

**Water Resources Report Number 64  
MISSOURI STATE WATER PLAN SERIES  
PHASE 2**

**SUMMARY AND ANALYSIS  
OF  
TOPICS IN WATER USE – REGIONAL REPORTS**



**MISSOURI DEPARTMENT OF NATURAL RESOURCES  
Water Resources Center**

## **Synopsis**

This publication summarizes the major findings of the five publications that make up Phase 2 of the Missouri State Water Plan. It also incorporates Major Water Use data collected by the department's Water Resources Center (WRC). The Phase 2 findings and Major Water Use data are analyzed to describe water use trends and water use concerns on categorical, regional and statewide scales. More information on the Missouri State Water Plan is available at: <http://www.dnr.mo.gov/env/wrc/statewaterplanmain.htm>.

## **Acknowledgements**

The State Water Plan staff appreciate the assistance provided by the Department of Natural Resources Regional Offices, the State Water Plan Interagency Task Force, federal and state agencies, local governments and the many individuals, without whose help the Regional Reports and this Summary would not be possible.

## **Phased Approach to Water Planning**

The State Water Plan Phase 1 effort consists of seven technical inventory and assessment documents that provide information about water resources and related subjects. Phase 1 publications addresses surface water, groundwater, water quality assessment, water use, hydrologic extremes, interstate water resources, and Missouri water law. More information on Phase 1 is available at: <http://www.dnr.mo.gov/env/wrc/statewaterplanphase1.htm>.

The State Water Plan Phase 2 effort consists of five reports that identify and discuss water use problems and opportunities related to drinking water, agricultural, industrial, recreational, and environmental needs. A water use opportunity is a "success story" or an opportunity for success that has been identified during the process of Phase 2. Each report covers a separate region of the state. For more information on Phase 2 of the Missouri State Water Plan, please visit the web site at: <http://www.dnr.mo.gov/env/wrc/statewaterplanphase2.htm>.

## **Overview of Phase 2**

The objective of Phase 2 is to identify and describe specific water quantity and quality problems that impede the economic, environmental and social use and enjoyment of the state's water resources. Phase 2 is a screening process that provides for the identification and concise discussion of water use concerns, and therefore, is a limited sampling inventory of the problems and opportunities associated with water use faced by Missouri businesses, local governments and private citizens. Five reports, covering six geographic regions of the state, with each report addressing six water use categories have been completed. The following map shows the areas covered by each of the Phase 2 reports.



## **Analysis of Water Use Findings**

Defining and addressing water problems and concerns requires an understanding of the issues that impede the intended water use. In most cases the problems are tied to issues involving both water supply and use.

### Statewide Water Use Findings

Several specific findings were common to all regions and are noteworthy for their statewide implications.

- Changing land use practices, urban sprawl, and contaminants from runoff, threaten water supplies, which in-turn impact water demand and water use.
- Drinking water supply and delivery infrastructure is not only stressed from age but also from capacity and supply limitations.
- Water supply quality or quantity threats exist in every watershed. Left unchecked, these threats can negatively impact drinking water supplies, agricultural water use, recreation, tourism, fish and wildlife, and business and industrial water uses.
- Problems associated with surface water are more noticeable than problems associated with groundwater; therefore they are identified more readily and more often.

### Regional Water Use Findings

A total of 122 water use problems and 31 water use opportunities were identified. The following paragraphs discuss key regional water use findings. The Southeastern and Southwestern Regions have been combined into the Topics of Water Use: Southern Missouri report.

- *Eastern Region:* Most water use concerns in the Eastern region are urban in nature. Findings include aging drinking water infrastructure and water wastage, contaminated or polluted surface water and groundwater, stormwater infrastructure and combined sanitary and stormwater systems. A related group of concerns center on brownfields, urban sprawl, floodplains, and land use management issues. Several findings are associated with the use and development of the water resources of the Missouri and Mississippi Rivers.
- *Central Region:* This diverse region has relatively abundant surface water and groundwater resources and as a result, water use concerns are primarily focused on water quality and resource protection. These concerns include surface water and groundwater protection from non-point sources, municipal, industrial, sewer, septic tank, and agriculture related potential contamination sources. Several findings involve riparian land use, in-stream sedimentation, channelization, gravel mining and bank erosion. Use and development of the Missouri River as a water resource is a recurring finding.

- *Northeastern Region:* This region is primarily rural, with findings reflecting those concerns. Findings for this region include: concerns with lack of planning and high costs of developing, expanding, maintaining, and replacing water supply sources and delivery systems; unclear water use rights; aging water supply sources and infrastructure; changing use demands stemming from population trend changes; and system stress in meeting water demands during periods of drought and industrial growth. Other significant concerns involve water quality and the environment; including water and land impacts associated with confined animal feeding operations, industrial and residential growth, stream channelization, sedimentation, streambank erosion, and loss of vegetated riparian corridors.
- *Northwestern Region:* This is a diverse water use region, ranging from large tracts of rural, agriculture areas to populous metropolitan and suburban areas. Identified concerns include: aging infrastructure and water supply impoundments; lack of both water supply and public water systems coordination (especially during drought); contamination of water supplies by chemicals, human and animal waste; urban sprawl and land use management; and channelization, sedimentation and stream degradation.

