# PUBLIC WATER SUPPLY CONSERVATION GUIDE

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by
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OKLAHOMA WATER RESOURCES BOARD

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# CHAPTER I

## INTRODUCTION

For many years Oklahoma has met the constantly increasing demand for water through the development of new sources of supply. From the drilling of new wells to the vast system of lakes and reservoirs, new sources of water have been developed to sustain the thriving Oklahoma economy and to maintain the comfort and well being of a growing population.

The future development of surface and ground water resources will certainly remain important policy considerations in the Oklahoma water picture. However, with a growing concern for preservation of the native values of rivers, fisheries and recreation opportunities on the one hand, and for the continually escalating costs of water development on the other, the emphasis is moving toward alternative methods to satisfy increasing water demands. These include, among others, better integration of surface and ground water supplies, reclamation of waste water and water conservation.

Recurring drought periods emphasize the need for conservation. Erratic annual and monthly precipitation patterns cause streamflows to cease and storage reservoirs to become so low that their waters may be rendered unsuitable for some purposes. Water levels in shallow aquifers drop, causing water wells to dry up.

Conservation enforced during dry periods and the sense of emergency prevailing during droughts are soon forgotten in times of plentiful rainfall.

Water conservation must be practiced regularly and consistently -- in times of plenty as well as in times of drought. Water saving measures also save energy, including the cost of pumping water, treatment and wastewater disposal.

Recent state and federal laws have added new priorities for water planning. New policies and requirements cover water and energy conservation, environmental and socioeconomic impacts, and cost-effectiveness analyses. Improvement in the efficiency of water use can help achieve many of these goals.

This report, consistent with the authority of the Oklahoma Water Resources Board as stated in Title 82 Oklahoma Statutes Section 1085.2, is concerned with urban and domestic water conservation. It is intended to provide public water suppliers, both municipal and rural, with a foundation of knowledge on available measures for obtaining more efficient use of our water supplies.

The information contained herein is derived from a diverse group of sources. The state's current water use is discussed along with potential water savings that can be realized through installation of specific water-saving devices in new homes and through retrofitting in existing homes (where feasible).

The report is designed to serve as a handbook for designing a local water conservation plan, outlining suggestions and methods that have proven successful for public water suppliers across the country.

Chapter II reviews residential practices, water use, and the potential water savings that Oklahoma could achieve through more efficient water use with appropriate devices.

Chapter III discusses the two ways in which conservation can be achieved by a utility: 1) through supply management, where water is conserved within the supply system; and 2) through demand management, where the user conserves within his home or business.

Chapter IV outlines a seven step program developed by the New England River Basins that details a procedure for officials of a public water supply system to follow in establishing a local water conservation plan that will recognize the different institutional, economic and social constraints of each community or rural water district.

Chapter V reviews two successful conservation programs and presents some of the projects they utilized in achieving their successful water use reduction campaigns.

## CHAPTER II

## ANALYSIS OF RESIDENTIAL PRACTICES

The per capita rate of residential water use is highly variable, influenced to a large degree by climate, seasonal variation and the location of water intensive industries.

Affluent customers use more outside water, for lawn watering and swimming pools, and somewhat more for water-using appliances, such as garbage disposals and automatic dish and clothes washers, than do the less affluent.[1]

Community development and the type of water use also affect the rate of water use. Per capita water use can be significantly increased beyond normal residential use by industries in the community. Per capita water use in apartments, townhouses and condominiums is generally significantly lower than the rate of use in single-family residences because of lower per capita exterior use.

Understandably, the selling price of water has significant effect on the rate of water use, although price versus use relationships vary widely from one area to the next. According to various studies, metering also significantly affects residential water use. Water use in certain metered areas is at least 25 percent lower than in areas without meters.[2]

In general, larger families use more water per dwelling but less water per capita. Inside use increases with size of family, but family size affects outside use only slightly.

Finally, water use in sewered communities is higher than areas where septic tanks are used. This is probably due to the user's concern that septic tanks require frequent cleaning.[3]

## CURRENT WATER USE

Water supply in Oklahoma is not only fundamental to the way people in the state live, but also to the way many earn their livings. A diverse set of water utilities develops this surface and ground water supply and distributes it to a variety of users -- from large agribusinesses and petrochemical manufacturing facilities to individual apartment dwellers.

Table 1 presents statewide water demands by type of use in 1977.[4]

TABLE 1. STATEWIDE WATER USE IN 1977

| Use | 1,000 A.F. | Percent of Total |
|---|---|---|
| Municipal | 402.2 | 16.6 |
| Industrial | 388.3 | 16.1 |
| Power | 110.9 | 4.6 |
| Irrigation | 1,514.8 | 62.7 |
| Total | 2,416.2 | 100.0 |

Municipal (and domestic) water use accounts for about 17 percent of the state's total water use. Projections made for the Oklahoma Comprehensive Water Plan indicate that the 1977 urban/rural domestic water use might climb to 650,800 acre-feet per year by 2000.[5]

Of the total 1977 residential water use in Oklahoma, 225,000 acre-feet, or about 56 percent, was for interior use.

Table 2 shows that 74 percent, or 166,500 acre-feet, was used in the bathroom; 11 percent for washing dishes and cooking; while 15 percent was used in washing clothes and for utility purposes.

Accordingly, the greatest potential for interior residential water savings will result from lower water use in the bathroom and from reduced water use for dish and clothes washing.

TABLE 2. RESIDENTIAL WATER USE IN OKLAHOMA, 1977

| USE | ACRE-FEET | |
|---|---|---|
| Interior | | |
| Toilet (.40) | 90,000 | |
| Bathing (.34) | 76,500 | |
| Kitchen (.11) | 24,700 | |
| Laundry & Utility (.15) | 33,800 | |
| Total | | 225,000 |
| Exterior | | |
| Lawn/Garden Watering | 159,300 | |
| Swimming Pools, Car Washing, Etc. | 17,700 | |
| Total | | 177,000 |

SOURCE: Oklahoma Comprehensive Water Plan

## PLUMBING FIXTURES AND OTHER WATER USING APPLIANCES

Substantial water conservation can be realized in new homes or in replacement construction by the installation of low-flow or water-saving devices. In existing homes, similar savings are possible through retrofitting, e.e., the modification of existing fixtures. Potential savings from various plumbing fixtures and appliances are summarized in Table 3 and discussed briefly in the following paragraphs.

TABLE 3. STATEWIDE SUMMARY OF POTENTIAL ANNUAL RESIDENTIAL WATER SAVINGS IN THE YEAR 2000

| Type of Use | Acre-Feet |
|---|---|
| Interior | |
| Toilet | 26,200 |
| Shower | 14,900 |
| Kitchen/Lavatory Faucets | 400 |
| Exterior | 57,300 |
| TOTAL | 98,000 |

SOURCE: Oklahoma Comprehensive Water Plan

## Toilets

In the residential setting, the largest user of water in the home is the flush toilet. Data on the amount of water used by flush toilets vary, but a generally accepted average is five gallons per flush. Because of its relatively high water use, the toilet has received a lot of attention from those interested in water conservation. A varied assortment of devices has been developed to modify the toilet to use less water and toilets are being marketed that use less water. Most residential conservation programs have encouraged the use of devices to modify existing toilets and mandated the use of water saving toilets in new or replacement construction (3.5 gallons per flush).[6]

Most conventional toilets use more water than is needed to perform essential functions. To remove wastes effectively, a siphon action must be started in the bowl and trap. To achieve this, the water entering the bowl from the tank must have sufficient velocity and volume.

In a number of field tests, conventional toilets were fitted with volume-reducing or flush control devices, which demonstrated possible reductions in water use of up to 25 percent. Most toilet tanks have excess volume, and the flush can be reduced or controlled by placing plastic bottles or "water dams" in the tank, or with other modifications. Bottles and water dams maintain the static head and velocity of the water while reducing the volume.

After the General Services Administration established a water conservation standard of 3.5 gallons per flush for tank toilets, manufacturers designed and marketed toilets to meet the standard. Most toilets available today successfully use 3.5 gallons or less through modified bowl and trap designs and lower volume tanks. Limited field testing of these toilets by the Washington Suburban Sanitary Commission of Hyattsville, Maryland (WSSC) and others showed an 18 percent overall reduction in water use.

