Water-Related Issues and Problems

Introduction

Presented here are state water issues identified by the Citizens' Advisory Committee and Technical Advisory Sub-Committee as a result of numerous meetings of both groups held from January 1994 through March 1995. The 20-member OCWP Citizens' Advisory Committee brought a grass-roots perspective to the formation of state water management and protection strategies while the Technical Advisory Sub-committee facilitated the involvement of 23 relevant state and federal agencies. The two groups also reviewed updated water use projections for Oklahoma.

This section highlights substantiating discussion of each water issue and/or problem. Prescriptive options developed by the committees to deal with these issues -- i.e., recommendations -- are presented in the following section.

WATER RIGHTS

Stream Water Rights & Administration

While problems related to state water rights management arise from time to time, the general abundance of supply (though unevenly distributed) and relatively strong legal foundation upon which Oklahoma water law is based preclude many potential conflicts surrounding administration of the current system. State laws relating to non-use and forfeiture of water rights generally serve their intended purpose -- i.e., to ensure that Oklahoma's water resources are used beneficially and for the good of the public.

The current system also benefits the state by encouraging small-scale water rights marketing agreements and local transfers which protect often costly investments made in putting state water to beneficial use. Without forfeiture proceedings or related measures to manage and control use, "stockpiling" of rights could result, leading to the inefficient use and development of water resources.

Still, stream water rights and administration could be improved through judicious revision of OWRB regulations. Because original Oklahoma water laws were not specifically designed to promote conservation of supplies, there is room to modify the existing system to maximize efficiency of use. The system could also be improved through more judicious enforcement, expansion of data collection and management programs (including hydrologic studies), and development of educational programs.

It has been argued that the prior appropriation system of water rights may encourage the uneconomic use of water and many question the need for statutes relating to water usage and forfeiture of rights, especially in significantly underappropriated stream systems where these regulations may encourage permit holders to waste water and deliberately overreport use. Also, in stream systems where relatively little water is available for appropriation, criticism has been directed at lenient schedule of use provisions that allow water resources and rights to be tied up for 50 years or more. In addition, regular permits issued under the current permitting system appropriate stream water on a year-round basis. As a result, the system does not take into account seasonal climatic variations (i.e., regional rainfall totals) or varying seasonal uses of water (for example, increased irrigation during the summer months) which affect immediate water availability.

Few problems exist with current forfeiture and cancellation/reduction laws. However, it is likely that other measures or regulations could be implemented in conjunction with, or in place of, existing laws to better ensure the intelligent and optimum use of Oklahoma's water resources while still protecting prospective water users (for example, allowances for cases where no other user is demanding water on a particular stream). Future efforts to improve this situation will be directed at more accurate accounting of water supply and use and more realistic determinations of "beneficial use" and "present or future need" in permit application proceedings

Currently, the OWRB lacks administrative enforcement authority to prohibit violations of permitted water use and is required to petition district court to impose compliance measures. Such problems hinder enforcement efforts and give added credence to an alternative system that provides financial and other incentives in exchange for compliance.

Finally, as competition increases for water resources, reliable information on the amount of water available for appropriation will be critical to ensure that the optimum amount of water is used to benefit the state's economy. While hydrologic surveys have been completed on virtually all state stream systems, it is essential that these investigations are continually updated. In addition, Oklahoma's current system of water use reporting requires some modification to better facilitate the collection of accurate, dependable data on usage.

Instream Flow Protection

Inadequate instream flow adversely affects all beneficial uses, including aquatic life, recreational activities, aesthetics, hydropower generation and navigation. Low flows can be caused by climatic and hydrologic conditions, diversions or operation of reservoir storage for offstream project purposes. Water quality problems that can result from insufficient streamflows -- many of which could also be addressed through potential watershed management or non-consumptive use permitting initiatives -- include inadequate dilution of point and nonpoint pollution discharges and damaging changes in water temperature and dissolved oxygen levels.

Excessive flows can be equally damaging. High flows may result from natural causes, such as storm events, or man-induced causes, such as reservoir regulation, causing adverse impacts on aquatic life, recreational activities and other instream uses.

Instream flow is indirectly recognized in Oklahoma's laws governing stream water use. However, several provisions in laws relating to water and water rights could provide specific opportunities to assure protection of stream flows. In general, some streamflow is protected by the requirement in the law relating to appropriation permits that prohibits interference with domestic uses. When the Oklahoma Water Resources Board considers appropriation permit applications, it must determine that the proposed appropriation use will not interfere with domestic uses. Board rules provide that for every affected household downstream of the proposed diversion point, it is presumed that 10 acre-feet of water per year is necessary to protect the domestic use of each household, unless there is evidence showing otherwise. This total of domestic use water must be allowed to "flow by" the point of diversion, thereby providing incidental protection for instream uses. Secondly, OWRB rules state that low- flow averages (i.e., "flows available less than 35 percent of the time") will not constitute water available for appropriation.

A mechanism established by the Legislature to provide general protection of instream flows is the Scenic Rivers Act. Under the Act, and for designated "scenic river areas" listed therein, there is a prohibition against state agencies approving plans to construct, operate or maintain any dam without legislative consent. There is an exception for municipal or domestic use, but only when the structure would not interfere with preservation of the free-flowing stream. In addition, the OWRB has implemented low-flow restrictions on the Baron Fork River, one of six scenic rivers in the state.

Many states that follow the appropriation doctrine are facing similar instream flow questions. Some state legislatures have elected to adopt laws specifying flows for specific streams or segments of streams at which no further diversions may take place. Other states have adopted the approach of allowing instream flows for beneficial use for recreation and fish and wildlife protection; these states either allow any person to apply for an instream appropriation or have limited the kind of entity that can apply (such as the state fish and game agency), but only for certain streams. Also, water rights agencies in some states may declare that certain minimum flows are not water available for appropriation on a real-time basis (cubic feet per second) and require that appropriation rights be conditioned accordingly.

A very controversial method to protect instream flows involves the "public trust doctrine." That doctrine has been adopted to address the appropriation of

water from a reservoir, declaring that all appropriations -- regardless of their priority dates -- are conditioned on water being available by the public trust to protect that which is owned by the public (i.e., fish and wildlife). Water banking and "donation" of existing water rights toward instream flow protection are additional alternatives.

The Franco case touched upon the use of water in the stream for aesthetics and minimum flows needed for recreation use and whether such uses might be considered reasonable. However, the extinguishment of riparian rights (except domestic use) by Senate Bill 54 in the 1993 legislative session appears to have eliminated the possibility to argue that a riparian rights claim could be used to protect instream flows.

The OWRB has not issued any water use permits expressly for protection of instream flows or instream flow maintenance. It can be argued that allowing water to flow downstream and, eventually, out of state does not promote the Legislature's policy of optimum beneficial use in the state and may not be a "beneficial use" as required under appropriation law. That legal point has never been tested in a court, although there have been several water rights issued for recreation, fish and wildlife uses, most of which are reservoir-related or involve a specific point of diversion.

Establishing minimum instream flows on a particular stream segment is a very difficult and controversial proposition involving numerous biological, hydrological, economical and legal factors. To conscientiously address the instream flow issue, the state must first decide if there is a need to provide waters with additional protection to that currently offered under state law and then, if necessary, develop a methodology for actually determining minimum instream flows. However, if the state resolves to pursue an instream flow protection strategy, it will be imperative to have accurate information on the amounts of water available for appropriation in each stream system. This goal will be contingent upon proper maintenance and expansion of data collection/management programs, especially OWRB hydrologic investigations.

Indian Water Rights

Indian water rights in Oklahoma concern both fundamental sovereignty and water quantity and quality. Indian claims to water rights could have a significant effect on existing state water law as well as the current system of water rights administration and water quality regulation in Oklahoma.

Winters v. U.S., often called the foundation upon which the issue of Indian water rights rests, and subsequent court cases (including U.S. v. Grand River Dam Authority) have generally determined that the federal government's establishment of Indian reservations implicitly reserved relevant water as well as land. In addition, Winters asserts that federal reserved rights cannot be lost by failure to put the associated water to beneficial use. This case law of Indian property rights, which extends to other federally reserved water rights, presents a challenge to any water resource project that involves disturbance of the beds and waters of state rivers, streams or groundwaters to which Native American claims might extend. In addition, the federal Clean Water Act recognizes Indian tribes on the same level as state government entities in development of water quality standards.

As a result, there is a need to resolve Indian and other reserved water rights claims, whether they involve court action or negotiated settlements. However, to date, involved parties have been reluctant to put the issue to a definitive test in state or federal court, primarily due to the potentially damaging financial, legal and political ramifications of litigation. Recent state laws dealing with state-tribal relations have encouraged mutual agreements. Similarly, to avoid potential legal conflicts, it will be essential for the state to work in cooperation with Oklahoma's Indian tribes to resolve related water rights issues. In order to resolve the Indian water rights issue in a non-confrontational manner, it is imperative for the state to first develop a level of trust with the Indian tribes. One of the most effective ways to foster this trust is for state water resource agencies to identify specific projects through which the state and Indian tribes can cooperate, then develop a responsible work plan to complete each project.

Groundwater/Stream Water Relationships

Because nearly all alluvial aquifers in the state discharge to or are recharged by a surface water body, conjunctive use of stream and groundwaters, at least on a case-by-case basis, has potential to augment and conserve state water supplies. Although current state water law does not recognize this hydrologic connection, the Oklahoma Water Resources Board has attempted to consider both stream and groundwater resources when appropriating water in areas where each could be affected.

The natural relationship between groundwater and stream water is extremely complex. The uppermost portion of the water table lies anywhere from a few feet to several hundred feet below land surface. During periods of high streamflow, significant aquifer recharge can occur. During other periods, the discharge of a shallow aquifer into the stream channel can provide a large portion of the water flowing in that stream.

In some areas or during certain periods of time, pumping groundwater from wells may reduce the amount of water flowing in a stream. When water is diverted from a stream for irrigation purposes, deep percolation losses could result in inadequate aquifer recharge. In addition, current Oklahoma groundwater law allows the withdrawal of water from an alluvial aquifer to exceed the recharge rate, possibly leading to the loss or depletion of base flow in an overlying stream.

Conjunctive use of stream and groundwaters could prove valuable in areas where both sources may be in short supply but together constitute sufficient supply to meet anticipated demands. However, while there are benefits to conjunctive stream and groundwater use, their joint management is complex. For example, water used for irrigation is in demand only part of the year while the majority of the streamflow passes downstream the remainder of the year. The maximum benefit would result if excess stream water flowing in the non-growing season could be stored for use when it is needed through artificial recharge or related storage projects.

In areas where stream or groundwater quality is relatively poor and substandard for economical treatment and potable use, it may be possible to blend to an acceptable level, prior to distribution, those poorer quality supplies with higher quality water from alternative sources. This would increase the overall availability of usable water and avoid the development of new and costly supply sources.