**Topics of Water Use: Southern Missouri Report** includes separate descriptions of the southeastern and southwestern regions.

*Southeastern Region:* This predominantly rural region is noted for large agricultural areas in the Bootheel and upland forests in the Ozark Mountains. With several National Scenic Rivers located in the region, recreational water use is a concern. Water concerns include: reliance on and depletion of high quality aquifers; aging water supply and delivery infrastructure; population growth; sewage discharges; mining, logging and other land use and development disturbances impacting both surface water and groundwater; unplugged and abandoned water wells and mining exploration wells; agricultural runoff; landfills and old abandoned dumps; recreational overuse of national scenic waterways; and water quality concerns associated with the surface water and groundwater interface.

*Southwestern Region:* This region has very diverse water use characteristics ranging from urban and suburban concerns to agricultural, recreational, economic, and environmental. Concerns identified in this region include: karst areas with direct surface water and groundwater interface; gravel mining; stormwater runoff; aging water supply and delivery infrastructure, drinking water quantity, stormwater and sewer systems; urban and suburban expansion and land disturbance; livestock operations and CAFO's; effluent discharge; abandoned and unplugged water wells; and mines and mine tailings.

### Categorical Water Use Findings

Drinking water and environmental concerns, with 34 and 49 findings respectively, are the categories where most (68 percent) of the findings are focused. The remaining categories of agricultural (12), industrial (14) and recreational (13) concerns are split almost equally. Water quality issues, water quantity issues, aging infrastructure, competing water needs, land use, and managing stormwater, and sewers and sewage are recurring concerns that crossed water use categories. The number of findings by both region and use category are shown in the table below. The following paragraphs discuss key categorical water use findings.

## STATE WATER PLAN PHASE 2 WATER USE PROBLEM AND OPPORTUNITY SUMMARY TABLE

The following table represents a summary of findings of topics (water use problems and opportunities identified and covered within each regional report).

Use Categories And Issues**	REGION*					TOTALS
	NORTHEAST	NORTHWEST	CENTRAL	SOUTHERN***	EASTERN	
DRINKING WATER	6	6	7	9	6	34
AGRICULTURAL	3	2	5	2	0	12
INDUSTRIAL	3	1	5	4	1	14
RECREATIONAL	1	0	4	6	2	13
ENVIRONMENTAL	10	15	10	11	3	49
OPPORTUNITIES	5	6	8	6	6	31
<b>TOTALS</b>	<b>28</b>	<b>30</b>	<b>39</b>	<b>38</b>	<b>18</b>	<b>153</b>

Number of Findings by Report and Category

\* Regions identified in these reports match the former MoDNR Regional Office configuration

\*\* Many water use issues that were identified are applicable to more than one Category

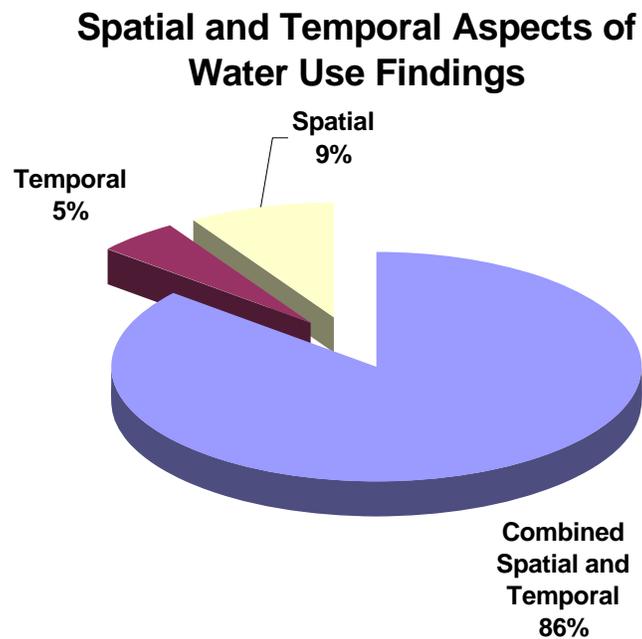
\*\*\* Southern Region includes previous Southeast and Southwest MoDNR Regional Office areas

- Consumptive, Non-Consumptive, Withdrawal and In-Stream Uses:* Broadly speaking, water is either used at its source (in-stream) or it is withdrawn from its source, transported, and used elsewhere. In-stream use does not involve an off-site transfer, consumption or a reduction in the quantity of source water. Non-consumptive use and in-stream use relates mainly to surface water and typically do not markedly affect water quantity or quality. Water that is transferred from a stream or lake to use at another location is a withdrawal. Unlike in-stream uses, withdrawals consume at least a portion of the water. Often the quality of the water returned is either degraded or different than that which was withdrawn. Impounded surface waters, ponds and lakes, are more difficult to classify in that their use often has characteristics of both in-stream and withdrawal. While there are exceptions, groundwater is typically withdrawn and consumed.

