake or reservoir.

System Capacity--The maximum amount of raw water a system's water treatment plant can effectively process and deliver. Whenever a system's average daily water use reaches 80 percent of the system's design capacity, system managers should consider and begin planning to expand the system's treatment plant capacity.

System Infrastructure--This refers to the basic engineering facilities and equipment, including the organizational structure, which make up the Norris public water supply system and facilitate its day-to-day operation and maintenance. These facilities include the system's water treatment plant, water mains and distribution lines, storage facilities, and the Commission itself.

3-Day, 20-Year Low Flow--This is the lowest average rate of flow for 3 consecutive days to or below which a stream or river's flow can be expected to decline to once in 20 years on the average. The 3-day, 20-year low flow is frequently used in Tennessee to plan for the disposal of liquid wastes into a stream.

Turbidity--A measure of water's "cloudiness" due to the presence of suspended matter.

Water Conservation--Any beneficial reduction in water use or loss. This can be done by reducing the overall demand for water, improving water use efficiency, reusing and recycling existing water, reducing water losses through leak detection and repair, and improving land management practices.

Water Rationing--The restriction of water use in order to ensure fair distribution and maintenance of available water supplies.

Water Shortage--A situation in which a specific water user's or geographic area's available water supply is inadequate to meet existing and future water demands or when "water availability" conditions are such that a temporary reduction in total use is required to protect the water resource from serious harm.

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APPENDIX I

SAMPLE MEMORANDUM AND PRESS RELEASES

Appendix not reproduced for Guide.
Appendix can be found in the Drought
Management Plan for Norris.

APPENDIX II

LEASE AGREEMENT BETWEEN UNITED STATES OF AMERICA BY TENNESSEE VALLEY AUTHORITY AND THE CITY OF NORRIS, TENNESSEE

Appendix not reproduced for Guide.
Appendix can be found in the Drought
Management Plan for Norris.

APPENDIX III

PROPOSED ORDINANCE NO. 359

ORDINANCE NO. 359

AN ORDINANCE TO AMEND TITLE 3, WATER AND SEWER, BY ADDING A NEW CHAPTER, CHAPTER 3, CONSERVATION OF WATER.

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF NORRIS as follows:

Section 1. That Title 3, Water and Sewer, be amended by adding a new Title 3, Conservation of Water in its entirety as follows:

13-301. DEFINITIONS. For the purposes of 13-301 through 13-308 the following terms, phrases, words and their derivations shall have the meaning given herein. When not inconsistent with the text, words used in the present tense include future words in the plural include the singular and words in the singular include the plural. The word "shall" is always mandatory and not merely directory.

(1) "City" is the City of Norris.

(2) "Person" is any person, firm, partnership, association, corporation, company, or organization of any kind.

(3) "Water" is water from the City Water Supply System.

13-302. Application of Regulations. The provisions of 13-301 through 13-308 inclusive shall apply to all persons using water both in and outside the City, and regardless of whether any person using water shall have a contract for water service with the City.

13-303. State of Emergency. Be it further ordained that the Norris Water Commission is hereby authorized and empowered to declare a state of emergency, at any time hereafter when same may appear to be necessary or advisable for the general welfare and benefit of the municipality, relative to the use or consumption of water furnished by the municipal water system to its users, customers or consumers. When a state of emergency has been declared, the Water Superintendent is hereby authorized, empowered, and directed to immediately restrict prohibit or regulate the use and consumption of all water by all of the City's users, customers and/or consumers in such a manner, to such an extent, and for such a length of time as is necessary or advisable for the general welfare and benefit of the municipality.

13-304. Certain Uses Prohibited. When an emergency is declared, the use and withdrawal of water by any person for the following purposes is hereby prohibited; except by expressed permission granted by the Water Superintendent.

(1) Watering yards. The sprinkling, watering or irrigating shrubbery, trees, lawns, grass, ground covers, plants, vines, gardens, vegetables, flowers, or any other vegetation.

(2) Washing mobile equipment. The washing of automobiles, trucks, trailers, trailer houses, or any other type of mobile equipment.

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(3) Cleaning outdoor surfaces. The washing of sidewalks, driveways, filling station aprons, porches and other outdoor surfaces.

(4) Cleaning buildings. The washing of the outside of dwellings; the washing of the inside and outside of office buildings.

(5) Cleaning equipment and machinery. The washing and cleaning of any business or industrial equipment and machinery.

(6) Ornamental fountains. The operation of any ornamental fountain or other structure making a similar use of water, not employing a recirculating system.

(7) Swimming pools. Private swimming and wading pools.

(8) Escape through defective plumbing. The escape of water through defective plumbing, which shall mean the knowing permission for defective plumbing to remain out of repair and which will include defects in swimming pools and fountains.

(9) Air conditioning. Use of air conditioning equipment requiring water, not employing a recirculating system.

(10) Restaurant service. Drinking water will not be served with meals unless specifically requested by the customer.

13-305. Enforcement. Every police officer of the City shall in connection with his duties imposed by law, diligently enforce the provisions of this Ordinance. The Water Superintendent shall have the authority to enforce the provisions of this Ordinance by the discontinuance of water service in the event of violation hereof in addition to the penalties set out herein below.

13-306. Penalties. Any person who shall violate the provisions of 13-301 through 13-308 inclusive shall be fined no less than ten dollars ($10.00) nor more than fifty dollars ($50.00) for each and every offense.

13-307. Separability. If any section, sub-section, sentence, clause, phrase or portion of this Ordinance is for any reason held invalid or unconstitutional by any court of competent jurisdiction, such portion shall be deemed a separate, distinct and independent provision and such holding shall not effect the validity of the remaining portions hereof.

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13-308. Ordinance Repealed. All ordinances or portions thereof in conflict with the provisions of this Ordinance are hereby repealed as of the effective date of this Ordinance.

Section 2. This ordinance shall take effect fifteen (15) days from and after its passage, the public welfare requiring it.

PASSED FIRST READING May 9, 1988

PASSED SECOND READING ____________

PASSED THIRD READING ____________

____
Roger W. Bollinger, Mayor

CORRECT: ATTEST

____
Coleen Sheppard, Acting City Manager