A number of different management plans have potential, depending on aquifer and stream characteristics, beneficial use, water need and other circumstances. Whatever management plan is implemented, the impact will affect the rights of all state water users, especially groundwater right holders who are afforded use privileges due to basic statutes related to private property rights. However, regulations that unduly infringe upon private property rights should be avoided to the greatest extent possible.

WATER QUALITY

Groundwater Protection

Although the quality of groundwater in Oklahoma is generally very good, some problems exist in individual groundwater basins. Abandoned, improperly plugged oil, gas and water wells; chemical waste and brine disposal wells; poorly designed sanitary landfills; and nitrates from rural and urban runoff are potential sources of pollution to state groundwaters. Due to these problems, and because increased population and economic pressures have produced greater demands for good quality groundwater, the need to protect groundwater resources is becoming a major state priority.

Successful efforts by the state to protect groundwater supplies include the Well Drillers and Pump Contractors Licensing Program, created to ensure the proper construction and plugging of water wells, and the state Wellhead Protection Program in which local communities voluntarily implement management and contingency plans to reduce or eliminate the risk of polluting local public water supplies. While the licensing program has been effective, studies indicate that inadequate well borings and casings are still allowing numerous contaminants to reach state aquifers. As a result, strengthening of the program may be necessary.

Oklahoma's groundwater basins are assigned to a three-tiered classification system based on their respective current or future economic and ecological value. Basins are designated as either Special Source (groundwaters considered very vulnerable to contamination; basins of exceptional water quality or ecological and environmental importance; or those necessary to maintain an outstanding resource), General Use (capable of being used as a drinking water supply with no treatment or with conventional treatment methods; those which have the potential for agricultural, industrial, recreational or other beneficial uses) or Limited Use (those of poor quality, probably requiring extensive treatment for use as drinking water supply).

The existing comprehensive classification system involving groundwater use, if coupled with an aquifer's specific vulnerability to contamination, could be an effective tool for optimizing groundwater protection efforts. This system would allow the development of a different protection strategy for each aquifer class. In addition, groundwater quality standards (discussed in detail under its respective heading), remediation, permitting requirements and enforcement activities could be designed specifically for each basin or groundwater class. The development of aquifer cleanup standards could further facilitate this protection effort.

Through its Comprehensive State Groundwater Protection Program guidance document, the U.S. Environmental Protection Agency encourages states to establish groundwater management efforts based on a local understanding of the relative use, value and vulnerability of the underlying groundwater and threat of contamination. The program itself consists of strategic activities that foster more efficient and effective protection of state groundwaters through improved operation of all relevant federal, state and local programs. The Oklahoma Department of Environmental Quality has fostered developed of these activities through the Comprehensive State Groundwater Protection. This effort -- designed to coordinate federal, state and local groundwater protection efforts -- is guided by the relative use, value and vulnerability of groundwater resources, including the relative threat of all actual or potential contamination sources.

The federal program is intended to empower states with the primary role in coordinating all federally funded groundwater programs. However, Oklahoma must ensure that sufficient flexibility is built into its program and the state should prioritize groundwater protection programs and activities to most efficiently utilize limited financial resources. And, although it has its liabilities, risk assessment could have promise in identifying safe, feasible and realistic groundwater protection measures. In addition, to properly address the state's unique groundwater resources and protection needs and recognize the significant climatological and hydrological differences between west and east, Oklahoma should seek to avoid broad-based regulations, especially those which unduly infringe upon individual groundwater property rights.

Information and technical support, rather than regulation, should be the primary emphasis in groundwater protection. Reliable background data, in particular, is essential to implementation of a successful and comprehensive state groundwater protection program. Revival of the state water well monitoring network, discontinued in 1992, or establishment of a comprehensive data collection program could be especially useful in obtaining water quality (as well as quantity) information on state aquifers. While regulatory measures can be effective, public education efforts and best management practices may be the most useful protection tools.

Groundwater Quality Standards

Serving several functions, groundwater quality standards are one of the most important mechanisms to protect groundwater resources. They specify a maximum concentration of a contaminant, describe an acceptable level of quality or define a specific groundwater use. Standards can also be used to establish limits on contaminants in effluent, evaluate ambient groundwater quality, establish a goal for remedial cleanup, trigger enforcement and help establish preventive programs to protect groundwater.

The Oklahoma Water Resources Board is authorized to promulgate standards of quality for waters of the state and to classify water bodies according to their best uses in the interest of the public under conditions the Board prescribes for the prevention, control and abatement of pollution. In accordance with provisions of the Clean Water Act and state statutes, Oklahoma has prepared and adopted water quality standards for stream waters of the state which are updated at least every three years. Formal adoption of groundwater quality standards occurred in 1982. However, unlike stream water quality standards, EPA does not approve or disapprove state groundwater standards.

The standards apply to all fresh groundwater (defined under state law as groundwater with a maximum total dissolved solids concentration of less than 5000 parts per million) in the state. They set forth that groundwater basins with an average yield of at least 50 gallons per minute are designated major groundwater basins. In general, the standards require that groundwater be maintained to prevent alteration of its chemical properties by harmful substances not naturally found in groundwater. This is accomplished by utilizing narrative criteria, 36 numeric standards for organic compounds, and a three-tired classification system based on the resource characteristics of each individual groundwater basin (as discussed under the Groundwater Protection issue). Future efforts to establish the vulnerability of these individual basins could improve this system.

The two principal uses of standards are reactionary and preventive management. If the standard is set at a level where contamination of an aquifer could occur, it becomes a reactionary mechanism that does little to protect groundwater quality, although it may prevent further degradation and initiate cleanup activities. If the standard is set at a more stringent level (an anticipated percentage of the enforcement level), then its breach signals the need for regulatory action to prevent contamination. In basic form, Oklahoma has reactionary groundwater standards. If a listed level is exceeded, it may be considered pollution and corrective action could be required. Numeric standards offer a specific definition of the expected level of protection and serve as an trigger mechanism for preventive or remedial actions. Also, enforcement tends to be more effective when citation to specific numeric limits can be made. However, because there are so many substances in commercial usage, it is impractical to set numeric standards for them all. In addition, it is extremely difficult to gather sufficient information on the health or environmental effects of a contaminant at a specific concentration level in groundwater. Risk assessment has been utilized, on a case-by-case basis, to measure associated threats to human health.

The goal of narrative standards is to establish reference points for judging whether groundwater quality is being protected. While narrative standards afford the state discretion in regulating a discharge, they sacrifice clear enforcement criteria when contamination is suspected. The matter before the state is whether or not existing narrative criteria are sufficient to protect groundwater quality. The current general wording of the standards is sufficient to encourage, though not ensure, groundwater protection.

DRASTIC, developed by the National Water Well Association for EPA, is a mapping system that evaluates the most important factors controlling groundwater pollution potential. These factors include depth-to-water, recharge, aquifer and soil media, topography, impact of the vadose zone media and conductivity. A modified version of the methodology could be used to delineate the varying vulnerabilities of each groundwater class. Based on evaluation of a groundwater basin, different DRASTIC indices could be divided into DRASTIC ranges -- i.e., slightly sensitive (SS), moderately sensitive (MS) and very sensitive (VS). The aquifer class, combined with the DRASTIC pollution vulnerability index, yields the complete classification of an aquifer.

Creation of an organizational framework to separately administer groundwater quality standards, apart from stream water, would not only facilitate stronger protection of state groundwater basins but simplify the rulemaking/revision process of each aspect of water quality standards. However, implementation of groundwater quality standards, as with stream water quality standards, will require reliable background data. Creation of a centralized ambient stream and groundwater quantity and quality monitoring program in Oklahoma would prove invaluable to the administration of both sets of standards. In addition, future standards revisions should consider the significant quality/quantity relationship between stream and groundwater resources.

Oklahoma Water Quality Standards contain a generic non-degradation policy statement defined to include both groundwater and stream water. Adoption of a specific groundwater protection policy statement would at least demonstrate to the public that the state is serious about protecting groundwater resources.

Nonpoint Source Pollution

The contribution of point versus nonpoint pollution sources varies by waterbody, although, in general, nonpoint sources account for the majority of pollutants present in the nation's waters. While federal and state programs have implemented significant controls upon the contribution of point source discharges, relatively little has been accomplished in similarly addressing nonpoint pollution. Throughout the country and especially in Oklahoma, which is sparsely inhabited in comparison to many other states, nonpoint source pollution is receiving significant attention by numerous agencies, special interest groups and the public.

Excessive nutrients and sediment are generally accepted to be one of the most prolific sources of nonpoint pollution, especially to surface waters in both rural and urban areas of Oklahoma. Nutrient pollution has been closely linked to municipal wastewater treatment facilities although it is now recognized that nonpoint sources are probably the most likely source of nutrients, especially in rural states. A recent study that examined the trophic status of small lakes in Oklahoma revealed that more than 50 percent could be classified as eutrophic, indicating a high level of nutrient loading. Given that these lakes are not subject to point source discharges, the nutrient loading is most likely tied to nonpoint sources. In addition, sediment pollution is almost entirely linked to nonpoint sources. In western Oklahoma, numerous streams suffer from the effects of excessive sedimentation.

Oklahoma's Nonpoint Source Assessment document provides an inventory of areas where impairment of beneficial uses has occurred due to nonpoint source pollution and identifies causative agents and their sources. The most frequently identified categories of nonpoint sources include agriculture, silviculture, urban areas, abandoned refineries, rural roads, mine lands, hydrostructure/tailwaters, in-place contaminants, industrial parks, septic systems and recreation.

Oklahoma has established an ambitious approach to nonpoint source management. The Office of the Secretary of Environment serves as the coordinating body for nonpoint source activities conducted under the CWA Section 319(h) Grant Program, which promotes voluntary approaches to nonpoint source pollution control. The Oklahoma Conservation Commission (OCC), which authored the Nonpoint Source Assessment document, serves as the lead technical agency

for nonpoint source programs and cooperates with state and local agencies, as well as both major state universities, on individual projects. The OCC also developed the state's five-year plan for implementing Nonpoint Source Management Program projects.

The effectiveness of best management practices (BMPs) and other voluntary water quality improvement efforts has been demonstrated through the relative success of state nonpoint source mitigation projects. However, funding for BMP implementation is relatively meager compared to funds pledged for implementation of point source controls. Oklahoma has received less than three million dollars for nonpoint source controls while hundreds of millions have been allocated toward point source controls. The scarcity of both state and local funds precludes implementation of many nonpoint mitigation projects, which are funded by a 60/40 federal/state cost-share.