Twenty-three (15 percent) of the total 153 findings directly involve consumptive use concerns, while 15 (10 percent) directly involve non-consumptive water use concerns. Only in the Central Region is there more non-consumptive water use concerns than consumptive concerns. Categorically, drinking water and agriculture problems are focused on consumptive use and other water related problems. Likewise, recreation and environmental related concerns are focused on problems associated with non-consumptive uses. Industrial findings are more evenly split between consumptive and non-consumptive concerns. By a wide margin, 42 percent of the water use problem and opportunity findings are focused on in-stream uses, especially in the categories of environmental (30 findings) and recreational uses (11 findings) and specifically in the Central and Southern Regions, with 18 and 16 findings respectively. The other significant related water use finding involves water used for drinking. Drinking water concerns center on water withdrawal (18 findings) and on other concerns (10 findings) that do not relate to the location of the water. This includes such findings as water laws, quality standards, and regional planning and contracts.

Withdrawal and in-stream findings are fairly evenly distributed in the agricultural and industrial categories, which appears to reflect the broad, overlapping areas of concern for these categorical water users.

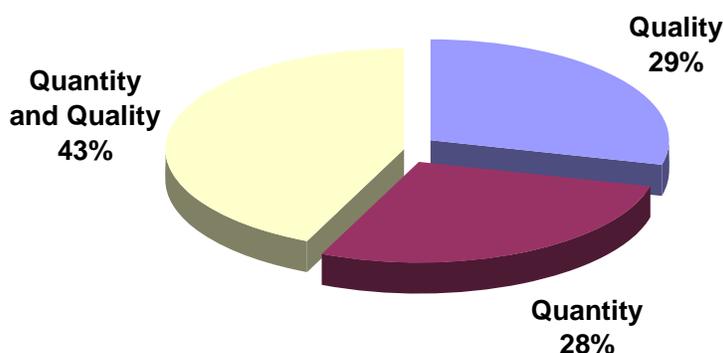
- Spatial and Temporal Findings:* If water is not available at a certain location and at the specific time that it is needed, then a water use demand problem results. Temporal water use concerns relate to *when* water is used or needed. Spatial water use concerns relate to *where* water is used or needed. Spatial and temporal issues are so closely intertwined, and so often overlooked, that it is important to note this as an important overall finding. Aging water supply infrastructures, loss of riparian corridors, water rights, stream bank erosion, sedimentation and channelization, loss of aquatic species are a few examples of spatial and temporal linked concerns. Geographically each of these potential problems have direct, tangible negative impacts at the local level; but in a broader context, each has negative implications for the state as a whole, both now and in the future. Several water use problems are found to transcend regional boundaries. Aging water supply infrastructure, runoff and land use related concerns, water quality and institutional, legal and administrative water use impediments are identified as problems in all six regions. Floodplain management, levees and levee construction, water quantity, and urbanization and related land development are each identified as concerns in five of the six regions.



An analysis of the Phase 2 findings indicates about 86 percent were a combination of spatial and temporal factors. Fourteen (9 percent) are primarily spatial in nature and 8 (5 percent) are primarily temporal in nature. Most (79 percent) of the spatial-only findings tend to be clustered in the recreational and environmental categories, while temporal concerns (88 percent) are linked to environmental concerns and the water use opportunities categories. There are no temporal-only concerns identified in the drinking water, industrial, and recreational water use categories. There are no spatial-only concerns identified in the water use opportunities category. One hundred thirty-one (86 percent) of the 153 total findings involve a combination of spatial and temporal water use concerns. Spatial-only and temporal-only findings are equally dispersed among the six different report regions.

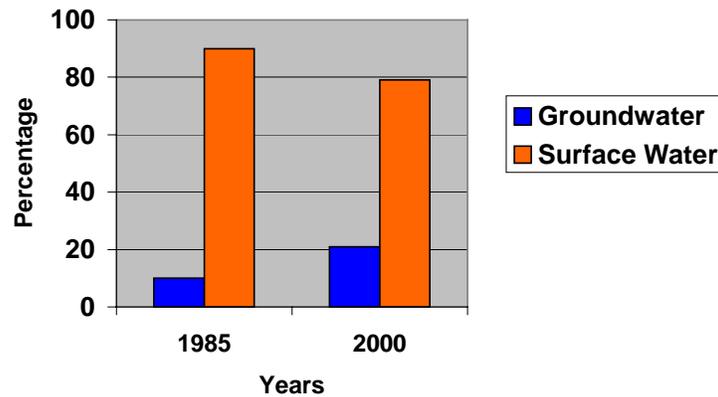
- Quality and Quantity Findings:* Water quality and quantity uses both compliment and compete. Dependent upon the water use, concerns tend to focus on one or the other until the relationship becomes unbalanced due to such things as drought or pollution. Of the 153 topics identified, 43 (28 percent) are oriented to water quality-only, 42 (27 percent) are focused on water quantity-only and 65 (42 percent) are a combination of quantity and quality concerns. This almost perfect split between quantity-only and quality-only tends to substantiate their interdependency. This is further illustrated by the finding that most concerns are a combination of the two. On a regional basis, findings indicate that a combination of water quality and quantity are more often perceived as water use problems than are either individually. On a categorical basis, water quantity concerns are more prevalent when it comes to drinking water and water use opportunities; while water quality concerns are more prevalent with agriculture and environmental uses. Industrial and recreational uses are fairly evenly split among water quality and water quantity. Three topics (2 percent) are neither quantity nor quality oriented.