Computations based on the slope of collection line specified in the Uniform Plumbing Code (one-fourth inch per foot), show that, theoretically, a flush of two gallons will satisfactorily carry waste from the toilet, through collection lines, sublaterals, laterals and sewers. If variances from the recommended slope are permitted, the probability of stoppages is increased.[7]

The International Association of Plumbing and Mechanical Officials (IAPMO) publishes and maintains a list (Research Recommendations) of approved plumbing fixtures for new installation. All water saving toilets on IAPMO's list have been tested and will perform satisfactorily.

While retrofit devices may not operate satisfactorily in all conventional toilets, most will operate with less water. In Oklahoma, assuming statewide retrofitting and use of low-flush toilets in all new construction, up to 26,000 acre-feet less residential water would be required in 2000 (than if current practices are continued).

Shower Heads and Faucets

In general, faucet and shower heads deliver more water than is actually needed. The flow could be controlled by use of a low-flow fixture, an attachment to the existing fixture, or a flow restrictor to the water line.

The question, "What are minimum acceptable flows?" has never really been answered, but depends in part on the appearance of the flow from the faucet or shower head.

Tests conducted by the WSSC indicate the use of low-flow shower heads would result in a water savings of 9 to 12 percent.[8] In Oklahoma, with a complete theoretical change over to 3.0 gallons per minute shower heads and 1.5 gallons per minute faucets, up to 15,300 acre-feet of water could be saved in 2000.

Automatic Clothes Washers and Dishwashers

Water for laundering is usually the third leading user of water in the home. For the same load, some clothes washers use 70 percent less water than others; some dishwashers use 50 percent less water than others. In terms of unit water savings, this amounts to reductions of up to 37 gallons for clothes washers and up to 8 gallons for dishwashers.

Retrofitting of older washing machines and dishwashers is not considered practical. However, as older appliances are phased out, they should be replaced with models designed to use less water. Water savings with existing appliances can best be effected by educating users to use them less often; e.g., only with full loads. Reduced use of these appliances also will save energy.

Other Saving Devices

Leak detection tablets have often been included in mass water-saving device distribution programs. The tablets are used to determine whether or not toilets are leaking water from the tank into the bowl at a rate not noticeable to the homeowner. Limited available data indicate that 14 percent of toilets in service may be leaking. The California Department of Water Resources tested a number of these tablets as part of their water conservation program. The formulations of the tablets were reviewed by a toxicologist to ascertain potential hazards to children, and all but one of those reviewed were found to be safe. The tablets vary in cost and some difference in their rate of dissolution was noted.[9]

Pressure reducing valves have been required in new construction by the Washington Suburban Sanitary Commission since 1973. These devices are placed in the main supply line to houses where water pressure exceeds 60 psi. Their function is to reduce service pressures to the 50 to 60 psi range. Little is known about the savings attributable to such devices, but they are recommended in new construction to reduce water use, pipe hammer and frequency of fixture maintenance.[10]

Spray taps were first researched in England in the 1950's. Their use has not been widespread in this country despite the significant water and energy savings reported. Some commercially available spray taps limit flows to 0.75 gallons per minute and have built-in mixing valves. They are more costly than conventional hardware, but enable cost reductions in other plumbing system components, and reported savings over the long term easily pay back the higher initial cost.[11]

## EXTERIOR WATER SAVINGS

A large portion of Oklahoma's residential water is used outside the home, principally for lawn and garden irrigation. Due to its seasonal nature and the limited variety of fixtures, exterior water use has received less research and attention than interior water use.

An estimated 90 percent of exterior water use is for irrigating lawns, shrubs and home vegetable gardens; the remaining ten percent is used for car washing, swimming pools, and cleaning driveways, sidewalks, and streets. Following application, water is stored in plants, transpired, and evaporated. Some runs into storm drains or percolates to ground water.

Because of the large percentage of residential water used for landscape purposes, significant amounts of water can be saved by eliminating overwatering and reducing evapotranspiration.

Some of the water applied to plants and shrubs evaporates and some is used for growth. Water in excess of these quantities either runs off or percolates. Although water deficiency will hinder plant growth and productivity, plants that need only moderate or small amounts of water are usually overwatered. As a result, as much as 20 percent of all applied exterior water may represent overwatering.[12]

In 1977, the estimated statewide excessive exterior water use resulting from overwatering was estimated at 35,000 acre-feet; which could increase to 57,300 acre-feet by the year 2000.

Automatic sprinklers, except those with soil moisture override systems (sprinklers that are activated at predetermined soil moisture conditions), are best for the irrigation of larger areas such as parks. All automatic sprinkler systems need periodic adjustment due to seasonal climatic variations, sprinkler head adjustment and changes in infiltration rates. The readings from soil moisture testing devices must be carefully interpreted. Soil texture, depth of test and type of plant are important considerations. Well controlled, timed sprinkler systems would not entirely eliminate overwatering, but could reduce it by 50 percent.[13]

Eliminating overwatering would not necessarily result in an equal net water savings. In many areas this excess water is not irrevocably "lost", because much of it percolates to usable ground water where it is pumped and reused.

In Oklahoma, an estimated 70 percent of the applied exterior water is consumed through evapotranspiration (ET) by lawns, ornamentals and home gardens. A possible reduction in ET would require extensive reductions in the intensive water-using plants used by many Oklahoma homeowners -- a highly impractical measure. Little data on the types of plants growing on public and private land exists, so the potential water savings from such a change cannot be estimated.

Certain plants native to Oklahoma, e.g., some varieties of oak and pine, require less water than many of the exotics brought here from other states and foreign countries. There are also low water using plants imported from other parts of the world with climate similar to Oklahoma. However, most homeowners select plants on the basis of appearance, availability, rapid growth, hardiness and cost -- not on the basis of how much water they require. Few homeowners are probably aware of the difference in water requirements among the many available varieties of plants, shrubs, trees, etc.[14]

Very little information on the various native plants and their water needs is readily available to homeowners. The best sources of such information are county agents of the OSU Extension Service, the Forestry Division of the State Department of Agriculture or local landscape architects and nurseries.

A successful statewide program to reduce exterior water use will require the cooperative efforts of the public and, particularly, public and private agencies and organizations. The following ideas might be promoted to encourage conservation:

1. The use of water-saving devices, such as automatic sprinkler sytems, and the use of soil moisture testers.

2. The protection of desirable native plants when new homes are constructed.

3. Government agencies should set an example by using low water using plants around public buildings.

4. Parks, golf courses and other public facilities that normally require large quantities of water should be designed to use native or low water using plants.

5. Demonstration gardens and landscaping that use little water could be established by state and local agencies as part of a state educational program. A good example of such a garden is the Freda Hambrick Memorial Garden at the National Cowboy Hall of Fame in Oklahoma City.

6. State and local agencies should cooperate with professional groups, such as the Oklahoma Horticultural Society and OSU Cooperative Extension Service, to educate the public in the use of native and low water using plants and improved watering habits.

# CHAPTER III

## MANAGEMENT OPTIONS FOR ACHIEVING CONSERVATION GOALS

Water conservation can be achieved within a community or rural water system in two ways -- supply management or demand management. In supply management the utility conserves within the supply system, while in demand management the user conserves within his home or business.[15]

### SUPPLY MANAGEMENT

Since the supply system is under the direct control of the local governing entity, saving water within the system is relatively straight forward. If adequate funding and/or labor is available, system improvements to reduce waste and loss can be implemented to save water without involving users.

Supply management should be used to achieve the following types of conservation goals:

1. Long-term (and under certain circumstances, short-term) use reduction;
2. Average or peak use reduction (if problem is caused by inadequate pipe capacity or inadequate storage capacity; and
3. Low or high percentage reduction.

Supply management may be useful for reaching short-term goals if a water supply system has not been adequately maintained over the years. It can also be helpful for peak use goals if the problem is caused by inadequate storage capacity or inadequate pipe capacity.

The table below summarizes the advantages and disadvantages of supply management.

TABLE 4

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Operating costs can be reduced | Some programs are expensive |
| Program is not dependent on users | A lot of labor is not dependent on users |
| Lost revenues can be recovered | Long lead time usually required for implementation |
| Flexibility can be maintained (i.e., it is possible to introduce a demand management program to meet emerging or changing circumstances if further reduction is needed. | |

The ability of supply management to reduce water use will vary according to the age and conditions of the water system and regular system improvement and replacement programs.[16]

Supply management programs which could be effective in reducing water use are metering, leak detection and repair, pressure reduction, watershed management, and evaporation suppression. Each of these programs is briefly discussed in the following narrative.

