Kansas Field Conference

FIELD GUIDE

2007 FIELD CONFERENCE

Wichita, Hutchinson, and Surrounding Areas

Industry and the Environment

June 6–8, 2007

Edited by

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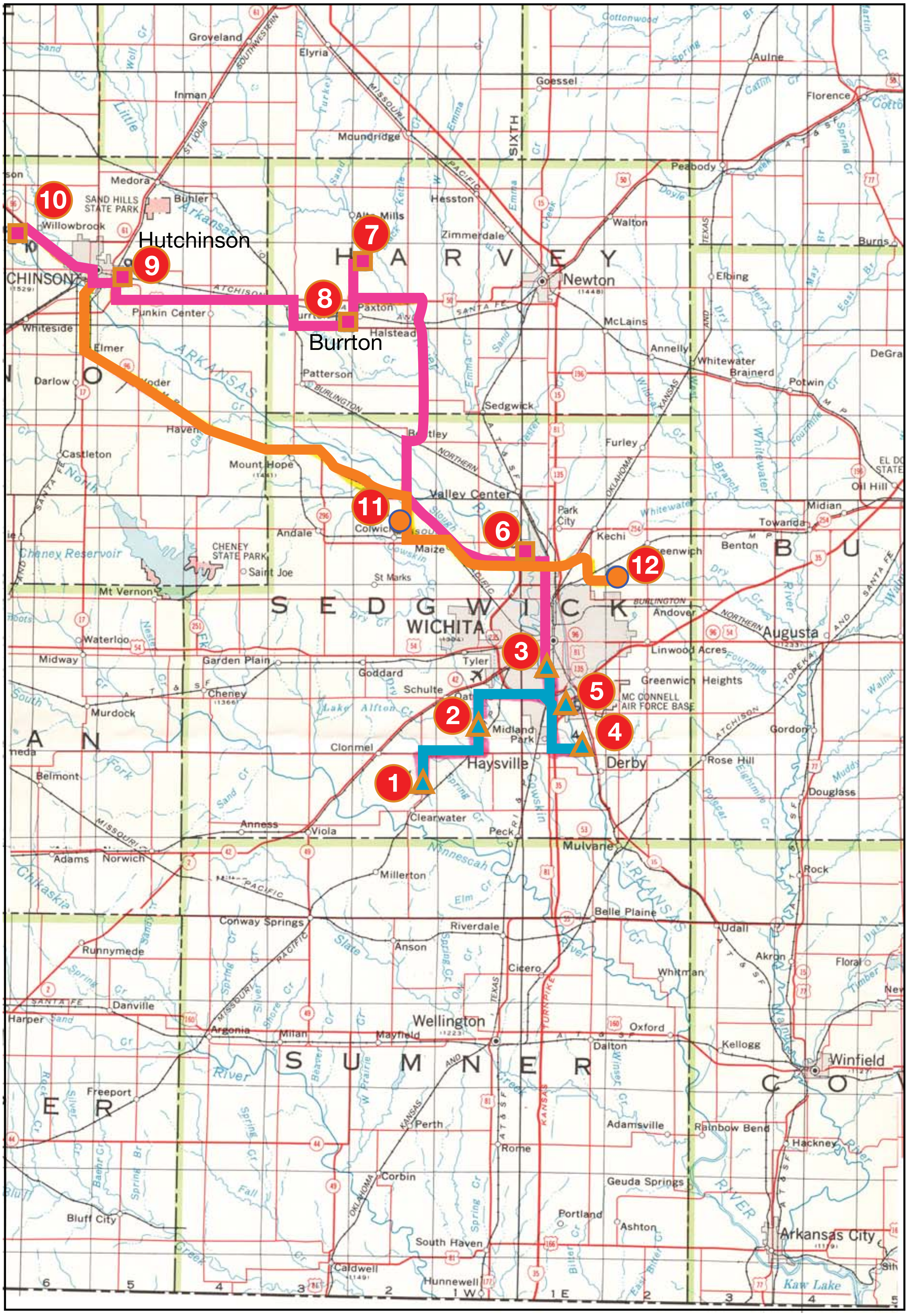

Wednesday, June 6
Stops 1–5

Thursday, June 7
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Wichita, Hutchinson, and Surrounding Areas
Industry and the Environment

2007 FIELD CONFERENCE

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Acknowledgments

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Wichita, Hutchinson, and Surrounding Areas
Industry and the Environment

2007 FIELD CONFERENCE
June 6-8, 2007

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BIOGRAPHICAL INFORMATION

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Title and Affiliation
Natural Resource Coordinator
Kansas Department of Wildlife & Parks
Address and Telephone and Telephone
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Experience
Fisheries biologist, Florida Game & Freshwater Fish Commission, 1986–89; Kansas Department of Wildlife & Parks, 1989–present
Education
Northeastern State University – BS, 1980
Oklahoma State University – MS, 1983

Ray Aslin
Title and Affiliation
State Forester
Kansas Forest Service
Address and Telephone
2610 Claflin Road
Manhattan KS 66502
785-532-3309
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Current Responsibilities
Administer statewide forestry programs including rural forestry, community forestry, fire management, and conservation tree planting
Experience
31 years with Kansas Forest Service: District Forester, 1975–87; Fire Control Specialist, 1987–88; State Forester, 1988–present
Education
University of Missouri – BS, 1972
University of Missouri – MS, 1975

Tim Boese
Title and Affiliation
Hydrologist
Equus Beds Groundwater Management District #2
Address and Telephone
313 Spruce St.
Halstead KS 67056
316-835-2224
tboes@gmd2.org
Current Responsibilities
Review all water-rights applications according to district rules and regulations; coordinate water-level and water-quality-monitoring in district
Experience
13 years as staff hydrologic technician; last 2 years as staff hydrologist
Education
Newton High School, 1987
Wichita State University, working on BS in geology

Chuck Brewer
Title and Affiliation
President
Geotechnical Service Inc. (GSI)
Address and Telephone
4503 E. 47th Street South
Wichita KS 67210
316-554-0725
cbrewer@gsinetwork.com
Current Responsibilities
President, GSI (environmental consulting company); Kansas Geological Society Board Member
Experience
18 years with GSI; Past President of Kansas Geological Society
Education
Fort Hays State University – BS, 1982

Mike Cochran
Title and Affiliation
Chief, Geology Section
Kansas Department of Health and Environment
Address and Telephone
1000 SW Jackson Street, Suite 420
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mcochran@kdhe.state.ks.us
Current Responsibilities
Responsible for underground injection control, water-well licensing, water-well plugging and abandonment, underground hydrocarbon storage, salt caverns wells programs
Experience
KDHE since 1977
Education
University of Kansas – BS, 1976

Tom Collinson
Title and Affiliation
Geological Survey Advisory Council (GSAC) Member
Address and Telephone
1508 Woodland Terr.
Pittsburg KS 66762

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Current Responsibilities
Farmer; Geological Survey Advisory Council (GSAC) Member

Experience
Retired publisher, Pittsburg Morning Sun

Education
University of Kansas – Bachelors, 1964

Susan Duffy

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Executive Director
Kansas Corporation Commission

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1500 SW Arrowhead Rd.
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785-271-3166
s.duffy@kcc.state.ks.us

Current Responsibilities
Executive Director, KCC

Experience
27 years in state government

Education
Wichita State University – Masters, 1980

Marci Francisco

Title and Affiliation
Kansas State Senate, 2nd District

Address and Telephone
1101 Ohio
Lawrence KS 66044
785-842-6402
maf@sunflower.com or francisco@senate.state.ks.us