### Quantity and Quality Aspects of Water Use Findings



- Surface Water and Groundwater Findings:* Between 1985 and 2000, total statewide water use increased by more than 2 billion gallons a day (US Geological Survey). Groundwater use increased at a faster rate than surface water use. In 1985, groundwater supplied about 10 percent and surface water sources provided 90 percent. In 2000, groundwater supplied about 21 percent and surface water sources 79 percent. This shift in groundwater use is significant because it represents a 280 percent increase.

### Change in Surface Water and Groundwater Use from 1985 to 2000



Groundwater is a common source for drinking water, self-supplied industries, and agricultural crop irrigation. Surface water is a common source for electrical power generation, drinking water, livestock water and recreation. Water use findings related to surface and groundwater indicate that overall there are substantially more problems and opportunities perceived with surface water use than with groundwater. Regionally, most groundwater related concerns (5 of 12 or 42 percent) correlate to the Southern region, which relies on groundwater more than any other region. Categorically, environmental and recreational water concerns, (43 of 76 findings representing 57 percent), are focused on surface water use. No groundwater only concerns were identified in the Northwest region or for industrial, recreational, or environmental-needs categories.

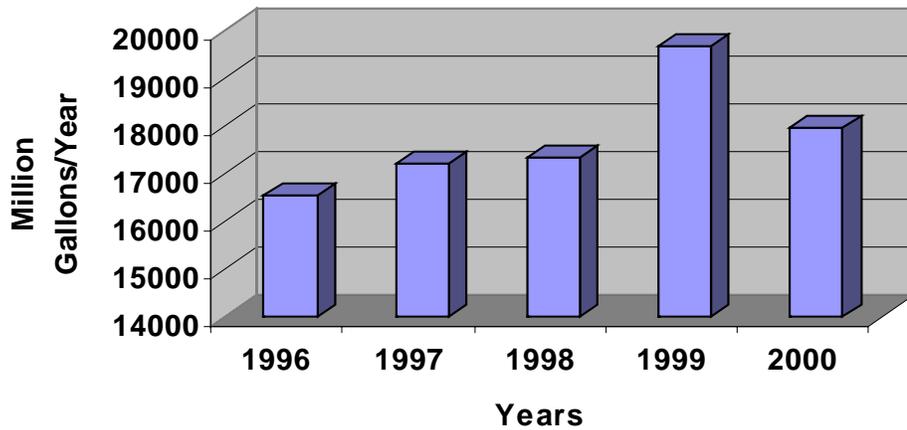
#### Major Water Use Data Analysis

During the decade of the 1990's, water use outpaced the growth of the state's population. Between 1990 and 2000, total statewide water use increased by almost 26 percent (US Geological Survey) while the state's population increased 9 percent (Missouri Census Data Center). Per capita water use grew from 1,358 gallons per person per day in 1990 to 1,470 gallons per person per day in 2000 (US Geological Survey).

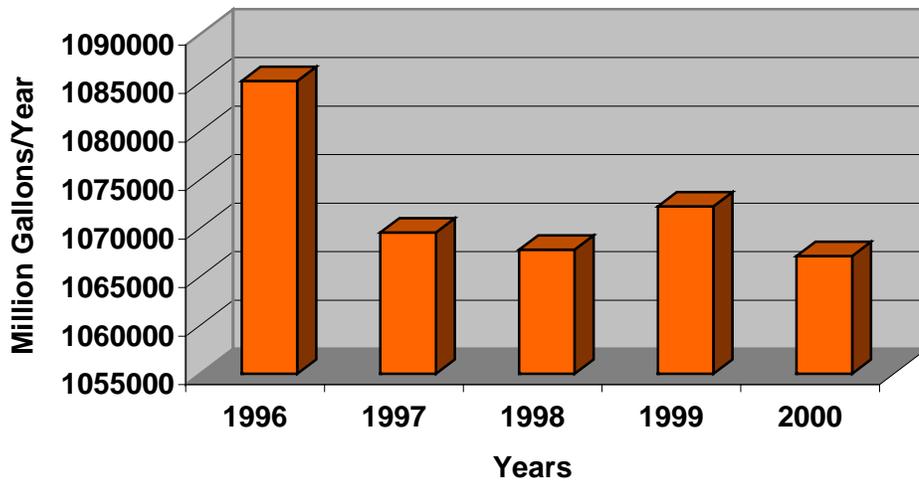
The Water Resources Center compiles and analyzes water use data for the state's major water users. Domestic, municipal, irrigation, recreational, industrial, electrical generation, fish and wildlife maintenance, and drainage and dewatering comprise the major water use categories tracked by the division. The following analysis is based on major water use data. More information on Major Water Users Law and the report *Major Water Use In Missouri: 1996-2000* is available at: <http://www.dnr.mo.gov/env/wrc/waterusestatutes.htm>.

- *Eastern Region*: Major water use data indicates that groundwater use has increased from 1996 to 2000, peaking in 1999. Municipal use represents approximately 85 percent of the reported groundwater use. Reported surface water use in the region has remained relatively constant. Municipal use and electrical power generation demands account for 99 percent of the reported surface water used in the region. Groundwater use represents about 1.5 percent of the total combined major water use within the region (WRC Major Water Use database).