## Metering

Metering is not an actual conservation technique in itself since it neither reduces water loss nor encourages use reduction. However, metering does provide an accurate accounting of all water uses throughout the system and can, therefore, be used in supply management programs such as leak detection and repair as well as in certain demand management programs.

Regular meter maintenance (testing and repairing) or replacement programs are helpful to adequately maintain water systems. Due to the high cost of maintenance, many utilities have found that regular meter replacement can be as cost-effective as meter maintenance.[17]

Leak Detection and Repair

Leaks in distribution systems waste both water and energy and can undermine roads and other structures. Even though leaking water may percolate to a usable aquifer, it must be pumped, treated, stored and usually pumped again to consumers.

In a 1971 report for the National Water Commission, Howe et al. estimated the nationwide loss through leaks in utility systems is about 12 percent of distributed water and that nine percent could be saved.[18] The report lists age, construction materials, physical and chemical soil properties, water properties, water pressure and improper maintenance as the principal causes of such leaks.

Leak detection and repair involves the analysis of unaccounted for water. Sources of unaccounted for water include defective hydrants, abandoned services, unmetered water (e.g., for municipal uses such as fire-fighting), inaccurately metered water, leaking meters, illegal hook-ups, unauthorized use of fire hydrant water, and leaks in mains and services.

The costs of a leak detection and repair program will vary considerably from system to system. A scan of the system may be appropriate if a lot of water is lost due to leakage. A water audit (combination of flow measurements and scanning usually performed by a consultant) may be in order to detect unaccounted for water that is not caused by leaks.

In some cases, the scan or audit techniques may discover the sources of water loss that are not large enough to locate. Water losses that are found economical to repair will vary from system to system, depending on the cost of water, the cost to produce and pump the water, and the specific costs of repair. Some general guidelines which may be helpful to determine those that may be economical to repair include:

1. If the leak is in excess of 250 gallons per day per inch diameter per mile of pipe; and
2. If the flow measured at night is in excess of 50 percent of average daily flow.

It should be noted that these guidelines would change if a water supplier is experiencing a severe water shortage that cannot be solved another way.[19]

Few Oklahoma utilities have actual leak detection and repair programs. A few have well planned priority systems that, based on customer reports, evaluate water loss and potential damage caused by leaks. Leaks are then repaired from a priority list in the most cost-effective fashion. Several of the larger water suppliers also have annual replacement programs which systematically replace older mains.

Of several central Oklahoma utilities, none reported leakage was a serious problem. Average losses were reported as four to eight percent -- well below the nationwide average. The low rate of loss is likely attributable to relatively new distribution systems and systematic maintenance. None of those contacted had a leak detection program, relying on reports from consumers and estimates to determine where water is being lost.

## Pressure Reduction

Pressure reduction is used in areas with excessively high pressure (generally in excess of 80 pounds per square inch) to reduce waste by simply reducing the amount of water delivered.

Pressure reduction in a service connection can reduce water used by 5 to 30 percent, depending on existing pressure levels. Despite potentially high levels of use reduction, total water use reductions will be low due to the limited number of applications. This program would be best considered for long-term, low-percentage reduction, average use goals.[20]

## Watershed Management

Watershed management is used to protect water supplies against contamination and overpumping and/or to maintain and increase water runoff to the source.

Techniques identified during the course of the New England River Basin Commission (NERBC) study include:

1. Evapotranspiration suppression: spraying vegetation in a watershed with a suppressant chemical to cover plants' pores;

2. Forestry management: thinning forests in watershed area to increase flows to source;

3. Zoning: limiting or prohibiting inappropriate land uses in the watershed area;

4. Purchase of surrounding watershed land: maintaining land under direct control; and

5. Subdivision regulations: requiring that development proceeds in a way that does not harm the watershed or recharge the area.[21]

Reservoir Evaporation Suppression

Evaporation suppression minimizes the loss of water through evaporation by covering open storage reservoirs. A program of this nature is expensive and should only be considered if evaporation losses exceed 10 percent or more of the total water supply. Although evaporation suppression is not usually recommended in the more humid areas of the country, it has been successful in protecting water quality in some cases.[22]

## DEMAND MANAGEMENT

Conservation plans become somewhat more complex when it becomes necessary to involve users. In general, users need to have a good reason -- an incentive -- to reduce their water use.[23]

Demand management programs can achieve any type of conservation goal, can achieve immediate use reductions, and can be inexpensive. Table 5 summarizes the advantages and disadvantages of demand management.

TABLE 5

| ADVANTAGES | DISADVANTAGES |
| --- | --- |
| Versatile | Utility revenues may drop |
| Some are inexpensive | Success varies according to user cooperation |
| Some do not require a lot of labor | User opposition can develop to some programs |
| Some can be quickly implemented | Positive results tend to diminish over time |

Following is a discussion of three operational demand management programs -- water pricing, regulation, and education.

## Pricing

Pricing programs, if properly designed, can earn extra revenue for a utility as consumption drops. (If the utility is unmetered, pricing cannot be used because water charges are not based on consumption.) Pricing has been shown to be most effective for long-term, low percentage, average or peak goals -- especially in encouraging reduction of residential peak use and of commercial/industrial average use.

The costs of a pricing program are mostly one-time costs. The utility has to set up a new billing system and, in most cases, a rate survey or cost of service study would be highly advisable.[24]

The principle goal in setting water rates is to secure sufficient revenue to offset costs, or in the case of a few commercial companies, to achieve a profit. Other goals should be that the pricing system is "equitable" and discourages "waste."[25]

Five common pricing systems are briefly described in Table 6. A flat rate and a declining block rate are the least equitable and do not promote elimination of waste. Although the uniform rate is considered equitable, it often has only a minor effect on waste. The increasing block rate and the peak load, or seasonal rate may offer the greatest opportunity for discouraging waste.

The key to an effective water pricing policy from the standpoint of conservation is to make it clear to the user that he can save money by minimizing water use. Therefore, the increase in water costs for quantities above the reasonable minimum required must be great enough to attract attention and become a factor of special concern in his budget or operating expenses. Pricing systems, such as the increasing block rate and the peak load (or seasonal) rate, offer an opportunity to

TABLE 6. SUMMARY OF PRICING SYSTEMS

| TYPE OF SYSTEM | DEFINITION AND COMMENTS | DEGREE OF EQUITY | EFFECT ON CONSERVATION |
|---|---|---|---|
| Flat Rate | A fixed amount is charged per time period, regardless of services used. Usually found in unmetered areas. The rate is often varied according to the size of the line. | Not Equitable | None |
| Declining Block Rate | The price per unit of water decreases as the quantity of use increases. Most commonly used rate structure in Oklahoma. | Not Equitable | Adverse |
| Uniform Rate | A constant price per unit of water is charged, regardless of the quantity used. | Equitable | Slight |
| Increasing Block Rate | The price per unit of water increases as the quantity of use increases. This rate used only rarely in Oklahoma. | Equitable | Major |
| Peak Load or Seasonal Rate | The price per unit is based on a uniform rate for a certain quantity. Unit cost above the base quantity increases with use. | Equitable | Major |

increase the awareness of the relationships between quantity used and cost.

Ad valorem taxes, often imposed to make capital improvements to a water system, are not visible as part of the water bill. For this reason they do little to encourage conservation.

In some parts of Oklahoma, charges for sewage treatment are included in the water bill. This is justified on the basis that the size of sewage treatment facilities is a function of the quantity of water to be treated. Including this cost serves the purpose of encouraging conservation by making the water bill significant to the user.

## Regulation

Regulation is a demand management program involving issuance of restrictions on the use of water, thus encouraging users to conserve to comply with the law (or suffer penalties). The program can be used to achieve almost any conservation goal, but is most effective for short-term, low percentage, average or peak reduction goals. Regulation can be quickly implemented and achieve immediate results.

The major disadvantage to regulation is that revenues will drop as consumption drops. Some users may oppose limitations on how they can use water.

Regulation is an effective, reliable demand management program. It has been highly successful in cities across the country. If a utility can overcome the revenue loss, regulation will likely be considered as a part of most conservation programs.[26]

Education

The main features of an education program include informing the users of the need to conserve and emphasizing how it will help the community or rural water district solve its problem while saving users money.

