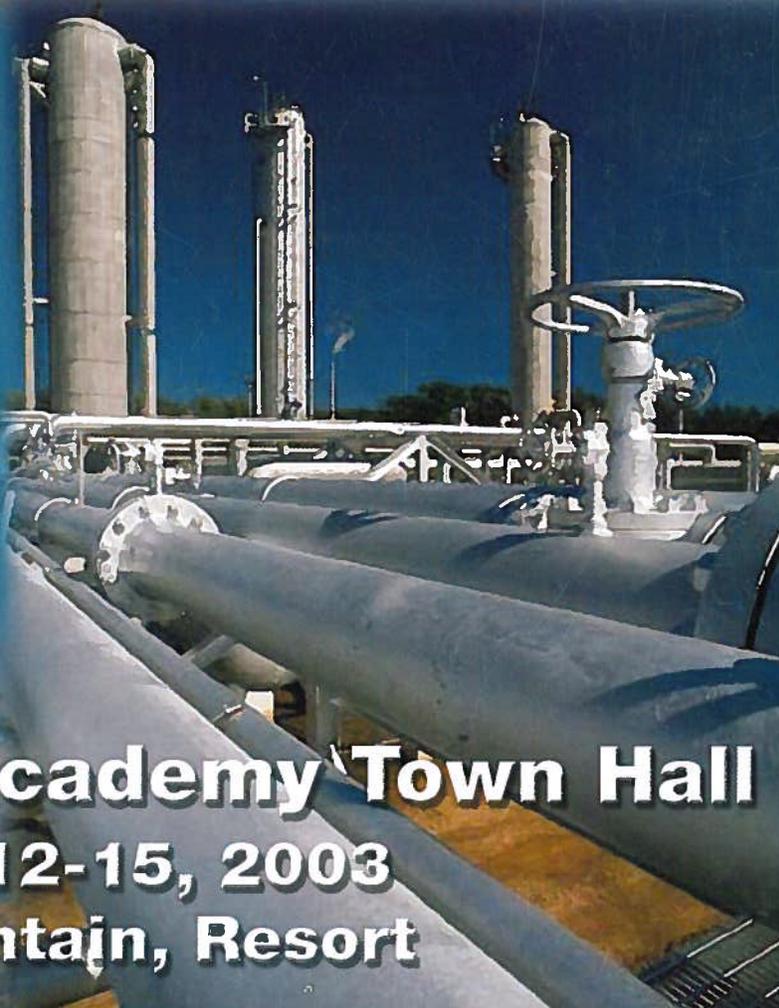


Oklahoma Resources Energy & Water



2003 Oklahoma Academy Town Hall
November 12-15, 2003
Quartz Mountain, Resort

Energy and Water
Our 2003 Town Hall

Julie Knutson, President and CEO, The Oklahoma Academy
John Feaver, 2003 Town Hall Chairman and President, University of Science and Arts of Oklahoma

This document was assembled to allow Town Hall members to educate themselves on the Energy and Water issues prior to our November Town Hall. It will help you become reasonably fluent and able to participate in informed group debate and discussions. And it will serve as a reference source for you.

We suspect that ... before August 14th ... some were wondering why we think that energy and water are so important to Oklahoma and the Nation. Then the lights went out in the Northeast. Our Research Chairman was in New York at the time. He reports that the most often uttered four-letter word was ... G-R-I-D ... as in power grid. He also reported that the most important short-term concern was “getting enough water.” He told us that one of the first things that came to mind was that we selected a wonderfully timed topic for our 2003 Town Hall.

We have slightly reorganized our Town Hall. This year our Academy Vice-Chairman will be the presiding officer over all Town Hall activities. And we have enlisted two experienced co-chairs; one for Energy and one for Water. They will help keep us on task and in focus as we conduct the Town Hall.

We also have done something else differently. We have included the public policy recommendations that are a part of the state’s existing Energy and Water Plans. There are 51 Energy recommendations and 76 Water recommendations. They are listed but not differentiated. That will be your job. We have also included policy recommendations from two New Mexico Town Halls. They are not intended to be pre-drawn conclusions ... they are intended to be a starting point for discussions. We hope you can synthesize them and develop a dynamic direction for Oklahoma.

Finally, here are the Cliff Notes for the topics. When considering energy, think of (1) maximizing production our existing resources and marginal reserves (2) marketing our energy knowledge and (3) alternative energy sources. When considering water, think of (1) water quantity (2) water quality and (3) ownership.

Here’s trusting that you will have a great Town Hall experience. We’ll see you at Quartz Mountain.



Julie Knutson
President & CEO
Oklahoma Academy



John Feaver
Chairman
2003 Town Hall



Larry Nichols
Co-Chairman (Energy)
2003 Town Hall



Howard Barnett, Jr.
Co-Chairman (Water)
2003 Town Hall



Michael Lapolla
Research Chairman
2003 Town Hall

Oklahoma Resources

Energy and Water

OUR TOWN HALL

Julie Knutson, President and CEO, The Oklahoma Academy

John Feaver, 2003 Town Hall Chairman and President, University of Science and Arts of Oklahoma

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ENERGY AND WATER

perspectives

Executive Summaries
New Mexico First Town Halls
Energy and Water



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We have retrospectively discovered that the New Mexico First organization sponsored two Town Halls in 2002. One was on Water and the other on Energy. As New Mexico is one of two other state with organization similar to the Oklahoma Academy, we thought it important that you review their findings.

The Town Halls were:

- ***New Mexico's Energy, Economics, and Environment, Carlsbad, NM, November 14-17, 2002***
- ***New Mexico's Water: Perception, Reality and Imperatives, Socorro, NM, May 16-19, 2002***

The Executive Summaries, including public policy recommendations, are at the beginning of our Energy and Water sections, respectively.

New Mexico First is a major statewide, non-profit, non-partisan membership organization which brings together a broad cross section of citizens to address important public policy issues facing all New Mexicans. New Mexico First seeks to be a "catalyst for positive action in New Mexico."

The mission of New Mexico First is to effect positive change in our state by addressing fundamental policy issues through the Town Hall process, creating a statewide network of informed and caring citizens, and leading New Mexicans to take action.

New Mexico First was formed to accomplish five goals:

- 1. Identify fundamental policy issues.*
- 2. Find positive solutions to the problems posed by those issues.*
- 3. Effect solutions through the dissemination of information.*
- 4. Identify, inform and motivate leaders for New Mexico.*
- 5. Create a statewide network of informed and caring New Mexicans.*

These goals are supported by the sponsorship of Town Hall meetings twice a year, each on a single topic of statewide importance. This forum is a model for discussion, cooperation, leadership development, and consensus building on issues critical to our state. In June 1989 the Board of Directors established the implementation of Town Hall recommendations as an organizational goal and policy.

Reprising 1990

Revisiting “Buffalo Commons”

Deborah E. Popper, Associate Professor of Geography, College of Staten Island/City University of New York, Staten Island, NY; and Frank J. Popper, Professor, Bloustein School of Planning and Public Policy, Rutgers University, New Brunswick, NJ. During the Fall 2003 semester the Poppers will also be Visiting Professors in the Civil and Environmental Engineering Department at Princeton University.



Town Hall Introduction

The Oklahoma Academy was five years old in 1990. While initial Academy work emphasized economic development and education, we became intrigued with the emerging public debate over land use.

Concurrently, Deborah and Frank Popper introduced a land planning theory that development of sparsely populated western regions should be purposely reversed.

As a centerpiece of our 1990 Academy Conference, the Poppers were invited to Oklahoma to “debate the issue” as an after-dinner event. Rural and western Oklahomans were ready for a fight. The Academy arranged for Dr. Tom Hill of the USDA to present an opposing point of view. In the end, we had a civil discourse leavened with humor and mutual respect.

When we decided upon our 2003 Town Hall topic, our first thoughts were to 13 years ago and the Popper-led discussions about land, water and resources. It was natural for us to invite them to reprise their 1990 visit as the Academy had not significantly discussed these issues since then.

They have done so graciously and gratis. The Academy thanks the Poppers for their participation, thinking, and good cheer.

Oklahoma’s Wichita Mountains National Wildlife Refuge has one of the most historic bison herds in the country, established in 1907 with some of the few bison then remaining in the country. Buffalo represent a significant heritage for Oklahoma, both real and symbolic.

In 1987 we published an article in *Planning*, the magazine of the American Planning Association, in which we explored the future of the Great Plains, the meaning of its ongoing population declines and the ways these intersected with economic and environmental pressures.

We suggested a new and mostly reversed course for the region’s future, one framed by the metaphor of the Buffalo Commons.

The idea was to rethink the resources that supported the area. Instead of continuing to organize development around extraction, with consequences like draw-downs on the Ogallala Aquifer and increased agricultural subsidies for crops that were then stockpiled, we suggested developing land uses that were more sustainable, restorative and regionally distinctive.

We wrote of tearing down fences, replanting the native grasses, and letting native species such as buffalo regenerate in larger numbers.

The idea initially met with enormous skepticism, but the demographic, economic, and environmental pressures we identified have continued, and the new direction we suggested is clearly materializing.

Throughout the Great Plains there are now more land conservancies dedicated to ecological restoration, more bison on public lands and private ranches, and more ecotourism.

In November 1990 we spoke at the annual meeting of the Oklahoma Academy for State Goals about our ideas for the Great Plains. We learned a lot from that trip. One vivid memory is of the fissures in Oklahoma's natural resource community.

The pressures on the Plains were obvious to all, but where the harm or fault lay was in the eye of the beholder. Energy, row crops, and livestock all were assigned or absolved of responsibility for being wasteful, or of garnering too much governmental advantage. This current meeting puts the different interests together and is structured around core concerns.

Water and energy organize all societies; they are at the base of what can be developed and how many can be supported, but they resonate differently in Oklahoma than in our Eastern state where average rainfall is higher and more regular and where energy has long come from elsewhere. Many Oklahomans' lives have depended directly on their local availability and wider markets.

The state participated exuberantly in the twentieth century's assertive experiments in turning nature over to human needs. Its oil and gas were taken out of the ground, its sod turned over.

Technological innovations, often powered by ever more efficient energy sources, made much of the activity possible. Energy and water came together especially in the 1960s when cheap fuel supported rapid expansion of irrigated agriculture, and center-pivots sprayed water across vast acres of western Oklahoma that had previously been consigned to dryland agriculture or rangeland.

“In November 1990 we spoke at the annual meeting of the Oklahoma Academy for State Goals about our ideas for the Great Plains. We learned a lot from that trip. One vivid memory is of the fissures in Oklahoma’s natural resource community.”

But water and fossil fuels are ultimately limited, and technological optimism is more tempered now than it once was.

This is where the Buffalo Commons comes in. It emphasizes using the limits creatively.

The Buffalo Commons land uses that have emerged are only some of the many possible ones. Long-term sustainability suggests more emphasis on renewable energy, like the wind that Oklahoma has in abundance, and fitting it into the landscape rather than overwhelming it. Long-term sustainability also implies agriculture that recycles nutrients rather than overwhelming its environment and that draws on reliably replaceable water.

As a flexible metaphor, the Buffalo Commons suggests we can never know enough about where we are, but should nonetheless continue seeking answers about our home places. Knowledge, imagination, and love of place are the keys. If we fit energy and water into that context, we should be able to look back on this era as a fruitful one.



Federal Government (Oil and Gas)

Carl Michael Smith, Assistant Secretary for Fossil Energy, U.S. Department of Energy

Town Hall Introduction

Assistant Secretary Smith served as Oklahoma Secretary of Energy in the Keating Administration before accepting his current position with the U.S. Department of Energy. He was succeeded in Oklahoma by Mr. Robert Sullivan, Jr.



Resource Conservation, Future Energy Resources, and Energy Supply, Security and Partnerships.

The U.S. Department of Energy, through its federal Oil & Natural Gas program, does not have a direct role in finding and producing hydrocarbons, but rather promotes the development of diverse

supplies of oil and natural gas. This is accomplished through a combination of policy and technology development activities. The program's mission is to create public benefits by providing sound science for responsible decision-making, and investing in higher-risk research that industry cannot take on itself.

Introduction

Natural gas and oil are the lifeblood of the U.S. economy. Together they account for more than 60 percent of the energy consumed in the United States. Although the United States obtains less than half its oil from domestic fields (the rest is imported), two-thirds of all the oil discovered in the country remains in the ground.

Natural gas is more plentiful than oil but as demand increases, U.S. producers are turning increasingly to deeper, more complex and difficult-to-produce gas reservoirs.

The federal government has responsibilities that necessitate the following roles relating to oil and natural gas resources:

- *Ensure energy security,*
- *Maximize the public benefit of oil and gas resources,*
- *Provide stewardship of federal lands,*
- *Promote effective environmental protection,*
- *Enhance U.S. global competitiveness, and*
- *Protect critical infrastructure.*

Recently, the federal Oil and Natural Gas program was realigned to exclusively support three of President George W. Bush's top energy and environmental initiatives: Clear Skies, Climate Change, and Energy Security. To achieve the President's objectives, the federal Oil and Natural Gas program will be organized around three research and development areas: Domestic

To achieve this mission, the Oil & Natural Gas program works closely with independent producers of oil and natural gas to respond to significant domestic issues such as coalbed methane production, hydraulic fracturing, land and resource access, and reservoir efficiency. The program also collaborates with academia and larger producers to identify significant new energy developments, such as methane hydrates, zero footprint technologies, and micro-drilling technologies that will allow the United States to bring previously untapped resources to market.

To accomplish its international goals, the program teams with regulatory and international customers, and deals with significant international supply and regulatory issues such as LNG, transparency in foreign regulatory regimes, and greater access for American investment abroad.

Natural Gas Research

The President's Clear Skies Initiative provides the rationale for most of the federal investment in natural gas research. Clear Skies legislation will likely further increase demand for this clean-

burning fuel. In the absence of new environmental requirements, natural gas use in the United States is likely to increase by nearly 54 percent by 2025.¹

The federal program in natural gas research is directed primarily at providing new tools and technologies that producers can use to diversify future supplies of gas. Emphasis will be increased in research that can improve access to onshore public lands. An important aspect of this research will be to develop innovative ways to recover this resource while continuing to protect the environmental quality of these areas.

Natural gas storage will also assume increasing significance in the United States as more and more power plants require consistent, year-round supplies of natural gas. Toward this end, the U.S. Department of Energy will initiate a nationwide, industry-led natural gas storage consortium.

The consortium will emphasize the creation of a balanced research portfolio of practical solutions, short-term projects, and basic research to improve the performance of the nation's gas storage infrastructure and explore opportunities for siting new liquefied natural gas facilities.

The most significant change in the Oil and Natural Gas program is the dedication of federal research funding toward hydrogen production from natural gas.

The most significant change in the Oil and Natural Gas program is the dedication of federal research funding toward hydrogen production from natural gas. Particularly, the program is developing new technologies that lower the cost of producing hydrogen from natural gas in ways that permit capture of associated carbon dioxide.

Over the long term, the production of natural gas from hydrates could have major energy security implications. Hydrates – gas-bearing, ice-like formations in Alaska and offshore— contain more energy than all other fossil energy resources. Hydrate production, if it can be proved technically feasible, has the potential to shift the world energy balance away from insecure sources of supply.

Oil Technology Development

The President's *National Energy Policy* calls attention to the continued need to strengthen the nation's energy security by promoting enhanced oil (and gas) recovery and improving oil (and gas) exploration technology through continued partnerships with public and private entities.

One example is the use of carbon dioxide injection to enhance the recovery of oil from existing fields. Carbon dioxide injection is a proven enhanced oil recovery practice that prolongs the life of some

mature fields, but the private sector has not applied this technique to its fullest potential due to insufficient supplies of economical carbon dioxide. A key federal role will be to facilitate the greater use of this oil recovery process by integrating it with carbon dioxide that will be captured at, and delivered from fossil fuel power plants.

The Oil and Natural Gas program is also focusing much of its efforts on a new domestic resource conservation effort that will target partnerships with industry and universities to sustain access to marginal wells and reservoirs. A high priority in this area is the development of “micro-hole” technology. Rather than developing just another new drilling tool, the federal program will integrate “smart” drilling systems, advanced imaging, and enhanced recovery technologies into a complete exploration and production system.

Micro-hole systems may offer one of the best opportunities for keeping marginal fields active because the smaller diameter wells can significantly reduce exploration costs and make new drilling between existing wells more affordable. Using breakthrough technology like this to keep marginal fields in production preserves the opportunity to eventually apply even more advanced innovations that could recover even larger quantities of domestic crude that traditional oil recovery methods currently leave behind.

The Oil and Natural Gas program is also focusing much of its efforts on a new domestic resource conservation effort that will target partnerships with industry and universities to sustain access to marginal wells and reservoirs.

Conclusion

The U.S. Department of Energy has been working with industry, universities, and States to ensure that the nation continues to develop, enhance and deploy innovative and cost-effective natural gas and petroleum technologies. With America’s oil production increasingly being supplied by small independent producers, the U.S. Department of Energy is continuing its efforts to help the smallest of these companies test higher-risk technologies that could keep oil flowing from thousands of U.S. fields.

The federal government continues to be a valuable partner in bringing unique technologies to the marketplace that can locate difficult-to-find resources; improve natural gas storage and retrieval; extend the life of domestic energy resources; and reduce well abandonments – all technologies that are essential to maximizing production of domestic resources while protecting the environment.

Footnotes

1 Energy Information Administration, U.S. Department of Energy, Annual Energy Outlook 2003, Table A1, January 2003.

Public Sector Perspectives
Federal Government (Water)

Abbreviated Executive Summary, Western Water Policy Review Commission

In directing the Western Water Policy Review Advisory Commission (Commission) to make recommendations about the proper role of the federal government in western water management for the next 20 years, the Congress gave our Commission a daunting task. For the past year and a half, we have labored to understand the details of numerous and often conflicting federal programs while striving not to lose sight of the “big picture.” Though many previous studies have documented the chronic problems of water in the West, the convergence of a number of trends makes this study unique and timely.

Early in our tenure, we learned that western water planners for the 21st century must address staggering growth projections. For the past 15 years, the West has been experiencing the most dramatic demographic changes for any region or period in the country’s history. Should present trends continue, by 2020 population in the West may increase by more than 30 percent. The West is rapidly becoming a series of urban archipelagos (e.g., Denver, Salt Lake City, Boise, Missoula, Portland, Phoenix, Albuquerque, Dallas, Houston, and Seattle) arrayed across a mostly arid landscape.

At the same time, reports to the Commission identified unhealthy trends in aquatic ecosystems and water quality, pressing water supply problems, unfilled American Indian water claims, an agricultural economy suffering the stress of transition, rapid conversion of open space to urban development, and rising drought and flood damage exacerbated by the potential for global warming. Additional population growth will only cause these crises to worsen unless bold action is taken. Population predictions underscore the urgency for wise long-range water policy planning, effective and efficient water management institutions, and consistent enforcement of existing laws.

Part of the impetus for our Commission’s formation was the Congress’s finding that current federal water policy suffers from unclear and conflicting goals implemented by a maze of agencies and programs. This finding was reinforced and documented by the Commission’s investigation. Lack of policy clarity and coordination resulting in gridlock was a consistent theme of public testimony and scholarly research.

We have concluded that these problems cannot be resolved piecemeal but, rather, must be addressed by fundamental changes in institutional structure and government process. Moreover, our work led us to an even more basic conclusion: that the geographic, hydrologic, ecologic, social, and economic diversity of the West will require regionally and locally tailored solutions to effectively meet the challenges of the 21st century of water management.

The lives of westerners and the places we live are changing so rapidly that irreversible developments are often not preceded by thoughtful policy discussion and choices. In this report, we offer suggestions for addressing water problems in a proactive manner that will foster the necessary policy discussion and integrate the increasingly complex interests in western water. This summary describes the many recommendations offered by the Commission. Two areas are highlighted first because they received the widest support among the diverse group of Commission members—Principles of Water Management for the 21st Century and New Governance of Watersheds and River Basins.

The entire 3,000 page report is available at <http://www.waterwest.org/reading/readingfiles/fedreport.htm>

Public Sector Perspectives
Oklahoma Secretary of Energy
Robert J. Sullivan, Jr., Secretary of Energy, Keating Administration

Editor
Tulsa World
PO Box 1770
Tulsa, Oklahoma 74104

July 17, 2003

Dear World Editor:

I was pleased to see in the July 17 Tulsa World a prominent article highlighting the prospect of high-speed rail transportation in Oklahoma. I would hope that planners of such ambitious projects, including our political leaders, would give serious consideration to designing such a system with wind energy as a possible power source.

The city of Calgary, Alberta (see next page) can demonstrate a successful commuter train operation that is powered by a wind farm located at one end of the system. Oklahoma ranks second in the nation by scientific measurement in per square mile wind characteristics suitable for power generation. As hydrocarbon powered generation of electricity increases in cost, both wind and solar power are coming closer to economic viability. Planners of transit systems would be wise to consider these locally abundant fuels of the future in designing any new systems in our state.

Oklahoma is blessed with an abundance of natural resources. We have more remaining , recoverable oil and gas reserves than have been produced since oil was discovered in our state over a century ago. These remaining reserves can and should be aggressively pursued as wellhead prices improve and justify their development. In the meantime, Oklahoma would be underserving our next several generations of citizens if we ignore similarly abundant wind and solar resources

Sincerely yours,

Robert J. Sullivan, Jr.
Oklahoma Secretary of Energy

RJSJr/sd

RIDE THE WIND
A Wind-Powered Light Rail System

www.calgarytransit.com/environment/ride_d_wind.html

Calgary Transit is constantly in search of more environmentally friendly products and services. One initiative has allowed CT to offer its customers the opportunity to “ride the wind.” Calgary Transit has entered into a contract with Vision Quest Windelectric and Enmax to purchase electrical power, supplied from their wind power farm, to operate the C-Train.

Twelve wind turbines are required to power the C-Train system. It is expected that the "Ride the Wind" program will increase power costs by less than one-half of one cent per passenger. This is a significant step towards reducing the environmental impact of transportation and makes Calgary's C-Train the first North American wind powered public transit system.

Although the C-Train operation does not produce local greenhouse gas emissions, the purchase of wind generated power will reduce Calgary Transit's contribution of pollution to the atmosphere from coal fired and natural gas electricity generation by about 26,000 tonnes.

Since the implementation of the Ride the Wind! initiative in the latter part of 2001, Calgary Transit has been the proud winner of two prestigious awards. In 2001 Calgary Transit won a Federation of Canadian Municipalities CH2M HILL Sustainable Community Award for its leadership in renewable energy.

Most recently, Calgary Transit was the recipient of a 2001 Pollution Prevention Award in the innovations category. The award is presented by the Canadian Council of Ministers of the Environment.

The C-Train is now 100 per cent emissions free. It is the first public Light Rail Transit system in North America to power its train fleet with wind-generated electricity.

A three-car C-Train can carry over 600 passengers, equal to 545 private vehicle trips. And the great thing about the C-Train it is 100% wind-powered. 12 wind turbines were installed near Pincher Creek to produce enough electricity to power the entire C-Train system.



Public Sector Perspectives
Oklahoma Secretary of the Environment
Miles Tolbert

Robert S. Kerr predicted that water would be for Oklahoma in the 21st Century what oil was in the 20th Century. Can we apply the lessons learned from our experience with oil and gas to our increasing valuable water resources?

We must first recognize that the supply of water, like that of oil, is finite. As a state we currently allocate some 5.8 million acre-feet of water every year. Of that, 55% is groundwater and 45% is surface. There is no realistic possibility of importing additional water into the State. Our critical task will not only be to take steps, as we have with oil, to use water more efficiently in order to extend the lifetime of these resources. It will also be to plan for the time when the resources begin to decline. The most recent Comprehensive Water Plan predicts that we will begin to run out of water in parts of Western Oklahoma in the next few decades.

We must remember that oil has generated wealth because we have done more than just pump it out of the ground. Oil made Oklahoma wealthy because we did more than merely extract it and use it or sell it. We added value to it through refining. We built up companies that marketed and distributed it and provided support services to others in the industry. These enterprises provided large numbers of technical and managerial jobs – many of which remain even as the quantity of oil produced in the state is declining. We must do the same for water. Our primary use of it is for agriculture. We must therefore move beyond the simple production of agricultural commodities and invest in enterprises which add value to agricultural products and develop skilled jobs in allied industries. This will generate broader wealth and will put us in a position to continue to prosper even after we run into the limits imposed by the finite resource.

We have been successful in the economic development of oil and gas in part because of legal rules which provide certainty. Oil and gas law protects the property rights and economic investment of someone producing oil and gas by ensuring that nearby production from the same formation does not unfairly interfere with his production.

As presently understood, our ground water law provides essentially no recourse when one person's water supply is affected by another's pumping. Uncertainty discourages investment. To resolve that uncertainty we need legal rules which recognize the physical interactions between the groundwater under one's person's property and the water, whether ground or surface, belonging to another. We will also need to resolve the (sometimes conflicting) tribal claims to surface water, claims which are being made with increasing insistence and sophistication.

Finally, we must recognize that, unlike oil, no water can be used for any consumptive purpose without affecting the environment. Surface water bodies are not only economic and recreational resources, they are critical ecological habitat. Furthermore, although it is not widely recognized, the pumping of groundwater has a direct effect on surface water flows. Any significant reduction in surface water flows, whether through direct diversion or the pumping of groundwater, will reduce both the quantity and quality of habitat available. Many animal species are flow dependent. For these species, relatively small changes in flow can have dramatic effects on their ability to maintain a viable population. We must be careful to ensure that in developing our water resources we maintain sufficient reserves to protect the wildlife species that are so heavily dependent on our streams and rivers.

Public Sector Perspectives
Oklahoma Secretary of Commerce and Tourism
Kathy Taylor

The responsibility of the Department of Commerce is to recruit, expand and sustain businesses in Oklahoma. There are many factors that contribute to a decision to locate, expand or stay in Oklahoma, and one of the principal concerns is the availability and cost of energy. But the initial cost of energy is only one aspect that businesses consider when examining the cost of doing business in our State. Forward-thinking businesses always look at the long term reliability and projected cost to ensure future growth and prosperity of their company.

The Department of Commerce maintains that energy efficiency and renewable energy technologies offer the most cost-effective, short-and long-term routes to a safer, more reliable and more resilient energy infrastructure. Development of an abundant domestic renewable resource base provides important energy diversity, protects the environment, protects public health, and promotes economic development, while making our country's energy systems less vulnerable. Oklahoma needs an energy policy that reflects creative and innovative use of all energy resources. This can be achieved through sustained investments in traditional centralized energy technologies, as well as energy efficient and renewable technologies.

The U. S. Dept. of Energy has designated the Oklahoma Department of Commerce as the State Energy Office (SEO) for developing and marketing energy efficiency and renewable energy programs. Oklahoma is now developing its resources in the areas of wind power, biomass research, ethanol production, and promotion of alternative fuels.

To support these goals, the State Energy Office has been instrumental in the formation of the Oklahoma Renewable Energy Council with representation from state agencies, higher education, business and industry, farmers and energy and environmental interest groups. Two large wind power farms are currently being established in western Oklahoma which will eventually produce 175 megawatts of renewable energy. The Oklahoma State Legislature

facilitated a partnership between the Oklahoma Department of Agriculture and the Oklahoma Department of Commerce that resulted in a feasibility study that

indicates that Oklahoma can support as many as three ethanol production plants.

Funds from the State Energy Plan support two Clean Cities coalitions in Oklahoma that promote the use of alternative fuels, including compressed natural gas and E85, in automotive fleets. In addition, the Office of Community Development administers a Weatherization Assistance Program and Energy Star appliance program to encourage low-income families to conserve energy and decrease energy costs in their homes. With cooperation with the Oklahoma Center for the Advancement of Science and Technology, the Department of Commerce participates in the Industries of the Future program which focuses on helping Oklahoma's forest industry become better, faster, cleaner, more energy efficient and more competitive in the global market.

A secure energy future is critical to our nation and the competitiveness of our state. We all must do our part to ensure that we move in that direction.

Strategic Goals of the State Energy Office

- *Reduce Oklahoma's dependence on foreign oil*
- *Reduce energy prices for the disadvantaged*
- *Increase the energy efficiency of buildings*
- *Increase the energy efficiency of industry and*
- *Encourage wind power & biomass industry*

Public Sector Perspectives
Oklahoma Corporation Commission
Denise Bode, Chairman

The states, just as envisioned by the founding fathers, are competing for their share of future growth. States that identify their natural advantages, - their resource assets in our case - and move aggressively to exploit them will prosper. Those who don't will be left in the dust.

There are a number of factors that determine our competitiveness: the tax burden (real and perceived), the quality of our education, investment in and access to transportation and our command and control of regulatory policies.

The Commission has regulatory responsibility for telecommunications, trucking, electric utilities, and the oil and gas industry, all of which make up Oklahoma's economic foundation, and all of which are undergoing significant change. And to complicate this mission, state commissions have now, since 9/11, been asked to address necessary defensive concerns regarding the critical infrastructure we regulate. As a result, the Corporation Commission must change as well.

In January, Commissioners Jeff Cloud, Bob Anthony and I commissioned a top-to-bottom audit and strategic plan for the commission, including a performance-based budget. We have contacted hundreds of Commission customers for input on how the Commission can cut the bureaucracy and streamline our process. The Commission is aggressively moving to implement those efficiency measures to streamline processing in both the oil and gas area and in the public utilities area.

As the energy industry that we regulate has become lean, mean and efficient, so must the Commission in response. We must be flexible when all but two of the top twenty producers in Oklahoma have 100 employees or less. They don't have deep pockets for paperwork so we have to learn to pick up the phone and work through problems. We are working to reduce paperwork and unnecessary hearings and to act for the benefit of our customers, not what is easy for us or because it has "always been done that way."

We are also preparing for change in the utility area. What has been one way for over 80 years, cradle to grave regulation is no longer necessary. If there is competition in utility services then government should allow that competition to grow. A vigorous competitive marketplace can provide better technology, more services, and better prices. The regulation and the regulatory agency like the Commission must change. But the transition from monopoly to competition is tricky. We must make sure that consumers are better off and there is real competition or we should not make the change. That is why you see the Commissioners involved in these deregulation processes, taking over the direction of policy from commission staff. We sure as heck better do it right, because telecommunications, electric and natural gas services are fundamental to our economy. And first rate, low priced services advantages Oklahoma in the game.

We favor new legislation that would provide for "one stop shopping" for the trucking industry that would make for more efficient regulation of this vital industry and save over one million dollars.

Finally, as Americans we all need to understand that security of our infrastructure is a new and permanent cost of doing business and plan for it. I currently serve at the state and federal level, planning prevention and response to terrorism of our critical infrastructure. We are working on training, information security, as well as strategies and approaches to assure that appropriate, cost effective, measures are taken by the industries we regulate to reduce the risk and vulnerabilities to disruption to critical facilities.

For Oklahoma to beat our competition, government must change. Although this agency is using less state revenue and has less staff than when I came on board in 1997, we view the present reductions in state revenues as an opportunity to become even more efficient. We are not just talking about efficiency and reducing the size of state government ... we are actually doing it.

Tribal Governments

Department of Justice Policy on Indian Sovereignty and Government-to-Government Relations with Indian Tribes. Office of Tribal Justice, U.S. Department of Justice. www.usdoj.gov/otj/sovtrbtxt.htm

Purpose: To reaffirm the Department's recognition of the sovereign status of federally recognized Indian tribes as domestic dependent nations and to reaffirm adherence to the principles of government-to-government relations; to inform Department personnel, other federal agencies, federally recognized Indian tribes, and the public of the Department's working relationships with federally recognized Indian tribes; and to guide the Department in its work in the field of Indian affairs.

Introduction

From its earliest days, the United States has recognized the sovereign status of Indian tribes as "domestic dependent nations." *Cherokee Nation v. Georgia*, 30 U.S. (5 Pet.) 1, 17 (1831). Our Constitution recognizes Indian sovereignty by classing Indian treaties among the "supreme Law of the land," and establishes Indian affairs as a unique area of federal concern. In early Indian treaties, the United States pledged to "protect" Indian tribes, thereby establishing one of the bases for the federal trust responsibility in our government-to-government relations with Indian tribes. These principles continue to guide our national policy towards Indian tribes.

The Executive Memorandum on government-to-government relations between the United States and Indian Tribes.

On April 29, 1994, at a historic meeting with the heads of tribal governments, President Clinton reaffirmed the United States' "unique legal relationship with Native American tribal governments" and issued a directive to all executive departments and agencies of the Federal Government that:

As executive departments and agencies undertake activities affecting Native American tribal rights or trust resources, such activities should be implemented in a knowledgeable, sensitive manner respectful of tribal sovereignty.

President Clinton's directive requires that in all activities relating to or affecting the government or treaty rights of Indian tribes, the executive branch shall:

- 1) operate within a government-to-government relationship with federally recognized Indian tribes;
- 2) consult, to the greatest extent practicable and permitted by law, with Indian tribal governments before taking actions that affect federally recognized Indian tribes;
- 3) assess the impact of agency activities on tribal trust resources and assure that tribal interests are considered before the activities are undertaken;
- 4) remove procedural impediments to working directly with tribal governments on activities that affect trust property or governmental rights of the tribes; and
- 5) work cooperatively with other agencies to accomplish these goals established by the President.

The Department of Justice is reviewing programs and procedures to ensure that we adhere to principles of respect for Indian tribal governments and honor our Nation's trust responsibility to Indian tribes. Within the Department, the Office of Tribal Justice has been formed to coordinate policy towards Indian tribes both within the Department and with other agencies of the Federal Government, and to assist Indian tribes as domestic dependent nations within the federal system.

Federal Indian Self-Determination Policy

President Clinton's executive memorandum builds on the firmly established federal policy of self-determination for Indian tribes. Working together with Congress, previous Presidents affirmed the fundamental policy of federal respect for tribal self-government. President Johnson recognized "the right of the first Americans . . . to freedom of choice and self-determination." President Nixon strongly encouraged "self-determination" among the Indian people. President Reagan pledged "to pursue the policy of self-government" for Indian tribes and reaffirmed "the government-to-government basis" for dealing with Indian tribes. President Bush recognized that the Federal Government's "efforts to increase tribal self-governance have brought a renewed sense of pride and empowerment to this country's native peoples."

Principles of Indian Sovereignty and Trust Responsibility

Though generalizations are difficult, a few basic principles provide important guidance in the field of Indian affairs:

- 1) The Constitution vests Congress with plenary power over Indian affairs;
- 2) Indian tribes retain important sovereign powers over "their members and their territory," subject to the plenary power of Congress; and
- 3) The United States has a trust responsibility to Indian tribes, which guides and limits the Federal Government in dealings with Indian tribes. Thus, federal and tribal law generally have primacy over Indian affairs in Indian country, except where Congress has provided otherwise.

Department of Justice Recognition of Indian Sovereignty and Federal Trust Responsibility

The Department resolves that the following principles will guide its interactions with the Indian tribes.

The Sovereignty of Indian Tribes

The Department recognizes that Indian tribes as domestic dependent nations retain sovereign powers, except as divested by the United States. The Department may take actions and positions affecting Indian tribes with which one or more tribes may disagree. In all situations, the Department will carry out its responsibilities consistent with the law and this policy statement.

Government-to-Government Relationships with Indian Tribes

In accord with the status of Indian tribes as domestic dependent nations, the Department is committed to operating on the basis of government-to-government relations with Indian tribes.

Consistent with federal law and other Departmental duties, the Department will consult with tribal leaders in its decisions that relate to or affect the sovereignty, rights, resources or lands of Indian tribes. Each component will conduct such consultation in light of its mission. In addition, the Department has initiated national and regional listening conferences and has created the Office of Tribal Justice to improve communications with Indian tribes. In the Offices of the United States Attorneys with substantial areas of Indian country within their purview, the Department encourages designation of Assistant U.S. Attorneys to serve as tribal liaisons.

In order to fulfill its mission, the Department of Justice endeavors to forge strong partnerships between the Indian tribal governments and the Department. These partnerships will enable the Department to better serve the needs of Indian tribes, Indian people, and the public at large.

Self-Determination and Self-Governance

The Department is committed to strengthening and assisting Indian tribal governments in their development and to promoting Indian self-governance. Consistent with federal law and Departmental responsibilities, the Department will consult with tribal governments concerning law enforcement priorities in Indian country, support duly recognized tribal governments, defend the lawful exercise of tribal governmental powers in coordination with the Department of the Interior and other federal agencies, investigate government corruption when necessary, and support and assist Indian tribes in the development of their law enforcement systems, tribal courts, and traditional justice systems.

Trust Responsibility

The Department acknowledges the federal trust responsibility arising from Indian treaties, statutes, executive orders, and the historical relations between the United States and Indian tribes. In a broad sense, the trust responsibility relates to the United States' unique legal and political relationship with Indian tribes. Congress, with plenary power over Indian affairs, plays a primary role in defining the trust responsibility, and Congress recently declared that the trust responsibility "includes the protection of the sovereignty of each tribal government." 25 U.S.C. . 3601.

The term "trust responsibility" is also used in a narrower sense to define the precise legal duties of the United States in managing property and resources of Indian tribes and, at times, of individual Indians.

The trust responsibility, in both senses, will guide the Department in litigation, enforcement, policymaking and proposals for legislation affecting Indian country, when appropriate to the circumstances. As used in its narrower sense, the federal trust responsibility may be

justiciable in some circumstances, while in its broader sense the definition and implementation of the trust responsibility is committed to Congress and the Executive Branch.

Protection of Civil Rights

Federal law prohibits discrimination based on race or national origin by the federal, state and local governments, or individuals against American Indians in such areas as voting, education, housing, credit, public accommodations and facilities, employment, and in certain federally funded programs and facilities. Various federal criminal civil rights statutes also preserve personal liberties and safety. The existence of the federal trust responsibility towards Indian tribes does not diminish the obligation of state and local governments to respect the civil rights of Indian people.

Through the Indian Civil Rights Act, Congress selectively has derived essential civil rights protections from the Bill of Rights and applied them to Indian tribes. 25 U.S.C. . 1301. The Indian Civil Rights Act is to be interpreted with respect for Indian sovereignty. The primary responsibility for enforcement of the Act is invested in the tribal courts and other tribal fora. In the criminal law context, federal courts have authority to decide habeas corpus petitions after tribal remedies are exhausted.

The Department of Justice is fully committed to safeguarding the constitutional and statutory rights of American Indians, as well as all other Americans.

Protection of Tribal Religion and Culture

The mandate to protect religious liberty is deeply rooted in this Nation's constitutional heritage. The Department seeks to ensure that American Indians are protected in the observance of their faiths. Decisions regarding the activities of the Department that have the potential to substantially interfere with the exercise of Indian religions will be

guided by the First Amendment of the United States Constitution, as well as by statutes which protect the exercise of religion such as the Religious Freedom Restoration Act, the American Indian Religious Freedom Act, the Native American Graves Protection and Repatriation Act, and the National Historic Preservation Act.

The Department also recognizes the significant federal interest in aiding tribes in the preservation of their tribal customs and traditions. In performing its duties in Indian country, the Department will respect and seek to preserve tribal cultures.

Directive to all Components of the DOJ

The principles set out here must be interpreted by each component of the Department of Justice in light of its respective mission. Therefore, each component head shall make all reasonable efforts to ensure that the component's activities are consistent with the above sovereignty and trust principles. The component heads shall circulate this policy to all attorneys in the Department to inform them of their responsibilities. Where the activities and internal procedures of the components can be reformed to ensure greater consistency with this Policy, the component head shall undertake to do so. If tensions arise between these principles and other principles which guide the component in carrying out its mission, components will develop, as necessary, a mechanism for resolving such tensions to ensure that tribal interests are given due consideration. Finally, component heads will appoint a contact person to work with the Office of Tribal Justice in addressing Indian issues within the component.

Disclaimer

This policy is intended only to improve the internal management of the Department and is not intended to create any right enforceable in any cause of action by any party against the United States, its agencies, officers, or any person.

Public Sector Perspectives
City of Duncan
Ken Vanderslice, City Manager



Maximizing opportunities to be effective stewards of the water resources within our State is a responsibility common to all who live, visit, or do business in Oklahoma. This responsibility, when met, accrues benefits that far exceed our respective life times and if pursued with a sense of sharing, the result will benefit the long-term interests of all in Oklahoma and our downstream neighbors.

An idea, need, and on occasion ... a disaster precedes our development of a plan.

In 1980, following attempts that date back to 1955, a Comprehensive Water Plan was adopted by the State Legislature. This Plan was last updated in 2000 covering projections through 2050. The Oklahoma Water Resources Board is responsible for managing the Plan.

From my perspective as a City Manager in the south central region of Oklahoma, it is startling to find that city engineers, consultants, local elected officials, water district managers and their boards, development authority directors, manufacturers, businessmen, ranchers and farmers have little or no knowledge of a State Comprehensive Water Plan.

These people along with many others are front-line STEWARDS of Oklahoma's water resource. When questions or problems arise over the scarcity and use (or export) of the water resource, conflict is sure to follow. Conflict over water can be constructive if a rational bottom-up plan exists, is supported with adequate resources (technical and monetary), is current, and is persistently

communicated as the way we do (water) business in Oklahoma.

The State Legislature can delegate to the Water Resources Board and hold them accountable for results IF they consistently, over the planning period, allocate sufficient resources to meet the assigned planning and implementation responsibilities.

The State Legislature should be in the role of a facilitator by providing funds and assuring technical support to the Oklahoma Water Resources Board. Additionally, the State Legislature can provide for a means of third-party mediation to assist in the inevitable conflict that will arise in developing the proper level of detail at the river basin or watershed level of a Comprehensive Water Plan.

An arbitration process could be established to assist in conflict or issues that arise that have a State-wide impact or may impact neighboring states.

It is my understanding that the Oklahoma Water Resources Board is considering, as a part of the 2005 Comprehensive Water Plan update, a shift in the planning process to include a bottom-up approach to the evolution of detail planning on a river basin or watershed basis.

This change in the planning process along with effective delegation and appropriate levels of resource allocation to the Water Resources Board deserves strong support from front-line stewards of Oklahoma water.

City of Duncan

Public Sector Perspectives
City of Guymon
Jess Nelson, Mayor



Energy and Water pretty well sums up what Guymon and Texas County are all about. We sit above one of North America's largest aquifers, the Ogallala, and one of North America's largest natural gas reserves, Guymon-Hugoton Field.

For many years, that abundant, and cheap, natural gas has been used to bring up the abundant water for drinking and irrigation. Texas County has become the number one county in Oklahoma, and in the top ten in the United States for gross agriculture receipts. If the energy or water supply were interrupted, for whatever reason, the economy of Guymon/Texas County would be destroyed.

Ninety five percent of the water from the Ogallala is used for irrigation and five percent, for municipal and industrial use. According to the United States Geological Survey (U.S.G.S.), the latest center pivot system has drastically reduced the depletion of the Ogallala to negligible or inches per year from up to 10ft. per year when flood irrigation was common practice.

The C.R.P. program has also helped by reducing the number of acres in cultivation, thus reducing the stress on the aquifer.

There has been great concern in recent years concerning the transfer of groundwater from the Texas Panhandle to municipalities. This concern

led to new water rules in Texas that are strikingly similar to Oklahoma's water rules.

Oklahoma currently has strong water laws that protect both, the long-term sustainability of our groundwater and the ability for the landowner to utilize the water to their benefit.

We need to be vigilant with current industries and selective with future industries as to water usage and possible contamination to the Ogallala. Yet, we must also continue to allow this resource to be utilized for the betterment of our society.

The use of natural gas for irrigation faces challenges from the volatility in the market price resulting from increased East and West Coast demands.

Northwest Oklahoma has the potential for developing alternative sources of energy such as wind, biomass and ethanol. We should be looking for ways to encourage their development. I think we should remember Mexico City. Five hundred years ago, Mexico City developed an "island paradise." Today, the lake surrounding the city is gone. All the ground underneath is irreversibly contaminated, and no potable water is available for miles around.

The future generations of Guymon/Texas County are depending upon our being good stewards of our natural resources today.



Mid-Continent Oil and Gas Association

Dr. Bruce M. Bell, Chairman, Mid-Continent Oil & Gas Association

Oil and natural gas industry trade groups, such as the U.S. Oil & Gas Association and Mid-Continent Oil & Gas Association of Oklahoma, since 1997 have been warning of significant upcoming problems due to inadequate deliverability of natural gas. The warm winters of 1998 and 1999 delayed the onset of problems, but they also increased its severity once it hit in 2000. The lesson here is that industry spokespeople were ignored; their predictions were called self-serving by environmentalists and politicians alike.

Today our message is, “We are entering a crisis.” We are still being ignored. We are still being investigated as conspirators!

Significant long-term supplies of natural gas lie off both the East (31 TCF) and West Coast (21 TCF), off the eastern Gulf of Mexico (43 TCF), in the Rocky Mountain basins (137 BCF) and in the north slope of Alaska, including the Alaskan National Wildlife Refuge (313 TCF). Yet drilling is banned or significantly restricted in all of these areas. If the U.S. wants an adequate supply of natural gas, industry must be allowed to drill where the reservoirs are located.

Senator Tom Daschle of South Dakota, faced with a succinct explanation of this situation, said a few weeks ago, “Well, we can compromise, find middle ground, but we aren’t going to be able to go to extremes, such as drilling in ANWR.” How much clearer can one say it? If we are not allowed to drill in those areas where adequate reservoirs are located, we will not be able to supply the gas.

Period!

***Energy, Science and the
Politics of Carbon: The Crisis is Here***
Reprinted from Energy Houston, Vol 4, No. 1: 2001

Perhaps the most discouraging aspect of preparing a detailed, statistic-filled and comprehensive analysis of the natural gas situation and yet being completely ignored is that this is only one aspect of what the American public needs to understand if we are to avoid a growing list of energy crises - and it is the easy one. The more fundamental problem areas involve ongoing scientific research that will permit us to better understand the planet on which we live. Global climate change is one of these areas - one that has become totally politicized and governed by what is now considered politically correct, ignoring relevant science. If you do not agree with those self-professed experts who want to save our environment, you are labeled “anti-environment,” greedy industrialists, etc.

Of greatest concern to the energy business is that a central theme of the environmental movement embraces the idea that carbon dioxide, produced by burning fossil fuels, is a “greenhouse” gas that is causing global temperatures to rise. This notion has now been discredited, but that does little to slow the steamroller effect of what can only be termed “carbon hysteria.”

Global Cooling and Global Warming

In the 1970s, a serious debate was raging over a then eminent global climate problem, global COOLING. Mean annual temperatures had been dropping from 1940 through 1970. It was feared that the climate was becoming significantly cooler and that we would soon return to another ice age, complete with glaciers covering much of the Northern Hemisphere. Many of these same groups of scientists are now proclaiming that humankind is causing the planet to WARM. Perspective becomes crucial to understanding this contradiction.

The most recent geological epoch, the Pleistocene, began about 1 million years ago and is generally referred to as the Ice Age. In fact, during the Pleistocene there have been at least three major glaciations, in which massive sheets of ice, 1,000-plus-feet thick, flowed down from the Arctic to cover much of the continental masses of the Northern Hemisphere. (Ice flows like a viscous liquid when put under enough pressure, caused by the weight of the great thickness of the ice sheet itself.)

The last of these great ice sheets receded (melted) only 10,000 to 20,000 years ago. We are now in the most recent interglacial. Geologically, nothing has changed from the last inter-glacial, and thus there is little reason not to believe that another glaciation will occur, if left to natural forces.

Times of glaciations require a special set of geological circumstances. Several periods of continental glaciations have occurred in the history of the earth. The Pleistocene is merely the most recent. Today, the continental masses of the Northern Hemisphere surround the Arctic Ocean. Water inflow to the Arctic is restricted to relatively narrow straits.

Today, the onset of a glaciation requires first a general warming of the earth, which gradually melts the mountain glaciers and the polar icecaps. As melting occurs, sea level gradually rises, thereby increasing the exchange of warmer equatorial ocean waters with colder polar water. Sea level has risen about 6-inches during the last century. Eventually, the arctic icecap melts and warm waters flow in from the Atlantic and Pacific Oceans, unrestricted, keeping the ocean ice free.

As long as the Arctic Ocean is frozen over, as it is today, the area is an arctic desert, with little moisture and thus little snow. Glacier formation requires huge quantities of snow to accumulate into the

massive ice sheets that flowed hundreds upon hundreds of miles southward. The secret to new glacier formation is to have a viable supply of moisture; in this case, evaporation from the open Arctic Ocean. Ice buildup continues until so much seawater becomes locked up in the glaciers that sea level falls 200 to 300 feet, as it did during the last major glacial advance, cutting off the flow of warm seawater into the arctic basin and thereby allowing the Arctic Ocean to freeze over once again. Gradually, the glaciers melt, sea level rises and the cycle is complete.

Note that the role of the sun is a crucial component in the earth's global temperature, one that is as yet little understood. Short-term global temperature changes are tied to sun spot cycles and perhaps other solar phenomena.

Who cares about ancient history - about what happened 20,000 years ago? Everyone should!

Increased solar activity caused an increase in the earth's mean annual temperature of a half degree Celsius during the first 40 years of the last century - which, by the way, is the entire increase that was recorded for the 20th century.

Several generalizations about global climate change are apparent from our recent geological past. The earth's mean annual temperature obviously is much cooler (5-10 degrees Celsius) during a continental glaciation, with huge land areas covered 365 days a year with ice, whereas the earth's atmosphere is much warmer during the interglacials.

Thus, as we are in an interglacial, the earth's atmosphere has warmed. We may be near the maximum average temperature for this interglacial, or we may have more to go. Certainly, at today's temperature, the polar ice caps and mountain glaciers are slowly receding (melting) and have been for a hundred years. The question is: Does man have any effect on global temperatures? More specifically, does the release of CO₂ from the burning of fossil fuels affect global temperatures?

When cooling vs. warming suppositions reversed in the mid-1970s and a group of environmentalists

decided that we were experiencing global WARMING, the single biggest man-made influence that could be identified was the burning of fossil fuels. Carbon dioxide, as a part of Earth's atmosphere, causes heat retention. Not nearly as much as water vapor, but it is still a significant factor. (Thank heaven, or the earth would be a frozen planet as are others in our solar system.) Politically correct climate change models postulated that CO₂ was a major contributor to warming, and even though man's total contribution is less than 1 percent of the atmospheric total, it was thought to be a critical component."

"CO₂ is a dangerous component of air pollution." This mantra has been repeated and repeated so often for the last 25 years that the general public has accepted it as a fact. The Kyoto Treaty embraces this contemptible conclusion and carries it to the egregious extreme that it would cripple the industrialized world, all in the name of protecting us from CO₂ emissions, which had only been postulated to be harmful and now are shown not to be so! Industry releases about 6 billion metric tons of CO₂ per year versus 190 billion tons by respiration and plant decay.

That's right, the ever-increasing human population and all the other higher animals on the planet are CO₂ generators.

CO₂ is no longer considered a major contributor to global warming by those very people who have been making the most noise about it for years. Their questions arose with research at NASA's Goddard Institute for Space Studies, which has been measuring atmospheric temperature from satellites for 20 years.

These temperatures have been verified using weather balloon data. Whereas surface temperatures, often taken near "heat islands" (large cities with massive expanses of concrete and blacktop that hold heat), had suggested global warming, atmospheric temperatures show absolutely no change in average mean temperature over the last 20 years. In fact, current temperatures are actually

below the 20-year average! Yet this is the time in which man-released CO₂ from burning fossil fuels has most added to atmospheric levels. If it has had any significant influence, it would have shown up by now. In 1988, James E. Hansen, head of NASA Goddard Institute, testified to then-Senator Al Gore's environmental committee that the "accumulations of greenhouse gases were warming the planet and to quit waffling." Today, he has acknowledged that CO₂ at most plays a minor role in climate change, and that other factors - such as soot - are being explored.

The energy industry immediately must spread the word about CO₂ and reverse the foolishness of draconian constraints on burning fossil fuels. Little else can be as important for our industry than correcting this misconception. As those people who are convinced that humans cause global warming begin to look for alternative culprits, the truth about CO₂ must be emphasized.

Sensible Responses to Ongoing Phenomena

In all likelihood, we are in a time of planet-wide warming, but one caused by an ongoing geologic phenomenon. Certainly temperatures have increased over the last 300 years since the Little Ice Age, discussed below. Humans, it appears, have little if any influence. But either way, CO₂ is not a major culprit. In fact, CO₂ is fertilizer, causing our diverse foliage to grow at faster rates. As we look for ways to lower high rates of human hunger worldwide, slightly higher CO₂ levels may be a significant benefit.

Recently completed oxygen isotope studies show an interesting pattern of temperatures for the last 6,000 years. The earth was 2 to 4 degrees Celsius cooler for the first 2,000 years of this period, followed by 2,000 years of temperatures 1 to 2 degrees Celsius above that of today. 2,000 years ago, temperatures became more variable, with periods as much as 2.5 degrees Celsius above average down to 5 degrees below current average.

The coldest time recorded was approximately 300 years ago, a period referred to as the Little Ice Age. Recorded history confirms isotope data that 1,000 years ago, the earth's climate was mild, referred to as the Medieval Climate Optimum.

This mild time was followed by intense cooling from 1660-1710. It snowed for 18 months straight in Europe. Records indicate that sunspots, dark blotches on the surface of the sun, virtually disappeared between 1645 and 1705, suggesting a probable cause for the cooling. Obviously, the earth has been warming since that time, again approaching the mean temperatures of the last 6,000 years.

Man must be vigilant to prevent damage to our planet. Humans need clean air and water and a healthy ecosystem.

Many environmental concerns are valid. But we must base conclusions on science, not on emotion. Conservation makes sense. Obtaining ever-increasing fuel efficiencies preserves a finite resource for the future. Renewable fuels are also needed, but their development and implementation will take many years. This is not due to a lack of funding, it's due to the time it takes to make significant breakthroughs and then transfer that technology to a workable mass-produced product.

The Kyoto Treaty is a stark example of politicians using extremist rhetoric to try to jockey for power." Carbon sequestration" has become their mantra. If you produce a lot of CO₂, then you are harming the earth and must pay those who are taking carbon out of the atmosphere, thereby helping the earth. Don't let facts get in the way.

The U.S. timber industry oversees vast reforested areas, which are filled with young, fast-growing forests that take up a tremendous amount of CO₂. Mature forests, including rainforests, have a huge amount of litter on the forest floor that is consumed by termites and other creatures, thereby producing CO₂- that is, putting the carbon back in the atmo-

sphere. Our reforested areas, by contrast, are in fact "carbon sinks" - i.e., net carbon extractors. Rainforests may actually be neutral or even CO₂ contributors due to slow growth rate and high litter decay. Likewise, our vast crop production each year" sequesters" large amounts of carbon.

Kyoto Treaty negotiations broke down last year, even though it was Clinton's environmentally correct administration, because Europe and Third World countries would not accept the idea that the U.S., as amply shown by recent research, was actually a net carbon reducer! This fact undercut their whole plan of the treaty: transfer wealth from the rich United States to the less developed countries.

The energy industry immediately must spread the word about CO₂ and reverse the foolishness of draconian constraints on burning fossil fuels.

So pervasive has become the notion that we must rigidly control CO₂ that Oklahoma passed a law to establish a Carbon Sequestration Board

to recommend how to implement carbon credits and debits, which can be traded among producers and reducers.

The Kyoto Treaty would have required that CO₂ emissions be reduced below 1990 levels in 10 years, or that less industrialized countries be allowed to sell "carbon credits" to major nations. Fortunately, the exclusion of major nations such as China, India and FSU countries led to the rejection of Kyoto even before the latest data on the U.S. carbon sink status were apparent.

Further evidence of the absurd lengths to which people are going to assuage environmentalist concerns over CO₂ is documented by TransAlta, Canada's largest private electricity producer. TransAlta has signed a multimillion-dollar contract with a U.S. company, Global Livestock Group, to provide a feed supplement for Ugandan cattle.

The supplement is sprayed on hay and food stuffs and is supposed to reduce belching and flatulence. TransAlta maintains that this reduction in expulsion of methane, another target "greenhouse gas,"

is equal to 30 million tons of carbon dioxide, for which the company would receive Kyoto Treaty carbon credits to offset its use of fossil fuels in power generation. This foolishness is expensive and dangerous.

A petition circulated by Dr. Arthur B. Robinson, president and research professor at Oregon Institute of Science and Medicine, states:

We urge the United States government to reject the global warming agreement that was written in Kyoto, Japan, in December 1997 and any other similar proposals. The proposed limits on greenhouse gases would harm the environment, hinder the advance of science and technology, and damage the health and welfare of mankind. There is no convincing scientific evidence that human release of carbon dioxide, methane or other greenhouse gases is causing or will, in the foreseeable future, cause catastrophic heating of the earth's atmosphere and disruption of the earth's climate. Moreover, there is substantial scientific evidence that increases in atmospheric carbon dioxide produce many beneficial effects upon the natural plant and animal environments on the earth.

Some 17,000 American scientists who hold university degrees in science, including many of our most eminent scientists, have signed this petition, including 400 atmospheric scientists and meteorologists and 2,000 physicists. The CO₂ myth that fossil fuels cause global warming has been debunked by many of those who created it. They search now for alternative culprits.

The petroleum industry must fight to educate people about CO₂. This is not a fight to end environmental goals, it is a fight to identify facts and fight real problems rather than politically motivated untruths.

Public Sector Perspectives
Nature Conservancy of Oklahoma
Tim Grogan, Executive Director, Oklahoma Chapter

“It is one thing to find fault with an existing system. It is another thing altogether, a more difficult task, to replace it with a better approach.”

Nelson Mandela, speaking of water resource management

During the 20th century, the conservation movement in America focused primarily on keeping nature and people separate. The results were impressive, as symbolized by the nation’s parks and wilderness areas, each with their own stringent restrictions on human use.

But in the 21st century, the challenge facing us all is exactly the opposite – instead of keeping people and nature apart, how do we best bring them together? In other words, *how do we integrate human needs with the needs of the environment in a way that benefits both?*

Nowhere is that question more critical than with the issue of fresh water. The purpose of this paper is to propose a process that, as part of a comprehensive, statewide water plan, can achieve that integration, creating a win / win result for both people and the places they love.

***Ecologically Sustainable
Water Management (ESWM)***

ESWM is a process that systematically identifies the needs of both humans and natural ecosystems, and develops solutions that integrate those needs. Originally developed by the Nature Conservancy, the model has been tested and implemented successfully a number of times across the country. ESWM is as simple as 1 - 2 - 3 ...

ONE
Identify Human Needs

The needs of local communities, cities, counties, industry, ranchers, agriculture, the environment, small business, and recreational users, among others, have to be heard and incorporated into water decisions to gain public support and acceptance. Further, those needs have to be identified in an open, collaborative process.



ESWM achieves this by creating a coalition of all relevant stakeholders to address water issues. For example, in response to the controversy over a proposed water sale from the Kiamichi River in Southeast

Oklahoma, the Conservancy helped organize a coalition of 22 public and private organizations ranging from federal agencies to citizens groups. This coalition is meeting to discuss its members’ various needs and concerns, and identify solutions that address those concerns.

TWO
Identify Nature Needs

The needs of rivers center around their historic pattern of seasonal high and low flows, and occasional floods and droughts, known as their flow regime. These needs have to be considered in water planning as aquatic and riparian organisms have adapted to these extremes over thousands of years and will often perish without them.

ESWM identifies these needs through scientific studies of the flow regime and the plants and animals dependent upon it. In the Kiamichi River example above, four separate studies are currently underway on this river system and its aquatic life. These studies are expected to produce a

“flow prescription” by next summer which will define the exact timing and volumes of water necessary to sustain the health of the river.

Similarly, the needs of underground aquifers are critical as they support the wells of innumerable homes, farms, and ranches, as well as the flow of numerous rivers and springs. Overwithdrawal from an aquifer can destroy in one lifetime what nature took many thousands of years to create. ESWM again uses scientific studies to identify the exact size, structure, and recharge rates of an aquifer to help define withdrawal rates which sustain its long term health.

THREE Integrate Those Needs

While the solution that best integrates human and natural needs once they have been identified is different for every water resource, a good example of how it might occur is dam management. The following chart illustrates the flow of the Mountain Fork River before and after impoundment by a dam:

As the chart dramatically illustrates, traditional water management has generally sought to dampen the natural variability of flows to attain steady and dependable water supplies. However, this radical

flattening of the historic “spikiness” of the flow regime can be devastating to the plant and animal life of the river.

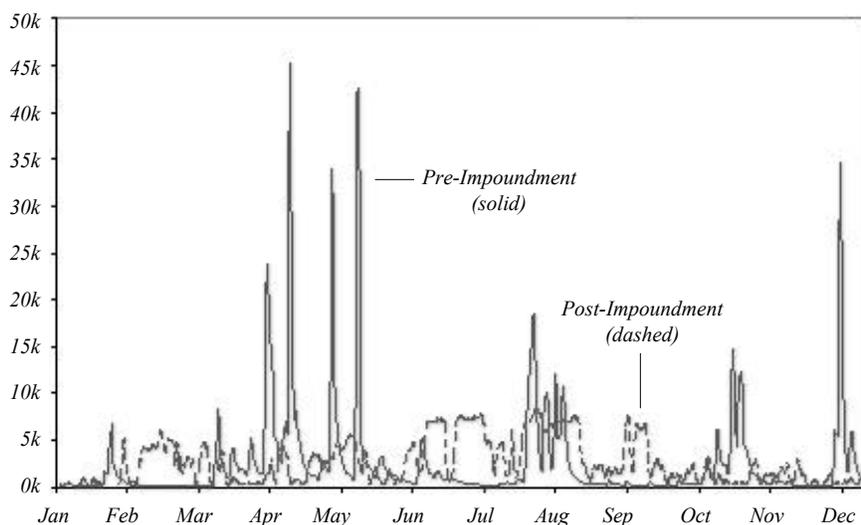
With the scientific knowledge ESWM provides, flows can often be modified for human purposes while maintaining an adequate semblance of the composition, structure, and function of natural ecosystems. Dam releases can often be adjusted to more closely mimic the historic needs of the river without significantly affecting human needs for the water.

Conclusions and Recommendations

In this paper, we have sketched what we believe to be a useful roadmap for finding ecological sustainability in water management – ESWM. This model puts ecological considerations up front along with other goals for water management planning. As part of a statewide, comprehensive water plan, it can provide an open, inclusive decision making process that is science driven and considers the needs of all stakeholders.

We believe that ESWM is not only the *right* thing to do, but also the *smart* thing to do to sustain our precious freshwater resources for the benefit of many future generations of Oklahomans.

The Mountain Fork River



Public Sector Perspectives
Oklahoma Chapter of the Sierra Club
Tom Libby, Chair, Oklahoma Chapter

Oklahoma's water resources may be adequate to provide for the needs of Oklahoma citizens now and in the future, but only if these resources are managed properly. The Oklahoma Sierra Club wants to ensure that water quality, as well as quantity, is adequate to support all designated beneficial uses. Public and private water supplies, recreation, plants, fish and wildlife, municipalities, industrial uses, irrigation and aesthetics all benefit from clean water protections.