Current Responsibilities
Ranking Minority Member, Agriculture and Natural Resources committees; Member, Utilities and Elections and Local Government committees; Office of Space Management (KU)

Experience
Mayor of Lawrence, 1981-83

Education
University of Kansas – BED, 1973
University of Kansas – B-Arch, 1977

Rocky Fund

Title and Affiliation
Kansas House of Representatives, 50th District

Address and Telephone
13161 S Road
Hoyt KS 66440
785-986-6775
rockfund@hotmail.com

Current Responsibilities
District manager, Jackson County Rural Water District #1 (7 years)

Experience
K-12 art teacher (21 years); Owner/operator farrier business (25 years)

Education
Wichita State University – BFA, 1978

Mary Galligan

Title and Affiliation
Assistant Director, Information Management
Kansas Legislative Research Department

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300 SW 10th Ave., Rm. 545N
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maryg@klrd.state.ks.us

Current Responsibilities
Staff House committees on Energy & Utilities, Health and Human Services, and Government Efficiency and Technology; Staff to Kansas Electric Transmission Authority; Admin. duties to KLRD

Experience
At KLRD since 1982

Education
Missouri State University – BS, 1973
University of Arkansas – MA, 1975
University of Kansas – MPA, 1985

Raney Gilliland

Title and Affiliation
Assistant Director for Research
Kansas Legislative Research Department

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Current Responsibilities
Staff House and Senate Agriculture committees; Senate Natural Resources; Senate Utilities; Joint Committee on Administrative Rules and Regulations

Education
Kansas State University – BS, 1975
Kansas State University – MS, 1979

Dale Goter

Title and Affiliation
Government Relations Director
City Manager’s Office
City of Wichita

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City Hall, 13th Floor
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Bob Grant
Title and Affiliation
Kansas House of Representatives, 2nd District
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Cherokee KS 66724
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grantbnl@ckt.net
Experience
Small-business owner; mayor of Cherokee for 16 years
Education
Southeast High School – 1966
Labette Community College – AA, 1971

Renae Hansen
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Staff for Rep. Carl Holmes
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hansenfamily1@cox.net
Current Responsibilities
Staff for Rep. Carl Holmes
Experience
Staff for several representatives
Education
Kansas State University – BS, 1984
Washburn University – 2000

Mike Hayden
Title and Affiliation
Secretary
Kansas Department of Wildlife & Parks
Address and Telephone
1020 S. Kansas Ave., Suite 200
Topeka KS 66612
785-296-2282
mike.hayden@wp.state.ks.us
Experience
President, American Sportfishing Assoc.; Assistant Secretary of Interior for Fish, Wildlife and Parks; Governor of Kansas, 1987-91; Speaker of the Kansas House, 1983-87
Education
Kansas State University – BS, 1966
Ft. Hays State University – MS, 1974

Dave Heinemann
Title and Affiliation
Geological Survey Advisory Council (GSAC) Member
Address and Telephone
3826 SW Cambridge Ct.
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daveh123@cox.net
Current Responsibilities
Geological Survey Advisory Council (GSAC) Member
Governmental Affairs—Stand Up For Kansas
Experience
GSAC past president; State Representative, 27 years; General Counsel, KCC, 2 years; Executive Director, KCC, 2 years; Department of Revenue, Special Assistant to the Secretary, 5 years
Education
Augustana College – BA, 1967
University of Kansas – 1967-68
Washburn Law School – JD, 1973

Bob Henthorne
Title and Affiliation
Chief Geologist
Kansas Department of Transportation
Address and Telephone
2300 Van Buren
Topeka KS 66611
785-291-3860
roberth@ksdot.org
Current Responsibilities
Oversee all geologic investigations for KDOT
Experience
KDOT, 27 years
Education
University of Kansas – BS, 1983

Carl Holmes
Title and Affiliation
Kansas House of Representatives, 125th District
Address and Telephone
P.O. Box 2288
Liberal KS 67905
620-624-7361
repcarl@aol.com
Current Responsibilities
Chair, Energy and Utilities Committee; Chair, Kansas Electric Transmission Authority; Chair, Joint Committee on Administrative Rules and Regulations; Chair, Biomass Committee of Kansas Energy Council; Chair, NCSL Advisory Council on Energy

Experience
Chair, Subcommittee, Agriculture & Natural Resources Budget; President, League of Kansas Municipalities
Education
Colorado State University – BS, 1962

Steve Irsik
Title and Affiliation
Chairman, Kansas Water Authority
Address and Telephone
5405 Six Rd.
Ingalls KS 67853
620-335-5363
steve@ucom.net
Experience
Farmer, rancher, and agriculture business
Education
Kansas State University – BS, 1969

Wayne Lebsack
Title and Affiliation
President
Lebsack Oil Production, Inc.
Address and Telephone
603 S. Douglas
Lyons, KS 67554
620-938-2396
Current Responsibilities
Manages oil and gas exploration and development; Trustee, The Nature Conservancy, Kansas Chapter; Chair, Stewardship Committee, The Nature Conservancy
Experience
Oil and gas exploration; ground-water exploration and pollution research; Barton County spelling bee champ, 1934
Education
Colorado School of Mines – Geol. Eng., 1949
Colorado School of Mines – Pet. Geol., 1951
Colorado School of Mines – 2 years grad. studies

Janis Lee
Title and Affiliation
Kansas State Senate, 36th District
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Kensington KS 66951
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jlee@ink.org
Current Responsibilities
Asst. Minority Leader; Ranking on Utilities, Assessment and Taxation, and Education committees; Member, Natural Resources and Agriculture committees; Member, KETA, KEC

Experience
Farmer and rancher
Education
Kansas State University – BS, 1970

Lane Letourneau
Title and Affiliation
Water Appropriations Program Manager
Division of Water Resources, Department of Agriculture
Address and Telephone
109 SW 9th St., 2nd Floor
Topeka KS 66612
785-296-3710
lletourneau@kda.state.ks.us
Experience
Oil-well logger, water rights (20 years)
Education
Fort Hays University – BS, 1983

Judith Loganbill
Title and Affiliation
Kansas House of Representatives, 86th District
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215 S. Erie
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judithloganbill@msn.com
Current Responsibilities
Elementary teacher
Experience
Teacher, 28 years; House of Representatives since 2001
Education
Bethel College – BS, 1975
Northern Arizona University – MA, Ed., 1981

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Westar Energy
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Current Responsibilities
Energy planning and environmental stewardship; Kansas Association of Conservation and Environmental Education (KACEE) Board Member
Education
The Ohio State University – BS, 1981
University of Kansas – MS, 1985

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Current Responsibilities
Director, Kansas Biological Survey; professor of ecology
Experience
Environmental and remote sensing research; research administration
Education
College of Emporia – BS, 1967
University of Colorado – MA, 1970
University of Kansas – PhD, 1976

Peggy Mast
Title and Affiliation
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Current Responsibilities
Member, Utilities Committee
Experience
26 years in oil-field industry

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Current Responsibilities
Chair, Natural Resources Committee; Chair, sand-pit development task force
Experience
Sedgwick County Commissioner
Education
Wichita State University – BBA, 1983
Friends University – MSES, 1998

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Current Responsibilities
Transportation, Energy & Utilities, and Govt. Efficiency and Technology committees
Education
Wichita State University – BS, 1976

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Public Affairs Manager
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Current Responsibilities
KDOT Public Affairs Manager for south-central Kansas (works with news media and public inquiries)
Education
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Experience
Rancher
Education
Kansas State University – BS, 1969

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Current Responsibilities
Energy and Utilities, Health & Human Services, and Insurance & Financial Institutions committees
Experience
PR & Marketing Director for dental practice; retired medical administrator; Shawnee Mission public schools