An education program can be effective for almost any goal. During a water crisis, it has been used frequently and successfully as the only conservation program for reducing water demand.

Education is generally well received by a community and can help reduce user opposition. For education to be successful, it must be reinforced -- repeated frequently.

The major disadvantages are that revenues may decrease with consumption, and results are not reliable because of the voluntary nature of the program.[27]

Although not a direct measure of saving water, education is an essential step toward implementation of direct water conservation measures. For example, the statewide use of low flush toilets and other waste-saving devices and appliances would save large quantities of water. But if consumers are to be receptive to the costs and inconveniences of water saving, they must be informed of the benefits and be convinced of the need to save water. At the same time, lawnmakers must be fully informed if they are to consider legislation concerning the use of low water using devices and fixtures.

User habits and views about the immediate availability of water are firmly established in the mind of the average consumer. Education is needed to overcome the commonly held view that water is abundant and that wasted water is of little consequence. A well-planned educational program is necessary to raise consumer's awareness -- to create a "water conscience."

Conservation education should be a long-range program intended to promote a conservation ethic. The first objective should be to convince local officials and managers or directors of water agencies and utilities of the need for long-range educational programs. These decision-makers must understand water conservation if they are to allocate funds and resources for such programs. The support of professional groups such as the American Society of Plumbing Engineers, the American Water Works Association, the Oklahoma Horticultural Society and the Oklahoma State University Cooperative Extension Service is essential. Environmental groups, such as the Sierra Club, can also lend powerful support for such a program.

A large portion of Oklahoma's population consists of school age children. Water conservation should be included in public school curriculum as part of an effort to instill the careful management of our resources.

Advertising is also a powerful tool that can inform the public through radio, television, newspapers and magazines. Cooperation with the media is an essential part of the program. Information can also be disseminated at a more personal level through public meetings, conferences, seminars and workshops.

## CHAPTER IV

## DEVELOPING A LOCAL WATER CONSERVATION PLAN*

During 1979 the New England River Basins Commission (NERBC), in cooperation with the U.S. Geological Survey, Resources and Land Investigations Program, developed a planning procedure for local water conservation. The project included an extensive literature search, development of local case studies, interviews with water supply engineers and policy makers and an evaluation of the effectiveness of alternative water conservation measures. From the information gathered and analyzed, NERBC developed a seven-step procedure designing a local conservation plan. The information contained in this chapter summarizes the data included in their February, 1981 report.

Even though the report was originally addressed to New England, the procedure outlined here is just as applicable to the State of Oklahoma. It is a flexible procedure which can be used by any type of water utility to meet a variety of goals.

Seven steps which were identified by the NERBC as essential to the formulation of an effective water conservation program at the local level are as follows:

1. Identify the problem/establish conservation goal;

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*SOURCE: New England River Basins Commission, Before the Well Runs Dry, Federal Emergency Management Agency, February, 1981.

2. Assess potential of supply management;

3. Analyze cost-effectiveness and impacts of management programs;

4. Identify actions to minimize adverse impacts;

5. Design management program;

6. Select and evaluate equipment; and

7. Summarize plan and its potential effects.

While water supply planning is conducted at all levels of government, the water supplier has the primary responsibility for developing adequate sources, ensuring safe and potable water, and delivering water in the most cost-effective and equitable manner possible. The water purveyor also has primary responsibility for water conservation planning.

Each water conservation plan will vary based on a number of factors. Listed below are several factors that can have a substantial effect on the design of an appropriate plan.

1. Number of connections/people in the service area;

2. Average annual water use;

3. Average annual use by user category (residential, industrial/commercial, public/institutional);

4. Average annual water use by user category, in percentage of total;

5. Average annual summer use;

6. Peak to average use ratio;

7. System safe yield;

8. Major high volume users and existing water use;

9. How much of the system is metered, according to user category;

10. Water rate structure; and

11. Community use of utility revenues for other programs.

In addition to the factors above, the local conservation plan must reflect the local legal institutional framework.

When cooperation is desired from local water users, it is essential to involve local interests and the public at large who will be affected by any conservation program. The degree to which public participation is required depends to a large extent on the institutional characteristics of the utility and the community setting. For example, in a small community or rural water system, ad hoc advisory committees and close coordination with elected officials can provide all the feedback needed to analyze and shape water conservation proposals. However, in large urban communities, formalized advisory committees may be required (along with considerably more time) to make detailed presentations to chief elected officials before conservation proposals emerge which can be presented to the general public.

It is highly desirable to build into the planning process the time and techniques necessary to consult with community leaders and interest groups having the largest stake in a water conservation effort. Public meetings should be scheduled with enough publicity at key points along the way to generate wide exposure and discussions of alternative conservation measures.[28]

## STEP 1: IDENTIFY PROBLEM/ESTABLISH CONSERVATION GOAL

The problem which has created the need for water conservation must be understood and accepted by local leaders if any plan to conserve water is to succeed. Therefore, it is important to convey this information to local elected officials, local government officials and key community leaders as soon as possible. It is hoped these officials will then assist in establishing a conservation goal.

Conservation can usually solve problems of inadequate supply, excessive energy consumption, and excessive waste water flows. The cause of the problem determines the conservation goal. The major causes of inadequate supply are drought, supply contamination, inadequate storage and/or distribution facilities, and excessive user demands.[29]

The percentage reduction should be expressed numerically. Consider that a range of one to ten percent reduction is low and a range of ten to twenty percent and over is high.[30]

## STEP 2: ASSESS POTENTIAL OF SUPPLY MANAGEMENT

In any conservation plan, supply management should be considered first. Designed to improve the efficiency and reduce waste within the production and delivery systems, supply management can reduce water loss and waste without dependence on water users.

If supply management is not adequate, then demand management should be considered.

## STEP 3: COST ANALYSIS AND IMPACT

The NERBC identified five supply management programs:

1. Metering;
2. Leak detection and repairs;
3. Pressure reduction;
4. Watershed management; and
5. Evaporation suppression.

The following demand management programs were noted:

1. Pricing - changing the water rate to encourage users to conserve to save money;

2. Regulation - issuing a restriction on the use of water, thus encouraging users to conserve to comply with the law; and

3. Education - informing users of the need to conserve, emphasizing that conservation will help the community solve its problems and help users save money.

In selecting the most effective program for a public water supplier, the cost-effectiveness and potential impacts associated with each aspect of the program should be analyzed.

A cost-effectiveness analysis weighs the costs of implementing a program against the expected results. If the results are worth the investment, the program is cost-effective. Some of the factors that are considered include the following:

1. Can this program save money?

2. Can the program ease the community over a water shortage?

3. Is the program fair?

Most supply management programs are cost-effective because they improve system efficiency. Some programs are capable of recovering lost revenues.[31]

The success of each management program depends on the characteristics of the community. The impacts listed below are common to all types of utilities and should be considered during the planning of any local conservation plan.

Change in Revenues

Metering and leak detection repair can recover revenues that have been lost through the under-registration of flow or the unauthorized use of water, such as hookups to an unmetered fire line. Pricing may increase revenues; education and regulation usually decrease them.

Costs to Implement Program

Costs of implementation will vary depending on the scope and objectives of the program. As mentioned earlier, supply management is generally more expensive than demand management.

Effect of Reduced Water Use Within the Community

With reduced water use within a community, variable costs of water production and delivery will decrease, new source development may be postponed, reduced or eliminated, new connections may become available, and potential damage to landscape and community aesthics (parks, fountains and water-related recreation areas, etc.) may result.

Public Reaction to Conservation Program

The degree of acceptance of the program will likely depend on the public's concept of its "fairness."

STEP 4: IDENTIFY ACTIONS TO MINIMIZE ADVERSE EFFECT

At this point in the procedure, all management options have been identified and analyzed. Preliminary findings should be reviewed with local elected officials and representatives of key groups in the community. It is important that the individual (s) presenting the information highlight the costs and relative effectiveness of the various approaches, indicating which could be eliminated based on their cost in relation to the amount of water to be saved. Conservation approaches that have the most adverse consequences should be noted along with appropriate efforts to minimize these impacts. A concerted effort should be made to approach those groups that conservation will affect negatively.