Despite the success of individual Section 319 projects, the overall scope of the state's nonpoint source control program is inadequate to address specific problem areas which are often impacted by numerous pollution sources. In addition, although EPA generally encourages the development of innovative practices (such as whole basin/total watershed planning, which must be included to receive priority funding for Section 319 nonpoint source projects), current policy restricts the funding of certain point source reduction practices that have demonstrated past success but involve problem areas which fall outside of Section 319 program eligibility requirements.

The implementation of total maximum daily loads (TMDL's) -- the sum of all point source wasteload allocations and nonpoint source load allocations -- into Oklahoma's water management strategy will provide improved monitoring of nonpoint source pollution. Although it is now recognized that nonpoint sources are an integral part of overall stream loading, the traditional TMDL process has included only point sources. TMDL's are currently being used as a tool to develop nonpoint source management options in Oklahoma's 303(d) priority watersheds. In addition, the Watershed Strategy Committee of the Watershed Nonpoint Source Working Group -- a coalition of numerous state and federal agencies, sub-state planning districts and universities who oversee and coordinate many state nonpoint source activities -- is now developing a TMDL process for use on 319(h) watershed projects.

Assessment of nonpoint source impacts, an integral part of the TMDL process, is very limited under current guidance. Expansion of Section 319 protocols to increase assessment would facilitate more effective prioritization of project areas for demonstration projects. In addition, as state Nonpoint Source Assessments become outdated, efforts should be made to update these documents.

While the voluntary approach to problem-solving is generally preferred -- as compared to regulatory controls -- it is unrealistic to expect this cooperative strategy to be successful, or desirable, in all cases. Individual cost-share burdens, reluctancy to cooperate, expensive controls or the extent of a particular problem may inhibit implementation of voluntary measures. However, in many cases, regulatory and enforcement measures provide the necessary incentive to encourage participation in voluntary programs.

Stream Water Quality Standards

According to Oklahoma law, "the Oklahoma Water Resources Board is authorized to promulgate standards of quality for state waters and classify the waters according to their best uses in the public interest under conditions prescribed for the prevention, control and abatement of pollution." In accordance with provisions of the Clean Water Act and state law, the State of Oklahoma has prepared and adopted water quality standards for intrastate waters. Under these statutes, the OWRB is also authorized to classify the state's waters with respect to their best present and future uses and set water quality standards.

Standards are designed to enhance the quality of Oklahoma's waters, protect their beneficial uses and aid in the prevention, control and abatement of water pollution in the state. Water quality standards have been established for all state waters through the assignment of beneficial uses and the development of criteria designed to protect these beneficial uses. Additionally, the standards assign additional protection to waters whose quality exceeds that necessary to protect beneficial uses and waters which are considered outstanding resources (through an Antidegradation Policy). State-adopted standards and implementation policies must satisfy public participation requirements (including public hearings). They also must be adopted by the Governor and State Legislature and reviewed and approved by the U.S. Environmental Protection Agency, at which point they become effective as federal law. State water quality standards may be revised at any time, but must be updated at least once every three years.

Significant advances have occurred in Oklahoma's Water Quality Standards since the original document was promulgated in 1968. The current document (revised in 1994) contains numerical aquatic life criteria; numerical criteria to protect human health for the consumption of water, fish flesh, and fish flesh and water; dissolved oxygen criteria; narrative aquatic life criteria which prevent acute and chronic aquatic life toxicity; and related criteria designed to protect aquatic life and human health. Additional criteria protect the beneficial uses of state waters: agriculture (including crop irrigation and livestock watering), body contact recreation (swimming and wading), aesthetics, public and private water supply, municipal and industrial process and cooling water, navigation and hydropower.

Oklahoma's Water Quality Standards document continues to evolve and improve. Narrative and numerical criteria to protect human health, wildlife and aquatic life are constantly being added and modified. Specifically, criteria for fish flesh have been developed utilizing risk assessment methodology, a potentially valuable water resource protection tool. Other recent activity in this area includes the addition of metals criteria to protect human health and aquatic life, new wildlife criteria and modifications to existing silver criteria. Oklahoma's Antidegradation Policy recently experienced changes related to stormwater discharges and anticipated language regarding stormwater discharges into Outstanding Resource Waters could affect Oklahoma's current Antidegradation Implementation Policy. The principles involved in the implementation of criteria into discharge permits will continue to be a major area of emphasis, as recently cited in the 1994 Continuing Planning Process (CPP) document. The CPP formalizes the process through

which Oklahoma prevents and controls pollution from toxic substances, primarily from point source discharges. Oklahoma has become nationally recognized in this area and will continue to maintain that status by refining mixing zone policies and models and testing and sampling requirements.

Recent work in the area of biological criteria (biocriteria) by other states and EPA is currently being evaluated for broadened inclusion in the standards. This may involve modifications to existing biocriteria -- narrative and/or numerical expressions used to evaluate the structure and health of aquatic communities -- through the delineation of ecoregions and reference streams. Development of biological criteria is being stressed by EPA due to its potential value in water quality management.

The concept of total maximum daily loads (TMDL's) is receiving a great deal of attention nationally. TMDL's are the sum of all point source wasteload allocations and nonpoint source load allocations, with an appropriate safety factor. The implementation of TMDL's into Oklahoma's water management strategy will facilitate the development of more accurate waste discharge permits and improve monitoring of nonpoint source pollution. However, this strategy is very complex and expensive, requiring a significant commitment of both staff and monies. Currently, TMDL implementation is impeded due to the lack of background water quantity and quality information, a situation that will likely worsen due to cut-backs in programs for the collection of ambient water quality data. Creation of a centralized state water quantity and quality monitoring network could also help identify potentially impaired waters and generally ensure that site-specific decisions are made on the basis of reliable data.

Other stream water quality standards issues that should receive consideration and/or refinement in the next decade include measures to protect instream habitat; improved protection of Outstanding Resource Waters; nutrient criteria; measurement of metals criteria (total versus dissolved); groundwater vulnerability assessment and cleanup standards; assignment criteria for Cool Water Aquatic Communities; High Quality Waters and Appendix B areas; criteria which protect the agriculture beneficial use; and default and regulatory flows. In addition, protection of stream waters on a regional or site-specific basis will also be a primary focus of future standards revisions. Proper attention to these matters will be determined, in part, by the significant amount of time and money required by the state in addressing federal mandates. Regardless, future development and implementation of water quality standards must be guided by sound, scientifically-based evidence on individual sites, conditions and species.

WATER & WASTEWATER SYSTEMS

Municipal & Rural Water/Wastewater Systems

Most Oklahomans depend upon either a municipal or rural water system for clean, potable drinking water. According to 1990 census data for Oklahoma, 1,223,121 housing units (87 percent) were on a public or private water supply system, 177,074 (12.5 percent) were on individual wells, and 6,304 households (0.5 percent) obtained water from some other source.

Unfortunately, many water systems in the state suffer from old age, too rapid growth and a variety of related problems which are exacerbated by current funding restraints, unfunded federal mandates and increasingly stringent environmental regulations. An April 1986 report by the Department of Community and Economic Affairs (DECA) on Oklahoma infrastructure revealed that distribution facilities are inadequate in nearly one-half of the municipal and rural water systems in Oklahoma; storage facilities are inadequate in 35 percent of the state's water systems; and more than 26 percent of municipal water systems are operating at greater than 70 percent of capacity.

Forty-four percent of the municipal wastewater plants in Oklahoma, including the majority of cities serving relatively large populations, discharge effluent to waters of the state. These discharges include wastewaters from domestic sources (such as residences and commercial and institutional facilities), industrial operations, infiltration/inflow entering sewer systems, and stormwaters. DECA's report states that almost all Oklahoma municipalities with a population of 10,000 or more operate their own sanitary sewer systems, as do a large majority of cities less than 2,500 in size. However, while virtually all cities of 10,000 or more possess their own storm sewer systems, many smaller cities and rural water districts do not.

DECA estimated that total water system needs over the period 1985-2000 will be approximately $4 billion while sanitary and storm sewer needs will exceed $3.4 billion. Water user fees -- the principal source of revenue for municipal and rural water/wastewater systems -- are generally insufficient to recover actual costs associated with operations, maintenance and capital. Also, many smaller systems lack a reserve fund to fund minor emergencies and repairs. State and federal grant and loan programs (including the popular State Financial Assistance Program and its source, the Statewide Water Development Revolving Fund) have stepped in to fund numerous system improvement projects. However, due to federal budgetary restrictions and economic difficulties at the state and local level, financing of water/wastewater facility needs will become increasingly difficult. Therefore, investigation of alternative strategies is required to meet current and future infrastructure needs.

Regional systems, where customers from many towns and water districts are served by a common source, are often able to provide the most efficient, economical and reliable water supply. Regionalization can also help lessen the potentially devastating impacts posed by stringent water quality regulations as well as funding constraints. In addition, regional systems promote unity among members and help avoid unnecessary -- though all too common -- disputes over water, typically affording all members an equal say in system operation, maintenance and overall administration. Factors that can impede regionalization include the potential loss of autonomy than can accompany consolidation of systems as well as differences in funding capabilities, system densities, service area size and methods of operation.

The 1980 Oklahoma Rural Water Survey, currently being updated by the OWRB, will be a useful tool in identifying potential regionalization opportunities. The survey contains valuable information to guide the operation, expansion and maintenance of Oklahoma's rural water systems. In addition, the revised data will help facilitate economic development in

rural areas by linking sources of water supply to new or expanding businesses and industry.

Privatization of water and wastewater facilities is a way for the private sector to work with local governments in obtaining and/or operating needed facilities. Privatization can take several forms, including "contracting out" the financing and ownership of facilities and providing service through contracts. Some of the advantages of privatization include construction savings, quicker procurement and scheduling activities, risk reduction, operational savings, tax benefits, debt capacity benefits and availability of financing. Disadvantages relate primarily to a perceived loss of control by municipalities, the potential negative aspects of long-term contracts, and uncertainties relating to legal and regulatory issues.

In the early and mid-1980's, several factors contributed to the emergence of privatization as an attractive alternative to traditional methods of providing public services. Federal and state grant funding for public infrastructure facilities had declined significantly while, at the same time, tax laws were passed to make private ownership of certain capital facilities much more attractive. The Economic Recovery Act of 1981 was the first major tax act to encourage capital investment by private investors.

Tax law amendments in 1982 and 1984 specified conditions and constraints on leasing and privatizing activities. However, they still provided a means by which the private sector could profitably enter into a service relationship with public entities. The provisions of the Tax Reform Act of 1986 and the Deficit Reduction Act of 1987 served as further constraints on privatization of water and wastewater treatment facilities since the private sector could no longer utilize the advantages of tax-exempt financing, accelerated depreciation and investment tax credits to cut the costs of environmental infrastructure projects. However, where the private sector has proprietary technologies or is better able to handle risks associated with facility operation, full privatization still occurs, despite the 1986 Tax Reform Act.