Education
Washington High School – 1967
Johnson County Community College
Kansas City Kansas Community College

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Title and Affiliation
Vice Chair
Kansas Water Authority
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2046 U.S. Highway 24
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Experience
Self-employed—farming operation and electrical & irrigation contracting business, 35 years
Education
High School – 1956

Adrian Polansky
Title and Affiliation
Secretary of Agriculture
Kansas Department of Agriculture
Address and Telephone
109 SW 9th St.
Topeka KS 66612
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apolansky@kda.state.ks.us
Current Responsibilities
Administrator for Kansas agriculture regulation and policies; advocate for agriculture; works with legislature for agriculture
Experience
Owner, Polansky Seed; Director of USDA FSA; President, KS Crop Improvement Association; Chairman, U.S. Wheat Association
Education
Kansas State University – BS, 1972

Larry Powell
Title and Affiliation
Kansas House of Representatives, 117th District
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Current Responsibilities
Chair, Agriculture and Natural Resources Budget Committee; Member, Agriculture and Natural Resources, Appropriations committees
Experience
Rancher, custom cutter, and implement dealer

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Kansas State Senate, 25th District
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Current Responsibilities
Chair, Education Committee; Member, Ways & Means, Confirmation Oversight, Commerce, and JJA/Corrections committees
Experience
Speech/language pathologist
Education
University of New Mexico – BA, 1972
University of New Mexico – MS, 1973
Wichita State University – PhD, 1981

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Current Responsibilities
Vice Provost for Scholarly Support; McGee Distinguished Professor of Geology at KU
Experience
Deputy Director, Kansas Geological Survey, 1987–1992; Chief Geophysicist, KGS, 1975–1992; Geophysicist, USGS, Menlo Park, CA 1972–75
Education
Kansas State University – MS, 1970
Stanford University – MS, 1973
Stanford University – PhD, 1975

Tracy Streeter
Title and Affiliation
Director, Kansas Water Office
Address and Telephone
901 S. Kansas Ave.
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785-296-3185
tstreeter@kwo.state.ks.us
Experience
State Conservation Commission Executive Director, 1995-2004; worked at SCC from 1985–

2004; involved in Brown County family farm until 1990; President, USD 338 Board of Education

Education

Highland Community College – AS, 1983
Missouri Western State – BS, 1985
University of Kansas – MPA, 1993

John Strickler

Title and Affiliation

Trustee, The Nature Conservancy, Kansas Chapter
Treasurer, KACEE (Kansas Association for Conservation and Environmental Education)

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Manhattan KS 66502-3447
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Current Responsibilities

Board of Trustees, Kansas Chapter, The Nature Conservancy; Treasurer, KACEE

Experience

Chair, The Nature Conservancy, Kansas Chapter; Executive Director, KACEE; Special Assistant for Environment and Natural Resources to Gov. Hayden, 2 years; Acting Secretary, Kansas Department of Wildlife and Parks, 1987 and 1995; Kansas State and Extension Forestry, KSU, 33 years; U.S. Forest Service, 4 years

Education

University of Missouri – BS, 1957
Kansas State University – MS, 1968

Ruth Teichman

Title and Affiliation

Kansas Senate, 33rd District

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Stafford KS 67578
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Current Responsibilities

Chair, Financial Institutions & Insurance Committee; Member, Ways and Means and Education committees; Joint Legislative Educational Planning and Pension, Benefits & Investments committees

Experience

Farmer/Banker

Education

Kansas State University – BS, 1965

Jason Thompson

Title and Affiliation

Assistant Revisor of Statutes
Revisor of Statutes Office

Address and Telephone

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Current Responsibilities

Staff for House Agriculture and Natural Resources Committee

Experience

Research Attorney, Johnson County District Court, 9/04–12/06

Education

Hutchinson High School, 1996
University of Kansas – BA, 2000
University of Kansas – JD, 2004

Mary Torrence

Title and Affiliation

Revisor of Statutes
Revisor of Statutes Office

Address and Telephone

State House, Suite 010-E
300 SW 10th St.
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785-296-5239
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Current Responsibilities

Legislative staff; drafting legislation and giving legal advice; administration of office

Experience

Revisor of Statutes Office, 33 years

Education

University of Kansas – BA, 1971
University of Kansas – JD, 1974

James R. Triplett

Title and Affiliation

Chair, Biology Department, Pittsburg State University
Chair, Geological Survey Advisory Council (GSAC)

Address and Telephone

Biology Department
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Pittsburg State University
Pittsburg KS 66762
620-235-4730
jtriplet@pittstate.edu

Experience

Ohio State Fisheries & Wildlife Division, 1975–1981; PSU Dept. of Biology, 1981-present (Chair, 1984-present)

Education

Pittsburg State University – BA, 1966
Pittsburg State University – MS, 1968
University of Kansas – PhD, 1976

David Warren

Title and Affiliation

Director
Wichita Water & Sewer
City of Wichita

Address and Telephone

City Hall, 8th Floor
455 N. Main
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316-268-4504

George Wilson

Title and Affiliation

Associate Vice Provost for Research
University of Kansas

Address and Telephone

Youngberg Hall
2385 Irving Hill Road
Lawrence KS 66045-7563
785-864-3475
gwilson@ku.edu

Current Responsibilities

Associate Vice Provost for Research; Vice President of KU Center for Research (KUCR); Distinguished Professor of Chemistry

Experience

Teaching/research assistant, assistant professor of chemistry, professor of chemistry

Education

Princeton University – AB, 1961
University of Illinois – MS, 1963
University of Illinois – PhD, 1965

Keith Yehle

Title and Affiliation

Director of Government Relations
University of Kansas

Address and Telephone

1450 Jayhawk Blvd
230 Strong Hall
University of Kansas
Lawrence KS 66045
785-312-7100
kyehle@ku.edu

Current Responsibilities

Leads the KU government relations team, which communicates the official position of the University before the U.S. Congress, Kansas Legislature, and government agencies

Experience

Deputy legislative director (1998–2001) and legislative director (2001–05) for Senator Pat Roberts; worked for Kansas Congresswoman Jan Meyers prior to 1997

Education

University of Kansas – BA, 1990

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Bill Harrison

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Director and State Geologist
Kansas Geological Survey

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Current Responsibilities

Plan and initiate major research programs; assess scientific quality of current programs

Experience

Kansas Geological Survey, 10 years; Lockheed Martin Idaho Technologies; EG&G Idaho, Inc.; ARCO Exploration & Technology; University of Oklahoma/Oklahoma Geological Survey, Faculty/Staff Geologist

Education

Lamar State College of Technology - BS, 1966
University of Oklahoma – MS, 1968
Louisiana State University – PhD, 1976

Rex Buchanan

Title and Affiliation

Associate Director
Public Outreach, Kansas Geological Survey

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Current Responsibilities

Supervise publication and public outreach activities, media relations, and non-technical communications

Experience

Kansas Geological Survey, 29 years; University-Industry Research, University of Wisconsin, 3 years; Salina Journal, 4 years

Education

Kansas Wesleyan University – BA, 1975
University of Wisconsin-Madison – MA, 1978
University of Wisconsin-Madison – MS, 1982

Cathy Evans

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Publication Assistant
Kansas Geological Survey

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Current Responsibilities

Work with coordinator of field conference and guidebook; write news releases; help produce non-technical or semi-technical publications

Experience

Kansas Geological Survey; University Press of Kansas; Spencer Museum of Art

Education

University of Kansas – BA, 1978
University of Kansas – MS, 1990

Shane Lyle

Title and Affiliation

Research Assistant
Geology Extension, Public Outreach Section, Kansas Geological Survey