Our water resources must be protected for future generations, for the ecological sustainability of watersheds and for the public right to sufficient quantities of affordable, clean drinking water. Furthermore public access to clean drinking water should be recognized as a basic human right that should not be abridged by privatization of water supply systems.

In years past, the public concern was to protect access to rivers for navigation and fishing. To protect these rights, navigable waterways and shorelines were held in the public trust. Today the public right to sufficient quantities of clean water must be given equal stature.

The Oklahoma Sierra Club supports and promotes the development of a new comprehensive water plan based on sound scientific principles and comprehensive data collection.

Oklahoma's current water plan -

- fails to protect beneficial uses other than for drinking water (such as fish and wildlife),
- fails to adequately reserve water sufficient to meet all present beneficial uses and preserve water quality,

- fails to adequately address groundwater or the interaction between surface water and groundwater resources
- and fails to provide for future generations.

Work must begin immediately on a new comprehensive water plan for Oklahoma which will:

- address the intimate interconnections between surface water and groundwater
- replace the concept of depletion schedules with sustainable usage rates
- protect ALL beneficial uses
- provide a new definition of excess water that
 - *guarantees minimum water reserves to meet all present and future beneficial uses, [guarantees minimum in stream flows]*
 - *preserves water quality*
 - *provides for future generations*
- recognize public access to clean drinking water as a basic human right that should not be abridged by privatization of water supply systems.
- involve public participation in all phases of the process.

Until a new comprehensive water plan is completed there are many things that can be done now.

- Existing Oklahoma Water Quality Standards must be utilized and enforced by all state environmental agencies within their areas of jurisdiction as directed in existing statutes.
- State agencies must develop and enforce detailed water quality implementation plans and procedures as is already required by Oklahoma law. These agencies include the Department of Agriculture, the Department of Environmental Quality, the Oklahoma Water Resources Board, the Department of Mines, the Department of Wildlife Conservation, the Conservation Commission and the Corporation Commission. Such plans must include how water use permit applications will be reviewed to ensure compliance with water quality standards.
- Moratoriums should be placed on large interbasin transfers of water until adequate protections are established.
- Moratoriums should also be placed on any new permits for CAFOs (Confined Animal Feeding Operations), LMFOs (Licensed Managed Feeding Operations) and any large animal feeding operation.
- Require permits for all poultry operations regardless of method of litter management and restrict locations of houses, lagoons and numbers of animals allowed.
- Discharge permits should not be issued unless it can be proven that no harm to water resources will occur.
- Streams should not be removed from the 303d list of impaired streams unless all water quality standards, including anti-degradation standards, are met.
- Federal agencies such as the Corps of Engineers must also comply with Oklahoma Water Quality Standards when issuing permits for dredge and fill activities, hydropower operation and other federally regulated activities.

Finally, the public must be educated about the need for water conservation. Sound water use practices reduce the amount of stress that is placed on our existing water resources, both by limiting water withdrawals and by decreasing wastewater discharges. Conserving water reduces wear and tear on major infrastructure such as water and wastewater treatment plants and the distribution systems that deliver water to consumers, and can postpone or eliminate the need for making major investments in new infrastructure.



AN OKLAHOMA RESOURCE

energy

A PROPOSED STRATEGY FOR OKLAHOMA

Why An Oklahoma Town Hall About Energy?

Charles Mankin, PhD, Director, Sarkey's Energy Center and the Oklahoma Geological Survey

Town Hall Introduction

As we began preparations for this document, we visited with Dr. Mankin. We were intrigued with his impromptu discussion of Oklahoma's "energy culture". At the end of our meeting we asked him to put those thoughts in words, and he happily agreed to do so. Upon receipt of Dr. Mankin's thoughts, we believe they capture the tone and spirit of "why a Town Hall about energy?" And that is why we are using that text to open our Energy section. We hope you enjoy Dr. Mankin's thoughts as much as we did.

Preamble

Oklahoma became a state on the back of one of the highest risk businesses in the world - the petroleum industry. Our State and the petroleum industry grew up together, and "risk" was considered to be a positive word. Unfortunately, the "Dust Bowl" came along. The departure of many of our citizens for greener pastures, attitudes in our State changed dramatically to becoming very "risk adverse."

That change has not served us well.

While Oklahoma City was once larger than Dallas, that metroplex has a population that is roughly equal to that of our State.

We need to restore "risk" as a positive word, and work toward the conversion of our economy from what is largely a resource-based activity (the export of energy and agriculture) to a fully integrated effort that takes advantage of our resources to generate employment opportunities in Oklahoma. At present, we export almost all of our agricultural products and two-thirds of our natural gas production to other states for minimal value to fuel their industrial activities. Why not use some of that to fuel industry in Oklahoma?

The Beginning

Oklahoma became the 46th state to join the Union on November 16, 1907, in large measure because of the discovery of crude oil some ten years earlier. In 1897, oil was discovered in what is now northeastern Oklahoma with the drilling of the Nellie Johnstone No. 1. Production was estimated at 50 to 75 barrels per day, but the lack of a market-together with other mechanical problems-prevented the well from becoming a commercial discovery. However, that discovery soon led to a rush of other drilling activity in this part of Indian Territory.

Ten years later, when Oklahoma became a state in 1907, its annual production was 41 million barrels, making it the largest oil-producing entity in the world. Such an achievement is difficult to comprehend given the conditions under which it was accomplished. Consider that a large number of rigs needed to drill these wells had to be built or brought in from other states. A large amount of pipe had to be acquired and each successful well had to flow to the surface because pumps were not available to produce fluids from depths in excess of several hundred feet. Most importantly, drilling was effectively random because knowledge about how oil occurred in the subsurface was not known. The first course in petroleum geology was not presented until some five years later.

While oil had been discovered earlier in Pennsylvania and was being discovered in other states, no region of the Nation was as active in the petroleum industry as Oklahoma. Optimism ran supreme as discovery after discovery was heralded across the Nation. This led to a large influx of people hoping to cash in on this bonanza. Tulsa would soon be known as the "Oil Capitol of the World" and Oklahoma City had a larger population than Dallas.

This rapid growth presented a fertile environment for innovations and improvements in drilling and completion technologies, and in understanding the reservoirs from which the oil was being produced. An array of tools and technologies were developed to improve the efficiency of the process, and ideas were being developed about where oil might be present in the earth. These considerations led to the development of a broad-based service industry, a number of whom are still in business today, and to educational programs to aid in the search for and development of this energy resource.

Education

It is believed that the first course in petroleum geology in the United States was offered at the University of Oklahoma during this time. The reflection seismograph, one of the most important tools to be developed for the petroleum industry did take place at OU by Dr. Clarence Karcher and his colleagues. Variations of this innovation continue to be the single-most important tool in petroleum exploration.

Natural Gas

Because of a limited understanding about where oil occurred in the subsurface and why it would flow to the surface in some instances and not in others, the presence of natural gas was not fully appreciated. Given the fact that there were no pipelines to move the gas to a market, it was considered to be a nuisance and was commonly flared at the wellhead. Unfortunately, natural gas was the reservoir energy that was causing the oil to flow to the surface. When wells were drilled into the “gas cap,” the flaring of that gas depleted the gas contained at the top of the structure, and thus depleted the reservoir energy that was causing the oil to flow to the surface. In addition, the depletion of the gas cap caused oil to migrate into that part of the reservoir, thus decreasing the amount of oil that could be produced through oil saturation of the former gas cap.

As a result of these actions, the recovery factor for many of the fields that were developed during this time is probably in the order of 12-15% of the

original oil-in-place. The very low recovery from these fields implies that there is a very large amount of oil remaining in these “depleted” reservoirs. Is this oil a potential candidate for future enhanced oil recovery? The potential volumes would suggest that an examination clearly is warranted.

In the early development of Oklahoma’s petroleum industry, natural gas did not play an important role. Since natural gas can only be transported efficiently through pipelines and cannot be easily “stored” above ground, the true value of natural gas was slow to be realized. Most of the natural gas produced in connection with crude oil was flared. Limited amounts were used in close proximity to the production. It wasn’t until the early 1940s that natural gas began to be moved through pipelines across the continent.

It wasn’t until 1979 that natural gas was sold in Oklahoma for \$1.00 per thousand cubic feet (mcf). In 1981, the gross value of natural-gas production exceeded that of crude oil for the first time. That trend continues today.

What is Oklahoma’s energy future? Is the industry in an inevitable decline or are there brighter days ahead? What do we need to know to make that determination?

We know that crude oil has a pressure and temperature limit. Thus, we know that its presence in deep sedimentary basins and in areas where rocks have been heated beyond the liquid stability limit is very unlikely. Given the extensive shallow drilling activities since 1897, it is unlikely that a large amount of crude oil remains undiscovered in Oklahoma. However, a large amount has been discovered in those past 105 years of production but, in many instances, has not been efficiently developed.

Therefore, a large amount of oil remains in existing and former fields that could be candidates for methods of enhanced recovery.

Enhanced Recovery

One enhanced recovery method that has proven to be very effective is injecting carbon dioxide into reservoirs that have reached their economic limits on primary and even water-flooding efforts. The major limitation to date is obtaining a large volume of carbon dioxide.

The initiation of a new federal program to remove carbon dioxide from the atmosphere over concerns for global warming may be an opportunity to achieve two goals at the same time. If the carbon dioxide that is extracted from sources that are producing large amounts of this gas can be injected into these reservoirs, crude oil could be produced and the carbon dioxide could be separated and injected again to recover more crude oil.

When the reservoir reaches the economic limit for such production, the carbon dioxide could be left in the reservoir to keep it from reentering the atmosphere. Should such a program materialize, some of the fields mentioned earlier in this document could be prime candidates for carbon-dioxide injection.

Natural gas, unlike crude oil, has no specific pressure and temperature limit. In the absence of oxygen, the methane molecule is exceedingly stable at great depths and high temperatures. Also, unlike crude oil, natural gas is highly compressible. So, a lot of natural gas can be present in a low permeability reservoir at great depth, and in reservoirs where the rock strata have been subjected to higher temperatures and pressures through deformation. Thus, the geologic environments where natural gas can be present is substantially greater than those where crude oil may be found.

So, deep sedimentary basins and regions where the strata have been deformed through tectonic processes could well be candidates for natural gas accumulations. In Oklahoma, those environments would include the deep Anadarko basin in western Oklahoma and the Ouachita fold belt in the southeastern part of our State.

Another unique environment where methane is present is in organic rich shales and coal seams. Oklahoma has a lot of coal in the eastern part of the State. Unfortunately, most of the coal is in relatively thin seams and commonly has a moderate amount of sulphur. Consequently, it has a limited market value. However, as a "reservoir" for natural gas, it represents another important source for the development of this commodity. At present in Oklahoma, there have been about 2,000 wells drilled for coal-bed methane production. This is but a small fraction of the opportunities for such development in our State.

Our Future

As we look to the future, natural gas is viewed as a growing source for this Nation's energy supply. At present, it is an important feed stock for the petrochemical industry, a major source of heat for other industrial activities, a rapidly growing source for commercial and residential heating, and a growing source for electric power generation.

However, an innovation, while not particularly new, may become one of the more important uses of natural gas. That is the conversion of natural gas to a liquid transportation fuel. The idea of gas-to-liquids (gtl) has been known for some time, but the large supplies of crude oil and the existing system of refineries have limited the interest in this technology.

However, as the US demand for transportation fuels has soared, the domestic supplies of crude oil has markedly declined. We are now importing 60 percent of our crude oil and refined products, much of which are from increasingly unstable parts of the world. Given this trend, it is only a matter of time until we will have to turn to this technology to meet our transportation needs.

The natural-gas resource base in Oklahoma and this Nation is very large. Expanding this view to the rest of the world displays a resource base that will meet global needs for many decades into the future, well beyond the time when we should have developed a hydrogen energy economy.

New Mexico First
A New Mexico Town Hall About Energy

New Mexico's Energy, Economics, and Environment, Carlsbad, NM, November 14-17, 2002

The Town Hall's goals were:

- to revisit the topic of energy;
- to agree on its interplay with two vital elements: economics and the environment;
- to use this opportunity to reduce the gap between the opposing views on the subject; and
- to find positive solutions to the challenges posed by these issues.

The Town Hall is concerned that the New Mexico public takes energy for granted and may believe energy shortages are someone else's problem. Some think that we can conserve our way out of any energy shortage. However, not many people are willing to take individual action and responsibility even though they may believe that society in general uses too much energy and causes environmental harm in doing so.

In addition to a lack of individual responsibility, it appears that there is a lack of sense of urgency because the public presumes that energy needs will be met in the near-term, thus shifting the problem to future generations.

The Town Hall believes the general public lacks a full understanding of energy issues, including energy production, infrastructure, transportation, indirect costs, and indirect benefits, and about how energy drives the economy. These issues are perpetuated by the lack of consensus among the experts and a high degree of rhetoric. The Town Hall seeks to avoid the extremes and to focus instead on the middle ground in which most thought and behavior occurs.

New Mexico has great potential to realize the full value of its natural resources, by increasing development of value-added industries that produce and refine natural resources and harvest renewable energy. Despite the benefits, there are challenges

for new energy development, including land ownership, inappropriate regulation, energy security, and demands on the state's water resources.

While extractive industries have finite resources, New Mexico has the opportunity to proactively develop additional reserves and alternative forms of energy.

The Town Hall believes discussion of the relationship between energy development and the environment is positive and that neither has to be sacrificed to achieve the other. There is a need for forums to reach science-based solutions to these conflicts.

All energy development impacts the environment: land use, habitat fragmentation, air quality, water quality, erosion, aesthetics, and noise. On the other hand, it can also be argued that the health, well being, and growth of the energy industry in New Mexico have had some positive impacts on the environment. The current standards for energy development are significantly higher than in the past, which has led to a decline in negative environmental impacts.

New Mexico has an abundant supply of resources, including wind, solar, biomass, oil, gas, coal, geothermal, and uranium deposits, as well as human capital. Given these resources, the Town Hall envisions a future in which the interests of energy, economics, and environment are balanced in a proportion that allows for the responsible development of renewable and non-renewable energy, quality economic development, and protection of human health and the environment.

To appropriately balance energy, economics, and environment, the Town Hall believes that the following pivotal issues must be addressed.

Policy

- a. Regulatory challenges: These include inefficient processes, inappropriate regulations, inconsistent decisions, energy policies that can be subject to frequent paradigm shifts, and frameworks that are not based on sound science. In addition, there is no accountability or consequence for misuse of environmental statutes or scientific information.
- b. Land: Access to land for energy infrastructure will remain a critical issue in New Mexico, where a large proportion of the state's lands are owned and managed by federal, state, and tribal governments.
- c. Capital: Continued emphasis must be placed on creating wealth in New Mexico by enhancing our access to new and existing financial market networks.
- d. Infrastructure: Renewing and adding sufficient infrastructure to accommodate new and existing energy resources is vital. Specifically, emphasis should be placed on the critical issue of energy security in New Mexico.
- e. Tax structure and business climate: New Mexico's tax structure does not encourage the investment of capital funds, and there are no tax incentives to improve conservation or efficiency. Favorable tax policies, such as industrial revenue bonds and federal production tax credits, can serve to make investment more promising.
- f. Price Stability
- g. Diversification: There is a need to bring new industries to New Mexico to reduce the effect of energy price volatility on state revenue. There is also a need to diversify our energy portfolio to reduce our dependence on extractive industries and minimize impacts on our environment. Opportunities to diversify may include renewable energy, nuclear energy, and water produced as a byproduct of oil and gas extraction.

Education

- a. Public education: New Mexico's public and its leaders need better education about the interrelationship among New Mexico's energy production, sensitive environmental issues, and the economy and about available assets, potential technologies, and alternative energy supplies.
- b. Workforce development: Options for developing our human capital include improving or developing consistent statewide training materials with common core curricula and increasing the effectiveness of energy-related educational programs at the technical-vocational level, community college level, and university level.

Recommendations

1. New Mexico should lead in the reform of regulatory policies at the state and federal levels to assure that:
 - a. *standards, regulatory requirements, and agency policies are appropriate, reasonable, and based on sound science;*
 - b. *environmental standards are reviewed and updated, if necessary, every five years;*
 - c. *time limits are set and enforced for energy and related environmental permitting, licensing, and right-of-way decisions;*
 - d. *streamlined procedures are established to obtain access to federal, private, and state lands; and*
 - e. *pueblos and tribal energy development and other related interests are sought and encouraged.*
2. Appropriate interim legislative committees and institutes should be established to review regulatory departments, agencies, and commissions to investigate whether the intent of the law is being properly implemented and to ensure that the tax

structures will foster growth of the energy industry and related manufacturing.

3. New Mexico should prudently develop its renewable energy resources through production and other incentives with appropriate sunset provisions to encourage economic development and to foster long-term price stability.

4. New Mexico should prudently develop and provide incentives for production of alternative transportation fuels.

5. New Mexico should be a strong energy leader in the future through fostering existing energy industries, nurturing new energy industries, and developing energy-related industries by:

a. Attracting investment capital to expand existing energy industries, enhance research and development for new and improvement energy technologies, and expand development of new energy sources in New Mexico. Actions to be taken include:

(i.) requesting the state and federal governments to support stable prices that encourage development of energy sources;

(ii.) creating performance-measured incentives such as lower tax rates and tax benefits for investment in the state;

(iii.) leveraging existing financial resources to increase energy development; and

(iv.) amending State Investment Council “return on investment” criteria to include all monies returned to the state, such as employment taxes and revenues to state trusts.

b. Diversifying New Mexico’s energy industry and energy-related industries by:

(i.) broadening performance-based incentives and support for renewable, alternative, and transitional energy sources to assure eventual independent profitability;

(ii.) supporting incentives for development of safe nuclear power and related industries in New Mexico; and

(iii.) attaining legislative support and utilizing research and development to establish viable treatment of energy-produced water for various uses.

6. By June 2004, New Mexico should establish a comprehensive, long-term (through 2024), state-wide energy policy and strategic energy plan that incorporates continued environmentally responsible energy development, encourages emerging energy technology, and increases public awareness by including:

a. a broad-based, coordinated, open process that includes key constituencies and technical experts;

b. public notification, education, consumer forums, dialog and collaboration among the public, industry and regulatory participants, and a regular update procedure;

c. optimization of all New Mexico’s energy resources to produce economic and environmental benefits through sustainable industries and their associated products;

d. improved job opportunities and economic stability through workforce development;

e. increased access to public lands; and

f. programs to leverage existing financial resources.

7. To support development of a state energy plan, New Mexico should undertake a comprehensive raw energy asset inventory.

8. The Governor should broaden and commit to an energy agenda that includes all energy sources and incorporates mitigation of adverse environmental impacts by:

- a. *directing the Secretary of the Energy, Minerals, and Natural Resources Department to be the advocate for energy development, to promote environmentally friendly energy development, to identify key problems, and to shepherd solutions to completion; and*
- b. *coordinating New Mexico's energy plan with other state and federal agencies.*

9. The legislature should identify and appropriate funds to develop and implement the energy plan.

10. New Mexico should improve its citizens' understanding of the energy industry, related environmental concerns, and their interplay with the economy by:

- a. *creating a consortium of government officials, university and community college leaders, and experts in the environment, economic development, and the energy industry to identify areas of tension, energy development issues, conservation opportunities, efficiency improvement strategies, and regulatory reform concerns;*
- b. *identifying key issues and background information to present to state and federal leadership and legislators;*
- c. *conducting a series of informational meetings or town halls with recognized leaders;*
- d. *encouraging direction to the Department of Education to include a statewide curriculum section covering New Mexico's energy heritage; and*

e. *developing a comprehensive workforce-training plan.*

11. New Mexico should create a Center of Energy, Economics, and Environment run by a coalition of the academic institutions, government agencies, private industry, and the national labs.

- a. *The Center would bring new knowledge, education, and understanding to the environmental and economic issues involved in assuring that the state continues to meet its energy needs.*
- b. *The Center would engage domestic and multinational industries, governments, academics, and the general public in the formulation of new forms of analysis; balanced, multidisciplinary education and technology development; and innovative visions.*
- c. *The Center would link state and federal regulatory agencies, research and development facilities, industry information centers, and teacher resource centers.*
- d. *The major components of this Center would be education, technology development and deployment, public outreach, and public policy.*



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A Proposed Energy Strategy
An Executive Summary

Robert J. Sullivan, Jr., Secretary of Energy, Keating Administration, State of Oklahoma

The problems we face today cannot be solved with the level of thinking that existed at the time they were created - Albert Einstein

Our Oil and Gas

The State of Oklahoma has been richly blessed with an abundance of natural resources. Since before statehood, the lands that now comprise Oklahoma have yielded billions of barrels of crude oil and trillions of cubic feet of natural gas. While these two prime energy resources have peaked in production (oil in 1967 and gas in 1990), there remain large quantities of recoverable oil and gas reserves to serve Oklahoma's citizens and our national energy demand as well.

We must recognize, however, that the pattern of declining production for oil and gas is inexorable, and we must strive to replace oil and gas as an economic engine if we are to prosper as a state in the decades to come. Fortunately, Oklahoma is additionally blessed with an abundance of renewable energy sources, as well as the intellectual resources needed to bring these newer energy assets to the marketplace economically.

It is critical that the three principal players in this transition process – the private sector, state government, and our higher education institutions – work efficiently together and focus on this transition, because it not only involves a shift from hydrocarbon-based energy to non-hydrocarbon sources, but it will directly affect the economic backbone of the state over the next quarter century, thereby directly affecting the quality of life for every Oklahoma citizen.

Fortunately, we have virtually all the tools available within Oklahoma's borders to effect this transition on a timely and efficient basis. We have



Robert J. Sullivan, Jr.

an active reservoir of private-sector knowledge and experience, housed not only in the multitude of energy companies domiciled in the state, but in a growing number of energy company retirees whose experience can be invaluable in maximizing the recovery of remaining oil and gas and the transition to other energy sources. Additionally, Oklahoma is well known for having an energy-friendly

governmental environment in which the private sector can work effectively. The cooperative approach well established in the Oklahoma Corporation Commission, the state Legislature, the Governor's office and other relevant agencies is critical to the implementation of the above-described transition of Oklahoma's energy/economic base.

Finally, and most importantly, Oklahoma is well endowed with a deep reservoir of knowledge in our higher education institutions (principally, the University of Oklahoma, including the Sarkey's Energy Center, Oklahoma State University, and the University of Tulsa) that can be brought to bear on both the economic pursuit of remaining hydrocarbon reserves and the development of market-based alternative energy sources. At present, these academic resources are somewhat isolated from the private sector. It will be critical to the task that far more extensive interaction and communication take place among our academic resources, private sector energy companies, and our state government.

If these private sector, governmental, and academic resources can be blended efficiently and directed through an orderly transition of energy bases, Oklahoma can achieve the value creation pattern conceptually depicted in the accompanying graph, to include the following three elements of energy value growth:

ONE Remaining Oil and Gas Reserves

Since the first oil discovery was made in Oklahoma over a century ago, over 14 billion barrels of oil and 87 trillion cubic feet of natural gas have been produced. Oil production peaked in 1967, gas in 1990, and the recent blended (oil and gas) annual production decline of about 10% can be expected to continue, if not steepen over the next several years.

Fortunately, Oklahoma can claim an abundance of remaining oil and gas reserves — at least as much as has been produced to date — but the cost of finding and producing these known reserves makes them marginally economic.

The strategy for Oklahoma as to these abundant known reserves is to create an economic, operational and attitudinal climate that will marry the knowledge and experience in our oil and gas industry with similar knowledge sources in our universities to encourage industry's aggressive pursuit of these reserves on an economically attractive basis.

The objective is to drive down finding and production costs, thereby allowing the economic harvesting of Oklahoma's known remaining reserves. It is unlikely that we can reverse our state's oil and gas production decline pattern, but we can affect favorably and significantly the *rate of decline*, thereby allowing time for alternative fuels to be developed and become contributors to Oklahoma's energy-derived economic value.



TWO “The Place” for Energy Answers

Although Oklahoma for decades has enjoyed the economic benefits of produced energy reserves, as a state we have missed the opportunity to leverage our collective knowledge of energy by failing to market ourselves to a world-wide market rife with energy related questions and problems. The strategy point here is to develop in a highly organized manner, a marketing program that presents Oklahoma as the single best place to go for energy related answers. The marketing thrust should include (but not be limited to):

- (a) Assurance to a world-wide marketplace that Oklahoma has a deep pool of human resources in the oil and gas industry, in our universities and in our state government who can be accessed for problem solving, advice and joint venturing.
- (b) A vigorous effort directed at recruiting out-of-state companies whose value creation process relies on resources and raw materials that originate in Oklahoma. The often-cited example is of the Michigan-based cereal makers who use Oklahoma's corn, wheat, and natural gas to produce cereal. The value added is all in Michigan. Such firms need to be recruited to domicile in Oklahoma.
- (c) The development of a marketing thrust that is based on Oklahoma's unique combination and abundance of renewable natural resources (wind, solar, biomass). Although marginally economic or non-economic at present, Oklahoma would be foolish to ignore this huge combination of renewable natural resources, as they very likely will be important elements in “tomorrow's energy world” — and Oklahoma is loaded with all three. The strategy point here is to focus on the research aspects of these three energy sources, primarily through our universities, so that Oklahoma can be presented to the energy world as a *vast outdoor laboratory* where tomorrow's energy resources are being made economic.

THREE

Developing Oklahoma's Renewable Resources

Although Oklahoma has been utilizing hydropower (our nation's primary renewable energy source at present) for several decades, it provides only about 4% of the state's generated electricity. The renewables in Oklahoma's energy future are wind power, solar power and biomass related power.

Wind in Oklahoma, by observation and by scientific measurement, is clearly abundant, with the western half of the state offering the best conditions for wind power projects. The main impediment is the lack of an adequate electricity grid to bring wind-generated power to market.

Similarly, although Oklahoma can claim over 300 days of sunshine annually, solar energy development in the state presently suffers from grid system access. Solar energy's best use, at least in its early years of development, is likely to be for commercial and residential usage for onsite heating, air conditioning and water heating applications.

Biomass has the potential to become a major source of global energy, especially in less developed countries. Given the state's abundance

of hydrocarbon reserves, and the potential wind and solar hold for Oklahoma, it is questionable whether biomass will ever be a large contributor of energy to Oklahoma consumers. The research and development required to make biomass energy economic, however, can and logically should be a focus of attention by Oklahoma's private sector and universities.

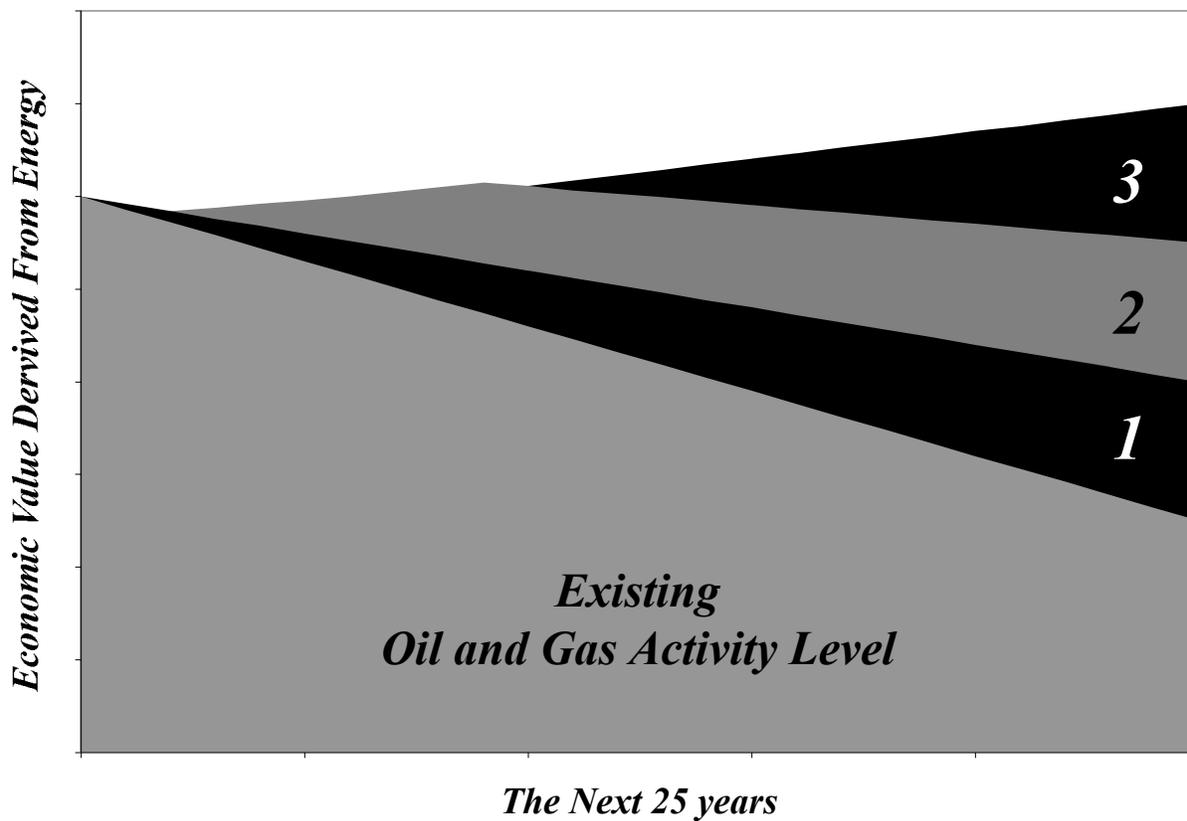
These three energy-based contributors to Oklahoma's future economic value have the potential collectively to reverse the decline pattern we have been experiencing from exclusive reliance on oil and gas production. This reversal of energy related economic fortunes, when added to any economic benefits that are based on non-energy related initiatives, can justify a confident view of Oklahoma's economic future over the next 25 years.

At the heart of any energy strategy should be the economic effect on Oklahoma's cities and towns. Having enjoyed the prosperity associated with our abundant oil and gas reserves for over a century, Oklahoma needs to maximize its remaining hydrocarbon reserve value while aggressively developing tomorrow's energy sources, all to the benefit of Oklahoma's citizenry.

Summary

An Energy Strategy for Oklahoma

Robert Sullivan, Jr., Secretary of Energy, Keating Administration, State of Oklahoma



1

Aggressive Program Aimed at Known but Marginally Economic Oil and Gas Reserves



Drilling in Oklahoma

2

Marketing Oklahoma Worldwide as an Energy Knowledge Resource Base



Sarkey's Energy Center

3

Harvesting Oklahoma's Vast Renewable Energy Resources



Solar Collectors



Robert J. Sullivan, Jr.
Secretary of Energy

**STATE OF OKLAHOMA
OFFICE OF THE
SECRETARY OF ENERGY**

Frank Keating
Governor

December 12, 2002

Dear Governor Keating,

It is with pleasure and a strong measure of enthusiasm and satisfaction that I submit to you an Energy Strategy for the State of Oklahoma for the next quarter century. As you will recall when we first discussed this matter in March 2002, Oklahoma has never had an energy strategy, or any form of visionary road map, to assist private and public sector decision-makers in the all-important and ongoing process of effectively and efficiently harvesting our state's abundance of natural resources.

The report contains fifty-one strategic initiatives designed to stimulate thought, discussion and, most importantly, action toward the ultimate goal of invigorating our state's economy, thereby improving the quality of life for all Oklahomans. To accomplish this, aggressive action is suggested on three fronts.

Economically harvest Oklahoma's vast known remaining oil and gas reserves.

Be energy leader by presenting and aggressively marketing Oklahoma as the single and best place in the world to come for resolution of virtually any energy related problem.

Third, we must launch an all-out effort to bring Oklahoma's unique and extensive renewable resources (wind, solar, biomass) to economic viability.

It is my vision that implementation of this aggressive strategy can and should be undertaken without the need for any significant state funding, because the main elements of the strategy are already in place (private sector players and knowledge base; research, data and knowledge imbedded in our universities; marketing capability in the Department of Commerce, etc.)

What is clearly required is a strong, visible leader of the implementation effort, an effective coordinating program, and public and private leadership's resolve to make it happen.

This report is not intended to be a comprehensive list of answers to energy problems, but rather a stimulus for all of us in public and private positions of leadership to focus on a direction that is logical and achievable, given the resources we are blessed to count as native to Oklahoma. There has been input to this report from over two hundred public and private sector contributors, to whom I am very grateful, as they represent our state's greatest resource—Oklahoma's knowledge of the energy world and the work ethic of our people.

Respectfully Submitted,

Robert J. Sullivan
Secretary of Energy

A Proposed Energy Strategy

Robert J. Sullivan, Jr., Secretary of Energy, Keating Administration, State of Oklahoma

OKLAHOMA'S RESOURCES

Oklahoma's most valuable resource is the collective ingenuity, work ethic, and knowledge of its citizenry. Oklahoma's second most valuable asset is its abundance of primary natural resources that are capable of providing its citizens with a reliable supply of energy for a virtually indefinite period of time.

Responsibly harvesting these energy resources and delivering them safely and efficiently to Oklahomans and to out-of-state consumers is the important responsibility of the state's private sector, as supported and encouraged by state government and the considerable intellectual resources housed in our public and private education systems.

The purpose of this statement of an energy strategy for Oklahoma is to provide a conceptual, yet practical, roadmap for all those involved in the business of responsibly shepherding Oklahoma's energy resources.

The focus of this document is on how best and most efficiently to accomplish that important undertaking. Accordingly, the recommended initiatives contained herein are directed at the primary players involved in the energy equation: decision makers in private sector energy companies, state government leaders, and the energy sectors of our state's universities.

Because the way we will manage our energy resources so dominates the future of Oklahoma society, anything less than full cooperation and coordination among these three sectors will cripple our state's economy and negatively affect its citizenry.

Oklahoma's energy resources rank at the very top of our nation's list of critical resources.

Responsible stewardship and development of these unique blessings will inure to the benefit of all Oklahoma citizens and the nation at large.

OUR NATION'S ENERGY PICTURE

As a country, the United States has a voracious appetite for energy. Americans are presently consuming energy at a rate of approximately 100 quads (quadrillion BTUs) annually. The Department of Energy estimates that 20 years from now we will be consuming about 175 quads per year. Our domestic supply of energy, including all sources, is growing at a rate of approximately 2.3% per year. About two-thirds of our country's energy consumption is satisfied by oil and natural gas. The conclusion drawn by virtually all forecasters of energy supply and demand is that the gap between energy consumed in this country and energy supplied within the United States will continue to widen, with an increasing amount of imported energy making up the difference.

In the spring of 2001, Vice President Dick Cheney submitted to President George W. Bush the initial draft of a National Energy Policy, as developed by a Cheney-headed task force that had worked for several months on the project. The focus of the National Energy Policy was to take a balanced approach to both the supply side and the demand side of the energy equation for our country.

On the supply side, a number of initiatives were recommended to encourage more rapid and efficient development of our traditional fossil-based energy supplies, including oil and gas drilling incentives, initiatives for increasing clean-burning coal as a fuel, and more aggressive exploration of federal lands to develop new reserves. In addition, infrastructure initiatives were suggested involving refurbishing our drilling rig

fleet, updating and expanding our oil, refined products, and natural gas pipelines, and increasing the capacity of our electricity transmission grid. Also recommended was a new emphasis on technologies aimed at more efficiently finding, producing, and developing our hydrocarbon resources.

On the demand side, emphasis was placed on common sense conservation. Conservation was defined as a means of more efficiently consuming the amount of energy needed by individual, institutional, and industrial consumers of energy, rather than forcing a curtailment of economic activity by those three segments of society. More than half of the 151 recommendations made by the National Energy Policy group dealt with conservation matters.

Despite the fact that our nation is consuming vast amounts of energy, we have actually become more efficient since the early 1970s, when the first Arab oil embargo jolted Americans into being more responsible as energy consumers. Over the past 30 years, Americans have actually reduced by 40% the amount of energy spent per dollar of gross domestic product. Energy use per capita has remained about flat.

For at least the next several years, as viewed by many knowledgeable energy forecasters, and as reflected in the Bush/Cheney National Energy Policy report, we can expect our nation to remain

heavily dependent on fossil fuels as our primary energy source. During that time period, however, technology should improve the basic economics of several alternative energy sources that will eventually supplant hydrocarbon-based energy sources in our supply profile.

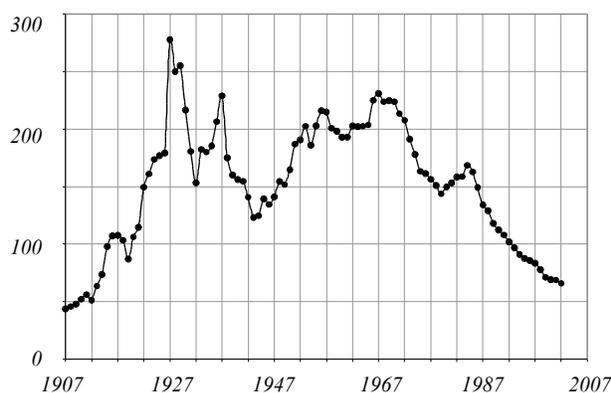
The nation's challenge will be to manage the orderly transition, with all its economic and societal stresses, from a hydrocarbon-based economy to one with a much larger role of non-hydrocarbon-based energy sources. While such a transition is inevitable, estimates of the timing and duration of the transition period vary widely. Supplying the energy needs of our nation will necessarily remain a top priority for large segments of private industry, academic institutions, and federal, state, and local public policymakers.

The problem of meeting our country's growing energy needs is ongoing and critically important. Concentrated efforts on both the supply and the demand sides of the problem will be required, and troublesome dislocations resulting in brown outs, price hikes, and spot shortages are likely as this complicated marketplace of energy suppliers and consumers continues to evolve toward efficiency and balance.

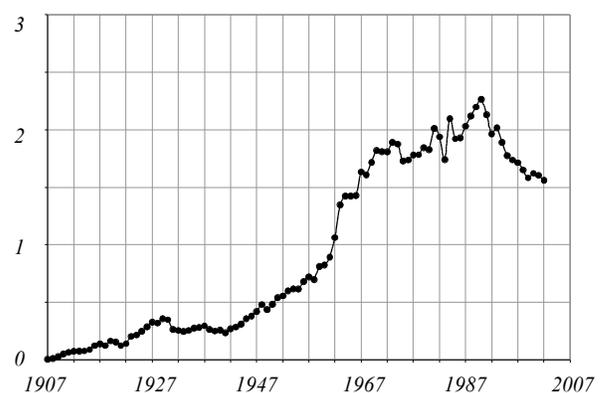
Oklahoma's Oil and Natural Gas

Since the late 1890s when oil was first discovered in what is now Oklahoma, our state has been blessed with an abundance of oil and natural gas

Production of Oil in Oklahoma
(millions of barrels)



Production of Natural Gas in Oklahoma
(trillions of cubic feet)



resources. In the ensuing time period of just over a hundred years, 14 billion barrels of oil and approximately 87 TCF of natural gas have been recovered from Oklahoma reservoirs. While annual oil production reached a modern day production peak of 221.3 million barrels in 1967, gas production peaked much later, in 1990, at 2.3 TCF. Both oil and natural gas have been on a steady decline since achieving those peaks.

The number of companies actively engaged in exploration and production activities in the state has also dropped through corporate consolidations and the departure from the industry of many independents due to the economic booms and busts that have characterized the oil patch for decades.

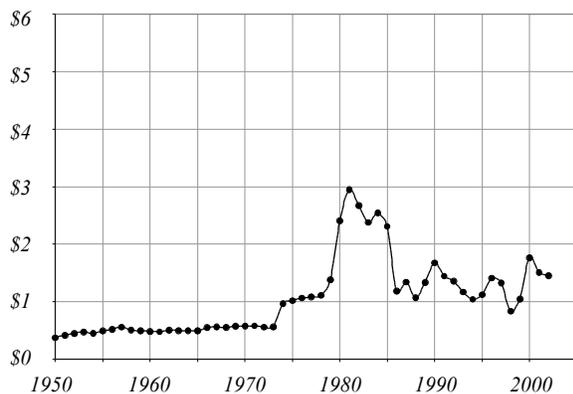
It is encouraging to note that Oklahoma's remaining oil and gas reserves approximate the state's total reserves that have been extracted over the past 100 years, according to Oklahoma Geological Survey estimates. Recovery of these remaining reserves, however, will require economically attractive wellhead oil and natural gas prices as well as improved recovery techniques. Technology will play a key role in developing these new and more efficient production and recovery methods and must necessarily require effective cooperation among industry, government, and educational institution leaders and researchers.

Much of the state's remaining oil reserves will be recovered through secondary and tertiary recovery methods. Many of the enhanced recovery research projects undertaken by major oil companies and in our universities have started and stopped several times over the past few decades due to wide volatility in oil prices and shrinking research budgets. Overall, the trend in such research has been down. If Oklahoma is to benefit from these vast oil reserves, a way must be found for aggressive laboratory and field enhanced recovery research to take place aimed at reducing the costs of bringing these reserves to market.

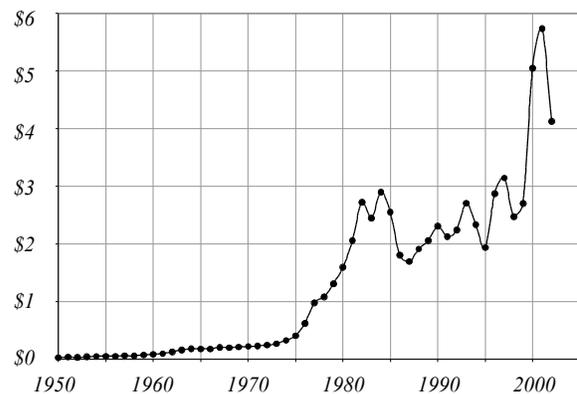
Oklahoma's natural gas reserves have been the primary focus of most of the state's explorationists over the past two decades. Gas has generally been perceived as somewhat easier to find than new oil reserves and less costly to produce with fewer environmental risks. Our state's natural gas production has been declining over the past 12 years as production from newly discovered reserves has failed to offset natural decline.

Most of the remaining natural gas reserves in this state must necessarily come from reservoirs at deeper depths than the reserves that have been produced in the past. Other, less conventional sources of natural gas, such as natural gas from coal seams and shale gas, may help flatten the production curve as they come onstream with their characteristically low deliverability but long-lived production patterns. Like oil reserves, however,

Value of Oklahoma Oil
(billions of 1982-84 dollars)



Value of Oklahoma Natural Gas
(billions of 1982-84 dollars)



Oklahoma's Gross Production Tax

The tax rate is based upon the average monthly product price as determined by the Tax Commission.

OIL

The average price of oil as determined by the Oklahoma Tax Commission is based upon the average price paid per barrel of sweet crude oil by the three (3) largest purchasers in Oklahoma. The three purchasers identified report to the Tax Commission each month on forms prescribed providing the average price paid for sweet oil in the previous month. The Tax Commission determines an overall average and posts the applicable tax rate on the Tax Commission Internet web site at www.oktax.state.ok.us and also made available by calling (405) 522-5031.

The Gross Production Tax rate on oil is as follows:

- If the average price of Oklahoma oil equals or exceeds Seventeen Dollars (\$17.00) per barrel, the tax shall be seven percent (7%).
- If the average price of Oklahoma oil is less than Seventeen Dollars (\$17.00) but is equal to or exceeds Fourteen Dollars (\$14.00) per barrel, then the tax shall be four percent (4%).
- If the average price of Oklahoma oil is less than Fourteen Dollars (\$14.00) per barrel, then the tax shall be one percent (1%).

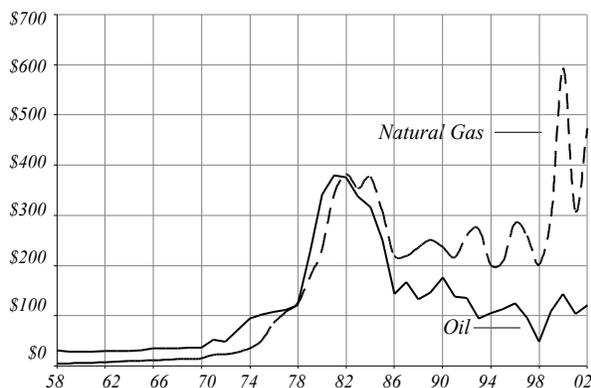
NATURAL GAS

The average price of gas as determined by the Oklahoma Tax Commission is computed each month by using Oklahoma average pricing information published monthly according to appropriate reference material prescribed by the Tax Commission. Each month's applicable tax rate on gas will also be posted on the Tax Commission Internet web site at www.oktax.state.ok.us and also made available by calling (405) 522-5031.

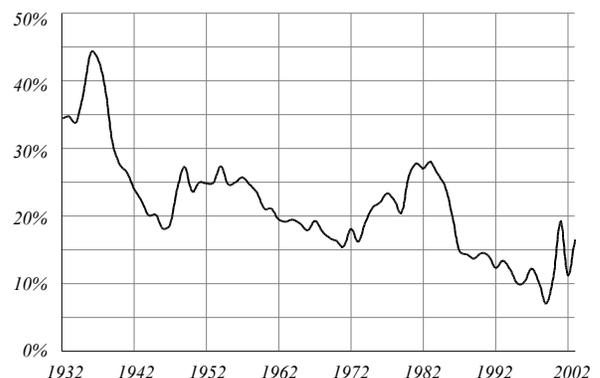
The Gross Production Tax rate on gas is as follows:

- If the average price of Oklahoma gas equals or exceeds Two Dollars and Ten Cents (\$2.10) per mcf, the tax shall be seven percent (7%).
- If the average price of Oklahoma gas is less than Two Dollars and Ten Cents (\$2.10) but is equal to or exceeds One Dollar and Seventy Five Cents (\$1.75) per mcf, then the tax shall be four percent (4%).
- If the average price of Oklahoma gas is less than One Dollar and Seventy-Five Cents (\$1.75) per mcf, then the tax shall be one percent (1%).

Oklahoma Gross Production Taxes
(millions of dollars)



Energy Taxes and State Tax Collections
oil and gas production taxes as a percent of total taxes



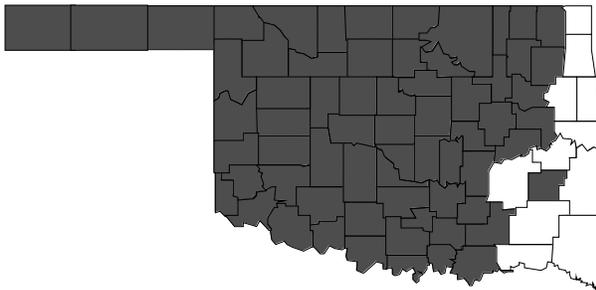
Oil and Gas in Oklahoma

Source: Oklahoma Corporation Commission 2002 Annual Report

Oil Producing Counties

In 2002, oil was produced in 66 of Oklahoma's 77 counties.
(the 2002 production was over 66 million barrels)

Source: Oklahoma Corporation Commission

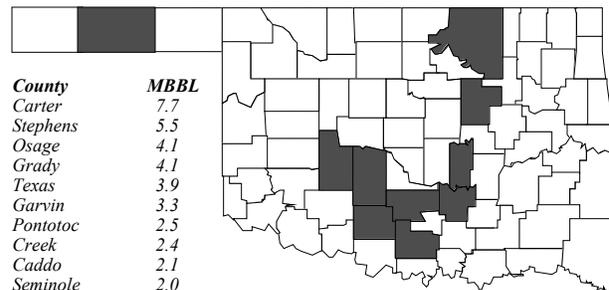


Counties without oil producing wells: Adair, Cherokee, Choctaw, Delaware, Haskell, LeFlore, McCurtain, Ottawa, Pittsburg, Pushmataha, and Sequoyah.

Leading Oil Producing Counties

Ten Leading Oil Producing [2002] Counties in Oklahoma
(each leading county produced more than 2 million barrels)

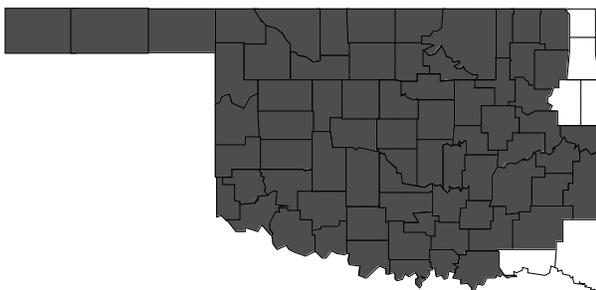
Source: Oklahoma Corporation Commission



Gas Producing Counties

In 2002, natural gas was produced in 71 of Oklahoma's 77 counties.
(the 2002 production was over 1.5 trillion cubic feet)

Source: Oklahoma Corporation Commission

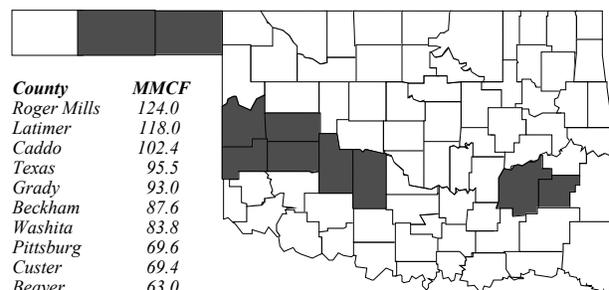


Counties without gas producing wells: Adair, Cherokee, Choctaw, Delaware, McCurtain, and Ottawa.

Leading Gas Producing Counties

Ten Leading Natural Gas Producing [2002] Counties in Oklahoma
(each leading county produced more than 50 billion cubic feet)

Source: Oklahoma Corporation Commission



these deeper and less conventional gas reservoirs can only be accessed at higher finding and producing costs than industry has enjoyed in the past. Accordingly, technology aimed at reducing finding and production costs will be critical to the state's ability to harvest its remaining natural gas reserves.

Other factors will also affect significantly the amount and pace of oil and gas reserve recovery in Oklahoma. An active, true market for the wellhead purchase of crude oil is essential to encourage industry to explore for and produce our remaining reserves. Over the past 25 years, the number of financially stable crude oil purchasers active in the state has fallen due to consolidations and purchasers leaving the business, a condition that is of great concern to all Oklahoma oil producers. In addition, the state's refining capacity has not grown over the past 30 years and, indeed, is in danger of shrinking as our aging refineries in the state face costly upgrades to comply with changing market needs and environmental regulations.

A large percentage of the state's oil-productive wells fall into the "stripper" or "marginal" well category. These oil wells are economically profitable as long as wellhead oil prices remain at fairly high levels, but become unprofitable at lower price levels. It is essential to preserve these wells, even during periods of low wellhead prices, because they represent primary access into older oil reservoirs that contain the bulk of the remaining oil reserves of our state. Accordingly, they are the access points for most of the future secondary and tertiary recovery projects that will be required to recover these reserves. To plug marginal oil wells is to reduce greatly the economic attraction for future recovery of secondary reserves, because the added cost of redrilling access holes into these reservoirs is likely to be prohibitive.

Oklahoma's natural gas production far exceeds gas consumption within the state. The state is therefore a significant exporter of natural gas to other states, where it is consumed by residential, commercial and industrial end users. Oklahoma

would be well served to use this valuable resource as a primary incentive to attract gas-consuming businesses to the state. Rather than export raw materials to other states where they are used in value-added industrial operations to produce other products, Oklahoma should seek to attract those industries to our state so that value creation can occur within our borders, thereby capturing the related benefits of job creation and other social and societal improvements.

In summary, although Oklahoma remains a significant producer of oil and natural gas in the United States, in order for its remaining reserves to reach market places efficiently and economically, a combination of forces must be in place so that those capable of harvesting these reserves will be encouraged to do so. These forces include a generally favorable climate of wellhead oil and natural gas prices, the availability of continually improving technologies aimed at lowering the finding and recovery costs of these reserves, and an industry-friendly environment that will assure a steady flow of financial and intellectual capital into the state's already attractive mix of these critical capabilities.

RENEWABLE & ALTERNATIVE ENERGY

Oklahoma has long been recognized for its leadership as an oil and natural gas producing state. Although not widely recognized for its unique, pristine environment, Oklahoma has one of the most diverse landscapes among all of the states in the nation. From the arid, short grass prairies of the panhandle to the swampy lowlands of McCurtain County, Oklahoma's biological and



ecological diversity represents a valuable and attractive asset for our citizens.

Many of today's modern environmental movements find their roots in conservation programs that were developed to address problems of the Dust Bowl years of the mid-1930's when Oklahoma landowners were devastated by brutal heat and wind damage. Although Oklahoma is seldom recognized for its environmental accomplishments, conservation and environmental protection have been addressed effectively by industry and state government leaders since Indian Territory first began maturing into the developed and economically successful state Oklahoma is today. The fact that relatively few environmental problems of any scale have arisen in Oklahoma where 550,000 oil and gas wells have been drilled over the past century is a testament to the axiom that sound energy policy and sound environmental

policy are not mutually exclusive, but in fact go hand in hand.

To continue the harmonious co-existence of energy development and environmental stewardship in Oklahoma, key players in industry, government, and academe must take leadership roles in the development of environmentally friendly energy initiatives, such as the development of bioenergy, ongoing research and development of wind and solar energy, and the preservation and expansion of hydropower — all naturally occurring, replenishable energy sources. Oklahoma is blessed with an abundance of several of these sources.

Bioenergy

Biomass, or organic matter, presently represents the fourth largest worldwide energy resource after coal, oil, and natural gas. In the future, biomass will be used to produce a combination of electricity, food, feed, fuels, and a wide range of industrial materials. Biomass power is the largest

Some Oklahoma Renewable Energy Applications (capacity = over 1 million kW)

<u>Owner</u>	<u>Fuel Type</u>	<u>Plant Name</u>	<u>Cap (kW)</u>
Weyerhaeuser Co.	Timber Residues	Weyerhaeuser Co.	35,000
USCE-Tulsa District	Water	Broken Bow Lake	100,000
USCE-Tulsa District	Water	Eufaula Lake	90,000
USCE-Tulsa District	Water	Fort Gibson Lake	45,000
Oklahoma Municipal PA	Water	Kaw Hydro	25,600
USCE-Tulsa District	Water	Keystone Lake	70,000
Grand River Dam Authority	Water	Markham Ferry	120,000
McGee Creek Authority	Water	McGee Creek	85
Grand River Dam Authority	Water	Pensacola	96,500
USCE-Tulsa District	Water	Robert S. Kerr Lake	110,000
Grand River Dam Authority	Water	Salina Pumped Storage	288,000
USCE-Tulsa District	Water	Tenkiller Ferry	39,100
USCE-Tulsa District	Water	Webbers Falls	60,000
	Solar	Harmon Science Center	2
Utility	Solar	Lawton EPA	18
Utility	Solar	Tulsa PV-EV Parking	4
Bergey Windpower Co.	Wind	Bergey Windpower Co.	50
J. Brown	Wind	Residential Wind Site	10
Drapery Manufacturing	Wind	Drapery Manufacturing	170
L. Dunn	Wind	Residential Wind Site	10
CW Miller, Jr.	Wind	Residential Wind Site	10

source of non-hydro renewable electricity in the world, with approximately 37 billion kWh of electricity produced each year. Generating this amount of electricity requires around 60 million tons of biomass per year.

Oklahoma is in an enviable position to marry the state's two top economic engines — agriculture and energy — while at the same time providing national and international leadership in the areas of developing clean burning fuels and reducing dependency on foreign oil.

Oklahoma's vast biomass resources can serve as a renewable source of energy that is environmentally friendly. Our state's abundant supplies of crop residues, grasses, trees, animal waste and other biomass resources should be exploited as they hold huge economic potential. In addition, Oklahoma has the intellectual resources to serve in a leadership role in developing the bioenergy technologies that will be required to bring biomass energy to the marketplace as a competitive alternative. To accomplish this, Oklahoma's energy sector, including industry, government, and our academic institutions, must work vigorously and effectively with others on a national level to develop effective private sector partnerships and coordinated research and development programs.

Wind Energy

Wind has been a naturally occurring source of energy for thousands of years, from powering ship sails to mill grinding. Oklahoma, where "the wind comes sweepin' down the plain," is well positioned to take advantage of this abundant resource, ranking 8th in the U.S. in wind energy potential, with a projected average of 82,700 megawatts (MW) and 725 billion kWh annually. Wind energy may be used to generate electricity, pump water, and perform a variety of other tasks. The American Wind Energy Association estimates that by the year 2020, 6% of the nation's electricity needs will be provided by wind energy. Some sources estimate Oklahoma has the potential to produce as much as 9% of the nation's electricity from wind.

Wind can be thought of as the next cash crop for Oklahoma ranchers and farmers who can enjoy royalties from the installation of turbines on their land while suffering minimal disturbance to their traditional farming and ranching activities. Our state is in a position to leverage off of its collective wind energy knowledge that resides in its universities, particularly Oklahoma State University and Oklahoma University, where the basic elements of wind energy application and economics are well established.

At present, however, our state does not have a single large wind energy project (greater than one megawatt), and we are falling behind our neighboring states in the development of wind energy. Oklahoma must adopt a more aggressive policy supporting wind energy development in an effort to tap this largely undeveloped resource so that it can be added to a more diverse, environmentally friendly energy portfolio. The nature of electric power generation by wind lends itself to complementing other more traditional energy sources of electric generation. For example, wind and natural gas are highly complementary for electricity generation as gas can be used to take up the slack during times of low wind production, while wind can serve to reduce the costs and environmental impact of hydrocarbon-generated electricity.

The principal impediment to the development of wind energy in Oklahoma for use in generating electricity is the lack of an adequate electricity power grid in the western half of the state where optimum conditions for wind generation exist. If this problem of adequate access to transmission lines can be solved, Oklahoma stands to be in the forefront of wind-generated power in the nation.

Solar

The sun is another example of an excellent natural energy resource, and Oklahoma has tremendous potential to develop this method of power, with sunshine approximately 300 days per year. Energy from the sun can be used for heating, cooling, and electricity generation.

To access this renewable resource, solar connectors utilizing mirrors to collect heat from the sun are installed to generate heat and electricity. Although the state shows abundant resources for producing solar power, the western half of the state has been judged to be the best region for the development of solar energy within our borders, with a potential of 42.3 million kWh per year — enough to power 4,249 homes.

Because access to transmission lines (same problem as with wind energy) is an impediment to large scale electricity generation, solar energy's use in the state is likely to be confined to satisfying more local energy needs, such as residential water heaters and perhaps residential lighting. If the state is to capitalize on its abundance of sunshine to generate electricity, the transmission grid problem must be solved and Oklahoma must be a significant contributor to the ongoing international effort to make solar energy competitive with other energy sources.

Hydropower

Hydropower accounts for approximately 4% of Oklahoma's electricity generation (about 2 billion kWh), produced from seven of its almost 5,000 dams. Oklahoma is the 21st largest producer of hydropower in the U.S.

According to the Clean Energy Coalition, hydropower is a resource at risk due to the regulatory burdens and costs associated with the federal hydro relicensing process. In the next 15 years, over half of all federally regulated hydro capacity must be relicensed. In Oklahoma, this includes the Markham Ferry and Salina projects, which represent 72% of the state's non-federal hydro capacity. Oklahoma could lose a number of projects in the licensing process. The Energy Information Administration reports that hydro generation will decline through 2020, "as regulatory actions limit capacity at existing sites." According to the U.S. Department of Energy, Oklahoma has a "moderate" hydropower resource as a percentage of the state's electricity generation. Oklahoma could produce an estimated 5,032,200 MWh of electricity annually from hydropower.

Alternative Transportation Fuels

Although Oklahoma is fortunate to have fewer air pollution problems than in more populated areas of the country, the state is not free of vehicular fuel-generated pollution problems, particularly in the major metropolitan areas. The sizeable impact of vehicles and other combustion engine generators on air quality cannot be ignored. In addition to increasing its commitment to reducing air pollution from mobile sources by incorporating more alternative fuel vehicles into fleets and emphasizing ride-sharing programs, the state needs to emphasize other Clean Cities Programs in large metropolitan areas.

To the extent that the ethanol initiative being pushed nationally is implemented in Oklahoma, our state would have the added benefit of serving as a supplier of grain for the production of ethanol. Ethanol's ability to compete economically with other energy sources is currently the subject of several national studies.

Other Environmental Considerations

Oklahoma can improve its already sound energy conservation program with an effort to encourage stronger participation in EPA's Energy Star program, which is primarily aimed at energy efficiency through environmentally favorable architectural practices and education programs for builders and manufacturers.

Carbon sequestration is a fairly new concept that is beginning to gain momentum in Oklahoma. It involves sequestering carbon close to the point of emission. Oklahoma's enormous agricultural community stands to benefit from this practice, which involves planting certain crops in an effort to more effectively sequester carbon releases and lessen the air quality impacts of carbon emissions.

Finally, programs such as those developed by the Oklahoma Energy Resources Board can serve as excellent models for the enormous potential for environmental improvements that lies in voluntary and cooperative industry/government joint ventures aimed at maintaining and improving Oklahoma's relatively clean environmental state.

OKLAHOMA'S COAL AND ELECTRICITY

Coal is a major source of energy in Oklahoma and in the nation. In 2000, coal was the energy source for 64% of the electricity generated in Oklahoma, with natural gas providing 31.6%.¹ Nationally, 52% of electricity is produced by coal² and 16% by natural gas.³

Oklahoma produced about 1.72 million tons of bituminous coal from 12 mines in six counties in 2001. Coal consumption in Oklahoma for 2001 was approximately 15,000,000 million tons.⁴ Most of the non-Oklahoma coal used in the state comes from Wyoming. The subbituminous Wyoming coal is low in sulfur content (0.4%) compared to Oklahoma coal with a sulfur content of approximately 2.5%. There are six coal fired utility plants in Oklahoma.

Oklahoma coal production has declined from its peak of 5.73 million tons in 1981, to a low of 1.59 million tons in 2000. Between 1989 and 2001, annual coal production varied from a high of 1.91 million tons to a low of 1.59 million tons. In 2001, the tonnage increased to 1.72 million tons.⁵

The reasons for the relatively flat production rate of Oklahoma coal are numerous: reduced demand for metallurgical coal, the loss of cement markets in Dallas, increased demand for low sulfur coal to meet emissions regulations, lower prices for coal, high transportation costs, lack of financial incentives, lack of available local investment capital, and lower prices for natural gas.

Until recent years, the major consumption of Oklahoma coal had been by out-of-state utilities. Major in-state use of Oklahoma coal has been by the cement and lime industry, and utilities.

The use of Oklahoma coal at the Applied Energy Services Cogeneration Plant (AES) near Shady Point, Oklahoma, has been vital to the industry. In 2000, AES used more than 1,000,000 tons of Oklahoma coal to generate electricity and provide food-grade carbon dioxide.⁶ The AES plant is a coal-fired, fluidized-bed combustion power plant,

which uses Oklahoma high-sulfur bituminous coal and limestone to generate electricity in an environmentally safe manner. The average purchases on an annual basis by AES Shady Point is 65% of the total state coal production.⁷

Commercial coal mining began in Oklahoma in 1873 with the removal of bituminous coal from underground mines in eastern Oklahoma. Surface mining began in 1915. Like the oil and gas industries, the coal industry has experienced production cycles. Since 1969, the coal industry has had as few as eight active mines and as many as sixty. There is potential for Oklahoma's coal resources to provide the basis for economic growth; only the apex of coal resources has been exploited. Large bituminous and metallurgical deposits remain to be produced, but require large capital investments by sophisticated mining companies.