Involvement of others at this point in time in the planning procedure (e.g. various interest groups) will offer a valuable reexamination of some conservation approaches. A second look (or third or fourth) is preferable to prematurely eliminating or selecting a program which still presents major questions regarding its costs, reliability and impacts.

Media coverage can also be valuable at this juncture. Public meetings or television coverage is encouraged of panel discussions which discuss why the conservation plan is needed, what alternatives are being reviewed, how long they will benefit the community, as well as any impacts.[32]

An education program can help almost any kind of conservation plan. Education is well received by users and can greatly improve their understanding, which in turn assists a public water supplier get the cooperation needed in implementing a successful conservation campaign.

## STEP 5: DESIGN THE MANAGEMENT PROGRAM

Having analyzed the impacts, necessary modifications, and the cost-effectiveness of the many conservation programs, administrators of a water supplier should be able to select the programs that will be most effective in their service area.

Supply management programs should be selected which have the fewest adverse impacts. Each program should again be reviewed to verify it has the potential to meet the conservation goal established. Once this has been accomplished, local planners can proceed with Step 6.

If demand management is required to meet the conservation goal, a more specific program should be designed using the following guidelines before proceeding to Step 6.

Pricing

If a pricing program was selected, it will be necessary to design a new water rate. Usually, a change in both price level (price per unit of water) and price structure (price level variations according to quantity used or time of use) are necessary. The most important part is price level. Only when the price level is high enough, regardless of structure, will users reconsider how they are using water and conserve.[33]

Any new water rate should be designed to accomplish the following:

1. Encourage the needed use reduction;
2. Cover the total cost of service; and
3. Minimize adverse impacts.

To achieve the necessary use reduction, it is important to estimate as accurately as possible the response by users to the new price, i.e., the elasticity value. Generally, as the price goes up, the demand for the produce goes down. As the price for water increases, the users will reduce their use. The elasticity value is simply the arithmetic value of the user's response, expressed as:

$$\text{Elasticity} = \frac{\text{Percent Change in Water Used}}{\text{Percent Change in Price}}$$

If response is low (i.e., water consumption is not reduced significantly in response to a price hike), then the elasticity will be low.

The value that will best describe the response of a service area to a change in price will depend on many factors, including the following:

1. The new price level (the lower the price, the less response);

2. The average user income (the higher the income, the less the response);

3. Average number of people per household (the larger the number, the less the response); and

4. The average rainfall and temperature (the more temperate the climate, the less the response).

Elasticity values for specific communities in the United States (applicable to New England) are as follows:[34]

| | RANGE |
|---|---|
| Total residential use | -0.05 to -0.45 |
| Indoor use | -0.07 to -0.30 |
| Outdoor use | -0.22 to -1.57 |
| Total commercial/industrial use | -0.56 to -1.33 |

In order to estimate an appropriate elasticity value for a specific service area, it is necessary to determine the factors significant to that area, then choose a value judged to best reflect how users will respond to a price increase. For most communities, elasticity value will be among the lower of those presented above. If there are two or more distinct user groups in the community, such as small-volume residential users and large-volume industrial users, an elasticity value should be selected for each group.

After the elasticity value has been obtained, the new water rate can be designed utilizing the following six-step method as identified by the NERBC:

A. Express the percentage reduction goal numerically, if this has not already been accomplished.

B. Estimate how much water use will drop after the price goes up, i.e., elasticity value for your community.

C. Determine percent of change in price needed to achieve the goal. Take the percent reduction goal (from Step A) and the elasticity value (Step B) and plug it into the elasticity equation. Solve the equation to arrive at the percent change in price.

D. Determine what the new revenues will be as a result of the new price level.

E. Compare the new revenues with your costs (remember variable costs will drop as water use drops). If the revenues are too low, you may need a higher price; if the revenues are too high, you may need a lower price; or a new price structure may be selected that will change revenues.

F. Pick a structure. There are at least 20 different kinds of price structures that can be used to modify price levels so that the total water rate (level and structure) can achieve one or more of the following:

    1. Reduce demand to achieve a conservation goal;

    2. Cover the true cost of supplying water;

    3. Be fair to all users in the service area;

    4. Reflect the point at which user demand is influenced in the service area; and/or

    5. Be politically acceptable.

(Note: A discussion on common price structure is contained in Chapter III.)

Any water rate has the ability to recover the total cost of service if the price level is high enough. When costs are compared to new revenues, it is important to include all costs -- including those of the conservation program itself -- so only one price hike will be necessary within a short period of time. Otherwise, a public utility may face overwhelming opposition and a loss in users' confidence.

Regardless of how the new rate is designed, there is likely to be some opposition. An educational program explaining the need for the hike will help to minimize the negative response.[35]

Regulation

If it is necessary to implement a program of regulation, specific regulations will have to be drafted to limit water use. Water limitation regulations are usually used to:

1. Restrict a specific water use;
2. Restrict the time during which specific uses are allowed;
3. Allow specific uses (such as pool filling) by permit only;
4. Restrict the quantity of water which can be used; and
5. Require the installation of low water using appliances only.

Table 7 lists the most commonly used regulations according to the conservation goal each has the most potential to achieve. A combination may be best suited depending on the specific situation in each service area. In some communities, regulations may not be allowed due to local laws. Regulations limiting specific uses may not be practical because they require enforcement, which may be impossible to implement. Other regulations, such as rationing, plumbing code changes and appliance retrofitting, may not be effective because of user and political opposition.

It is important that the use of stringent regulations, such as rationing and use bans, be reserved for high percentage reduction, short-term goals and for times of extreme emergency such as drought. Otherwise, user opposition may be substantial enough to reduce cooperation.

TABLE 7. REGULATIONS ACCORDING TO CONSERVATION GOAL

| | Short or Long Term Goal | % Reduction in Water Use LOW | HIGH |
|---|---|---|---|
| **FOR AVERAGE DEMAND PROBLEMS** | | | |
| Restricting Quantity: Rationing* | S,L | | |
| Restricting Quantity: Moratorium on new hook-ups | S | | |
| Restricting Use: Restaurants serve water only on request | S | | |
| Requiring Special Equipment: Plumbing code changes | L | | |
| Requiring Special Equipment: Appliance Retro Fit | L | | |
| **FOR PEAK DEMAND PROBLEMS** | | | |
| Restricting Use: Ban car washing, irrigation, etc.* | S,L | | |
| Restricting Time: Limit car washing, landscape irrigation by months, days | S | | |
| Requiring Special Equipment: Landscape irrigation with hand held hose only | S | | |
| Requiring Permit: Pool filling | L | | |
| Restricting Time: Limit hours for car washing, irrigation, etc. | L | | |

*Probably not well accepted on long term basis.

SOURCE: New England River Basin Commission, Before the Well Runs Dry, A Handbook for Designing a Local Water Conservation Plan, Federal Emergency Management Agency, February 1981.

Less stringent regulations, such as plumbing code changes and limits on specific uses, are usually well accepted for long-term, low percentage goals.

All regulations require some level of enforcement. It is important that labor is available to enforce regulations or they may fail to achieve their goal.[36]

In order to implement a regulatory program restricting water use, it is necessary for most public water suppliers to have the authorization of the appropriate authority - usually the city council, commission or governing board. A sample ordinance is attached as Appendix A of this report.

## Education

Education can be the key to the success of a conservation campaign because it can help users understand why conservation is needed. It can also minimize opposition to other programs and improve water supply planning coordination among community officials.

Education is most effective during a crisis when user awareness of water is high. At other times, users need constant reminders of the need to conserve. Therefore, education programs need to be frequently repeated.

School conservation programs have proven successful in a number of areas across the country. School programs can teach children water-saving habits, and they will possibly teach their parents as well.

## STEP 6: SELECT AND EVALUATE EQUIPMENT

Each supply management program implemented will require specialized equipment or actions. For example, if metering is selected, administrators of the water supplier will have to choose the type of meter for installation and/or design a meter replacement (or maintenance) program. Decisions of this nature will depend on the individual community and the preference of responsible officials.

Reduction of water use in the user's home or business can be accomplished through: 1) water saving fixtures, 2) reuse/recycle systems, and 3) user habit changes.