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Current Responsibilities

Geology Extension Coordinator; Kansas Field Conference

Experience

Kansas Geological Survey; Environmental and Engineering Geology, 12 years

Education

Kansas State University – BS, 1993

Jim McCauley

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Current Responsibilities

Geologic mapping; remote sensing; public inquiries

Experience

Kansas Geological Survey, 30 years; KU Remote Sensing Laboratory, 6 years

Education

University of Kansas – BS, 1970
University of Kansas – MS, 1973
University of Kansas – PhD, 1977

Bob Sawin

Title and Affiliation

Research Associate
Geology Extension, Public Outreach Section, Kansas Geological Survey

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Current Responsibilities

Geology Extension; Kansas Field Conference; geologic mapping

Experience

Kansas Geological Survey, 15 years; Petroleum Geology, 15 years; Engineering Geology, 6 years

Education

Kansas State University – BS, 1972
Kansas State University – MS, 1977

Wichita, Hutchinson, and Surrounding Areas: Industry and the Environment

2007 FIELD CONFERENCE

June 6-8, 2007

Welcome to the 2007 Field Conference, co-sponsored by the Kansas Geological Survey (a division of the University of Kansas), the Kansas Department of Health and Environment, the Kansas Department of Transportation, the Kansas Department of Wildlife and Parks, and the City of Wichita. Previous Field Conferences have focused on specific topics, such as energy or water, or specific regions of the state. This year's Field Conference is centered around natural-resource and environmental issues in Wichita and the surrounding area, including the City of Hutchinson. While some of the issues we will consider are site specific, others (such as ethanol, subsidence, and water contamination) have implications and applicability for the entire state and even the surrounding region.

A Preview

Day 1

We will begin this year's Field Conference in and around Wichita. Wichita is located on a flat alluvial plain, with a relatively shallow water table. That natural setting, combined with the size of the area's population and the industrial nature of much of its economy, has combined to create a range of environmental issues. We'll take a look at those issues, and the response to them. Many of these issues involve water and its contamination, both natural and human-made. We will discuss water quality and the development of sand-pit lakes in the area; talk about ground-water contamination beneath downtown Wichita and the resulting project to pump and treat ground water; and visit the facility where that water is treated, and see Wichita's efforts to use that water-treatment facility as a public education opportunity. The Arkansas River is a prominent feature in the Wichita landscape, and issues related to its contamination, and public access to recreation on the river, will be topics today.

Water is not the only natural-resource issue facing the city, however. Because this area is underlain by salt deposits, and because salt is easily dissolved by ground water, subsidence (or the sinking of land above underground void spaces) is also an issue. As the city has expanded, it has encountered areas of subsidence in western Sedgwick County. We will look at the issues posed by subsidence and highway construction, along with ways to detect and design around subsidence. Finally, we'll visit a chemical-manufacturing facility that uses solution-mined salt in its manufacturing process and see how surface runoff at the plant is collected and disposed of in deep underground-injection wells.

Day 2

Because Wichita is large and growing, developing a sufficient supply of water is of great importance here. The city uses water from Cheney Reservoir, to the northwest of Wichita, and from the Equus Beds aquifer to supply its needs. We will look at an innovative project to take water from the Little Arkansas River, north of Wichita, and put it back into the Equus Beds aquifer. This process, known as artificial recharge, is both expensive and occasionally contentious, because of concerns about water quality. We'll also look at areas where oil-exploration activities in the early 20th century resulted in the contamination of substantial amounts of ground water with oil-field brine, and we'll talk about efforts to control that contamination.

The remainder of Day 2 will be spent in Hutchinson. Salt has been mined here since the late 1800s. But salt has led to subsidence issues here, too; we'll look at a recent sinkhole on the city's south side that was the result of solution mining of salt in the early 1900s. We will hear about attempts to engineer around the problems created by that sinkhole and look at other possible areas of subsidence nearby. We'll study ground-water contamination issues in Hutchinson that are somewhat similar to those faced in downtown Wichita, and we'll learn about Hutchinson's approach to dealing with them. We will visit the Yaggy Natural Gas Storage Area, a series of void spaces that were created in the salt specifically to be used to store natural gas. This facility was mothballed because of a 2001 accident that allowed natural gas to escape and move beneath Hutchinson; we'll talk about recent attempts to use this storage space for petroleum as part of the nation's Strategic Petroleum Reserve program.

Finally, we will travel underground for supper in the Kansas Underground Salt Museum, where you will have the opportunity to see salt deposits up close, learn about salt mining, and tour the newly opened museum, the only one of its type in North America.

Day 3

Our focus today will be ethanol: its production, its economics, and the implications of increased ethanol manufacturing in Kansas. We will visit the town of Colwich to see one of the first ethanol-production facilities in the state. We'll finish the day by traveling back to Wichita and hold a panel session on ethanol at the Great Plains Nature Center. We will talk about the ethanol business in Kansas, including the economics and regulation of ethanol, along with its impact on water, wildlife, agriculture, and other aspects of the Kansas landscape and economy.

The Natural Environment

During these three days, we will spend our time in two very similar physiographic regions: the Arkansas River Lowlands and the Wellington–McPherson Lowlands. Though separated into different physiographic regions, these areas are geologically similar: both are relatively flat alluvial plains, made up of sand, silt, and gravel dumped here by streams and rivers.

The Arkansas River Lowlands is made up of rocks deposited by the Arkansas River during the last 10 million years as the river flowed through Kansas from its source high in the Rocky Mountains. In the Rockies, the Arkansas is supplied with runoff, snowmelt, and rock debris that weathers from the mountains, but as the river moves out onto the High Plains, it receives little in the way of additional water. In fact, it loses water to its sandy riverbed. As its flow decreases, the river's ability to carry sediments also diminishes and it begins to dump its sediment load. It changes from a degrading stream (one that cuts downward in its channel) to an aggrading stream (one that builds up the riverbed).

The Wellington–McPherson Lowlands of south-central Kansas is also developed on alluvial deposits. This sand, silt, and gravel was eroded from slightly older rocks in the High Plains to the north, then carried by streams flowing south into the Arkansas River between one and two million years ago, during the Pleistocene Epoch. An important underground feature of the Wellington–McPherson Lowlands is the Equus Beds aquifer. The Equus beds is made up of thick (more than 250 feet) deposits of silt, sand, and gravel, in many places saturated with water. This aquifer is an important source of water for Wichita, McPherson, Newton, and other communities in this region. These deposits were named for fossils of Ice Age horses that were found among the unconsolidated deposits (*equus* is the Latin word for horse).

Sand dunes, formed by wind, occur in many places in both regions. Most of these dunes are covered with grass and other vegetation, which keeps the sand from shifting. Such sand dunes are considered inactive—that is, they are no longer moving in response to wind.

Probably the most notable natural feature in this area is the Arkansas River. The Ark gets its start in the Rocky Mountains near Leadville, Colorado. It moves south and east, through the Royal Gorge, then out onto the plains of eastern Colorado and western Kansas. It makes a sweeping bend northeast and then southeast again where it is joined by the Little Arkansas River in Wichita, then heads into Oklahoma. It joins the Mississippi River at Napoleon, Arkansas. At 1,450 miles in length, it is the fourth-longest river in the U.S. In 1985, Kansas filed suit over Colorado's delivery of water in the Arkansas River, a suit that was settled in Kansas' favor and is currently in the damages stage. Today the Kansas portion of the river generally carries water until it reaches the area west of Garden City; it is generally dry from that point until it begins flowing again at Great Bend. In an effort to re-establish flow in the middle portion of the Arkansas River basin in Kansas, a voluntary program was recently established to buy back irrigation-water rights.