Identified coal resources are present in an area of approximately 8,000 square miles in eastern Oklahoma. The coalbeds are of Middle and Late Pennsylvania age, 0.8 to 10 feet thick, 0.4% to 6.5% in sulfur content, coking or noncoking, and contain 11,500 to 14,500 BTU. Oklahoma contains 8.09 billion tons of coal classified as identified coal resources determined by the Oklahoma Geological Survey. The amount of economically recoverable coal resources is estimated to be 1.58 billion tons of which 343 million tons are strippable.⁸

Production and market issues affect whether or not some coal reserves are economical to produce. Regulations concerning mining and reclamation requirements also play a role in limiting coal production. Federal regulations under development include a variety of measures requiring reductions in emissions of nitrogen oxide, sulfur dioxide, and mercury.

Future production of Oklahoma coal will hinge on development of additional markets for high sulfur coal and the increased use and development of clean coal technology at coal fired utilities both

within the state and in the surrounding area. State incentives will greatly enhance the present and future production of Oklahoma coal.

REBUILDING THE INFRASTRUCTURE

One of the greatest challenges facing Oklahoma in the near term is the need to rebuild an aging energy infrastructure. The energy infrastructure is comprised of a wide variety of components, each of which plays a role in the finding, producing, transporting and consumption of energy sources. Infrastructure includes not only such tangibles as pipelines and refineries, but also the basic human skills required for identifying and producing these resources.

The energy industry in Oklahoma has undergone massive changes in the past 20 years. The industry itself has seen a wild roller coaster ride of price changes, regulatory restructuring, acquisitions, mergers, bankruptcies and changing consumption habits. Yet the fundamental elements of the energy infrastructure have not kept pace with the increased need to get various forms of energy to its marketplace for consumption on a timely and efficient basis when it is needed.

For example, Oklahoma, like the rest of the country, has not been able to add oil-refining capacity to match domestic demand. The result has been the loss of market share to imported refined products. The electricity market has undergone radical changes as a result of partial deregulation. Natural gas has gone from a tightly regulated energy source to a largely deregulated commodity. Coal has come and gone in favor of other fuel sources.

It is important that as Oklahoma considers its energy future it takes into account the infrastructure improvements and expansions required to make energy available to its residents and consumers in other states.

Oil and Natural Gas Pipelines

The infrastructure for Oklahoma's oil and natural gas industry is as old as the industry itself, which

dates back to 1897 when the first commercial well was completed in the state. Oil and gas travel by pipelines and trucks from widely scattered points of production through a series of refining, or purifying, steps. The consumer-ready product ultimately travels again by truck, rail or pipeline to the point of consumption.

In many Oklahoma fields where oil and gas originate, production has been ongoing for decades. In some of these older fields, the primary production comes from marginally economic wells. As profit margins have grown thinner and thinner, maintenance budgets have been squeezed. There are continual challenges in ensuring the integrity of pipelines and other facilities. These systems themselves are a complex web of pump stations or compressor stations, control systems and thousands of interconnections, owned primarily by an army of small independent producers. Maintaining and ensuring the security of this complex structure will be an ongoing challenge.

In addition, oil producers face the prospect of increases in demand and changes in the destinations where petroleum must be delivered. Pipelines are inherently less flexible than other forms of oil transport. They are fixed assets that cannot be adjusted easily for capacity or changes in points of delivery. However, they are essential to the efficiency of the oil production industry. Pipelines are very efficient ways to move petroleum and petroleum products.

They are relatively inexpensive to operate and are generally quiet and safe. Insufficient domestic pipeline capacity has caused peak load problems in moving oil and petroleum products such as gasoline from one region of the country to another. Similarly, natural gas pipelines in some instances are insufficient to handle delivery of the growing demand for natural gas.

Virtually all natural gas in the United States is moved by pipeline. As Oklahoma strives to sustain and encourage economic development, the question of energy availability will become

increasingly important. The state's private and public sectors must work together to ensure that the natural gas pipeline infrastructure is sufficient to meet not only Oklahoma's consumption needs but our need to export large volumes of gas to out-of-state markets. The future very well may require that new pipelines be sited in Oklahoma.

A variety of state and local government offices, as well as the federal government, may control parts of pipeline siting. In some cases, siting a pipeline can take years to accomplish as a myriad of environmental, regulatory, and public perception challenges are addressed. Despite some of the difficulties in siting, these functions are best regulated by the states, which are more closely aligned with local interests.

Oil and Natural Gas Refineries

The U.S. demand for refined petroleum products, such as gasoline and heating oil, currently exceeds the domestic capacity to produce. Refineries in the state are running at or near full capacity during times of peak demand. Still, domestic refiners cannot fully supply the market. As a result, excess demand has been met by increased exports. Refineries in the state are subject to significant environmental regulation and will face new clean air requirements over the next decade. Requirements for lowering sulfur content in gasoline have caused substantial capital investments, thereby endangering the economic viability of these facilities.

For example, Conoco announced the decision to invest \$146 million in its Ponca City refinery to comply with new clean-air standards for fuel that take effect in 2004. Under rules adopted by the U.S. Environmental Protection Agency, the sulfur content in gasoline must be lowered to 30 parts per million (ppm) from about 300 ppm. The construction project will create as many as 600 jobs. Conoco said it secured \$ 20 million of a tax-exempt bond allocation from the Oklahoma Economic Development Bond Oversight Commission, which will lower the project's financing costs.

Due to low profitability and rates of return, there have been no major refineries built anywhere in the country for the past 25 years. Growth in refinery capacity has increased less than two percent per year, as a result of de-bottlenecking and incremental expansion of existing facilities.

Oil and Natural Gas R&D

It is vitally important for the domestic oil and gas industry to maintain a significant level of research and development to remain competitive in the world marketplace. This effort is an investment in the state's and the industry's future. In fact, technological advances might be the most important factor in ensuring America's non-renewable resources are fully developed. Unfortunately, the oil and gas field services sector ranked last in R&D expenditures as a percentage of sales among 19 industries surveyed in 2001 by Schonfeld† & Associates, Inc.

Oil field service companies and others are concentrating much of their research efforts on technology that make exploring for oil and gas more cost effective. At the present time, however, there is a lack of research focused on innovative ways to increase production from existing wells and reservoirs. This is of particular significance to Oklahoma because it ranks second nationally in both the number of and production from wells that produce 10 barrels of oil per day or less. At year-end 2001, there were more than 55,000 of these oil wells in the state.

In addition, Oklahoma ranks sixth in the number of gas wells that produce 60,000 cubic feet (mcf) or less per day. The state ranks third in the total gas produced from these low volume, marginally profitable wells.

Conventional, secondary and tertiary recovery technologies have improved recovery rates over the years. However, nearly two out of every three barrels of oil discovered in the United States remain trapped underground after conventional recovery operations. This staggering amount of remaining oil – approximately 200 billion barrels

nationwide – can be one of the state’s best sources for additional production.

New technologies are required to recover oil left behind because it is difficult to access or is held tightly in place within tiny rock pores.

Programs that create technology to improve recovery rates and lower finding and production costs translate into reasonable energy costs for consumers.

However, R&D cannot be turned on and off, but is a continuous process that builds upon its previous successes and failures. If the United States is to maintain its ability to produce its domestic supplies of oil and natural gas at a reasonable cost to consumers, state government, working with our universities and interested private companies, must fill some of the void left by major oil-producing and service companies, in particular the large multi-national companies, who have left the domestic oilfields.

Oil and Natural Gas Manpower

In the past 20 years, the oil and gas industry has faced great difficulties in finding and retaining adequate manpower to function safely and efficiently. The difficulty is traced to the uncertain nature of the industry itself. Boom and bust cycles have resulted in uncertain employment prospects even for the most skilled oilfield workers.

Research cutbacks have eliminated many of the scientists associated with oil and gas exploration and production.

Competition in technical fields such as geology, geophysics, and engineering has resulted in a dramatic decline in the number of students pursuing petroleum engineering degrees.

These challenges and others have made it difficult for companies to find and retain the quality employees necessary for efficiently exploring for, producing and refining oil and gas.

The issue has grown too complex and too critical for the industry to solve on its own. Solving the problem will require more than simplistic solutions aimed only at finding workers.

Security

There are thousands of miles of unguarded pipelines crisscrossing Oklahoma. There are several, well-lit refineries and oil-storage facilities in the state. There are in fact billions of dollars in assets at risk.

Since the Sept. 11, 2001 attacks, the industry has implemented heightened security procedures that restrict access to certain facilities, increasing surveillance at key facilities, increasing the use of employee access cards and control and stepped up the dialogue with appropriate law enforcement agencies.

On the other hand, some energy producers have no security measure whatsoever. Protecting the infrastructure of the energy industry is fundamental to energy security.

Public Education

At the risk of redundancy, a key to the state’s energy future is a citizenry well educated in the issues surrounding the oil and gas industry and other slices of the total energy pie. Energy is the single largest contributor to the state’s economy and has been a cornerstone of the state’s development for more than 100 years.

It would be difficult to “over-educate” the public on the challenges facing the state in terms of retaining its leadership position in the nation’s oil and gas industry. Oklahoma can ill afford to lose the billions of dollars that oil and gas pump into cities and town, farms and schools and trickle down to virtually every retail sector in the state. Constantly educating the public is essential to the task of implementing any strategic energy initiatives.

Ensuring that Oklahomans of all ages recognize the value of a vital oil and gas industry is good for the state.

Electricity

The electricity infrastructure includes a number of generating facilities located throughout the state and a grid of transmission lines that move electricity intrastate and to the national grid for regional delivery. Oklahoma generating plants are fueled by natural gas, coal, oil and hydropower. Fossil fuel-powered plants need a reliable transportation system that permits the delivery of fuels as necessary. A transportation network for waste disposal is also necessary for power plants that create by-products.

Major restructuring has occurred within the electricity industry over the past 20 years. Vertically integrated electric utilities that provided generation, transmission and distribution services to distinct areas have begun to change. In many parts of the country, utilities have “unbundled” the generation, transmission and distribution services. The result has been the creation of competition and uncertainty in an industry that had been tightly regulated.

More electricity is being shipped longer distances over a transmission system that was initially designed only to provide limited power and reserve sharing among neighboring utilities. Independent power producers have stepped into the market and now compete with established generating facilities operated by utility companies.

Oklahoma appears to be well positioned as a location for independently owned, gas-powered generating facilities. Within the past two years, there were 16 gas-fired power plants either under construction or in the permitting process, although construction on only six is being continued. These plants were intended to convert some of Oklahoma’s abundant supply of natural gas to electricity for export to out-of-state markets.

These options seemed viable as long as energy traders such as Enron were present in the marketplace to link generators with end-users. Independent generators have recently had to rethink business strategies and subsequently have

cut back on aggressive plans for adding generating capacity. Until stability returns to the electricity industry, there will be little incentive to build additional generating capacity.

Electricity - Transmission

Electricity transmission constraints have led to power disruptions at several locations in the country. With deregulation have come questions about transmission reliability and the impacts on a society that has become increasingly dependent on electricity at both work and home.

Power availability and reliability are very important concerns for the state’s economic development. Transmission facilities are a key to reliability and flexibility. Under current law, the siting of transmission facilities is a function of state and local government entities where the views of local citizens can be raised. These facilities must be adequate not only to provide intrastate electric power delivery, but also permit exports to other states.

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FOOTNOTES

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Recommended Strategic Initiatives

Robert Sullivan, Jr., Secretary of Energy, Keating Administration, State of Oklahoma

Oklahoma's Oil and Natural Gas

1. State government should strengthen old incentives and develop new ones for the oil and gas industry to initiate and apply new technologies that will lower finding and producing costs of our extensive known remaining oil and gas reserves.
2. Oklahoma's energy industry, state government, and academic institutions should improve and develop interactive programs that will result in the more effective application of technologies to the pursuit of new oil and gas reserves and production.
3. A critical review of taxes of all kinds should take place with an eye toward ensuring that Oklahoma is a tax-friendly environment for energy companies to pursue the state's energy resources. Tax items such as credits for capital investment on energy projects, accelerated depreciation for energy-related capital expenditures, tax credits for fuel efficiency programs, and a review of ad valorem tax treatment for producing facilities are examples of areas that should be considered for improvement.
4. Strong incentive programs for secondary and tertiary oil recovery projects should be established or improved to encourage the recovery of additional oil reserves known to exist in older reservoirs.
5. The Oklahoma Corporation Commission's exclusive jurisdiction over all oil and gas regulation should be clarified to ensure that producers can interact with a single agency in all regulatory matters that affect their operations.
6. Legislation should be adopted to assure that recently deregulated natural gas gathering facilities are operated in a manner that does not curtail production or penalize gas producers. Producers should have access to gatherers' information that will allow a review process through the Oklahoma Corporation Commission if producers can demonstrate that gathering rates are punitively high in a specific locale.
7. All plugging and other regulations governing marginally productive oil and natural gas wells should be reviewed to provide, to the extent possible, for the extended lives of these assets so that enhanced oil recovery projects in the future can be encouraged.
8. Creative incentives should be developed to encourage large-scale projects on both state-owned and privately-owned minerals designed to develop exploratory activity on heretofore dormant producing areas.
9. Private sector stakeholder groups (producer associations, royalty groups, and surface owner representatives) should strive to achieve a better understanding of each other's respective needs and concerns in order to reduce potential conflicts in the pursuit of the state's resource development goals.
10. The state should take the lead in resolving a growing number of issues involving water rights so as to reassure the energy industry that such conflicts will not impede the state's private sector resource development goals.

Renewable & Alternative Energy

11. Encourage the development of the electricity grid system to serve areas of the state where wind energy and solar energy are abundant.
12. Given its vast wind and solar resource base, Oklahoma should encourage and lead research in these fields to make them economically competitive with other energy sources.
13. Private/public consortiums should be developed, with our higher education institutions taking the lead, to accelerate the establishment of Oklahoma as a vast "outdoor laboratory" for wind and solar energy development.
14. The state should establish a competitive incentive package designed to attract and grow wind power companies to Oklahoma.

15. Oklahoma should strive to establish itself as a research base for the growing solar power industry, given the knowledge base housed in the state's universities and our 300+ days per year of solar sourcing.
16. Oklahoma should take an active role in assisting in the federal relicensing process of its seven hydropower plants in the state as they come up for renewal.
17. The state should seek private sector involvement in developing an aggressive plan for capitalizing on the huge state potential for biomass-based electricity generation.
18. An effort should be made to expand Oklahoma's Bioenergy Initiative with an emphasis on forging partnerships with Oklahoma's private energy sector, as well as agriculture producers, forestry companies, and other natural resource industries to develop effective partnerships with new, coordinated R&D programs.
19. Oklahoma needs to develop a sound strategy for advancing both bioenergy and wind energy projects in Oklahoma with particular emphasis on complementing and augmenting existing electricity generation from coal and natural gas fuels (e.g., co-firing, supplementing and peaking, etc.).
20. The state would be wise to develop an economically based program for increasing demand for alternative fuel vehicles, including the demand for Oklahoma-produced alternative fuels (ethanol).
21. The advent of national, even global, Renewable Energy Credit (REC) programs is imminent. If Oklahoma is to compete in the markets for renewable energy and RECs, we must cause in-state transmission grid upgrades and encourage regional upgrades in transmission connectivity.
22. Oklahoma should pursue and establish a carbon sequestration program to reduce the levels of harmful carbon compounds in the atmosphere.
23. As a state, we need to foster the expansion and creation of organizations that accomplish significant environmental enhancement through voluntary/public-private partnerships, using the Clean Cities programs and the Oklahoma Energy Resources Board as models.

Rebuilding the Infrastructure

24. It is suggested that the governor initiate efforts to organize and expedite the activities of all state and local pipeline permitting entities for the purpose of coordinating and monitoring the permitting process and encouraging prompt approvals.
25. The state should consider a lead agency that would have authority to monitor permit processing schedules.
26. The state's Department of Commerce should be involved with the coordination effort and recommendations to streamline permitting processes.
27. The state should consider establishing a special task force of environmental experts to focus and coordinate all environmental issues stemming from a proposed major pipeline.
28. The state should encourage research spending, including public and private dollars, to improve and develop pipeline installation techniques that cause minimal surface damage, and are safer and quicker.
29. The state should encourage increased education and information sharing with the public regarding pipeline issues.
30. The state should support research and development efforts directed at issues of pipeline maintenance and safety, such as corrosion prediction, protection and mitigation; inspection methods and tools; defect detection; and pipeline data management, integration and analysis.
31. The state should review pipeline ad valorem taxes with an eye toward providing incentives for pipeline owners and operators to maintain and modernize this key infrastructure system in Oklahoma.

Oil and Natural Gas Refineries

32. The state should work toward providing more regulatory certainty for refinery operators and streamline permitting processes where possible.
33. The state should assist the refining industry when appropriate in educating the public regarding the critical nature of refinery operations in providing energy products for the country.

Oil and Natural Gas R&D

34. Re-energize the research and development component of the oil and gas industry in Oklahoma by playing a leadership role in finding appropriate R&D funds, promotion and provision of tax incentives.
35. The state should encourage cooperative private-public research and development to address reserve recovery issues in the oilfield.
36. The state should consider supplying seed or matching monies for projects that encourage maximizing oil-recovery rates or minimize production costs for marginal wells.
37. Through the university system, Oklahoma should encourage applied research on oil and gas production challenges and cost barriers.

Oil and Natural Gas Manpower

38. As part of a broader energy strategy, the governor should consider creation of a blue-ribbon task force to study the personnel situation in Oklahoma and develop ways to combat the effects of the industry's cyclical nature upon the workforce.
39. The state should encourage the industry to implement non-traditional programs to generate interest in careers in the energy industry.
40. Our major universities must find ways to encourage the creation of research opportunities for students who are interested in the petroleum sector by creating meaningful internship programs at our universities.

Security

41. Oklahoma must develop cooperative efforts to improve the security of energy facilities by working with appropriate law enforcement agencies and industry.
42. We must create a heightened sense of awareness among the public concerning the threats to energy facilities and providing appropriate response mechanisms.

43. Public/private education efforts, such as those presented by the Oklahoma Energy Resources Board, should be created and encouraged. Private sector leadership is critical to the success of these efforts.

Electricity

44. Oklahoma needs to continue to work toward establishing an electricity regulatory climate that is stable, considers the needs of industry and consumers, and fits the regional and national picture.
45. We should promote Oklahoma's strength in terms of gas supply for potential new generating facilities.
46. We should reexamine the status of deregulation nationally and its impact on Oklahoma's generating capacity.

Electricity Transmission

47. State leaders need to be certain that Oklahoma is moving toward increased transmission line reliability.
48. Oklahoma must work with neighboring states on the issue of interstate connectivity and compatibility.
49. We must preserve the state's authority over siting issues.

Coal and Electricity

50. Oklahoma's state leaders should work with the Department of Mines and private mining companies to encourage market development of high sulphur coal uses.
51. State officials should provide assistance to Oklahoma coal producers to mitigate several federal regulations that presently curtail the state's coal production.

Oklahoma Natural Gas: Past Present and Future

Dan T. Boyd, Oklahoma Geological Survey. Reprinted with permission from Oklahoma Geology Notes, Winter 2002, pages 143-155.

Editor's Introduction:

Natural gas surpassed oil in economic value decades ago. It is the principal driver and bedrock of Oklahoma's energy industries.

This published article is the definitive examination of the role of natural gas in our state culture, economy and ethos. This article has been edited for this Academy Town hall. We have eliminated some of the scientific and technical discourse that would be difficult for the layperson; and we have eliminated a significant number of charts for publishing practicality.

Nevertheless, the text published here will provide ample information concerning natural gas.

Oil ... and Gas

Oil put Oklahoma on the map.

This is true both figuratively and literally, as in 1907 oil was the driving force behind turning the Oklahoma Territory into the State of Oklahoma. Industry's early success in finding abundant oil, and later natural gas, has made these our primary sources of energy. Relatively inexpensive energy is one of the largest factors responsible for the unprecedented levels of prosperity now enjoyed by the United States and the rest of the developed world. Although both U.S. and Oklahoma oil and gas production are past their peak, we continue to be a key producing state, ranking fifth nationally in oil and third in natural gas.

Natural gas is especially important to Oklahoma because it alone maintains a positive State energy budget that would otherwise be strongly negative. In spite of our national ranking, oil consumption in Oklahoma is about 50% higher than production,

and local coal production accounts for less than 10% of State consumption. For oil, the possibility of discoveries that could significantly impact State production declines (Boyd, 2002a). Coal in Oklahoma is another resource that has largely been defined, but in order to meet strict sulfur-emission requirements, the vast bulk of coal burned in the State now comes from Wyoming. In marked contrast, gas exploration and development can bring large rewards.

Oil and gas are formed by alteration of microscopic organisms that are deposited with the sediment that composes sedimentary rocks. The sediment and organic remains reach maximum thickness where they accumulate in large, gradually subsiding depressions called geologic basins. With increasing temperature and pressure that result from increased burial depth, organic remains slowly change into oil and natural gas.

Those compounds consist dominantly of hydrogen and carbon, and hence are called hydrocarbons. As oil and gas are less dense than the water in which the sediment was deposited, where permeable rock permits they migrate upward. The upward movement ends where impermeable rock blocks the migration path, creating a seal that may form a hydrocarbon trap. A key factor in the extent and sealing ability of the petroleum accumulation thus formed is the extent and sealing ability of the impermeable rock.

Gas is almost always associated with oil, as it represents the lighter chemical fraction (shorter molecular chain) formed when organic remains are converted into hydrocarbons. Therefore, in addition to being found underground as discrete gas reservoirs, much natural gas is also found dissolved in subsurface oil. As this oil is brought

from reservoir conditions to the surface, and its pressure is reduced to the atmospheric level, dissolved gas comes out of solution much like carbonation from a soft drink when the cap is lifted.

Section omitted.

Regardless of the type of source rock involved or the relative volumes of oil and gas that are initially generated, temperatures and pressures invariably rise with increasing burial depth. As the thermal energy in a subsurface system increases, the longer-chained hydrocarbons present in oil begin to break into progressively smaller pieces.

Eventually a critical depth is reached below which liquid hydrocarbons are no longer stable. Although oil cannot exist anywhere below this critical depth, natural gas can still be present in large quantities. This is important for Oklahoma because many of the State's source rocks and reservoirs are, or were in the geologic past, located below the depth at which oil is stable. The combination of deep sedimentary basins and a source rock chemistry that is dominantly gas-prone has made large parts of Oklahoma almost exclusively gas producing.

Section omitted.

Early History

Natural gas has always been found in conjunction with oil exploration, which in Oklahoma began late in the 19th century. In the early days, gas was usually looked upon as a nuisance or a drilling hazard, and when encountered it was vented until it was determined whether oil lay below the gas. If only gas was produced, the well was usually plugged and abandoned. (Plugging usually means placing cement in a borehole to keep subsurface fluid from moving to the surface or from one permeable rock layer to another.) Abandonment is the final act in the life of a well, and usually ensures that the well can never be used again.

However, if the well eventually started producing oil as well as gas, it was treated as an oil well, with any associated gas either vented into the atmosphere or flared (i.e. burned). It is impossible to say how much gas was lost then, but Beebe (1962) has estimated the volume vented or flared in Oklahoma at 500 billion cubic feet (BCF).

Initial gas activity in Oklahoma was restricted to the northeastern part of the State. It began in 1894 when Cudahy Oil Company drilled two wells in the Muskogee area, each with commercial gas shows. Neither well produced gas, for no local market existed. However, in 1901 gas from two wells completed in the Red Fork and was sold to a brick plant in Tulsa, marking the first commercial use of natural gas in Oklahoma. After this milestone, gas production was added in Bartlesville-Dewey Field (1904), Glenn Pool Field (1905), Hogshooter Field (1906), Boynton Field (1910), and Cushing Field (1912). Depew Field, which began producing gas in 1912, was converted to storage in 1951. With 63 BCF of capacity, it was the largest gas storage facility in the United States (Koontz, 1962).

In 1906 the Oklahoma Natural Gas Company, today the State's dominant supplier, was formed to deliver gas to the Oklahoma City Market (Moore, 1962). At the time, gas fields were near the towns they served, but, as demand climbed and nearby wells were depleted, the industry was forced to rely on more distant sources of supply. Despite a rapid increase in gas drilling and reserve additions due to a spate of discoveries in the late 1920's, it was not until the Anadarko and Arkoma basins and shelves (including the panhandle) were exploited in the middle of the 20th century that reserves began to grow exponentially.

The earliest years of the Oklahoma gas industry were sustained by small accumulations associated with shallow oil fields on the Cherokee Platform in the northeastern part of the State. Throughout most of Oklahoma's history an abundance of cheap oil made it the fuel of choice, keeping the demand for natural gas low, and thus its price and drilling

activity. Another factor was the regulation the regulation of natural gas by the federal government through 1978, which kept oil prices low relative to oil. Also underlying low demand in the early days was a lack of pipelines. Although crude oil can be transported anywhere there are roads, gas requires a gathering system that usually entails huge up-front costs.

In a classic Catch-22 scenario, the economic justification for a pipeline requires that a threshold of production rate and reserves be met, and that, in turn, means money must be spent in drilling wells. However, even if the wells justify the expenditure, they must remain shut-in (generating no cash flow) for a prolonged period during construction of the gathering system. Once this hurdle is overcome and pipelines are in place, drilling and production commonly increase exponentially. Drilling success then spurs expansion of the system, which in turn opens more-distant areas to exploration and development.

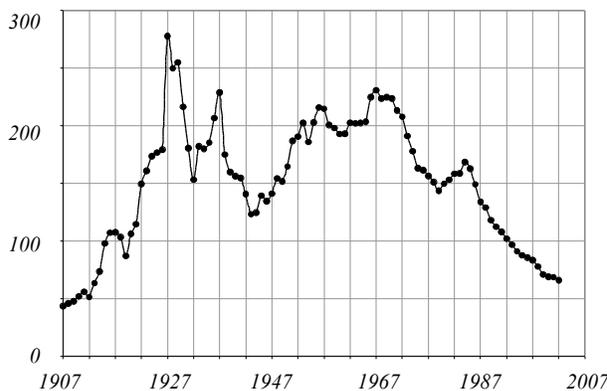
Despite early difficulties, all major gas fields in the greater Anadarko and Arkoma Basins were discovered before natural gas deregulation. Some of the fields were discovered quite early, but they were not close to main populations centers. As a result they were usually not fully developed (or their size appreciated) until much later, when gas became a primary drilling objective rather than an unintended consequence of oil exploration.

Recent History

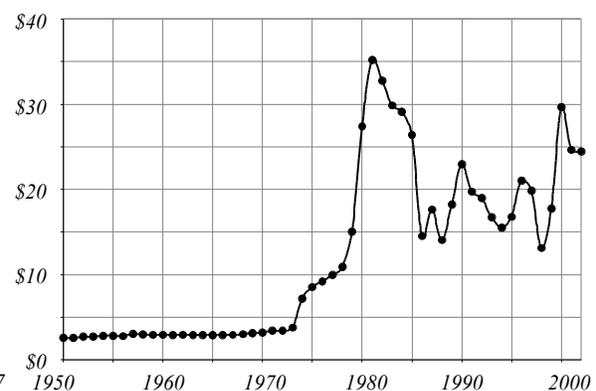
Although commercial gas production in Oklahoma began in 1901, annual production did not begin growing until the 1940s (Claxton, 2001). Growth continued through the early 1960s, with production rates more than doubling between 1960 and 1970. As measured by the standard average energy equivalence of 6 thousand cubic feet (MCF) per barrel (42 U.S. gallons) of oil, Oklahoma's primary production shifted in 1963 from oil to gas. The change occurred despite the fact that oil production in 1963 was still well over 500,000 barrels per day. In the year 2000, Oklahoma's cumulative production of gas (measured in sales) exceeded cumulative oil for the first time. Although these are important milestones, the critical point is that natural gas has been Oklahoma's primary energy resource for almost 40 years. In addition, because oil production has declined to one third of the level in 1963, and is still falling, the importance of gas in the State's energy mix continues to increase.

As is true of any commodity, the effort expended in the search for natural gas has increased as its value increased. The wellhead price (the price received by the operator) remained low and changed little during the first 73 years of commercial production in the State. Then in 1974, for the first time, the price of natural gas began rising more than a penny per year. The change resulted from the deregulation of gas prices, which

Production of Oil in Oklahoma
(millions of barrels)



Price of Crude Oil
(average annual price, dollars per barrel)



hitherto had been part of an elaborate system that kept interstate below intrastate prices. This caused shortages to develop in gas-importing states, while surpluses were generated in major gas-producing states such as Oklahoma.

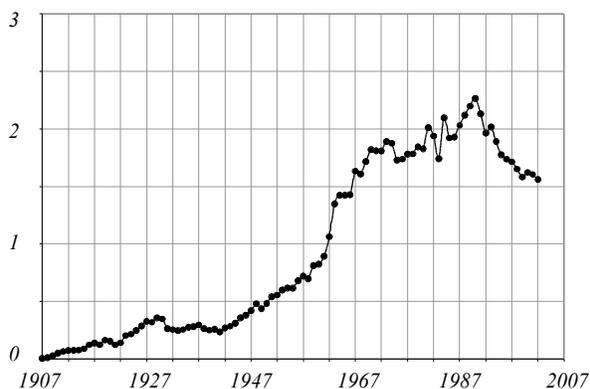
In response, the Natural Gas Policy Act was enacted in 1978 to deregulate the price that pipeline companies paid for gas, and the average annual price of gas rose from 23 cents per MCF in 1974 to \$1.49 in 1980. The rapid increase is significant because it encouraged gas-targeted exploration and development and because the 1980 price has essentially remained the floor price for gas ever since. In the succeeding 21 years, the average annual wellhead price for Oklahoma natural gas was lowest in 1995. The value, \$1.43 per MCF (unadjusted for inflation), is about the same as in 1980. Even in constant dollars this historic low still exceeds the price through most of the State's history.

However, it must be emphasized that the average annual price is not the net value realized by gas producers, and it in no way conveys the degree of volatility with which operators must contend. In any given year, the price low can be a fraction of the annual value shown. Although they average out in the long term, successful operators must be able to weather many short-term dips in price.

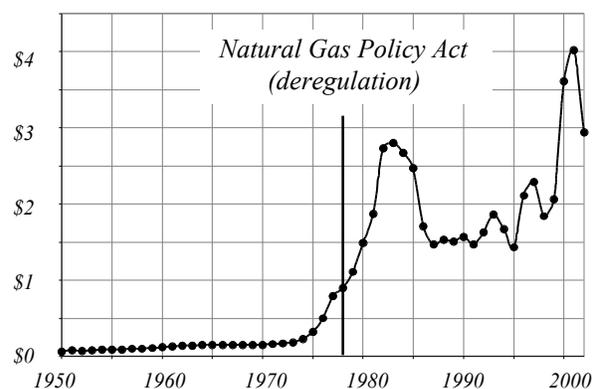
As we might expect, the number of wells drilled for gas has closely tracked the gas price. After the Arab oil embargo of 1973, which sent oil prices to record highs, the resulting increased demand for gas helped push prices higher for this commodity too. A combination of domestic deregulation and international politics precipitated a large increase in completions of gas wells from 1977 through 1985, a peak period in the last important drilling boom (Boyd, 2002a). However, with deregulation and eased political tension, market forces gradually have resumed control – resulting in moderate to low prices that suppressed gas drilling activity from 1986 through 1999.

Mirroring a dramatic rise in gas prices in 2000 (above \$3.50 per MCF) and 2001 (above \$4.00), the number of gas completions recorded for those complete calendar years was the highest in the State since the early 1980s. Many factors were responsible for this increase, primarily the markedly higher oil prices in the same period. Upward pressure on the price of natural gas continued as the industry found itself unable to keep pace with peak seasonal demand. Because gas storage facilities and their high delivery rates are key to meeting demand in winter, when storage levels drop significantly, concern for supply is heightened, and prices rise.

Production of Natural Gas in Oklahoma
(trillions of cubic feet)



Price of Natural Gas
(dollars per MCF)



Section omitted.

Potato Hills

An example of an important conventional gas discovery in Oklahoma is the Potato Hills Field, which is in a structurally complex area of southeastern Oklahoma. It was a marginal producer from its discovery in 1960 through January 1987, when it went off production after making less than 1BCF of gas. There was no further activity in the area until 1997, when a well drilled in the same section as a dry hole drilled in 1961 established new gas production in the Jackfork Sandstone and initiated a spate of drilling that continues today. Since recently drilled wells sent on lone in late 1998, Potato Hills has produced more than 100BCF of gas. Although production appears to be in decline, in the first 4 months of 2002 the field still produced an average of 61 million cubic feet (MCF) per day. The production added by Potato Hills Field is among the most significant in decades. As the State has nearly 500,000 wells, entirely new discoveries have become increasingly rare. However, this field shows that Oklahoma's gas potential, even in areas that have been drilled intensively, is still far from fully defined.

Coalbed Methane

A non-conventional gas resource, coalbed methane, is a comparatively recent addition to Oklahoma's energy mix. As plant material is heated and compressed into what will eventually become coal, methane is released. The generation of methane turns coal into a source rock from which gas sometimes migrates into adjacent, permeable rock (such as sandstone) where the gas can be produced as in a conventional reservoir. More often, the gas has no way to escape and stays locked in the coalbed.

Section omitted.

The coalbed-methane play in Oklahoma is little more than 10 years old, and continues to be quite active. Because the productive coals have been penetrated many times by deeper wells targeting

conventional oil and gas, the location, depth, and thickness of prospective coals are usually well established. The principal unknown is producibility – the rate at which gas will flow from the coal – but cannot be ascertained until the well has been drilled and completed.

Section omitted.

At mid-2002, about 2,000 coalbed-methane wells had been drilled in Oklahoma (Cardott, 2002), with new ones being added at a rate of about one per day. As coalbed methane is not distinguished from conventional gas, it is difficult to estimate its contribution to State production. However, if initial production is 60 MCF per well per day (Cardott, 2002), Oklahoma's production at the end of 2002 is about 120 MMCF per day, or about 44 BCF per year. Although this represents slightly less than 3% of the total gas production for the State, large prospective coalbed-methane areas remain undrilled or under-drilled. Consequently, coalbed methane's share of the State's natural gas production will undoubtedly continue to increase. Shallow, low-cost coalbed-methane wells are suited to the small operators that dominate in Oklahoma. Although stabilized production rates are typically low (50-100 MCF per day), risk of a dry hole is low because the targeted coals are pervasive. In addition, coal acts as both reservoir and source rock, so areas with methane potential are vast. Another incentive for some operators is a federal tax credit applied to coalbed methane. As part of the Crude Oil Windfall Profits Tax Act of 1980, the credit (Section 29) was designed to encourage production of non-conventional fuels. These include shale oil, tar sands, tight gas, and coalbed methane.

Areas that produce coalbed methane in Oklahoma include parts of 15 counties on the eastern margin of the Cherokee Platform and the northern half of the Arkoma Basin. IN 1995 the USGS estimated the mean, proved coalbed-methane reserves for the Cherokee Platform and Arkoma Basin at 4.6 TCF. Although these provinces (and reserves) are shared by Kansas and Arkansas, the estimate demonstrates

the magnitude of the coalbed-methane play. Judging by experience in other basins, as drilling and production continue, estimates of coalbed-methane reserves will likely rise markedly.

Drilling and completion activity is an excellent indicator of the industry's focus on adding reserves. Changes in price, success rate, economics, tax incentives, and technology are all reflected in these data that show where the money has gone. In the last half century, the percentage of wells completed as dry holes in the State has fallen from almost 40% to under 10%. This shows that as well density has increased and the number and size of productive fields has grown, dry-hole risk has fallen and drilling has become more developmental in nature.

We could infer from the current dry-hole percentage that the areas with the lowest risk have been drilled, and that risk-to-reward analyses make most of the undrilled areas unappealing. Exclusive of enhanced recovery projects, the reserve size of new oil prospects is almost universally low. However, because gas can exist at greater depths than oil and flow from less-permeable rock, it is still possible to find important new reserves of natural gas in densely drilled areas. Also, the value of gas, relative to oil, has increased, prompting the percentage of gas-well completions in the State to rise dramatically, from less than 5% in 1957 to nearly 70% today. Well completion statistics clearly show that the industry in Oklahoma has undergone a pronounced change in focus, mostly in the last 15 years, from oil to gas.

If completion marks the birth of a productive well, then abandonment marks its demise. From 1971 through 2001, former oil wells accounted for more than 80% of all abandonments. In that period about 47,000 oil wells were plugged and abandoned, compared with about 11,000 gas wells. Not only are more gas wells being drilled each year in Oklahoma, but proportionately fewer are being abandoned. However, past drilling was so strongly directed toward oil that, despite recent activity, at the end of 2001 the ~84,000 active (unplugged)

oil wells in the State still greatly outnumbered the ~33,000 active gas wells.

Section omitted.

Clearly, in order to maintain production volume, wells must be kept active as long as possible. In 1992 the Oklahoma Legislature created the Oklahoma Commission on Marginally Producing Oil and Gas Wells for the express purpose of helping producers manage marginal oil and gas wells. The program was designed to help operators weather the inevitable price dips, and to minimize the long-term production decline. In addition, the Oklahoma Geological Survey offers low-cost geologic-play-based workshops and other programs to aid operators. Survey programs help identify practical techniques and technology for finding new fields, as well as means of efficient production in existing fields. They give local operators access to regional studies, technical insights, and resources usually available only to large companies. An example is the series of workshops coordinated by Brian Cardott designed to benefit Oklahoma's numerous small coalbed-methane operators.

Where Do We Stand Now?

The bulk of Oklahoma's energy production and more than 70% of its drilling focus on natural gas. Drilling in the State today, especially exploratory, is dominated by wells with gas objectives. The result is that from 1901 through mid-2002 a staggering 90 TCF of natural gas was produced and sold. However, the health of the industry must be measured by the volume of hydrocarbons that remain to be produced – the remaining reserves.

That leads to the question: How much is left?

Estimating ultimate remaining reserves is difficult because it requires accurate knowledge of resources in the ground, as well as long-term price forecasts. This requires foreknowledge of demand, technical innovation, political stability, and other factors that may affect economics and is why

predictions of remaining reserves can change dramatically from year to year. This complexity has led the industry to use a tiered system of estimates designed to convey differing levels of uncertainty. Although names and definitions commonly vary from company to company (a variety of subcategories also exist), reserves commonly comprise three tiers.

Reserves

The top tier is called proved reserves; it is the key volume because its low technical and economic risk allows it to be given a monetary value. Proved reserves are defined by the EIA as the volume that geological and engineering data demonstrate with reasonable certainty to be recoverable from known oil reservoirs under existing economic and operating conditions. Other reserve categories that may eventually be upgraded to proved are, in increasing degree of uncertainty, probable reserves and possible reserves. Because all reserve categories are defined by analog production and subsurface data, they are understood better than any of the statistically defined categories under the heading of resources.

Because of the volume and complexity of data involved in thoroughly analyzing the thousands of fields and hundreds of formations that produce gas in Oklahoma, the EIA calculates remaining reserves by simply asking operators for their reserve volumes and then totaling the numbers reported. Assuming that operators do not invoke unrealistic recovery assumptions or price forecasts, such an analysis should give the minimum volume recoverable based on wells producing from known reservoirs in a particular year. However, the estimate reveals nothing about the impact of new discoveries, increased drilling, higher recovery in low-permeability reservoirs, new technology (in drilling, completion, and production), non-conventional gas such as coalbed methane, or changing prices.

We must remember that remaining (proved) reserves, when added to cumulative production, are not meant to approximate ultimate recovery.

All types of reserves change continuously, the only certain reserves being those that have already been produced. To give an example, in 1946 Oklahoma's estimate of proved gas reserves was 10.1 TCF, an estimate that rose steadily to 18.3 TCF in 1962. But since 1962 more than 72.5 TCF has been produced, four times the proved reserves estimated in 1962. Clearly, the gas resource volume from which reserves come is finite. However, from year to year a combination of factors including new discoveries, greater efficiency in recovery, and higher prices, has repeatedly forced upward revisions in estimates. From 1977 through 2000, reserves ranged from 12.5 to 16.7 TCF, with peak years in the 1980s, during and just after the last major drilling boom. For the same period, gas production ranged from 1.6 to 2.3 TCF per year.

Where proved reserves go up from one year to the next, the volume increase is in addition to that year's production. The actual swing in ultimate-recovery estimates from one year to another is much larger than the graph suggests. Throughout Oklahoma's history the estimates of ultimate gas recovery have always gone up. However, when estimates rise more slowly than production, proved reserves go down, and this is shown as a net negative year for the State. For example, in calendar-year 1999 additions totaled 0.5 TCF. Because production for the year was 1.6 TCF. In the following year, reserve additions totaled 2.7 TCF; when offset by that year's production of about 1.6 TCF, the net-reserve addition was 1.1 TCF, essentially balancing the previous year's net-reserve loss.

A common measure of reserve life is a comparison of reserve volume to production rate, usually expressed as the R/P ratio. This is the length of time that proved reserves can sustain the current production rate with no decline. For example, a state with 10 TCF of reserves that is currently producing them at 1 TCF per year has an R/P ratio of 10. Since 1977 for Oklahoma the ratio has averaged 7.7 years, ranging from a high of 9.3 years in 1983 to a low of 6.6 years in 1993. Based

on the most recent reserve estimate (year-end 2000), Oklahoma's R/P of 8.5 years is above the 25-year average. However, we certainly have no reason to become complacent, as the main factor keeping reserve life stable is the State's declining production rate. With production always at 100% of capacity, gas rates have slid from 1.9-2.3 TCF per year in the 1980s to 1.6-1.8 TCF per year since 1995.

Gas, unlike oil, has had no discernible long-term decline in annual estimates of the State's reserves. Although Oklahoma's production rate is clearly declining in the long term, two years of increased prices and attendant higher drilling activity have, at least temporarily, slowed the decline. How long current production rates can be maintained is impossible to determine, but if prices stay high, drilling should increase, and the inevitable long-term decline in production should be reduced. Price reductions do not usually cause gas wells to be shut-in, but they do slow the rate at which new wells are drilled. Because a new well typically has a steep initial production decline, less drilling invariably leads to lower gas deliverability. The resulting reduction in supply then pushes prices higher, usually dramatically so.

In 2001, Oklahoma's annual gas production of was about two thirds of the peak rate in 1990. However, because the gas price in 2001 was more than two and a half times that in 1990, its gross value of \$6.5 billion far exceeded 1990's \$3.5 billion. Even adjusted for inflation, 1990's record gas production was worth \$1.9 billion less than 2001's production. This illustrates how the annual value of gas to the State of Oklahoma depends far more on its average price than on how much is produced. Much of the fall in State revenue for 2002 (relative to 2001) can be directly attributed to lower gas prices and proportionately lower tax revenues. The price of oil and gas, especially gas, is critical to Oklahoma's economic future.

The Future

The continued vitality of Oklahoma's natural gas industry relative to oil is due to many factors. The initial large-scale exploration of gas occurred more recently than for oil, so proportionately more gas is left. From a regional perspective the State has more gas-than oil-prone areas, and many areas where drilling is sparse also tend to be strongly favorable for gas. In addition, gas can exist at much greater depths and flow through less-permeable rock, so that even where drilling is dense there are large areas in which deeper reservoirs are incompletely evaluated. At shallow depths in the eastern part of the State are many productive coal seams that have been penetrated by thousands of wells with deeper objectives. Although once ignored, the coal has now added important reserves and production to our natural-gas mix.

The primary factor affecting the health of Oklahoma's natural gas industry will always be price. Although we have little control over the value of gas, we can influence how much we produce. The most direct way to increase gas production is to discover large, long-lived fields. As history has shown repeatedly, in the early stages of exploration in a hydrocarbon-rich state like Oklahoma new discoveries are not difficult. Then, as more wells are drilled, large discoveries become less frequent. But even now the industry is not so mature that large gas reserves cannot be added.

In some parts of the State, both productive and unproductive, reservoirs with gas potential remain underexposed or underdeveloped. Due to their geologic complexity and corresponding high risk, they may be largely untested. Or they may require only proper techniques of drilling, completion, or production to become viable. Although the State's gas production and reserves are declining, both

conventional and non-conventional additions continue to be made. The Potato Hills Field is an example of a large, conventional accumulation, recently identified. Coalbed-methane recovery is a non-conventional play that is adding important reserves.

So new reserves continue to be added. However, generally low production rates for individual wells and steep declines mean that high levels of drilling activity are necessary to sustain Oklahoma's gas production. When drilling declines, reserves and production rates drop, as they did after 1990. In 2001 the EIA estimated proved reserves for the entire Mid-continent at 58 TCF. Perhaps more important, the agency also estimated and technically recoverable gas resources (both conventional and non-conventional) in the same region at 250 TCF. Although not all of this can be assigned to Oklahoma, the estimate does suggest that our area has at least four times as much undiscovered, recoverable gas as proved reserves.

These facts are encouraging, but as with any other commodity the primary driving force in the Oklahoma gas industry is economics.

Any forecast presupposes that the industry will not be hurt by a price reduction that suppresses drilling for an extended period of time. Increases in demand show no sign of abating, and national and State production, even when drilling activity is high, struggles to stay flat. Even if we disregard warm winters, global warming, and fluctuations in gas storage volumes, a large long-term price drop seems unlikely. Although such an occurrence could devastate the gas industry, as well as the State's overall budget, the resource must be produced eventually.

Gas is environmentally friendly, relatively abundant, and its infrastructure can support substantial growth in the market. Oklahoma's location, geology, resource estimates, pipeline system, and the energy industry's strong history, all ensure that gas will be a key component of the State's economic future well into the 21st century.

Acknowledgments

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Our Energy Industry
The Changing Role of Oil & Gas

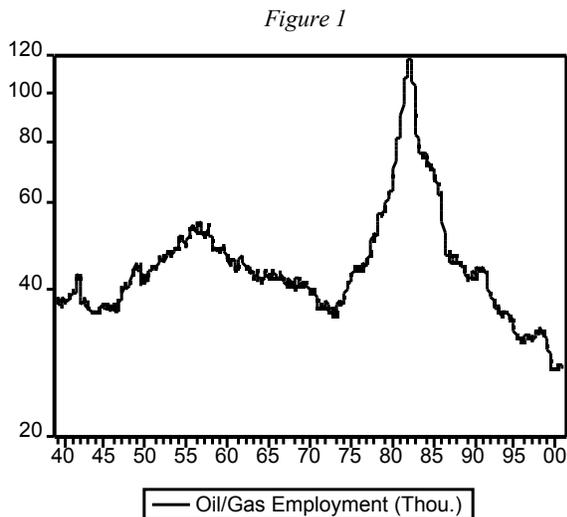
Mark C. Snead, Research Economist, College of Business Administration, Oklahoma State University

Introduction

The historical dependence of the state economy upon the oil and gas industry cannot be overstated. Towns such as Tulsa, Cushing, Ponca City, Bartlesville, Enid, and others, owe much of their heritage and current economic clout to the boom of the oil and gas industry in the twentieth century.

Just how important was the oil patch to state prosperity in its heyday? In a word, vital. From 1975 to the height of the boom in 1982, oil and gas companies operating in Oklahoma increased their payrolls from about 40,000 to nearly 120,000 employees while riding the wave of high prices in the energy complex. In 1982, 1 in 12 state workers were employed in the oil patch. (Figure 1 documents employment trends in the industry since 1939.)

The unusual profitability of the oil and gas companies not only allowed them to pay well above state average wages, but also provided the wherewithal to fund an enormous number of city development and philanthropic activities. These companies, along with their well-paid employees, were the financial engines behind the expansion of many Oklahoma cities.



The state's economic health also compared much more favorably with the nation during this period. After lagging the nation for decades in per capita personal income, the state jumped from a mere 85% of the national average to near parity with the nation in relative per capita income in 1982.

Figure 2 highlights this remarkable reversal that was due in large part to the unusually good health of the oil and gas sector.

Current Trends

Unfortunately the boom is over in Oklahoma, leaving the oil bust of the 1980s as arguably the defining economic event in Oklahoma the past 50 years. Oil production within the state has declined steadily to less than 40% of 1986 levels, with natural gas faring better but now producing only 65% of 1990 levels. Figure 3 documents the steady decline in both gas and oil production within the state's borders.

The trend in employment, however, is much more troubling than the production numbers. Only 25,000 oil and gas workers remain in the state, or approximately 20% of the peak hiring level reached in 1982. More than 90,000 workers have

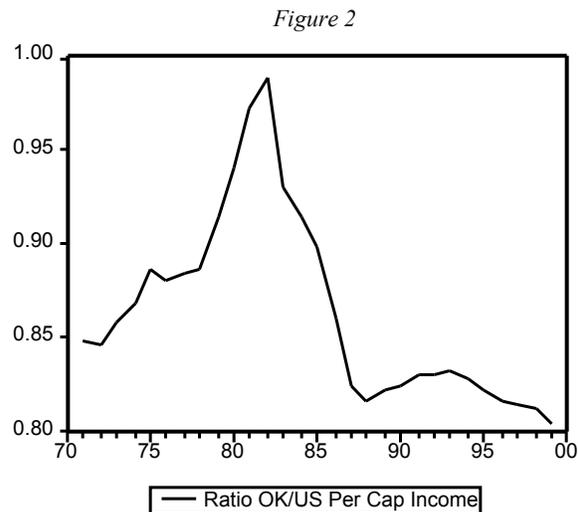
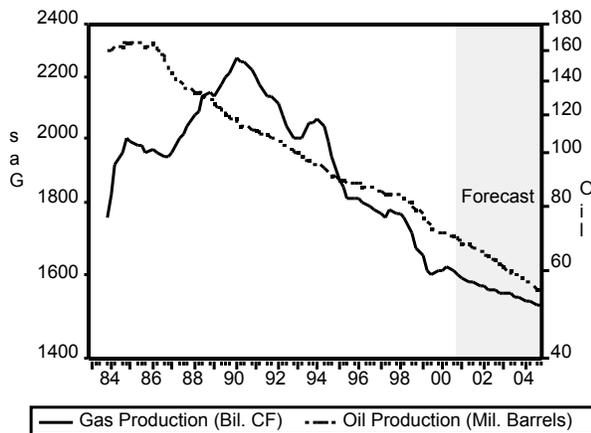


Figure 3



been forced out of the industry less than 20 years, leaving only 1 in 60 state workers in oil and gas related jobs today.

In the Tulsa metro area alone, long known as the 'Oil Capital of the World', oil and gas-related wage and salary workers now number less than 7,000, down from a peak of nearly 29,000 in 1982. The percentage of total Tulsa area workers employed in the oil and gas sector has dropped from approximately 10% of the workforce in 1982 to only 1.7% forecasted for 2001. Several smaller Oklahoma cities including Bartlesville, Enid, and Ponca City continue to struggle against the decline of large oil patch-related paychecks.

Possibly most troubling is the decline in Oklahoma's per capita income relative to the nation since 1982. Not only has the state given back all of the gains enjoyed in the boom, but has fallen below the pre-boom level to only 80% of U.S. per capita income.

Forecasts

Where is the industry headed from here? In our most recent forecast in the Oklahoma Economic Outlook, we project that the industry will benefit temporarily from the recent rise in oil and gas prices and remain mostly steady in 2001, but likely has not yet reached a long run bottom. Figure 3 highlights the downward trend we see for production in the industry through 2004. Annual

oil production is forecasted to fall below 55 million barrels, and annual gas production below 1,530 billion CF, by 2004. The employment forecast in Figure 4 shows a similar pattern. We project a -2.4% decline in oil and gas related wage and salary employment for all of 2000, a modest decline of -0.4% in 2001, and then declines of -3.0% in 2002 and -3.8% in 2003.

The relatively stable employment forecast for 2001 reflects the expected stimulus to the state economy from the spike in both oil and gas prices experienced in 1999 and 2000 (see Figure 5). Prices are expected to moderate through 2004 from the peak levels posted this year, but should remain above 10-year average levels. These forecasts are provided by The Standard & Poor's DRI Division of the McGraw-Hill Companies (Lexington, MA) and are used as inputs to the Oklahoma State Econometric Model.

The projected continued downturn in the oil and gas sector will likely contribute to a further decline in the state's per capita income relative to the nation. Our forecast calls for Oklahoma per capita income to fall to 77% of the national average by 2004. The loss of jobs at the high end of the wage scale will inevitably pull down the state average.

Figure 4

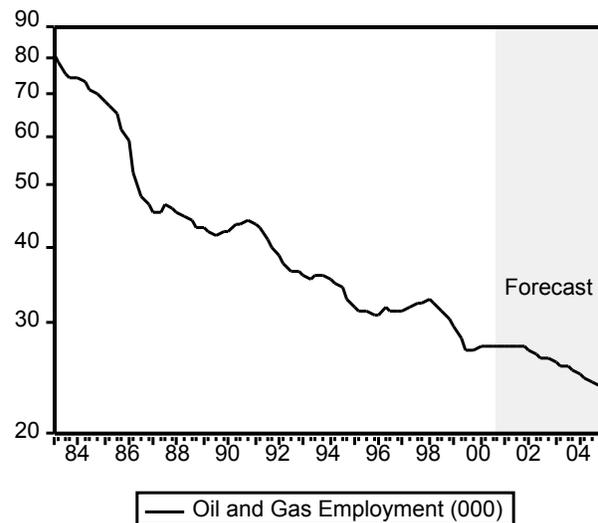
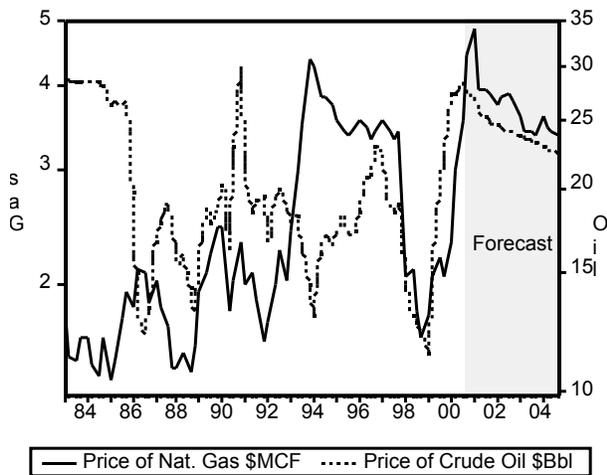


Figure 5



Summary

It has been a long, bumpy road to recovery from the collapse of the state energy sector, and our recent forecast suggests more contraction ahead. The industry should hold its ground in 2001, but look for continued weakness in production and hiring as energy prices moderate once again. The oil and gas industry, nevertheless, will remain an important component of the Oklahoma economy.

The sector pays the highest average wages among all major industries in the state and will continue to

play an important, though diminishing, role across the state. The industry also is not likely to disappear altogether in the near future given that the state possesses significant refining capacity and vast natural gas reserves. But the excessive windfall profits enjoyed during past energy price spikes will instead produce merely a modest temporary bonus to the state.

At least there is a silver lining in this story. We now have a much less oil and gas-dependent Oklahoma that is more representative of the national economy. No longer will the excessive volatility of the energy sector transmit such tremendous shocks through the state economy. It has been a gut-wrenching two decades in reaching this point, but that is the price of having a more diversified, insulated, and stable Oklahoma economy in the long run.

*Mark C. Snead, Research Economist
Business and Economic Research
College of Business Administration
Oklahoma State University
(405) 744-7405
econmcs@okstate.edu
December 2000*

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Our Energy Industry
State Policy and Energy Producers

Thomas S. Price Jr., Senior Vice President, Investor and Government Relations, Chesapeake Energy

Town Hall Introduction

Our Town Hall will focus upon three key themes concerning energy resources: (1) maximizing existing energy resource production (2) marketing our collective energy knowledge to the world and (3) consider the potential of alternative energy sources.

Regardless of future wind, hydrogen, solar and other applications ... it is clear that the existing oil and gas extraction industries are the current and near-term bedrock energy industries in Oklahoma. Their activities will provide the jobs and public revenue needed as a base to propel Oklahoma forward.

We are seeing a slow out-migration of oil and gas companies. Consider the Phillips-Conoco merger and the consideration of Citgo to move to Houston.

We thought it important to know the thinking and perspective of a leading energy producer in Oklahoma who is solidly committed to our state even though they could locate anywhere. We sought to know what opportunities they see in the future and why they believe Oklahoma is a good place to do energy business.

Chesapeake was selected because of the size of their Oklahoma-based business portfolio in both gas and oil. They are the leading producer of Oklahoma natural gas and rank in the top 10 in oil production.



INTRODUCTION

Not since the drilling boom of the late 1970's and early 1980's – when high oil and gas prices coincided with readily accessible credit to attract massive capital inflows to the state – has Oklahoma had such an exceptional opportunity to capitalize on its vast natural gas reserves. With enormous levels of untapped deep natural gas deposits, available public and private capital sources, and a supportive legislative and regulatory environment, Oklahoma's natural gas industry has the potential to continue as the state's premier economic catalyst for at least the next decade.

However, without focused action from our state leaders, Oklahoma's window of opportunity will rapidly close. As justified public concerns about the shortage of natural gas continue to rise, massive investments are being considered for extracting stranded Arctic natural gas by pipeline and for the building of new liquefied natural gas (LNG) import terminals. For this reason, Oklahoma's leaders should prioritize the encouragement of energy investment in our state before potential increased supplies of Arctic gas or LNG rise to meet demand, thereby reducing gas prices to levels that make Oklahoma's deep gas drilling less attractive and accordingly less prolific.

TRUE MARKET VALUE

Gas Pricing in the “New Era” of Production

Natural gas continues to be recognized as a clean, efficient and versatile fuel. At the same time, it is being highly valued as a scarce resource. Fortunately for Oklahoma's natural gas producers and state gross production tax receipts, it is no longer a world of \$3.00 natural gas.

Today's \$5.00 gas price illustrates the growing disparity between natural gas supply and demand. It is the combined result of a continued rise in U.S. reservoir depletion rates, the degradation of

2001
Leading Gas Producers in Oklahoma

Oklahoma Corporation Commission 2001 Annual Report

Producer	MCF
1 Chesapeake Energy Corporation	89,157,911
2 Apache Corporation	85,766,865
3 Marathon Oil Company	64,725,367
4 Amoco Production Company	54,332,850
5 Vastar Resources Inc	54,183,872
6 Kaiser-Francis Oil Company	53,558,578
7 Burlington Resources Oil & Gas Company	47,822,448
8 Samson Resources Company	47,222,522
9 Dreyfus, Louis Natural Gas Corporation	35,088,132
10 Sonat Exploration Company	34,492,731
11 Sanguine Ltd	32,899,149
12 GHK Company (The)	27,054,710
13 Texaco Exploration and Production Inc.	24,776,524
14 Oxley Petroleum Company	23,622,151
15 Questar Exploration & Production Inc	22,338,446
16 Helmerich & Payne Inc	21,847,985
17 Enron Oil & Gas Company	21,572,524
18 Ocean Energy Inc	21,432,093
19 Anadarko Petroleum Corporation	21,173,374
20 Phillips Petroleum Company	19,491,477
21 Cross Timbers Operating Company	19,008,242
22 Chevron USA Inc	17,217,230
23 St Mary Operation Company	16,703,463
24 Crawley Petroleum Corporation	14,397,062
25 OneokResources Company	13,999,101
26 Unit Petroleum Company	13,656,426
27 Kerr McGee Oil & Gas Onshore LLC	13,171,131
28 Mobil Oil Corporation	12,974,205
29 New Dominion LLC Corporation	12,184,467
30 Ricks Exploration Company	11,909,765
31 OXY USA Inc	11,167,776
32 XTO Energy Inc	11,163,964
33 Ward Petroleum Corporation	10,098,935
34 Exxon Company USA	10,065,183
35 JMA Energy	9,998,633
36 Gungoll Carl E Exploration Inc	9,925,866
37 Newfield Exploration Mid-Continent Inc	9,247,702
38 Chaparral Energy Inc	9,124,174
39 Cabot Oil & Gas Corporation	8,997,664
40 Conoco Inc	8,364,112



domestic drilling prospects, the increase in industry finding and development costs, the reduced capital allocation to U.S.-focused drilling prospects and most importantly, the voracious appetite of industrial fuel users at sub-\$5.00 gas. These simultaneous factors are helping keep clean-burning natural gas valued at a premium to its BTU energy equivalent value.

In the 1990s, natural gas prices at the wellhead averaged \$2.19 per mcf, only 1/8th of average oil prices (\$18.10 per barrel) during the same period. On an energy equivalent basis, natural gas should be valued at approximately 1/6th the price of oil, if it is priced equal to its per-unit energy production. This is the case today, with the forward 12 month natural gas “strip” (i.e., the average of the next 12 months natural gas prices) selling over \$5.00, just over the 6:1 ratio, with the oil “strip” selling at \$29 per barrel.

The change in this ratio has a significant effect on Oklahoma. If the Btu equivalent pricing relationship in existence today had held true during the 1990s, Oklahoma producers would have received and paid taxes on gas averaging \$3.02 per mcf. This is \$0.83 in excess of the amount actually received. Considering the 18.7 billion cubic feet (bcf) produced in Oklahoma during the 1990s, this ten-year “mis-pricing” of Oklahoma’s natural gas cost the state \$1.118 billion in lost gross production tax receipts.

During the first three fiscal years of this new era for natural gas pricing (2001, 2002 and 2003), wellhead natural gas prices averaged \$3.52 per mcf. Over the same period, Oklahoma gross production tax (GPT) receipts from natural gas production averaged \$419 million per year compared to \$232 million per year during the prior six years (1995-2000). This extra \$187 million per year was important to the state, but these high prices proved even more significant in fiscal 2003. Actual 2003 GPT collections for natural gas surpassed estimates by 32%, contributing a total of \$426 million during a year with a state budget shortfall from other revenue sources of \$539 million!

Oklahoma's July 2003 tax collections clearly demonstrate not only the increased contribution higher gas prices are making to the state but the need to encourage even more energy industry capital investment. Total July state tax collections were \$343.2 million, \$40.5 million of which came from GPT collections or 12% of state tax receipts. These GPT receipts were up \$19.3 million from the prior year and were \$14.6 million or 56.4% higher than the state's estimate.

THERE'S MORE TO COME

Oklahoma's Vast Remaining Gas Reserves

Lots of natural gas still exists in the Oklahoma. This is good news for Oklahoma, its economy and its near-term budget needs. Not only is there an estimated 13.6 trillion cubic feet (tcf) of remaining proven reserves to be produced, but the Potential Gas Agency, an industry study group associated with the Colorado School of Mines, reports "most likely, probable and possible" Oklahoma reserves total an additional 62.7 tcf, an amount over 4 times the size of currently booked reserves. If only half of these projected gas reserves are discovered and sold at \$4 per thousand cubic feet (mcf), state gross production tax receipts would grow by an additional \$9 billion!