Water-Saving Fixtures

The choice and installation of a water-saving fixture is usually done by the user. Many utilities have developed education programs to inform users which fixtures are best, where to get them and how they should be installed. Some have bought the fixtures and sold them to users at cost, while still other utilities have bought, distributed and installed them in the user's home or business. The most effective program has been when the utility handled purchase, distribution and installation. Even though this type of program is expensive, it can be cost-effective in some situations.[37]

The most successful water-saving fixtures are those which operate in a manner exactly like conventional fixtures, which include the following:

1. Toilet tank inserts (dams, bottles, etc.);
2. Shallow toilet traps;
3. Low flow showerheads;
4. Hose attachments; and
5. Automatic shutoff valves (public lavatories or industrial/commercial use).

When the above fixtures have been installed in a majority of homes or businesses, the NERBC estimates a water supplier can expect up to 15 percent average use reduction. They note these fixtures are reliable and are likely to reduce use for the short-term as well.[38]

For high percentage reduction goals, the only reliable fixtures for residential use are expensive (i.e., vacuum flush toilets and pressurized flush toilets). Therefore, if high percentage reduction is required, a water supplier should consider relying on large-volume users to reduce their use. Substantial system-wide reductions in water use can be achieved if a few of the largest users cut their demand dramatically. Fixtures, such as multiple rinse tanks and counter-flow rinses, can achieve up to 99 percent reduction in some industrial processes (often a community's largest water consumer).

Table 8 indicates some commonly used water saving fixtures according to conservation goals.

Reuse/Recycle Systems

Reuse/recycle systems can be used to achieve nearly any conservation goal, but are best for long-term, average or peak goals. They are usually too expensive for short-term goals.[39]

The implementation of individual systems such as grey-water reuse is probably too difficult for broad-based residential application. Further, residential users have shown resistance to reuse/recycle systems.[40]

To date, these systems have been used most frequently by industry. Increasing water and waste water disposal costs are making reuse/recycle systems (particularly reuse) more cost-effective. They are reliable enough to achieve long-term reductions and can be designed to meet any

## TABLE 8. COMMONLY USED WATER SAVING FIXTURES ACCORDING TO CONSERVATION GOAL

Step 6

| | Short or Long Term Goal | COST: Capital | COST: Compared to Conventional Fixtures | % Reduction in Water Use (0% 50% 100%) | Use Pattern Similar ? | Comments |
|---|---|---|---|---|---|---|
| **FOR AVERAGE DEMAND PROBLEMS** | | | | | | |
| Shallow Trap Toilet | L | $75 | = | | ✓ | Very well accepted by users. |
| Dual Flush Toilet | L | $85 | = | | ✓ | Minor change in use pattern required. |
| Toilet Tank Inserts | S,L | $.90-4.00 | | | ✓ | Retro-fit to conventional fixtures. |
| Shower Flow Restrictors | S,L | $.75-25.00 | = | | ✓ | Some retro-fit to conventional fixtures. |
| Faucet Aerators | L | $1-5 | = | | ✓ | Well accepted by consumers. |
| Hot Water Pipe Insulation | L | $.50/ft. | ↑ | | ✓ | Saves up to 8 gals. per capita per day. |
| Fog and Spray Nozzles (IND./COM. ONLY) | S,L | $150 | | Variable | ✓ | Retro-fit to conventional fixtures. |
| Vacuum Flush Toilet | L | Expensive | ↑ | | ✓ | Mixed acceptance by consumers. |
| Pressurized Flush Toilet | L | $360 | ↑ | | ✓ | Requires electricity. |
| Multiple Rinse Tanks (IND./COM. ONLY) | L | Expensive | | | | Change in process required. |
| Counter-Flow Rinse (IND./COM. ONLY) | L | Expensive | ↑ | | | Change in process required. |
| Automatic Flow Regulators (IND./COM. ONLY) | L | $190 | | | ✓ | Retro-fit to conventional plumbing. |
| **FOR PEAK DEMAND PROBLEMS** | | | | | | |
| Drip Irrigation Systems | L | $7-30 | = | Variable | ✓ | For gardens, trees, shrubs only. |
| Time Controlled Sprinkler | L | $70 and up | ↑ | Variable | ✓ | Needs electricity. |
| Moisture Indicators | S | $.05-25.00 | = | Variable | NO | Mixed acceptance by consumers. |
| Hose Attachments | L | $1-40 | = | Variable | ✓ | Well accepted by consumers. |
| Swimming Pool Covers | L | $220-4,800 | ↑ | | NO | Mixed acceptance by consumers. |
| Tensiometers | L | $15-30 | ↑ | Variable | NO | Mixed acceptance by consumers. |

SOURCE: New England River Basin Commission, *Before the Well Runs Dry, A Handbook for Designing a Local Water Conservation Plan*, Federal Emergency Management Agency, February 1981.

situation. They are likely to be used more frequently in the future despite their expense (both capital and operation) and the resistance from residential users.

### User Habit Changes

User habit changes should not be relied upon to achieve long-term goals since it is difficult to change people's habits permanently. For the same reason, user habit changes should not be relied upon to achieve high percentage reduction goals, even for a short time, unless there is a severe crisis. During crises, users are generally much more cooperative and are willing to alter their normal patterns of behavior. In cases where utilities have relied upon user habit changes to reduce water use during a crisis, it has been found that people usually return to their water wasting habits when the crisis was over.[41]

While user habit changes may be the least expensive way of reducing water use, they will in most cases be limited to use for short-term problems.

## STEP 7: SUMMARIZE FINAL PLAN

To ensure that the conservation plan is complete, it should be summarized as follows:

1. Conservation Goal
2. Supply Management Programs
3. Demand Management Programs
4. Public Involvement

As a last check, it is advisable to make a formal presentation to the local elected officials, and have the Advisory Council (if organized for your community) report on the process and give their perception of the public reaction. If possible, this event would be well served by one or more media activities concentrating on the positive theme that the community has, through the wise leadership of its elected officials, set in place a management framework which will enable the community to better meet its water supply needs. Once the programs have started, other sources of public information (churches, schools, community organizations, etc.) should be utilized to spread the word and maintain the public's water consciousness, particularly if critical times are expected. It is important that newly elected or appointed officials are briefed on the plan, its purpose and methods, because the conservation plan will need continuing support over time if it is to be of value to the community.[42]

# CHAPTER V

# SAMPLE CONSERVATION PROGRAMS

## WASHINGTON D.C. SUBURBAN SANITARY COMMISSION (WSSC)

In 1970, a potential water supply shortage, coupled with a ban on new sewer connections caused by insufficient sewage treatment facilities, led to a moratorium on new home construction in Hyattsville, Maryland. As a result, WSSC began an imaginative program to reduce water use and waste flows. The campaign included consumer involvement and education, retrofitting of plumbing devices and appliances, and legal measures.

### Consumer Involvement and Education

a. Water-Saving Idea Contest, with U.S. Series "E" bonds as prizes

b. Free distribution of residential interior conservation handbook, "It's Up to You," to all customers

c. Water saving workshops for all property owners

d. Slide speaker programs

e. House-to-house distribution of information cards, buttons, stickers, bumper stickers

f. Series of radio and TV spots

g. Continuous newspaper publicity

h. Poster contest, with U.S. Series "E" bonds as prizes

i. Free distribution of a handbook, "Keeping the Garden Green"

j. Production of the film, "Drip," for schools and community groups

k. Information about appliances, such as dishwashers and washing machines

l. Organized "Camel Day," a one-day demonstration of minimal use of water with public participation.

Retrofitting and Leak Detection

a. Installation, maintenance and testing of several types of toilet-tank inserts and shower flow restrictors

b. Free distribution of 890,000 plastic quart bottles for reducing water volume in toilet tanks

c. Free distribution of 400,000 shower head flow restrictors

d. Free distribution of 600,000 dye pills for detection of leaks in toilet tanks

Legal Measures

a. Revision of the plumbing code to require pressure-reducing valves, water saver toilets and low flow shower heads, and to set the maximum allowable faucet flow in new and replacement construction

b. Compilation and maintenance of a list of approved water saving devices

The conservation campaign resulted in annual water savings of 8,000 acre-feet.[43]

MARIN MUNICIPAL WATER DISTRICT (MMWD)

MMWD began a comprehensive water conservation program in recent years to minimize cost and inconvenience to consumers. Except for new construction, the program has been voluntary. In 1976, the occurrence of a dry year prompted the District to place mandatory controls on use of water for landscape watering, sidewalk cleaning and car washing.