Technical assistance is currently available through the Oklahoma Rural Water Association and U.S. Environmental Protection Agency funding to help state communities identify system design, management and consolidation alternatives. Unfortunately, many communities with outdated or insufficient water and/or wastewater systems are reluctant to seek help through the state because of their fear of possible consent orders or related regulatory mandates. An expanded, non-regulatory state technical assistance program could help promote privatization and regionalization, where appropriate, and the implementation of other concepts to stretch financial resources and improve management of Oklahoma's water/wastewater systems.

Financing

The primary state financing provider for community water and wastewater projects is the Statewide Water Development Revolving Fund (SWDRF), created by the State Legislature in 1979 and confirmed by popular vote in 1984. The corpus of the SWDRF provides a reserve for the OWRB's bond issues. Due to the excellent credit ratings on the issues, the Board's bond program offers small borrowers lower interest rates than could be obtained if they marketed their own bonds. Interest earned on the Revolving Fund is the source of funds for the OWRB's emergency grant program. Qualified projects can apply for up to $100,000 in grant money. The program is based on a priority point system, with the type of emergency being the primary factor.

Also, in response to the 1987 amendments to the Clean Water Act, which contain provisions for a transition from the traditional method of direct federal grant awards to communities for assistance in the construction of sewage treatment facilities to a new method of repayable loans, the Legislature more recently established the Wastewater Facility Construction Revolving Loan Account State Revolving Fund (SRF) Program. The Act requires each state to provide a 20 percent match in order to receive Environmental Protection Agency SRF capitalization grant monies. Together, these programs make up the State Financial Assistance Program (FAP), administered by the Oklahoma Water Resources Board.

Other major sources of loans and grants are:

Rural Development (RD) -- (formally Farmers Home Administration)
RD provides funding for both municipal and rural projects related to watershed protection and flood prevention/control; water conservation, development and storage; and water treatment, pollution control and wastewater disposal. To qualify for RD loans or grants, communities or rural areas must have a population of 10,000 or less. While the RD loan program has recently grown stronger, the grant program has not experienced similar growth and grant requirements have become more stringent. Funding levels are expected to remain relatively constant over the next several years.

Oklahoma Department of Commerce (ODOC)
The purpose of the Community Development Block Grant (CDBG) program, administered by the ODOC's Division of Community Affairs and Development, is to assist in developing viable urban communities by providing decent housing, suitable living environment and expanding economic opportunities, primarily for persons of low and moderate income. Grants are provided only to cities and towns under 50,000 in population and counties under 200,000.

Indian Health Service (IHS)
The IHS offers a grant program for water and sewer projects. However, qualifying criteria are very stringent and funded projects are limited to those which benefit significant Indian populations.

There is currently a lack of reliance on individual bond issuances as a source of funding for water systems; only 3.5 percent of municipalities and practically no rural water systems obtain revenue from this source. The absence of debt issuance relative to other revenue sources may be explained by the lack of a market for these issuances, particularly for small municipalities and most rural water districts. Many of these jurisdictions have low credit ratings, or no ratings at all, in the market for local government issuances. Debt issuances from these jurisdictions are regarded as relatively risky, thus resulting in higher interest rates which can price many smaller entities out of the debt market. Also, bonds issued by municipalities in Oklahoma are subject to tax exemption only by the federal government; exemptions for state, as well as federal, taxes would allow local governments to

issue bonds at lower interest rates.

Due to the inability of small borrowers to market their bonds at an attractive rate, the OWRB issued pooled revenue bonds with the "pool" consisting of many small borrowers. The advantage to this type of financing is that the ratings on the bond issues are not based on one small borrower, but rather the pool of borrowers. As a result, ratings are much higher and interest rates much lower. In addition, the Board's pooled revenue bonds are double tax exempt, making for an even lower interest rate than could be obtained by an individual borrower.

The Statewide Water Development Revolving Fund, which hundreds of Oklahoma communities have turned to for infrastructure needs, has been utilized for many other purposes (especially Tar Creek remediation and Sardis Reservoir water storage payments) in addition to its original primary function as a water/wastewater project funding source. The remaining balance of the SWDRF has been obligated as the required state match for Oklahoma's SRF Program. It has been estimated that a minimum $8 million recurring annual demand could be placed on the Fund. Complicating this situation, Oklahoma and other states have been forced to assume greater responsibility in both the planning and financing of water resource development projects due to the federal government's recent declining role in this area. Due to the state's significant infrastructure needs, significant capitalization of the Revolving Fund is needed, not only to meet upcoming unfunded federal mandates but to satisfy existing 1987 mandates related to point and nonpoint source discharges, water quality standards and related programs. Also, additional funding will be needed to provide the state match to allow establishment of the federal Drinking Water State Revolving Loan Fund Program. It is anticipated that this loan program will be fully functional and providing drinking water loans by mid-year 1997.

Several dedicated revenue sources have been formally or informally proposed to capitalize the SWDRF so that it can remain responsive to Oklahoma's future water resource development needs. These include water user fees, groundwater and stream water permit renewal fees, a water development fee (similar to the Oklahoma Department of Environmental Quality's solid waste fee), reapportionment of existing taxes (such as the Motor Fuel Special Assessment Fee) and direct legislative appropriation.

RESERVOIR OPERATIONS

Allocation & Control

Within the past four decades, an impressive number of reservoirs and lakes have been constructed in Oklahoma. While smaller lakes primarily serve local water supply and flood control needs, most federal projects are utilized for additional multiple purposes such as flood control, water supply, irrigation, power, navigation, recreation, fish and wildlife and water quality enhancement.

Undoubtedly, some federal reservoirs in the state are not being managed to their full potential or to the maximum benefit of Oklahoma citizens; others may have allocations of storage that are insufficient for water supply or other current or projected needs. Occasionally, the difficult task of operating a reservoir for numerous purposes -- especially in regard to releases for flood control, navigation and hydropower -- leads to conflict and necessitates a reassessment of the current operational plan and project benefits. Exploration of opportunities to enhance the operations and benefits of existing reservoirs will become an increasingly attractive planning option, especially due to the current costs and environmental restraints associated with new project construction.

Although most reservoirs in Oklahoma have been planned, constructed and operated on an individual basis, past experience indicates that implementation of system operating plans can significantly increase the benefits of one or more projects in a particular stream system. These plans can be formulated, especially for larger reservoirs located in the same basin, to achieve a reasonable balance of purposes for which a project is operated and to maximize benefits without significant adverse impacts on aquatic life, recreation or existing water rights holders in a stream system.

Flood control, the primary benefit of the majority of the state's 34 major reservoirs as well as hundreds of upstream detention projects constructed by the SCS/NRCS, is a purpose that has generated considerable controversy in Oklahoma. As demonstrated by numerous flooding disasters throughout state history, intelligent and responsive flood control operation is essential to the safety and economic viability of Oklahoma citizens. Especially in eastern Oklahoma, improvement of existing project operation plans or implementation of system operating plans could likely enhance the overall effectiveness of federal flood control efforts. However, the most significant impact upon flooding problems will be achieved through continuation and strengthening of existing floodplain management and hazard mitigation programs. (Floodplain management strategies are discussed in detail under Floodplain Management -- Floodplain Protection and Preservation.)

Storage reallocation -- in most cases, where a certain amount of storage originally allotted to a specific project purpose is increased, reduced or exchanged with storage set aside for another purpose -- presents an opportunity to place under-utilized storage to a more currently needed beneficial use. Due to the considerable effects that reallocation of a major reservoir can have on operation of that project or an entire stream system, the process may require Congressional review and approval. However, the State of Oklahoma must take all appropriate measures to protect current project benefits as well as the water rights of existing users. A potential deterrent to reallocation is the Corps' current policy which requires water reallocated from existing storage to be repaid at updated, rather than original, construction costs

While there is normally no set priority for federal project purposes, water for water supply, flood control, irrigation or other uses which justify the majority of the project's cost (as well as those which constitute the majority of storage) normally prevails during drought episodes or other temporary water emergencies. Other times, for various reasons, these "primary" project purposes are under-utilized and, as a result, "secondary" (nonconsumptive) uses -- such as recreation or fish and wildlife -- become increasingly important as the project matures. In such circumstances, these uses may require and deserve similar protection as provided to the original, major project purposes. However, state law does not acknowledge protection of such uses through allocation of water rights. It could prove advantageous for the state to study the potential for requiring certain

exempt water use interests to obtain appropriate water rights and/or storage for their specific uses.

Regardless of the method desired to maximize reservoir storage and/or uses, reaching consensus among affected parties will remain a critical factor in preventing or solving reservoir operation disputes. At Lake Texoma, where various interests clashed over operation of the lake, an advisory committee of water supply, hydropower, flood control, recreation and fish and wildlife advocates was created to resolve the issue. After considerable study, these parties conceded to a seasonal operation plan which facilitates all reservoir uses and benefits. In addition, at Broken Bow Reservoir, the Oklahoma Water Resources Board, State Department of Wildlife Conservation, Southwest Power Administration and Corps entered into an agency memorandum of understanding that set temporary conservation pool releases to facilitate operation of a downstream trout fishery. Although development of fair and mutually beneficial operation plans can be a difficult and arduous task, these successes demonstrate the value of dialogue, compromise and consensus building in satisfying competing uses in Oklahoma's lakes and reservoirs.

Maintenance & Renovation

Structural, as well as operational, modification is a cost-effective method of maintaining a particular reservoir project, producing additional storage/yield and increasing existing benefits -- especially in light of difficulties related to new construction. Prior to consideration of physical improvements, appropriate measures must be taken to ensure that structural modifications are sound and existing project purposes are maintained.

One maintenance problem that will impact the future beneficial uses of Oklahoma reservoirs, especially as they increase in age, is sedimentation. Studies can identify reservoirs experiencing accelerated sediment loading as well as potential mitigation measures that can stretch the water supply potential of existing projects. A coordinated and expanded state bathymetric mapping program could improve sediment monitoring as well as provide updated information on reservoir yield.

In discussing maintenance and renovation of reservoirs in Oklahoma, it is extremely important to consider the locks, dams and river channel which constitute the McClellan-Kerr Arkansas River Navigation System. Opened for navigation in the early 1970's, the system is vital to the economic development of Oklahoma as well as the entire Arkansas River Basin region. However, recurring low water levels on the Mississippi River have resulted in the loss of considerable revenues through delays to the Waterway's ports, customers and shippers along with increased operation and maintenance costs due to dredging.