While the future looks promising for Oklahoma's energy industry, the state has few alternative economic drivers in other industry segments. The problem is further exacerbated by the exodus of such high-profile public companies as Phillips Petroleum, Parker Drilling, and Noble Affiliates. Today, Oklahoma is home to less than one-tenth of one percent of the headquarters of the nation's public companies (109/13,903), with energy-related companies comprising approximately 40% (42/109) of this total.

Unquestionably, Oklahoma must broaden its economic base beyond the energy industry. However, we are fortunate to have the opportunity over the next ten years to use a very strong energy sector as a bridge to future economic development.

2001		
Leading Oil Producers in Oklahoma		
<i>Oklahoma Corporation Commission 2001 Annual Report</i>		
Producer	Barrels	
1	Coho Oil & Gas Inc	2,342,985
2	Kerr McGee Oil & Gas Onshore LLC	2,110,611
3	Texaco Exploration & Production Inc	1,677,213
4	Anadarko Petroleum Corporation	1,662,641
5	Marathon Oil Company	1,651,416
6	Mobil Oil Corporation	1,476,612
7	Dreyfus, Louis Natural Gas Corporation	1,357,728
8	New Dominion LLC	1,342,808
9	Chesapeake Energy Corporation	1,317,783
10	Citation Oil & Gas Corporation	1,228,339
11	Belco Operating Corporation	1,087,715
12	Calumet Oil Company	923,907
13	Altex Resources Inc	836,900
14	Samedan Oil Corporation	766,126
15	Enron Oil & Gas Company	707,853
16	Mack Energy Inc	656,985
17	Centana Energy Corporation	650,381
18	Hyperion Energy LP	606,899
19	Exxon Company USA	600,797
20	Henry Corporation of Oklahoma	567,637
21	Ensign Operating Company	552,954
22	Apache Corporation	530,151
23	Jones L.E. Operating Inc	525,508
24	Stephens & Johnson Operating Company	525,049
25	Marjo Operating Company Inc	522,871
26	Lamamco Drilling Company	521,650
27	Kaiser-Francis Oil Company	514,176
28	Lariat Petroleum Inc	489,241
29	Vintage Petroleum Company Inc	464,524
30	Continental Resources Inc	463,711
31	Questar Exploration & Production Inc	427,032
32	Maynard Oil Company	419,131
33	Cross Timbers Operating Company	406,355
34	Samson Resources Company	391,920
35	Ward Petroleum Corporation	390,182
36	Crawley Petroleum Corporation	376,514
37	Prime Operating Company	356,732
38	Berexco Inc	354,959
39	Harmon C.E. Oil Inc.	332,508
40	Chaparral Energy Inc	329,150



2001
Oil & Gas Leases by County

Oklahoma Corporation Commission 2001 Annual Report

COUNTY	Producing	Non-Prod	Total	% Prod
TEXAS	2,588	1,305	3,893	66%
BEAVER	2,488	2,456	4,944	50%
MAJOR	2,330	2,186	4,516	52%
KINGFISHER	1,979	2,757	4,736	42%
PITTSBURG	1,713	478	2,191	78%
GRADY	1,678	1,528	3,206	52%
CANADIAN	1,637	1,398	3,035	54%
GARVIN	1,632	2,990	4,622	35%
STEPHENS	1,605	2,403	4,008	40%
CREEK	1,500	4,351	5,851	26%
GARFIELD	1,489	2,455	3,944	38%
ROGER MILLS	1,330	429	1,759	76%
CARTER	1,317	2,116	3,433	38%
OSAGE	1,150	1,821	2,971	39%
CADDO	1,089	1,306	2,395	45%
BLAINE	1,041	924	1,965	53%
LATIMER	1,038	290	1,328	78%
CUSTER	1,037	376	1,413	73%
SEMINOLE	1,018	3,864	4,882	21%
HARPER	1,003	987	1,990	50%
HUGHES	958	2,542	3,500	27%
HASKELL	933	316	1,249	75%
DEWEY	923	1,210	2,133	43%
LINCOLN	907	2,648	3,555	26%
LOGAN	882	2,361	3,243	27%
OKMULGEE	875	3,969	4,844	18%
ELLIS	868	772	1,640	53%
MCCLAIN	861	1,135	1,996	43%
WOODS	861	699	1,560	55%
WOODWARD	834	795	1,629	51%
OKLAHOMA	786	2,338	3,124	25%
LEFLORE	699	318	1,017	69%
PONTOTOC	688	2,021	2,709	25%
POTTAWATOMIE	688	2,451	3,139	22%
NOBLE	638	1,814	2,452	26%
PAYNE	595	2,194	2,789	21%
WASHINGTON	582	1,215	1,797	32%
OKFUSKEE	562	2,546	3,108	18%
ALFALFA	541	886	1,427	38%
BECKHAM	530	461	991	53%
WASHITA	489	253	742	66%
GRANT	433	1,103	1,536	28%
KAY	421	1,924	2,345	18%
NOWATA	417	1,147	1,564	27%
PAWNEE	373	1,430	1,803	21%
TULSA	369	1,777	2,146	17%
MCINTOSH	353	396	749	47%
CLEVELAND	294	765	1,059	28%
LOVE	282	449	731	39%
COAL	203	249	452	45%
MUSKOGEE	199	929	1,128	18%
MARSHALL	192	155	347	55%
COMANCHE	182	459	641	28%
CIMARRON	168	441	609	28%
SEQUOYAH	154	73	227	68%
ROGERS	146	704	850	17%
COTTON	115	401	516	22%
JEFFERSON	87	336	423	21%
KIOWA	85	326	411	21%
WAGONER	62	960	1,022	6%
GREER	58	167	225	26%
MURRAY	44	148	192	23%
JACKSON	43	79	122	35%
BRYAN	39	60	99	39%
ATOKA	30	24	54	56%
TILLMAN	24	142	166	14%
PUSHMATAHA	18	6	24	75%
MAYES	10	48	58	17%
CRAIG	9	73	82	11%
HARMON	3	11	14	21%
JOHNSTON	3	5	8	38%
ADAIR	0	0	0	0%
CHEROKEE	0	0	0	0%
CHOCTAW	0	0	0	0%
DELAWARE	0	0	0	0%
MCCURTAIN	0	5	5	0%
OTTAWA	0	0	0	0%
TOTAL	51,178	84,156	135,334	38%

It is important to remember Oklahoma is the third leading natural gas producer in the U.S., with an estimated 1.5 tcf produced in the state during 2002. This represents approximately 8% of total U.S. consumption. According to a recent study by Mark Snead (see preceding section, page 41), in 2000 there were more than 2,100 firms engaged in oil & gas production and drilling in Oklahoma. These firms employed an estimated 58,000 people. Of that total, 27,300 (47%) were employed in the exploration and production segment. According to the 2000 Bureau of Labor statistics, these are some of Oklahoma's best and highest paying jobs. The incomes averaged \$53,151 per year, almost double the \$27,000 average for all Oklahoma industries.

Given our state's large remaining natural gas reserves – and gas prices that are more than double those of the 1990's – Oklahoma should be attracting drilling dollars in large quantities. Yet few public companies have chosen to focus their efforts in our state. U.S. drilling has been de-emphasized by the major oil companies, and even most of the larger independents find offshore and foreign drilling more profitable. This has left relatively few companies with the required capital to successfully exploit Oklahoma's plentiful drilling opportunities

CHESAPEAKE ENERGY

Tapping Oklahoma's Exploration Opportunities

One company that has recognized the advantages of drilling in Oklahoma is Chesapeake Energy Corporation. Headquartered in Oklahoma City, Chesapeake was incorporated in 1989 with no operated wells, zero oil and gas reserves, less than \$50,000 in total invested capital and only 10 employees. Today, Chesapeake employs approximately 1,100 people and is the nation's busiest driller with 44 active rigs. The company is the fifth largest natural gas producer in the U.S. and now operates 5,650 wells – 4,400 in Oklahoma. Chesapeake also has estimated natural gas equivalent reserves of 2.9 trillion cubic feet of natural gas and has an enterprise value of approximately \$4.6 billion.

Chesapeake has become Oklahoma's dominant natural gas producer and explorer, currently accounting for 14% of the total natural gas produced and 28% of the drilling being conducted in the state. Thirty-seven of the 130 active rigs drilling in Oklahoma are on Chesapeake operated leases. In fact, Chesapeake's total Oklahoma drilling activity exceeds that of the next eight most active operators in the state combined. In Oklahoma alone, Chesapeake employs 900 people directly and 2,775 people indirectly through its drilling activities.

Chesapeake's ability to access the nation's capital markets to import much-needed financial resources has been a tremendous benefit to the state. Since the company's initial public offering in 1993, Chesapeake has raised \$4.2 billion in public debt and equity offerings. The majority of this capital, along with the company's internally generated cash flow, has been invested in Oklahoma.

Approximately \$2 billion has been invested in 3-D seismic, Oklahoma leasehold acquisition and the drilling of 1,140 Chesapeake operated wells. In addition, Chesapeake has invested approximately \$3 billion in acquiring smaller undercapitalized companies and under-exploited producing oil and gas properties in the state.

REDEFINING AN INDUSTRY

Chesapeake's Competitive Advantages

Chesapeake's principal competitive advantage is its scale. It is the largest producer in the Mid-Continent, which is the third largest gas supply region in the country. Through the 4,400 wells it operates, the 37 company-operated drilling rigs and the additional 5,100 wells the company participates as a non-operator, Chesapeake has built an unparalleled geological database and field operations base. This gives Chesapeake what it believes to be the lowest unit operating expenses and highest cash margins of any operator in the state.

Another competitive advantage Chesapeake possesses in Oklahoma is its deep drilling

2001 Active Oil & Gas Wells by County

Oklahoma Corporation Commission 2001 Annual Report

COUNTY	Oil	Gas	Total
MAJOR	561	655	1,216
CARTER	971	92	1,063
STEPHENS	813	198	1,011
GARVIN	827	180	1,007
CREEK	746	110	856
GRADY	313	477	790
BEAVER	128	581	709
KINGFISHER	433	170	603
SEMINOLE	508	67	575
OKLAHOMA	444	120	564
ROGER MILLS	57	498	555
CADDO	297	217	514
CANADIAN	155	320	475
PITTSBURG	0	464	464
LATIMER	0	432	432
OKMULGEE	308	114	422
NOWATA	355	52	407
PONTOTOC	383	19	402
PAYNE	360	32	392
HUGHES	147	229	376
BLAINE	118	257	375
WOODS	151	222	373
GARFIELD	253	115	368
LINCOLN	280	86	366
MCCLAIN	283	79	362
OKFUSKEE	285	75	360
POTTAWATOMIE	339	11	350
WASHINGTON	254	85	339
CUSTER	20	318	338
NOBLE	282	53	335
HARPER	43	278	321
KAY	255	58	313
TEXAS	111	189	300
LOGAN	212	73	285
DEWEY	106	162	268
PAWNEE	239	7	246
TULSA	190	51	241
WOODWARD	32	205	237
ELLIS	56	141	197
BECKHAM	43	151	194
LEFLORE	0	192	192
WASHITA	7	173	180
GRANT	139	34	173
ALFALFA	128	45	173
HASKELL	1	164	165
COMANCHE	95	49	144
ROGERS	119	16	135
CLEVELAND	126	6	132
WAGONER	88	30	118
MARSHALL	85	31	116
MUSKOGEE	55	34	89
COAL	18	58	76
MCINTOSH	2	71	73
MURRAY	63	3	66
LOVE	53	7	60
COTTON	51	5	56
CIMARRON	23	27	50
JEFFERSON	48	1	49
TILLMAN	48	0	48
OSAGE	41	5	46
KIOWA	35	3	38
SEQUOYAH	0	29	29
MAYES	20	0	20
BRYAN	13	7	20
GREER	9	5	14
JACKSON	13	0	13
ATOKA	3	7	10
CRAIG	6	2	8
HARMON	4	0	4
PUSHMATAHA	0	2	2
ADAIR	0	0	0
CHEROKEE	0	0	0
CHOCTAW	0	0	0
DELAWARE	0	0	0
JOHNSTON	0	0	0
MCCURTAIN	0	0	0
OTTAWA	0	0	0
TOTAL	12,651	8,649	21,300

capability. Although everyone from the coffee shop crowd to Federal Reserve Chairman Alan Greenspan is talking about the declining natural gas supply these days, few energy companies are doing anything about it. Chesapeake is a significant exception! On average, the company drills the deepest wells in the United States, and is currently drilling 16 wells in Oklahoma deeper than 15,000 feet. This represents 50% of all deep drilling occurring in the state.

An additional competitive advantage is Chesapeake's commodity price risk management program. During the past two years the company's hedging efforts have increased the company's profitability by over \$200 million. Because of its premium cash flow generation, the company has consistently kept its Oklahoma rig count at levels approximately four to five times greater than its nearest competitors.

Equally important to Chesapeake's success is its familiarity with Oklahoma's operating and regulatory environment. The company's 20-plus years of experience in Oklahoma – a state with relatively small surface tract ownership (historically 640 land allotments), minimal federally-owned land, multiple "severed" mineral owners, and a unique "force pooling" regulatory environment – offers a significant advantage over those competitors with less experience in this environment.

Finally, Chesapeake has built a business environment and company culture that attracts the best and brightest geologists, geophysicists, engineers, landmen, accountants and support professionals in the industry. The company's substantial investment in building the premier work environment in Oklahoma has enabled it to attract hundreds of professionals from surrounding and competing states. Furthermore, Chesapeake's commitment to community involvement has built an unequalled esprit-de-corps and a great sense of pride among the company's 1,100 employees.



PREDICTING THE FUTURE

The Long-Term Outlook For Oklahoma's Energy Exploration

Today's high natural gas prices reflect the difficulty of finding new supplies of natural gas in the United States. Despite a 30% increase in the total number of active U.S. drilling rigs year-over-year, publicly owned U.S. energy producers reported an approximate 1-2% decrease in domestic production in the second quarter of 2003. In fact, domestic U.S. gas supplies have declined the last eight consecutive quarters.

At the same time, Oklahoma's estimated 14 tcf of proven reserves, and 60 tcf of probable and possible reserves, make it one of the largest potential gas supply basins remaining in the U.S. The state's two major basins, the Arkoma and Anadarko, are projected to hold over 90% of Oklahoma's deep hydrocarbon accumulations. However, the technical and financial challenges associated with profitably extricating these deeper deposits are many, including poor quality seismic resolution of deep reservoirs and traps; higher formation pressures and temperatures that make drilling costs substantially higher; and the high probability of encountering significant impurities in the gas which reduce overall wellhead price realizations.

For these reasons, few of Chesapeake's U.S. competitors have focused their drilling budgets on exploration of Oklahoma's remaining hydrocarbons. While Chesapeake has 84% of its rigs currently drilling in Oklahoma, the rest of the nation's 25 most active operators, together, have only a total of 37 active rigs in the state, a modest 9% of their total U.S. rig count.

What can be done to create a more attractive investment environment in Oklahoma? A significant number of measures are already in place. The Oklahoma legislature has created as favorable and hospitable drilling environment as anywhere in the nation. It has recently supported legislation providing ultra-deep (over 15,000 feet) drilling incentives, and has included energy jobs under the state's "Quality Jobs" classification.

Energy Employment
The Mining Sector by State: 1997

U.S. Census Bureau, 1997 Economic Census

	<u>Population</u>	<u>Estab</u>	<u>Employees</u>	<u>Payroll</u>	<u>Prod Wkrs</u>	<u>Val Added</u>	<u>Index</u>
United States.....	281,421,906.....	25,000.....	509,006.....	\$20,798.....	389,232.....	\$133,636.....	18.09
Wyoming	493,782.....	669.....	15,436.....	723.....	12,367.....	5,395.....	312.61
Alaska	626,932.....	141.....	10,137.....	672.....	7,585.....	9,565.....	161.69
West Virginia.....	1,808,344.....	766.....	23,927.....	1,042.....	20,450.....	4,161.....	132.31
Louisiana.....	4,468,976.....	1,608.....	52,816.....	2,302.....	38,255.....	21,889.....	118.18
New Mexico	1,819,046.....	606.....	14,600.....	574.....	11,520.....	5,336.....	80.26
OKLAHOMA	3,450,654.....	2,271.....	25,976.....	967.....	16,957.....	5,509.....	75.28
Nevada.....	1,998,257.....	250.....	14,035.....	626.....	12,451.....	1,959.....	70.24
North Dakota.....	642,200.....	227.....	4,098.....	176.....	3,361.....	1,017.....	63.81
Montana.....	902,195.....	294.....	5,328.....	216.....	3,864.....	1,047.....	59.06
Kentucky	4,041,769.....	691.....	22,400.....	832.....	19,413.....	3,297.....	55.42
Texas	20,851,820.....	6,412.....	105,492.....	4,334.....	73,686.....	32,485.....	50.59
Utah.....	2,233,169.....	316.....	8,134.....	335.....	6,593.....	1,875.....	36.42
Kansas	2,688,418.....	1,026.....	7,998.....	245.....	5,993.....	2,178.....	29.75
Colorado.....	4,301,261.....	885.....	12,263.....	522.....	7,881.....	2,872.....	28.51
Arizona	5,130,632.....	206.....	12,889.....	510.....	10,699.....	2,171.....	25.12
South Dakota	754,844.....	67.....	1,837.....	67.....	1,635.....	166.....	24.34
Idaho.....	1,293,953.....	118.....	3,021.....	118.....	2,418.....	291.....	23.35
Alabama.....	4,447,100.....	291.....	9,066.....	371.....	7,421.....	1,775.....	20.39
Virginia.....	7,078,515.....	417.....	11,711.....	429.....	9,860.....	1,449.....	16.54
Minnesota	4,919,479.....	145.....	7,154.....	348.....	6,071.....	954.....	14.54
Mississippi	2,844,658.....	368.....	4,096.....	115.....	3,100.....	531.....	14.40
Pennsylvania	12,281,054.....	914.....	17,522.....	677.....	14,262.....	2,411.....	14.27
Arkansas	2,673,400.....	307.....	3,250.....	98.....	2,602.....	704.....	12.16
Vermont.....	608,827.....	52.....	658.....	22.....	538.....	72.....	10.81
Ohio.....	11,353,140.....	828.....	11,997.....	454.....	8,961.....	1,746.....	10.57
Indiana.....	6,080,485.....	347.....	6,007.....	241.....	5,013.....	795.....	9.88
Illinois.....	12,419,293.....	650.....	10,798.....	437.....	8,557.....	1,381.....	8.69
Missouri.....	5,595,211.....	306.....	4,561.....	146.....	3,645.....	503.....	8.15
Tennessee.....	5,689,283.....	221.....	4,473.....	137.....	3,614.....	479.....	7.86
Georgia.....	8,186,453.....	205.....	6,354.....	233.....	4,984.....	1,024.....	7.76
Michigan.....	9,938,444.....	445.....	6,687.....	271.....	5,030.....	1,182.....	6.73
California	33,871,648.....	910.....	22,110.....	945.....	16,908.....	7,497.....	6.53
Nebraska.....	1,711,263.....	150.....	1,078.....	31.....	858.....	104.....	6.30
Iowa.....	2,926,324.....	177.....	1,700.....	55.....	1,428.....	217.....	5.81
Oregon.....	3,421,399.....	134.....	1,739.....	61.....	1,216.....	161.....	5.08
Washington	5,894,121.....	154.....	2,890.....	114.....	2,170.....	349.....	4.90
Wisconsin.....	5,363,675.....	147.....	2,304.....	92.....	1,598.....	312.....	4.30
Florida.....	15,982,378.....	225.....	6,688.....	249.....	5,424.....	1,009.....	4.18
North Carolina	8,049,313.....	171.....	3,231.....	118.....	2,644.....	533.....	4.01
South Carolina	4,012,012.....	74.....	1,388.....	44.....	1,099.....	166.....	3.46
Maryland	5,296,486.....	93.....	1,771.....	64.....	1,429.....	257.....	3.34
New Hampshire	1,235,786.....	32.....	396.....	18.....	293.....	44.....	3.20
New Jersey.....	8,414,350.....	95.....	1,864.....	84.....	1,350.....	243.....	2.22
New York.....	18,976,457.....	359.....	3,879.....	142.....	2,819.....	474.....	2.04
Connecticut.....	3,405,565.....	62.....	626.....	27.....	467.....	105.....	1.84
Massachusetts.....	6,349,097.....	72.....	1,063.....	42.....	704.....	110.....	1.67
Delaware	783,600.....	11.....	107.....	4.....	90.....	15.....	1.37
Rhode Island.....	1,048,319.....	16.....	120.....	5.....	82.....	13.....	1.14
Hawaii	1,211,537.....	7.....	120.....	6.....	100.....	22.....	0.99
Maine.....	1,274,923.....	21.....	76.....	1.....	50.....	4.....	0.60
Offshore		41.....	11,135.....	455.....	9,717.....	5,782.....	#DIV/0!

No.865.Mining Summary by State:1997

[The mining sector comprises establishments that extract naturally occurring mineral solids, such as coal and ores; liquid minerals and gases, such as natural gas. The term mining is used in the broad sense to include quarrying, well operations, beneficiating (e.g., crushing, screening, washing, and flotation), and other preparation customarily performed at the mine site, or as a part of mining activity] 1 For pay period including March 12. 2 Covers production, development, and exploration workers. For pay period including March 12. 2 District of Columbia is included with Delaware. 3 Not associated with a state. Source: U.S. Census Bureau, 1997 Economic Census, Mining, Series EC97N21S-GS, issued April 2001. Index provides relative scale of employees in population working in the mining industry.

The Oklahoma Corporation Commission (OCC) is the regulatory body charged with preventing waste of the state's natural resources and assuring maximum recovery of oil and gas reserves. It is also comprised of knowledgeable energy industry experts whose prompt adjudication of industry disputes facilitates the drilling of wells across the state. The Commission recently reduced the Oil and Gas Division's budget by 7%. This resulted in staff reductions. It is imperative that these positions be restored in order to maintain an aggressive drilling program in the state.

The principal remaining issues are environmental and legal. In the environmental arena the issues of regulatory issues and permitting burdens dominate. Concerned Oklahoma natural gas producers and others across the country are well aware of the need to be attentive to environmental issues, such as preserving clean water and clean air. In fact, the natural gas we produce emits 99% less sulfur dioxide (SO₂), 80% less nitrogen oxide (NO_x), 100% less mercury, and up to 50% less carbon dioxide (CO₂) than the largest power generation fuel, coal. Natural gas producers are also concerned about the impact caused to industrial consumers, their customers and their employees of rising natural gas costs. In Oklahoma alone, hundreds of jobs have been lost or suspended due to the rise in natural gas prices during the past several years. Lower income families and individuals on fixed incomes have also been adversely impacted. If Oklahoma's natural gas producers are going to be responsive to increasing the drilling for and supply of natural gas, there must be a reasoned debate on the environmental/energy cost issue.

While our society at-large may be willing to pay the increased energy costs and accept the manufacturing jobs lost to overseas competitors from higher energy input costs, such decisions should be made in a reasoned atmosphere with as objective a discussion of the tradeoffs as politically possible.

In Oklahoma specifically, energy producers are dealing with many issues, including limited scientific study and arbitrary enforcement of an alleged "endangered specie" the American Burying Beetle; a vague and broad definition of the "waters of the U.S." and an unreasonable attempt to enforce onerous stormwater permitting regulations, in spite of a clear statutory exemption for the oil and gas industry. Each of these issues has caused needless uncertainty and delay in the prosecuting of drilling operations.

Also of concern in Oklahoma is the need for legal reform. Although not unique to this industry, lawsuits plague oil and gas producers. In particular, virtually every major operator in the state has been named in one or more class action suit, primarily involving royalty payment disputes. Most of these cases settle, but few truly benefit anyone but the lawyers and serve only to strain oilfield relations and delay development.

EXTENDING OUR HERITAGE

Continuing the Contributions to Oklahoma

This "new era" for natural gas pricing should be a boon for Oklahoma's economy. The natural gas and oil (in that order) exploration and production industry can provide an important economic bridge until the state's economic strength is enhanced and other industries can provide similar high-quality, high-paying opportunities for Oklahoma's best and brightest. Until that time, the state's leaders should be encouraged to review any and all policies, taxes, regulations, and other environmental and legal obstacles to attracting outside drilling capital to our state.

Since statehood, the economic contribution, corporate commitment and philanthropy of Oklahoma's energy producers has created an improved quality of life for all Oklahomans. Many Oklahoma communities owe much of their heritage to the risk taking, job producing and wealth enriching efforts of Oklahoma's energy producers. We at Chesapeake are proud to continue that tradition of commitment to the state's continued cultural and economic improvement.

Our Energy Industry
Protecting Critical Infrastructure
Denise Bode, Chairman, Oklahoma Corporation Commission

Our job at the Corporation Commission is first and foremost to ensure that Americans are better off as a result of our oversight of the various market players that we regulate. My job at the Oklahoma Corporation Commission is an integral part of insuring that Oklahomans are better off because of the breadth of our regulatory control over everyday life, almost 70 percent of the state's economy is impacted-every time you turn on your computer, cook a meal, take a drink of water, make a call or fill up your car. We have regulatory responsibility for telecommunications, trucking, electric utilities, and the oil and gas industry, all of which make up Oklahoma's economic foundation, and all of which are undergoing significant change. And to complicate this mission, state commissions have now, since 9/11, been asked to address necessary defensive concerns regarding the critical infrastructure we regulate. As a result, the Corporation Commission must change as well.

Critical infrastructures are those physical and cyber-based systems essential to the minimum operations of the economy and government. They include, but are not limited to, telecommunications, energy (oil and natural gas, electric power), banking and finance, transportation, water systems and emergency services, both governmental and private. Many of the nation's critical infrastructures have been seen as separate systems in the past with little interdependence. However, as a result of the internet and other new information technology these infrastructures have become increasingly automated and interlinked.

These same advances have created new vulnerabilities to equipment failures, human error, weather and other natural causes, and physical and cyber attacks. In addition, with greater market competition in traditional monopoly utility services, efficiencies and cost-cutting may impact cost recovery and thus willingness to upgrade necessary security of our critical infrastructure.

As Americans we all need to understand that security of our infrastructure is a new and permanent cost of doing business and plan for it. I currently serve both on the board of the National Homeland Security Training Center and helped coordinate the planning of a response to terrorism on Oklahoma's infrastructure.

At the national level I serve with other state regulators on a new Committee for Critical Infrastructure to develop strategies and approaches to assure that appropriate, cost effective, measures are taken by the industries we regulate to reduce the risk and vulnerabilities to disruption to critical facilities.

Issues we are highlighting include how to communicate Homeland Security threats and warning - What type of information is reported to the commission and where is that information channeled? We are identifying and working with the U.S. Department of Homeland Security (DHS) and industry to identify best security practices as a guide for regulators and utilities as they seek to recover prudently incurred costs necessary to further safeguard the reliability and security of our energy supply and delivery infrastructure.

How critical infrastructure protection information can or should be exempt from disclosure under freedom of information acts is another area of discussion. We are also working with industry, DHS and other colleagues in state government to undertake a comprehensive review and updating of plans, rules, orders, and programs designed to assess the vulnerability of energy supply and delivery infrastructures and respond to supply disruptions when they occur. Again, how we manage these new responsibilities organizationally is a new challenge for state commissions.

Maximizing Existing Resources

Energy Research and Development

Christine Hansen, Executive Director, Interstate Oil and Gas Compact Commission

Introduction

The combination of advanced research and high technology is the single greatest contributor to low consumer natural gas and oil prices. As with most industries, the greatest technological advances are ahead of the petroleum industry, not behind it.

Many of the significant natural gas and oil technology breakthroughs were developed in Oklahoma, a state facing choices. Oklahoma could choose to continue leadership in petroleum technology advances. It could choose to continue its history of training the world's petroleum scientists. It could look at the natural gas and oil industry as a vital cog in the international economy and continue to play a huge role in world energy. It could see itself as the center of petroleum technology advancement in the world. Or Oklahoma could turn its back on the industry that made it a great state and pronounce the petroleum industry "one that is dying."

The broader vision of the state as a world energy center is set out in the Oklahoma Energy Strategy prepared by Energy Secretary Robert Sullivan. It is an innovative and highly possible scenario if Oklahoma embraces its petroleum legacy rather than turning its back on this critical industry.

The Interstate Oil and Gas Compact Commission (IOGCC) strongly supports research and works to promote increased government funding of this research. The IOGCC, representing governors of 30 natural gas and oil producing states, has found that funding for petroleum technology research is being reduced drastically at the very time the industry needs more research. While the governors of the IOGCC have tried to focus national attention on the issue and have endorsed proper funding of important state and national institutions, inadequate funding for research and development continues to be a grave concern.



Sarkey's Energy Center, University of Oklahoma

Poro-Mechanics Institute • Institute for Science and Public Policy • Institute for Energy and the Environment • Institute for Exploration and Development Geosciences • Energy Institute of the Americas • Institute for Reservoir Characterization • Institute for Energy Economics and Policy • Institute for Gas Utilization Technologies

Rather than expanding research to recover domestic natural gas and oil resources, industry and government are reducing research. There is a continuing gap between research dollars the petroleum industry spends versus outlays by other industries. There also is a gap in federal funds allocated through the U.S. Department of Energy versus other research funding agencies.

Since being formed by the governors and chartered by Congress in 1935, the IOGCC has been a booster of programs that create new technology to increase environmental protection, improve recovery rates, and lower exploration and production costs. Such research and development is an investment in the country's future and its energy security. Technological advancement might be the most important factor in ensuring that the nation's non-renewable resources are fully developed and the principles of resource conservation are served, while achieving reasonable prices for consumers.

Research is not instant. It cannot be turned off and on like a water tap. The acquisition of new knowledge and the embodiment of that knowledge in new products and services for the benefit of the economy is a cumulative process requiring continuous effort to sustain it. Accumulated cutbacks in public and private research in the natural gas and oil sector could set the stage for a major shortfall in development of this vital energy source.

When E. W. Marland brought the first geologist to Ponca City to help him find the big new fields in Oklahoma, the industry worldwide began to understand the need to employ scientists and to use technology. (Marland Oil Company preceded Conoco-Phillips. E. W. Marland was the 10th governor of Oklahoma, serving from 1935 to 1939, and was the founder of the IOGCC.) For decades following that early use of scientists and technology, research expanded. States committed increased funding for geology and petroleum engineering departments at their universities, and state geological surveys were expanded to help

serve the oil industry. Because of the recognition of the importance of scientists and research spending, the scientists were revered in the industry.

The oil price collapse of the 1980's quickly reversed that situation. Scientists were laid off and research departments were closed. Funding for university research was curtailed and even the prestigious United States Geological Survey suffered cuts. That downward trend continues today.

**Examination of Effects
of Corporate Mergers on R&D Expenditures**
R&D Expenditures in Millions of Dollars

	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	
<i>Chevron Texaco</i>					\$209	
<i>Texaco Inc.</i>	\$147	\$138	\$96	\$108		
<i>Chevron Corp.</i>	\$179	\$187	\$182	\$171		
<i>Total</i>	\$326	\$325	\$278	\$279	\$209	
	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>
<i>ExxonMobil</i>				\$630	\$564	\$603
<i>Exxon Corp.</i>	\$520	\$529	\$549			
<i>Mobil Corp.</i>	\$206	\$234	\$204			
<i>Total</i>	\$726	\$763	\$753	\$630	\$564	\$603

Source: 10K Annual Reports filed with the U.S. Securities and Exchange Commission

Research and development spending by the petroleum industry continues to lag behind other industries. Simultaneously, federal support for research and development is being reduced, creating an outlook even more bleak and setting the stage for a major energy crisis.

Research and development is widely recognized as the key to economic growth. Decisions about how much the petroleum industry spends on research and development, how the industry spends that money, and how technologies are deployed are all critical to the nation's energy security and to the future of the U.S. economy. Alan Greenspan, chairman of the U.S. Federal Reserve, recently strongly reiterated the connection between the U.S. economy and the price and availability of energy.

R&D by Federal Agency, 1997-2001
(Budget Authority in Thousands of Dollars)

<u>Agency</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>
Defense	34,788,263	35,286,223	35,645,859	36,875,907	36,396,615
HHS	12,785,262	13,901,663	15,915,736	18,140,350	19,234,564
NASA	9,327,300	9,568,029	9,525,693	9,568,073	9,602,367
ENERGY	5,603,506	5,873,804	6,009,730	6,305,572	6,793,467
Agriculture	1,388,619	1,441,046	1,614,133	1,752,045	1,779,318
Interior	57,901	5,531,969	641,542	565,974	619,387

Source: U.S. National Science Foundation/Division of Science Resources Studies, Survey of Federal Funds for Research and Development. Total Department of Energy Research and Development for FY 2002 was \$8.1 billion.

If research has been identified as the task necessary to consistently lower energy prices, and if lower energy prices have a potent effect on the national economy, it makes sense for the country to devote national resources to energy research. It also makes sense for individual states to devote resources to such research. Support should start with sufficient funding for state geological surveys and should be expanded to provide special petroleum research money; similar to the allocation enacted in North Dakota this year.

Our nation has seen a dramatic increase in merger activity in recent years in all areas of the industry. The desire for reserves, cost-cutting and higher refining/marketing share has fueled those mergers and created consolidated balance sheets. Those consolidated balance sheets show that research departments have been the biggest losers in the mergers.

The \$81 billion merger between Exxon and Mobil, for example, formed the world's largest privately owned petroleum company in terms of revenue. But research and development expenditures by ExxonMobil decreased by 16.3 percent in 1999, the year of the merger, and, in 2000, by another 10.5 per-cent from the 1999 level.

Research for natural gas and oil fares no better in the public sector. Of course, states have had extremely constrained budgets recently and have been unable to expand any expenditures, let alone a "frill" like research spending. At the federal level, research spending for energy is the smallest of the nation's research budgets.

Five federal agencies account for 90% of the federal government's research and development funding – the Departments of Defense, Health and Human Services, National Aeronautics and Space Administration (NASA), Energy, and the National Science Foundation. The Department of Energy spending on research and development consistently has ranked at the bottom of the scale among the top five research funding agencies.

Research spending has continued to decrease with recessionary pressures. While this is true across industry sectors, the domestic natural gas and oil sector has taken the largest hit. Reversing this trend in Oklahoma would make a difference to the state, the nation, and the world.

CONCLUSION

Research and development in the natural gas and oil industry is critically important to Oklahoma for two reasons. First, research and development extends the productive life of Oklahoma's abundant natural resource of petroleum. Second, research and development is a key economic development factor as it can spawn new industries and attract additional research and development. Investments in research and development now will pro-vide jobs in Oklahoma for decades.

Oklahoma should look for economic development opportunities first in the industry that it knows the best– natural gas and oil.

Marketing Our Energy Knowledge
Capitalizing on Oklahoma's Energy Complex

R. Dobie Langenkamp, Director

National Energy-Environment Law and Policy Institute, University of Tulsa College of Law

R. Dobie Langenkamp is Professor of Law and Director of the National Energy-Environment Law & Policy Institute at The University of Tulsa College of Law. Langenkamp served as Deputy Assistant Secretary of the U.S. Department of Energy from 1977-1981 and 1997-1998. From 1981 through 1996 he was president and owner of Cherokee Operating Company, an Oklahoma exploration and production company. He is a graduate of Stanford University and the Harvard Law School.

NELPI's primary objective is to strike a balance between material abundance and environmental protection. It is doing so through teaching, research, scholarship, publications, and effective communication about energy and the environment within interdisciplinary frameworks of policy, science and law.

Introduction

Oklahoma's energy future can be as bright as its past. The mistake is to believe that Oklahoma will cease to be an energy center merely because its oil production has declined and gas production is in a mature and steady phase. To an extent not appreciated, the Oklahoma City/Tulsa corridor supplemented by other state areas constitutes an impressive energy complex of international significance. With the exception of Houston, no city can surpass this aggregation of energy expertise.

The strength and potential of this state as an energy center is based on its skills, its people, and its business climate. No other Oklahoma sector provides such an opportunity for growth.

THE ENERGY COMPLEX

The building blocks of Oklahoma's energy complex consist of its exploration and service/supply companies, its refineries, its engineering

and geological consultants, its universities and professional organizations, its energy-related associations and the many independent experts at both ends of the turnpike and elsewhere in the state. Oklahoma City and Tulsa alone have almost 300 "oil producers," 366 "exploration and development" companies and 180 "service and drilling companies." Oklahoma is home to one of the major integrated oil companies—Kerr-McGee—and one of the largest independents, Devon Energy. Oklahoma has more than 130 drilling rigs drilling at this time at depths of up to five miles. By way of comparison, all of Mexico has less than 75. Oklahoma operating companies operate six times as many producing oil wells (85,837) as Venezuela (15,580). Although the production is minimal in comparison, the number of active producing oil and gas wells in Oklahoma far exceeds the number of wells in all of OPEC combined. This high level of activity, albeit at a lower production level, results in a substantially greater body of experienced workers and service companies. An assessment of the energy infrastructure must not omit the comprehensive system of oil pipelines that makes Cushing, Oklahoma one of the world's true oil transportation centers.

Oklahoma has two superb petroleum engineering schools at OU and TU. There are hundreds of energy-producing companies, from Devon with \$12 billion capitalization to small, one-man E&P companies. Oklahoma is the headquarters of the International Society of Petroleum Geologists and the National Energy-Environment Law and Policy Institute at The University of Tulsa College of Law. Oklahoma University operates the internationally known Sarkeys Energy Institute. The National Association of Royalty Owners (NARO) representing royalty owners around the country is located in Oklahoma. Also important is the Oklahoma Society of Petroleum Accountants,

THE OKLAHOMA ENERGY COMPLEX

(partial listing not intended to be all-inclusive)

EDUCATIONAL

University of Tulsa

- *College of Petroleum Engineering, Department of Geosciences*
- *College of Law (National Energy-Environment Law and Policy Institute)*
- *Petroleum Abstracts*

University of Oklahoma

- *Sarkeys Institute-Institute for Energy & Economic Policy/Energy Institute of the Americas*
- *College of Petroleum Engineering, School of Geology & Geophysics*

Oklahoma State University

- *Department of Electrical Engineering and Energy Laboratory*

GOVERNMENTAL

*Interstate Oil & Gas Compact Commission
National Petroleum Technology Office (U.S. Department of Energy)
Oklahoma Corporation Commission
Oklahoma Marginal Well Commission
Oklahoma Geological Survey
Oklahoma Energy Resources Board (OERB)
Grand River Dam Authority
Southwest Power Administration (US DOE)
Oklahoma Municipal Power Authority*

HEADQUARTERS COMPANIES

Kerr-McGee Corporation; Devon Energy Corporation; CITGO; Vintage Petroleum, Inc.; Samson Resources Co., Unit Corporation, Helmerich & Payne, Inc., Williams Companies, Inc., Transok Inc.,

Chesapeake Energy Corporation, APCO, American Central Gas Technologies, Inc., ONEOK, Inc., Oklahoma Natural Gas, Continental Resources, Inc., Ward Petroleum Corporation, Kaiser-Francis Oil Company, Explorer Pipeline Company, Ram Energy, Inc., LeNorman Energy Company, Jolen Operating Co., Nadel & Gussman, Lumen Energy, and Primary Natural Resources.

DIVISION OFFICES:

XTO Energy, Inc., Apache Corporation, ConocoPhillips, EOG Resources, Inc., Halliburton Energy Services, Marathon Oil Corporation, and BJ Services Co.

Schlumberger Oilfield Co., Service Drilling Co., Weatherford International, Coral Energy-Shell Trading, AEP-PSO, Florida Power and Light (Oklahoma Wind Energy) and Zilka Renewable Energy.

ENGINEERS AND CONSULTANTS

KWB Property Management, Inc., Lee Keeling & Assoc., Oil and Gas Consultants International, Ellis-Johnson Engineering, Environmental Remediation Specialists, Inc., and Davis Environmental Drilling LLC.

ASSOCIATIONS

*American Association of Petroleum Geologists
Association of Desk and Derricks Clubs
Natural Gas Association of Oklahoma
National Association of Royalty Owners
Oklahoma Landmen's Association
Society of Petroleum Evaluation Engineers
Petroleum Equipment Institute
Society for Sedimentary Geology
Oklahoma Independent Petroleum Association
International Society of Energy Advocates
Oklahoma Bar Association—Mineral Law Section
Oklahoma Renewable Energy Council*

which has played a large role in the development of standards and practices for petroleum accounting around the country. Leading energy associations in Oklahoma include the Society of Petroleum Engineers, the Society of Exploration Geologists, the Society of Sedimentation Geologists, the Natural Gas Association of Oklahoma and the Oklahoma Society of Petroleum Landmen.

The US Department of Energy has located its National Petroleum Technology office in Tulsa. The world's largest collection of energy-related information is collected and catalogued daily and made available worldwide by Petroleum Abstracts at the University of Tulsa. When assistance was needed in restoring Iraqi crude production, the Corps of Engineers staff from Tulsa was among those doing the job.

GOVERNMENT

Oklahoma City is the permanent home of the Oil and Gas Compact Commission, which provides background and support to producing states all over the US.

The Oklahoma Corporation Commission with its Oil and Gas Division provides a body of experts who supervise drilling, completion and abandonment of wells. It is one of the most active and competent of such regulatory agencies in the nation and is a model for the regulatory agencies of newly developing countries, which frequently send representatives to observe the commission in its regulatory function. It has through the years proved to be not only a regulator of the industry but an asset to its sensible development.

The US Department of Energy's Southwest Power Administration is located in Tulsa and is responsible for the marketing of 445 MW of hydropower from six dams located in the region. It is one of only 5 federal power marketing agencies in the US.

ACADEMIC

Perhaps most important to the energy complex are the educational institutions based in Oklahoma that are involved in training for the worldwide development of energy resources. The University of Tulsa Petroleum Engineering School and School of Geosciences draws students from around the world, as does the University of Oklahoma School of Petroleum Engineering and the Oklahoma State Electrical Engineering Laboratory and Department. The key to growth and development in energy in Oklahoma is the knowledge and experience base, the skilled engineers and geologists and drilling technicians. There are over 100 petroleum consultants listed in the Tulsa and Oklahoma City directories.

But the petroleum business is changing and Oklahoma must change with it. More and more petroleum development is occurring overseas or in previously unexplored areas in North America. As a result, we see

Tulsa's Vintage Petroleum with substantial holdings in Argentina, Helmerich & Payne drilling in Venezuela, Samson investing in Russia, Kerr-McGee drilling in the Bohai Bay off China's coast and Devon spreading its exploration wings around the globe (from the Caspian sea to Canada). Syntroleum is licensing its gas-to-liquids technology in Latin America and Europe, among other places. In the upstream arena we see PDVSA in Venezuela relying on Tulsa people to operate Citgo. There are five refineries in Oklahoma handling almost 500,000 barrels of crude per day—almost twice the state's daily production.

Other companies supply drilling and other equipment worldwide: Ramsey Winch, Bovaird, CRC Evans Pipeline International, Sheehan Pipeline Construction., T.D. Williamson and Woolslayer Companies. Globalization is a reality in the petroleum industry perhaps to a greater extent than any other.

How many know that as many rigs are drilling in Oklahoma today as in Saudi Arabia, Iran and Venezuela combined? How many are aware of the significance of the Cushing terminal in world petroleum markets? How many are aware of the extent of the Oklahoma energy complex?

ELECTRICITY

With its abundant gas resource, easy siting and pipeline network, Oklahoma is well placed to become one of the several electricity exporting states. As of this year approximately 9 megawatts of new power production is under construction or on the planning board. Oklahoma could become a leading state on a per capita basis in electric power production. In short, Oklahoma is an electric energy exporter and should continue to increase capacity for export.

ALTERNATIVE ENERGY

Oklahoma companies have already moved aggressively into the field of wind power development. Numerous good sites have been located in western Oklahoma and plans have been made for the construction of wind farms. This is an area of potential growth in the coming decade that should be encouraged. Western Oklahoma is one of the premier areas for wind power development. At present there are five small projects in Oklahoma with a capacity of about 200 KW.

Oklahoma with its Grand River Dam Authority and Corps of Engineers is 21st of the 50 states in hydro production.

Power generation from the burning of biomass such as wood chips and chicken litter is also on the drawing board in Oklahoma. At present Weyerhaeuser has a 35,000-Kw plant near Valliant, Oklahoma.

But more importantly, Oklahoma has a product to sell in addition to oil, gas and electric power. Oklahoma has experience, skill and expertise from its century-long involvement as one of the world's energy centers. The task we have is to capitalize on this experience and knowledge in a worldwide marketplace. Oklahoma's energy future is not based only on MCFs but on the talent and expertise of its energy industry. Abundant natural gas and the transportation system to move it is one of the state's greatest strengths.

What is it that draws the companies and skilled professionals—engineers, geologists, computer programmers, executives—to Oklahoma? What is it that keeps people and companies in Oklahoma? Good schools, good cities, a clean environment, a good business climate, good transportation and a good quality of life.

RECOMMENDATIONS

The following is an approach for strengthening the Oklahoma Energy Complex and, thus, energy jobs:

1. **Appreciate and support the existing energy industry and organizations.** Be sensitive to the needs of the many energy companies and consultants that operate out of Oklahoma or have district offices here. Do not take them for granted.
2. **Take the offensive.** Begin a campaign to bring energy company and energy organization headquarters to Oklahoma. The same effort that Houston made to try to get Citgo to relocate should be made by Tulsa with regard to target companies in Wichita, Topeka, Wichita Falls, Amarillo, Lubbock, Ft. Smith and Dallas-Ft. Worth. All of these cities are closer to Oklahoma City and Tulsa than Houston. We should concentrate initially on the smaller independents and domestically oriented exploration companies. Houston's advantage regarding the offshore industry and Mexico is irrelevant to those seeking to explore in the mid continent, New Mexico, the Rockies or Canada.
3. **Use Oklahoma's political clout.** Oklahoma is fortunate to have two very senior U.S. Senators, both of whom are trusted friends of the energy community. Both should be regularly called upon to help accomplish the above objectives. In years past the Oklahoma delegation was a leading supporter of the energy industry here. Mike Smith, former Oklahoma Secretary of Energy, is now the Assistant Secretary for Fossil Energy at the US

Department of Energy, one of the more powerful positions in the energy department. The Oklahoma congressional delegation is well placed to be of assistance and should be regularly called upon.

4. **Coordinate the efforts of the energy community.** The Oklahoma Independent Producers Association, OU's Sarkeys, TU's National Energy-Environment Law and Policy Institute, NARO, the Interstate Oil and Gas Compact Commission, the Oklahoma Corporation Commission, the Oklahoma Geological Survey and the Oklahoma Marginal Well Commission are all important players. The office of the Secretary of Energy should be the coordinator and the cheerleader for this vital industry.
5. **Recognize the importance of critical mass.** Every component of the energy economy is helpful or supportive of other components. E&P companies need to have drilling companies, a community of investors and the assistance of professional engineers and information technology companies. Every time a company or energy group is lost, the energy complex is weakened. The reverse is also true.
6. **Support the energy component of Oklahoma higher education.** This means supporting NELPI and Sarkeys. This means maintaining the strength of the TU and OU Petroleum Engineering and Geological Sciences programs. This means broadening the business schools' curricula to include courses on international petroleum business and transactions. This means calling to the attention of companies everywhere the research capabilities of the Petroleum Abstracts division at TU. This means keeping a large suite of energy courses at the three law schools.

7. **Publicize Oklahoma's expertise in the energy area.** How many know that as many rigs are drilling in Oklahoma today as in Saudi Arabia, Iran and Venezuela combined? How many are aware of the significance of the Cushing terminal in world petroleum markets? How many are aware of the extent of the Oklahoma energy complex?
8. **Keep the National Petroleum Technology Office open and in Tulsa.** Each year there are those in the federal government who attempt to terminate this essential function of the US Department of Energy. We need to let our representatives know how important this office is for Tulsa. (The U.S. has had only one federal petroleum energy research facility and it is in Tulsa. It has a budget of approximately \$50 million per year and a large number of highly skilled energy experts on the staff.)
9. **Continue to improve the state's educational system and quality of life.** Make this state the place to maintain an office or laboratory. Establish better airline service. In a worldwide energy economy, the ability to travel easily and efficiently is key to remaining a technology center. We could attract many of the companies located elsewhere if we could provide direct air service.

CONCLUSION

Oklahoma energy companies have a long history of involvement around the nation and abroad. From the wells drilled in Sherwood Forest by drillers from Ardmore that helped fuel the British fighter planes in WWII to the pipelines laid in Iran by the Williams Company, Okie oilmen, engineers and investors have played a major role in the development of energy resources around the nation and the world. In the process, they have built Oklahoma and they have assembled knowledge and expertise on a world-class basis. In a knowledge-intensive world, this expertise is a state treasure. We must remember that Silicon Valley developed not because of any tangible natural resources, but because of the skilled and entrepreneurial people assembled there.

The Energy Weather Project at OU

Institute for Energy Economics and Policy, University of Oklahoma

Students: Enmanuel Cabrera, Alicia Fitts, Reed Timmer and Xiaoyi Mu

Faculty Advisors: Peter Lamb, PhD CIMMS, Dennis O'Brien, PhD IEEP, and Mike Richman, PhD CIMMS

Town Hall Introduction

The University of Oklahoma provides national class programs in several academic and research areas. Two that are especially noteworthy are the programs in energy and meteorology. This sample report illustrates how "energy knowledge can be marketed".

This abstracted report was provided by The University of Oklahoma Sarkeys Energy Center Institute for Energy Economics & Policy (IEEP). The mission of the Center is to develop quality research and technical understanding of energy systems, organization, and global supply and demand. IEEP is an experienced facilitator and provider of strategic advice for energy organizations, boards and management.

Directed by Brock Chair and Professor, Dr. Dennis O'Brien, formerly Deputy Assistant Secretary for International Energy Security for the U.S. Department of Energy and an executive with Caltex Petroleum Corp., the IEEP focuses on the global energy industry and its relationship with national and state energy industry issues and policy.

The institute brings together the extensive resources of the University of Oklahoma in business, economics, and energy sciences, as well as external resources to address key economic, technology, geopolitical, political, and social policy issues related to energy.

In addition, IEEP focuses on important energy relationships in the Middle East, Latin America, Asia-Pacific, and their relationship with the United States and Oklahoma.

Executive Summary

In June of 2002 the Energy Weather Project (EWP) began its research into the correlation between weather and energy commodity prices. The project's objective was threefold.

First, the project provided an opportunity for an interdisciplinary approach to research and learning for a team of four graduate students.

Second, the project afforded the team and the university an opportunity to research a relationship that is critical to the operations and finances of the global energy sector.

And third, the research undertaken could be utilized to develop forecast models which would likely hold some commercial value within the sector.

The research would support the publication of a Seasonal Outlook with monthly updates throughout the Season to be distributed to individuals and companies within the sector.

The team has already established a strong correlation between weather, demand, and energy commodity prices. Our experience suggests that additional research into this correlation and into the correlation between weather, supply and energy commodity prices would support numerous additional research topics for graduate students as well as meeting a growing need for this data within the energy industry.

Further, our research suggests that weather must not only be forecast over the longer term in order to provide seasonal price trends, but also must be forecast on a shorter term basis in order to better predict prices in the daily and weekly spot

markets. Future research will therefore be directed towards the development of weather forecasts which offer ten to fourteen day predictions and the development of energy models which relate both demand and supply with energy commodity prices.

The following report provides an introduction to the EWP, background on the need for research, a summary of accomplishments, an analysis of the research thus far completed, and the team's thoughts on future research necessary to further the EWP's work, along with some conclusions regarding the project.

Introduction

With the threefold objectives of providing an interdisciplinary learning and research opportunity for four graduate students, providing research on a critical issue for the energy sector, and developing a commercially viable product for that sector, the EWP began its work in June of 2002.

The EWP's primary goal was to research and analyze the correlation between weather and energy commodity prices. Research would include the development of models which would in turn support, along with analysis of weather, macroeconomic and geopolitical issues, the publication of a Seasonal Outlook, along with monthly updates. This publication would be shared with the energy sector.

A secondary and longer term goal was to research the potential impacts of Climate Change on the energy sector. The research was to utilize University of Oklahoma's expertise in both meteorology and energy. It was also intended to support a growing commercial demand for a product that relates weather to energy.

The EWP's team is composed of four members, each representing a different academic discipline, and is guided by Dr. Dennis O'Brien, Energy Economics, and Dr. Peter Lamb, Meteorology and Dr. Mike Richman, Meteorology.

Background

As the energy sector's understanding of the impact of meteorology, including both weather and climate change, on its operations and finances has increased, the demand for products which provide weather and energy commodity pricing analysis has increased. It is estimated that weather alone impacts some twenty percent of the national economy. Over seventy percent of all businesses across a wide range of sectors face some degree of weather risk. The energy sector is no exception with weather affecting each and every component of the value chain.

With technological advances in information gathering and sharing, there has been enormous growth in the development of products which attempt to provide data and mitigate the associated risks. For example, weather derivatives allow companies within a variety of industries to offset some of this risk. While the first weather derivative transaction occurred only in 1997, these products have become the fastest growing of all derivatives globally. Weather derivatives are dependent upon an understanding of the risks inherent in both weather and energy and of the relationship between the two variables. They are even more dependent upon weather and energy data, in any number of forms and from any number of sources.

Initial research into this information suggested that while there are numerous sources of weather information and an equal number of sources pertaining to energy commodity pricing, there are very limited sources of information which analyze the correlation between these two variables and which also take into consideration non weather variables such as macroeconomic and geopolitical issues.

Additionally, sources which provide an analytical model that could be used by the industry as a basis for operational or financial planning are far less numerous, pointing to the need for a concise and comprehensive forecast mechanism, supported by state of the art research and analysis. One of the

EWP's objectives was to develop a product that could meet this need.

The EWP initially chose to focus its research on the four commodities most impacted by weather during the Winter Season (November through March) and utilized by the highest number of consumers, both residential and commercial. These commodities were crude oil, heating oil, propane, and natural gas. The degree to which weather and other variables such as geopolitical and macroeconomic considerations affects each of these commodities differs as a result of the varying demand and supply relationships for each commodity. For the purpose of this brief overview of those relationships, it is important to realize that heating oil and propane are products refined out of crude oil. Natural gas can be a by product of crude oil or can be produced independently of crude oil.

Crude oil prices are driven not only by national demand impacted by weather and macroeconomic variables but also by supply variables impacted by geopolitical dynamics such as the war in Iraq. Demand is across both residential and commercial sectors and is distributed across the country. These variables all affect prices on a year round basis.

Additionally, prices can be influenced by the refining sector's forecasts of demand for particular products which can be produced out of crude oil. For example, during the Winter Season, refiners focus on maximizing production of heating oil while during the summer the focus is on maximizing production of gasoline.

The refining sector can also influence prices based upon their forecasts of stock or inventory levels relative to past years' demand and supply. For example, if weather forecasts suggest that demand will be exceptionally high but refiners forecast stocks to be at historically low levels, prices will rise and vice versa. These forecasts of supply can be based less on actual physical inventories than on perceptions of demand and the ability of the market to supply that demand.

Heating oil prices are driven by regional demand (the Northeast) impacted significantly by weather especially during the Winter Season and affected by the price of crude oil. Heating oil is approximately twenty five percent of a barrel of oil; its price tends to follow that of crude oil. For each dollar increase in a barrel of crude oil, heating oil prices tend to increase about twenty cents.

Additionally, heating oil prices can be significantly impacted by supply interruptions due to severe weather and unrelated to crude oil supply. For example, while refiners may produce adequate amounts of heating oil to meet demand, hard freezes on rivers in the Northeast have been known to slow or stop the movement of heating oil by barge. Demand is largely residential and is skewed to heavier population areas within the Northeast. These variables affect heating oil on a seasonal basis.

Propane prices are driven by weather related demand in the Midwest and Great Plains primarily in the residential sector. While these areas represent a broader geographic area than the Northeast and often have similar Winter Season weather to the Northeast, propane prices tend to be less volatile because these areas have less population and thus less demand. Demand tends to be seasonal.

Natural gas prices are driven by weather related demand across the nation and across residential and commercial sectors. Supply can be impacted by severe weather in producing regions such as the Gulf Coast. For example, tropical storms have been known to shut down operations for several days. Prices are somewhat seasonal as a result of higher demand in the Winter Season. However, this seasonal price swings have been alleviated as many utilities switch to natural gas to produce electricity, for which demand peaks in the Summer Season. Prices can also be impacted by the distribution system for natural gas. Because most natural gas is produced in the Mid-Continent and the Gulf of Mexico and most demand is in the population centers in the Northeast and on the

West Coast, it must be transported across an elaborate network of pipelines, all of which are subject to weather. An additional variable which can impact natural gas prices is tied to fuel switching. Once natural gas prices or crude oil prices hit certain levels, commercial consumers will switch from one to the other depending on which is cheaper. Fuel switching has had less of an impact on prices in recent years because most of the commercial consumers who are capable of making the switch did so in earlier years when the gap between natural gas and crude prices was much more significant.

As the brief overview above suggests, the variables affecting energy commodity prices can be complex. What is apparent, and what is supported by the EWP's research is the correlation between weather and demand, especially on a regional basis, and between weather and supply.

Conclusions

It is apparent from the EWP's interactions with the energy sector that there is an increasing demand for the research currently underway. Changes within the energy industry, whether it is the impact of shifts amongst the trading companies or deregulation in the electricity markets, all force companies to operate with an increasingly heavy emphasis on risk management. The EWP continues to offer the University of Oklahoma a unique opportunity to provide many of its corporate supporters and other companies with the combination of interdisciplinary expertise from a nationally renowned university and a database management system currently not matched in the market to help companies better evaluate and manage risk related to weather and energy.

It is also apparent that there are numerous opportunities both within the university and outside of it for cooperative research using as a foundation the research that the EWP has begun. For example, Dr. Daniel Sutter, Economics, has

met with the EWP to discuss the development of a case study format which would enhance his research into the value of weather forecasts for the energy sector, and particularly for utilities. Cal Kilgore, an alumnus of the University of Oklahoma, of the EAI, has indicated his support for the inclusion of the EWP's weather analysis on their website if we can provide it in a format consistent with their current reports. Don Murry, Vice President, CH Guernsey, has met with us to discuss and compare the forecast models and analysis currently being undertaken at his firm and synergies with the EWP.

Further, there is continued corporate interest in the EWP's research. For example, Samson, a large independent energy company based in Tulsa, has requested that the EWP meet with them to share our results. JM Huber, another independent energy company, based in Houston, is also interested.

However, just as the market in which these companies operate is undergoing constant change, so the research that the EWP is undertaking will need to evolve. The EWP should continue to build upon not only its own research but also that within the university both from faculty and students in order to develop results which can be effectively utilized within the energy sector. In order to evolve, additional resources are necessary. Qualified graduate students who bring the benefits of interdisciplinary and diverse background to the project are critical as is continued funding to support these students and the research of which they are capable. The EWP estimates that excluding start up expenses, average monthly operating expenses are approximately \$4,000 per month during the Fall and Spring semesters and \$6,000 per month during the Summer.

The EWP has clearly demonstrated the value of an interdisciplinary approach to research as well as the potential value of that research in the marketplace.

Institute for Energy Economics & Policy

Renewable Alternative Energy Sources
Looking to Oklahoma's Energy Future

*Mark Meo, PhD, Science and Public Policy Program & School of Civil Engineering and Environmental Science,
University of Oklahoma; and Steven J. Stadler, PhD, Department of Geography Oklahoma State University*

Town Hall Comments

This section is about renewable energy resources, one of the three major sections of Secretary Sullivan's proposed Energy Strategy for Oklahoma.

Dr. Meo and Dr. Sadler are university-based proponents of alternative energy sources. they were asked to contribute this piece and to discuss the several forms of alternative energy sources.

You will notice that this section emphasizes wind power while also discussing biomass, solar and other forms. This emphasis upon wind power is for practical reasons.

First, there is a great potential in Oklahoma. Second, two major wind farms will be operation by the end of 2003. And third, the Oklahoma Corporation commission has officially adopted a rate structure for in generated electricity. In other words, wind power is here in one form or another.

Lastly, wind generated electricity seems to be the most cost effective alternative energy source available today and the trend is for it to be more economical in the future.

For these reasons we also solicited the perspectives of AEP, a major national producer of electricity. AEP is very active in wind power generation in the private sector.

Oklahoma has already adopted tax incentives for this form of energy. The next step will be to accelerate this progress and tackle the physics of electricity storage and transmission of wind generated electricity.

Introduction

Almost three decades ago, the United States was confronted with a national energy crisis that drew painful attention to the nation's growing dependence on imported petroleum and the unpleasant impacts associated with escalating costs and sudden interruptions in supply. In relatively short order, public interest was captivated by alternative energy sources that were domestically abundant yet relatively undeveloped and underutilized.

Federal research and development was begun in earnest to capture the energy available from such familiar and omnipresent renewable resources as the sun, the wind, and the crops and trees that flourished on the bountiful plains and forests that covered the land. Although subsequent declines in the real cost of imported petroleum heralded the end of large-scale government development programs such as the Synthetic Fuels Corporation by the early 1980s, interest in developing more affordable renewable energy technologies continued, albeit at a much reduced level of funding and political support.

Today, the level of public interest in renewable energy has been reawakened, and the prospects for Oklahoma to become involved with the expanded use of innovative technologies that were once perceived as distant dreams are emerging rapidly.

Not only has the nation once again been reminded of the perils of international political unrest and the real risks of domestic terrorism, but nation states, energy industries, and concerned citizens everywhere have become more aware of the negative potential that over-reliance on carbon-intensive energy resources portends for the future climate of the planet. In addition, the decades-long effort to reduce costs and develop more

economically competitive technologies has begun to bear fruit. Wind power today is commercially competitive with electricity produced from natural gas [see *Renewable Energy Cost Trends*]. And as the price of natural gas continues to rise and remain high, a larger number of renewable energy technologies will become more commercially competitive.

As cumulative scientific evidence tilts the balance of informed opinion toward the national benefits of attaining a more sustainable society, government and industry leaders have begun to re-think the role of renewable energy systems to provide enhanced security, a cleaner environment, and a more sustainable economy.

To this end, the United States and Europe have both announced a shared commitment to develop a cleaner hydrogen-powered future complete with the energy infrastructure needed to produce, distribute, and consume the fuel. In a parallel manner, all of the world's major automotive manufacturers have begun to invest billions of dollars into the development of hydrogen-powered vehicles as well as stationary power plants that employ fuel cells which convert hydrogen into electric energy and harmless water vapor. The breadth and depth of this commitment to sustainable energy is very likely to reduce the cost of these technologies and foster their widespread adoption and use in the near future.

For Oklahoma, the pace of change is already noticeable. By the end of this year, the state will see the opening of its first utility-scale wind farms located in the Slick Hills near Lawton (at Blue Canyon) and the Woodward area. With a combined total of 175 megawatts (MW) of power produced at these wind farms (with the potential for more in the future), Oklahoma Gas & Electric customers for the first time will be able to purchase "green" electrons from the utility. In addition, the state Department of Commerce announced in July the opening of Oklahoma's first "E-85" ethyl alcohol fuel filling station in Oklahoma City. With the equally rapid development of renewable energy

systems in the neighboring states of Kansas, New Mexico, and Texas, it is becoming more evident that the future of alternative energy has finally arrived.