The Water District credits its campaign of public education with the reduction of per capita use from 171 gallons per capita per day in 1970 to 160 gallons per capita per day in 1976. A retrofit program is expected to reduce per capita water use in existing homes and businesses to 136 gallons per capita per day by 1984 and other construction per capita use to 117 gallons per day.

The retrofit program for present consumers included free distribution and installation of water-saving devices, including flow control inserts and low flow shower heads that restrict the flow to a maximum of 3.5 gallons per minute; door-to-door distribution of dye pills for leak detection; and weighted plastic bottles for tank installation. MMWD encourages installation of pressure reducing valves on domestic plumbing fixtures where needed to reduce water pressure to 50 pounds per square inch.

To encourage retrofitting, MMWD contacts consumers in two ways: (1) billing inserts, with a postage-paid return card to request water conservation devices, and (2) a door-to-door canvass by college students.

In all new construction, plumbing features such as 3.5 gallon toilet tanks, three gallons per minute shower heads and pressure reducing valves which restrict pressure to 50 pounds per square inch are required. Hot water pipes must be insulated and hot water recirculating systems are required.

As part of the overall water conservation program, MMWD:

a. Evaluates landscaping in specified areas. In some areas, irrigation systems must be approved.

b. Evaluates all proposed water conservation measures.

c. Sets recycling requirements for car washing facilities.

d. Requires the use of reclaimed waste water when it is available at reasonable costs.

e. Requires the use of recycling and water saving devices as made possible by advancing technology.

f. Provides technical help to large public and private irrigation consumers and recommends improved irrigation practices and landscape alterations.

g. Provides technical help to industrial and commercial consumers.

h. Conducts seminars and conferences to demonstrate water saving techniques in the garden.

As part of the consumer education program, MMWD has sponsored a low water-using garden at the Marin County Civic Center.

# CHAPTER VI

## SUMMARY

Increasing public concern for preservation of the value of our water resources and the continually increasing cost of water development have emphasized the need to investigate alternative methods of satisfying rising water demands. In this report, water conservation is discussed as one method that can be effectively utilized to address a variety of water supply problems.

Municipal water use is second only to irrigation in demands on state water resources. An analysis of residential practices reveals substantial water savings can be realized through retrofitting with water-saving devices in existing homes and installation of water efficient plumbing fixtures in new and replacement construction.

A seven-step procedure developed by the New England River Basins Commission is presented, detailing the design of a local water conservation plan. The procedure is designed to accommodate the distinctive needs of individual communities, reflecting the local legal institutional setting. Public water suppliers are encouraged to first utilize supply management, conserving within the supply system, before attempting demand management. Saving water within the supply system is relatively straightforward, while relying on users makes the plan more complex.

Among options available to a water supplier are the supply management tools of metering, leak detection and repair, pressure reduction and watershed management; and demand management tools such as pricing, regulation and education.

Even though water supply planning is conducted at all levels of government, the water supplier has primary responsibility for developing adequate sources, ensuring safe and potable water, delivering water in the most cost-effective and equitable manner possible and planning for water conservation. This report is intended to provide technical assistance to Oklahoma public water suppliers in developing local conservation plans. It is hoped that it will give the reader a better understanding of the important role water conservation can play in alleviating water supply problems of both a short and long-term nature.

The Oklahoma Water Resources Board, as the state agency responsible for the effective management, conservation and protection of state water resources, has a variety of pamphlets, brochures and other literature available on the subject of water conservation.

Other recent publications related to water conservation and/or water use include the following:

Reported Water Use in Oklahoma, 1978, Publication 102.

Oklahoma Comprehensive Water Plan, April 1980, Publication 94.

"Water Rates in Oklahoma," October 1981.

"Oklahoma Water Use Data System, Project Work Plan," November 1980.

"It Pays to be a Water Watcher," Oklahoma Water Resources Board, May 1981.

Rural Water Systems in Oklahoma, September 1980, Publication 98.

On request, staff members are available to speak on the subject of water conservation at public meetings, seminars and workshops.

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## FOOTNOTES

[1]California Department of Water Resources, Water Conservation in California, Bulletin 198, Sacramento, California, May 1976, p. 14.

[2]Ibid., p. 14.

[3]Ibid., p. 14.

[4]Oklahoma Water Resources Board, Oklahoma Comprehensive Water Plan, Publication 94, Oklahoma City, Oklahoma, 1980, p. 67.

[5]Ibid., p. 67.

[6]W.E. Sharpe, "Selection of Water Conservation Devices for Installation in New or Existing Dwellings," Proceedings: National Conference on Water Conservation and Municipal Wastewater Flow Reduction, Chicago, Illinois, November 28-29, 1978.

[7]California Department of Water Resources, Bulletin 198, op. cit., p. 17.

[8]Washington Suburban Sanitary Commission, "Summary Edition, Final and Comprehensive Report, Cabin John Drainage Basin, Water Saving Customer Education and Appliance Test Program," February 1973.

[9]California Department of Water Resources, AB380-A Pilot Water Conservation Program, Bulletin 191, Sacramento, California, 1978.

[10]Sharpe, op. cit., p. 94.

[11]Walker Crosweller and Co., Ltd., Designing for Unataps: A Technical Guide to Hot and Cold Water Systems, Gloucestershire, U.K., Walker Crosweller and Co., Ltd., 1975.

[12]California Department of Water Resources, Bulletin 198, op. cit., p. 23.

[13]Ibid., p. 23.

[14]Ibid., p. 24.

[15]New England River Basins Commission, Before the Well Runs Dry, A Handbook for Designing a Local Water Conservation Plan, Federal Emergency Management Agency, Washington D.C., February 1981, p. 6-7.

[16]Ibid., p. 21.

[17]Ibid., p. 42.

[18]Charles W. Howe, et. al., "Future Water Demands - The Impacts of Technological Change, Public Policies, and Changing Market Conditions on the Water Use Patterns of Selected Sectors of the United States Economy: 1970-1990," Report prepared for the National Water Commission, March 1971.

[19]New England River Basins Commission, op. cit., p. 43.

[20]Ibid., p. 44.

[21]Ibid., p. 45.

[22]Ibid., p. 45.

[23]Ibid., p. 7.

[24]Ibid., p. 45.

[25]California Department of Water Resources, Bulletin 198, op. cit., p. 31.

[26]New England River Basins Commission, op. cit., p. 46.

[27]Ibid., p. 46.

[28]Ibid., p. 16.

[29]Ibid., p. 18.

[30]Ibid., p. 19.

[31]Ibid., p. 42.

[32]Ibid., p. 50.

[33]Ibid., p. 56.

[34]Turnovsky, Stephen J., "The Demand for Water: Some Empirical Evidence on Consumer's Response to a Commodity Uncertain in Supply," Water Resources Research, V. 5, No. 2, April 1969.

[35]New England River Basins Commission, op. cit., p. 63.

[36]Ibid., p. 68.

[37]Ibid., p. 84.

[38]Ibid., p. 84.

[39]Ibid., p. 85.

[40]Ibid., p. 85.

[41]Ibid., p. 85.

[42]Ibid., p. 90.

[43]California Department of Water Resources, Bulletin 198, op. cit., p. 35.

## REFERENCES


California Department of Water Resources, Water Conservation in California, Bulletin 198, Sacramento, California, California Department of Water Resources, May 1976.

California Department of Water Resources, AB380-A Pilot Water Conservation Program, Bulletin 191, Sacramento, California, California Department of Water Resources, 1978.

Howe, Charles W., et. al., "Future Water Demands - The Impacts of Technological Change, Public Policies, and Changing Market Conditions on the Water Use Patterns of Selected Sectors of the United States Economy: 1970-1990," (Report prepared for the National Water Commission), March 1971.

New England River Basins Commission, Before the Well Runs Dry, A Handbook for Designing a Local Water Conservation Plan, Federal Emergency Management Agency, Washington D.C., February 1981.

Oklahoma Water Resources Board, Oklahoma Comprehensive Water Plan, Publication 94, Oklahoma City, Oklahoma, Oklahoma Water Resources Board, 1980.

Sharpe, W.E., "Selection of Water Conservation Devices for Installation in New or Existing Dwellings," Proceedings: National Conference on Water Conservation and Municipal Wastewater Flow Reduction, Chicago, Illinois, November 28-29, 1978.