### Eastern Region Groundwater Usage

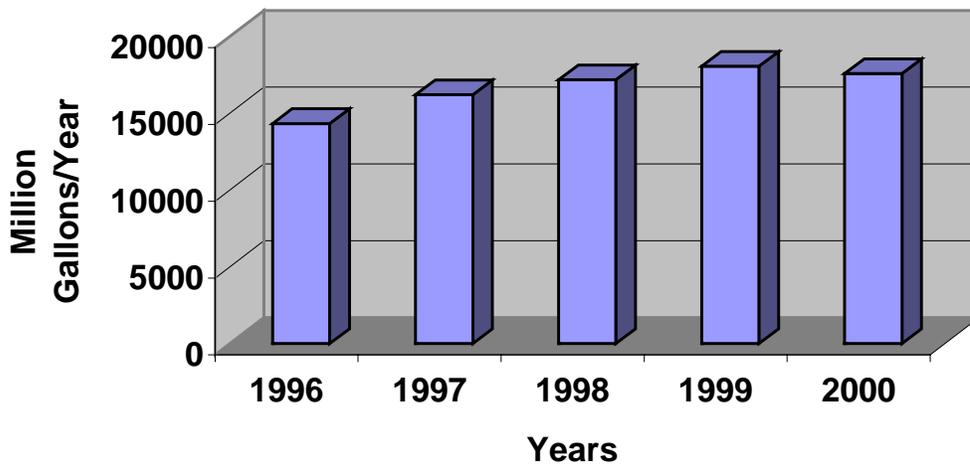


### Eastern Region Surface Water Usage

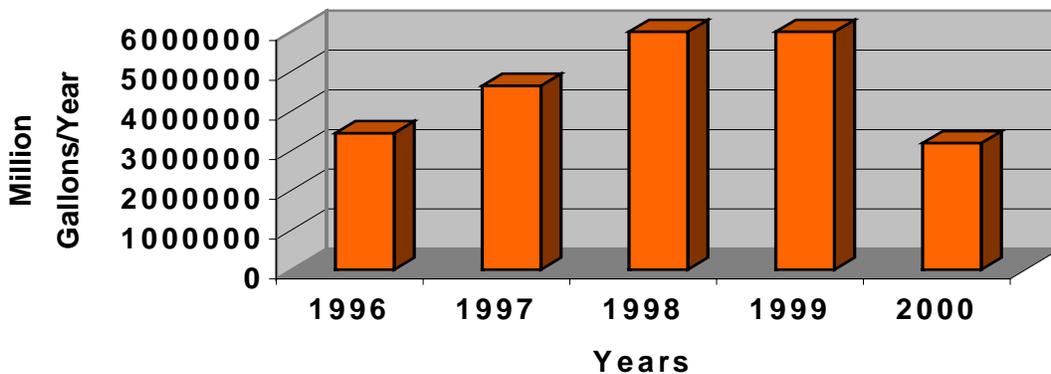


- Central Region:* Major water use data indicates that groundwater use has increased annually between 1996 and 1999 but decreased slightly in 2000. Municipal use and domestic use of groundwater comprises approximately 76 percent and 10 percent respectively of the total annual use. Reported surface water use in the region indicates fluctuating demands. Peak reported surface water use occurred in 1998 and lowest use occurred in 2000. Electrical power generation is the major surface water use category, averaging 99.9 percent of the total surface water withdrawals. Significant quantities of surface water were reported for domestic, municipal and fish and wildlife categories, even though together they represent less than 0.1 percent of the total. Surface water use in this region alone represents over 56 percent of the total surface water used in the entire state. Groundwater withdrawals represent about 0.3 percent of the combined total water use within the region (WRC Major Water Use database).