In this review, we will discuss two forms of renewable energy that have been the subject of study at the University of Oklahoma and Oklahoma State University.

(1) First, we address the prospects of ethyl alcohol (ethanol) production in the state and the multiple energy products that can be produced from biomass (i.e. *grassohol* made from plant matter).

(2) Next we will review the approach taken by the Oklahoma Wind Power Initiative (OWPI) to assess the potential for wind power development in the state. Following this discussion, we summarize the influence of current and future policy on Oklahoma's renewable energy resources, and discuss the implications for the future.

Economics of an Oklahoma Ethanol Industry

Ethanol is the third largest use of corn crop accounting for approximately 7% of the nation's corn crop. Ethanol production has increased over 500% in the last 10 years and there are over 30 plants now under construction. Farmer-owned cooperatives account for over 50% of ethanol production. Currently, the major use of ethanol is for blending in cities designated as EPA "non-attainment" areas. Ethanol also functions as an octane enhancing blending agent. The possible elimination of the popular petroleum based octane booster (MTBE) and increased interest in bio-based fuels has stimulated this rapid industry growth.

Ethanol prices depend upon the price of feedstuffs (mostly corn) and the price of unleaded gas. The ten year average wholesale price (before all tax effects) of ethanol is around \$1.10/gallon which is significantly higher than the before-tax price of unleaded gasoline which has averaged around \$.70/gallon. The viability of ethanol production is therefore dependent upon federal tax incentives

(around \$.50/gallon) and additional state tax incentives.

The major cost factors of ethanol are grain, natural gas, labor and transportation. Each \$.25 increase in grain price impacts the costs and profitability of a typical 30 million gallon per year (MPGY) plant by over \$3M. The availability and price of the distiller grain by-products is also an important consideration. A 30 million gallon/year plant produces over 93 million tons of wet distillers grain by-product, or an amount sufficient for a 175,000 head cattle feeding operation. Natural gas inputs account for \$.10-\$.20 gallon of ethanol production cost. Each \$1/MCF change in natural gas price will impact the costs of a typical 20 MPG/Year plant by over \$1.3M.

The outlook for ethanol depends on whether the anticipated increased utilization outpaces production growth. The establishment of an Oklahoma ethanol production industry would have a positive impact (5-10¢/bu) on the grain feedstuff.

Local communities could also benefit since over 80% of revenue generated by an ethanol plant is likely to be expended within a 50-mile radius of the plant. Oklahoma is a feed grain deficit state. In the absence of other advantages, Oklahoma is unlikely to be a competitive (least cost producer) ethanol producer using corn or milo feedstuff. Oklahoma does have potential advantages in natural gas prices and in utilization of the distillers grain by-products. The profitability of Oklahoma ethanol plants will be impacted by grain, natural gas, distillers grain and unleaded gasoline prices.

Currently, interest in Oklahoma ethanol production is focusing on the use of a new hulless barley. Barley would provide a better agronomic fit with Oklahoma, particularly if winter grazing is feasible. It is difficult to determine whether the hulless barley can provide sufficient returns to the producers and be a cost competitive feedstuff for the ethanol producer. New technologies for ethanol production are focusing on the use of bio-fuels such as switchgrass, wheat or rice straw, corn

stalks or municipal wastes. The realization of these technologies would pose threats to existing grain based plants as well as opportunities for new bio-fuel based production.

The Oklahoma GRASSAHOL Initiative

Most of the ethanol produced in the U.S. is from fermentation of corn grain. Conversion technologies used in the grain-based fermentation systems are approaching their inherent theoretical limits. Alternative methods for producing ethanol and other biobased products have been developed that are based upon the use of low-valued lignocellulosic biomass such as crop residue and perennial grasses. One of the alternative technologies is gasification-fermentation.

The primary mission of the Oklahoma/Mississippi Consortium (consisting of Oklahoma State University, University of Oklahoma and Mississippi State University) is to further develop the gasification-fermentation technology to produce ethanol and other valuable products. In the proposed bioconversion process, biomass is combusted in a gasifier under conditions of controlled oxygen supply where all of the components (cellulose, hemicellulose, and lignin) are pyrolyzed to a gas known as synthesis gas (primarily CO, CO₂, and H₂).

The syngas then flows through a cleaning and cooling system, and is subsequently directed to a bioreactor where it is microbially catalyzed to a mixture of ethanol, inert gases, water, and other potentially useful products such as acetic acid. From the bioreactor, the mixture is further processed to separate and recover the essential products, especially ethanol which is then distilled into a fuel grade product. This bioconversion process utilizes the total biomass, including lignin, thereby increasing ethanol yield by more than 20 percent over the corn starch fermentation process.

Preliminary production cost estimates are less than \$1.00 per gallon, significantly less than current industry capabilities. In addition, much higher

carbon conversion efficiencies are realized in this process over other processes.

It is envisioned that this work could result in the establishment of numerous centralized, small to medium scale ethanol production facilities that can be located throughout cultured biomass production and waste biomass generation areas which will be used to convert these biomass sources into a utilizable and profitable fuel source. Additionally, since many areas in both Oklahoma and Mississippi are among the poorest regions of the United States, this project will stimulate economic development with the realization of the vision. Additionally, a significant portion of the industrial base in or near Oklahoma and Mississippi is heavily oriented toward petroleum refining, allowing for easy implementation of ethanol-gasoline blending as policies and incentives change.

Oklahoma Wind Power Assessment

As the fastest growing renewable energy resource in the world, wind power has become an attractive energy option for turbine manufacturers, such as GE Wind Energy, as well as for energy development companies concerned about providing power that is clean, inexpensive, and sustainable. In the Great Plains region, Oklahoma's wind resource holds promise for developers and landowners who wish to benefit from the nation's growing desire to secure reliable energy supplies from domestic resources.

Many facets of wind-farm development—permitting, land leasing, and construction, to name a few—involve aspects that oil and gas industry professionals are well equipped to handle. However, wind-resource evaluation is quite different from typical oil and gas exploration. Hence, a need was perceived for developing products and services for locating and evaluating wind resources to aid those who are interested in diversifying their energy sources but who lack experience in wind-resource assessment. Furthermore, because an in-state ownership scenario returns economic benefits to Oklahoma

that are many times the economic returns from ownership by out-of-state concerns, these products and services are thought to be an important stepping-stone toward promoting economic development in the state.

The Oklahoma Wind Power Initiative (OWPI) began in July 2000 with a mission to provide wind-resource information and outreach to stimulate wind-power development in the state. OWPI's principal products include long-term wind-energy climate products and statewide wind-resource maps (see <http://www.ocgi.okstate.edu/owpi>).

One of OWPI's many goals is to develop and improve high-resolution (1 km or better) wind-power maps for Oklahoma at heights of 50 m and more, corresponding to hubheights of many modern wind turbines.

Prior to this study, the best resource map available for Oklahoma was developed by the U.S. Department of Energy and Pacific Northwest National Laboratory in 1987 as part of their nationwide assessment. The model grid from which this map was generated had a resolution of one-third degree longitude by one-fourth degree latitude, or approximately 25 to 30 km in each dimension (Elliott and others, 1987). At the time of its development, the primary source of wind data was from National Weather Service and military weather stations, which are spaced relatively far apart.

The creation of a wind-resource map for the entire country was ambitious and offered very good information for the time, but the resolution was too coarse to permit discernment of localized favorable terrain and vegetative features. Hence, this map is not practical to use for highly localized wind-farm prospecting or for development of state-scale economic models.

To provide maps with improved resolution and accuracy, OWPI investigated the use of simple models that could be run on personal computers. OWPI planned to use these models with input data

from the Oklahoma Mesonet (Mesonet), a network consisting of 114 environmental monitoring stations. These stations measure parameters from the soil and atmosphere; the data collected include readings of wind speed and direction at a height of 10 m.

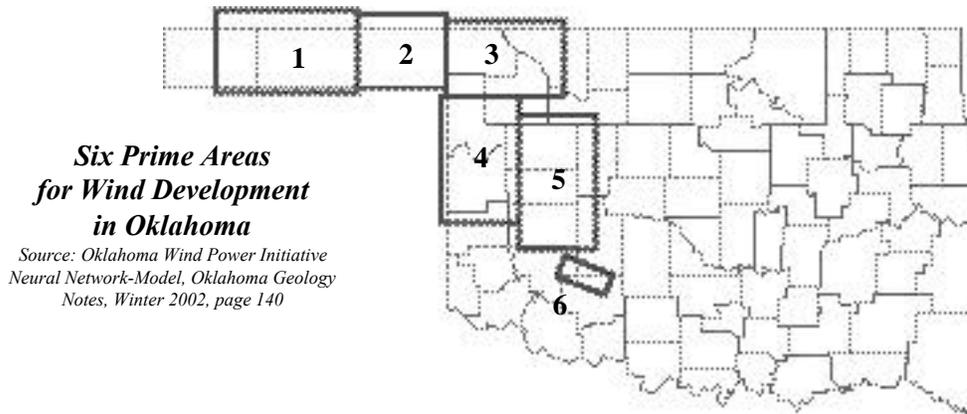
On the basis of 12 months of data collected from a 40-m tower in northwestern Oklahoma (near Buffalo), the wind resource for the tower's location was calculated to be 500 W/m² at the 40-m level. To determine if this value represents a long-term average value, it was benchmarked against a nearby Mesonet station and found to be quite close. That is, the WPD value was calculated for the benchmark station over the same data-collection period and was found to be within 0.5% of that station's average WPD, calculated by using 7 years of data.

Hence, the value of 500 W/m² could be assumed representative of long-term values. Then, using the

power law and average measured wind shear between 10 and 40 m, the 50-m WPD was estimated to be 550 W/m². According to the adjusted NN model's output (with correction factor applied), the 50-m WPD for the grid cell containing the tower was 477 W/m², whereas the WindMap model estimated a 50-m WPD of 456 W/m². WPD estimates from both models appear to be quite conservative, especially for ridges and hills. Although one validation point is not enough to justify a conclusion, informal discussions with wind-farm developers seem to substantiate that OWPI's models may underestimate true WPD by >10%.

Economic Analysis Using OWPI's Products

After obtaining a reasonable model of Oklahoma's wind resource, GIS tools were used to approximate potential economic development from this energy source. Oklahoma has several prime areas for potential wind-energy development. Starting with



**Six Prime Areas
for Wind Development
in Oklahoma**

Source: Oklahoma Wind Power Initiative
Neural Network-Model, Oklahoma Geology
Notes, Winter 2002, page 140

Region	a Capacity	b Investment	c GAR	d EALP
1 Texas/Cimarron Counties	4,910	\$3,928	\$405	\$12.1
2 Beaver County	1,890	\$1,512	\$156	\$4.7
3 Woodward-Buffalo-Alva	2,320	\$1,856	\$191	\$5.7
4 Cheyenne-Arnett	2,460	\$1,968	\$203	\$6.1
5 Weatherford-Hobart	1,970	\$1,576	\$162	\$4.0
6 Slick Hills	240	\$192	\$20	\$0.6
a Capacity	Estimates for installed megawatt capacity			
b Investment	Capital Investment (in millions of dollars)			
c GAR	Gross Annual revenues (GAR) from sale of electricity (in millions of dollars)			
d EALP	Estimated annual lease payments (EALP) to local landowners (in millions of dollars)			

the neural-network-model resource map, six regions were identified [Figure next page] and GIS tools were used to evaluate the land area in those regions. The accompanying table [next page] lists the six prime areas and gives an approximation for wind-power development potential in each, as well as the total for all six areas.

The following are important assumptions for this development model: (1) transmission capacity is not a limiting factor; (2) 30% of the area with a class 4 or better (good to excellent) wind resource is developed; (3) 9 MW of rated wind-generator capacity will be installed per square mile of developed area, on average; (4) capital investments are based on \$0.8 million per MW installed nameplate capacity (Wayne Walker, Zilkha Renewable Energy, LLC, Houston, Texas, personal communication, 2001); (5) gross annual revenues (GAR) are estimated, using benchmark figures from wind farms in existence and scaled by MW nameplate capacity; (6) GARs are based on a \$30 per MW-hour wholesale rate, assuming a 33%-capacity factor and a 95% turbine average availability; and (7) estimated annual lease payments are calculated by assuming 3% of GAR.

Under these assumptions, OWPI's resource map gives an estimate of total developable wind power of 13,790-MW nameplate capacity, corresponding to a capital investment of >\$11 billion, >\$1.1 billion in GAR, and >\$34 million per year in landowner payments.

Assuming a 33%-capacity factor and a 95% availability, a 13,790-MW nameplate capacity corresponds to almost 4,400 MW of average production, which would provide >38.5 billion kilowatt-hours every year. This amount of electricity corresponds to roughly two-thirds of Oklahoma's entire electricity generation in 2000 (see <http://www.eia.doe.gov/cneaf/electricity/epav1/ta7p2.html>). Clearly, this demonstrates a potential for Oklahoma's winds to deliver a tremendous amount of power for sale here and out of state, but only under special conditions.

For one thing, the estimate assumes no transmission constraints, and this is far from the case for Oklahoma. Without improvements to transmission facilities, Oklahoma will see less than 1,000-MW nameplate wind-generation capacity installed. Still, this model provides a useful figure to help estimate the potential development if means for transmission of electricity, or hydrogen fuel, are significantly upgraded.

Indicators for Wind's Future Role in Energy Diversification

It is expected that the future development of Oklahoma's wind resource will unfold in a variety of ways, depending on what happens in the Federal and state capitals. If Federal energy policy creates a national renewables portfolio standard (RPS), mandating that utilities provide a predetermined percentage (e.g., 10%, the rate in the U.S. Senate's version of the current National Energy Bill) of electricity from renewable sources, wind power will become immensely attractive to developers.

Should the Oklahoma Legislature promulgate a state-based RPS, such as the one now in place in Texas, the competition to develop the most attractive local sites will likewise quicken. Other issues that are likely to influence the development of Oklahoma wind resources include (1) transition to a competitive market in electric power, (2) growth in distributed energy resources, (3) growth in demand for hydrogen fuel to power fuel cells, (4) development of an emissions trading scheme to reduce carbon dioxide emissions from fossil-energy combustion, and (5) economic-development benefits that will accompany the growth of a new industry in the State.

Transition to a Competitive (Deregulated) Market.

While the transition to a more competitive market in electric power has been put on hold by many states in the wake of California's recent energy crisis, Congress has been deliberating the prospects for facilitating the development of a more competitive market in power supply.

Since policy makers recognize that the national electric grid was never envisioned to transfer power from a large number of generators to an equally large numbers of consumers, widespread development of wind power may have to wait until the grid is improved. Advocates of wind-energy development are now actively pushing for grid-improvement plans that pay attention to utilizing the tremendous wind resource available in the Great Plains and moving its energy to large markets across the country. With fair access to an improved nationwide grid, and hence to distant areas with large appetites for energy, wind's environmental and competitive advantage (including its value as a hedge against fuel-cost spikes) will spur development immensely.

Distributed Energy.

Continued reductions in the cost of wind power have made it economically attractive to developers who may wish to enter a distributed market for energy supply. Distributed generation offers opportunities for small wind farms to serve local users directly, and small wind farms offer opportunities for local ownership, thereby increasing economic returns to in-State concerns.

Furthermore, while feeding into electrical distribution systems offers technical challenges, one large advantage is that wind-farm development will not be restricted to proximity to transmission lines with capacity. This offers more opportunity for economic development in remote rural communities. Small, locally owned, utility-scale wind farms (with 1–10-MW capacity) have been in place in Europe for some time. Minnesota offers a recent model for such development that is working in the United States (Miller, 2002); owners of large wind turbines there expect to earn 10 to 15 times the income they would realize as landowners selling wind rights, or up to \$30,000 per year per turbine. After loans are retired, the annual income from each turbine jumps to \$80,000.

Production of Hydrogen for Fuel Cells.

In addition to producing electricity, developers in windy regions in the Great Plains may also find it attractive to store energy in the form of hydrogen,

made by splitting water into its component elements. With the emergence of hydrogen powered fuel cells for mobile as well as stationary power use, parts of the Great Plains could emerge as important sources of fuel for automobiles and for fuel cells sized to provide power to houses. For Oklahoma, the rapid emergence of fuel-cell usage over the coming decade would lead the next boom in a storied history of energy supply.

Carbon Dioxide–Emissions Trading.

Growing concern about global climate change has led a number of companies to search for ways to reduce their emissions of carbon dioxide. While many strategies exist for sequestering carbon dioxide, such as pumping it underground for storage in partly empty oil and gas reservoirs, the lack of gaseous emissions associated with wind power makes it especially attractive to industries that are looking for cost effective ways to purchase carbon credits. The emergence of a national market in carbon credits, similar to the international market that was created by the Kyoto Protocol, will enhance the domestic appeal of wind-power development.

Economic Development.

Wind-power development has direct local economic benefits that can be captured by landowners and communities where land is leased by developers. For landowners, annual royalty payments in the range of \$2,000 to \$5,000 per turbine can be realized. Communities may see increased revenue from property taxes—revenues that would benefit their schools, roads, and other infrastructure needs.

Because wind-power systems are the most competitive of the renewable-energy technologies, wind-rich regions also have the potential to become key sites in the design and development of the next generation of these systems. In Oklahoma, the success of Bergey Windpower Company in Norman, a manufacturer of small wind turbines sold throughout the world, is a good example of the economic-development opportunities that can accrue to proactive planning and management. An important state policy incentive is now in place to

boost production and sales of small turbines. If an effective policy incentive is also put into place in Oklahoma to promote wind-farm development, Oklahoma's rural landowners and communities will reap immediate economic gains.

Furthermore, the demand for wind turbines in this area will make Oklahoma more attractive to the wind-turbine industry when it comes to locating facilities for the manufacture and maintenance of turbines and turbine parts.

Summary and Conclusions

The future of Oklahoma's energy industry is changing rapidly and renewable energy resources can be expected to play a larger role in it. As the costs of production continue to decline, wind power and liquid fuels from biomass can provide new economic development opportunities for the state. With a national commitment to develop hydrogen fuel and the vehicular infrastructure needed to use it, Oklahoma is well-positioned to engage in the future transition to cleaner burning fuels and sustainable energy systems. As concern about the potential impact of carbon dioxide on the atmosphere grows, we can expect to see increased interest in technologies that can safely sequester carbon dioxide from the atmosphere, or don't produce it at all.

With the emergence of a fuel cell-oriented future, we can expect the combined efforts of the public and private sector to continue to drive down the cost of innovative technologies and enhance the commercial appeal of Oklahoma's resources. Results from joint OU and OSU research clearly show that significant parts of western Oklahoma and the Panhandle have wind resources that make the development of large utility-scale wind farms economically feasible. These wind farms could potentially bring billions of dollars to Oklahoma in economic development. In view of finite fossil-fuel

reserves, an expected increase in demand for hydrogen fuel, and expected advances in wind, solar, and bioenergy technologies, renewable energy appears as a viable and sustainable path for energy diversification.

Acknowledgments

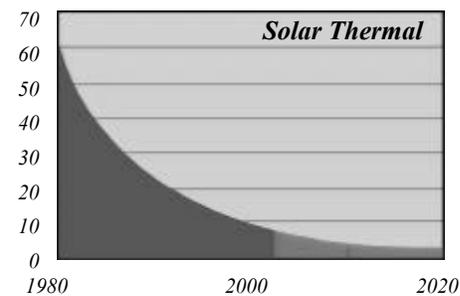
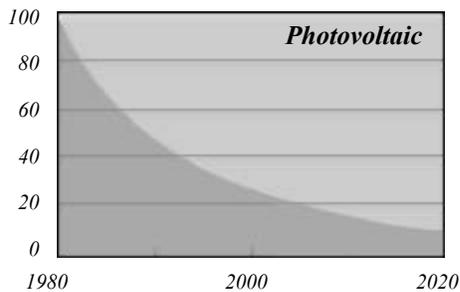
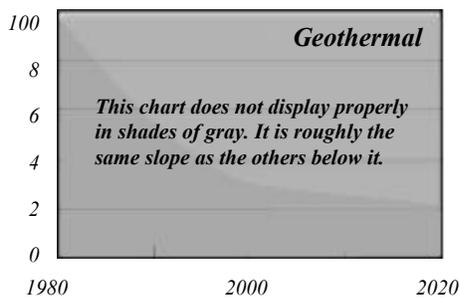
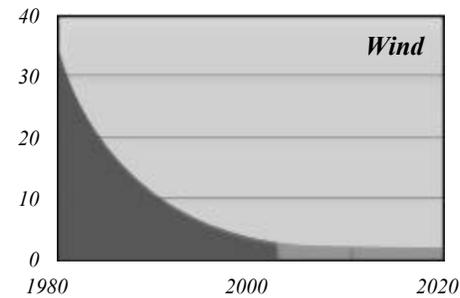
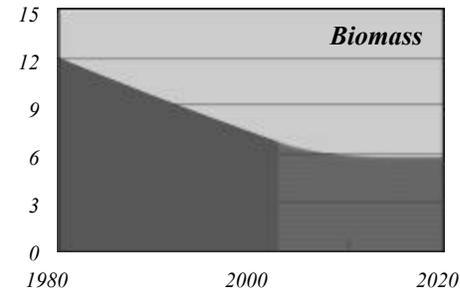
*This review draws heavily upon the ongoing work reported by Profs. Ray Huhnke and Philip Kenkel at Oklahoma State University, which they generously shared with the authors. We gratefully acknowledge their contribution. It is also based on the wind resource assessment work reported in **Oklahoma Geology Notes**, v. 62, no. 4, Winter 2002 by Timothy W. Hughes, Mark Meo, Troy Simonsen, Steven J. Stadler, and Jeremy Traurig (Developing Oklahoma Wind-Resource Models and Products: Opportunities for Energy Diversification by the Oklahoma Oil and Gas Industry). For his pioneering work in wind resource assessment, Tim Hughes received the American Wind Energy Association's Academic Achievement Award for 2003.*

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USDOE National Renewable Energy Laboratory
Renewable Electricity Technology Cost Trends
(costs in cents per kWh in constant 2000 dollars)

Source: www.nrel.gov. These graphs are reflections of historical cost trends NOT precise annual historical data. Updated: 10/02



Background

- The Cost Curves are expressed in constant, 2000 year dollars and based on a uniform set of financial assumptions consistent with Generating Company Ownership (balance-sheet financing).
- Actual project costs can vary substantially – not only over time, but from project to project – based on variables such as siting and permitting costs, land costs, transmission access, labor costs, and financing terms.
- The Cost Curves are **not based on specific project data**, but are composite representations derived from a variety of sources outlined below.
- Historic costs from 1980 to 1995 generally reflect costs that were published in various DOE Renewable Energy Program plans such as five-year program plans, annual budgets, and other program publications.
- The Future Cost Curves generally reflect how the DOE Renewable Energy Programs expect the costs of renewable energy to decrease through lowered technology costs and improved performances, resulting from R&D efforts and other factors.
- Projections of cost to 2020 for biomass, geothermal, and photovoltaic energy technologies are based on the DOE/EPRI Renewable Energy Technology Characterizations published in 1997. Wind and solar thermal costs represent more recent DOE Renewable Energy Program projections.
- The Cost Curves generally assume the availability of high-quality resources. This is an important point because systems using lower quality resources are being built, in some cases with costs as much as double those shown.
- The Cost Curves do not include the effects of tax credits or production tax incentives.

General Observations

- The renewable technology cost trends typically show a steep decline from 1980 to the present. Projections show this decline to continue, but at a slower absolute pace as the technologies mature.
- Historic cost of energy trends reflected in this chart are in broad agreement with the trends published in “Winner, Loser, or Innocent Victim? Has Renewable Energy Performed as Expected?” Renewable Energy Policy Project, Report No. 7, April 1999.

Technology Specific Notes

- Wind technology cost projections represent wind power systems in locations with Class 6 resources. Low wind-speed turbine technology is under development, which will make available large amounts of usable wind resources that are closer to transmission. Lower costs will result from design and technology improvements across the spectrum from foundations and towers, to turbine blades, hubs, generators, and electronics.
- Biomass cost projections are based on gasification technology. Lower costs will result from technology improvements indicated by current pilot plant operations and evaluation, including improvements in feedstock handling, gas processing/cleanup, and overall plant design optimization.
- Geothermal cost projections are for Flash technology. Cost reductions will result from more efficient and productive resource exploration and characterization as well as from continued improvements in heat exchangers, fluid-handling technologies, turbines, and generators.
- Solar thermal cost projections are for Parabolic Trough and Power Tower Technologies and are based on a detailed due-diligence study completed in 2002 at the request of DOE. Cost reductions will result from improved reflectors and lower-cost heliostat designs, improved solar thermal receivers, heat exchangers and fluid handling technologies, and turbines and generators, as well as from volume manufacturing.
- Photovoltaic cost projections are based on increasing penetration of thin-film technology into the building sector. Likely technology improvements include higher efficiencies, increased reliability (which can reduce module prices), improved manufacturing processes, and lower balance of system costs through technology improvements and volume sales.

Winds of Change: A Utility Perspective on Wind Energy

Richard P. Walker, Director, Business Development for AEP Wind Energy, LLC

Introduction

American Electric Power has been active in the development of wind energy resources since 1993, when it initiated its Renewable Energy Development Research Project, which included an assessment of wind and other renewable resources in Oklahoma, Texas, and Arkansas. Concurrently, it embarked upon an investigation of available technologies to convert these resources into usable electrical energy.

Preliminary findings identified the existence of abundant renewable resources as well as significant technological developments leading to steady cost reductions and efficiency improvements.

AEP now owns two of the largest wind energy projects in the world, both completed in 2001, and has been involved with two other wind projects completed in previous years. It continues to work on greenfield development of other wind sites, and has evaluated several opportunities to purchase wind projects being developed by other companies.

Technological Advances in Wind Energy

Numerous advances in wind technology have been accomplished since the early 1980's when large-scale wind projects first began appearing in the United States. These advances have helped reduce the cost of wind energy from 30 to 40 cents per kWh in the early 1980's to as low as 4 to 5 cents per kWh currently at good wind sites.

Including the value of the Federal wind energy production tax credit (PTC) reduces the cost of energy to somewhere around 3 cents per kWh, which is very cost competitive with traditional generation sources, particularly with gas prices in the range of \$5 to \$6 per MMBtu. The substantial

increase in the size of wind turbines and the height of the towers being utilized has been a large part of the decreasing cost of wind energy, as well as the economies of scale gained from much larger projects being constructed today.

Technological advances in materials and equipment have resulted in much higher efficiencies, better availability, longer turbine life, and greatly reduced maintenance, which all translates to improved economics.

Reasons for AEP's Interest in Wind Energy

AEP is the largest owner of electric generating capacity in the United States, and it relies on a variety of resources including coal, lignite, natural gas, oil, nuclear energy, hydroelectric energy, solar energy, and wind energy. All of these resources tend to have some environmental issue associated with them, but coal, lignite, and nuclear energy tend to draw the largest amount of scrutiny from the public and regulators.

Wind energy is generally regarded very favorably by the environmental community and thus helps balance the environmental risk associated with the overall fleet of generation. Natural gas price volatility and, more recently, escalating prices, makes wind generation a very attractive supply option since contracts for wind energy generally have fixed prices of anywhere from 10 to 20 years.

This certainty is valued both from the standpoint of an owner of generation and a buyer of the output. Customer, shareholder, and regulator support is another important factor to the increased use of wind energy by AEP. Several polls conducted by AEP and other companies in recent years show high levels of support among these groups for increased use of renewable energy resources.

Potential Barriers to Consider

- 1 The PTC is currently scheduled to expire at the end of 2003, and if Congress chooses not to extend this tax credit, the competitiveness of wind energy versus traditional resources will be negatively impacted.
- 2 Lack of transmission capacity in windy areas also is a problem that must be dealt with before wind energy can provide large amounts of the electricity needs of Oklahoma and the U.S.
- 3 In addition, the electric industry needs to have a better understanding of how an intermittent resource such as wind will affect the operations of the electric grid when introduced in large volumes. In the past, this was generally ignored as projects were in the 5 to 50 MW range. Now, projects of 200 to 400 MW are becoming more common, and electric system operators are now starting to take note of this resource and its impact on the system.
- 4 The wind industry needs to be aware of these concerns and engage in dialogue with transmission grid operators to understand their concerns and to help the grid operators understand how wind turbines perform.



Oklahoma's Unfulfilled Potential

U.S. Wind Energy: Potential and Installed

Shown below are the top 20 states' wind energy potential, as measured by annual energy potential in billions of kilowatt-hours, factoring in environmental and land effects. In the "installed column is the megawatts of wind power installed as of 8/1/2003.

	<i>Potential</i>	<i>Installed</i>
	<i>BKW</i>	<i>MW</i>
1 North Dakota	1,210	4.8
2 Texas	1,190	1,095.5
3 Kansas	1,070	113.7
4 South Dakota	1,030	3.0
5 Montana	1,020	0.1
6 Nebraska	868	14.0
7 Wyoming	747	140.6
8 OKLAHOMA *	725	0
9 Minnesota	657	360.6
10 Iowa	551	422.7
11 Colorado	481	61.2
12 New Mexico	435	1.3
13 Idaho	73	0
14 Michigan	65	2.4
15 New York	62	48.5
16 Illinois	61	0
17 California	59	1,832.2
18 Wisconsin	58	53
19 Maine	56	0.1
20 Missouri	52	0

Source: Potential - An Assessment of the Available Windy Land Area and Wind Energy Potential in the Contiguous United States, Pacific Northwest Laboratory, 1991. As cited at www.seic.okstate.edu/owpi/About/windresource.htm. Installed - American Wind Energy Association as of August 1, 2003. www.awea.org.

** Note: There will be two wind farms installed in Oklahoma in late 2003. The estimated capacity will be 175 megawatts.*

Renewable Alternative Energy Sources
Forecast for New Wind Power Installations

American Wind Energy Association: Provided by William R. McKamey, AEP-Public Service Company of Oklahoma

The American Wind Energy Association (AWEA) reported today that the U.S. looks likely to install 1,400-1,600 MW of new wind power this year, reducing demand for natural gas and bringing new jobs and tax revenues to cash-strapped states, while at the same time helping to achieve cleaner air. While the outlook for the balance of the year is strong, AWEA warned that the wind industry's future beyond year's end will be strongly influenced by whether Congress extends the wind production tax credit (PTC) scheduled to expire Dec. 31.

According to AWEA's quarterly assessment of the wind energy market, the wind project developments that are underway could increase the cumulative total of U.S. installed wind capacity to over 6,000 MW. That level of wind capacity will be able to produce approximately 16 billion kWh of pollution-free electricity, enough to serve 1.57 million average U.S. homes.

In the past month, a number of large projects have been announced that will increase the year-end tally. AWEA Executive Director Randall Swisher commented, "We see more reason for optimism than we did three months ago. The market appears to be firming as the end of the year draws nearer." Developers are pushing to complete projects by the end of the year in order to qualify for the PTC. A quick extension of the credit is urgently needed, Swisher said, to ensure that the momentum gained toward industry growth is not lost as it has been in the past when the credit expired: "The PTC provides a simple, yet powerful and necessary, boost to the development of clean, renewable wind power.

"The industry's growth continues to be hampered by a wide range of market barriers, from utility unfamiliarity with the technology to problems obtaining fair access to transmission lines. The

PTC provides the stimulus needed to overcome these barriers and open the market, and its extension is critical to the industry's future."

A three-year extension of the PTC is included in both the House and Senate versions of comprehensive energy legislation now pending in Congress. Swisher also called on energy bill conferees to support Senate-passed provisions that would establish a national Renewables Portfolio Standard (RPS) requiring that 10% of the nation's electricity come from renewable energy sources by 2020 and a Small Turbine Investment Credit for homeowners who install residential wind machines.

Conservation of Natural Gas

Across the country, customers are facing electricity and natural gas rate hikes due to the natural gas supply shortage. Every unit of electricity that is produced by a wind farm is one for which the country does not have to burn natural gas or other resources. AWEA estimates that an installed capacity of 6,000 MW of wind power will save approximately 0.5 billion cubic feet of natural gas per day (Bcf/day) in 2004, alleviating 10-15% of the supply pressure that is now facing the natural gas industry.

For example, FPL Energy is now putting the finishing touches on the largest wind power project to be installed in the U.S. this year -- the 204-MW New Mexico Wind Energy Center. At average production rates, that project will produce energy to supply more than 51,000 homes. More than six Bcf of natural gas per year would be needed to generate the same amount of electricity.

AWEA believes that more wind plants provide what is potentially the quickest and best supply-side option to ease the natural gas shortage (www.awea.org/newsroom)

Economic Development

The best wind power resource in the country is in rural areas, where it is a welcome source of skilled jobs, income to farmers, and taxes to the community. New wind facilities are adding high-tech jobs in places where the economy continues to stagnate.

Wind farms also expand the local tax base, and keep energy dollars in the local community instead of spending them to pay for coal or gas produced elsewhere.

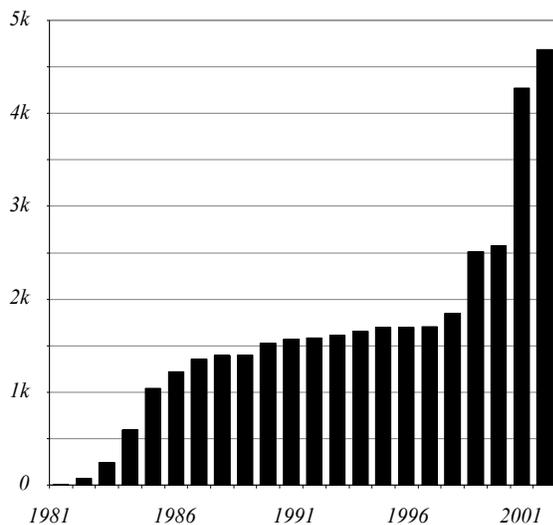
A consortium of wind power leaders -- including Shell WindEnergy, Padoma Wind Power, Green Mountain Energy Co., TXU Energy, Cielo Wind Power, and Orion Energy -- recently announced that it would build a 160-MW project in western Texas.

The consortium will lease the land for the project from private farmers and ranchers, who can receive \$2,000 to \$3,000 per turbine annually, with no more than 2.5 acres per turbine removed from production for turbines, access roads, and other equipment.

WIND POWER

U.S. Installed Capacity (Megawatts) 1981-2002

Sources: U.S. Department of Energy Wind Energy Program & AWEA



SW Oklahoma

Blue Canyon Wind Farm

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The Blue Canyon Wind Farm, to be built in partnership with Kirmart Corporation, will be located on one of the best wind sites in Oklahoma. Located approximately 15 miles northwest of Lawton, Oklahoma, Blue Canyon will offer robust transmission resources to areas served by all the major utilities and electric cooperatives in the state.

Western Farmers Electric Cooperative (WFEC) will buy all 74.25 megawatts (MW) of the electricity produced from the first phase of Blue Canyon, enough to power approximately 22,300 Oklahoma homes.

This is the first such agreement to purchase energy produced from an environmentally friendly wind farm in Oklahoma. The 20-year purchase agreement will provide wind power to WFEC's 19 rural electric cooperatives that serve farms, rural residences, towns, and commercial/industrial customers in approximately two-thirds of rural Oklahoma.

Zilkha has been developing the Blue Canyon project for over 18 months and has made major progress on several fronts, including securing more than 16,000 acres of land for the project, acquiring interconnection to the regional transmission system, and performing numerous voluntary environmental studies to ensure that local area will not be adversely impacted.

The Blue Canyon Wind Farm Project will produce as much as 300 megawatts of affordable pollution-free electricity when all phases of construction are complete. In addition to power generation, the Project will bring new jobs and tax revenues to surrounding counties.

Southwestern Oklahoma has long been known for its vigorous wind resource. The Blue Canyon Wind Farm will be built on a geological feature known as the Slick Hills. The hills rise above the surrounding plains, 300 feet in less than two and a half miles.

Renewable Alternative Energy Sources
Wind Power in Woodward, Oklahoma
Russell Ray, World Staff Writer, 08/17/2003, Tulsa World

WOODWARD -- Giant cranes plod from field to field, assembling the state's first wind farm north of this western Oklahoma town off Oklahoma 34.



Workers with Florida Power and Light, the nation's top wind farm developer, carefully hoist an 87,500-pound propeller into the air, using a large crane and some rope guides. Minutes later, the fiberglass creation is bolted to a 210-foot-high tower as cattle and horses graze among the cedar trees below.

About 50 of the 68 wind turbines planned for construction have been completed. They dominate the horizon, each standing 310 feet tall at the rotor's tip, as tall as a 20-story building.

"I haven't had anybody comment negatively about the way they look," said Project Manager Gary Bouska. "In fact, most people are surprised at how graceful they look. People are very impressed with the size."

The company expects to complete the \$102 million project late next month, and utilities may start shipping the power to Oklahoma customers by early October, officials said. Capable of producing 102 megawatts, the wind farm will generate enough electricity to power about 30,000 homes.

Last week, state regulators approved a rate plan for power produced by the wind farm. Customers of Oklahoma Gas & Electric Co., the state's largest electric utility, can purchase the wind-generated electricity for an additional 2 cents per kilowatt hour. "We'll start enrolling customers in September," said Brian Alford, a spokesman for OG&E. The surcharge, however, is offset to some extent

because customers who choose the "green power" option don't have to pay the fuel costs associated with coal or gas-fired power.

Construction of the wind farm began in mid-May. Since then, company officials have recorded wind speeds as high

as 65 mph. Several ravines within the 1,200-acre site help create the stronger winds. Like water in a waterfall, the wind currents pick up speed as they break down the ravines. "We've had wind speeds over 8 mph almost every day," Bouska said.

Half of the plant's capacity -- 51 megawatts -- is dedicated to OG&E. The other half belongs to the Oklahoma Municipal Power Authority, which provides power to 110,000 customers in 35 cities and towns.

"It's clean. It's good for Oklahoma, and it provides Oklahoma an option to have green power," he said. However, backup generation from conventional power plants must be secured by wind power providers because the wind doesn't blow all of the time. "One of the problems with wind is you can't count on it," Bouska said.

For the wind farm's landowners, the project will create a significant source of additional income. "On average, I would guess they make somewhere between \$3,000 and \$4,000 a year per turbine," Bouska said.

Known as the Oklahoma Wind Energy Center, the wind farm will employ six people permanently and will be operated by Florida Power and Light. FPL facilities accounted for 40 percent of the wind power produced in the United States last year, said company spokesman Steve Stengel.

Renewable Alternative Energy Sources
Pricing Wind Generated Electricity in Oklahoma

Tom Droege, World Staff Writer, 08/13/2003, Tulsa World

Some OG&E customers will be able to buy "green power" solely or in blocks.

Wind-generated electricity blew into the state in a big way Tuesday when the Oklahoma Corporation Commission approved a rate plan for a major utility company to provide the alternative energy to some of its customers.

Oklahoma Gas and Electric Co., the first regulated utility in the state to offer wind-generated electricity, received permission from commissioners during the hearing to move ahead with its renewable energy rate plan.

The 34-turbine wind farm where the electricity will be made is under construction near Woodward and is expected to be finished by December. It will generate about 50 megawatts of electricity, enough to power as many as 15,000 households in the area, said OG&E director of public affairs Paul Renfrow.

"As of today, we are in the wind business," Renfrow said. "This is going to test the appetite Oklahomans have for wind power."

Under the approved plan, customers will have the option to buy 100-kilowatt blocks of "green power" at a rate of 2 cents per kilowatt. Or, customers can buy green power for 100 percent of their electrical usage at 2 cents per kilowatt, he said.

Customers who opt for wind-generated electricity will pay a surcharge for the service. But they will be exempt from the fuel adjustment charge -- currently about 1.4 cents per kilowatt -- the cost utilities pay for fuel used to make electricity.

So for every 100 kilowatts of wind-generated power OG&E customers buy, they will pay \$2 and be credited \$1.40 for the fuel adjustment cost. The net result is a charge of 60 cents for 100 kilowatts of wind-generated electricity. The average home uses about 1,000 kilowatts of electricity a month.

"The pricing concept is going to be tough to explain," Renfrow said. It boils down to green power costing the consumer an average of about \$6 a month more than traditional, fuel-generated electricity, he said.

OG&E expects to roll out a marketing campaign for its wind-generated electricity in the next month and customers in the Woodward area will be able to sign up for the service as early as September.

Florida Power and Light is building and will operate the wind farm, with half of the energy produced going to OG&E and half going to the Oklahoma Municipal Power Authority.

With about 700,000 customers around the state, OG&E is the largest electricity provider in Oklahoma. AEP-PSO, which has about 500,000 customers and serves Tulsa, is unsure about the demand for wind-generated electricity in the area.

"We've not had much customer demand for it," said AEP-PSO spokesman Jeff Rennie. "We're unsure about the market, but we are monitoring it."

Nonregulated electric utilities in Oklahoma also are working on wind-power projects around the state, including one near Lawton run by Western Farmers Electric Cooperative.

Representatives from Zilkha Renewable Energy, the developer on that project, were in Oklahoma City on Tuesday along with several other wind power developers, manufacturers and advocacy groups to promote the use of wind-generated electricity. Cleanliness and availability were touted as the advantages wind power has over the more volatile fuel-generated electricity.

"Betting on natural gas right now is like betting on the stock market," said Zilkha spokesman Michael Skelly.

HyTeP Hype: State Bets on Hydrogen Future

Andrew Webb, New Mexico Business Weekly Staff, © 2003 American City Business Journals Inc.

Not since the fuel crisis of the 1970s has there been so much public and private interest in powering cars and generating electricity with hydrogen fuel cells, the only byproducts of which are pure water and heat.

International events of the last couple of years have demonstrated the United States' shaky relationship with the Middle East, the source of most of the world's oil. Moreover, pollution concerns and the knowledge that fossil fuel production cannot be sustained indefinitely, at current levels have brought a new urgency to the development of hydrogen as an alternative. As the drumbeat grows louder -- President George W. Bush recently announced \$1.2 billion in funding for hydrogen research over the next five years -- New Mexico business and political leaders say the state is poised to leverage its natural resources, fledgling fuel cell businesses and federal lab connections to be at the center of the new industry.

But to be ready for an industry some predict will hit full swing in a decade, the state will have some catching up to do.

"If we start paying attention in 2006, we're too late," says state Economic Development Secretary Rick Homans.

That in mind, a consortium of industry, business and political leaders from New Mexico and around the nation gathered in Santa Fe last week to lay out an ambitious roadmap aimed at helping the state capitalize on its fuel cell heritage and future. That plan would prepare the state's infrastructure and grow its small cadre of fuel cell-related businesses to coincide with expected increases in hydrogen research at Los Alamos National Laboratory and the fledgling industry's early steps towards commercialization, which are expected within a few years.

"New Mexico has many of the assets needed," says Kenneth Freese, a program manager at Los Alamos National Laboratory's industrial business development department. Freese is on loan to the Economic Development Department to coordinate the Hydrogen Technology Partnership, or HyTeP project, a group of about 10 industry and political leaders charged with working with the state at large to grow a fuel cell cluster. "We have research, we have hydrogen, we have an unusual constellation of bipartisan political support that is bringing together the private and public sector to identify where the opportunities lie.

"We're talking about 10 to 15 years before this is a fully developed industry. That means we have time to put in place the business infrastructure before it's needed."

Freese says New Mexico's natural resources -- abundant natural gas and sun -- are its key assets in the race to become what the economic development department calls the "hydrogen state." Among several current methods of deriving hydrogen, about half of it is produced by reforming it from natural gas. Freese says scientists believe future methods will include cracking water molecules with electricity to obtain hydrogen -- a task that could be performed with solar power.

Hydrogen is the most prevalent element in the universe. Called the "forever fuel" by some proponents of alternative energy, some scientists say it stores energy more effectively than conventional batteries, and it burns twice as efficiently in a fuel cell as gasoline in a regular internal combustion engine.

Hydrogen fuel cells were first developed in the mid-19th century, but due to a lack of necessity, the technology hibernated until the U.S. space programs in the 1960s breathed the first life into such

systems. Though the materials used to make them were then, and remain, very expensive, they proved themselves capable of providing dependable, long-lasting power -- and producing drinkable water to boot.

Fuel cells are manufactured as flat plates, each capable of producing a specific amount of current. The plates are stacked to produce more power. Hydrogen and oxygen are fed into the cells, where they are combined to make electricity in a process similar to a car battery.

But unlike a battery, which is thrown away at the end of its life, fuel cells can be resupplied indefinitely.

Researchers and supporters envision a world filled with fuel cell-powered devices -- from homes to cars, that can plug into the commercial energy grid while not in use, to sell power.

"This fuel could make obsolete our big-scale oil-polluting network, through a locally-based system," writes Jeremy Rifkin, president of the Foundation on Economic Trends and author of the book "The Hydrogen Economy: The Creation of the Worldwide Energy Web and the Redistribution of Power on Earth," in an article in the January 2003 issue of *Environmental Magazine*.

New Mexico boasts a small group of companies either fully or tangentially involved in the production of fuel cell components and related technology, including MesoFuel, Superior Micropowders and Surfact in Albuquerque, as well as Los Alamos' Energy Related Devices. They were joined at last week's workshop by representatives from large national and international corporations working to develop hydrogen fuel cell products, including as General Motors, Motorola and UTC Fuel Cells, a Connecticut supplier of hydrogen fuel cells for stationary power and the space program.

Citing the state investment council's recent authorization to invest state funds directly into companies, Homans says he envisions existing firms, new

companies, and fuel cell research from the labs coalescing to create a hydrogen economy cluster that could attract even more companies to the state to help commercialize the technology.

"We want to use the resources we just got out of the Legislature," he says.

HyTeP officials are eyeing several key stages in the coming timeline of fuel cell commercialization, Freese says. The first is the development of stationary fuel cells -- small, semi-portable units that could provide uninterrupted power to homes and commercial buildings, among other things. UTC and other companies already market such systems, he says. Next are smaller, more portable power systems for two markets -- civilian uses such as cell phones and radios, and military systems, to replace batteries for long-term power supply in the field.

Finally, he says, will be what many consider the holy grail of fuel cell application -- transportation.

But fuel cell cars are at least a decade from the showroom floor, says former Los Alamos National Laboratory scientist Byron McCormick, who now serves as executive director of fuel cell research at General Motors. Though several automotive giants are working on fuel cell-powered cars -- GM had a couple mockup examples of its futuristic-looking AUTOnomy in the parking lot -- actually selling them presents a confounding chicken-and-egg question: Where will owners get the hydrogen?

There are only a few hydrogen providers around the country, and major fuel companies have balked at the cost and perceived danger of providing compressed hydrogen without many potential customers. There are a few -- several fuel cell buses operate in the United States and Europe, and Honda last year leased a handful of its 80-horsepower, Ford Festiva-sized FCX vehicle to the city governments of Los Angeles and Tokyo, where the firm will build compressed hydrogen fueling facilities. The company currently has no plans to mass-market the vehicles, or any fuel cell cars,

anywhere, citing infrastructure and cost problems that still must be solved before such commercialization is feasible.

Until there are hydrogen stations on every corner, fuel cell transportation development is likely to center around reforming readily available gasoline, a process which does reduce pollution, but still puts carbon into the air and fails to solve the fossil-fuel dependence problem.

For now, McCormick says, key markets might lie in developing countries where fossil-fuel-burning vehicles are less ubiquitous -- allowing for "top-down" development of a hydrogen provision infrastructure.

"There are 6 billion people, and only 700 million cars," McCormick says, noting that currently, only 12 percent of the world's population has access to automobiles.

The trick, he says, will be bringing the costs down. Though hydrogen itself isn't inherently expensive, making, transporting and storing it is, and fuel cell components include pricey, precious metals.

McCormick says General Motors and its fuel cell research partner Toyota continue to work to refine fuel cell technology with Los Alamos National Laboratories, which has a 27-year history in hydrogen research.

"New Mexico has the leadership and the technology to be a real player in this," he says.

New Mexico isn't the only state whose leaders have recognized the potential importance of the hydrogen industry. Ohio recently opened its first hydrogen fuel station for cars, and a \$100 million, three-year fuel cell initiative will include three more. The state of Michigan is developing a 700-acre, state-owned campus to provide tax-free research space for hydrogen innovators. Texas and California are also exploring the fuel cell industry, Homans says. During an afternoon brainstorming session, in which the 150 workshop attendees broke up into groups to hash out the various challenges and solutions to fostering New Mexico's hydrogen industry, several brought up the topic of differentiating the state from others gunning for "hydrogen state" status.

Economic Development Department Office of Science and Technology Director Randy Burge says the 10-person HyTeP team will spend the next few months disseminating the input received during the workshop and developing a business plan for growing the fuel cell industry in the state.

"The Economic Development Department will invite you with your ideas, we'll invite you to feed them to us," Burge says, noting the development team hopes to have planning wrapped up by the end of the summer.

Andrew Webb, NMBW Staff

awebb@bizjournals.com | 348-8324

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<http://albuquerque.bizjournals.com/albuquerque/stories/2003/05/05/story2.html>

Colorado

Business Empire Transforms Life for Colorado Ute Tribe

Ianthe Jeanne Dugan, Staff Reporter of The Wall Street Journal

IGNACIO, Colo. (June 13, 2003) -- On a cool Tuesday morning last fall, hundreds of Southern Ute Indians headed for the bank.

The Wells Fargo drive-through in this speck of a city was swamped by tribal members cashing checks for over \$10,000, prompting a teller to rush outside and tape up a sign: "No cash transactions over \$3,000 through the drive-up." Customers parked their new Cadillacs and pickup trucks and strutted inside.

It's become an annual ritual for a tribe that couldn't afford indoor toilets and electricity until the 1950s and had few jobs until the mid-'90s. Each year, the Southern Utes, whose reservation rings this tiny town, get a cut of the profits from a series of unique business ventures run by the tribe. The enterprise has made each of its 1,384 members a millionaire on paper and transformed the tribe into a powerful force shaping the future of the "Four Corners" junction of Colorado, Utah, New Mexico and Arizona.

A decade ago, the tribe, which sits on one of the biggest supplies of natural gas in the U.S., fought energy companies to open one of the first Native American gas-production operations. Then it fought its own members to reinvest most of the profits into real estate and energy ventures as far away as Hawaii and Canada.

Now the tribe is a conglomerate with \$1.45 billion in assets, making it one of the richest tribes in history and one of the few whose wealth doesn't hinge on gambling. It has new sewers, an elementary school, a lavish college-scholarship plan and the only triple-A bond rating among tribes. When the

local phone carrier buckled under the rapid expansion, the tribe built its own fiber-optic network.

"Everyone wants to keep up with the Joneses," says the 54-year-old tribal chairman, Howard Richards Sr., whose childhood home had dirt floors. "Well, now we are the Joneses."

But the road to riches has taken some dark twists. The tribe's business plans and newfound wealth have led to environmental controversies, racial tensions, even a murder. And many Southern Utes are uneasy and resentful about how the tribe's wealth is distributed, a topic that inspires shouting matches at tribal meetings and requests for orders of protection.

Once a year, the tribe splits 10% of its profits among the 600 members between 26 and 60 years old; elders get \$54,500 apiece annually. The remaining profits go into businesses mainly chosen by white executives, who dominate the tribe's top business posts.

Many tribal members say they aren't getting a fair share of the profits. Some gripe that they learn about business deals after the fact, in the local newspaper. "We've found out that the old saying is true -- money is the root of all evil," says 79-year-old Annabelle Eagle, her diamond tennis bracelet resting on a hand-made skirt. Her son, Sage Douglas Eagle Remington, 60, fears tribal leaders and white executives are gaining too much power, creating a "nouveau riche banana republic."

Tribal leaders argue that the investments will ensure riches for genera-



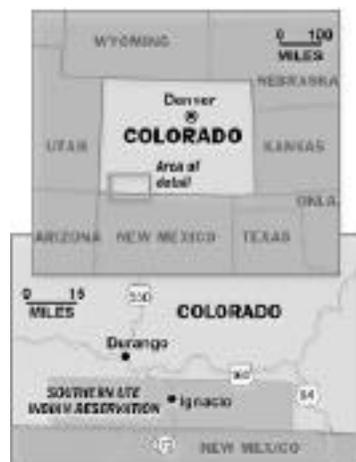
Annabelle Eagle

tions to come. "One day, we might wake up and say there's no income from oil and gas," says Leonard Burch, who retired as tribal chairman in November, after serving most of 30 years. "People say, 'We need more money.' We say, 'No, you don't. You need to invest.' "

For all the controversy, the Southern Utes' success is unfolding as a model in Indian country. Leaders of other tribes are trekking here to learn how to duplicate the Southern Utes'; achievements. And the larger Ute tribe in eponymous Utah, which also has natural gas reserves, has hired away one of the Southern Utes'; financial advisers. "They see their cousins coming to powwows in nice cars," says the adviser, John Jurrius, "and they want to know how they can work that magic."

The Southern Ute model could prove as lucrative as gambling to some tribes. Native lands contain 10% of the known onshore supply of natural gas, but most of it is mined by non-Native entities that typically pay royalties of 12.5% of sales. Tribes' royalties totaled \$200 million last year. The Southern Utes, meanwhile, pulled in \$100 million on profits from their gas-production company. They also collected half of all the natural-gas royalties paid to Indian tribes.

In the late 19th century, the Utes were driven out of the gold-rich San Juan Mountains and into the territory that now bears their name. A chunk of the tribe, now the Southern Utes, was relegated to the high desert in Colorado. Half the land was opened to non-Indian settlers, who grabbed choice tracts, creating a checkerboard of a reservation the size of Rhode Island. Now there are 1,000 Southern Utes and 15,000 others within the bounds of the reservation, including U.S. Sen. Ben Nighthorse Campbell, a Northern Cheyenne.



The Southern Ute land was too arid for farming. But "the government didn't know there was gold in them thar hills," says Mr. Burch, 69. "We had no idea what was sitting right under us."

The first glimmer came in the 1950s, when energy companies found natural gas in the area. The companies cut deals with the Bureau of Indian Affairs, which handled leases for tribes, to mine the gas from sandstone. But the royalties were so meager that in the mid-'60s the tribe suspended its \$100-a-month stipend to members for two years. It tried to boost revenue with a restaurant, a hotel and a marina on Navajo Lake, Southeast of Ignacio, but they all flopped. Its casino survived, and takes in \$9 million in profits annually, but is too remote to draw hordes of high rollers.

Then, in the late 1980s, energy companies came up with new technology to extract natural gas from coal. The Southern Utes had coal in abundance. But this time the tribe didn't want outside companies to extract the fuel. Mr. Burch, who had worked for the Bureau of Indian Affairs' realty office, came to a simple conclusion. If the tribe controlled natural-gas production, it would keep all the profits.

The tribe began buying back leases and existing wells. In 1991, it sued Amoco Co., two dozen other energy companies and 5,000 non-Ute landowners who lived on tribal land. The companies had signed leases with the landowners to extract gas from the coal on their property -- 200,000 acres that homesteaders took a century earlier. The tribe owns the coal on that land, and argued in its suit that it also owned the gas in that coal. The Southern Utes also hired engineers to assess how much fuel companies were drawing from existing leases and making sure the tribe was being paid in full. With the help of one of those engineers, they started building their own production company.

Robert Zahradnik, formerly of Exxon, helped draw up a business plan for Red Willow Production Co., calling for \$8 million in start-up capital, the tribe's annual revenue at the time. Given the tribe's history of failed businesses, it was a tough sell. But proponents won out, and in 1993 Red Willow was launched.

Still, the tribe struggled for respect. Mr. Zahradnik recalls a well owner, based on Manhattan's Park Avenue, rejecting him "with amused condescension" when he proposed buying the wells. "We could buy their building now if we wanted to," he adds.

In the late 1990s, the tribe got a huge boost when Amoco, now part of British Petroleum, agreed to turn over a 32% working interest in 400 wells on the reservation to settle the lawsuit. That move, along with acquisitions, helped the tribe leap from the reservation's 62nd biggest production company to the second, behind only BP. It now has stakes in pipelines controlling 1% of America's natural gas. (The U.S. Supreme Court ultimately ruled against the Southern Utes in the suit.)



Bob Zahradnik

As the tribe's coffers swelled, the battles began, first with the tribe's youths. Like most tribes, the Southern Utes set aside a portion of their wealth in a trust that children begin to get when they turn 18. But they saw the dangers of that arrangement in 1995, when a Southern Ute girl was shot dead, and her friend wounded, by robbers seeking the friend's "18 money," which she had received that day. The friend started the night with \$6,000, and was down to \$2,700 by the time the criminals caught up with her.

The tribe decided to distribute the 18 money in eight annual installments, instead of four, so the teenagers wouldn't get so much at once. Teenagers protested to the tribal council, to no avail.

Another alarm went off in 1997, during a retreat at the Rolling Thunder Hall, a conference room at the casino. The tribe's Department of Energy presented charts projecting that natural-gas profits would begin to decline in 2002, and that the tribe would eventually slide back into poverty. They needed a financial adviser.

Enter Mr. Jurrius, a self-described "tough-talking Texan in a suit," whom the tribe plucked from a Houston energy company. Mr. Jurrius was paid a retainer, plus a bonus if he exceeded projected profits. Neither he nor the tribe will disclose his salary.

Mr. Jurrius set up an office in a basement that had been the tribe's morgue. Working with Andersen Consulting, he came up with a plan. The tribe would establish two funds to underwrite investments and support tribal members.

The Permanent Fund would take 75% of energy royalties, and the profits from the Sky Ute Casino, and invest the money in securities. This would fund the

tribal government and pay monthly allotments of \$520 to tribal members. The rest of the royalties, and all of the profits from the tribe's energy and real-estate holdings, would go into the Growth Fund. This would distribute 10% of profits to adults under 60 and underwrite the annual elder pension. The rest of the money would be earmarked for investments, with a goal of a 15% return or better.

Tribal leaders pushed through the plan over strong opposition. Some members were still leery of big business ventures. Others questioned the fairness of the income distribution. Indian tribes consider property communal, and profits are shared equally. "I'm a capitalist working for a bunch of socialists," says Mr. Zahradnik, the Growth Fund's operating director.

The Growth Fund, which has averaged a 30% return annually, poured the tribe's natural-gas profits into far-flung real-estate and energy ventures. Recent deals include a \$123.4 million cash purchase of a Hawaiian oil and gas company and \$85 million in real-estate deals that made the Southern Utes the landlord of the Federal Aviation Administration in Kansas City and TRW in Denver.



Pearl Casias

But since big business moves were made without the input of tribal members, they began to suspect they weren't getting their fair share of the profits. The fact that outsiders served as presidents of each of the tribe's seven businesses added to the alienation. "There's a communication problem," say Tara Vigil, a 33-year-old mother of four who works for the Growth Fund. "People are saying, 'We have money, why don't we see it?'"

Members drive nice cars but park them in front of modest homes and double-wide trailers. On the big payday last fall, many members headed straight from the bank to a pawnbroker, where they retrieved \$20,000 of saddles, blankets, tools, chainsaws, jewelry and even cars.

At council meetings, tribal members accused council members of lining their pockets. (Council members won't disclose their salaries.) Occasionally, screaming matches broke out and fistfights were threatened. By far the biggest critic has been Mr. Remington, who has a shock of white hair and is summed up by the bumper sticker on his 1999 Chevy Cavalier: "Tribal Elder Who Kicks Butt." At one meeting, he demanded of Pearl Casias, the tribe's vice chairman: "Did John Jurrius buy you that car?" Ms. Casias recalls telling him she bought her convertible BMW with her own money.

"It seems like the more money we have, the less people get along," says Ms. Vigil.

During the last election, candidates opposed to the business plan appeared on the ballots in droves. But members voted in Mr. Richards, a proponent.

The grumbling goes beyond tribal members. The taxes paid on gas that comes out of the reservation account for a quarter of the taxes in La Plata County, where the tribe is now the biggest employer. But the tribe doesn't pay property taxes on land within the bounds of the reservation, and area residents fear the tribe will pull land off the tax rolls as it snaps up real estate.

Another fight centers on the tribe's plans for 1,400 acres near Durango. Area residents say that building 2,000 residential units and a half-million square feet of medical offices, stores and a new hospital will choke roads. Mr. Zahradnik expects people to both live and work in the development, thereby lessening traffic.

That is just one of several environmental battles that the tribe faces. Area residents are complaining about the environmental damage the natural-gas wells cause, which Mr. Zahradnik says the tribe has corrected.

The money has also attracted hordes of gold-diggers. Every week, the tribe shoos away people falsely claiming to be Southern Ute to get a cut of the cash, outside entrepreneurs looking for investors and romantic suitors. Hal Koenig, the tribe's criminal investigator, says that suspects frequently tell him they moved to the reservation to find a rich spouse. One such suspect landed in custody for beating his Southern Ute wife. Another stabbed someone in the street.

Some Southern Utes worry that the money will erode their culture. "Before the money, everything was easier, simpler," says Everett Burch, brother of the former chairman. People have lost their hunting skills, he says, and wouldn't know how to survive without "luxuries" such as electricity.

Tribal leaders argue that the money will help preserve the culture: With profits from its funds, the tribe has built an elementary school to teach the Southern Ute language and traditions. Meanwhile, Ms. Casias says a new apprenticeship program will elevate more members to leadership spots in the tribe's businesses. And the investment funds have begun circulating a newsletter to communicate their plans better.

Proposal Stirs Sharp Debate

THE DENVER POST

07/28/2003

WASHINGTON — Sen. Ben Nighthorse Campbell's plan to deregulate gas drilling, power plants and other energy projects on Indian land has sparked a heated debate in Indian country about the federal government's obligations to tribes.

Campbell, the only American Indian in the Senate, says his proposal would bring badly needed jobs and development to severely depressed reservation economies. The proposal is backed by the Bush administration, at least three tribes and the staff of a leading Indian energy group, the Council of Energy Resource Tribes.

The plan would allow tribes to develop their own environmental regulations, which would have to be approved by the Interior Department.

Once approved, tribes wouldn't have to wait for the federal government to do environmental impact statements — which take a year or more and cost hundreds of thousands of dollars — to do energy projects.

But the nation's biggest tribe, the Navajo Nation, is leading a host of others in a fight against the proposal, comparing it to the Navajo's disastrous entry into uranium mining during the Cold War. The mining sickened thousands of Indian miners and scarred Navajo lands with abandoned mine shafts.

Navajo President Joe Shirley Jr. says Campbell's plan would let the federal government out of its legal "trust" obligation to look out for the interests of tribes.

"I view the trust relationship between the Navajo and the U.S. government as a sacred relationship," Shirley said in an interview. "This is an issue resounding through Navajo Country."

Another leading group, the National Congress of American Indians, is in the middle, expressing "concern" that the relationship between tribes and the federal government would be reduced.

Campbell's deregulation plan — supported by Colorado's Southern Utes, the Cherokee Nation and the Jicarilla Apache Nation in New Mexico — is part of the massive energy bill moving through Congress. The Indian energy measure could be the first item up for a vote this week.

The tribes' deregulation is "totally voluntary," Campbell stressed in an interview.

Under the current system, wealthy tribes can organize their own energy deals without the oversight of the Bureau of Indian Affairs or costly environmental impact statements, Campbell said.

"The real disparity comes in where wealthy tribes can just do it on their own. Tribes with less money have to go through the federal government."