The Built Environment

With a population of more than 350,000, Wichita is the largest city in Kansas. It was founded at the confluence of the Arkansas River and the Little Arkansas River in the 1860s. It is named after the Wichita Indians, who camped and lived here previously. The city was an early center for the state's oil industry, with the discovery of the El Dorado field, the most productive oil field in Kansas history, to the east of Wichita in 1914. In the 1920s, Wichita developed into a center of aircraft manufacturing and labeled itself the "air capital." With the demand for aircraft in World War II, manufacturing led to a population increase, and by 1950, Wichita was the state's largest city. McConnell Air Force Base, named after a pair of Wichita brothers who were Air Force pilots, was established in 1951. In addition to its aircraft industry, a number of other notable companies were founded in Wichita, including Koch Industries (the largest privately held company in the world), Pizza Hut, and White Castle.

Wichita is the county seat of Sedgwick County, named after a Civil War soldier. Sedgwick County's population is just over 450,000, or about 100,000 above the city of Wichita's population. Sedgwick County was the state's most populous county until fairly recently, when it was surpassed by Johnson County (Sedgwick remains the state's second most populous county). The area's population generally fluctuates according to the health of the economy; from 1990 to 2000, the population of Sedgwick County increased by about 12 percent.

The City of Hutchinson lies north and west of Wichita about 30 miles. Hutchinson is considerably smaller, with a population of about 40,000. In addition to the salt-mining industry, which has existed here since the 1880s, the city is known as the home of the annual Kansas State Fair, the national junior college basketball tournament, and the Dillon's grocery stores. The world's largest and longest grain elevator was built here in 1961. Hutchinson is the county seat of Reno County.

About the Kansas Field Conference

Some issues are best understood by seeing them firsthand. The 2007 Field Conference marks the 13th year the Kansas Geological Survey (KGS) has worked with co-sponsors to develop this opportunity for policy-makers to see and experience some of the natural-resource issues with which they grapple. Participants have been selected to provide a range of legislative, governmental, education, and private-business expertise. Local and regional experts in natural-resource issues will meet us at each site and describe the location and the issues related to it. The objective is to let participants see the results of their decisions and to talk with local, State, and Federal governmental officials, environmental groups, business people, and citizens' organizations. The result should give participants a broader, more-informed perspective useful in formulating policies. In addition, the Field Guide you are holding provides background on sites and issues, and serves as a handy reference long after the Field Conference is over.

During the Field Conference, participants are expected to be just that—participants. We want you to contribute to the discussion, to ask questions, and to otherwise join in on deliberations. **The bus microphone is open to everyone, and we encourage everyone to participate.**

Please remember that in the course of the Field Conference, we do not seek to resolve policy or regulatory conflicts. We do try to provide opportunities to familiarize policy makers with resource problems. By bringing together experts on the unique technical, geographical, geological, environmental, social, and economic realities of south-central Kansas, we hope to go beyond merely identifying issues. We want this combination of first-hand experience and interaction among participants to result in a new level of understanding of the state's natural-resource issues.

In doing this, we attempt to present, as nearly as possible, all sides of contentious issues. Please know that the opinions presented during the Field Conference are not necessarily those of the KGS or Field Conference co-sponsors. Nonetheless, we do believe it is important for participants to hear various viewpoints on complex issues.

The Kansas Field Conference is an outreach program of the Kansas Geological Survey, administered through its Geology Extension program. Its mission is to provide educational opportunities to individuals who make and influence policy about natural-resource and related social, economic, and environmental issues in Kansas. The KGS's Geology Extension program is designed to develop materials, projects, and services that communicate information about the geology of Kansas, the state's natural resources, and the products of the Kansas Geological Survey to the people of the state.

The Field Conference was begun in 1995 with the support of Lee Gerhard, then the Survey's director and state geologist. The Field Conference is modeled after a similar program of national scope, the Energy and Minerals Field Institute, operated by the Colorado School of Mines. The KGS appreciates the support of Erling Brostuen, Director of the Energy and Field Institute, in helping develop the Kansas project.

The KGS Field Conference has been recognized by

• The National Institute of Standards and Technology as among 50 Best Practices for Communication of Science and Technology for the Public, 2001; and

• The Division of Environmental Geosciences of the American Association of Petroleum Geologists, which presented the Field Conference with its Public Outreach Award in 1998.

The KGS appreciates your attendance at this year's Field Conference and your willingness to share your insights for its improvements. Your input has helped make the Field Conference a model that has been adopted by other state geological surveys.

Sponsors

Kansas Geological Survey

Since 1889, the Kansas Geological Survey has studied and reported on the state's geology. Today the KGS mission is to study and provide information about the state's geologic resources and hazards, particularly ground water, oil, natural gas, and other minerals. In many cases, the Survey's work coincides with the state's most pressing natural-resource issues.

By statutory charge, the Kansas Geological Survey's role is strictly one of research and reporting. The KGS has no regulatory function. It is a division of the University of Kansas. The KGS employs about 70 full-time staff members and about 80 students and grant-funded staff. It is administratively divided into research and research-support sections. KGS programs can be divided by subject into water, energy, geology, and information dissemination.

Water—Water issues affect the life of every Kansan. Western Kansas agriculture and industry rely heavily on ground water; in eastern Kansas, growing populations and industry generally use surface water. KGS water research and service include an annual water-level-measurement program (in cooperation with the Kansas Department of Agriculture, Division of Water Resources), studies of recharge rates, water quality in the Arkansas River, depletion of the Ogallala aquifer, the interaction between streams and aquifers, and a variety of other topics.

Energy—Kansas produces more than $4 billion worth of oil and natural gas each year. Because much of the state has long been explored for oil and gas, maintaining that production takes research and information. The KGS studies the state's coal resources and one newly developed source of energy, coalbed methane. The KGS does research on the state's petroleum reservoirs, new methods of providing information (such as a digital petroleum atlas), and new methods of exploring for and producing oil. The KGS is completing a multi-year study of the resources of the Hugoton Natural Gas Area and issues related to carbon dioxide sequestration. The KGS also has a branch office in Wichita, the Wichita Well Sample Library, that stores and loans rock samples collected during the drilling of oil and gas wells in the state.

Geology—Much of the KGS's work is aimed at producing basic information about the state's geology, information that can be applied to a variety of resource and environmental issues. The KGS develops and applies methods to study the subsurface, such as high-resolution seismic reflection; undertakes mapping of the surficial geology of the state's counties; and studies specific resources, such as road and highway materials. The KGS reports on non-fuel minerals (such as salt, gypsum, aggregates, etc.) and is charged with studying geologic hazards, such as subsidence, earthquakes, and landslides.

Geologic Information—To be useful, geologic information must be disseminated in a form that is most appropriate to the people who need it. The KGS provides information to the general public, policy-makers, oil and gas explorationists, water specialists, other governmental agencies, and academic specialists. Information is disseminated through a publication sales office, automated mapping, the state's Data Access and Support Center (located at the KGS), a data library, electronic publication, and Geology Extension.

KGS staff participating in the 2007 Field Conference include the following:

Bill Harrison, Director and State Geologist
Rex Buchanan, Associate Director, Public Outreach
Cathy Evans, Publication Assistant
Shane Lyle, Research Assistant, Geology Extension
Jim McCauley, Assistant Scientist, Stratigraphic Research Section
Bob Sawin, Research Associate, Geology Extension

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Kansas Department of Transportation

The Kansas Department of Transportation (KDOT) was founded in 1917. It is charged with providing a statewide transportation system to meet the needs of Kansans. Its primary activities are road and bridge maintenance; transportation planning, data collection and evaluation; project scoping, designing, and letting; contract compliance inspection of material and labor; Federal program funding administration; and administrative support. In addition to dealing with roadways for automobile traffic, KDOT is responsible for other modes of transportation, including aviation, rail, and bicycles/pedestrians. The Department has more than 3,000 employees. KDOT's headquarters are in Topeka with six district offices, 26 area offices, and 112 sub-area offices across the state.