Of the waterway's 445 miles, the first 10 miles are dependent upon the Mississippi River's elevation while the remainder of the system is controlled by 17 locks and dams. When the Mississippi water level drops, loaded barges cannot enter or leave the waterway. Consequently, many customers are often forced to ship by other modes of transportation, causing significant losses of time and money. These unnecessary market losses and widespread economic dislocations could be avoided through construction of Montgomery Point Lock and Dam on the White River, the final lock and dam envisioned in the original system plan. Otherwise, the uncertain flow levels of the Mississippi River will continue to make navigation on the McClellan-Kerr increasingly difficult and jeopardize the $1.5 billion already invested in the waterway.

Navigation on the system has also experienced significant periods of high flows in recent years causing disruptions and delays in barge movements. These high-flow conditions result in increased fuel, labor and capital costs due to the additional time required for movements, reduced tow sizes and increased accident rates. The recession of high-flow events also causes periodic delays and blockages due to shoaling. The Arkansas River Basin Study, completed in May 1991, investigated opportunities for improvements to the McClellan-Kerr System. The two primary measures analyzed to address the high-flow problems were increasing the available storage in the basin and/or modifying the system operating plan to more efficiently utilize existing storage.

WATER MARKETING

Water Transfer

Water transfer and marketing, a strategy which allows water to be used where it is needed most or has the greatest economic value, can be beneficial for all of Oklahoma. Because water is a somewhat renewable resource and has value as a commodity, water and water rights/storage transactions can create attractive investment opportunities as well as assist in repaying the debt of many communities who have entered into federal water storage contracts. Other benefits include conservation of supplies, especially during times of drought; protection of habitat for fish and wildlife; and preservation and enhancement of water quality.

The ease in transferring rights under the prior appropriation system facilitates economic transactions that promote optimal development and use of both stream and groundwater resources. If water rights are transferred in an open market, they tend to migrate from the least efficient uses to more efficient and economically productive uses. It appears that the transfer of water rights from decreasing agricultural needs to escalating municipal use will become more widespread, leading to the growing emergence of water markets. However, water rights transactions should be limited to some extent to preserve the social, economic and political diversity of rural areas, especially in Oklahoma where agriculture is of such importance to the economy. Individual marketing projects must be achieved in a manner that balances existing uses and avoids excessive reservoir fluctuations.

The expense, legal complications and political obstacles which frequently accompany large-scale water transfers often preclude those projects. While safeguards, such as the requirement of legislative authority for the interstate transfer of water, help ensure that water transactions are conducted fairly, they may also hinder projects which appear to be beneficial to all involved parties.

Many states have created "water banks," entities which oversee and control water sales as well as buy available water and storage rights, holding them in trust for potential future users. An Oklahoma water bank could provide for better conservation of water resources and more efficient administration of state water law (such as granting the purchase/loan of portions of water rights, thereby allowing users to avoid reduction or forfeiture of their rights). In addition, the bank could facilitate discussions related to protection of fish and

wildlife resources through establishment of minimum lake levels and/or instream flow maintenance. However, above all, Oklahoma requires a coordinated water marketing policy or system to facilitate both the large- and small-scale lease and transfer of water and water rights.

In Oklahoma, only two major transfer projects have been seriously considered -- the statewide transfer plan proposed in the 1980 OCWP and, more recently, an attempt to lease surplus water from the Kiamichi River Basin to North Texas Municipal Water District. The OCWP conveyance plan, although a potential long-range option, has been judged economically unfeasible and updated water projection figures indicate that the major importation of water will not be necessary to meet needs of the state's eight planning regions in the near future. And, although the Kiamichi project yielded to widespread local opposition and substantial political pressure, it brought to light many issues that, if addressed, should benefit future intrastate and interstate transfer efforts.

The statutory definition of "surplus water," set out in 1974 legislation authorizing the original OCWP, is critical to the implementation of individual water transfer projects and in protecting future needs and uses in the area of origin. Determinations of surplus water will also help identify amounts of water needed for future beneficial use in each of Oklahoma's eight planning regions.

HB 2036 requires the OCWP update to review the definition of "excess and surplus water of this state" and consider a procedure for determining this water to ensure that areas of origin will never be made water deficient. Surplus water is currently defined in the Oklahoma Administrative Code as "that amount of water which is greater than the present or reasonably foreseeable future water requirements needed to satisfy all beneficial uses within an area of origin." In fact, one of the major water marketing requirements prior to any long-term agreement for the sale or lease of water is the accurate assessment of local needs -- i.e., a fair and factual definition of surplus water. In regard to the planning horizon utilized for the OCWP, "reasonably foreseeable" is considered to be 50 years because it represents the outer limits of reliable population and water requirement forecasting and it encompasses the minimum life span of most major water supply projects in Oklahoma. However, the most accurate method to determine surplus water in a basin may be on a case-by-case basis.

To ensure future supply for the state's planning regions and to better facilitate future intrabasin water transfers, forecasted estimates of surplus water in Oklahoma must be conservative on available water and liberal on needs. Numerous untapped sources of water throughout the state can be secured and utilized through development of system operating plans, reallocation of reservoir storage, utilization of unneeded sediment storage and administrative actions, such as the cancellation and reduction of unused water rights. However, to be more accurate, future estimates of surplus water could consider the percent of time reservoir storage is reliably available for varying uses. For example, the yield for municipal supply is calculated to be accessible 98 percent of the time while more supply from the same source would be available for irrigation use, but for a lesser percentage of time. As a result, the amount of surplus water available for large-scale transfers could vary according to its proposed use in the receiving area.

WATER SUPPLY AUGMENTATION

Weather Modification

Weather modification is considered by many to be an effective and promising water resource management tool. Interest in enhancing rainfall by artificial means prompted the Oklahoma Legislature to pass the Oklahoma Weather Modification Act. The Act provided for the encouragement and regulation of weather modification activities and, as amended in 1973, assigned the responsibility of its administration to the Oklahoma Water Resources Board.

While moderate success of test programs have proponents convinced of the effectiveness of the technology, others remain skeptical. In an effort to alleviate uncertainties surrounding the use of weather modification technology, the 1980 Oklahoma Comprehensive Water Plan recommended that the Governor and Legislature support the development and implementation of a comprehensive weather modification program for the State of Oklahoma. As a result of this recommendation, the OWRB, Bureau of Reclamation and Texas Water Commission joined forces during the mid-1980's under the Southwest Cooperative Program to demonstrate state-of-the-art cloud seeding technology and its promise in increasing summertime rainfall in the Southern Plains region. Findings from that multi-year effort, combined with more recent results from other programs, suggest that increases in summertime convective rainfall of 10 to 30 percent and reductions in hail loss on the order of 25 to 45 percent are achievable through carefully planned and conducted programs.

Groundwater Recharge

Artificial groundwater recharge -- i.e., diversion of runoff into groundwater basins for storage and later use -- could be an effective tool for managing declining or limited groundwater resources. The technology can lessen pumping costs, provide additional water supplies in times of drought and help utilize stream water that may otherwise be lost during wet years.

In 1984, the Bureau of Reclamation, in conjunction with the U.S. Geological Survey and Environmental Protection Agency, initiated a feasibility study to demonstrate the potential of artificial groundwater recharge technologies in stabilizing and replenishing declining aquifers under a variety of hydrogeologic conditions. The Bureau, in cooperative agreement with 17 western states, selected 21 sites to test various artificial means of supplementing groundwater supplies. As part of this study, the Bureau, Southwest Soil and Water Conservation District and the Oklahoma Water Resources Board are cooperating in a five-year, $2 million effort to recharge the Blaine Aquifer which provides irrigation water to a 1,500 square-mile area in southwest Oklahoma and adjacent parts of Texas. Centered near Hollis, the Blaine Recharge Demonstration Project includes five recharge wells, a recharge dam and 25 monitoring and observation wells. This program supplements an existing, private project, initiated in 1968, of 45 recharge wells operated by the Southwest Soil and Water Conservation District.

A second state groundwater recharge demonstration project, near Woodward, has been proposed to increase water supplies in alluvium and terrace deposits of the North Canadian River. The plan concept involves installation of an under-

ground barrier down-gradient of an existing municipal water well. It is presumed that the barrier dam would increase the production of water from the existing well, resulting in reduced demand on the Ogallala Aquifer.

Reclamation & Reuse

Future water shortages and cost considerations will generate increased pressure to reclaim and recycle wastewater. In many areas of the country, wastewater reclamation -- the reuse of highly treated effluent -- has become an important source of water for landscape and agricultural irrigation, aquifer recharge, industrial cooling, power generation, paper production and food processing. The central issues preventing full utilization and acceptance of reuse techniques include health concerns and the rights to reclaimed water, especially when the water is used to maintain streamflow (i.e., instream flow and/or water quality problems could result in removing effluent from stream systems).

In agriculture, reuse of municipal and industrial effluent for irrigation, as well as the reuse of irrigation tailwater or drain water through installation of pumpback systems or planting of salt tolerant crops, is gaining greater acceptance. In some situations, agricultural return flows are already reused simply because downstream agricultural appropriations depend on upstream return flows. However, salinity buildups and the existence of trace elements can be limiting factors in agricultural recycling. Additional research is needed to determine the possible health and environmental effects of reuse and land application of wastewater.

Industries -- such as food processing, paper manufacturing, and other industries that have a heavy demand for water -- could defray some of the cost of production by selling treatment services to surrounding communities. In addition, significant savings in water use can be accomplished by substituting lower quality reused municipal wastewater for fresh water during the cooling and manufacturing process. In closed cooling systems, water is returned to a tower, pond or lake to be cooled and reused. These cooling lakes can also be used for recreation and fish farming. Another industrial practice involves combining industrial waste flow that requires high nutrients for treatment with municipal wastewater containing those nutrients. Recycling of process water by Oklahoma industries has been limited because of the relative availability and abundance of high quality, generally inexpensive municipal water.

For homeowners, a number of residential on-site water reuse (gray water) systems are technically feasible and environmentally sound. However, this practice is not yet accepted by most household water users.

Chloride Control

Water quality problems, both natural and man-made, affect many of Oklahoma's stream and groundwater resources. Natural dissolved solids and salinity problems, in particular, impede the development and maximum use of water resources in much of western Oklahoma. High concentrations of minerals, primarily chlorides, are emitted into streams from salt springs and salt flats, often rendering both the stream and adjacent alluvium and terrace groundwaters unfit for use. In addition, many of the carbonate aquifers in the region contain naturally occurring salts that impair groundwater quality. In some areas, this problem has been aggravated by oil and gas exploration and production activities.

Chloride control and desalinization have been used with some success to cope with salt contamination. Desalinization, which involves treating salt-concentrated water until it is suitable for beneficial use, is being utilized to treat water at Foss Reservoir, on the salty Washita River. Chloride control does not alter the quality of the water at its source, but rather diverts fresh and usable water around identified salt flats and natural brine springs by means of dikes, dams and retention structures.