Indian land is believed to include about 10 percent of the country's domestic energy resources.

The Navajo have been joined by numerous other tribes, including the 19-tribe Inter Tribal Council of Arizona, in saying that Campbell's plan would fundamentally alter the relationship between the federal government and tribes.

Minnesota - Iowa - Texas
Other States Investing in Wind Power Generation
Oklahoma WinCharger, May/June 2003

MN Wind Projects Boosted by New Approvals

The Buffalo Ridge wind project in Minnesota got a boost when the state Public Utility Commission approved a new transmission line to carry electricity from the project to the Minneapolis-St. Paul metroarea. Xcel Energy hopes the new transmission line will be in place by 2006.

For the PUC to approve the transmission upgrade, Xcel Energy had to agree to install a total of 825 MW of wind energy on the same timetable as the upgrades to the transmission. Xcel Energy currently has about 460 MW of wind energy installed or under development. The decision by the PUC means that some 365 MW of additional wind must be built in the state in the next four years.

WinCharger Editor's Note: The transmission upgrade efforts in Texas and Minnesota clearly demonstrate those states' commitments to further development of windpower. While Oklahoma can develop a fair amount of wind farms (but less than 1000 MW) before transmission constraints stop the progress, upgrades to transmission take a long time to implement. Therefore, it is important to plan early for overcoming future transmission shortfalls.

Texas Considers Upgrading Transmission Lines

The Texas House Regulated Industries Committee recently passed a bill (HB 2548) that would encourage the development of transmission lines to West Texas wind-facilities. Wind farm development in West Texas has been slowed and much of the power produced from the wind facilities in the region is not reaching its consumers because of a lack of transmission capacity.

This bill would hopefully encourage further wind development by increasing the transmission capacity in West Texas. The bill now awaits consideration of the full House.

Iowa to Build Largest Wind Farm in the World

MidAmerican Energy, Iowa's largest utility, recently announced it will build a 310-megawatt (MW) wind facility somewhere in the north central or northwest part of the state. The project will become the world's largest land-based wind farm if completed before the expansion of the Stateline facility currently in operation in the Pacific Northwest.

At the same time, Iowa's governor, Tom Vilsack, signed into law a bill to allow investor-owned utilities to receive a state tax credit for building and owning wind facilities - something previously reserved for those companies that bought renewable energy from other sources.

The new wind farm will consist of 180 to 200 turbines, with a rated generating capacity of 1.5 to 1.65 MW each. When the wind project is complete,

MidAmerican Energy will own or have under contract in Iowa more than 435 megawatts of wind, biomass or hydroelectric energy - or 43 percent of Governor Tom Vilsack's goal of 1,000 megawatts of renewables by 2010. Iowa hosts 423 MW of wind power generating capacity, the third largest amount in the U.S. after California and Texas.

WinCharger Editor's Note: The WinCharger applauds MN and IA for developing significant amounts of wind power. It is worth noting that studies rank MN and IA no. 9 and 10, respectively, among the states for potential wind energy

AN OKLAHOMA RESOURCE

water

A PROPOSED STRATEGY FOR OKLAHOMA

Why An Oklahoma Town Hall About Water?

“Lawmakers see need for major changes in water laws” by Ray Carter, *The Journal Record*

THE JOURNAL RECORD

OKLAHOMA CITY [May 20, 2003] - While the budget shortfall has dominated much of this year's legislative session, water issues have also been a recurring theme as lawmakers have discussed bans on the sale of water, restrictions on temporary water permits and the need for scientific study of Oklahoma's water resources.

Water issues – and the fine line between the private and public property rights involved – may be revisited for several years to come, state lawmakers say.

Sen. Jay Paul Gumm, D – Durant, believes the Legislature will have to retool state law to change the way underground water is treated as private property under existing law. “A lot of Western states have already gone through the difference between ground and surface water, and I suspect that in time Oklahoma will have to go through that as well. And at that point, we'll have to make a policy decision as to what's best for the entire state. Again, that's going to be a complicated, controversial, difficult issue to tackle and we just don't have time to do it right now.”

Gumm, who authored a bill this year to prohibit the sale of water from the Arbuckle-Simpson Aquifer in southern Oklahoma until a comprehensive study of the aquifer is completed, said he believes state law currently draws an arbitrary line between groundwater and surface water.

Under current law, a property owner cannot take actions that prevent surface water from traveling downstream to neighbors in most circumstances – but groundwater can be depleted without as much concern to the impact on neighbors, he said.

“If it were surface water doing the same thing, they couldn't dam it up and take it somewhere else,” Gumm said.

Gumm and people in the southeast feel individual property owners can now sell groundwater that flows into local streams and serves as the only source of water for several communities without regard to the impact of water sales on those communities.

“Given the fact that this water doesn't stay under this property, it's almost like they're taking

advantage of a loophole in the law that groundwater is different,” Gumm said.

Other lawmakers also say the Legislature may eventually re-examine property rights issues associated with groundwater.

“Currently, in our water law, we have no connection between groundwater and surface water,” said Sen. Bruce Price, D- Hinton. “Protection spring flow is not a beneficial use under the list, so if we need to do anything, we need to address that.”

While the budget shortfall has dominated much of this year's legislative session, water issues have also been a recurring theme as lawmakers have discussed bans on the sale of water, restrictions on temporary water permits and the need for scientific study of Oklahoma's water resources.

However, Price said developing state policy to protect water flow may be difficult. He said new law would have to set specific criteria to determine when a change in water flow is caused by depletion.

“It’s affected by seasonal changes,” Price said, “How are you going to tell whether the pumping has an effect or whether the weather has the effect?”

Although officials refer to the Arbuckle-Simpson Aquifer as a “single source” aquifer, Price noted that, “it all comes from rainfall and riverflow.”

“There’s a lot of ways they recharge,” he said.

And studies have shown that the Arbuckle-Simpson recharges at a very high rate, perhaps five to six times the amount needed to offset current proposed permitted uses of water from the aquifer.

“I’m not too concerned about it being overproduced at the minute,” Price said.

Prohibiting the sale of water may also equate to wasting the resource, he said.

“We’ve got water that is wasted and goes on down the river to the Gulf of Mexico, basically – runoff from aquifers, if you will, in the spring flow,” Price said. “You might ask the question, ‘Why should we allow waste to occur when the resource is vitally needed for development use?’”

He also warned that any change in law could have serious financial consequences for property owners in the state.

“When we buy our surface land, knowing that that resource is under there, that’s part of the purchase price that we pay for that land and the right to

produce that water if we get a permit to do so,” Price said.

Sen. Owen Laughlin, R-Woodward, said Gumm’s bill and other proposed bans on the sale of groundwater – even on a temporary basis – could essentially represent an unconstitutional–“taking” of private property without compensations.

“In Oklahoma right now, we have property rights in water that lies beneath our land,” Laughlin said. “You can buy and sell those. It’s transferable. And to me this bill really strikes at the heart of those property rights, because there’s some sort of a quasi-government property right, it seems to me, to be created if the government can come in and say

we have some property right interest here; it’s not defined, but we’re going to put a moratorium on you transferring your vested property right interest in water by some overreaching government ownership interest. That concerns me a lot.”

Laughlin said the government legitimately regulates water quality to prevent one person from polluting another person’s water, “but to impose some arbitrary moratorium based on what seems to be some sort of

ownership interest by the public is troubling to me.”

He said the state can already prevent pumping if officials believe that depletion will cause long-term problems.

“A temporary water permit is just that,” Laughlin said. “It does not vest anything in the owner of that permit. It is temporary. It can be removed without due process as a matter of fact, as I understand it. So even if there is inadequate water there, the permits are only temporary.”

Lawmakers on all sides of the water issue agree that a thorough assessment of the state’s water supply and future needs should be conducted.

“We need to do a comprehensive plan for the whole state,” said Rep. Debbie Blackburn, D- Oklahoma City. “Texas has done one. That’s the reason they’re coming up here trying to get our water.”

Lawmakers on all sides of the water issue agree that a thorough assessment of the state's water supply and future needs should be conducted.

"We need to do a comprehensive plan for the whole state," said Rep. Debbie Blackburn, D-Oklahoma City. "Texas has done one. That's the reason they're coming up here trying to get our water."

In recent years, officials in north Texas tried to enter a contract with southeastern Oklahoma entities for the long-term rights to water in that area, which would have been piped to water-starved Texas communities.

Blackburn said it doesn't make sense for "a state that went through the Dust Bowl not to protect our most precious resource."

She said federal money is available to help begin a statewide water study and suggested state money should also be appropriated for that purpose, in spite of this year's budget shortfall.

"There are some things you just have to put aside in order to do something that to me is just critical," Blackburn said. "And to do just the Arbuckle-Simpson because 'that's all we can afford' is foolish."

Blackburn said the Oklahoma Water Resources Board estimates a true statewide study of Oklahoma's water resources would cost \$6 million and could take "at least five to ten years to do flow studies."

She said a study is more sensible than efforts to prevent the sale of water.

"You can't stop sales forever, indefinitely," Blackburn said.

Price said a thorough study is needed if lawmakers seriously intend to alter Oklahoma's water law.

"Our water law has been developed over several decades and I think it's extremely good water law," he said. "And before we change anything we need to be very aware of all the ramifications and not just shoot from the hip because of a current perception. And probably, rather than piecemeal it one aquifer at a time, we ought to look at the whole state and how we deal with groundwater and surface water and how those resources interact."

Price said any attempt at revising the state's water laws should rely on data collected through extensive monitoring "and not just react from emotions, which we seem to be doing right at the minute."

Blackburn said her "immediate goal" does not involve revising the way Oklahoma's property rights laws treat groundwater.

But she suggested water issues may pit individual property rights against the desire to maintain water resources for the good of the state.

"... the Oklahoma Water Resources Board estimates a true statewide study of Oklahoma's water resources would cost \$6 million and could take "at least five to ten years to do flow studies."



"Groundwater does affect surface water," she said. "They are interconnected. They're not separate. It's all a part of the same thing and it is possible to drain so much water out of an aquifer (that) it is absolutely non-replenishable. It can never be replenished in a lifetime. That is the kind of information we do not have."

New Mexico First
A New Mexico Town Hall About Water

New Mexico's Water: Perception, Reality and Imperatives, Socorro, NM, May 16-19, 2002

A New Mexico where water is valued as the lifeblood of the state's rich cultural diversity and the basis for its economic engine.

This is the vision of the 28th New Mexico First Town Hall. Establishing a framework for policy decisions that involve tough trade-offs is imperative, the attendees agreed, as is identifying institutional, technological and behavioral changes that will optimize the availability and quality of water.

New Mexico's water supply is finite and highly variable. Furthermore, in many areas it is not sustainable given present use levels, much less future needs. Also, most of the state's surface water is already spoken for, although most water rights claims have not been adjudicated. In some areas, legal rights to appropriate water exceed the amount of water available.

The Town Hall articulated four questions that pose significant challenges and offer opportunities to move New Mexico into a new era of active water management. The Town Hall declared that balance is a fundamental guiding principle: balance between sustainable supply and demand, growth and environmental protection, agricultural and municipal/industrial uses and rural & urban communities.



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New Mexico's Water Rights

Knowing who has the rights to use what water is essential for planning; yet the current adjudication process is slow, cumbersome and expensive. Increased funding for the Office of the State Engineer could allow for staff increases and database development. Further, parties should be encouraged to enter into negotiated settlements instead of litigation.

How Do Additional Factors Relevant to New Mexico Affect Our Water Resources?

Among other obligations, we must comply with Endangered Species Act standards on riparian habitat maintenance, honor Native American rights, honor the legal standard of prior appropriation of rights, conform to treaties with Mexico and meet rigid delivery schedules to fulfill our interstate river compacts. These factors are often the source of litigation; instead New Mexico should foster alternative, collaborative ways of handling such disputes. In addition, New Mexico should explore renegotiating interstate compacts, treaties and obligations. We must also find ways to store excess water above external delivery obligations in wet years.

How Will We Plan for the Future?

Planning for New Mexico's water needs is complicated by water supply variability from region to region, year to year and season to season. This reality is being addressed by current regional planning efforts, which engage stakeholders at all levels. The challenge will be to integrate regional initiatives into a statewide plan. Information is key to planning, and New Mexico needs additional resources to complete a water rights database. Finding funds to support these projects is a significant challenge, as is creating a plan that will balance the benefits of economic growth with the imperative to preserve traditional cultures and quality of life while remaining within projected supply.

How Can We Involve the Public in Addressing Critical Water Issues?

Diverse groups of people must be engaged; decision makers must be given tools; scientists must be trained. Agricultural users must be given resources and incentives to implement conservation and watershed rehabilitation programs. Better-informed citizens are more likely to participate in planning processes and help garner the support of others for decisions they help to make. Universities, the New Mexico Department of Education, the national labs and others might jointly convene public forums to debate priorities for regional and statewide water administration.

Recommendations

1. Adjudicate water rights for the entire state with the goal of completion within the next 10-15 years.

Enforcement of water rights and usage, protection against losing New Mexico's water to neighboring states and Mexico and an effective system for transferring water rights and for water banking all depend on an accurate accounting. To date, only a small portion of water rights claims have been adjudicated, so the Town Hall urges the following actions:

- *The governor, legislature and judiciary should establish and fund procedures to determine the volume and priority dates of water rights, including Native American rights, by 2018, with first priority given to interstate streams.*
- *The legislature should authorize and fund the creation of New Mexico water courts to allow specialized judicial consideration of complex water rights cases and to improve the efficiency and timeliness of adjudications and administrative appeals from the State Engineer.*

2. Aggressively develop, preserve and protect New Mexico's water resources.

The growing demand for water in New Mexico makes it imperative to supplement our finite supply with new sources and protect existing resources.

- *Adequate resources should also be provided for New Mexico's legal defense against external threats.*
- *The legislature should authorize and fund the Office of the State Engineer to provide a comprehensive water model to determine quantities and projected longevity of our water resources.*
- *An entity, preferably already existing, should be designated to coordinate and implement water-related activities. A dedicated revenue stream should be established for this purpose.*
- *Conservation should be aggressively promoted; strategies could include tax incentives, water banking, public education and involvement, structuring water rates to provide incentives for conservation and conservation technologies.*
- *Watersheds and riparian areas should be rehabilitated, protected and maintained through comprehensive management.*
- *Current and developing technologies should be deployed for the purification of water of impaired quality.*
- *Methods for reuse of treated effluent for beneficial use should be researched and implemented.*
- *Building codes should be revised to encourage water saving and harvesting designs, such as water-collecting gutters, storm sewers and landscaping.*
- *Infrastructure and systems for conservation and more efficient distribution and waste collection and disposal should be upgraded.*

- *Existing consortiums of research institutions should be developed and enhanced to work on developing technology in evaporation, sensor technology, real-time data collection, desalinization, reinjection, watershed rehabilitation and weather modification.*
- *Water law should be aggressively enforced by priority and amount and those who illegally use water as well as those who damage water infrastructure should be prosecuted.*
- *Loss of entitlements should be prevented by placing full allocations to beneficial use of the San Juan-Chama Project water and Gila River water.*

3. Provide adequate funding, appropriate organizational structure, and necessary statutory language to ensure implementation of all aspects of New Mexico's active water resource management.

The Town Hall sees an urgent need to adequately fund and coordinate the activities of all state agencies and other entities involved in water management, including:

- *water rights adjudication: administration and mediation*
- *water resources: data collection, supply determination*
- *water planning: regional, drought, conservation compliance issues (e.g., interstate river compacts, ESA, NEPA)*
- *interaction and cross-agency coordination*
- *providing accountability to the legislature*
- *providing technical assistance to communities to secure water rights and water supplies*

These elements of water management currently are assigned to specific agencies. For those that are not, the Town Hall recommends:

- *Add to the Interstate Stream Commission's statutory mandate to include explicit authority to acquire and manage water for environmental and quality of life uses.*
- *Support a State Engineer's forum to develop legislation in 2003 to address current loopholes in the permitting process, including unregulated domestic well development, lack of required metering for surface and ground water diversions and clarifying the purpose of impounding water for unregulated uses.*
- *Provide adequate funding of existing agencies to allow them to fulfill their statutory authorities.*
- *Provide resources to the OSE to exercise its authority to limit ground water diversions and require metering of domestic well use.*
- *Adequately endow the Water Trust Board and appropriate funds for water projects, especially to leverage federal funds.*
- *Avoid costly and lengthy litigation by having the 2003 legislature consider a joint memorial to the U.S. Congress asking that judicial agencies emphasize settlement of Native American water claims.*
- *Ask the state legislature for a joint memorial to encourage our congressional delegation to secure additional federal funding for our national labs and universities for water-related research and development.*

4. Create a State Water Plan, integrating regional plans, no later than December 31, 2004.

The Town Hall believes a comprehensive state water plan, reflecting significant public involvement, is a central tool for actively managing water resources. To this end, the Town Hall agrees that the legislature should mandate the creation of a state water plan, with its content elements defined, utilizing completed regional water plans to the extent practical.

The Town Hall makes these further recommendations:

- *Include in the mandate adequate funding for staff, consultants, quantification, database development and other expenses.*
- *Include in the plan mechanisms for implementation of recommendations, ongoing management of the resource and regular revisions and updates.*
- *Incorporate concepts of sustainability to ensure that short-term uses do not compromise our ability to meet long-term needs.*
- *Strengthen the existing regional water-planning template and create a state water-planning template to ensure stakeholder-driven public participation.*
- *Use the state water plan as a strategic umbrella, placing regional plans under it to generate a list of projects within the state framework, followed by prioritization of funding for projects.*
- *Provide in the plan model ordinances for small communities and templates for drought plans.*
- *Make public education an integral part of the state water plan.*

The Implementation Team should also:

- *Work with the media to ensure comprehensive, timely water-issue coverage.*
- *Recommend funding for public information officers and legislative liaisons at the Office of the State Engineer and the Interstate Stream Commission.*
- *Work with other entities in the state that can assist with public awareness.*

5. Create a recurring revenue source for funding the Office of the State Engineer, Interstate Stream Commission and Water Trust Fund.

The Town Hall believes that a long-term revenue source, in addition to general funding, is needed for managing the state's water.

State Water Plan: Issues, Problems and Recommendations

Duane Smith, Executive Director, Oklahoma Water Resources Board

Town Hall Introduction

Oklahoma has a Water Plan.

That's the good news. The bad news is that the Plan is outdated; and the plan is not robust enough to resolve contemporary issues; nor is it funded well enough to perform basic statewide planning and survey functions.

Meanwhile, our southern neighbors have recently invested considerable political capital and currency in creating an effective statewide water plan and accompanying political, regulatory and planning infrastructure. As a result, Texas has developed a new appreciation for their need for reliable water supplies.

Coincidentally and illustratively, it is this new-found need that has resulted in Texas asking to buy Oklahoma water. This proposed water sale, in turn, has set off Oklahoma's most bitter internal water dispute in many years. And to complete the circle, the proposed sale of water to Texas amplifies our weak Water Plan.

The following section is the "Issues, Problems and Recommendations" section of the existing State Water Plan. The Plan was published in 1995. Therefore the data in this section needs revision. The Plan is to be revised every 10 years with 2005 being the next target date for revision.

This section is presented to provide an overview of state issues and recommendations to provide a more responsive and effective water policy.

While a decade has elapsed since the Plan was developed, it is believed the major issues remain unaddressed and unresolved.

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.



Duane Smith

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

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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 under-appropriated stream systems where these regulations may encourage permit holders to waste water and deliberately over-report 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-tiered 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 con-

trols. 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, reluctance 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; measure-

ment 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 afford-

ing 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.

(May 1997) The U. S. Environmental Protection Agency (EPA) recently released the results of its first nationwide survey of drinking water needs. This survey estimates how much water systems need to spend now and in the next 20 years to meet current and future federal regulations. Four thousand water systems participated in the survey. The survey showed estimated total infrastructure needs in Oklahoma of \$2.031 billion. \$399 million is needed for large water systems, \$543.9 million for medium systems, and \$1.088 billion for small water systems. An estimated \$1.3 billion is needed in Oklahoma to meet existing current needs. 233.5

million dollars is needed just to meet the requirements of the federally mandated Surface Water Treatment Rule requirements in Oklahoma. An additional \$106.6 million will be needed to meet the requirements of the federally mandated Enhanced Surface Water Treatment Rule and \$140 million will be needed to meet the federally mandated Disinfectant By-product Rule which will soon be in place. It is estimated that there is a \$604 million need to upgrade distribution and storage in Oklahoma water systems.

EPA sent questionnaires to the nation's 794 large water systems and to a random sample of 2,760 water systems serving between 3,301 and 50,000 people. In addition, 537 small water systems were surveyed and the results used to estimate the needs of all water systems. EPA will use the results of this survey to allocate funding for each state for the Drinking Water State Revolving Fund.

The survey showed nationwide infrastructure needs of \$138.4 billion for the twenty-year period beginning in 1995. An estimated \$76.8 billion is need for current infrastructure improvements to protect public health. The remaining \$61.6 billion is for projects needed to provide safe drinking water through the year 2014.

The Oklahoma legislature recently authorized the Drinking Water State Revolving Fund to provide a low-interest source of funding to water systems to meet help meet these infrastructure needs in the state. The Department of Environmental Quality is working directly with public water supplies throughout Oklahoma to help them meet the requirements and obtain needed funding through the program from the OWRB.

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" (non-consumptive) 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 during drought and help use 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 Environmen-

tal 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 underground 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 features; 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 endan-

gered 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.

Data Collection & Management

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.

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 flood-plain 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 Oklahoma 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 Mesonet

The Oklahoma Mesonet (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 state-wide 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 Mesonet 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.

Issues and Problems
Public Policy Recommendations for Water

WATER RIGHTS

Stream Water Rights & Administration

- 1 The Oklahoma Water Resources Board should, within current statutory guidelines, seek to emphasize conservation and efficient use of stream water resources through improvement of the current system of water rights forfeiture/reduction and schedule of use. The OWRB should consider:
 - (a) *allowances for a permit suspension period, rather than actual cancellation of water rights, if a concerted effort is demonstrated to market the rights;*
 - (b) *forfeiture exemptions for conserved water, perhaps through allowing water users to use, sell or lease the water they conserve;*
 - (c) *establishment of more stringent limitations on the state's schedule of use provision, unless a significant investment is made, to prevent delays in putting water to beneficial use; and*
 - (d) *implementation of administrative fines for failure to report water use or falsification of water report forms.*
- 2 The OWRB should, within current statutory guidelines and accounting for the inherent inefficiencies associated with the various types of water systems, provide for the proper enforcement of conservation measures where excessive waste takes place through leaks, evaporation or other problems occurring during the use and distribution of permitted water.
- 3 The OWRB should study the implementation of a permitting system to account for seasonal changes in water availability, including development of guidelines for seasonal or monthly allocations and withdrawals that could free-up additional sources of water.
- 4 The Oklahoma Water Law Advisory Committee should explore potential OWRB rule revisions and/or statutory amendments that would provide for:

more realistic and fair determinations of "beneficial use" and "present or future need" in cases of water rights adjudications; and assessment of administrative fines for flagrant or repeated violations of permit limits.
- 5 The OWRB should implement a system to periodically check the accuracy of reported water use and consider the implementation of requirements to emphasize accountability for water, perhaps through threat of perjury (including potential development of affidavit report forms) or initiation of water use metering for right holders who knowingly falsify or consistently fail to file reports of water use.
- 6 The OWRB should complete and provide for continuous update of hydrologic surveys to accurately determine the amount of water available in Oklahoma's rivers and streams.
- 7 The OWRB should improve education of permit holders regarding water use and conservation through agency-sponsored public workshops and related efforts involving direct interaction with the public.

Instream Flow Protection

- 8 The Oklahoma Water Resources Board should work with other appropriate state and federal environmental and natural resource agencies to develop an implementation strategy that provides instream flow protection for the state's designated scenic rivers.
- 9 The OWRB and Oklahoma Department of Wildlife Conservation should work with the U.S. Army Corps of Engineers, Bureau of Reclamation and Grand River Dam Authority to ensure that existing and modified reservoir releases are managed to provide dissolved oxygen concentrations that maintain or improve downstream conditions for aquatic life and recreation.

Indian Water Rights

- 10 The Oklahoma Water Resources Board should request the Oklahoma Water Law Advisory Committee and selected tribal representatives to explore Indian water rights and quality issues in Oklahoma. Specifically, the group should:
 - (a) study formation of a permanent committee consisting of local, state, federal and Indian representatives to address appropriate water rights issues;
 - (b) develop a mutually acceptable negotiation system or process to fairly resolve current and future water rights issues; and
 - (c) identify water resource projects warranting cooperative action.
- 11 The State Legislature should consider appointing qualified Indian representatives to appropriate boards, commissions and other governing bodies of the State of Oklahoma.

WATER QUALITY

Groundwater/Stream Water Relationships

- 12 The Oklahoma Water Resources Board should:
 - (a) identify and quantify impacts that can result from the interaction between groundwaters and stream waters, especially the quality and quantity effects of groundwater withdrawal on stream water base flow;
 - (b) identify the potential benefits of the joint management and conjunctive use of state stream and groundwater supplies and develop potential management schemes which consider opportunities for watershed planning; and identify specific areas or watersheds/basins that could potentially benefit from conjunctive management and promote the formation of local advisory committees to guide management programs.

Groundwater Protection

- 13 The Oklahoma Water Resources Board should initiate studies to establish individual aquifer classifications based upon each aquifer's vulnerability to contamination.
- 14 Appropriate state environmental and natural resource agencies should adopt and implement a flexible, comprehensive state groundwater utilization plan that:
 - (a) prioritizes groundwater protection/ utilization programs and activities; and
 - (b) avoids regulations which unduly infringe upon individual property rights while protecting legitimate public interests.
- 15 Appropriate state environmental and natural resource agencies should evaluate the use of risk assessment methodology as a groundwater protection and cleanup tool.

16 The OWRB should coordinate efforts of appropriate state and federal environmental and natural resource agencies, universities and organizations to establish a comprehensive state water quantity and quality data collection program to monitor the condition of Oklahoma's stream and groundwater resources.

17 Appropriate state environmental and natural resource agencies should encourage state communities utilizing groundwater as a major water supply source to participate in voluntary state programs to protect local groundwater supplies.

Groundwater Quality Standards

18 The Oklahoma Water Resources Board, through the Water Quality Standards process, should further develop and upgrade Oklahoma's groundwater quality standards as both a protection and cleanup tool. Consideration should be given to:

- (a) development and implementation of numeric groundwater quality standards;*
- (b) development of a narrative standards statement prohibiting discharges of pollutants which result in contamination that could impair human health;*
- (c) use of risk assessment methodology;*
- (d) development and implementation of realistic, site-specific cleanup criteria to guide remediation of polluted groundwaters;*
- (e) further development of the groundwater classification system through adoption of a vulnerability mapping program utilizing DRASTIC or other appropriate methodology;*
- (f) creation of an organizational framework allowing the OWRB to separately administer stream and groundwater quality standards;*

(g) the quality/quantity relationship and interaction between stream and groundwater resources; and

(h) adoption of a specific groundwater protection policy statement that indicates what type of protection (i.e., non-degradation, limited degradation and differential protection policy statements) the state will implement or achieve.

19 The OWRB should coordinate efforts of appropriate state and federal environmental and natural resource agencies, universities and organizations to establish a comprehensive state water quantity and quality data collection program to monitor the condition of Oklahoma's stream and groundwater resources.

Nonpoint Source Pollution

20 The State Secretary of Environment should:

- (a) encourage implementation of innovative nonpoint source reduction and management practices while also stressing use of proven measures;*
- (b) assure that state programs incorporate an adequate level of watershed planning, best management practice design, water quality monitoring and assessment of progress;*
- (c) assure that state projects are focused on identified nonpoint source priority areas;*
- (d) study implementation of a comprehensive state program that accentuates voluntary nonpoint source control measures through development and implementation of appropriate management plans for operations which manage nonpoint pollution sources; and*
- (e) encourage development of technical assistance programs that promote establishment of pollution prevention plans by landowners.*

Stream Water Quality Standards

21 The Oklahoma Water Resources Board should:

(a) increase efforts to implement water quality standards, especially biological criteria and total maximum daily loads, on a watershed basis, including additional protection for Outstanding Resource Waters;

(b) utilize the input of appropriate environmental and natural resource agencies to evaluate the use of risk assessment methodology as a water resource protection and cleanup tool; and

(c) bring together appropriate state and federal environmental and natural resource agencies, state universities and other involved organizations to assess current state efforts related to the collection and dissemination of water resource data and determine the need for a centralized ambient stream and groundwater quantity and quality monitoring network in Oklahoma. The OWRB should then submit study findings and recommendations to the Governor and State Legislature.

22 Oklahoma's Congressional Delegation should encourage the federal government to:

(a) limit federally mandated actions and promote promulgation of water quality standards by individual states to allow states greater flexibility in addressing state-identified priorities and regional and/or local standards issues;

(b) continue refinement of the Total Maximum Daily Loads concept; and

(c) require water quality standards implementation procedures that consider not only criteria and permit development, but also field validation of discharge permits which protect human health and aquatic life.

WATER/WASTEWATER

Municipal & Rural Water/Wastewater

23 The State Legislature should capitalize the Statewide Water Development Revolving Fund to a level that will help ensure a continuing source of funding for water/wastewater system projects which will result in a higher quality infrastructure system for economic development and environmental protection activities.

24 The Oklahoma Water Resources Board and State Department of Commerce should identify and implement incentives through which state financial assistance programs can encourage local interest and cooperation in regional planning projects.

25 The OWRB and State Department of Environmental Quality-in cooperation with the Oklahoma Municipal League, Oklahoma Rural Water Association and other appropriate agencies and organizations-should develop a coordinated technical assistance strategy to promote interest in regionalization among local water/wastewater systems and encourage cooperation among potential regional entities. The strategy should define appropriate state, local and federal roles in regional water system planning-establishing the state as a facilitator of regional planning activities and as the primary source of information (especially through the updated Oklahoma Rural Water Survey and local needs assessments) on municipal and rural water/wastewater systems-and emphasize improved education of local water system decision-makers.

26 The OWRB, Department of Environment Quality, State Department of Commerce and other appropriate state and federal environmental/financing agencies should initiate a cooperative effort to promote privatization opportunities and assist in establishment of private/public partnerships, where appropriate, that will minimize regulation and result in decreased costs for governmental services.

Financing

27 The State Legislature should capitalize the Statewide Water Development Revolving Fund to a level that enables the Fund to meet Oklahoma's annual recurring water development needs.

28 The Oklahoma Department of Commerce should ensure that the Community Development Block Grant program continues to provide priority funding to water and wastewater projects that pose a serious or immediate threat to the health or welfare of citizens.

29 Oklahoma's Congressional Delegation should encourage the federal government to establish funding levels sufficient to satisfy upcoming Clean Water Act mandates and provide states with the maximum flexibility possible to administer state Revolving Fund programs.

RESERVOIR OPERATIONS

Allocation & Control

30 The Oklahoma Water Resources Board, Corps of Engineers, Bureau of Reclamation, Natural Resources Conservation Service and other appropriate federal, state and local entities, should initiate a cooperative effort to improve and enhance the various benefits of state reservoirs through:

(a) evaluation of individual project operations in basins throughout the state to identify where system operating plans could be implemented or existing plans improved; and

(b) pursuit of cost-effective opportunities for storage reallocation in existing projects.

31 Oklahoma communities should participate in floodplain management and flood prevention opportunities offered under the Hazard Mitigation Grant Program, including channel improvements, construction of dikes and other diversion structures, acquisition/relocation projects, and the return of land to the floodplain and/or its natural state.

32 The Oklahoma Congressional Delegation should amend the Water Resources Development Act of 1986 so that reallocation of storage is based on original construction costs, as provided in the Water Supply Act of 1958.

33 The OWRB, Corps of Engineers and other appropriate state and federal agencies should study the potential for establishing a system to manage and administer important non-consumptive water uses, such as navigation, fish and wildlife and recreation. Consideration should be given to obtaining water rights or storage and entering into memoranda of agreement for these uses.

34 The OWRB, Corps of Engineers, Bureau of Reclamation, Natural Resources Conservation Service and other appropriate federal, state and local entities should develop a mechanism- such as creation of advisory committees, consisting of representatives of appropriate water uses, or development of agency memorandums of understanding - to facilitate the implementation of modified system operating plans, where needed, and address disputes related to reservoir operations.

Maintenance & Renovation

- 35 The Oklahoma Water Resources Board, Corps of Engineers, Bureau of Reclamation, Natural Resources Conservation Service and other appropriate federal, state and local entities should undertake appropriate studies-including preliminary cost/benefit estimates-to identify potential reservoir candidates for physical modification.
- 36 The OWRB, Oklahoma Department of Transportation, State Legislature and Oklahoma's Congressional Delegation should continue to support construction of Montgomery Point Lock and Dam by the U.S. Army Corps of Engineers with a scheduled completion date of September 2001.

WATER MARKETING

Water Transfer

- 37 The State Legislature and Oklahoma Water Resources Board should review existing water statutes and identify barriers to water marketing and measures that could be instituted to better facilitate voluntary water marketing and transfers and protect affected parties, including negotiations with the federal government to avoid purchasing reservoir storage at updated costs.
- 38 The OWRB should develop a state water marketing and transfer policy, including guidelines to accomplish individual marketing projects. The policy should strongly consider problems and issues identified by the OWRB in its effort to lease surplus Kiamichi River Basin water, including:
- (a) satisfying, to the greatest extent possible, public concerns on mitigating potential impacts on local economic development;*
 - (b) protecting the most locally important uses of the transferred water; and*
- 39 The OWRB should study the feasibility of creating a state water bank to:
- (a) locate and purchase sources of available or surplus water rights and storage;*
 - (b) evaluate all opportunities for water importation and transfer;*
 - (c) coordinate the sale and/or loan of available supplies and water rights to prospective customers, including transfers through the establishment of regional systems; and*
- coordinate efforts to educate the public on water transactions.*
- 40 The OWRB should identify and investigate methods to utilize untapped sources of usable water in Oklahoma through:
- (a) development of system operating plans;*
 - (b) reallocation of reservoir storage;*
 - (c) utilization of sediment storage;*
 - (d) administrative actions, such as the cancellation and reduction of unused water rights;*
 - (e) greater consideration of reservoir storage yield that will vary according to proposed use in the receiving area; and*
 - (f) consideration of additional reservoir project construction.*

WATER SUPPLY AUGMENTATION

Weather Modification

- 41 The Governor and State Legislature should identify the state's need for (and subsequent role in) a carefully focused, multi-year cloud seeding demonstration program to determine the ultimate utility of weather modification as a water resource management tool.

Groundwater Recharge

- 42 The Oklahoma Water Resources Board should initiate a comprehensive study to identify additional potential artificial recharge areas in the state, including a detailed assessment of the Blaine Recharge Demonstration Project.
- 43 The OWRB, through the Water Law Advisory Committee, should review state water rights and water quality laws to determine what, if any, additional legislation is needed to address the various water rights and quality considerations of artificial recharge.

Reclamation & Reuse

- 44 The State Department of Health and/or Department of Environmental Quality should take an active role in establishing guidelines for the safe and authorized use of recycled wastewater, identifying programs where reuse should be automatically considered as an alternative, investigating technological opportunities for efficient water reuse and examining the effects of an expanded reuse program which considers the effects of water withdrawals on downstream users.
- 45 The Oklahoma Water Resources Board should develop measures to encourage water suppliers and individual permit holders to implement conservation/management plans-including consideration and use of return flows and treated effluent-to reduce consumptive use of stream and groundwaters.

Chloride Control

- 46 Until potential environmental impacts are resolved, Congress should not support full implementation of the Red River Chloride Control Project, as presently designed.

WATER CONSERVATION

Water Conservation

- 47 The State Legislature should promote statewide water conservation by:
 - (a) encouraging cities, water supply districts and other entities to develop and implement water conservation programs that include the addition of water-saving plumbing fixtures and household appliances in new construction and as replacements for existing fixtures;*
 - incorporating water conservation policy goals into all appropriate activities and programs of state government; all agencies responsible for constructing, leasing, or maintaining state facilities and property should be directed to use water-conserving plumbing fixtures and devices, water efficient landscape practices and other programs to maximize water use efficiency; and*
 - (b) providing appropriate funding to affected state agencies to retrofit existing state facilities with water-conserving devices.*
- 48 The Governor and State Legislature should create a permanent funding source to allow continuation of the Oklahoma Leak Detection Program.
- 49 The Oklahoma Water Resources Board and Oklahoma Rural Water Association should facilitate public education efforts to encourage participation in the Oklahoma Leak Detection Program by rural communities and water districts.

50 The State Secretary of Environment should appoint a task force of appropriate state agencies to develop a state water conservation plan that incorporates all aspects of public, agricultural and industrial water use. The plan should identify educational opportunities as well as potential incentives to encourage conservation.

51 The OWRB, Rural Development, Oklahoma Department of Commerce, Indian Health Service and other appropriate funding entities should consider incorporating incentives for development of individual water system conservation plans into their requirements for water/wastewater project financial assistance.

52 The OWRB and other appropriate state agencies should study establishment of a technical assistance program to assist industries in implementing water conservation measures.

53 The OWRB should continue to promote information among water suppliers regarding price structuring options, including the increasing block rate structure, that promote conservation while recognizing the socioeconomic requirements of Oklahoma communities. This effort should be expanded to include improved public education regarding the factors that determine the “true” cost of water (i.e., costs associated with delivery, treatment, etc.).

WATER RESOURCE PLANNING

Basin/Watershed Management

54 All appropriate state and federal water resource agencies should develop and implement watershed planning and management strategies by:

(a) delineating uniform, manageable watershed planning boundaries, such as those currently recognized by the U.S. Geological Survey, that incorporate distinct hydrologic units of both stream and groundwater resources;

(b) identifying and incorporating methodologies that facilitate the evolution of local, state and federal water resource programs to a watershed management approach;

(c) studying creation of local watershed management organizations for problem-solving and issue resolution; and

(d) coordinating implementation of Geographical Information System technology at the local, state and federal level.

Drought Preparedness

55 The Secretary of Environment should appoint a State Water Resource Drought Coordinator to coordinate federal, state and local drought response efforts in Oklahoma. The State Drought Coordinator should be charged with developing a comprehensive drought preparedness plan for mitigating the effects of drought episodes in Oklahoma. Such an effort should include the investigation of:

(a) a monitoring/early warning system-including the development and implementation of drought indices that signal the onset and/or varying stages of drought-to provide information about the timing and severity of drought episodes;

(a) techniques to assess the probable impacts of prospective drought episodes;

(b) approaches to coordinating governmental activities including information exchange and drought declaration/revocation criteria and procedures;

(c) assistance programs with pre-determined eligibility and implementation criteria;

(d) financial/research resources needed to implement drought assessment and response activities; and

(e) educational programs designed to promote drought mitigation/ preparedness among the economic sectors most impacted by drought.

Wetlands Protection & Management

56 State and federal environmental and natural resource agencies should continue efforts to develop a state comprehensive wetlands protection and management strategy that includes:

(a) defining wetlands;

(b) designating beneficial uses of wetlands;

(c) identifying and inventorying wetlands within Oklahoma;

(d) identifying measures to mitigate losses of wetlands, protect wetlands and manage them on a watershed or hydrologic unit basis;

(e) developing standards for critical wetlands;

(f) recommending measures to ensure the protection of landowner property rights while protecting legitimate public interests; and

(g) defining the roles of appropriate state agencies in wetlands protection and management.

Endangered Species

57 Appropriate state and federal environmental and natural resource agencies should facilitate increased public involvement in the Endangered Species Act administration and decision-making process.

58 The Oklahoma Water Resources Board should ensure that future state water quality standards revisions consider the comments and policies of other state and federal environmental and natural resource agencies to achieve a reasonable and environmentally-sensitive balance between protection of endangered and threatened species, economic concerns, consumptive water uses and related considerations.

59 The Oklahoma Department of Wildlife Conservation and other appropriate state and federal environmental and natural resource agencies should improve coordination, during the planning stages, in assessing the effect of existing and potential water resource development on the state's endangered and threatened species. This effort should include identification of the status of rare, threatened and endangered species in proposed project areas and development of measures to avoid potential adverse impacts.

FLOODPLAIN MANAGEMENT

Floodplain Protection & Preservation

60 The Oklahoma Water Resources Board and State Office of Civil Emergency Management should establish a committee-including representatives of the Oklahoma Conservation Commission, Oklahoma Department of Environmental Quality, Office of the State Secretary of Environment and other appropriate agencies-to consider the need for a unified statewide flood control plan that addresses such issues as National Flood Insurance Program community participation, Community Rating System participation, flood hazard mitigation, dam safety, floodplain mapping, wetlands protection, and related floodplain protection/preservation measures.

61 The State Legislature should consider enactment of:

(a) a state Emergency Disaster Response and Recovery Act to facilitate state response to major flooding and other natural disasters; and

(b) legislation to mitigate the effects of stormwater diversion projects on the regulatory floodplain, including damages to adjacent property resulting from diverted runoff.

- 62 The OWRB and Office of Civil Emergency Management should encourage Oklahoma communities to:

(a) develop and maintain a priority list of eligible hazard mitigation projects;

(b) participate in pre-disaster planning efforts;

(c) create a training program, with state assistance, for community officials to educate their residents on flood disaster preparedness;

(d) develop local stormwater management plans;

(e) strengthen enforcement of local ordinances;

(f) develop and implement responsible flood alert systems; and

(g) consider, where possible, enactment of ordinances requiring an appropriate increase in local base-flood elevations.

PROBLEM MEDIATION/ARBITRATION

Water Resource Dispute Resolution

- 63 The Oklahoma Office of Personnel Management should develop and offer training in dispute resolution to all Environment Cabinet agencies.

- 64 The Office of the Secretary of Environment should:

(a) evaluate the Administrative Procedures Act and other applicable Oklahoma laws to identify any impediments to the use of dispute resolution techniques in resolving water resource disputes; and

(b) direct all agencies under the Environment Cabinet to promulgate rules of procedure for alternative dispute resolution methods in their respective areas of jurisdiction.

Local Empowerment

- 65 The Oklahoma Water Resources Board should facilitate creation of a task force of citizens and appropriate agencies to reassess state, federal and local roles in water resource management to identify areas which could facilitate greater control of water resources by local entities and increased local input into state administration of Oklahoma's stream and groundwaters.

- 66 The State Secretary of Environment should form a citizens-based task force to assess the relative value and effectiveness of state and federal water quality and quantity management programs.

Interstate Water Disputes

- 67 The State of Oklahoma should continue to utilize interstate stream compacts as a major vehicle to address and resolve interstate stream water problems with neighboring states. Specifically, the Oklahoma Water Resources Board should:

(a) review the provisions of each of the four interstate stream compacts to ensure that they sufficiently respond to Oklahoma's water resource needs;

(b) explore the potential for addressing interstate environmental and water quality issues, including project construction, under the compacts; and

(c) propose necessary changes in the compacts to the appropriate state and federal legislative bodies.

- 68 The State of Oklahoma should cooperate with neighboring states to investigate establishment of interstate groundwater compacts to resolve potential future disputes involving shared groundwater resources.

DATA COLLECTION/MANAGEMENT

Stream Gaging Network

- 69 The Oklahoma Water Resources Board, U.S. Geological Survey and other appropriate state and federal agencies, communities and individuals should seek to improve the efficiency and effectiveness of the state stream gaging program. This effort should include:

(a) identification and encouragement of partnerships and other measures to help defray costs associated with the state stream gaging network;

(b) identification of opportunities to improve education on the value of stream gage data and the benefits it provides to water resource managers and the general public; and

(c) a determination of the benefits of program expansion or potential integration into a state stream and groundwater quantity and quality monitoring network.

- 70 The State Legislature should continue financial support of current stream gaging programs so that agencies can better manage water resources, especially during periods of drought.

Water Well Measurement

- 71 The Oklahoma Water Resources Board and U.S. Geological Survey should:

(a) update and restrict the state water well measurement network to those with known, reliable information on construction history, depth of completion and location;

(b) re-evaluate the distribution of wells included in the network and refine the network accordingly;

(c) refine measurement procedures to improve accuracy of the well measurement program, such as testing selected wells periodically to determine their response to water level changes; and

(d) ensure that all water well measurement information is readily available and published on a regular basis.

Water Quality Sampling & Monitoring

- 72 The Oklahoma Water Resources Board should identify and recommend to the State Legislature a mechanism-which operates in concert with the federal Clean Lakes Program-to fund water quality assessment of Oklahoma lakes.

- 73 The OWRB should bring together appropriate state and federal environmental and natural resource agencies, state universities and other involved organizations to assess current state efforts related to the collection and dissemination of water resource data and determine the need for a centralized ambient stream and groundwater quantity and quality monitoring network in Oklahoma. The OWRB should then submit study findings and recommendations to the Governor and State Legislature.

Oklahoma MesoNet

- 74 All appropriate state and federal water resource agencies and entities should work closely with MESONET project leaders to explore opportunities for additional data collection activities and value-added products applicable to water resource management activities. These agencies and entities should also identify measures to improve delivery and dissemination of MESONET data.
- 75 MESONET supporters should coordinate efforts to provide public education on the availability, use and access of the system.

Water Resource Data Management

- 76 The Oklahoma Water Resources Board should form a committee consisting of representatives of the State Department of Environmental Quality, Oklahoma Conservation Commission, U.S. Geological Survey, Bureau of Reclamation, U.S. Army Corps of Engineers and other appropriate state and federal environmental and natural resource agencies to investigate options-including possible use of the Internet system-to create, fund and manage a coordinated water resource computer network and data bank that is compatible with the state Geographic Information System. This committee should also coordinate public education efforts related to availability and accessibility of water resource data.

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2003 Oklahoma Water Legislation

Staff, Oklahoma Water Resources Board

HB 1146

Confidential Water Vulnerability Assessments:

This legislation, actually an Open Records Act amendment, relates to terrorism and directs certain state environmental agencies and public utilities to keep information relating to vulnerability assessments of water and wastewater systems confidential. Information may be used for internal and for survey purposes only.



HB 1256

Mandatory Zero-base Budgeting

This legislation spells out the specifics on a mandatory zero-base budgeting process (more of a performance-base budgeting concept) to be implemented throughout state government next year.

HB 1219

Tourism and Recreation Loan Repayment

The Oklahoma Tourism and Recreation appropriations bill creates a—“Tourism and Recreation Environmental Loan Proceeds Revolving Fund ” for administering OWRB Clean Water SRF Loan proceeds for wastewater infrastructure improvements at several state lodges. It appropriates \$477,674 for the purpose of repaying the OWRB Clean Water SRF loan. (Related language contained in HB 1478.)

Travertine Creek, which flows within the Chickasaw National Recreation Area, near Sulphur, Oklahoma, is one of the many watercourses supported by springs emanating from the Arbuckle-Simpson Aquifer. Senate Bill 288 places a moratorium on the issuance of permits from the groundwater basin for uses outside the basin area until and if an OWRB study determines that sufficient yield is available.

HB 1478

Tourism and Recreation Loan Repayment

This bill contains a listing of capital projects with costs that are authorized for funding by the Oklahoma Tourism and Recreation Commission from revenue bond proceeds.

The bill also authorizes the Commission to repay an OWRB Clean Water SRF loan from annual legislative appropriations on a year-to-year basis for wastewater infrastructure improvements at several state lodges that are under consent orders by the Oklahoma Department of Environmental Quality. (Related language contained in HB 1219.)

This legislation requires the Secretary of Environment, in consultation with the Secretary of Agriculture, to prioritize the disbursement of federal funds received by the Secretary of Environment pursuant to the Federal Water Pollution Control Act. It also requires the Secretary of Environment to submit an annual report to the Legislative Leadership detailing the disbursement of these federal funds.

SB 154**OWRB Appropriation**

This bill appropriates \$4,028,476 from the State General Revenue Fund to the OWRB for program duties and activities. It includes, for the first time since inception of the program, \$1,000,000 in the agency's base appropriation for the Beneficial Use Monitoring Program (BUMP). Also included is \$169,578 pass-through funding to the Oklahoma Rural Water Association for technical services and training to rural water and wastewater system operators and board members. It also appropriates \$2,200,018 from the General Revenue Fund to the Rural Economic Action Plan (REAP) Program and sets OWRB employee limits at 91 FTEs. The overall appropriation represents a 22.8% decrease from last fiscal year (includes this year's previous cuts).

SB 155**OWRB Gross Production Tax REAP Approp:**

This bill authorizes the expenditure and transfer of funds from the gross production tax REAP Water Projects Fund for the following:

- (1) OWRB - \$535,000 for water studies, dam repair, rural development issues and other activities;
- (2) Conservation Commission - \$160,000 for section 319 match, \$500,000 for Cost-Share Program, \$500,000 for Upstream Watershed Rehabilitation Program, and \$118,000 for Conservation District operations; and
- (3) Oklahoma Rural Water Association —\$118,000 for technical assistance and training to rural water and wastewater system operators and board members. The Oklahoma Tax Commission estimated \$5.17 million would be available to the Fund from gross production taxes. HB 1207, the appropriation bill for the Oklahoma Corporation Commission, directed \$3,260,000 from the Fund be transferred to the Commission to pay for administration expenses.

SB 288**Arbuckle Simpson Aquifer Moratorium**

This legislation imposes a moratorium on the issuance of any temporary groundwater permit for municipal or public water supply use outside of any county that overlays, in whole or in part, the Arbuckle Simpson Aquifer. The moratorium also applies to municipal and political subdivisions outside the basin from entering into contracts for use of such water. The moratorium would also apply to pending applications and any revalidation of existing temporary permits. The moratoriums are to remain in effect until such time as the OWRB conducts a hydrologic study of the aquifer and approves a maximum annual yield that will not reduce the natural flow of water from springs or streams emanating from the aquifer. The legislation also adds another requirement for groundwater permit approval for use within the basin. The Board must find that the proposed use is not likely to degrade or interfere with springs or streams emanating from the aquifer.

SB 408**Grand Lake Water Studies:**

This legislation mandates numerous administration and operation initiatives to the Grand River Dam Authority. Of importance to the OWRB is a comprehensive study of Grand Lake. The bill directs the Secretary of Environment, with assistance of state environmental agencies, to conduct a comprehensive study of Grand Lake to identify factors that may impact the economic growth and environmental beneficial use of the lake and its tributaries for area residents and the expected population growth of the area. As part of the study or as a separate study, the OWRB is to conduct a Clean Lakes Study and produce a bathymetric map of the lake for assessment of current capacity and the amount and location of deposited sediment. Studies proposed would be funded at least in part with \$125,000 appropriated in the legislation.

Ten Myths About Water in Oklahoma

John Harrington, Director, Water Quality Division, Association of Central Oklahoma Governments

- 1 Aquifers are underground lakes** - Aquifers are areas that contain potable water in the pore space of the rock. An actual underground lake is a rare geologic item. This misunderstanding probably stems from the fact that most people associate large bodies of water with lakes and streams.

Aquifers do not behave like lakes, and wells are not like straws sucking up the water. Think of an aquifer as a sponge rather than a lake. A pumping well will cause the area around the well to dry up. This will lower the static water level immediately next to the well but affect the water level less and less the farther the distance from the well. The static water level of an aquifer can be different across the area of an aquifer, unlike a lake that has the same surface level no matter where you are on the lake.

A corollary to this idea is that groundwater flows in underground rivers. Again, a true underground river is a geologic rarity and most groundwater flows very slowly, usually at velocities of inches or feet per year.
- 2 River pollution is mostly from industrial sources** - Only 15 percent of respondents in a recent National Geographic Society Poll knew that the greatest source of river pollution comes from the actions of individuals, usually in the form of some nonpoint source pollution.
- 3 Storm drains go to the sewer plant** - The guys down at the treatment plant are busy enough treating sewage without worrying about stormwater. Storm drains usually end at the nearest creek, where the discharge becomes part of the ecosystem. That discharge can include motor oil, antifreeze, and other household waste that makes the fish and fauna extremely uncomfortable. Find someplace else to dump your oil – preferably at a recycling center.
- 4 Water is a renewable resource** - Unfortunately, the hydrologic cycle is a closed loop and thus the amount of potable water remains fairly constant. Water is not created, but potable water can be destroyed, usually through contamination of some sort. And although two-thirds of this planet is water-covered, less than 2.5% is potable. With more people and industry, demands on water are increasing and the supplies in some parts of the world are shrinking.
- 5 Water is free (or very inexpensive)** - It isn't!! Getting it to your house costs big bucks!! According to the Oklahoma Department of Environmental Quality (ODEQ) Needs Survey, Oklahoma has an estimated \$2.3 billion in drinking water infrastructure need over the next 20 years. The need for fiscal year 2002-03 drinking water projects is \$124 million. The wastewater picture is even more dismal: \$1 billion over the next 20 years with a fiscal year 2002-03 need of \$223 million. With increasing demand from an increasing population, plus costs from tighter environmental regulations, the price of water is heading towards blue sky.
- 6 The taste of water is a good indicator of water quality** - I have tasted some groundwater that could gag a horse, while the owners of the well praised it for the sparkling taste. It all depends on what you get used to. Taste, odor, and clarity are very much in the eye (or mouth) of the beholder and do not reflect the purity of the water. Water that is contaminated with bacteria or chemical pollutants can often taste perfectly fine. Only

laboratory testing can conclusively determine the quality of water.

Incidentally, the majority of people who have tasted chemically pure water don't like the taste; they claim it tastes "flat".

7 **Using a home water treatment device will make tap water safer or healthier to drink -**

Some people use home water filters to improve the taste, smell, or appearance of their tap water, but it does not necessarily make the water safer or healthier to drink. The treatment system may not treat trace substances such as metals. Additionally, all home treatment devices require *regular maintenance*. If the maintenance is not performed properly, water quality problems may result. Common carbon adsorption filtration systems can actually harbor bacteria if the filter is not replaced at regular intervals, especially if the source water is not chlorinated.

8 **Bottled water is safer than tap water -** Not necessarily. The strong underpinning for the success of bottled waters is their perceived safety compared to ordinary tap water. But unlike tap water, the quality of finished bottled water is not government monitored.

A March 1999 study by the U.S.-based Natural Resources Defense Council (NRDC) that found that one-third of the 103 brands of bottled water it studied contained levels of contamination, including traces of arsenic and E. coli. One-quarter of all bottled water is actually taken from the tap, though it is further processed and purified to some degree, said the NRDC study, and in many countries, bottled water itself is subject to less rigorous testing and lower purity standards than tap water. "One brand of 'spring water,'" reported the NRDC ... actually came from a well in an industrial facility's parking lot, near a hazardous waste dump, and periodically was contaminated with industrial chemicals at levels above FDA standards."

You don't need to buy bottled water for safety reasons if your tap water meets all federal, state, or provincial drinking water standards. If you want water with a different taste, you can buy bottled water, but it costs up to 1,000 times more than tap water. Of course, in emergencies, bottled water can be a vital source of drinking water for people without water.

9 **Spring water or artesian water comes from deep within the Earth -** All ground water originates as rain that has infiltrated through the soil and into the saturated zone. Once in the ground, the water can have different residence times from the point where it originates as precipitation recharge to where it reaches wells, springs, and surface water. A spring is just where the water table intersects the ground level. So the residence time can be days, weeks, or hundreds of years, depending on the groundwater system.

10 **The 100-year flood happens every 100 years -** The term "100-year flood" is (hopefully) being phased out of existence because of the huge amount of misunderstanding here. The truth is that an uncommonly big flood can happen any year. The term "100-year flood" is really a statistical designation, and there is a **1-in-100 chance** that a flood this size will happen during *any* year. Perhaps a better term would be the "1-in-100 chance flood."

This becomes more meaningful to the average person when we start thinking about the chances of a 100 year flood coming during the time you own that 30 year mortgage on that house in a flood plain. Works out to be around a one-in-four chance of finding your house somewhere in Arkansas one wet spring day....

Oklahoma's Water Quality

Jon Craig, Water Quality Division, Oklahoma Department of Environmental Quality



Scientists have been aware of the adverse impacts of water pollution for centuries. The average citizen of the United States has only been interested for a few decades. Only recently has the issue shown up on our public policy radar screens.

Professional marketers, politicians, and the news media are all aware of our seemingly limited ability to deal with more than one national issue at one time. When such an issue is identified, they will ride the crest as long as possible. An issue of prime national interest may be short lived, with public concern waning as citizens tire of all of the rhetoric and seek other problems to worry about.

During "sweeps week," television news programs frequently develop "special" weeklong news stories to draw viewers to the nightly newscasts. Like the cliff hanging serials shown on movie screens in a by-gone era, a new installment of the "hot" news item is shown each day. With the intent of drawing the same viewers back to the screen for each new revealing episode.

Clean Water Act of 1972

When Walter Cronkite of the CBS Television Network presented a series of daily segments related to the state of the environment on the 5:30 news report entitled "Can the World be Saved?" citizens became alarmed about the condition of the environment. At the time, Walter Cronkite was perhaps the most respected and trusted man in America. When Walter spoke, we paid attention.

Concern was raised further by reports of a river in Ohio catching fire due to solvents being mindlessly dumped into by an unregulated industry.

News reports of a lifeless Lake Erie, devoid of fish confirmed that the Great Lakes had become vast cesspools for municipal sewage and discharges of industrial wastes.

For many Americans, scenes of dead fish along the shore of streams and lakes, along with photographs of commercial fishermen catching fish marred with skin ulcers ratcheted concern about water pollution to a new high.

Because of the alarm expressed by citizens, supported by any number of studies and reports by respected scientists supporting the concerns, Congress made a major effort to address the water pollution so evident in the United States by developing the Clean Water Act of 1972.

The Act contained a host of provisions, many of which have yet to be fully achieved.

While the Act had many supporters, it was also controversial not only because it set a national plan for restoration of the nation's waters, but also because it called for a massive influx of federal dollars to achieve the restoration. While it would appear that federal legislation to make all of the waters of the nation suitable for fishing and swimming would be consistent with the desires of the average citizen, it was controversial enough to warrant a veto by President Nixon. Congress mustered enough votes to override the veto and the Clean Water Act became the law of the land on October 18, 1972.

Benchmarks

The restoration of national water quality required benchmarks, or standards against which progress is measured.

The scope and purpose of the Clean Water Act was controversial. The Act would classify most surface waters in lakes and streams as national waters, and establish a national policy for restoring and protecting them. This would be regardless if they were totally within a single state occupied a multi-state region. This “nationalization” of waters caused concern. The Act would certainly decrease a state’s authority and responsibility, abdicating the responsibility to protect the streams and lakes from water pollution to the federal government.

To allay this concern, the Clean Water Act specified that each state was required to develop water quality standards for all of the waters within that state’s borders. These standards were then to become the goal.

While the Clean Water Act clearly recognized each state’s responsibility to establish water quality standards, the Act specified the federal government would be the ultimate approving authority. The federal agency tasked would be the federal Environmental Protection Agency.

The Act contained additional provisions that the federal government could promulgate water quality standards ONLY if a state failed to do so, or if the water quality standards developed by that state were deemed to be inappropriate for the particular body of water. Thus, states retained the ultimate responsibility for establishing quality benchmarks.

The Act specified the components of water quality standards that must be established for each body of water. The two components most often associated with determining the “cleanliness” of a body of water are (1) designated uses and (2) criteria.

Designated Use

The designated use, or “beneficial use”, is the use to which the body of water would normally be used if it were not polluted by human activity.

For instance, a lake might be of such quality as to serve as a source of raw water for a public water supply. That is to say that the natural quality of water in that lake is adequate for use as a public water supply, with only conventional treatment

prior to its being served to the public. Other potential designated uses might include uses such as irrigation, water for cattle, swimming, fishing, and the like.

It is obvious that all waters, even in their natural state are not suitable for all designated uses. A body of water may naturally contain so much dissolved salt that it cannot be used for a source of drinking water for a public water supply. An example is the Cimarron River. A large quantity of salt enters the river as it flows through Major County, rendering it unsuitable for human consumption even after treatment provided by a conventional water plant.

In this case, the concentration of salt in a water body can dictate whether or not the designated use can be achieved. Since the salt found in the Cimarron River is naturally occurring, it is not considered to be pollution, as pollution is only associated with mans’ activities. Because the naturally occurring salt renders the water in the Cimarron River unusable as a domestic water supply, it is generally accepted that the designated use of “public water supply” is probably inappropriate for the Cimarron River.

The chemical, which is salt in the case of the Cimarron River, or physical condition, such as water temperature, which is critical in achieving the designated use is referred to as the criteria, which is the second component of water quality standards.

In summary, a “designated use” is one that should be achievable naturally, if mans’ activities were not present to impair that use. If a designated use could not be achieved, even if mans activities were not present, then the designated use is probably too stringent.

Shortly after the passage of the Clean Water Act, states began a program of sample collection and analysis to establish a base level of information for the bodies of water within the state. The data was used to establish an overall view of the quality of the individual water bodies, and to establish and verify the designated uses of that water body.

If the criteria for a designated use, such as the concentration of salt in a stream, exceeds that which is identified as necessary to meet a designated use is not met, then the designated use is said to be impaired. For instance, if the criteria for salt are 250-PPM chloride for a public water supply, and activities of man have caused the chloride concentration to be 600 PPM, that designated use cannot be met and is impaired.

Now, monitoring programs by the Oklahoma Water Resources board, the Conservation Commission and other groups measures the criteria in the water bodies of the state. An evaluation of those measurements, compared to the criteria established for a designated use in the water quality standards can identify those water bodies that have impaired designated use. This impairment is generally caused by water pollution or other activities of man.

It is important to recognize that all bodies of water in Oklahoma were NEVER of the same quality, even long before the state was open to settlement. Natural conditions restrict the designated uses of most water bodies, which is why it would be inappropriate to establish a designated use which would support a year round population of rainbow trout for most streams in Oklahoma.

In western Oklahoma, perhaps the most common pollutant impacting surface waters is sediment, which is carried to the streams by rain-induced runoff from farmland, construction sites, and parking lots. Fertilizers are carried by sudden showers, not only from vast cultivated farmland but also from the lawns of the city dweller. Failing septic tanks and improperly operated municipal sewage treatment plants may also contribute vast quantities of nutrients to a stream, thereby encouraging algal blooms which can choke the stream and suffocate fish due to an almost total absence of dissolved oxygen in the pre-dawn hours.

In eastern Oklahoma, the activities of man impact the quality of the adjacent surface waters in much the same way as occurs in the west, except that changing agriculture methods have resulted in a boom in the production of poultry, confined in houses with controlled temperature and the resultant concentration of waste litter.

The waste litter from poultry production is used as a fertilizer for the growth of crops, such as hay or pasture land. Unfortunately, the ratio of phosphorous to nitrogen required by the crop as compared to the ratio of nitrogen to phosphorous available in the litter means that application rates are often out of balance. In order to meet the nitrogen requirements of the crops, poultry litter must be applied at a rate that may supply from three to five times more than the amount of phosphorous, which the crop can use. The surplus phosphorous can then be carried to adjacent streams and lakes, resulting in algal blooms, odors, tastes, and even fish kills.

Major efforts are underway nationwide to develop solutions to the problems associated with the land application of poultry litter.