The agency is organized into divisions of public affairs, administration, aviation, engineering and design, operations, and planning and development. Within the Division of Operations is the Bureau of Materials and Research. This Bureau is responsible for approved materials, pavement management, testing, and research. Within that Bureau is a geotechnical unit that includes a geology section. That section supplies information and recommendations regarding surface and foundation geology, hydrology, and bridge-deck conditions to the Bureau of Design for project-plan preparation; conducts special surveys on selected subjects such as soil shrinkage, rock expansion, and pile-foundation requirements; and constructs new water wells in rest areas and rehabilitates and maintains existing wells for all KDOT facilities. Because of its role within KDOT, the geology section has actively studied issues related to subsidence and its impact on roads in the state. Robert Henthorne is the chief geologist within the unit.

In 2006, the agency identified six critical areas for which to measure performance—safety, preservation and maintenance, program and project delivery, system modernization, workforce priorities, and economic impact. Because of concern about traffic fatalities and injuries, a special task force was established to develop recommendations about ways to lower the number of highway deaths and injuries. The agency's top priority is the completion of the 10-year Comprehensive Transportation Program (CTP), begun in 1999. In 2005, KDOT spent about $621 million on CTP-related construction contracts. KDOT is now beginning the process of developing a Long-Range Transportation Plan, information that will be used to chart a course for the agency over the next two decades. The current Secretary of the Kansas Department of Transportation is Deb Miller, the first female director in the agency's history.

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Source: Kansas Making Progress: Our Transportation Performance: 2007 Annual Report, Kansas Department of Transportation.

Kansas Department of Wildlife and Parks

The Kansas Department of Wildlife and Parks is responsible for management of the state's living natural resources. Its mission is to conserve and enhance Kansas' natural heritage, its wildlife, and its habitats. The Department works to assure future generations the benefits of the state's diverse living resources; provide the public with opportunities for the use and appreciation of the natural resources of Kansas, consistent with the conservation of those resources; and inform the public of the status of the natural resources of Kansas to promote understanding and gain assistance in achieving this mission.

The Department's responsibility includes protecting and conserving fish and wildlife and their associated habitats while providing for the wise use of these resources, and providing associated recreational opportunities. The Department is also responsible for providing public outdoor-recreation opportunities through the system of state parks, state fishing lakes, wildlife management areas, and recreational boating on all public waters of the state.

In 1987, two State agencies, the Kansas Fish and Game Commission and the Kansas Park and Resources Authority, were combined into a single, cabinet-level agency operated under separate comprehensive planning systems. The Department operates from offices in Pratt, Topeka, five regional offices, and a number of State park and wildlife area offices.

As a cabinet-level agency, the Department of Wildlife and Parks is administered by a Secretary of Wildlife and Parks and is advised by a seven-member Wildlife and Parks Commission. All positions are appointed by the Governor with the Commissioners serving staggered four-year terms. As a regulatory body for the Department, the Commission is a non-partisan board, made up of no more than four members of any one political party, advising the Secretary on planning and policy issues regarding administration of the Department. Regulations approved by the Commission are adopted and administered by the Secretary. Mike Hayden is the Secretary of Wildlife and Parks.

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Kansas Department of Health and Environment

In Kansas, health and environmental issues are regulated by the Kansas Department of Health and Environment (KDHE). Its mission is "to protect the health and environment of all Kansans by promoting responsible choices." KDHE is divided into two major divisions—health and environment—along with a branch of laboratory services. The Division of Environment, the part of the agency involved with this year's Field Conference, operates the following programs:

- The Bureau of Air and Radiation, whose purpose is to protect the public and the environment from radiation and air pollution.

- The Bureau of Environmental Remediation, which responds to environmental emergencies and manages environmental contamination through pollution-source control, containment, or remedial action.

- The Bureau of Environmental Field Services, which administers all environmental-program operations at the six KDHE district offices and provides scientific, technical, and operational support for KDHE Division of Environment programs.

- The Bureau of Waste Management, which is responsible for programs associated with the handling and disposal of waste materials in Kansas.

- The Bureau of Water, which administers programs related to public water supplies, wastewater-treatment systems, the disposal of sewage, and nonpoint sources of pollution. Programs are designed to provide safe drinking water, prevent water pollution, and assure compliance with State and Federal laws and regulations such as the Clean Water Act and Safe Drinking Water Act. This bureau has programs in geology, industry, livestock management, municipalities, public water supply, watershed management, technical services, and watershed planning and Total Maximum Daily Load (or TMDL) of pollutants in streams. The Bureau's geology section is responsible for overseeing both underground-injection wells and underground storage of hydrocarbons and natural gas. Because of the responsibilities related to water, this bureau of KDHE is responsible for much of the regulation of the water-related issues being discussed on this year's Field Conference.

The agency's Secretary is Roderick Bremby, who is appointed by the Governor. Ronald Hammerschmidt is Director of the Division of Environment, Karl Mueldener is Director of the Bureau of Water, and Mike Cochran is chief of the Bureau's geology section.

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Bureau of Water
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Geology Section
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www.kdheks.gov

City of Wichita

The City of Wichita has operated a Council-City Manager form of government since 1917. The Council's mission is to provide policy direction for the city in developing, implementing, and maintaining services to the citizens of Wichita. The Council enacts ordinances, laws, and policies; adopts the budget; levies taxes; and appoints members to citizen advisory boards and commissions. The seven Council members are elected to four-year terms on a nonpartisan basis with staggered terms of office. Six Council members are elected by district, and the Mayor is elected at-large. The current Mayor of Wichita is Carl Brewer.

The City Manager is responsible for implementing the policy direction of the Council. The City Manager submits the annual budget, advises the Council on matters affecting the city, administers and oversees city operations, and appoints and removes city personnel. The City Manager's office assists the Council with special projects and research assignments. Recent projects have included staffing the Regional Economic Area Partnership (REAP), an organization serving to unite cities and counties in south-central Kansas on issues of mutual interest and economic growth, and coordinating public information sessions to discuss the benefits and impacts of annexation on affected residents. Other duties of the City Manager's office include the preparation of agendas for weekly Council meetings; the staffing of various boards, commissions, and task forces; and the oversight of non-departmental programs and activities. The current Wichita City Manager is George Kolb.

Among the City of Wichita's departments is Environmental Services, which is responsible for air quality, animal services, child-care licensure, environmental assistance and remediation, environmental compliance, neighborhood environmental code enforcement, food protection and tobacco control, hazardous materials response, nuisance abatement, and water quality. This department is heading up the Arkansas River Water Quality Campaign, an effort to study and address water quality in the Arkansas and Little Arkansas rivers, particularly in terms of fecal coliform bacteria. Wichita, KDHE, and the U.S. Geological Survey maintain about 55 sample sites along the Arkansas and Little Arkansas. The Wichita Area Treatment, Education, and Remediation (WATER) Center is operated through this department. Kay Johnson is Director of Environmental Services.

The Water and Sewer Department is dedicated to providing high-quality, reliable, and customer-convenient water and sewer service that represents extraordinary value. The Wichita Water and Sewer Department supplies and distributes high-quality water, and collects and treats wastewater for the City of Wichita. Services provided include pumping and purifying water, maintaining the water-distribution and wastewater-collection systems, treating wastewater, managing facilities, and planning for future needs, all with the most responsible use of financial resources. The department operates and maintains four wastewater-treatment facilities and 57 sanitary-lift stations. David Warren is the Director of the Water and Sewer Department.