### Central Region Groundwater Usage

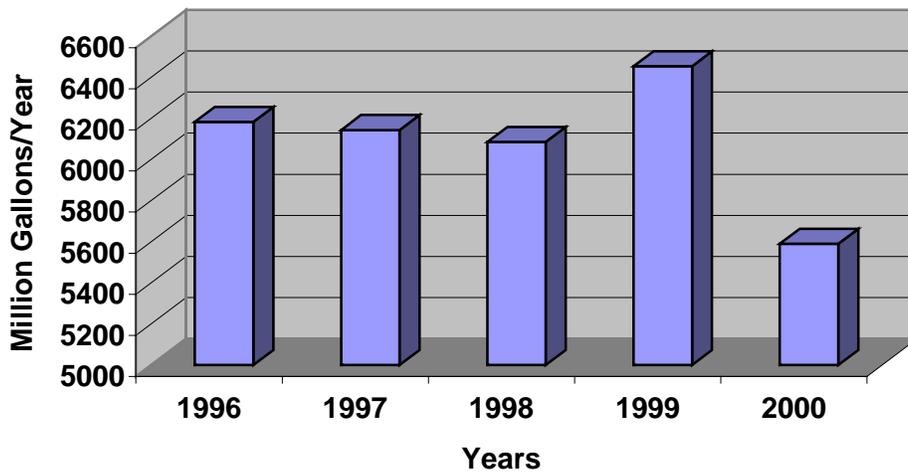


### Central Region Surface Water Usage

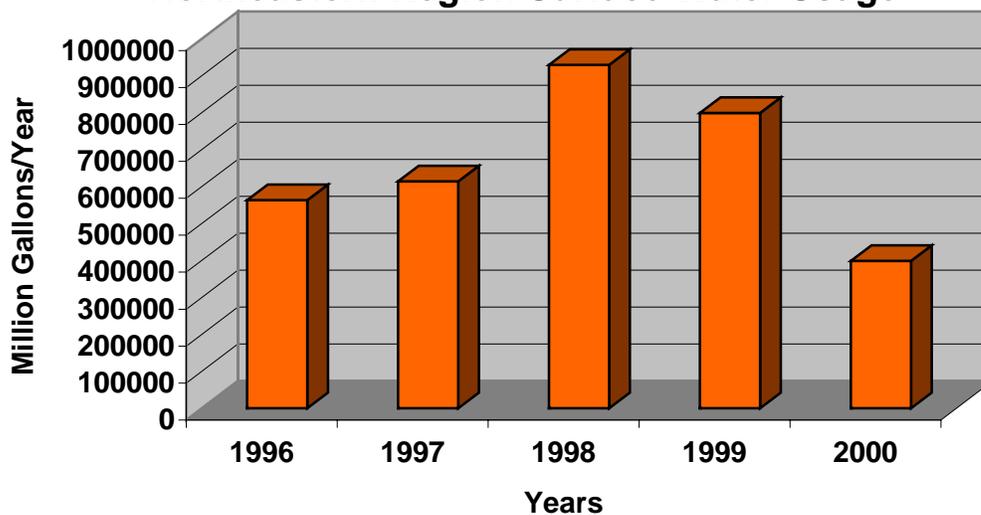


- Northeastern Region:* The reported total groundwater use for the years 1996 through 2000 reached a high in 1999 and a low in 2000. Groundwater withdrawn by municipalities and irrigators account for around 85 percent of the reported groundwater use. Industrial use of groundwater showed a 28 percent drop while groundwater used for electrical generation showed a 17 percent increase. Surface water use varied considerably from a high in 1998 to a low in 2000, a difference of 232 percent. Electrical power generation, municipal needs, and fish and wildlife demands accounted for around 99 percent of the reported surface water use. Groundwater use represents about 1 percent of the combined total major water use within the region (WRC Major Water Use database).