The ongoing Red River Basin Chloride Control Project, located in southwest Oklahoma and Texas, is a pilot project authorized by the Flood Control Acts of 1962, 1966 and 1970 and Water Resources Development Act of 1986. In the project region, 10 natural salt source areas contribute some 3,600 tons of salt to the Red River each day. The Arkansas River and its two principal tributaries in north Oklahoma, the Salt Fork of the Arkansas and Cimarron Rivers, also exhibit chloride problems, although a Corps study determined that project to be economically infeasible based on federal resource planning guidelines.

With the Red River Basin Chloride Control Project fully operational, an estimated 65 percent of the chlorides emitted from the 10 major source areas would be controlled. At Lake Texoma, a potentially valuable water supply, water meets the Environmental Protection Agency's dissolved salt standard for municipal water only three percent of the time. It is anticipated that the project would reduce the lake's chloride levels by some 45 percent, making Lake Texoma water useable 94 percent of the time.

Formal study of the Red River chloride situation was initiated in the late 1950's. Actual development of dams, dikes and diversion structures to control an anticipated 65 percent of the chlorides was initiated in 1964 by the U.S. Army Corps of Engineers; operation of the project continues today at full federal expense. The total project cost is estimated to be approximately $262 million with a return on investment (cost-to-benefit ratio) of 1.3 to 1.

To initially determine environmental impacts of the project, numerous studies were conducted by the Corps as part of the final environmental impact statement (FEIS) which was filed with EPA in 1977. Due to changes in project design and in the existing environmental setting, the Corps' Tulsa District reevaluated the project for compliance with current environmental laws and regulations in 1991. They determined that a supplement to the FEIS would be required to assure compliance with the National Environmental Policy Act (NEPA) and other environmental laws. As a result, the District has conducted four additional environmental studies which address various concerns related to the project.

Natural resource agencies and recreational interests have expressed serious concerns regarding construction of the remaining portions of the project. Specific major concerns include the potential impact of decreased chloride concentrations in the Red River basin on primary production and sport fish abundance in Lake Texoma; impacts on federally listed threatened and/or endangered species; potential impacts of selenium concentrations in brine storage lakes; indirect impacts of the project on streamflow and riparian corridors; impacts of flow modification on fishes of the upper Red River; fish and wildlife mitigation fea-

tures; land use changes at the Area VI disposal site in Oklahoma; and preparation of the FEIS supplement.

A major environmental, as well as economic, concern surrounds the Lake Texoma fishery which contributes some $22.7 million annually to local and state economies in the two-state area. A minimum eight percent decline in the overall sport harvest has been predicted, although further studies of the extent of this particular impact are ongoing. Environmental agencies -- in particular, the U.S. Fish and Wildlife Service and Oklahoma Department of Wildlife Conservation -- have expressed concerns that the Red River Chloride Control Project will adversely affect water quality conditions that have maintained the long-term productivity of Lake Texoma. Increased turbidity in the lake, a condition which could result from the decreased salinity levels, could prove detrimental to the profitable and thriving Texoma striper fishery. Also, increased water withdrawals and consumptive water use, especially in Lake Texoma, could impact national wildlife refuges and state wildlife management areas/parks in the region.

In July 1994, the Corps and USFWS completed a formal consultation which resulted in an agreement that includes a number of measures to conserve and avoid impacts to the Interior least tern, Bald eagle and Whooping crane, although concerns remain about potential changes in the habitats of those species. Impacts to these and other threatened and/or endangered and related sensitive species which occur in the project area are also being re-evaluated.

In addition to potential environmental concerns, increased irrigation resulting from the project could have an adverse cumulative impact on flow within certain segments of the upper Red River during dry periods. However, careful regulation of area water resources, facilitated through information obtained from gaging and monitoring stations established to record changes in flow and water quality, could help diminish this problem.

WATER CONSERVATION

Water Conservation

Water conservation measures have promise to save significant amounts of water and, as a result, forego the need for new water supply construction and development. In the home (including public and private buildings), primary conservation measures include efficient water-using equipment, changes in plumbing codes and, especially, modifications of behavior and habits affecting water use. While revised building codes that require installation of water-saving devices transfer the additional cost from the builder to home buyer, this equipment can provide various economic benefits as well as assist in preserving supplies for future use.

Within the home, about three-quarters of water use occurs in the bathroom where toilets alone consume an estimated 40 percent of all water used. In office buildings, schools and public buildings, toilet flushing is the predominant water use. Substantial water savings can be realized by installing low-flush toilets that use 1.6 gallons of water per flush, as compared to 3.5 to 8.0 gallons per flush for conventional toilets. Toilets using higher volumes of water can also be modified through the installation of certain devices in the tank to reduce the flush volume.

Bathing accounts for 34 percent of water consumed in the home, with 60 percent of this total used in the shower. Many companies manufacture shower heads or adapters that conserve water by reducing the maximum flow rate or producing a low-flow shower spray. Since conventional showers use up to 10 gallons per minute, and showers average five minutes in duration, water use can be reduced up to 70 percent by utilizing a flow control device which reduces the rate of flow to three gallons per minute.

The benefits of water conservation are many. In addition to the obvious benefit of conserving the state's limited and precious water supply, the energy savings achievable through the use of these fixtures and overall consumer cost savings can be substantial. A major concern regarding municipal water conservation measures is the potential financial impact on utility revenues that could result from the sudden, reduced volume of utility revenue when the fixed costs of the utility have to be met regardless of sales. However, phasing-in of conservation programs and practices could address those concerns. The availability of water-efficient fixtures and appliances at costs comparable to more wasteful fixtures, as well as the ease of their use in construction, make a statewide effort governing the sale and use of efficient fixtures and appliances a viable way to achieve substantial in-home water savings. On a larger scale, this particular method of water conservation can help avoid costs associated with development of new supplies and, because of reduced flows, can decrease the price of wastewater treatment. However, full implementation of water-saving plumbing fixture standards could take long to achieve.

Each year, Oklahoma's rural water systems collectively lose millions of gallons of treated drinking water through water line leaks and malfunctioning meters. To address this problem and identify energy and water losses that diminish the profits and efficiency of these smaller systems, the Oklahoma Water Resources Board proposed creation of the Statewide Rural Energy and Water Conservation (Oklahoma Leak Detection) Program. Created in 1993 and funded by $300,000 in federal oil overcharge monies from the U. S. Department of Energy, the program allows the OWRB to offer interest-free loans up to $30,000 for water audits, leak detection surveys and to make associated repairs. The Oklahoma Rural Water Association coordinates those activities. The initial water audit and leak detection survey identifies and assesses water, energy and revenue losses while resulting information determines what projects can most effectively reduce those losses. Eligible entities include rural water districts, non-profit corporations, municipalities and public trusts who provide water service to a maximum population of 10,000. Program funding is scheduled for termination in March of 2003.

The key to water conservation -- applying to in-home as well as agricultural and industrial water use -- is education. The environmental movement of the 1960's and 70's spawned widespread public awareness of environmental problems, especially the importance of conservation and protection of our water resources. Today, citizens are aware of the benefits in preserving, protecting and conserving valuable stream and groundwaters and they are equipped with the knowledge necessary to make intelligent decisions regarding water use and protection. However, there remains a need to develop and

foster additional respect for Oklahoma's water resources through education of adults as well as children.

Although education is important, perhaps the most powerful incentive for conservation is price. The price of water should reflect the actual costs of the water itself, plus costs associated with treatment and distribution. In far too many communities, however, water is practically a free resource with its price bearing little resemblance to the actual cost of treatment and delivery -- a fact which often escapes the citizen consumer. Furthermore, small-volume users typically pay much more by volume than do large users and there is little incentive to industry, a major water user, to conserve.

The general function of prices is to assert checks and balances on production and consumption in an economy. In this role, prices have two functions: to discourage excessive consumption of a commodity and to induce the desired supply of that commodity. Prices can play this role not only in the private sector of the economy, but also in regulating the production and consumption of certain commodities produced by governments and local entities. The price of water generally represents the amount necessary to cover a utility's capital and operating costs, including allowances for rehabilitation and replacement. The typical rate structure is the declining block rate system under which there is a charge per gallon for the first block of use which is greater than the charge per gallon for the next higher use category. In effect, the declining rate system subsidizes the larger user at the expense of the small user and is often used to attract industry to an area. However, under this system, there is little incentive to conserve.

It is the pricing of this additional amount of water that has potential for conservation because most of it is used for less critical tasks such as lawn watering. Increasing the price of the initial block will increase revenue but not discourage use. Increasing block rates are more effective. As larger quantities are used, the consumer has to pay an increased cost. Increasing the price of additional blocks -- at least to reflect the full incremental cost of delivery -- may alter use patterns in cases where water is priced below this level.

WATER RESOURCE PLANNING

Basin/Watershed Management

The traditional data-gathering approach to water resource management and planning has been controlled by political, rather than geographical, considerations -- and for good reason. The observance of political boundaries facilitates the flow of information and data from the source entity (such as the U.S. Census Bureau) to water resource agencies who require and depend upon this information to administer numerous state and federal programs.

Today, however, it can be argued scientifically that watersheds constitute the most sensible hydrologic unit within which to manage stream water resources and, especially, protect and enhance water quality. The majority of current watershed management studies are (and likely will be) driven by the nature of the individual problem at hand. Undoubtedly, increased attention to nonpoint source pollution will result in unprecedented incorporation of watershed management techniques.

Watershed management tools can be used to identify holistic cause-and-effect water quality relationships, link upstream uses or problems to downstream effects, develop reasonable water cleanup plans and educate the public. By cutting costs and focusing limited staff and resources on the most important water quality problems, basin-wide watershed management enables a state to protect waters in a more effective and consistent manner. Adoption of watershed management approaches in Oklahoma could also facilitate elimination or consolidation of the many time-intensive federal reporting, or "list-making," requirements. Similarly, a strategy to manage groundwater could be based upon the unique characteristics of a specific basin or aquifer. Coordination of geographic-based water planning includes components of planning and implementation, data collection and dissemination, information and research, and public education and information.

While numerous federal and state agencies (such as the Oklahoma Water Resources Board, U.S. Geological Survey, U.S. Environmental Protection Agency and Natural Resources Conservation Service) currently utilize various aspects of watershed planning and management, many recognize conflicting watershed boundaries. For example, the OWRB, through its stream and groundwater management and permitting programs, conducts studies of water availability in state stream systems and groundwater basins. Water quality standards and related studies are implemented on a primarily local, watershed-oriented basis while Oklahoma's interstate stream compacts recognize large river basins. However, more recent water resource planning activities have emphasized political boundaries. Population, economic and other societal information that is critical to water resource planning must be compiled with consideration for municipal, county and state boundaries -- an approach that limits the institution of watershed planning which recognizes natural geographic boundaries. This political/geographical overlap has traditionally posed problems for water resource planners who must extrapolate redundant, and often incomplete, water quality/quantity data.