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SCHEDULE AND ITINERARY

Wednesday, June 6, 2007

6:30 am	Breakfast at Ted’s Montana Grill
7:15 am	Conference Overview *Bill Harrison*, Director, Kansas Geological Survey
8:00 am	**Bus leaves Candlewood Suites for Site 1**
8:30 am	**SITE 1 •** Salt-Related Subsidence, Highway Design, and Remediation, Wichita *Bob Henthorne*, Kansas Dept. of Transportation
9:15 am	Bus to Site 2
9:30 am	**SITE 2 •** OxyChem Facility, Wichita *Greg Davis*, OxyChem
10:45 am	Bus to Site 3
11:15 am	**SITE 3 •** The Gilbert and Mosley Project, The WATER Center, Wichita *Kay Johnson*, City of Wichita
12:00 pm	Lunch at The WATER Center
1:00 pm	Bus to Site 4
1:15 pm	**SITE 4 •** Arkansas River Public Access, Wichita *Tom Swan*, Kansas Dept. of Wildlife and Parks
2:00 pm	Bus to Site 5
2:15 pm	**SITE 5 •** Arkansas River Water-Quality Campaign, Wichita *Vaughn Weaver*, City of Wichita
4:45 pm	Bus to motel
5:00 pm	Arrive at Candlewood Suites
6:00 pm	Bus to dinner at Wichita Sports Hall of Fame Museum
8:00 pm	Bus to motel

Salt-Related Subsidence, Highway Design, and Remediation

Salt dissolution, either natural or human-induced, is responsible for surface subsidence areas (sinkholes) in Kansas. The eastern edge of the Hutchinson Salt Member is actively being eroded, or dissolved, by contact with ground water (fig. 3–1). This area, where the salt is closest to the surface, is known as the dissolution front. Because salt is so easily dissolved in water, outcrops at the surface are not present in Kansas. As the salt is dissolved away, the overlying rocks and sediment settle into the void that was once occupied by the salt (fig. 3–2). Dissolution of the salt (which thickens and dips to the west) over the last several million years has caused the salt front to migrate westerly, leaving behind a broad north-south-trending depression that extends from Saline County to Sumner County. Contained within this low-lying area are numerous sinkholes and undrained depressions at the surface, and distorted bedrock and lost circulation zones (voids encountered during well drilling that drain drilling fluids from the hole) in the subsurface. This westerly migration of the salt front continues today at a rate of about 2 miles every million years, causing new sinkholes to form.

Historically, the Smoky Hill River followed this low-lying area created by the dissolution of the

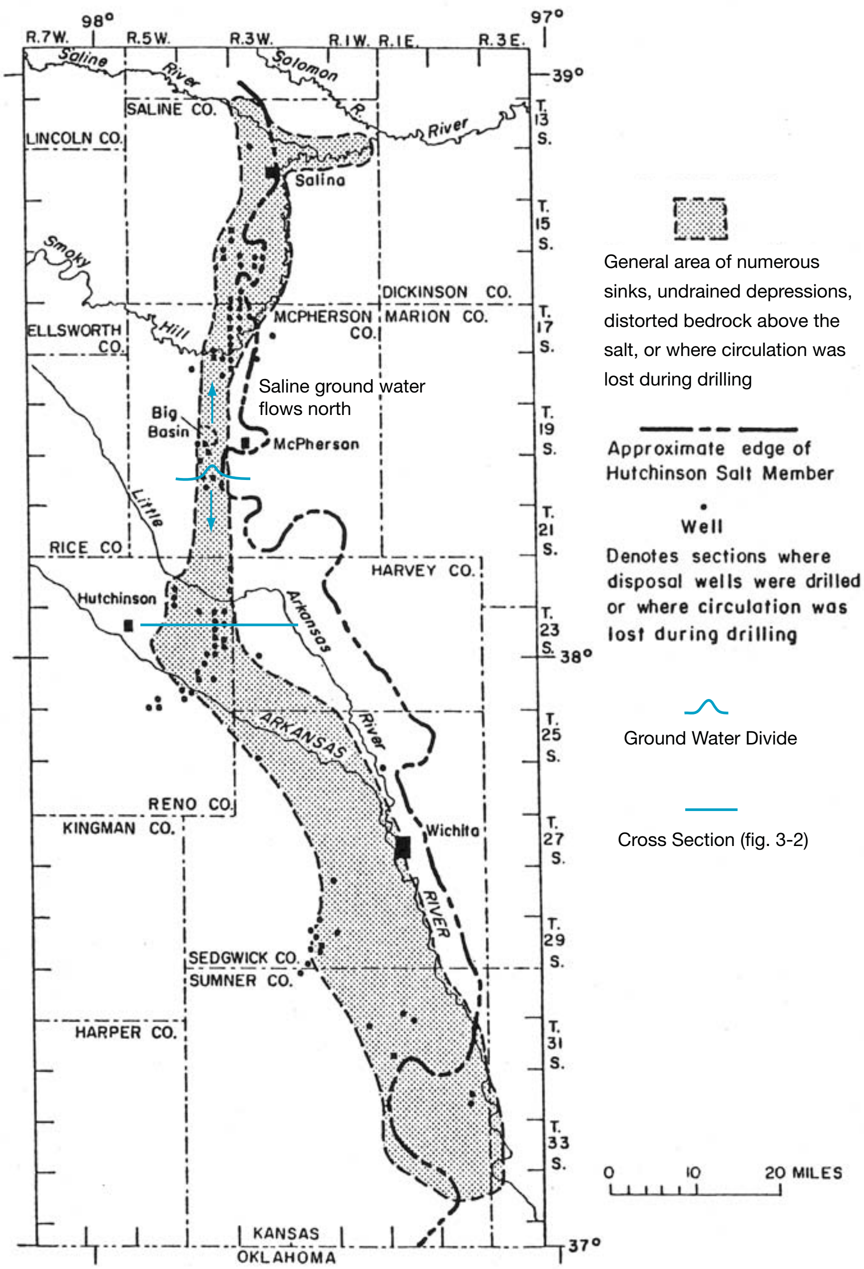

Figure 3–1. Map showing eastern edge of the Hutchinson Salt Member (modified from Gogel, 1981).