**Northeastern Region Groundwater Usage**

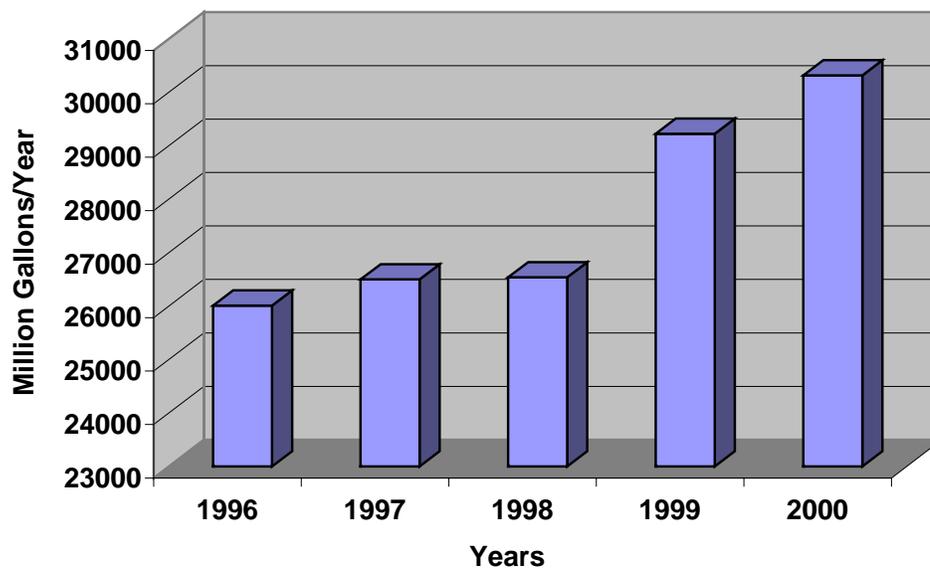


**Northeastern Region Surface Water Usage**

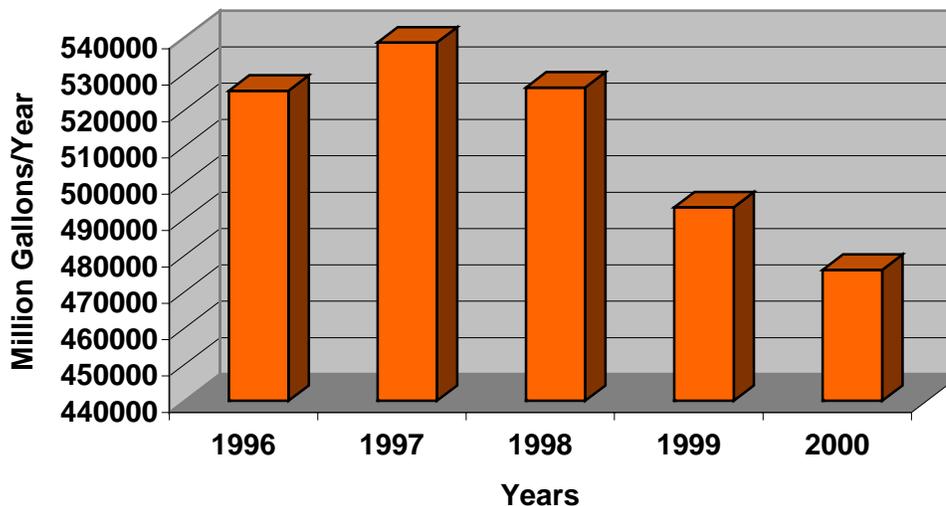


- Northwestern Region:* The reported total groundwater use for the years 1996 through 2000 indicates a consistently increasing demand. Groundwater withdrawals reported by municipal and domestic users, account for approximately 84 percent of the reported groundwater used by all major groundwater users. Major surface water use in the region indicates fluctuating demands. Total surface water use increased slightly from 1996 to 1997 and then fell each year from 1997 through 2000. Peak surface water use occurred in 1997 and lowest use occurred in 2000. Electrical power generation and municipal use were the major demand categories, averaging about 98 percent of the total surface water withdrawals. Water use reported by major users for domestic, irrigation, recreation, industrial, fish and wildlife, and drainage purposes comprise the remaining 2 percent. Groundwater use represents about 5 percent of the total combined groundwater and surface water use within the region (WRC Major Water Use database).

### Northwestern Region Groundwater Usage

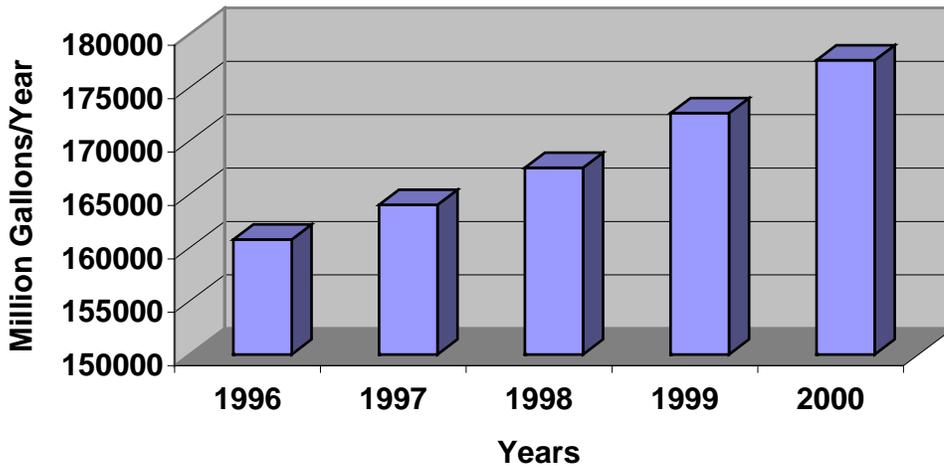


### Northwestern Region Surface Water Usage

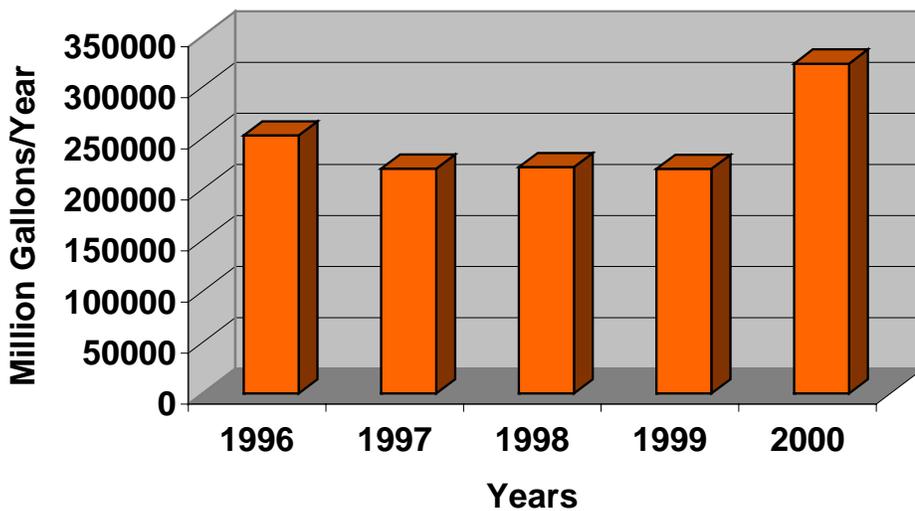


- Southeastern Region*: Major water use data indicates groundwater use has steadily increased from 1996 to 2000. Irrigation of Bootheel croplands is the largest groundwater demand category, averaging about 82 percent annually. Municipal use is the second largest demand category at approximately 7 percent. Reported surface water use in the region fluctuated annually from 1996 to 2000. Five of the eight major water use categories followed this overall trend. Electrical (92 percent), fish and wildlife withdrawals (4 percent), and municipal, industrial, and irrigation (each at 1 percent) were the largest reported surface water users. Groundwater use is significantly higher in this region, at over two times the quantity used in the other five regions combined (WRC Major Water Use database).