A holistic water resource planning and management approach is needed to merge political and geographical differences. Recently, EPA provided the state with funds to develop a Whole Basin Protection Approach (WBPA) Implementation Plan for addressing water pollution on a watershed basis. This effort will include delineation and prioritization of watershed planning units as well as methods for synchronizing National Pollution Discharge Elimination System (NPDES) permits, nonpoint source implementation activities and related pollution prevention programs.

Geographic information systems (GIS) technology -- which involves the use of computers for mapping, management and analysis of spatial information -- exhibits much promise in watershed management. These systems possess capabilities for the encoding, storage, processing and display of computerized maps and images. Geographic information systems are beginning to emerge in Oklahoma and most other states. A consensus among state and federal agencies of watershed planning boundaries would

greatly facilitate the exchange of information within the state GIS program.

Drought Preparedness

Drought, which is all too frequent in Oklahoma, has serious social, economic and environmental repercussions. Particularly damaging to the state's agricultural industry, drought has been characterized as a "creeping phenomenon," making an accurate prediction of either its onset or end a difficult task. To most observers, it seems to start with a delay in the timing (or a failure) of the rains normally expected. A major problem in responding to drought lies in the fact that it has a different meaning to different people, largely dependent on their particular background and interest. Essentially, there are meteorological, agricultural, hydrologic and socioeconomic droughts, all relating to some shortfall in water.

Critical to determinations of drought's probability, however uncertain, is the existence of a system to facilitate the long-term, reliable and continuous monitoring of hydrometeorological conditions. According to a 1991 National Research Council report, which discussed the importance of identification and analysis of hydrologic extremes (including both drought and flood), "Estimation of the severity and interval of likely recurrence for this drought [the 1985-86 drought in the southeastern U.S.] was made possible by the availability of high-quality hydrometeorological records maintained continuously for a site since 1934. An even longer precipitation record, 110 years, was located for a nearby station. Whereas the drought was the most severe in the 53-year record, the 110-year record revealed five periods of even less rainfall before 1934. This information substantially altered the interpretation and implications of the 1985-86 drought, showing it to be a much more common event than first considered."

Past efforts in Oklahoma to deal with episodes of drought, both on the state and local level, is best described as crises management. The state must recognize that planning for Oklahoma's critical and emergency water resource needs should not be carried on only during times of drought crises.

Wetlands Protection & Management

Wetlands protection and management is one of the most divisive water policy issues and, as a result, federal regulation of wetlands has experienced numerous recent changes. Developers and farmers have protested the various wetland rules and regulations as being onerous land use requirements while environmentalists insist that more regulatory action is needed to sufficiently protect wetlands. The state must develop balanced policies that bridge the gap between these interests.

Because no individual entity has either the mandate or resources to provide adequate wetlands protection in Oklahoma, wetlands conservation and management are the shared responsibilities of numerous federal, state and local agencies as well as conservation organizations, private corporations, landowners and special interest groups. However, in May 1990, the State Legislature directed the Oklahoma Conservation Commission to prepare a wetlands management strategy for the state in cooperation with numerous state and federal agencies, including the U.S. Environmental Protection Agency, which has granted funds to states for wetlands conservation planning purposes. Also on the federal level, the National Academy of Sciences has been directed by Congress to review the wetlands definition and delineation issue.

Because the wetlands issue has such potential to influence private, state and federal land ownership and administration in Oklahoma, development of wetlands management strategies should be a cooperative effort that assures wetlands protection while balancing economic concerns and interests.

Endangered Species

The Endangered Species Act (ESA) was passed in 1973 "...to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered and threatened species, and to take such steps as may be appropriate to achieve the purposes of [several International] treaties and conventions." The ESA, which has been amended several times since initial passage, provides for a comprehensive approach to identifying species in need of special attention, conserving species and the habitats upon which they depend and recovering species to the point of delisting.

Congressional policy states "...that all Federal departments and agencies shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of [the ESA]." Furthermore, the ESA requires that federal agencies shall, in consultation with the U.S. Fish and Wildlife Service, ensure that any action authorized, funded or carried out by such agency does not jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat. However, many environmental organizations and agencies believe that federal and state agencies have failed to fully consider the potential impact of individual water resource development projects and related activities on endangered/threatened species.

Nationwide, more than 800 species of plants and animals have been listed as threatened or endangered under authority of the ESA. In Oklahoma, 21 species are currently listed, with one presently proposed for addition. Because the life cycles of many threatened/endangered species in Oklahoma depend, at least in part, upon the aquatic habitats provided by state streams, rivers, lakes or ponds, these species can be profoundly affected by changes in water levels, flows and quality. While both the ESA and Oklahoma Water Quality Standards (through the state's Antidegradation Policy) provide protection to state species classified as threatened or endangered by the U.S. Fish and Wildlife Service, development of water projects or use of water within key river basins may adversely affect critical habitat or otherwise impede plans for species recovery. However, while conflicts between water's environmental value and agricultural, urban and other uses of water could potentially result in expensive and time-consuming litigation and/or prohibit implementation of important water projects, to date, the ESA has been a factor in the development of only one water project in Oklahoma (Lukfata Reservoir, in southeast Oklahoma).

Recently, the U.S. Fish and Wildlife Service proposed to list the Arkansas River shiner-- a small fish peculiar to much of the Arkansas River Basin which has disappeared from over 80 percent of its historic range -- as an endangered species. There are unanswered questions related to decline of the shiner and past water development. On the other hand, there is concern regarding the possible effects the listing may have on

future water development and use (including implementation of potential low flow requirements and restrictions on groundwater pumping) in the Canadian River, North Canadian River and Cimarron River Basins. Reliable, long-term hydrologic information will be required to resolve this and future issues related to wise water management and protection of endangered/threatened species.

In some surrounding states, judicial decisions related to the needs of federally-listed species have resulted in changes in the administration of stream and groundwater resources. In response to the U.S. Court of Appeals, the Texas State Legislature has ruled that enforcement of the ESA has priority over the groundwater rights of Texas landowners when the two are in conflict. This major water rights decision in Texas merits careful examination for its applicability to Oklahoma and accentuates the fact that the sometimes competing needs between environmental and non-environmental water uses must be given serious consideration by the state when formulating the wide range of water management options.

FLOODPLAIN MANAGEMENT

Floodplain Protection & Preservation

In the wake of the 1993 Mississippi River flood, the federal government has made a renewed effort to promote floodplain management, including investigation of options to return floodplains to their natural condition, and prevent recurring flood problems. Oklahoma should keep abreast of federal activities in this area as well as continue current floodplain management efforts related to the National Flood Insurance Program (NFIP), federal Hazard Mitigation Grant Program (HMGP) and related programs that have resulted in reduced flood damages throughout the state.

Since Oklahoma joined the NFIP in 1975, the program has been directly responsible for mitigating state flood losses and associated costs. Currently, 358 communities, including 47 counties, have enrolled in the NFIP. However, 16 counties and 79 cities and towns not participating in the program have been identified as having flood hazard areas; 20 additional non-participating counties are unmapped, yet most are suspected of possessing flood-prone areas. Expansion of state mapping efforts, in cooperation with the federal government, could improve this situation, especially considering that increased development in many regions has caused significant alterations in federally-delineated, 100-year floodplain elevations.

While the Hazard Mitigation Grant Program has provided much-needed assistance to many Oklahoma communities in decreasing future flood losses, many elect not to participate due to the program's required 25 percent match. Identification of a funding mechanism that would assist communities with the required cost-share money could provide a boost to program participation. In addition, cities and towns with frequent flooding problems should be encouraged to participate in hazard mitigation planning efforts prior to disasters rather than during post-disaster recovery periods. Improved education, training and planning is needed to reduce the flood risk at the local level and prevent repetitive flood damage.

The availability of long-term and reliable hydrometeorological data is just as important to flood planning as it is to drought planning and other water resource management efforts. For example, precise delineation of the 100-year floodplain relies, to a great extent, upon accurate and accessible streamflow data, especially estimates of extreme discharge and stage (elevation of the water). Also, the existence of a real-time monitoring network, utilizing U.S. Geological Survey stream gage information, is vital to development of effective flood forecasting and warning systems, such as that implemented by the City of Tulsa. In this regard, there is a need to update and improve the current USGS stream gaging network as well as perform maintenance on individual stream gages throughout the state.

Other methods through which state and/or local governments could reduce flood damage and mitigate related hazards include stormwater management planning; development of alternative methodologies for determining flood elevations; improved enforcement; increasing public awareness and education; implementation of state Geographic Information Systems; and investigation of a system that limits future development where a high ratio of impervious to pervious land exists.

PROBLEM MEDIATION & ARBITRATION

Water Resource Dispute Resolution

Activities surrounding the utilization and protection of water are frequently debated and many times litigated. As a result, resolution of disputes involving these issues is growing in importance. Through consensus building techniques, a knowledgeable facilitator, perhaps one authorized state agency, can bring affected parties to the table to air concerns in a non-litigation setting. Such a mechanism -- as currently employed by the Oklahoma Water Resources Board in its effort to mediate disputes involving the state's rural water systems -- could produce an atmosphere conducive to problem-solving and one that avoids costly and lengthy litigation which many times results in undesirable results for all involved parties.

Other potential avenues to solve water use and management disputes include creation of a state arbitration panel and implementation of advisory committees to increase awareness and understanding among parties involved in individual disputes. In addition, there is a need for the state to reevaluate current water law and policy to ensure that it is set forth in a clear and concise manner.

Local Empowerment

Citizens in many areas of the state believe that state regulation of water quantity and quality, especially groundwater, should be curtailed to the greatest extent possible and that the role of the state in addressing water problems should be as facilitator and educator, rather than as manager. Empowerment of local entities with decision-making responsibilities through creation of groundwater management districts (such as those implemented in the State of Kansas), watershed management districts and related organizations, if done responsibly, could benefit water management agencies as well as local water users who are directly impacted by regulation of their water resources. However, local leaders must be equipped with sufficient equipment and education to make informed decisions and agree to be held accountable for those decisions.

In addition, increased accountability at the local level would undoubtedly short-circuit many potential water resource disputes and problems -- relieving both the frequently back-logged state court system of unnecessary legal cases and involved parties of the exorbitant costs of litigation. As unfunded federal mandates continue to increase and emphasize the need for local (as well as

state) funding sources for water/wastewater projects, the role of local governments in the control and management of stream and groundwater resources will similarly evolve. Finally, current and upcoming funding restraints will necessitate a comprehensive review and prioritization of water quality and quantity management programs in which the state participates, then possible elimination of those programs deemed to be redundant and/or wasteful.