Turnovsky, Stephen J., "The Demand for Water: Some Empirical Evidence on Consumer's Response to a Commodity Uncertain in Supply," Water Resources Research, V. 5, No. 2, April 1969.

United States Water Resources Council, State Water Conservation Planning Guide, Washington, D.C.: U.S. Water Resources Council, October 1980.

Walker Crosweller and Co., Ltd., Designing for Unataps: A Technical Guide to Hot and Cold Water Systems, Gloucestershire, U.K.: Walker Crosweller and Co., Ltd., 1975.

Washington Suburban Sanitary Commission, "Summary Edition, Final and Comprehensive Report, Cabin John Drainage Basin, Water-Saving Customer Education and Appliance Test Program, February 1973.

Appendix A

SAMPLE ORDINANCE

AN ORDINANCE RELATING TO WATER SHORTAGES; AUTHORIZING DECLARATION OF AN EMERGENCY; DEFINING EMERGENCY; PROVIDING FOR PROCLAMATION AND ORDER; REQUIRING PUBLICATION OF PROCLAMATION; SPECIFYING DURATION; PROVIDING FOR APPEALS; ESTABLISHING PENALTIES; AND DECLARING AN EMERGENCY.

BE IT ORDAINED BY THE (council/board/commission) OF THE (city/town) OF ____________________, OKLAHOMA:

SECTION 1. Whenever an emergency exists by reason of a shortage of water due to inadequate supply, limited treatment or distribution capacity or failure of equipment or material, the (mayor/city manager) is hereby authorized to restrict or prohibit the use of water from the (city's/town's) water system.

SECTION 2. An emergency exists whenever the (mayor/city manager) reasonably determines that the (city's/town's) water system is unable or will within sixty (60) days become unable to supply the full commercial and domestic needs of the users thereof, including adequate fire protection.

SECTION 3. Upon the determination that such an emergency exists the (mayor/city manager) shall issue a proclamation delcaring the emergency and setting out with particularity an order restricting use of water from the (city/town) system. Such an order may (1) restrict water usage during certain periods of the day or week or according to any orderly and nondiscriminatory scheme and (2) prohibit usages not essential to public health and safety. The order may be revised from time to time as the (mayor/city manager) deems necessary.

SECTION 4.A. The proclamation required by the preceding section shall be published in a newspaper of general circulation in the (city/town) or, if there is no such newspaper in which the proclamation may be published within twenty-four (24) hours after the emergency arises, publication shall be by posting a copy of the proclamation in ten (10) prominent places in the (city/town). The emergency shall be in full force and effect upon publication. Substantial compliance with this section is sufficient to effect the emergency.

B. Whenever a sudden or unexpected event so reduces the availability of water or water pressure as to create an immediate threat to public health or safety the notice of the proclamation may be given by any reasonable means, including electronic means. The emergency shall be in full force and effect upon such notice. Provided that, if any such means is other than that required in paragraph A of this section, the proclamation shall be republished in accordance with paragraph A within twenty-four (24) hours of the first notice.

SECTION 5. A duly proclaimed emergency shall continue and the terms of the proclamation shall be in force for thirty (30) days or until such time as the (mayor/city manager) or the (council/board/commission) shall cause to be published a proclamation that the emergency has ended, whichever is shorter, unless the (council/board/commission) by resolution approved by a majority of all its members extends the proclamation.

SECTION 6. Any person feeling aggrieved by a proclamation of the (mayor/city manager) shall have the right to present the matter to the next regular or special meeting of the (council/board/commission) or to any emergency session called to discuss the water emergency. The (council/board/commission) may exempt such aggrieved person, wholly or in part, from compliance with the proclamation order upon a showing that compliance creates an immediate threat to the person's health or safety. The ruling of the (council/board/commission) by a majority vote of all its members shall be final and binding as to the continunce of any terms of the proclamation. Until and unless the action of the (mayor/city manager) is modified or revoked by action of the (council/board/commission) all water users shall be bound by the proclamation.

SECTION 7. Any person who in any manner directly or indirectly violates or permits others under his supervision, custody or control to violate any term of a duly publish proclamation shall be guilty of a misdmeanor. Each separate day of water use in violation of such proclamation shall constitute a separate offense and each separate prohibited use on the same day shall constitute a separate offense. Violation of this ordinance shall be punishable by a fine of __________ dollars ($__________) for each offense.

SECTION 8. It being immediately necessary for the preservation of the public peace, health and safety, an emergency is hereby declared to exist by reason whereof this ordinance shall take effect and be in full force from and after its passage and approval.

## GLOSSARY

ACRE-FOOT: A measure of the volume of water that would cover one acre to a depth of one foot. One acre foot equals 325,581 gallons.

COST OF SERVICE STUDY: A comprehensive analysis of all the factors affecting the cost incurred by a water supplier in providing service to customers.

DEMAND MANAGEMENT: Water conservation programs that depend on users to conserve within their homes or businesses. Demand management programs are generally designed to provide users with an incentive to reduce their water use.

DISSOLUTION: Separation into component parts; disintegration.

DOMESTIC USE: Relating to the household or family; domestic water use refers to that required for washing, food preparation, showers, etc. See "Residential use."

DROUGHT: Generally, the term is applied to periods of less than average precipitation over a certain period of time; nature's failure to fulfill the water wants and needs of man. There is no universally accepted quantitative definition of drought.

LATERALS/SUB-LATERALS: Conduits carrying raw sewage from the collection lines to the main sewer.

LOW-FLOW DEVICES: Any of a variety of water-saving fixtures that reduce the volume of water released on conventional plumbing equipment (e.g., modifications are available for showerheads, faucets, and hose attachments).

METER: An instrument for measuring the amount of water used. Metered water is the water sold to customers on the basis of actual metered use; does not include losses in distribution.

MUNICIPAL USE: Water for a community which may consist of domestic, industrial, and commercial uses.

OVERPUMPING: Removing water from a water source at a rate exceeding that which it is being recharged or replenished.

PERCOLATE: Movement of water through the subsurface soil layers, usually continuing downward to ground water or unconfined aquifers.

PRESSURE-REDUCING VALVES: Valves inserted in a water line to regulate the pressure to a residence or service area. Pressure reducing valves are generally used only where pressure exceeds 80 pounds per square inch.

PRICING: Use of the rate structure and/or price level to encourage consumers to reduce water use without adversely affecting revenues.

PURVEYOR: A water supplier.

RATE STRUCTURE: Price level variations according to the quantity of water used or time of use.

REGULATION: A demand management program in which consumers are limited by specific uses, plumbing code changes or appliance retrofit. Rationing is the term frequently applied to many programs involving regulations.

RESIDENTIAL USE: Refers to water used for domestic use and lawn watering and other outside water use associated with the home.

RETROFIT: To furnish or replace with water-saving fixtures not available when manufactured.

SCAN: A procedure to thoroughly examine a water system for leaks using listening techniques. The most widely used listening equipment includes the aquaphone, the geophone, and electrosonic instruments.

SEPTIC TANK: A tank in which the solid matter of flowing sewage is disintegrated by bacteria.

SPRAY TAP: This device mixes air with water and propels the mixture, using a water flow of .25 to .5 gallons per minute - a reduction of over 90 percent from conventional showers. The reduced flow will also save energy, although some energy is required to produce the compressed air. This new device still requires testing to determine consumer acceptibility.

SUPPLY MANAGEMENT: Refers to programs to reduce water loss or waste within the supply system without depending on water users.

UNNACCOUNTABLE WATER: The difference between the quantity of water introduced into the system and the quantity delivered to the eventual customer; usually expressed as a percentage of delivered water.

URBAN USE: Refers to water use for urban purposes including residential, commercial industrial, recreational, etc.. The term is applied in the sense that it is a kind of use rather than a place of use. Included delivered water and unnaccountable water.

VACUUM FLUSH TOILET: Uses either a low vacuum or an injection or air to assist in removing waste from the bowl. They operate on 1.5 to 2 quarts of water per flush - up to 90 percent less than conventional toilets. Compared to the standard gravity-flow-waste-discharge system, the vacuum system is complicated because it requires energy to activate the necessary air pressure. Vacuum toilets, which can be used with existing sewage-collection systems, have been used in Europe for years.

WATERSHED: A region bounded peripherally by a water parting and draining ultimately to a particular watercourse or a body of water.