**Southeastern Region Groundwater Usage**

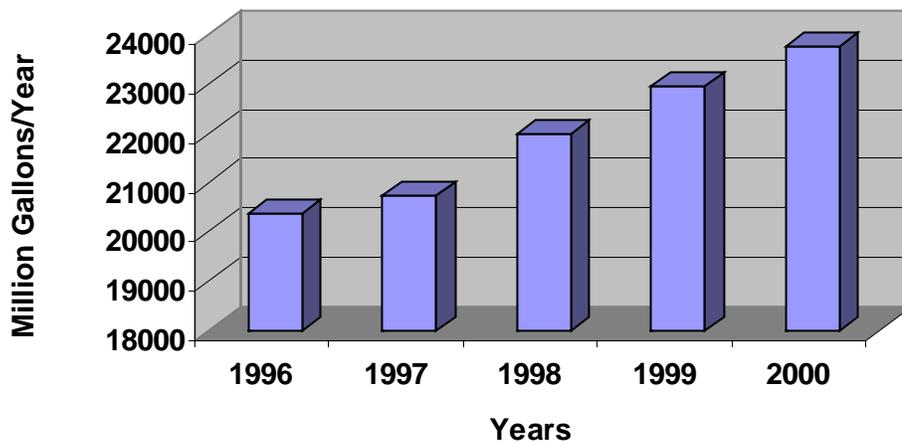


**Southeastern Region Surface Water Usage**

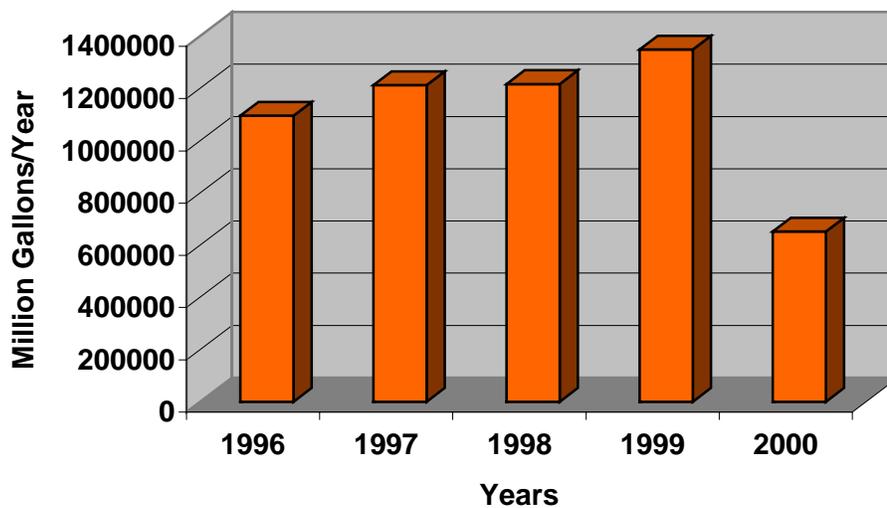


- Southwestern Region:* Major water use data indicates that groundwater use has consistently trended upward. Municipal withdrawals at 54 percent, industrial withdrawals at 18 percent, irrigation withdrawals at 10 percent, domestic withdrawals at 7 percent, and electrical power generation withdrawals at 6 percent, constitute 95 percent of the major groundwater user categories. Domestic use of groundwater has consistently trended downward over the time period. Reported surface water use in the region increased annually from 1996 through 1999 then fell sharply in 2000. Electrical power generation is the major surface water user in the region at almost 97 percent. Surface water used for municipal, irrigation, and fish and wildlife needs, have been increasing while domestic and industrial surface water use categories have declined. Groundwater withdrawals reported by major users within the region represent about 2 percent of the total reported water use (WRC Major Water Use database).

### Southwestern Region Groundwater Usage



### Southwestern Region Surface Water Usage



## Understanding the Phase 2 Findings

Taken as a whole, the Phase 2 effort points to four important universal water use findings. Each of these four findings is forward looking and is based on documented historical trends. The first two are direct linear findings. *As population increases water use increases* and *as income increases water use increases*. The significance of these findings is related to the overall scale of water demand and use.

The second finding is important because it has a multiplier effect on total overall water demand. *With the passage of time, each person uses an increasing amount of water in a greater variety of ways to meet a greater variety of water needs at an increasing number of locations*. Only 16 states, in the year 2000, used more fresh water daily per capita than Missouri.

The third finding relates directly to the demand that is placed on the water supply. *The more water that is withdrawn from the supply, and not returned to the source or the water supply otherwise replenished, makes the remaining supply increasingly vulnerable to both contamination and overuse*. Surface water resources are relied upon to supply the majority of the water quantity that is demanded. Groundwater sources are being developed with greater frequency and for greater quantities.

As noted in the State Water Plan enabling legislation and Phase 2 findings there are many aspects of water use. Water use and water supply are intricately related. Problems with the quality or quantity of the water supply lead to water use problems, and conversely how, where, and why water is used impacts the water supply. Assessing a water use issue as a problem without a complete understanding of it and the directly and indirectly related issues can result in an incomplete or incorrect course of action. For these reasons, the water use problems identified in the Phase 2 reports underscore the importance of thinking comprehensively and working cooperatively in solving the water use problems facing Missourians.