Interstate Water Disputes

Resolution of interstate water issues and problems is currently facilitated through the four existing interstate stream compacts to which Oklahoma is a party. These compacts are important to Oklahoma to assure receipt of adequate surface flows/releases from upstream states. Generally, the compacts provide a means of working out problems between states in an orderly manner, preventing the likelihood of litigation in most cases. Recently, the Arkansas-Oklahoma Arkansas River Compact Commission has begun to address some water quality issues, along with traditional water quantity matters, and the Red River Compact Commission has already established a standing environmental committee.

Groundwater basins, like their stream watershed counterparts, often extend beyond the geographic outline of a state's boundaries. Through formation of groundwater compacts with neighboring states, Oklahoma could not only improve the planning, development and management of shared groundwaters, but be part of a forum to facilitate the resolution of conflicts involving groundwater allocation, pollution and related problems. However, any interstate groundwater agreement or compact must be in harmony with state water policy, applicable laws and the public interest.

DATA COLLECTION & MANAGEMENT

Stream Gaging Network

In order for the state to manage its water resources, appropriate data must be properly collected and analyzed. According to the National Research Council, which discussed the role of data collection in 1991, "Detection of hydrologic change requires a committed, international, long-term effort and requires that the data meet rigorous standards for accuracy... The absence of supporting facts does not lead to understanding and can result only in conjecture."

While the U.S. Geological Survey has collected stream gage data nationwide since 1888, the State of Oklahoma has participated with the federal agency in cooperative stream gaging programs since 1935. The USGS provides federal matching funds for one-half the program cost, enabling state, local and tribal agencies to acquire reliable streamflow data. The Oklahoma Water Resources Board, as the primary state cooperator in the program, depends heavily on this data to determine amounts of water available for use. In addition, there are numerous communities and organizations in Oklahoma -- including the National Weather Service, Federal Emergency Management Agency and many state and local disaster agencies -- who currently use the program's real-time data for flood forecasting, flash flood warnings, regulation of reservoir discharge and emergency management.

USGS stream gaging data is also used in Oklahoma to provide valuable information related to floodplain development; water supply forecasting, planning and research; construction and design of bridges and dams; and facilitation of interstate stream compacts to which the state is a party. In addition, during periods of extensive drought, real-time data can be valuable in monitoring diversions of water. This is especially critical in areas of direct diversion for irrigation when users desire water at essentially the same time.

Water Well Measurement

The state water well measurement program was initiated in 1937 by the U.S. Geological Survey and, since 1950, has been conducted jointly by the USGS and Oklahoma Water Resources Board. The objective of the annual statewide effort is to gather historical records of groundwater level fluctuations and, from them, predict water use trends and future availability of groundwater supplies. Specifically, resulting data is utilized by the OWRB in determining the maximum annual yields of state groundwaters.

Although most of the wells in the network are irrigation wells, those supplying municipal, industrial and domestic water are also included. Typically, some 1,200 wells are measured throughout the state. Because of the great reliance on groundwater for irrigation in the Panhandle and to facilitate cooperative federal/state efforts to track water level changes in the Ogallala Aquifer, more than 200 wells are measured in Texas, Cimarron and Beaver Counties. Some wells are equipped with instrumentation that provides a continuous record while others are measured by hand. Because depletion of groundwater is a serious problem in some areas of the state, well measurement and monitoring will provide the state and local landowners with the necessary information to better manage this resource.

Water Quality Sampling & Monitoring

Water quality monitoring, including observance of biological communities, is an integral tool in determining the current status of stream and groundwater resources and effectively managing their future use. Monitoring provides a means to identify the presence and extent of contamination, recognize regional trends and correlate known contamination problems with suspected health problems.

State water quality sampling activities are directed by several state agencies, including the Conservation Commission, Water Resources Board, Department of Health, Department of Environmental Quality and Department of Wildlife Conservation. These agencies receive assistance from federal agencies (especially the U.S. Geological Survey), state universities and citizens.

Historically, the majority of water quality data on Oklahoma's stream water resources has been obtained through the National Stream Quality Accounting Network, maintained and primarily funded through the USGS for more than a decade. However, insufficient funding has resulted in the abandonment of many state water quality monitoring stations which are part of this and other federal programs. The nine remaining USGS stations are scheduled to be discontinued when the National Stream Quality Accounting Network comes to a close. The two water quality sites funded through the USGS Benchmark network will likely continue.

In addition to USGS efforts, DEQ maintains a statewide ambient trend monitoring network. The network, in place since the mid-1970's, once contained 100 stations throughout Okla-

homa which were sampled on a monthly basis. Unfortunately, the program has not been maintained and no ambient water quality data is presently collected for the network.

As part of a separate program, the OWRB conducts sampling studies on numerous publicly-owned lakes with assistance from federal Clean Lakes Program grants. Through the State Lake Water Quality Assessment Program, approximately 120 of Oklahoma's largest lakes are sampled at least once every five years to determine their trophic status. In addition, more than 80 smaller urban lakes are periodically sampled by OWRB staff or "Oklahoma Water Watch" program citizen volunteers. This valuable program provides physical, chemical and biological data for use in identifying pollution problems, recommending solutions and implementing restoration measures. Reservoir water quality information is also gathered by the Oklahoma Department of Wildlife Conservation through its fish monitoring efforts.

The USGS, OWRB and other state and local agencies also cooperate in water quality monitoring programs on specific projects and the USGS monitors surface waters for additional federal programs, such as the National Water Quality Assessment (NAWQA). However, NAWQA monitoring sites are normally established for a specific purpose and may not be entirely useful for state ambient water quality data needs.

Although Oklahoma contains more than 3,500 generally recognized waterbodies, less than 500 have been assessed for water quality. While sampling of all stream waters is unrealistic, additional sampling stations are required for the state to establish an adequate database for planning activities and the monitoring of pollution control measures. A regional approach to sampling would allow for determination of baseline water quality without monitoring of individual resources. Oklahoma requires a plan -- perhaps established in conjunction with, or as a result of, coordinated state watershed planning efforts -- for determining what waterbodies should be measured, the location of sampling points and frequency of assessment.

Biological assessment techniques augment and enhance traditional measures of water quality which have historically focused upon chemical analysis. Biological assessment can establish reference criteria upon which regional assessments of water quality conditions may be based and can provide long-term information on conditions at individual sites to enable monitoring of quality over time. This form of assessment can also detect the effects of those chemicals that are either no longer present or are not normally tested for in routine analysis. In addition, tissue analyses of specimens from the biological community can detect chemicals that are accumulated or magnified at levels below what can be detected through conventional analytical procedures. Finally, analysis of the biological community enables rapid screening of water quality so that resources can be directed where they are needed most.

In 1983, the OWRB began an extensive annual groundwater quality sampling program of 21 major groundwater basins in the state. The purpose of the program was to obtain ambient, or natural, groundwater quality data in an effort to characterize the basins in Oklahoma. The program was refined to include only wells on which information about well construction, location and surrounding land use is available. Individual water samples were analyzed by the State Department of Health laboratory for a wide range of metals and chemical pollutants.

The monitoring network, discontinued several years ago, was designed to obtain water quality data over large representative areas for the major state aquifers. However, while providing good areal coverage and potential trends over time for aquifers with the greatest use, the network neglected many small aquifers used for domestic supplies as well as specific areas that may have been experiencing significant water quality degradation. These deficiencies should be corrected in the event the sampling program is reinstated.

The USGS has also sampled and analyzed water from approximately 25,000 wells and springs in Oklahoma. These data have been collected primarily through special projects, including cooperative efforts with the OWRB.

In addition to past and present water quality monitoring and sampling programs, water quantity programs -- such as the state's well measurement and stream gaging efforts -- provide valuable information vital to development of accurate and effective waste discharge permits and related water quality considerations.

Because of the number of state agencies with legislatively assigned responsibilities for water-related issues, coordination of water quality monitoring activities has been a historical problem in Oklahoma. Communication between agencies, including development of uniform methods of collecting samples, would ensure the consistency and effectiveness of individual water-related sampling programs Coordination would eliminate or reduce duplication in project identification and planning, as well as in information gathering and analysis. Taken one step further, development of a centralized stream and groundwater monitoring network and/or expansion of current programs could provide more reliable background data with which to improve administration of the state's various water management programs.

Oklahoma Mesonetwork/Next Generation Weather Radar

The Oklahoma Mesonetwork (MESONET) is part of a recent initiative to place timely and highly useful weather information in the hands of state citizens. A joint effort between the University of Oklahoma and Oklahoma State University, MESONET consists, in part, of 111 automated observing stations located throughout Oklahoma's 77-county area that continuously monitor a number of important weather and soil conditions.

Every 15 minutes, data observed over five-minute intervals are relayed from each remote station to a central processing site which receives, quality controls, stores and disseminates the observations, as well as value-added products, to a large statewide community of users -- all within minutes of each observation.

MESONET, in conjunction with the National Weather Service's Next Generation Weather Radar (NEXRAD) program's network of operational doppler radar systems, has facilitated remarkable improvements in remote sensing of the environment. These radars provide high-resolution data and products which, in the past, have been available from only a few research meteorological radars during limited time periods. This new partnership enables MESONET users to access additional cutting-edge, value-added weather products.

Beneficiaries of MESONET data include water resource planners, farmers, ranchers, foresters, educators, transportation officials, emergency management officials, energy officials, meteorologists, weather sensitive businesses and the general public. Because MESONET has been designed for a variety of purposes and utilizes several mechanisms to disseminate information, the Oklahoma Mesonetwork may represent one of the most significant improvements ever in environmental data collection.

Water Resource Data Management

The current wealth of water resource information available from state and federal agencies, municipalities, universities and other research centers, and related sources is invaluable in the administration and management of Oklahoma's stream and groundwaters. Unfortunately, much of this data is widely scattered and exists in a variety of formats. Consequently, procurement of this data by a single individual, agency or organization is often difficult, expensive and time-consuming.

Establishment of a central depository for water resource data would be very costly and inefficient. A more viable approach would be to establish a central contact station with the ability to access water related data banks at all relevant state and federal agencies. The creation of a state water resource computer network and data bank, available to all participating water agencies, would facilitate the more efficient, economical and responsive administration of Oklahoma's water resources. Utilization and/or expansion of the Internet system could be a promising tool to access and disseminate water resource data.

Geographic information systems (GIS) -- which involve the use of computers for mapping and analysis of spatial information -- are a promising tool in the research, planning and management of water and other natural resources. GIS possesses various capabilities for the encoding, storage, processing and display of computerized maps and images and the manipulation of socioeconomic data which is vital to holistic water resource planning. Currently, more than one dozen state agencies and academic institutions are working independently to implement GIS technology in Oklahoma. However, only a small portion of the existing data is available for use beyond the agency or institution where it was developed and costs to create system data sets are far in excess of the costs of hardware and software. Recent legislation established a council of agencies and universities whose mission is to develop a strategy to implement a state GIS and coordinate state GIS efforts.