What is the quality of the waters of Oklahoma?

In some cases, the water quality is vastly improved over what it was just a few decades ago. Best management practices have reduced pollution from farming operations. The construction of vastly improved municipal wastewater treatment plants has greatly decreased pollutant loadings. Funding for these construction projects was often provided through the Clean Water Act and other state and federal assistance programs. Now, industries too are required to produce an effluent from their wastewater treatment plants, which is protective of the designated uses of the water quality standards.

Where is the proof?

In the United States, rivers no longer catch fire due to solvents being dumped indiscriminately into the water. The Great Lakes are no longer dead, and provide commercial fisherman with an adequate supply of lake trout. Drive along the Cross-town Expressway in downtown Oklahoma City some weekend. Note the number of individuals fishing for - and catching - healthy, edible fish from the Canadian river. That was not the case just thirty years ago.

Water Quality? Overall, it is improving.

Who Owns The Water?

Dean Couch, JD, Legal Counsel, Oklahoma Water Resources Board

The issue of who owns the water could be quite simple. No one does. That is a surprisingly brief answer to a rather complex issue. But not surprisingly, a further explanation may be helpful. This paper will address the issue from the perspective of the non-Indian law.

Common Law - To put it simply, water itself, the physical molecules of water in nature, are owned by no one, or so was the legal view based in Roman law, which was extensively consulted by 19th century courts to develop the “common law”, and later by legislatures in developing early statutes on water law. Professor Dan Tarlock, Professor of Law at the Chicago Kent College of Law in Illinois, explains it this way in his treatise on water law:

“Roman law, with its penchant for complete classification, divided things into two categories, owned or unowned. Things common to all such as air and running water were variously classified as *res communes* or *res nullius*, things owned by no one.

“*Res communes* or *res nullius* were part of the negative community. Things in the negative community were incapable of private ownership without some further act of appropriation [citation omitted]. The common law adopted the Roman law [citation omitted] classifications to establish the principle that no one could obtain title to the corpus of water but could only obtain a usufructory privilege to the use of the water of a stream [citation omitted]. Water was often analogized to animals *ferae naturae* to justify property rights based on capture [citation omitted].”¹ Emphasis in original.

In other words, centuries ago, the Romans treated water in nature like wild animals; no one can claim ownership to water until the water is captured. After its “capture”, water can be considered personal property. Before its capture, only the “right” to appropriate the water can be owned. Several years ago, a lawyer working with an Indian

tribe in Oklahoma advanced his view that the corpus of the water, i.e. the physical molecules of water, was owned by the Indian tribe wherever the water was found within the historical boundaries of the tribe. That view has not been presented to any court for adjudication.

Classifications of water - Before reviewing ownership laws of the State of Oklahoma, one must first consider the three fundamental physical classifications of water.

1. Stream water - surface water flowing in natural waterways or impounded in ponds or lakes;
2. Groundwater - percolating underground water (all water under the land surface is presumed to be percolating groundwater); and
3. Diffused surface water – sheet water that flows over the land surface.

State of Oklahoma ownership laws - In 1890, seventeen years before statehood, the Oklahoma Territory legislature adopted the following statute relative to ownership of water:

“The owner of the land owns water standing thereon, or flowing over or under its surface, but no forming a definite stream. Water running in a definite stream, formed by nature over or under the surface may be used by him as long as it remains there; but he may not prevent the natural flow of the steam, or spring from which it commences its definite course, nor pursue nor pollute the same.”²

Now, 113 years later, the property rights law of the State of Oklahoma says the same thing, with a few embellishments.

A. The owner of the land owns water standing thereon, or flowing over or under its surface but not forming a definite stream. The use of

groundwater shall be governed by the Oklahoma Groundwater Law. Water running in a definite stream, formed by nature over or under the surface, may be used by the owner of the land riparian to the stream for domestic uses as defined in Section 105.1 of Title 82 of the Oklahoma Statutes, but he may not prevent the natural flow of the stream, or of the natural spring from which it commences its definite course, nor pursue nor pollute the same, as such water then becomes public water and is subject to appropriation for the benefit and welfare of the people of the state, as provided by law;

Provided however, that nothing contained herein shall prevent the owner of land from damming up or otherwise using the bed of a stream on his land for the collection or storage of waters in an amount not to exceed that which he owns, by virtue of the first sentence of this section so long as he provides for the continued natural flow of the stream in an amount equal to that which entered his land less the uses allowed for domestic uses and for valid appropriations made pursuant to Title 82 of the Oklahoma Statutes;

provided further, that nothing contained herein shall be construed to limit the powers of the Oklahoma Water Resources Board to grant permission to build or alter structures on a stream pursuant to Title 82 of the Oklahoma Statutes to provide for the storage of additional water the use of which the landowner has or acquires by virtue of this act.

B. All rights to the use of water in a definite stream in this state are governed by this section and other laws in Title 82 of the Oklahoma Statutes, which laws are exclusive and supersede the common law.”³

Reviewing the three classifications of water and the state’s property ownership law reflected in statute quoted above, the issue of who owns the water can be broken down as follows:

1. Stream water is “public water”;
2. Groundwater is owned by the owner of the surface of the land;
3. Diffused surface water is owned by the owner of the surface of the land.

Although the ownership provisions of this one state law might seem straightforward, there are other laws on use and other matters that should be considered in answering the question of “who owns the water”.

Stream water

Riparian versus appropriation – The Oklahoma property statute quoted above declares that stream water (water in a “definite stream” which is recognized to include lakes and ponds) is “public water” subject to appropriation. The appropriation system of water use regulation relies on the “first-in-time” priority system whereby in times of shortage, the most recent appropriator must reduce or cease diversions so more senior appropriators might have water. A person does not have to own land adjacent (riparian) to a stream or lake to obtain an appropriation right. While recognizing the appropriation doctrine as controlling, Oklahoma’s statutes go on to recognize that riparian landowners can use water flowing in a stream for “domestic use” (defined narratively as household use and cattle watering and other minor use) without an appropriation permit. Also, the appropriation law specifies that a permit to appropriate cannot interfere with “domestic use”. Together, these laws mean that riparian domestic use has a “superpriority” over appropriations.

A cloud in state law on this point was created by the Franco case. In a 1990 opinion issued in early 1993, the Oklahoma Supreme Court declared that in addition to the riparian domestic use protection recognized in the statutes, riparian rights to a reasonable use must also be considered and protected by the appropriation law.⁴ The Court listed factors to consider to determine whether a

non-domestic riparian claim was reasonable, including size of stream, custom, climate, season of the year, size of diversion, place and method of diversion, type of use and its importance to society (beneficial use), needs of other riparians, location of the diversion on the stream, the suitability of the use to the stream, and the fairness of requiring the user causing the harm to bear the loss.⁵ As can be seen, these factors are so wide open that riparian landowners claiming a non-domestic use of water might find it difficult to show that their claim is reasonable.

To cloud this whole situation further, the Oklahoma Legislature in 1993 reacted quickly to the Court's opinion and attempted to nullify what the Court ruled by enacting a new law expressly declaring legislative intent to extinguish unused riparian rights to future use except for domestic use.⁶ There has been no controlling court decision to guide us on whether the 1993 statute is effective to nullify the Franco court opinion.

Public trust – The priority in time concept is the foundation of appropriation rights, giving such rights stability and certainty. In a controversial case, the California Supreme Court decided in a 1983 case that an after-the-fact condition could be placed on a 1940s vested appropriation right held by the City of Los Angeles to prevent environmental harm to Mono Lake and wildlife that relied on certain minimum lake levels.⁷

In other words, despite reliance on the stability of a state issued appropriation right in the 1940s, and despite millions of dollars spent on pumps and pipelines to use the water, the California court made L.A. go to replacement sources of water at a cost of millions of more dollars. The Court recognized a “public trust” over water in California existed for the benefit of the people long before L.A.’s appropriation right was issued and that continued exercise of the water right was always conditioned on complying with the public trust., Because the vested right had always been conditioned, there was no taking and no requirement for the state to pay L.A. any “just

compensation” for taking the vested right. The Oklahoma Legislature has not so far expressly recognized a public trust relative to water. But if it ever does, we must all watch out. The range and extent of the public trust and how it may impact what is otherwise viewed as vested property rights (the taking of which requires payment of just compensation) would be left up to long-term, expensive and uncertain litigation. Come to think of it, maybe the lawyers would welcome a declaration of the public trust in Oklahoma.

Anti-export and interstate commerce – The interstate commerce clause is applicable to ownership and use of stream water and groundwater. In a 1982 case⁸, the United States Supreme Court declared that water is an article of interstate commerce, thereby establishing the applicability of many Supreme Court decisions that address a state's sovereign ability to regulate or interfere with interstate commerce and implement anti-export laws. Interestingly, the Supreme Court in the 1982 case rejected Nebraska's argument that the public ownership of the water subject of Nebraska's anti-export law gave the state greater authority to restrict out of state use. The Supreme Court relied in part on a previous decision of the Court against Oklahoma's attempt to restrict the export of minnows caught and sold out of state. Currently, Oklahoma statutes have imposed a moratorium on the out of state sale and use of water.⁹ The moratorium was a reaction to proposals by Governor Keating's office to have the state enter into a compact with the Choctaw Nation and Chickasaw Nation and to consider marketing water from southeast Oklahoma to the Dallas-Fort Worth Metroplex. In view of the U.S. Supreme Court's position on a state's anti-export laws for water, it is not clear how the moratorium would fare in a court challenge.

Use-it-or-lose-it forfeiture – A fundamental principle of the appropriation doctrine is that the appropriator must beneficially use the water. The person who obtains an appropriation right cannot just tie get a permit and then speculate that someone else will need the water and pay holder of

the permit to use the water or transfer the permit. This forfeiture concept is an off-shoot of the requirement to beneficially use the water and is common to most appropriation laws.

In Oklahoma, an appropriation right is not “vested” unless and until it is used in seven years. After first use begins and the right becomes vested, the right remains subject to forfeiture if the full amount authorized is not used for the purpose authorized at least once every seven years. Failure to use the full amount results in the forfeiture of the amount not used (and corresponding reduction of cancellation of the water right). If the appropriation right authorizes use from a lake, the forfeiture of the appropriation does not directly affect rights to storage, which is a separate matter.

Rights to storage distinguished – A final clarifying point about “who owns the water” relates to who owns the bucket if the water is stored. While Oklahoma state law clarifies that water molecules in definite streams is “public water” subject to appropriation (with limits for riparian domestic and perhaps riparian reasonable use), a storage right is a completely separate matter. In view of the potentially intermittent flow of most Oklahoma stream sources (even the Arkansas River and Red River have recorded near zero flows occasionally), surface water users who need water in low or no flow periods must store water in off-stream or on-stream impoundments (lakes).

To impound water, a person must obtain rights to use the surface of the land where the impoundment will be located. Such rights can include flowage or flood easements or outright fee ownership of the land. It can be problematic if the mineral interests are severed and access to extract the minerals will be restricted, as demonstrated by the Osage Nation claims concerning the once-proposed Candy Lake in Osage County where the Osage Nation owns the mineral interests.

The state water ownership statute indicates that a riparian landowner may use the bed of a stream on owner’s land (for a pond or gully plug) to store a

domestic amount of water. The state’s stream water use statute clarifies the ownership statute and says that water for domestic use may be stored in an amount not to exceed two years supply.¹⁰

If a water user cannot build his or her own reservoir, the user may contract to use storage at a reservoir owned by some other person. This is the typical situation involving the large reservoirs constructed by the U.S. Army Corps of Engineers (e.g. Lake Texoma, Canton Reservoir, Tenkiller, Hugo Reservoir) or Bureau of Reclamation (e.g. Fort Cobb, Lugert-Altus).

Persons who wish to divert water from those reservoirs must enter into contracts with the appropriate federal government entity for use of the storage (that impounds the water) created by the dam. The contracts usually call for the contracting party to repay the federal government the proportionate costs of construction of the reservoir and the annual ongoing maintenance expense.

The user of the storage (and water from the storage) obtains only a contract right from the federal government. The user does not obtain ownership of the dam or the lake, or the recreation areas, or the land inundated by the water. The federal government retains the title to the land. However, the federal government when it buys land and builds a dam to impound water is not automatically issued a state water right authorizing use of the water in the reservoir. Therefore, the federal government does not assign or delegate authority to use the water from the storage when it enters a storage contract with a water user. The user must get a separate appropriation permit from the state.

Groundwater

Ownership versus use regulation - As indicated in the discussion about ownership interests, percolating underground water is “owned” by the owner of the land. However, the state ownership law clarifies that the “use” of groundwater is

governed by the Oklahoma Groundwater Law. Domestic use of groundwater is exempt from the permit requirement of the Oklahoma Groundwater Law. However, domestic use is subject to the prohibition against “waste”. In this context, domestic use relating to groundwater from wells is defined identically to “domestic use” relating to stream water (household and cattle watering). For other than domestic use, any person wishing to use groundwater must obtain a permit from the Oklahoma Water Resources Board.

Permits issued by the Oklahoma Water Resources Board quantify the amount of water that is owned and that can be withdrawn by pumping wells. The Oklahoma Groundwater Law adopted by the state incorporates an allocation system whereby the amount of groundwater that can be withdrawn by landowners is based on the number of surface acres that the landowner owns. Permits themselves are owned and may be transferred, but subject to conditions primarily related to ownership of the land.

Surface ownership or lease – Although the ownership statute concerning water quoted previously indicates that the owner of the land owns the groundwater under the surface, the ownership right to groundwater can itself be severed and held by a person who does not own the surface. State property statutes indicate that the right of taking water can be a “burden or servitude” that can be either attached to the land or not attached to the land.¹¹ In other words, a landowner can carve out the right to own and take groundwater from under the land and either reserve the groundwater when transferring title to the rest of the surface, or the landowner can transfer ownership rights to another person while retaining all remaining rights to the surface. A person holding the right to groundwater can apply for a permit to use the groundwater, or can lease the right to another person. In all these transactions, the documents should address the potential for domestic use and whether a domestic use right remains with the other surface rights.

Use of groundwater for oil and gas recovery – In two cases, the Oklahoma Supreme Court addressed the issue of whether a mineral interest owner (or the mineral interest owner’s lessee oil company) had a separate “right” to use groundwater for oil and gas production. The Court did decide that a severed mineral interest has a common law right to a reasonable use of groundwater to enjoy the mineral interest. After this court case, the Legislature amended the statutes relating to the authority of the Oklahoma Water Resources Board to issue permits to use groundwater by clarifying that a permit applicant must either own the surface or hold a lease from the surface owner. In a challenge to that law, the Court said that the law could apply only to mineral interests that were severed from the surface after the passage of that law (May 28, 1985). Even if a mineral interest owner or lessee can rely on a pre-1985 severance of the mineral interests, a permit from the Oklahoma Water Resources Board to use the groundwater is still required.

Tribal Nations Water Claims

Last but not least, a paper on who owns the water in Oklahoma should mention Indian water rights claims. For an issue on which two-day and three-day symposia are held, a half page discussion cannot do justice to the issue, particularly with 39 federally recognized tribes in this state.

In a more traditional situation in the western United States, Indian tribes were moved to or were otherwise gathered together in designated areas as described in treaties made by the federal government or through Executive Orders of the President. The designated areas were set aside from non-Indian settlement, or “reserved” from the public domain as white settlers moved west, and therefore became known as “reservations”. In 1908, the United States Supreme Court held that when the federal government created a reservation for an Indian tribe in Montana, an implied right to use water in a river that bisected the reservation area was established. The Court also said that the first-in-time priority component of the

appropriation doctrine applied, and the priority of the implied right was the date the reservation was created. That priority was earlier and superior to the non-Indian appropriations Montana had issued upstream from the reservation. The non-Indian interests were junior. The implied water rights recognized for the Indian tribe which are based on the creation of the reservation are referred to as “Winters Rights”. Using only the Winters Rights principle, most tribes were located in Oklahoma long before statehood and would have a senior claim to most all non-Indians.

However, that is only the beginning of the story. Other matters to consider involve the shifting federal policy of assimilation of the Indians, then to a policy of self-governance. Much of the land in what is now the state of Oklahoma has been allotted to individual tribal members, then sold to non-Indian interests. Just before statehood, in anticipation of merging Indian Territory and Oklahoma Territory into the 46th state of the union, a Dawes Commission was created to speed up assimilation of Indians and extinction of tribal governments.

But the Enabling Act from Congress that established the framework to create Oklahoma directed that nothing in a State of Oklahoma constitution could limit or impair the rights of persons or properties pertaining to Indians, and sure enough, the State of Oklahoma Constitution disclaims all right and title to all lands lying within the state owned or held by any Indian, tribe or nation.

Finally, unique in the United States are the Five Civilized Tribes of Oklahoma who were granted land patents from the U.S. for the lands transferred to them in consideration of the lands given up in the eastern U.S. The U.S. Supreme Court held that the State of Oklahoma or its agencies cannot claim implied property interests in those lands because the state never received an interest because the U.S. had previously transferred such lands to the Five Civilized Tribes through the patents.

The implications for water rights are substantial. The Choctaw Nation and Chickasaw Nation have claimed all the water found in the 22 counties in southern and southeast Oklahoma. There has been no court challenge to address those claims.

ENDNOTES

- 1 *Tarlock, Law of Water Rights and Resources*, § 3:3, p. 3-4.
- 2 *Terr. Okla. Stat.* § 4162 (1890); taken from *Dakota Terr. Comp. Laws* § 2771 (1887).
- 3 *Section 60 of Title 60 (on Property) of Oklahoma Statutes*.
- 4 *Franco-American Charolaise, Ltd. v. Okla. Water Res. Board*, 1990 OK 44, 855 P.2d 568.
- 5 *Supra*, 1990 OK 44, ¶14 and footnote 40, citing *Restatement (Second) of Torts* § 850A [1979].
- 6 *Section 105.1A of Title 82 of the Oklahoma Statutes*.
- 7 *National Audubon Society v. Superior Court of Alpine County*, 33 Cal. 3d 419 (Cal. 1983) (*Mono Lake case*).
- 8 *Sporhase v. Nebraska*, 458 U.S. 941 (1982).
- 9 *Section 1B of Title 82 of the Oklahoma Statutes, effective June 6, 2002*.
- 10 *Section 105.2A of Title 82 of the Oklahoma Statutes*.
- 11 *Sections 49 and 50 of Title 60 of the Oklahoma Statutes*.

Water Policy Impacts of Arsenic

John Harrington, Director, Water Quality Division and Zach Taylor, Executive Director
Association of Central Oklahoma Governments

Town Hall Introduction

This section was solicited to examine the unintended consequences of public policy actions.

In the final days of the Clinton Administration, a federal regulation was approved requiring the lowering of acceptable arsenic levels in drinking water. The levels were reduced from 50 to 10 parts per billion (ppb). The rationale was based upon debatable science.

Few noticed.

If they did, the assumption was that the regulations would be rescinded. Two months later the new Bush Administration proposed rescinding the regulations. The young administration was immediately subject to the political claims they were “poisoning children.” The proposal was withdrawn.

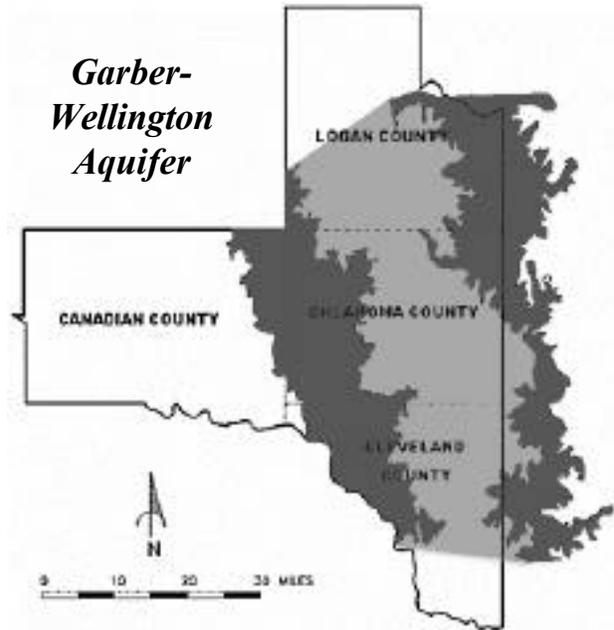
The curtains of political theater were opened, and another set of unintended consequences began playing out.

We may think this is a funny political story of political “gotcha” nonsense. Well ... that policy is causing nightmares for a host of central Oklahoma communities west of I-35 whose water sources (The Garber-Wellington Aquifer - see right) have 30 parts per billion of arsenic.

Now they have to find alternate sources of water. Where to look? How much to pay? This is where the major problems start! Then we find out that our state water laws and state water plan don't help. Planning and dispute resolution are not immediately possible.

So we delay. And communities such as Piedmont, Yukon, and Mustang have nowhere to turn.

Garber-Wellington Aquifer



1998

The year was 1998. In Samta Village in the Jessore District of Bangladesh, a poor young girl named Shakti lay dying. The cancer was slowly eating away at her liver, and the resulting muscle spasms had kept her bed ridden for months. Her parents, far too poor to afford medical help, watched her hopelessly as she wasted away. Rumors had made their way through the village that she was one of many afflicted – there was something in the well water....

2003

Five years later, a gavel pounded on a table in the Oklahoma State Legislature. Senate Bill 288 had passed over the objections of water ranchers in southeastern Oklahoma. The state's only designated sole source aquifer, the Simpson-Arbuckle, was to have a moratorium on water permits until hydrologic studies had been made. The water ranchers – individuals who own large areas of groundwater rights over the Simpson-

Arbuckle aquifer— would be unable to acquire their permits. Thirsty cities in Central Oklahoma would have to wait, or find other sources to tap for their growing populations.

Global Connection

The two incidents just described are literally worlds away, yet are intimately connected by a single word: arsenic. The story of arsenic in the past decade weaves a trail around the world, from Southeast Asia to Chile to southern Utah. It also touches the daily routines of the poorest people in the world while influencing the administrative policy of two US presidents. It will touch you and me as we pay for our water and place our trust in policy makers as they struggle between the proverbial rock and hard spot – public safety vs. price.

Arsenic – Some Basic Facts

While arsenic and its associated compounds have long been the mainstay of a good murder mystery, the element itself is a mundane steel gray or yellow semi metallic solid; it tarnishes in air, and when heated is rapidly oxidized to arsenous oxide with the odor of garlic. The thirty-third member of the elemental table was so named from the Greek *arsenikon*, identified with *arenikos*, the word for male, from the belief that metals were different sexes. Arsenic is used in bronzing, pyrotechny, and for hardening and improving the sphericity of shot. The most important compounds are white arsenic, arsenic sulfide, Paris green, calcium arsenate, and lead arsenate; the last three have been used as agricultural insecticides and poisons. It is four times as poisonous as mercury.

Most fruits, vegetables, meats and fishes contain some arsenic, especially sea fishes and shell fish. Most of this arsenic is organic in nature and is not toxic. Nonorganic arsenic is found in volcanic rocks and sediments derived from volcanic rocks and is generally toxic to humans; arsenopyrite being the most common mineral form. It is typically present in groundwater in large delta systems whose river sources originate in volcanic rocks, or the sandstones of ancient river systems,

such as the Garber-Wellington aquifer in Central Oklahoma. The Ganges River that flows through the country of Bangladesh is one such system. It is here that the modern day arsenic story begins.

A Good Idea Gone Bad....

The decade of the 1980's brought a large-scale effort to provide the Bangladesh people drinking water. Hundreds of thousands of "tube wells" provided new groundwater supplies to thirsty areas of the country. Agribusiness in the area boomed, providing food and cash.

However, a new health problem began to emerge – arsenicosis, or arsenic poisoning. This came in several forms, such as hyperpigmentation (dark spots), hypopigmentation (white spots) and keratoses of the hands and feet. Internal cancers of the kidney and liver showed up later. While the world focused on the radioactive effects of the Chernobyl disaster in Russia, a disaster far larger was quietly taking place among the indigenous poor landless farmers on the Ganges delta.

Risky Business

In America, public water systems are required by federal law to provide a safe product to the consumers. The United States Environmental Protection Agency (EPA) lists minimum contamination levels (MCLs) for many organic and inorganic elements. The water provider must adhere to these levels and heavy administrative fines are levied when the operator is found to be out of compliance.

These levels are set by risk factors. Our daily lives are permeated with risk factors – we all run a risk of being killed in a car accident on the way to work, but the comparison benefit of drawing a paycheck usually makes this risk well worth taking. To produce water that is absolutely pure, safe and free of any contaminants would be hideously expensive, so public policy allows these contaminants, but at a very low level.

For water, the very low level is a quantity determined by the fatality of an "average" person weighing 70 kilograms and consuming

approximately 2 liters of water per day for a lifetime (70 years). The risk then assigned to this individual would be a 1 in 10,000 chance of dying from this particular element. In other words, if a town of 10,000 people lived 70 years drinking two liters per day of the public water, only 1 person would die of a disease related to that contaminant. Note that is a general policy and not a statutory mandate.

Arguably, this is a very low risk. For a comparison, let us look at other risks we take for granted in our normal lives. The first table shows several activities with the lifetime risk associated with them. For example, the chances of a fatal drowning for an individual in the US is on the average 1 in 7,683 over that individual's lifetime – a fairly small risk. The chances of fatally drowning are about ten times larger than being hit by lightning. But being hit by lightning is about twice as common as fatally being bit by a dog.

Lifetime Death Risks in the U.S.

<i>Incident</i>	<i>Risk</i>
<i>Car occupant</i>	242
<i>Uncontrolled fire in building or structure</i>	1,290
<i>Fall on and from stairs and steps</i>	2,739
<i>Drowning</i>	7,683
<i>Lightning</i>	71,601
<i>Bitten or crushed by reptiles</i>	115,486
<i>Bitten or struck by dog</i>	137,694

Although we can quantify risk, to the average individual risk has an emotional element that defies logic. In some areas of our lives we demand extremely small risks, especially when it comes to our health and our children's health. Hence the changes in public attitude in the last generation over the issues of automobile seat belts and cigarette smoke. On the other hand, risk factors mean seemingly nothing while we eagerly spend our money at the lottery in hopes of becoming millionaires, when we would be far more likely to be struck by lightning on a summer day.

Finally, one must realize that with a demand for less risk comes the corollary of fewer options. This is best illustrated in the financial sector, where a direct relationship exists between the types of financial instrument one invests in versus the amount of risk associated with that instrument. Those people who rely on steady protected interest incomes have only a small number of investments to choose from, usually Treasury notes and certificates of deposit. People who are more willing to accept larger risks with their investments have a smorgasbord of opportunities to make money, from oil investments to pork bellies to swamp land in Florida....

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We May Have a Problem Here...

Back in Bangladesh, World Health Organization scientists and government officials were assessing the effects of the arsenic problem. The survey indicated arsenic contamination in at least 46 districts out of 64. Out of 30,000 samples, arsenic contamination occurred in about 20% of the samples. The acceptable level of arsenic in drinking water was 0.050 milligrams per liter (mg/l) for Bangladesh, the same regulatory level as the United States had since the 1940's. With a large new database regarding the effects of arsenic on human populations, scientists were able to re-evaluate the risk level for arsenic in water. The conclusions:

“Considering other data and the fact that the concentration of arsenic in drinking-water at an estimated skin cancer risk of 10-5 is below the practical quantification limit of 0.01 mg/l (10 parts per billion or ppb) as well as a view to reducing the concentration of arsenic in drinking-water, *provisional guideline value of 0.01 mg/l is recommended.* The guideline value is associated with an excess life-time risk for skin cancer of 6x 10-4 (i.e. six persons in 10,000).” (WHO 1996)

Language such as this got the ear of EPA officials. *At one-fifth the current maximum contamination level, the risk level calculated by WHO was still six times greater than acceptable public policy!!* The federal government sprang into action and the arsenic question was top priority. Other arsenic studies came forward and were reviewed. Soon scientists had a plethora of arsenic data, but some troubling issues came with the data. These issues

could be grouped under two headings: dose-response and comparative populations.

Are We in a Straight Line??

The WHO statement above alludes to the first problem with the words “practical quantification limit”. In plain English, this means that the item we are measuring is so small that we are having problems finding a tool to measure it! Most arsenic analyses with dates in the 1990's were accurate only to 10 ppb. The technology simply was not in place and the need to analyze arsenic to 1 ppb was not present. As a result, scientists had plenty of arsenic data at concentrations well above the newly proposed contamination level, but none at or below the level. This wreaked havoc on the dose-response analysis.

Dose-response analysis is exactly what it sounds like – I give you so much of this stuff and then I watch to see what happens. If you are a laboratory rat and I give you enough arsenic, you will die. If I give you only half the dose, perhaps you will not die as fast. And so on.

A linear dose-response curve implies that there is a direct relationship between the dose and the response. If I plot the amount of dosage against the amount of response (lifetime), the relationship will be a straight line. One can then predict the reaction to the dosage at any point along the line and can even project the relationship into areas where there is no response data if one is confident of that linear property between dose and response.

Similar Lifetime Risks in the United States
Arsenic in Water at 50 PPB

<u><i>Incident</i></u>	<u><i>Risk</i></u>
<i>Occupant of pick-up truck or van.....</i>	<i>1,095</i>
<i>Fall on and from stairs and steps</i>	<i>2,739</i>
<i>Accidental drowning and submersion</i>	<i>1,028</i>
<i>Uncontrolled fire in building or structure</i>	<i>1,290</i>
<i>Poisoning</i>	<i>1,400</i>
<i>Assault by sharp object.....</i>	<i>1,983</i>
<i>Motorcycle rider</i>	<i>1,295</i>

Similar Lifetime Risks in the United States
Arsenic in Water at 10 PPB

<u><i>Incident</i></u>	<u><i>Risk</i></u>
<i>Exposure to electric current, radiation, temperature, and pressure</i>	<i>8,544</i>
<i>Fall on and from ladder or scaffolding</i>	<i>8,689</i>
<i>Inhalation of gastric contents.....</i>	<i>9,372</i>
<i>Drowning and submersion in bathtub</i>	<i>10,499</i>
<i>Accidental suffocation and strangulation in bed</i>	<i>10,948</i>
<i>Accidental Poisoning by Alcohol.....</i>	<i>11,854</i>
<i>Exposure to excessive natural heat</i>	<i>11,894</i>

However, most of the arsenic data was in the 50-500 ppb concentration range. Although the data seemed linear at those ranges, projecting the line over one order of magnitude to 5 ppb made many scientists nervous. No dose response data existed at 5 or 1 ppb to draw the line at these concentrations. Is it safe to assume the relationship was the same at these low levels?

Several scientists pointed out that certain relationships may look linear at high concentrations, but are actually exponential; assuming these relationships are linear at low concentrations would lead to highly erroneous conclusions. Other scientists argued that there may be a “threshold point” where the concentration of arsenic is so small that the human body just ignores the contaminant as if it did not exist and therefore there is no response. Could there be a threshold point, and if so, at what level?? There was no data.

Are You Like Me?

The second major problem was comparative populations. Simply put, are the people in Bangladesh going to react to arsenic in the same fashion as John Q. Public in Peoria. Arsenic data in the United States was limited; the EPA relied heavily on a peer-reviewed report from the National Academy of Sciences National Research Council (NRC). The report by the NRC notes some deficiencies in the data it reviewed: “*the statistical issues surrounding risk assessment for arsenic in drinking water are challenging... the best available (arsenic) data are from ecological studies, which are not ideal for risk-assessment purposes.*”

In the Federal Register June 22, 2000, EPA defended their position when the 10 ppb standard was proposed:

In response to the comment that there is a lack of evidence for health effects below 50 ppb, we note that the National Academy of Sciences’ National Research Council (NRC) has categorically determined, based on their review of the most recent data and

information concerning the health effects of arsenic, that the current standard of 50 ppb is not protective and should be revised downward as soon as possible (NRC, 1999).

However, the EPA itself conducted a small study in Utah that was not part of the NRC report. Their conclusions, published in the Federal Register, raised a few eyebrows:

EPA scientists conducted an epidemiological study of 4,058 Mormons exposed to arsenic in drinking water in seven communities in Millard County, Utah (Lewis et al., 1999). The 151 samples from their public and private drinking water sources had arsenic concentrations ranging from 4 to 620 mg/L with seven mean (arithmetic average) community exposure concentrations of 18 to 191 mg/L and all seven community exposure medians (mid-point of arsenic values) <200 mg/L.

Observed causes of death in the study group (numbering 2,203) were compared to those expected from the same causes based upon death rates for the general white male and female population of Utah. Several factors suggest that the study population may not be representative of the rest of the United States. The Mormon Church, the predominant religion in Utah, prohibits smoking and consumption of alcohol and caffeine. Utah had the lowest statewide smoking rates in the U.S. from 1984 to 1996, ranging from 13 to 17%. Mormon men had about half the cancers related to smoking (mouth, larynx, lung, esophagus, and bladder cancers) as the U.S. male population from 1971 to 1985 (Lyon et al., 1994). The Utah study population was relatively small (~4,000 persons) and primarily English, Scottish, and Scandinavian in ethnic background.

... Millard County subjects had higher mortality from kidney cancer, but this was not statistically significant. Both males and

females in the study group had less risk of bladder, digestive system and lung cancer mortality than the general Utah population. The Mormon females had lower death rates from breast and female genital cancers than the State rate. These decreased death rates were not statistically significant. Although deaths due to hypertensive heart disease were roughly twice as high as expected in both sexes, increases in death did not relate to increases in dose, calculated as the years of exposure times the median arsenic concentration. The Utah data indicate that heart disease should be considered in the evaluation of potential benefits of U.S. regulation.

The EPA rejected the Mormon data while accepting data from Bangladesh, Taiwan, and later Chile as representative populations. The basis for Utah data rejection was on diet, behavior, and ethnic background as being different from the general population of the United States.

The EPA was also required to set up the Small Business Advocacy Review (SBAR) Panel as required by section 609(b) of the Regulatory Flexibility Act, to obtain advice and recommendations of representatives of the small entities that potentially could be affected by this regulation. The panel response in the Federal Register was succinct:

Regarding health effects, the Panel recommended the following: Further evaluate the Utah study and its relationship to the studies on which the NRC report was based and give it appropriate weight in the risk assessment for the proposed arsenic standard; and examine the NRC recommendations in the light of the uncertainties associated with the report's recommendations, and any new data that may not have been considered in the NRC report.

However, the EPA stuck by the NRC recommendation and the 10 ppb standard was recommended. Three days before the Clinton administration ended, the recommendation was signed into law.

Whoa There!!

Two months later, the Bush administration put the new arsenic standard on hold. "The scientific indicators are unclear as to whether the standard needs to be as low as 10 parts per billion," the new EPA Administrator Christie Todd Whitman stated.

This incensed certain elements of the environmental movement, including the Natural Resources Defense Council. "This outrageous act is just another example of how the polluters have taken over the government," said Erik D. Olson, an attorney for the environmental group, referring to the mining interests involved in arsenic production. The NRDC also targeted the city of Norman, Oklahoma as having the highest arsenic content of any well system in the country in 1996, a statement picked up in a journal no less respected than Scientific American. Somebody didn't do their homework – nine of the wells with reported arsenic were not public supply wells and were scheduled to be plugged and abandoned. The public works department was never contacted by either organization. Seems that the information came from the EPA database....

By this time, public works departments in arsenic-prone areas were beginning to take the issue seriously. In Oklahoma, the news was not very good. The Oklahoma Department of Environmental Quality estimated statewide that 40 systems were affected, with about 120 wells not able to meet the 10 ppb standard. The bad news did not fall in an even fashion – for example, in central Oklahoma the Garber-Wellington aquifer had arsenic, but only in areas west of Interstate 35 where the aquifer was deeper and the water softer. With over four dozen wells, the city of Midwest City had no arsenic problem; twenty miles to the west in Canadian County, the city of Yukon had an average arsenic level of 36 ppb. In fact, three of the larger communities in Canadian County – Piedmont, Yukon, and Mustang – were facing a very bleak future in terms of water supply.

Options, Please!

The reality came quickly, painfully, and with a hefty price tag. A city had three options.

The first option was the engineering solution. Treat the water. This developed into two lines of thinking. The first was to use reverse osmosis to remove the arsenic. The good news was that it was a tried and true method that worked. The down side was that it was a very expensive process and the waste stream may actually be classified as hazardous waste. For a small utility, this was not practical. The second line of thinking was the coagulation-filtration method. The waste stream was not hazardous, but required some pretty fancy chemistry with some hefty investment. The price tag for the city of Norman was estimated at \$17 million for capital investment, with operation and maintenance running at \$2.2 million annually on a system presently worth \$42 million. Again, not practical for a small utility.

The next option was the geologic solution. This also had two lines of thinking. The first was to go into each arsenic-producing well and seal off with cement the sandstones that had unacceptable levels of arsenic. Since each well usually had several sandstones with different arsenic concentrations, the result would be a well that would have a lower water yield, but with acceptable water quality. This option is currently being used in several well fields in central Oklahoma today.

The second line of thinking was to find areas within the aquifer where there is no arsenic in the water. Two geologic mapping projects are currently underway in the Garber-Wellington aquifer focusing on this option. Once completed, water right leases may be purchased in areas where the water is determined to be of better quality.

The third option was to buy water from some other entity or source. In some instances, water under the control of outside interests is available. However, depending upon a water supply that is under the control of others without good financial planning may jeopardize an asset that is vital to many communities. The ability of a community to

operate and control its water system is of critical importance because it represents a stable future and is one of the few available secure revenue sources. When a community is forced to rely upon an outside provider for water, both those vital elements may be impacted, requiring strategies to secure the future growth and direction of the community.

Bell, Round 2

Meanwhile, in Washington the Bush administration was reviewing the science behind the new arsenic regulation. The American Water Works Association noted the cost of this rule was staggering -

“The rule is expected to impact about 10 percent of the nation’s community drinking water providers, and the expensive new treatment processes it requires makes the arsenic rule one of the most costly drinking water regulations ever. Complying with the new standard could cost individual ratepayers in the desert Southwest, Midwest and New England as much as \$2000 a year.”

The NRC formed a new subcommittee to update the 1999 Report. The subcommittee reviewed data for dose-response assessment and risk estimation and determined whether EPA’s risk estimates for 3, 5, 10, and 20 ppb of arsenic were consistent with available scientific information, including information from new studies. Although the Utah report was reviewed, the subcommittee again rejected the report.

“...the Utah study used a comparison group with differences in life-style characteristics from the study population. The study population was composed of individuals with religious prohibitions against smoking, and the unexposed comparison group was the overall population of Utah, where such religious prohibitions are not practiced by all residents.”

In the review, a new set of data from Chile was also presented. The conclusions from the University of Santiago report was devastating to the water supply

community – at the accepted risk factor, the arsenic concentration in water would have to be 3 ppb.

In September 2001, the review panel presented the findings:

“There is a sound database on the carcinogenic effects of arsenic in humans that is adequate for the purposes of a risk assessment... The available data on the mode of action of arsenic do not indicate what form of extrapolation (linear or nonlinear) should be used below arsenic concentrations at which cancers have been observed in human studies. As discussed previously, there are no experimental data to indicate the concentration at which any theoretical threshold might exist. Therefore, the curve should be extrapolated linearly from the ED to determine risk estimates for the potential concentrations of concern (3, 01 5, 10, and 20 µg/L). The choice for the shape of the dose-response curve below the ED is, in part, a policy decision.

... even at the highest risk estimates made by the subcommittee, the increases in cancer due to arsenic in drinking water would be difficult to detect statistically in the U.S. population. For example, a lifetime excess risk of bladder cancer incidence in males of 45 per 10,000 would represent only 13% of the total risk for male bladder cancer in the United States from all causes.

...The results of this subcommittee’s assessment are consistent with the results presented in the NRC’s 1999 Arsenic in Drinking Water report and suggest that the risks for bladder and lung cancer incidence are greater than the risk estimates on which EPA based its January 2001 pending rule.”

The new Bush administration had no choice but accept the findings. With the aftermath of September 11, 2001, there were other priorities now, such as homeland security. EPA

Administrator Christine Todd Whitman noted in her press release:

“Throughout this process, I’ve made it clear that EPA intends to strengthen the standard for arsenic by substantially lowering the maximum acceptable level from 50 ppb. This standard will improve the safety of drinking water for millions of Americans and better protect against the risk of cancer, heart disease and diabetes”.

Others, such as the NRDC, were going for the extra mile. “It’s clear that the handwriting was on the wall, that the EPA could not adopt a weaker standard than the Clinton standard. But the scientific evidence now proves we need a standard of 3 ppb to protect health.” said Erik D. Olson. Even Congress was taking notice now. “The administration had no choice,” Sen. Barbara Boxer, D-Calif., said, adding she would now push for a lower standard. “Their own study undermined their dangerous position that the 50 ppb standard could continue until further notice. They had no choice but to do this, but now the bar is higher because the study said that even at 3 ppb the arsenic is very dangerous.”

Back at the Ranch...

Small communities with arsenic issues were now in a panic. Staring at a 2006 deadline to get their water supplies to conform to the new 10 ppb arsenic regulation, each one of the basic three options were evaluated and re-evaluated. Those communities who had the ability to rework their well fields and geologically evaluate new areas for groundwater exploration started their programs. Those communities that did not have the potential to explore for new groundwater sources started to cast their nets wider. And the direction they were looking was in south-southeast Oklahoma.

Between Sulphur and Ada, Oklahoma, lies an area of complex geology. A drive along Interstate 35 through the Arbuckle Mountains shows one the difficulties of understanding this part of the world – limestone beds stand on end, or are folded and twisted in fantastic shapes. In this area is the Simpson-Arbuckle formation, a prolific aquifer that

is little understood and less developed. On the surface are several large ranches, whose owners hold the groundwater rights. And the groundwater has virtually no arsenic.

The basic idea is classic supply and demand. Certain municipalities in central Oklahoma needed arsenic-free water. The water ranchers were willing to sell the water. But navigating this process proved no easy sailing.

The first issue was one of scale. Simply put, were there enough customers to make the initial capital investment for lease purchase, well drilling, pumps, pipeline, and maintenance worth the effort? And would it be at a price that was competitive with other available sources of water?

The answer to the first issue was not easy. To be cost-competitive according to their studies, about 100,000 customers needed to be found. A regional water association was formed in Canadian County to recruit member cities, but even with most of the municipalities in the county on board, the number of customers was a little over half the amount needed. Communities in Cleveland County were approached, but with large areas of the Garber-Wellington aquifer east of Interstate 35 still undeveloped for arsenic-free groundwater, Cleveland County communities had different agendas.

The second issue was even tougher. Let's label it as a resource management question. Municipalities in southeastern Oklahoma looked at the proposal with alarm. Would the demand from central Oklahoma affect their water supplies? The Simpson-Arbuckle aquifer is also home to several high-quality bass streams. Would additional demand on the aquifer affect the flow to the streams and change the ecosystem? There were no immediate answers from the geologic and environmental scientists. The area was complex, little studied, and up until now no funding or needs for research had been recognized.

The Oklahoma Water Resources Board (OWRB) is the designated authority in Oklahoma to review

and decide groundwater allocations. As the project came to review, the OWRB was flooded with calls and letters from concerned citizens from southeast Oklahoma. The first public hearing was postponed when the administrative judge was injured in a car accident. Before the meeting was rescheduled, however, the Oklahoma legislature began to move.

Senate Bill 288

A flood of groundwater bills swept through the state capitol at the start of the legislative session. Proponents of the water ranchers argued that the sale of water would have no impact on either the water supplies of southeastern Oklahoma cities or the ecosystem. Opponents wanted to place a moratorium on all new water permits across the state until geologic studies had been done on all aquifers. To everyone, it was evident that a new day was coming for the groundwater community in Oklahoma.

By May 2003 the legislature had crafted a solution. The Simpson-Arbuckle aquifer had been previously declared a sole-source aquifer by the federal EPA, a designation unique to this area in Oklahoma. Using this designation as a tool to limit the bill's effect only to the Simpson-Arbuckle aquifer, the legislature declared a moratorium on water permits for sole-source aquifers until geologic and environmental studies had determined a safe yield. The bill also included language that protected the surface water flow as well.

Opponents of the bill immediately criticized the bill as being unfairly focused on just one aquifer and discriminatory with respect to the water ranchers who should be able to enjoy the benefits of their groundwater rights. Legal actions may be pending.

Where Are We Now?

The 2003 Oklahoma legislature has gone home. In Bangladesh, Shakti's parents buried their daughter and live out the life of landless farmers. In Washington, the clock is ticking towards 2006, when the 10 ppb arsenic regulation will be enforced.

Southern Oklahoma
The Arbuckle-Simpson Aquifer
Citizens for the Protection of Johnston County Water



The Arbuckle-Simpson aquifer is in an area of about 800 square miles in the Arbuckle Mountains and the Arbuckle Plains of south-central Oklahoma. The area includes parts of Carter, Coal, Johnston, Murray, and Pontotoc Counties. Average annual precipitation is about 34 to 39 inches. The aquifer supplies small, but important, quantities of water, mainly for public supply.

Hydrogeology

Freshwater may extend to depths of greater than 3,000 feet. Wells completed in the Arbuckle-Simpson aquifer commonly yield from 100 to 500 gallons per minute and locally yield as much as 2,500 gallons per minute. Springs that issue from the aquifer discharge from 50 to 18,000 gallons per minute. The water is a calcium bicarbonate type and commonly is hard but has a dissolved-solids concentration of generally less than 500 milligrams per liter.

Recharge to the aquifer occurs from precipitation that falls on the higher elevations of the aquifer outcrop areas and is estimated to be 4.7 inches per year. Intense faulting of the rocks affects the ground-water flow system because faults might act as barriers to ground-water movement or as conduits through which water travels to the surface.

Water is discharged naturally from the aquifer by numerous springs and seeps; much of this discharge becomes the base flow of streams. The base flow of streams that drain the aquifer is estimated to be about 60 percent of the total annual runoff from the Arbuckle-Simpson outcrop area.

Ground-Water Development

The largely undeveloped Arbuckle-Simpson aquifer is estimated to have 9 million acre-feet of freshwater in storage. The water is usually a calcium-magnesium bicarbonate type that is suitable for most uses. An estimated 8 million gallons per day of freshwater was withdrawn from the Arbuckle-Simpson aquifer during 1985. About 5 million gallons per day was withdrawn for public supply, and about 2 million gallons per day was withdrawn for agricultural purposes. About 1 million gallons per day was pumped for industrial, mining, and thermoelectric-power uses, and about 200,000 gallons per day was withdrawn for domestic and commercial uses.

web: sr6capp.er.usgs.gov/gwa/ch_e/E-text9.html#arbsim

October 2, 2002

Citizens for the Protection of Johnston County Water

Minutes of Board Meeting, October 2, 2002, Best Western Inn, Tishomingo

The meeting was called to order by Earl Brewer, Chairman, at 7:30 pm. Attending were Brewer, John Bruno, David Brown, Ray Lokey, Gary Greene and Floy Parkhill. Bruno moved and Greene seconded to circulate a petition (Attachment 1) at the Chickasaw Festival on Saturday. Approved unanimously. Brown announced that \$654 would be contributed by the Southern Oklahoma Water Alliance. Bruno moved and Brown seconded motion to have the Chairman send a letter (Attachment 2) to the editors of the Oklahoma and Tulsa newspapers. Approved unanimously.

Attachment 1: PETITION

To Oklahoma Elected Officials:

I am an Oklahoma resident who is gravely concerned about our water resources. The plan to commercially pump water from the Arbuckle-Simpson aquifer could cause an economic, environmental, ecological and cultural disaster in several southern Oklahoma counties. Please use your good offices to ensure that this disaster does not occur.

Attachment 2: Editor - The Sunday Oklahoman
October 2, 2002

A number of stories have recently appeared in The Oklahoman related to water issues facing the state. The Sunday Oklahoman editorial of September 1 was prescient in its contention that water disputes will intensify. A dispute over a plan to pump water from the Arbuckle-Simpson aquifer in southern Oklahoma is now underway.

Springs from this aquifer fill streams that are home to Turner Falls Park, Chickasaw National Recreation Area, Blue River Public Hunting and Fishing Area, Tishomingo National Fish Hatchery, Tishomingo National Wildlife Refuge, Slippery Falls Boy Scout Ranch, Camp Simpson Boy Scout Camp, Camp Bond Church Camp. These spring-fed waterways are also the primary source for municipal water for the cities of Ada, Sulphur, Tishomingo and Durant.

Under current state water law, all surface water is owned by the state but the landowner owns underground water. This creates a dilemma for the state. The springs create state property (surface water) but the state would be denied that property if commercial pumping from the aquifer depletes the springs. Should private property rights supercede state property rights? Does assertion of private property rights prevail if such assertion causes a broad economical and ecological disaster?

Abundant excess surface water exists within the state's boundaries. Governor Keating's office stated that around 6 million acre-feet (about 2 trillion gallons) of water annually flows out of Oklahoma unused. This is two-thirds the estimated total volume of water in the Arbuckle - Simpson aquifer!

It is difficult to understand why we as a state would allow possible destruction of our natural waterways when we have viable alternatives available. Why must citizens of the state have to choose between pristine natural resources and water supplies for population centers when we can have both? As we roll into the future, efficient and smart utilization of our state's resources is not only desirable, it is essential to our future progress.

Floy Parkhill, Secretary
<http://www.arbsimaquifer.net/citizengroup/boardminutes10032002.htm>

Southeastern Oklahoma
Selling Water: The Proposal

*Abstract of Status Report to the Office of the Governor
Joint State/Tribal Water Compact & Water Marketing Proposals SE Oklahoma Water Resources Development Plan
Prepared by Oklahoma Water Resources Board*

HCR 1066

In part to address the outstanding payment situation involving Sardis Reservoir and inquiries by north Texas entities to purchase water, the Oklahoma Legislature adopted HCR 1066 in 1999. The legislation directed the Oklahoma Water Resources Board (OWRB), in cooperation with representatives of Choctaw Nation and Chickasaw Nation, to prepare a Kiamichi River Basin Water Resources Development Plan, which was mandated to be consistent with cornerstone principles for water resources development set forth in HCR 1066. A Working Group was established and public hearings were held. After analyzing potential development in light of the cornerstone principles, the February 2000 Kiamichi River Basin plan made two recommendations: (1) the State of Oklahoma should continue to pursue formal development of a compact with the Choctaw and Chickasaw Nations, and (2) the State and the two Tribal Nations should invite comment from the public into any process that allows water to be transferred out of the Kiamichi River basin.

HCR 1109

Following up on HCR 1066, in May 2000, the Legislature adopted HCR 1109, which contained two major directives for the OWRB: (1) coordinate with the Corps of Engineers on a study of southeast Oklahoma's water resources, and (2) bring proposals for development of those waters to the State Legislature for consideration. HCR 1109 required all valid proposals to be consistent with the cornerstone principles set forth in HCR 1066 and all principles established in the February 2000 Kiamichi River Basin Water Resources Development Plan (including the recommendation to compact with the Tribal Nations).

**Memorandum of Understanding (MOU)
for Draft Compact and Draft Contract**

Following the HCR 1109 directives, Governor Keating, Chief Pyle of the Choctaw Nation, and Governor Anoatubby of the Chickasaw Nation signed a Memorandum of Understanding in October 2000 that established a timeline for negotiating a draft compact among the three governments, and for soliciting and reviewing proposals for the development of water in southeast Oklahoma.

**Proposals to
Develop Southeast Oklahoma Water**

Pursuant to the October 2000 MOU, and as an initial step in soliciting water development proposals, OWRB staff and representatives of the Tribal Nations prepared and distributed Requests for Qualifications to interested entities. Three responses were received. The proposal submitted by Central Oklahoma Water Authority, apparently a proposed brokerage entity, was rejected. Further discussions and negotiations were conducted with representatives of the remaining entities, the North Texas Water Agency (NTWA) and Oklahoma City Water Utilities Trust (OCWUT).

Draft State/Tribal Water Compact

1. The draft State/Tribal Water Compact addresses three major subjects: (1) water rights administration, (2) water quality standards administration, and (3) economic development. The Tribal Nations claim ownership and sovereign authority to regulate all water (surface water and groundwater) within their original tribal boundaries (all or parts of 22 counties in southeast Oklahoma).

2. The Compact, as drafted, would have the Tribes agree to delegate whatever authority they may have over surface water and groundwater in southeast Oklahoma to the State. Also, current state law and water rights permitting would continue to control water use in the 22-county area. Citizens in the area would not notice any change in water rights administration and the Tribes would release claims to previously issued state water rights (such as those granted to Oklahoma City). Groundwater is included solely to remove the cloud on title. The Compact expressly states that groundwater, private property under state law, cannot be sold.
3. The Compact would also have the Tribes agree that the State's water quality standards apply in the 22-county area, and that if the Tribes adopted their own water quality standards, as allowed under federal law, their standards would be limited and could not affect water on non-tribal land.
4. Concerning economic development, the Compact, as drafted, would have the State and Tribal Nations agree to limitations and conditions on selling water from the Compact area out of state. Net revenues would be split 50/50 between the State and Tribal Nations. The Compact would also create a State-Tribal Intergovernmental Compact Commission (STICC) consisting of an equal number of State and Tribal members. The Compact Commission would only administer out of state water sale contracts. The Compact Commission would not administer water rights.
5. The draft Compact expressly provides that the full Oklahoma Legislature, not just the Legislature's Joint Committee on State-Tribal Relations, would have to approve the Compact before it would be presented to the United States government (Secretary of Interior or Congress) for final ratification.

**North Texas
Water Agency (NTWA) Proposal**

1. The North Texas Water Agency, consisting of five large public entities that supply water to more than five million customers in the north Texas area, proposes to use up to 320,000 acre-feet of water per year from two of the six major river basins in southeast Oklahoma. As more fully explained in the draft contract, the State-Tribal Compact Commission and NTWA would be parties to the contract whereby STICC would supply water to a point of delivery in Texas just across the south bank of the Red River (which forms the Oklahoma-Texas boundary). The system to supply water would be owned entirely by STICC and developed in three phases over a 20-year period. No Texas entity would own any property in Oklahoma. STICC would hold water rights authorized or granted by the Oklahoma Legislature. The NTWA would pay all costs associated with the water supply project (except for any minor separate costs for local entities to tie into pipelines and related projects). Absolutely no new reservoirs would be built to supply water to Texas. Texas would rely only on available run-of-the-river water and only under strict conditions for diversion. All of Oklahoma's present and future needs would be protected, including local uses and potential use by central Oklahoma. Drought protections for Oklahoma would be recognized and NTWA would expressly waive any and all claims to downstream dependency.
2. The first phase of the system would divert water from diversion works (not a reservoir) on the Kiamichi River between Hugo Reservoir and the Red River where up to 120,000 acre-feet of water per year would be available. Phase 2 of the system would allow STICC to deliver up to a total of 180,000 acre-feet of water per year, including the Kiamichi River amount plus water from another point of diversion on the Little River downstream from Pine Creek Reservoir. Finally, phase 3 of the

system would have STICC divert a total of 320,000 acre-feet of water (120,000 acre-feet from the Kiamichi and 200,000 acre-feet from the Little River and Mountain Fork basins downstream from where the Mountain Fork flows into the Little River). The diversion works on the Little River would consist of a low water dam that would not impede natural flows or cause additional flooding outside the river banks or an off-stream diversion structure.

3. On average, more than six million acre-feet of water flows out of Oklahoma from the six major river basins located in the southeast region. The Kiamichi River Basin alone produces more than 1.4 million acre-feet of water in an average year while the Little/Mountain Fork River Basins collectively produce more than 2.4 million acre-feet. The NTWA proposal would use only about 7 percent of the average annual flows from these three basins.
4. The draft contract provides a three-year period within which STICC would have to complete environmental studies and obtain all necessary licenses and permits before it could begin to build the water transfer system. The NTWA would pay all costs of such studies. Endangered and threatened species would have to be protected. Low flow needs of the Kiamichi River, Red River, and Little River would have to be addressed. The EPA and U.S. Fish and Wildlife Service would be consulted.
5. The NTWA would pay for pipelines, easements, STICC overhead costs, and all environmental studies required for system development. The NTWA would also pay a "commodity charge" for the intrinsic value of the water; Oklahoma citizens and entities would not pay any commodity charge to use water. Differences in valuing the commodity charge caused negotiations with the NTWA to break down in January 2002. Oklahoma calculated the present value at \$339 million

(amortized over 100 years to produce more than \$5 billion) while the NTWA estimated the present value at approximately \$174 million (to produce about \$1.4 billion over 100 years). A portion of the proceeds could be used to pay the Sardis Reservoir repayment contract, which has a current outstanding balance of approximately \$38 million.

6. The draft contract could not become effective until the Water Compact becomes effective and the full Oklahoma Legislature approves the contract.

Oklahoma City Water Utilities Trust (OCWUT) Proposal

1. The Oklahoma City Water Utilities Trust is interested in securing a long-term future supply from southeast Oklahoma. OCWUT currently relies on Atoka Lake and McGee Creek Reservoir for approximately one-half of its total supply. OCWUT pumps water from McGee Creek Reservoir to Atoka Lake and from Atoka Lake to Lake Stanley Draper, where it is treated and distributed throughout the Oklahoma City area. OCWUT has indicated that Kiamichi River water would be pumped approximately 20 miles to McGee Creek Reservoir. OCWUT's response to the RFQ contained two options for development, both of which anticipate a low water dam diversion point on the Kiamichi River, near Moyers, or from a point closer to the headwaters of Hugo Reservoir: (1) use of Sardis Lake storage as backup supply, amounting to approximately 150,000 acre-feet of water per year, and assumption of the Sardis Lake contract from the State, or (2) use of run-of-the-river flows of the Kiamichi River for about 50,000 acre-feet of water per year (leaving at least 10 cubic feet per second low flow protection and no impact on Hugo Reservoir yield). OCWUT discussed the possibility of a hybrid of these two options. Analysis of the NTWA proposal indicates no impact to water that may be used by OCWUT under either of OCWUT's options.

2. OCWUT's proposal would satisfy the cornerstone principle that waters from the Kiamichi River should be used for local and state uses before being considered for use out of state. OCWUT already possesses the necessary infrastructure to utilize waters of the Kiamichi River for the very long-term needs of central Oklahoma communities, including Norman, Edmond, El Reno, Yukon, Mustang, and others if those entities can reach intergovernmental agreements with OCWUT as to the cost of storing and pumping the water.
 3. OCWUT's Option 1 (assumption of the Sardis Reservoir repayment contract with the Corps of Engineers) would relieve the state of the \$38 million conditional obligation to the federal government.
- environmental and social problems often associated with large metropolitan areas, but instead would prefer to develop less obtrusive recreation and tourism opportunities.
2. Water marketing could provide much-needed capitol for infrastructure improvements, to foster tourism, and perhaps attract light industry and other employment opportunities to southeast Oklahoma. There is a current need of more than \$90 million for water and wastewater improvements in the southeast while much more is needed for roads and related projects key to future development. It is appropriate that areas producing marketed water should be appropriately compensated and have priority in obtaining funds for much-needed infrastructure.

Development In Southeast Oklahoma

1. The economic situation in southeast Oklahoma has generally lagged behind the rest of the state for a variety of reasons. Local citizens point out that there has been comparatively less oil and gas activity in the region. Some say that no water from the area should be sold to boost economic development; instead, industries will eventually come to the water in southeast Oklahoma. Two related viewpoints on this issue are that: (1) southeast Oklahoma possesses significant water resources, yet industries have not located there (unlike the north Texas area), and (2) many southeast Oklahoma residents do not want the air and water pollution, congestion and related
3. Because a substantial majority of the Tribal Nation members reside in southeast Oklahoma, most of the Tribes' net water marketing proceeds (pursuant to the Compact, as drafted) would be utilized in southeast Oklahoma. In addition, the State could establish a public trust with membership from a cross-section of interests in southeast Oklahoma to set priorities for expenditure of the State's proceeds. Funds could be used for grants and as security and collateral to leverage bond issues for loans. The state public trust could use the existing experience of the OWRB and Oklahoma Department of Commerce to provide guidance in coordinating the extremely large amount of public infrastructure financing that could be possible from marketing available surface water resources.

AGENCY MEMBERS
CITY OF DALLAS
CITY OF IRVING
NORTH TEXAS MUNICIPAL WATER DISTRICT
TARRANT REGIONAL WATER DISTRICT
UPPER TRINITY REGIONAL WATER DISTRICT

NORTH TEXAS WATER AGENCY

c/o NTMWD
505 E. BROWN STREET
PO BOX 2408
WYLIE, TEXAS 75098-2408
972/442-5405
972/442-5405/FAX

February 1, 2002

The Honorable Frank Keating CMRRR 7001 1940 0000 3808 9804
Governor's Office
State Capitol Building, Room 212
Oklahoma City, OK 73105

Re: Water Marketing Partnership

Dear Governor Keating:

On behalf of the North Texas Water Agency (NTWA), I want to express our appreciation for being invited to submit a proposal for the beneficial use of excess water in southeast Oklahoma. Also, I want to thank the State of Oklahoma as well as the Choctaw and Chickasaw Indian Nations for the time and effort spent over the past 12 months meeting with NTWA, discussing arrangements for a beneficial, long-term water marketing partnership. All five members of NTWA, which include the North Texas Municipal Water District, Tarrant Regional Water District, City of Dallas, Upper Trinity Regional Water District, and City of Irving, want to reassure you that we remain ready to continue these talks.

We recognize the importance of all of the Cornerstone Principles as developed in compliance with House Concurrent Resolution (HCR) 1066 and 1109 and further agree that protective measures concerning drought, the environment, flooding, downstream dependency and future partnership. Each of these issues have been thoroughly discussed and in principal agreed to by both parties. Protection for Oklahoma is priority "Number One."

The State of Oklahoma has been blessed with an abundant supply of water, so much so that enormous volumes of flow through Oklahoma each year and leave the state unused. Records indicate that an average of two trillion gallons flow out of Oklahoma each year. The volume alone from only six river basins in Southeast Oklahoma, not counting all of the water supply still held in existing reservoirs, is almost four times the amount of water used each year by New York City with a population of over 8 million. It is a small portion of this enormous volume of water that NTWA is interested in purchasing at a fair and reasonable price to both parties. To date both sides have expended a great deal of energy analyzing the very complex issue of water pricing. We believe that both sides

page 2 ...

have negotiated in good faith and that our meetings have been most productive. Currently, we believe we are very close to a mutually agreeable level of compensation for water from southeast Oklahoma.

The benefits to be gained from a water marketing partnership are numerous and of historic proportions.

- **The North Texas area** can gain a supplement water supply to compliment existing and future Texas water supply projects.
- **The People of Oklahoma** can receive a revenue stream fro water unused and currently leaving the State without compensation that could be used to help stimulate economic development and create new jobs.

Additionally, the revenue could provide a funding source for some of Oklahoma's ongoing programs to upgrade public water supply and wastewater infrastructure, improve existing roads, add to existing health care facilities and other similar programs.

We have a historic opportunity to show the rest of the Nation that by working together in partnership great benefits can be achieved for the people we serve. The members of the North Texas Water Agency are ready and willing to resume talks with Oklahoma immediately. It would appear to be a great loss to both sides to miss this opportunity; however, we must soon turn our attention to other opportunities if there is no desire to continue discussions. Let's not let this happen.

Again, let me thank our Oklahoma friends and counterparts for the opportunity to explore this partnership. I want to leave you with the hope that we will begin talks again soon and that by working together we can achieve the benefits that lie ahead.

Sincerely,

James M. Parks
Chairman, North Texas Water Agency

Southeastern Oklahoma
Selling Water: A Supporting View
Oklahoma Water Resources Board

State/Tribal Water Compact & Southeast Oklahoma Water Resources Development Plan

What is the State/Tribal Water Compact and what are its primary provisions?

The State/Tribal Water Compact, currently in the draft stage, is an agreement between the State of Oklahoma and Choctaw and Chickasaw Tribal Nations to address water rights administration, water quality standards administration, and development and use of water in the 22-county area of southeast Oklahoma comprising the territories of the two Tribes.

Why did the State choose to compact with the Tribes?

Based upon independent analysis of water rights claims made by the Choctaws and Chickasaws the State chose to compact with the Tribes, rather than litigate. Similar cases in the U.S. where Indian water rights have been litigated have involved lengthy and expensive court battles.

Eventual legal decisions rarely resolve all the pertinent issues regarding Tribal water rights, often resulting in a further clouding of the situation and threatening potential economic development opportunities related to water use. Under the draft State/Tribal Water Compact, the Tribal Nations expressly release all claims to water rights issued by the State, including Oklahoma City's rights to Atoka Lake and McGee Creek Reservoir.

Can the State/Tribal Water Compact or a potential water sales contract be approved without consent of the Oklahoma State Legislature?

No. Both the Compact and a water contract must be approved by the full vote of the State Legislature.

In particular, Oklahoma law prohibits the interstate sale of Oklahoma water across the state's border without consent of the Legislature. The draft Compact also provides that a water sale contract must be approved by full vote of the State Legislature and cannot be materially amended without approval of both the Oklahoma Legislature and Choctaw/Chickasaw Tribal legislatures.

Does the Compact transfer water rights and subsequent decision-making power to the Tribes?

No. The draft compact states that all existing appropriation rights to stream water, water in lakes, and water in farm ponds are protected, as they are under Oklahoma law, and parties to the compact resolutely agree that the agreement will not impact private property rights. Provisions of the compact ensure that the state's existing water rights administration process will proceed as normal.

Does the Compact provide for marketing of groundwater?

No. The draft compact specifically declares that groundwater will not be sold. Furthermore, a provision of the compact states that a potential water marketing contract must expressly provide that groundwater, a private property right under Oklahoma law, will not be used to supplement an the out-of-state sale.

What benefits and projects would be enabled through a potential water marketing agreement?

In addition to resolving the state's \$38 million obligation related to construction of Sardis Lake, the people of Oklahoma stand to benefit greatly from the \$339 million (estimated at \$5.1 billion

over 100 years, including an up-front payment of more than \$35 million) offered by the North Texas Water Agency, according to terms of the last contract proposal. State funds (50 percent of the revenues, which could be optimized through leveraging) are proposed for uses exclusively related to water, wastewater and other economic development need in southeast Oklahoma, especially in providing water to rural areas in need of supply. The Choctaw and Chickasaw Tribes will utilize their shares for a variety of purposes, including (according to terms of the Compact) economic development, education, tribal government programs, social service programs, road programs, tribal infrastructure development, health care, senior citizens programs, youth programs, housing programs, acquisition and management of real property, culturally relevant programs, and similar programs. Among various indirect benefits provided through the agreement are the resolution of Tribal water rights claims that could deter economic development in southeast Oklahoma, ensuring future use of Atoka and McGee Creek Reservoir by Oklahoma City, and avoidance of millions of dollars in court costs.

Would removal of water from the Kiamichi River or elsewhere negatively impact the environment or endangered species?

Because no plan for the development of southeast Oklahoma waters has been formally introduced, no official environmental studies have yet been conducted. However, such studies would be mandated, both by Oklahoma officials and under requirements of the Endangered Species Act and related state and federal laws, to determine environmental impacts, if any, of proposed projects and necessary mitigation. These detailed analyses would contemplate, among other issues, the impacts of releases from Hugo Lake on the Kiamichi and Red Rivers, specific stream flow requirements of the endangered Rock Pocketbook mussel in the Kiamichi River, flow requirements in the Little River downstream from its confluence with the Mountain Fork, and potential impacts of proposed diversion points. Under terms of the latest

contract proposal from the North Texas Water Agency, no new reservoirs would be constructed on the Kiamichi, Little, Mountain Fork, or Glover Rivers, including Tuskahoma and Lukfata Reservoirs. Avoidance of potential environmental impacts, especially those related to endangered and threatened species, has been a vital consideration in the investigation of water development opportunities in southeast Oklahoma.

If a water marketing agreement is effectuated, should the State be concerned about potential downstream dependency claims by Texas?

No. Among the parameters for any out-of-state water sale contract stated in the draft State/Tribal Water Compact is that the contract must contain an express waiver of downstream dependency. Judicial precedent indicates that such express provisions in agreements between two or more parties are upheld in a court of law. In addition, the Red River Compact (between the States of Oklahoma, Texas, Arkansas, and Louisiana), which apportions water in the Basin to member states, limits the amount of water a Texas entity(s) could legally claim to that amount specifically apportioned to Texas under the agreement, regardless of the needs that develop in Texas.

Would the potential water marketing agreement violate terms of the Red River Compact with the State of Arkansas?

Terms of the Red River Compact require Oklahoma to allow 40 percent of the total runoff produced in the watersheds downstream from Pine Creek, Broken Bow, and the authorized (but not proposed for construction) Lukfata Reservoir sites to flow down the Little River into Arkansas. However, most of the 2.4 million acre-feet/year of water produced in the watersheds originates upstream of those sites and is thus not subject to 40-percent flow obligation.

Would the marketing of state water resources make Oklahomans vulnerable to water supply shortages in the event of an extreme drought situation?

Southeastern Oklahoma
Selling Water: An Opposing View

Jeannine Hale and Suzette Hatfield

Oklahoma Family Farm Alliance, Oklahoma Sierra Club and Southern Oklahoma Water Alliance

The State-Tribal Compact and Texas water sale is dead.

It's obvious that negotiations are continuing. The Choctaws are spending BIG BUCKS on newspaper and radio advertising to promote the deal. A Texas spokesman, quoted in the Dallas Morning News, said the contract is 90% complete.

Water Compacts must be approved by the Oklahoma Legislature.

According to House attorneys, a Compact involving Indian tribes may only have to pass the State-Tribal Relations Committee and be signed by the governor.

We have to include the tribes in any water deal-they own streams.

The law firm of Ryley, Carlock and Applewhite, expert in tribal water rights, was hired by the State of Oklahoma to analyze the validity of tribal claims. The conclusion of attorney Michael Brophy, was that "Neither the Choctaw Nation nor the Chickasaw Nation owns the water in the (Kiamichi) Basin."

But...by including the Indians in the deal, we can stay out of court. They won't litigate to assert tribal claims.

There are worse things than going to court. The current Compact offers the Choctaws 37 1/2% of any net revenues and the Chickasaws 12 1/2%. Let's look at some numbers. ALL Indian tribes in Oklahoma together with allottees own 2.5% of the land in the state. Tribal governments own about 97,000 acres, or 151 square miles. Oklahoma's smallest county is Marshall County, with 371 square miles. The population of ALL tribes constitutes 7.9% of the state's people. The Choctaws and Chickasaws form 3%. How can the Oklahoma

Water Resources Board possibly justify a giveaway of HALF the potential revenues from a water sale as a bribe for this small population?

Another problem is precedent. Our state would have to buy off tribes in 74 out of 77 counties to do other inter-basin water transfers-even within our state! And, we won't stay out of court. Groups representing environmental, agricultural and industry interests are poised to sue to protect their water claims.

A water compact and sale would bring much needed development to southeastern Oklahoma.

All revenues from a sale would pass through a Compact Commission. This unelected group would have authority to spend or invest monies, build water storage structures and incur indebtedness. No distributions to anyone are guaranteed-not for schools, not for roads, not for water supplies. Any new industry would be crazy to locate in southeastern Oklahoma after establishment of this Compact. By attributing ownership of half the water to the tribes, the State of Oklahoma would be granting tribal governments jurisdictional authority that they currently do not have. How so?

Water permitting can be stymied pursuant to a tribal protest by claims of violations of tribal sovereignty, tribal political integrity or tribal economic security. (State-Tribal Water Compact Sect. 4.5.b) Such situation is not unprecedented. The State of Montana is currently enjoined from issuing water permits until all the water needs of the local tribes can be quantified. Tribes are preparing to become environmental regulators. Under an EPA provision called "Treatment as States", tribes that can show jurisdiction and ability may be delegated regulatory authority for Clean Water Act, Safe Water Drinking Act and Clean Air Act programs currently administered by our DEQ.

The Chickasaw tribe has already applied for treatment as a state.

Overlapping jurisdictions and conflicting environmental programs would be major hurdles for industries and would discourage development. In a landmark case, “Montana v United States EPA”, tribes were granted the right to regulate activities of non-members if they could show that activities would affect the “political integrity, economic security, or the health and welfare of the tribe.” According to the 9th Circuit Court of Appeals, that’s easy.

Cities would not be exempt from the headaches, either. The Isleta Pueblo tribe in New Mexico was granted EPA delegation as a state. The tribe established Water Quality Standards so strict that the City of Albuquerque had to spend more than \$200 MILLION in additional water treatment in year 2000 so that the tribe would have ceremonially clean water.

Groundwater uses won’t be affected. The Compact says that groundwater sales are not authorized.

While it is true that no marketing of groundwater is authorized by the Compact, groundwater is clearly pledged to meet the State’s obligations under any sale.

Section 3.1 states, “The water rights and water quality administration provisions of this Compact are applicable to all stream water and groundwater falling on, flowing in, under through or bordering all or portions of the following 22 counties within the State...”

So, the Compact even includes rain and farm ponds!

The Pecos River Compact of 1948 between New Mexico and Texas serves as an example of a boon-to-bust water deal.

When New Mexico entered into the agreement to deliver a stated annual amount of water to Texas, there was plenty of fresh water flowing in the Pecos River. A water sale looked like an economic

windfall. After all, near the state line, the sweet water was sullied by the Malaga Spring as it brought briny water up from the salty Rustler aquifer.

As years passed, irrigation draws and municipal use, combined with years of drought, reduced the flow in the Pecos to a trickle. New Mexico was unable to meet its commitment to Texas. Texas sued.

The U.S. Supreme Court fined New Mexico \$14 million for the shortfall in water deliveries and ordered compliance.

A state body, the Ad Hoc Pecos River Basin Committee, has proposed a plan that includes curtailment of municipal water supplies and purchase of \$68 MILLION in water rights from farmers so that New Mexico can pump groundwater into the Pecos River to make it flow over the border.

The Committee plan states, “The overall situation to maintain compliance with the Compact is very difficult and has the potential to cause substantial economic harm, including harm to the State of New Mexico as well as its citizens through reduced economic activity.”

The Pecos River Compact serves to warn us of what could happen with Arkansas in the future if we give half our water to the tribes, then we run short and can’t send enough downstream. The State of Arkansas will surely be suing the State of Oklahoma, not the tribes.

We need the Texas water sale to pay for Sardis Reservoir.

The State of Texas violated their Canadian River Compact with Oklahoma by constructing an unauthorized lake, thereby stopping water flows into Oklahoma. Let’s use the proceeds from a suit against Texas to help pay for Sardis.

If we don't use the water or sell it, the Feds will seize it and give it to Texas. After all, we will only have 5 Congressmen and Texas will have 30!

This is one of the most bizarre statements we've heard. The Tenth Amendment to the Constitution of the United States reads: "The powers not delegated to the United States by the Constitution, not prohibited by it to the States, are reserved to the States respectively, or to the people." That includes administration of water rights and a whole lot more.

Oklahoma would only be selling EXCESS water to Texas. It's just water that goes over the Hugo Dam, turns salty in the Red River and is lost forever.

How do we know it is excess? We have no long-term plan for Oklahoma's water uses. The current so-called "Comprehensive Water Plan" is only an incomplete inventory of water resources for an inadequate 10-year horizon. The Texas sale would commit Oklahoma water for 99 years.

Without a REAL plan and a better definition of excess, we can't ensure that we will have enough water in our streams to protect all beneficial uses for the future.

The Hugo Dam only captures the flow in the Kiamichi basin. It's not the end of the line. There are many Oklahoma water users downpipe from Hugo. Five other major basins are pledged in this Compact as well.

It's hard to look around southeastern Oklahoma and find any sign of excess water in the summer-time. The McCurtain County Fire Department has been hauling hundreds of thousands of gallons of water every day for the past four summers to replenish farm ponds and dry groundwater wells.

Our Federal government has appropriated \$21 million in drought relief for the very counties that have been designated as donors for the Texas water deal. Many rural Oklahomans still have no running water or access to rural water systems. Have their needs been enumerated?

The rhetoric about salty water echoes the empty promises made to New Mexicans 54 years ago about the Pecos River sale. And, they are simply NOT TRUE.

According to Dwayne Raper, chairman of the Little River Conservation District in Ashdown, Arkansas, downstream farmers use the Red River water for irrigation. Salinity studies done by the University of Arkansas Water Laboratory and the NRCS show that the saltiest samples are only 25% of the threshold value for salinity. The sample site had been irrigated with Red River Water for 20 years. Oklahoma has long-standing obligations under the Red River Compact with Texas, Arkansas and Louisiana to guarantee flow. An acknowledgement by Oklahoma that tribes own rights to part of this flow would modify that agreement between the states - but Arkansas and Louisiana have not been consulted and the legal process for modifying an interstate compact is not being followed. We can expect those states to go to court to secure their shares.

Even so, this is a regional problem, not a State problem. We should let the folks in the 22 (or 29) affected counties make the decision about the Compact and sale.

The State-Tribal Water Compact is just the first domino to fall. Other tribes are waiting for their opportunities to Compact for water resources (such as Grand Lake, Tenkiller and Kaw Lake) and assume regulatory authority. If you live in any county other than Cimarron, Texas or Beaver, there are century-old tribal claims on your land. There are aboriginal claims on the Panhandle.

All water users upstream of any tribal jurisdiction would be subject to that tribe's regulatory agencies.

The Oklahoma Legislature represents ALL Oklahoma citizens, including members of Indian tribes. The people of Oklahoma, through these elected representatives, should decide whether water should be used in state or sold.

Source: http://oklahoma.sierraclub.org/chapter/watersale/myths_and_truths.htm

Southwestern Oklahoma
Water Use at Lake Altus

Donna Kirby, Manager, Lugert-Altus Irrigation District
Jim Bevers, Vice President, Quartz Mountain Conservation Coalition



Town Hall Introduction

The Oklahoma Academy first held our Town Hall at Quartz Mountain Resort in October 2002. Many remarked at the “low” lake level and wondered why. When the Academy rescheduled our Town Hall at Quartz Mountain - and selected “water” as a topic - it was a no-brainer to consider using the varied uses of Lake Altus as a case study.

As we asked knowledgeable parties to contribute to this research, it was clear that there are - at best - misunderstandings about the uses of the lake. At worst, there are intractable counter claims that require resolution.

We thought it odd that there would be contention after almost 60 years of operation in a water-scarce part of the state. We also found it revealing that there is seemingly no institution (outside of the court system) to resolve such disputes.

By requesting contributions from the Manager of the Lugert-Altus Irrigation District, and an officer of the Quartz Mountain Conservation Coalition, we will leave it to you to consider policy changes that could remedy the dispute.

Managing Lake Altus

Donna Kirby, Manager, Lugert-Altus Irrigation District

I have been the manager Lugert-Altus Irrigation District for 19 years. Over the years, we have dealt with a myriad of issues as the District has matured. One of the most difficult is to balance the uses of the water. Southwestern Oklahoma is not blessed with abundant supplies; and it is for that reason that water for irrigation is a primary concern. Others have needs and wants but we cannot make more water. We have to do the best we can with what we have. Given potential misunderstandings, it will be helpful if we review the history of the development of the District. Once we appreciate that, it is much easier to discuss current areas of debate and concern.

Authorization and Creation

The federal authorization for the W.C. Austin Project was the Flood Control Act approved on June 28, 1938, Public Law 761, 75th Congress, 3rd session, and signed by the President on February 13, 1941. The original federal authorization designated all waters of the north fork of the Red River for this project. The stated purposes were flood control, irrigation and municipal water supply only. Other uses such as tourism, recreation, fish and wildlife are secondary to the original federal authorization.

Lake Levels

Why does our lake level fluctuate so much? The W.C. Austin project is the only irrigation project in the state of Oklahoma. That is why we see seasonal fluctuations of the lake level. Other lakes that are designated for flood control or municipal water supply in Oklahoma, show small amounts of fluctuations in their lake levels.

Improvements

The District has been operating for 57 years. We have been pursuing every opportunity to try and help improve our situation. The District has spent significant time and money on issues such as:

- (1) *the Chloride Control Project that would help put water into the canal and could possibly decrease the amount we would have to withdraw from the lake at times, and*
- (2) *the Sweetwater Creek Dam that the District has been fighting for over 40 years that would take water away from the lake, and*
- (3) *the Mangum Lake Project that could help to supplement our water, and*
- (4) *the Red River Compact trying to get rules and regulations to protect the lake from upstream development and also when a hydroelectric power company filed for a permit to do a study on putting in a hydro-electric plant that would need water released to produce electricity at all times.*

There is no telling how much money has been spent by the district on all of these issues that could affect the water in the lake and could have been used for conservation measures for the district.

Ownership/Management

The District has always stated that the federal government is the owner of the complete W.C. Austin Project including the dam, Lugert Reservoir, canals, etc., and the District and city of Altus own the water rights by permit from the OWRB.

We are not a private contractor. We have bought out our contract with the federal Bureau of Reclamation and can transfer title of all facilities below the dam if we so desire. No vendor at the reservoir has the right to do that. But we can not transfer title of the reservoir because of the flood control mission, uses by the City of Altus, and our leases with the state for tourism and recreation and wildlife. Our contract is perpetual for operations and maintenance even though we have completed our repayment portion.

Conservation Projects

The federal Bureau of Reclamation and the District work with the Oklahoma Fish and Wildlife Department upon request. An example was the project that allowed the OFWD to install brush in the lake to improve fish habitats. Another example is when aerators were installed in the lake. The OFWD selected the aerators, the federal Bureau of Reclamation purchased them and the District paid for the electricity to run them.

The federal Bureau of Reclamation only has irrigation projects in the 17 “western” states plus Kansas, Texas and Oklahoma. Some districts have all underground pipe, some get all of their water from a river system, some districts have wastewater that goes back into their main channel and is re-used, and some get their water out of reservoirs. Consider these excerpts of a report published by Tom McGuckin (Forest Guardian) that covered 1978 to 1992.

“Consider the farmer, right now, without established property rights, there is a potential threat that environmental regulation could deprive farmers of water during their growing season. If, however, the farmer owns a property right to the water, no one can take the water without just compensation....What about protecting the environment and endangered species? The marketplace is the great equalizer: non-owners of water can compete in the market place for sellers with all other potential buyers. Let the highest valued use win. For example, if we as a society want to save the minnow then we must be willing to pay the cost by purchasing water from those who own it...if saving the minnow requires purchasing “50,000 acre feet at \$1,500 per acre foot, this is a total cost of \$75 million.”

Since that report, many conservation-related tasks have been accomplished in the District They include:

- (1) *borrowing \$1.4 million from the Oklahoma Water Resources Board to concrete and rip-rap the area around Bird Mountain*
- (2) *buying a clay-rich farm near the Magnum Y to provide soil to build the toe up around Bird Mountain and to clay-line several miles of dirt canals to reduce water seepage*

(3) installing over 10 miles of pipe, installing 8 pumps to lower the canal levels, and installing around 2400 ft. of terrranap liner.

(4) farmer-built tailwater pits

(5) installation of concrete ditches, drip systems and sprinkler systems.

We have goals and a long range plan to keep on improving the district. In the next 10 years we plan to install another 25 to 30 miles of pipe in our laterals. We also may install more pumps. We will put in more clay liners. We are looking at many different ways to increase the watershed and working with the bureau on different ways to improve the district.

By federal law, operators of federal water projects receive reimbursement of operating costs allocated for flood control. Many years we spend an average of \$100,000. Our allocation for flood control is 22% and in the past it has averaged approximately \$20,000 which is a reimbursement of money already spent by the District. The District has a public audit done every year which is filed with all proper agencies.

The lowest point that water could ever run out of the lake or the lowest discharge point is the bottom of our gates. Without the permission from the city of Altus to use their water allocation, would have to leave their 10,000 A/F of water. It is the fiduciary responsibility of the board of directors to deliver all water necessary to meet the crop requirements. They have no legal responsibility to leave water at the lake.

City of Altus

The city of Altus has a right to storage of 10,000 A/F of water at the lake. The city has the same right as the District has to use their water. Both entities use the same facilities: Lake Lugert and the canal to the Altus Reservoir Turnout.

The district can not charge the city for their water. It belongs to them. The district bills the city for annual operation and maintenance charges at a preset percentage rate by contract with the federal

Bureau of Reclamation whether or not the city uses their allotment. Many years this O&M charge has been forgiven. This O&M amount can vary from year to year. It has been \$0.00 to last years amount of \$30,320.16.

Tourism

Tourism enhancement is the responsibility of the state of Oklahoma. The fact is that the lake would of never been built solely for tourism. And it would not have been built if it were not for the District being formed, and the District stepping up and signing the contract, and the farmers mortgaging their land.

In other words, if not for the District, all the people that are benefiting and profiting from the lake would not have so benefitted.

Summary

The District will receive criticisms at times for the methods and manner in which the lake is managed.

We respond, "if the District is not managing the lake properly, why is there still irrigation going on after 57 years?"

The District does believe that the management is a water-use and conservation issue. That issue is why the District has been spending many dollars over the years taking the steps to conserve the water that we have. The producers (farmers) of the District produce over \$30 million worth of gross amount of products annually with an economic impact of over \$210 million. There are over 100 producers from the area, over 400 landowners, many families, businesses, banks, cities and other smaller towns, counties, schools and also many other people over southwest Oklahoma and many other parts of the United States that reap the benefits from the District. After all we all eat and wear clothes.

The irrigation district, producers and many landowners would like to thank the Academy for giving us this time to present the facts.

Who Is Watching The Lake?

Jim Bevers, Vice President, Quartz Mountain Conservation Coalition

Introduction

If Lake Lugert-Altus contains no water, is it still considered a lake?

Recently, this is just one of many disturbing questions that citizens in southwest Oklahoma began asking themselves. During the drought-plagued summer of 2002, local individuals began to ask questions as we watched the rapid depletion of the lake's water. Consequently, we found the answers to be quite disturbing. Our most shocking discovery was this: The lake can be legally drained.

According to sources at the Lugert Altus Irrigation District and the Bureau of Reclamation they have NO legal responsibility to keep any water in the lake. That means that the environmental and other public values of the lake can be disregarded for the exclusive use of agriculture. Citizens who found this completely unacceptable banded together to form the Quartz Mountain Conservation Coalition.

What Is At Stake?

We have three areas of major concern.

First, the public's interest in the lake is completely unprotected. There are no safeguards to shield the lake's public resources from being usurped by private irrigators.

Second, there is the wildlife issue. A wonderful variety of fish, birds, mammals, and reptiles call the lake and the Quartz Mountain Nature Park home. To drain the lake would create a devastating loss of habitat and bring certain death and decimation to many species.

Third, there is the eco-tourism issue. With a burgeoning tourist industry in the area, local proprietors and business owners understand that without water in the lake, the tourists will not come. The newly built lodge and conference

center will become nothing more than a dwindling enterprise among the ruins. A vanquished outpost that declares, "No one is watching the lake."

A History Of The Problem

Lake Lugert-Altus was built in 1927 before the authorization of the W. C. Austin Project in 1941.

The original purposes ascribed by the land deeds that allowed the creation of Lake Lugert specify water uses to be "domestic, industrial, and other uses; for irrigation purposes and for storage purposes; for recreation, sport, fishing, hunting, and fish propagation, or either of Said purposes, and to control of Said Reservoir."

(1) The Rivers and Harbors Act of 1938, the legislation which was passed to construct the W. C. Austin Project, states clearly that "due regard shall be given for wildlife conservation."

(2) In addition, the 1943 contract between the Bureau of Reclamation and the Lugert Altus Irrigation District also states that beyond irrigation, flood control, and municipal water usage, the lake was also to be used for "other purposes."

(3) These "other purposes" are defined by the original land contracts and legislation which established Lake Lugert. Unfortunately, the current water management disregards the "other purposes" of the lake and only recognizes the purposes of irrigation and flood control.

(4) Furthermore, the construction cost of the W. C. Austin Project was \$12.8 million. Of that total, \$9.8 million or 76% of the total cost was paid by the American taxpayer. The Lugert Altus Irrigation District paid \$2 million or 16%. The City of Altus paid \$1 million or 8%. This clearly demonstrates that the majority of the cost for Lake Lugert-Altus was paid by the general public.

A Current Assessment

The existing management has changed little since the 1940's. The population of southwest Oklahoma has increased and the economy has diversified from the 30's and 40's and now encompasses a variety of businesses and industries other than agriculture. The management of these natural resources has not undergone the same diversification or modernization as the surrounding areas. The irrigation methods and management have changed little since the 1940's. We believe that irrigation experts would conclude that the current practices are not sustainable.

It is significant to note that all maintenance and management of Lake Lugert-Altus has been assigned by the Bureau of Reclamation to the Lugert Altus Irrigation District. The Quartz Mountain Conservation Coalition advocates a new management structure that represents all the users of the lake.

The lake and its many uses have become a very integral part of our lives. According to the Oklahoma Department of Recreation and Tourism, tourists generated \$3.8 billion to our state economy in 2002.(5) Quartz Mountain State Park averages 750,000 tourist days annually.(6)

A Solution

The Quartz Mountain Conservation Coalition believes that a significant upgrade of the lake's management plan is mandatory. We advocate the creation of a new long range, comprehensive master plan that equitably meets the needs of all users of the lake. The policy should be created by the federal government and implemented by state and local partners.

Specifically a minimum lake level should be determined and enforced. This minimum level should provide a safe haven for fish and wildlife, one serviceable boat ramp at all times, and a reserve water allotment for times of drought. The Quartz Mountain Conservation Coalition recognizes and endorses the principle that the majority of water should still be used for irrigation;

however, the public's interest should be represented as well. According to a 1994 Congressional Study on natural resources, the following statement lends a perspective on this issue: "Participants in the debate over natural resource policies often lose sight of the fact that use of federal land is a privilege. The government permits a variety of commercial ventures on public lands to support broader public purposes. Although contracts allowing these activities may last for several years, the use of federal property never becomes a permanent right or entitlement. A commercial interest that uses land for several years should receive no special prerogatives because of its traditional association with the property. With the exception of lands that pass out of federal possession through sale or exchange, all public lands retain an overriding public ownership."(7)

The resources of the Quartz Mountain Region belong to all of us. We need to work together to make this area an even greater place to live.

(1) Land Deed: by and between Ruby Maxey; and Walter Maxey, and The City of Altus, a municipal Corporation; party of the Second part. Filed for Record April 1, 1929 and recorded in Book 192, at page 39. (2) The Rivers and Harbors Act of 1938 (3) United States Department of the Interior, Bureau of Reclamation, Contract No. Ilr-1375 dated January 12, 1942 (4) "Taking From the Taxpayer: Public Subsidies for Natural Resource Development", Democratic Staff Report, Subcommittee on Oversight & Investigations, Committee on Natural Resources, U.S. House of Representatives, One Hundred Third Congress, Second Session, August, 1994, Washington, D.C. (5) Oklahoma Department of Tourism Director, Direct Impact of Travel (6) W. C. Austin Project, Southwest Region Bureau of Reclamation, Region Revision 8/83, Project Data Book (7) "Taking From the Taxpayer: Public Subsidies for Natural Resource Development", Democratic Staff Report, Subcommittee on Oversight & Investigations, Committee on Natural Resources, U.S. House of Representatives, One Hundred Third Congress, Second Session, August, 1994, Washington, D.C.

Water Planning in the Illinois River Basin

Mark Meo, Robert Lynch, Fedaku Moreda, Blake Pettus, Ed Sankowski, Zev Trachtenberg, and Baxter Vieux of the University of Oklahoma, Norman and Lowell Caneday, Will Focht and Keith Willet of Oklahoma State University, Stillwater

Town Hall Introduction

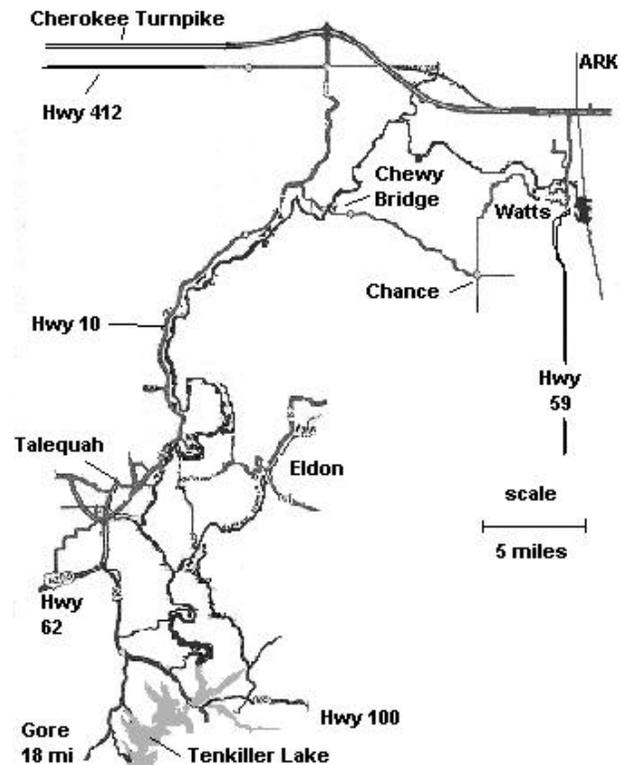
The water uses in the Illinois River Basin have been contentious for years. The tension has been between states, and between commercial users. Almost all disputes are being resolved in the courts rather than through an effective planning process.

This section was chosen to illustrate the mechanics and principles of advanced and sophisticated water use planning. The process was developed in Oklahoma by professionals at OU and OSU. The process was described in a peer-reviewed journal article. That article is abstracted here. The original article has been heavily edited; much of the technical detail and length has been omitted.

The Illinois River Basin has multiple uses for its water. Industrial, commercial, and recreational uses often conflict. How best to resolve these conflicts? At one level, a collaborative planning effort is essential. But immediate difficulties arise when complex water planning is reduced to text, often laced with emotion and self interest.

How best to depict the “cause-effect” of any impacts on the water. The answer is visually ... and interactively.

This model is offered to suggest that even if Oklahoma adopts a formal and progressive regional water planning process, there must be tools available to provide the best decision support; it serves as a national example of 21st century water planning tools.



Introduction

The overall objective of this project is to identify and compare different environmental and social values held by stakeholders in the Illinois River watershed, and test a management protocol that is technically effective, economically efficient, and socially and politically acceptable.

In the first phase of the project, baseline technical, economic, and socio-political assessments were conducted that served as the basis for subsequent interactive computer visualization presentations with policy makers to define alternative management policies that meet these three criteria.

In the second phase, policy alternative-specific assessments were conducted and visualizations prepared for presentation to stakeholders as a vehicle for designing and developing consensus about alternative land and water uses through facilitator-assisted interactive policy dialogues. The results of two rounds of asynchronous negotiation sessions that alternated between policymakers and stakeholders were presented to policy makers for a third time to help finalize their policy proposals. In the final phase of the project, the acceptability of the proposals was tested through a telephone survey of basin stakeholders. The overall effectiveness of the protocol was judged successful with the results of the telephone survey and the views of project participants.

Socio-Political Assessment

The socio-political assessment team was responsible for two major components of the research project. The first involves the identification of stakeholders' concerns about the Illinois River, preferences for river basin management, and knowledge of the causes and effects of river basin activities. Its second responsibility was to design and conduct an asynchronous policy dialogue between policymakers and stakeholders that yielded consensus policy outputs that are judged legitimate by both the participants and the larger stakeholder population.

Baseline Socio-Political Assessment

In the first phase of the project, the Socio-Political Assessment (SPA) team completed the baseline socio-political assessment. Interviews (n=330) of stakeholders, interested parties, and policy makers were completed in Spring, 1999. Three rounds of interviews were conducted involving 270 participants.

Data Acquisition

In the first round, 150 face-to-face interviews, lasting from 2-4 hours each, were held with participants residing, recreating, doing business, or having regulatory jurisdiction over activities in the Illinois River Basin.

In this first round, an extended discussion of participant concerns about activities adversely affecting the Illinois River Basin.

Next, each participant was asked to complete Likert scale items inquiring into trust and preferences for policy making.

Next, the participant was asked to rank order eight alternative policy making strategies, ranging from technocratic expert-based policy making to fully participatory third-party facilitated policy making.

Finally, the participants were asked to conduct a cognitive mapping exercises re: their concerns about river basin impacts.

In the second round, 120 additional face-to-face interviews (two-thirds of which were with persons not participating in round one) were conducted.

In the third round, 60 more face-to-face interviews (again, only 1/3 of which had been interviewed in either round one or two) were conducted using mental modeling.

Data Analysis.

The questionnaire data, Likert scale data, and card ranking data were analyzed using descriptive statistics.

The cognitive maps were recorded electronically into Visio 5.0 software databases.

Negotiation Workshops

The asynchronous policy dialogue was conducted in three rounds, beginning with a 2-day policymakers' workshop in October, 2000. Two professional negotiation facilitators assisted with the workshops. The policymakers initially focused on phosphorus management and riparian area protection. After an educational session, stakeholders agreed to these two priorities but also wanted alcohol and behavior control. Subsequent sessions produced a consensus on these three policies by both groups.

Major SPA Baseline Findings

- *Disagreements exist over the magnitudes and causes of problems in the Illinois River as well as over who is to blame and what should be done.*
- *Stakeholders trust government – particularly the federal government – much less than they trust independent experts and each other. As a result, stakeholders express an overwhelming preference to participate directly in the policy making process as opposed to deferring to government discretion.*
- *Though stakeholders believe that controversy and factual uncertainty is high and continuing, most are not so ideologically committed to a position that consensus is impossible. The conflicts that exist are not bipolar.*
- *Stakeholders are most concerned and knowledgeable about problems and associated impacts that are visible, local, and have media attention – including problems with alcohol consumption, inappropriate behavior by tourists, and littering. However, policymakers are most concerned about less visible, widespread, water quality-based problems and impacts such as nutrient loading (phosphorus) from fertilizer over-application and municipal effluents and riparian area protection.*
- *Stakeholders prefer coercive policies regarding enforcement of existing laws and regulations, such as apply to point source discharges and violations of civil law regarding behavior, drinking, and drugs. However, they prefer educational and voluntary strategies, with compensation for economic losses, for impact management from less regulated activities such as farming and other rural and suburban land uses.*

Test of Legitimacy

A random sample telephone survey of 458 stakeholders in the basin was conducted in April, 2002. It confirmed that all provisions of the three policy proposals were highly satisfactory (Phosphorus management policy: 95% satisfaction; Riparian area protection policy: 91% satisfaction; Alcohol and behavior control policy: 85% satisfaction), with the exception of two tourist fee increases that were added at the last workshop as revenue generating mechanisms – despite opposition by stakeholder participants. This robust test supports the claim that the policy legitimation protocol was successful.

The researchers believe that asynchronous policy dialogues that are informed by intensive assessments of stakeholders' concerns, preferences, and knowledge, can be successful in contexts dominated by distrust, controversy, and factual uncertainty. However, in other contexts, synchronous dialogues (with policymakers and stakeholders) may be better – in conformance with democratic norms of political participation.

River Recreation Assessment

The goal of this project was to survey Illinois River floaters regarding their knowledge of the environment, management strategies employed, and satisfaction with their respective recreation experiences. Visitors were contacted on outfitters' buses prior to their float experience and were asked to complete an "ecological and river management knowledge" test. Approximately four hundred visitors completed the pre-test. These visitors were then asked to participate in a mail-out post-test on satisfaction with the management strategies and the float experience. Approximately three hundred visitors agreed to participate in the post-test. Data were coded and analyzed. Findings were subsequently utilized by the socio-political assessment team and the economic assessment team.

Economic Assessment

This research was concerned with economic impact assessment activities. Economic impact analysis in each of the relevant Illinois River Basin regions was conducted in three stages: regional baseline impact assessments, regional option-specific assessments, and refined basin-wide assessments. Early activities were concerned with completion of databases and economic modeling structures. It is fair to assume that tourism/recreational activity is an important contributor to the economic base of the Illinois River Basin. The tourism/recreational linkages in local economy were estimated with the input-output model IMPLAN.

The impact of tourism/recreational activity is driven by expenditures which constitute a component of final demand for the region. The changes in these final demand expenditures are the key for motivating the economic impacts which are of concern in this research.

The first task in quantifying these linkages was to estimate the magnitude of recreational expenditures.

Nurseries and greenhouse operations also constitute a significant portion of the region's economic activity. Likewise, this industry may play an important role in establishing the environmental conditions within the Illinois River Basin area.

Broiler production has also become an important component of the economic basis in the Illinois River Basin region. A corresponding by-product is the generation of poultry litter. This litter is an important source of crop nutrients, but high concentrations of litter applications raise concerns about the environmental impacts of increased nitrate, phosphorus, and bacteria levels in water supplies. Among other things, the loss of phosphorus in runoff from agriculture is thought to be an important source of eutrophication.

Technical Assessment Team:

Modeling and Visualization

The objective of the modeling task was to develop and apply a distributed parameter hydrological model that relates ecological and water quality impacts to current stakeholder management practices, and can be used to assess potential land use alternatives. From the modeling results, scientific visualization techniques were applied to aid communication to stakeholders concerning the implications of development and management practices in the basin. They included:

Basin property data

Water quality data analysis

Water quality modeling

Scientific Visualizations

Scientific Visualizations

Initial efforts to visualize the simulation of water quality and other issues in the Illinois basin involved the transformation of the DEM into a data structure required by Macromedia Director software. The work on this program has advanced and now four layers of information are integrated: A flight layer, a photo layer, a water quality layer, and an aquatic life layer.

The flight layer enables a user to experience a virtual flight over the watershed with a three-dimensional effect.

The photo layer enables the user to select a certain region and have a close look at different environmental concerns. Currently, about 72 photographs with the description of each concern are available.

The water quality layer depicts the map of the gauging stations with historical data displayed for each station on water quality parameters, including phosphorus, nitrates, turbidity, etc. The graphs are supplemented by a description of the critical issues concerning the status of each water quality parameter.

The aquatic life layer shows the number and diversity of selected species within the river system and Lake Tenkiller.

To facilitate understanding by stakeholders of the complex biological, physical, and socio-political relationships in the watershed, interactive influence diagrams of these systems used by the SPA team were developed along with the other visual elements.

The resulting visualization vehicle is known as the Watershed Management Decision Support System (WMDSS) and was subsequently used in the policymaker and stakeholder negotiation workshops. For reference, the WMDSS also contains the current Illinois River Management Plan, a Riparian Area Protection Handbook, and a 20 minute video of the Illinois River Watershed and its history.

**Technical Assessment Team:
Ecological Analysis**

This effort focused on developing visual presentation materials that would help communicate the risks to biological communities in the Illinois River watershed and the health of Lake Tenkiller.

This topic represents information where different stakeholder groups are likely to have different views of the meaning and importance of the same information.

A significant challenge in this regard was the development of visual risk communication materials that are scientifically valid yet meaningful to all stakeholder groups.

Chemical Data

In addition to the three USGS gauging stations, the Oklahoma Scenic Rivers Commission conducts sampling at 7 locations along the river and monitors for turbidity, total nitrogen, nitrate, ortho-phosphate, and total phosphorous. These data were gathered and graphed, with indications of appropriate water quality standards, for the period

of record, although the time frame is too short to make conclusions about water quality trends.

A significant concern of many stakeholders is the effects of animal waste on water quality, specifically the over 45 million poultry produced annually. In order to address these concerns, we sought to develop a measure of the relative magnitude of poultry and cattle waste in the basin.

Data on human and animal numbers were gathered from the U.S. Census Bureau and the Natural Resource Conservation Service. Additional data was gathered from NRCS and other sources concerning the amount of nitrogen and phosphorous produced by humans and animals.

Based upon phosphorous and nitrogen production, it was calculated that the animals in the basin are equivalent to approximately 5 and 15 million people, respectively. An additional concern has been the effects of septic tanks on water quality. It was calculated that 72% of human generated waste is discharged to septic tanks, which elevated the concern over their influence, however, the amount of nutrients produced by humans is at most 1-2 percent of that produced by animals.



Northwestern Oklahoma
The Ogallala Aquifer

Manjula V. Guru, Agricultural Policy Specialist and
James E. Horne, President & CEO, The Kerr Center for Sustainable Agriculture. Poteau, Oklahoma

The Ogallala (1) Aquifer (also known as the High Plains Aquifer) is now facing declining water levels and deteriorating water quality. More than 90% of the water pumped from the Ogallala irrigates at least one fifth of all U.S. cropland. This water accounts for 30% of all groundwater used for irrigation in America.

Crops that benefit from the aquifer are cotton, corn, alfalfa, soybeans, and wheat. These crops provide the Midwest cattle operations with enormous amounts of feed and account for 40% of the feedlot beef output here in the U.S.

Since the advancement of agricultural irrigation in the earlier part of the 20th century, the Ogallala has made it possible so that states such as Nebraska and Kansas can produce large quantities of grain required to feed livestock. (2)

If the High Plains Aquifer were unaffected by human activities, it would be in a state of equilibrium in which natural discharge from the aquifer would be approximately equal to natural recharge to the aquifer. However, activities such as pumpage from wells, surface-water diversions for irrigation and hydroelectric-power generation, and cultivation and grazing practices result in non-equilibrium in the aquifer. The result is that discharge does not equal recharge in many areas. This non-equilibrium results in substantial changes in groundwater levels. (3)

Half of the U.S. population and almost all of those in rural areas draw water from underground



aquifers for their domestic needs. Additionally farmers depend on it for irrigation. Once thought an unlimited source of pure water, these sources are increasingly threatened. While toxic waste dumps, cesspools, landfills, and septic tanks contribute their share of wastes to groundwater, agricultural chemicals contribute the most in sheer volume and affect the greatest area. Excess nitrates from fertilizer (and manure), can leach into ground water, and in high enough concentrations make such water dangerous to drink. Other farm run-off can also reduce water quality. Furthermore, some farm pesticides pollute ground water in agricultural areas. (4)

Conservation of water is therefore imperative. It is extremely important that we search for solutions to deal with the problem. We also need to urgently explore the alternative approaches that could be taken instead of those being implemented now.

The Ogallala

The Ogallala ranges in thickness from less than one foot to 1300 feet from one place to another. The average depth, however, is 200 feet. The aquifer underlies a considerable portion of the Great Plains region, particularly in the High Plains of Texas, New Mexico, Oklahoma, Kansas, Colorado, and Nebraska (see Figure 1). The depth of the aquifer from the surface of the land, and its natural thickness, vary from region to region. (6)

As a whole the aquifer covers 174,000 square miles and has long been a major source of water for agricultural, municipal, and industrial development. The surface area of each state covered by the

Ogallala formation varies in about the same proportion as the volume of water in storage. Nebraska with 64,400 square miles and Texas with 36,080 are the largest. New Mexico, Oklahoma, South Dakota, and Wyoming all have less than 10,000 square miles of surface area underlain by the Ogallala. (7)

The amount of water in storage in the aquifer in each state is dependent on the actual extent of the formation's saturated thickness. In 1990, the Ogallala Aquifer in the eight-state area of the Great Plains contained 3.270 billion acre-feet of water. Out of this, about 65% was located under Nebraska, Texas had about 12% of the water in storage or approximately 417 million acre-feet of water, Kansas had 10% of the water, about 4% was located under Colorado, and 3.5% was located under Oklahoma. Another 2% was under South Dakota and 2% was under Wyoming. The remaining 1.5% of the water was under New Mexico. (9)

The Ogallala Aquifer was formed over twenty million years ago. The formation process began when gravel and sand from the Rocky Mountains was eroded by rain and washed downstream. Those sediments soaked up water from rain and melted snow forming a sponge-like structure. (10) Most of the water has been held within the aquifer for millions of years. (11)

History of Use

Use of the Ogallala began at the turn of the century, and since World War II reliance on it has steadily increased. The withdrawal of this groundwater has now greatly surpassed the aquifer's rate of natural recharge. Some places overlying the aquifer have already exhausted their underground supply as a source of irrigation. Other parts have more favorable saturated thickness and recharge rates, and so are less valuable.

Reasons to tap the water are many. American farmers suffered and failed during the 1930's because they did not have the technology to reach it. After the government's initial failure to get farmers to move elsewhere, the New Deal commit-

ted the federal government and society to take drastic steps to keep farmers on the Plains. The miracle of new irrigation technologies did much to protect farmers from the harshness of drought during the 1950's, early 1970's, and in the late 1980's. In addition it helped create today's highly productive industrial farming and feedlots in the plains.

Many people assume that large groundwater formations may temporarily run low, but will fill again when rainfall is plentiful - as do lakes, rivers, and reservoirs. However, unless the areas impacted are unaffected by the factors that contribute to high evaporation - such as minimal rainfall, abundant sunshine, low humidity, and periodic strong winds - this assumption is not even remotely correct. Therefore, it is imperative that we find solutions through research to water problems and maintain the aquifer as a continuing resource.

By the time we know whether today's conventional High Plains farmers can live with less groundwater, it may be too late to save enough to keep them on the land. Pumping the Ogallala is still a one-time experiment, unrepeatable and irreversible.

Case of the Oklahoma Panhandle

The Oklahoma Panhandle, which is composed of Cimarron, Texas and Beaver counties, is a 5,680 square mile semi-arid area in western Oklahoma. Prior to 1950, crop production in the area was almost exclusively dry-land wheat and grain sorghum. However, with the introduction of irrigation practices, principal crops in the area now include grain sorghum, corn, and alfalfa which are produced to supply feed for the large beef feedlots in the area, and wheat which is produced primarily for the export market.

With the discovery of a significant quantity of high-quality groundwater underlying most of the region, came the development of irrigated production practices. Development of agricultural crop production under irrigated conditions has contributed to increased economic activity in the Oklahoma Panhandle and surrounding regions. Acres

irrigated in the Oklahoma Panhandle increased from 11,500 in 1950 to 427,000 in 1973, and totaled 405,700 in 1979 (see Table 2).

The primary sources of irrigation water in the Oklahoma Panhandle is the Ogallala Aquifer, a major underground aquifer supporting irrigation water throughout much of the Great Plains. Continued overdraft of the Ogallala Formation and water level declines of two to three feet per year in many areas, make physical exhaustion of the aquifer a major concern. The characteristics of the aquifer make physical exhaustion a very real possibility - one that has already occurred for some irrigators in parts of the Oklahoma Panhandle.

The rapid development of irrigated crop production has resulted in overdraft of the aquifer, with withdrawals greatly exceeding natural recharge and return percolation of irrigation water. The result has been a gradual decline in the water table within the aquifer. The declining water table interacts with rapidly increasing costs of energy inputs, particularly natural gas being utilized by most irrigation systems in the Oklahoma Panhandle and, other things being equal, reduces the profitability of

irrigated crop production. Continued declines in the water level within the aquifer threaten the capital-intensive irrigated agricultural economy of the area.

Several factors are interacting to reduce the economic life of the aquifer. One, rapid water withdrawals lower the water table and increase the vertical lift of the water to the surface. And two, declines in saturated thickness of the aquifer reduces the well yield, measured in gallons per minute, which increases the time required to apply a specified quantity of water onto the crops. Reduced well yield and increased feet of lift interact with the cost of pumping irrigation water and reduce the profitability of irrigated crop production.

In a study conducted over the period 1978-80 by Oklahoma State University and the Oklahoma Water Resources Institute, the economic life of the underground water supply in the Oklahoma Panhandle was analyzed. Economic exhaustion is said to occur when net returns from the production of the best dry-land crop alternative exceeds the net returns of the most profitable irrigated crop activity. The study predicts that the decline in the

Table 2
Irrigation Statistics for Oklahoma Panhandle area.

	<i>Total</i>		<i>Gravity Systems</i>		<i>Sprinkler Systems</i>		<i>Irrigation Wells</i>	
	<i>Farms</i>	<i>Acres</i>	<i>Farms</i>	<i>Acres</i>	<i>Farms</i>	<i>Acres</i>	<i>Farms</i>	<i>Acres</i>
1950.....	53.....	11,500						
1952.....		13,000						
1954.....		24,680.....		23,758.....		922.....		23,580
1955.....	212.....	34,247.....		32,030.....		2,317.....		32,797
1956.....	266.....	71,200.....		64,700.....	41.....	6,500.....	336.....	70,100
1957.....	267.....	76,500.....		68,360.....	49.....	8,140.....	359.....	75,225
1958.....	279.....	69,575.....		62,623.....	53.....	6,960.....	—.....	67,375
1959.....	275.....	71,500.....		65,820.....	46.....	5,680.....	365.....	69,520
1963.....	304.....	84,500.....	241.....	71,560.....	75.....	11,940.....	409.....	83,020
1965.....	745.....	138,000.....	586.....	122,000.....	104.....	16,000.....	972.....	135,500
1967.....	1,150.....	263,000.....	1,010.....	224,850.....	145.....	38,150.....	1,358.....	261,000
1969.....	960.....	315,518.....	835.....	282,618.....	141.....	32,900.....	1,634.....	213,518
1971.....	1,375.....	356,360.....	1,165.....	302,938.....	255.....	54,422.....	1,846.....	344,040
1973.....	1,530.....	427,000.....	1,360.....	324,500.....	175.....	102,500.....	2,207.....	422,680
1975.....	1,094.....	404,610.....	901.....	329,460.....	193.....	75,150.....	2,112.....	402,550
1977.....	1,155.....	385,900.....	896.....	301,650.....	259.....	85,700.....	2,172.....	384,000
1979.....	1,223.....	405,679.....	898.....	297,649.....	350.....	97,215.....	2,227.....	403,619

Source: Mapp, 1980.

underground water supply and conversion from irrigated to dry-land production would be a part of the future of the Oklahoma Panhandle. The study did not answer the question of exactly when this conversion will occur and which crops will remain under irrigated production until the economic life of the aquifer is exhausted for agricultural purposes. However, the study concluded on the note that the eventual economic exhaustion of the aquifer appears inevitable unless dramatic and unforeseeable output price increases or institutional or technological changes occur. (19)

An example of the aquifer's water depletion in the Oklahoma Panhandle area is in Texas County. Texas County consumes almost all of its water from the Ogallala Aquifer flowing some 200 feet beneath the Panhandle. In 1990, approximately 363 million gallons per day of groundwater were pumped from the High Plains Aquifer. Throughout the High Plains, the water table dropped 9.9 feet from predevelopment times to 1980, and then dropped another 3.05 feet from 1980 through 1995. Irrigation methods became increasingly efficient with fully automatic center-pivot drop sprinklers. But as efficiency rose, crop acreage rose as well. While there were approximately 54,400 acres in irrigated corn in 1991, there were approximately 90,000 acres in irrigated corn in 1998. (20)

Texas County has more than 380,000 head of feedlot cattle, a ready market for the corn. While corn is a particularly thirsty crop unable to grow without irrigation in Texas County, it yields up to 200 bushels per acre with 22 inches of irrigated water. With an estimated 90,000 acres of corn in 1998 and each acre using approximately two-acre feet per year, (21) Texas County uses approximately 58,653,180,000 gallons of irrigated water a year on corn alone. Corn is fed to both cattle and hogs, and uses some of the nutrients in the hog manure. While livestock water usage is 3% directly, livestock feed requires all that irrigated fields can produce, accounting for 92% of water withdrawal from the High Plains Aquifer in Texas County. (22) While hogs are not the sole cause of water depletion as well as water quality deteriora-

tion in the Panhandle, the large hog operations increase pressure on an already stressed ecosystem. The growth of intensive hog operations contributed to a 66% increase in livestock water use between 1990 and 1995. (23)

Water Quality in the Oklahoma Panhandle

In the Panhandle of Oklahoma, the environmental capital can be easily overlooked with its treeless plains being open and wide as the horizon. But this wide open space is a premier cattle raising and dryland farming area as well as a cornucopia of irrigated corn thanks to the underlying Ogallala Aquifer.

The increased use of confined animal feeding operations for cattle, poultry, and hogs has raised concerns regarding the possibility of groundwater pollution. Full-grown hogs, grown under confined conditions, produce 15 pounds of waste per day. Since hog manure is disposed of as highly-liquid slurry in confinement operations, the cost to transport it are prohibitive. Therefore, it has to be used in the local area. Although there are many systems to handle hog waste, lagoons are the cheapest and least efficient. The current regulations allow lagoons to be constructed to hold the waste and to seep at roughly one-quarter inch per day. The Oklahoma Department of Environmental Quality translates that into a total of more than 500 gallons per acre per day. (24)

Thus more area is put into irrigated corn which is a high user of nitrogen - a key component in manure. Irrigated corn, in the course of consuming enormous amounts of water, produces nutrient runoff particularly high in phosphorous because of the use of animal manure as a source of nitrogen. Sunflower, milo, and native grass also have effluent spread on them. There is no procedure in Oklahoma to monitor how much and where nutrients are spread on the various crops and grasses grown in the Panhandle. And one does not need to speculate about where this runoff finally travels, i.e., into the Ogallala Aquifer. (25)

End Notes

1. N. H. Darton is credited with naming the aquifer in 1899 after the town of Ogallala, Nebraska.
2. *Aquifer Close Up*. Published by Center for Biological Computing, Indiana State University, Department of Life Sciences. [<http://mama.indstate.edu/users/johannes/aquifer/htm>].
3. *Precipitation is the principal sources of natural ground-water recharge in the High Plains*. Recharge from precipitation is quite variable in the High Plains, both in time and in space. Factors that affect this variability include the precipitation regime, evapo-transpiration, soils, vegetation, and land-use practices, and the characteristics of the unsaturated zone between the soil zone and water table. In a few areas, however, natural recharge can result from seepage losses from streams and lakes. This recharge is particularly important along parts of the Platte River system in Colorado, Nebraska, and Wyoming, where substantial seepage losses of stream flow originating outside the High Plains result in recharge to the High Plains Aquifer. (*High Plains Aquifer Background Information*. <http://www-ne.cr.usgs.gov/highplains/bckgrnd.html>).
4. Cunningham, W.P., & B.W. Saigo. *Environmental Science: A Global Concern*. William C. Brown publication. Dubuque, Iowa. 1990.
5. *The Ogallala Aquifer*. High Plains Underground Water Conservation District No.1. [<http://www.hub.ofthe.net/hpwd/ogallala.html>].
6. Glantz, M. *The Ogallala Aquifer Depletion*. 1989.
7. See Note 3.
8. USGS. *Characteristics of the High Plains Aquifer*. [<http://www-ne.cr.usgs.gov/highplains/hpchar.html>].
9. *Id.*
10. *The aquifer is porous and filled with water; lying between a water table and a bedrock bottom.*
11. *The aquifer is replaced by precipitation and surface streams. It is recharged primarily by direct infiltration of precipitation falling on the overlying soils. When the amount of water withdrawn from the aquifer continually exceeds the recharge, a mining situation results.*
12. Opie, J. *OGALLALA: Water for a Dry Land*. University of Nebraska Press. 1993, p. 294.
13. *It has in fact been known to cause the "blue baby syndrome." Nitrates can be changed to nitrites by bacteria in our bodies and reduce the oxygen carrying ability of blood especially in babies and young children. Also, nutrients can not only form nitrosamines that are suspected of causing stomach cancer, but can cause excessive algae growth in lakes and estuaries.*
14. *Non-point refers to sources of pollution that are scattered, with no specific place or point where they discharge into a body of water. This makes them more difficult to identify, monitor, and regulate. Such sources include run off from farm fields, golf courses, lawns, roads, parking lots, etc. Point sources, on the other hand, are specific locations such as drainpipes, or sewers. (USGS. High Plains Regional Ground Water (HPGW) Study. National Water-Quality Assessment (NAWQA) Program. [http://webserver.cr.usgs.gov/nawqa/hpgw/HPGW_home.html]).*
15. *Id.*
16. Cash, D. *Assessing and Addressing Cross-Scale Environmental Risks: Information and Decision Systems for the Management of the high Plains Aquifer*. GEA Discussion Paper E-98-17.
17. See Note 13.
18. *Id.*
19. Mapp, H.P. Jr. *Impact of Availability of Water and Cost of Energy Inputs on Agricultural Production in the Oklahoma Panhandle*. Oklahoma Water Resources Research Institute. 1980.
20. *Oklahoma Agricultural Statistics Services, Oklahoma Department of Agriculture*. [<http://www.usda.gov/nass/>].
21. *One acre foot equals 325,851 gallons.*
22. *Bringing Home the Bacon: The myth of the role of corporate hog farming in rural communities*. Research provided by The North Central Regional Center for Rural Development. Sponsored by The Kerr Center. 1999. p. 37.
23. *Id.* p.38
24. Schepers, J.S., D.D. Francis, and M.F. Vigil. *Nutrient management and utilization from manures*. pp. 686-88. *Proceedings of "Agricultural Research to Protect Water Quality " Conference. Held in Minneapolis, MN on February 21-24, 1993.*
25. *Id.*

Kansas
New Thoughts About Water Policy

LAWRENCE -- Kansans have long struggled with the best way to manage the state's water. Now a new book from the University of Kansas-based Kansas Geological Survey questions some of the traditional ways state and local agencies have made decisions about water.

Survey water specialist Marios Sophocleous edited the book, "Perspectives on Sustainable Development of Water Resources in Kansas," which points out flaws in a traditional management concept known as safe yield.

Under a safe yield approach to water management, Sophocleous says, water use is limited to the amount of annual recharge -- that is, the amount replenished naturally through precipitation and water seepage from the surface.

Sensible as this simple formula seems, Sophocleous says, "if you use safe yield as a definite recipe, you end up depleting other water supplies." Like many simple concepts, safe yield doesn't tell the whole story.

The problem is that safe yield ignores the complex relationships between surface water (lakes, streams, springs and marshes) and groundwater (water found in underground rock formations called aquifers).

For example, under natural conditions, before wells start pumping, aquifers discharge water to streams, marshes and springs. The amount discharged equals the amount of recharge. This means that under a traditional safe yield approach, pumping removes groundwater that would otherwise be discharged at the surface. The streams, marshes and springs eventually dry up.

"This is what has happened to some perennial streams in western Kansas," Sophocleous says.

Sophocleous says that a recognition of the connection between surface water and groundwater is already shaping the way water resources are

managed in Kansas. Two of the state's five ground-water management districts now factor in natural ground-water discharge when evaluating new applications to use groundwater.

Promoting a better understanding of the complexities of the water system was one of the goals with this new book. Towards that end, Sophocleous asked nine other water scientists to write chapters discussing issues of safe yield and sustainability from a variety of perspectives. In addition to Sophocleous's chapters on Kansas water resources and sustainability issues, the book includes chapters on water chemistry, agriculture and climate change. "The book presents the most up-to-date views on the subject and places the discussion on a sound scientific footing," Sophocleous says.

Sophocleous admits that understanding the complex relationships between ground and surface water is just a first step down the path towards sustainable development, managing the state's water so that both current and future needs are met. "As a concept," Sophocleous says, "sustainable development is still pretty vague. No one knows for sure exactly what it means or how it can be attained."

How the concept will be applied in Kansas remains to be worked out, but it will be different in different parts of the state. In western Kansas, where irrigation sucks up 90 percent of the ground water, sustainability will be difficult to achieve. In central and eastern Kansas, where there's less irrigation and more precipitation, "sustainability is a possibility," Sophocleous says. But, he adds, "education is vital if consensus on these issues is to be achieved." Written in semi-technical language, the book contains numerous illustrations and a lengthy glossary.

Story By Liz Brosiu. <http://www.ur.ku.edu/News/98N/SeptNews/Sept15/water.html>. Copies of the book are available from the Kansas Geological Survey at 1930 Constant Avenue in Lawrence (785-864-3965).

Texas
Drafting A State Water Plan

As part of the regional and state-level water planning process, the Texas Water Development Board (TWDB) has created a policy stakeholders' group to assist in identifying significant water policy issues and to make recommendations for appropriate actions by the board. These recommendations will take the form of issue papers (called issue recommendation papers or IRPs), to be presented at a September 18 meeting in Austin. At this meeting, the papers will be discussed and the stakeholders will vote on whether or not they can "live with" the papers' recommendations. The group's work, it is hoped, will assist the board and agency staff to draft the 2002 State Water Plan, as directed by 1997's Senate Bill 1.

The group is in the same mold as last year's groundwater stakeholders' group, also sponsored by the TWDB. This summer, the board invited some 80 people representing water-related interests to select and rank water policy issues. These people have now joined roundtable groups; these are charged with identifying policy recommendations for each identified policy issue. Participants represent financial concerns, public interest groups, state agencies, law firms, environmental advocates, river authorities, water utilities, engineering firms, and groundwater districts.

These participants identified eleven water policy issues and ranked them in this order: surface water; the financing of water infrastructure; environmental protection/flow maintenance; agriculture/rural; groundwater; water marketing; conservation/drought management; water quality; non-traditional water management strategies (e.g., brush control, desalinization); planning and implementation; and data collection and information.

Within each of the policy issues identified, there is an entire subset of related questions. For example, within the issue of surface water policy, lie the sticky questions regarding the roles of re-use (and its impact on downstream water rights) and

interbasin transfers in meeting water needs. On the matter of financing water infrastructure, questions abound: what is the proper role and goal of state financial assistance; what is the proper balance between local and state financing; and what is the fitting level of state assistance for large, rural, small, or economically disadvantaged communities? As the cost for agricultural water increases and its availability declines, what should be the state's policy to ensure the viability and the sustainability of agriculture (and, it should be added, to ensure the viability and sustainability of communities significantly dependent on agriculture)? What role should water marketing play in state water policy and what level of government should regulate it? How should concerns about third party impacts and environmental degradation caused by water marketing be addressed?

In a series of meetings throughout July and August, the roundtable groups convened in Austin to develop these policy recommendations and attempt to answer the troublesome questions listed above. Ground rules established by TWDB staff state that the optimum goal for each roundtable group is consensus support, but consensus is not narrowly defined. If consensus is unattainable, it is to be noted in the issue paper ". . . and the degree of support for each recommendation should be indicated." Any dissenting opinions will be represented in the final issue paper and discussed at the September 18 meeting. On September 19, the Water Development Board will meet and may or may not select the issue topics and their proposed changes to be included in the draft of the state water plan. As noted in TWDB documents related to the process, "Neither the TWDB staff nor the Board guarantees that all stakeholder recommendations will be followed."

*<http://www.county.org/resources/library/cissue/LN/vol11no14/Record284758.html> Vol. 11, No. 14
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