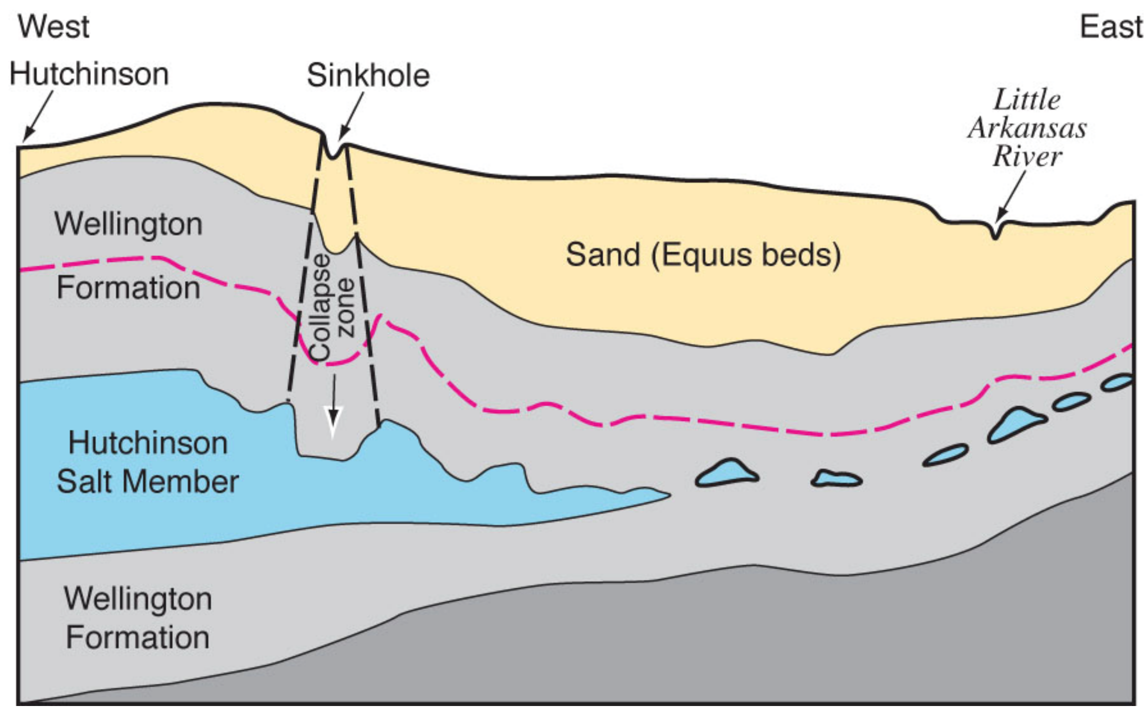

Figure 3–2. Generalized cross section from Hutchinson to the Little Arkansas River west of Newton (in Harvey County), showing the dissolution front and related subsidence features. Red line represents deformation of beds within the shale.

salt, from near Lindsborg to the Arkansas River near present-day Wichita, until the Kansas River system eroded to the south during the Pleistocene (Ice Ages) and captured the flow from the Smoky Hill.

Natural sinkholes, such as Lake Inman and Big Basin in McPherson County, are common in the dissolution front along the eastern edge of the Hutchinson Salt Member. Human-induced subsidence areas are rare, but when they occur, they are usually attributed to salt mining or oil and gas operations. Sinkholes that suddenly collapse are called catastrophic sinkholes. The sinkhole that developed in Hutchinson on January 3, 2005, was a catastrophic sinkhole that was associated with solution-salt mining. Sinkholes that have formed gradually are visible along I–70 at milepost 179, west of Russell in Russell County. This subsidence is probably related to an abandoned oil well. In Reno County, gradual subsidence is occurring at the intersection of US–50 and Victory Road, about 6 miles east of Hutchinson. This sinkhole is probably the result of natural processes along the dissolution front.

Salt-Dissolution Sinkholes and Transportation

Sinkholes caused by salt dissolution in Wichita, Hutchinson, and surrounding areas affect both existing roadways and proposed construction projects. The Kansas Department of Transportation (KDOT) uses several methods to address these problems.

Proposed construction projects use air photos to locate potential sinkholes, and the new alignments are driven and walked at various times of the year (fig. 3–3). Normal investigative measures such as drilled borings are not used to locate sinkholes because the salt is too deep, and the concern that it could create a new subsidence feature by penetrating the overlying bedrock and salt layer with the boring.

Most of the significant and/or catastrophic failures have been related to oil production and improperly plugged wells (e.g., I–70 in Russell County). On all new projects, a search is conducted to identify abandoned oil wells and all wells plugged prior to 1965. If problems develop along existing alignments, the location and status of existing wells are checked first. KDOT has worked with the Kansas Geological Survey to conduct high-resolution seismic investigations on four different projects: US–50 and Victory Road east of Hutchinson; US–50 and the South Bypass around Hutchinson; K–61 around Inman; and I–70 at the Witt Sink in Russell County. The main concern for each of these projects was the potential for a catastrophic failure.

Remediation of salt-dissolution sinkholes is difficult because once a sinkhole is recognizable, the surrounding bedrock has become fractured and faulted. This allows additional freshwater to contact the salt, which keeps the sinkhole active. Remediation is usually

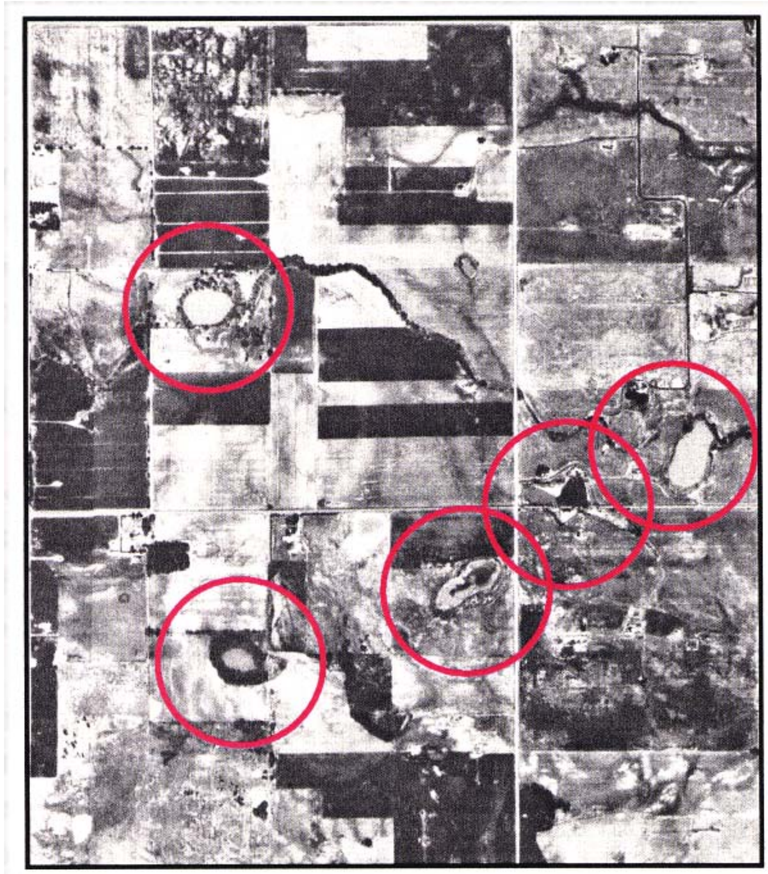

Figure 3–3. Sinkholes affect existing roadways and have to be considered when designing new alignments (modified from Miller, in preparation).

limited to filling the depressions and waiting for the subsidence to continue. Most roadways are maintained by grading and resurfacing roads through sinkhole areas. Expensive grouting procedures have been tried with very limited success. Remediation of the US–50 and Victory Road sinkhole has been limited to grading (to maintain surface-water flow through the ditches) and new asphalt. Maintenance costs vary from year to year but are usually less than $2,000.

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OxyChem Facility

Occidental Chemical Corporation is a division of Dallas-based Occidental Petroleum Corporation and manufactures basic chemicals, vinyls, and performance chemicals directly and through its affiliates (collectively called OxyChem). The Wichita OxyChem facility, formerly known as Vulcan Chemicals, was purchased from the Vulcan Materials Company in 2005, when Vulcan divested its chemical holdings.

The basic raw material at the Wichita plant starts with saltwater and electricity. Chlorine is derived from a salt-brine solution, which is pumped from a solution mine located outside of the facility. Solution mining is a process where water is injected into a salt formation and brine is withdrawn (fig. 3–4). Because solution mines cannot be entered, seismic surveys are typically used to estimate cavern dimensions. After the brine reaches the plant, it is separated from other elements through electrolysis. During electrolysis an electrical current passes through the saltwater and splits apart positive sodium and negative chloride ions to form molecular chlorine gas. The chlorine gas is dried, chilled, and pressurized or converted to liquid and used to manufacture various chemical products.

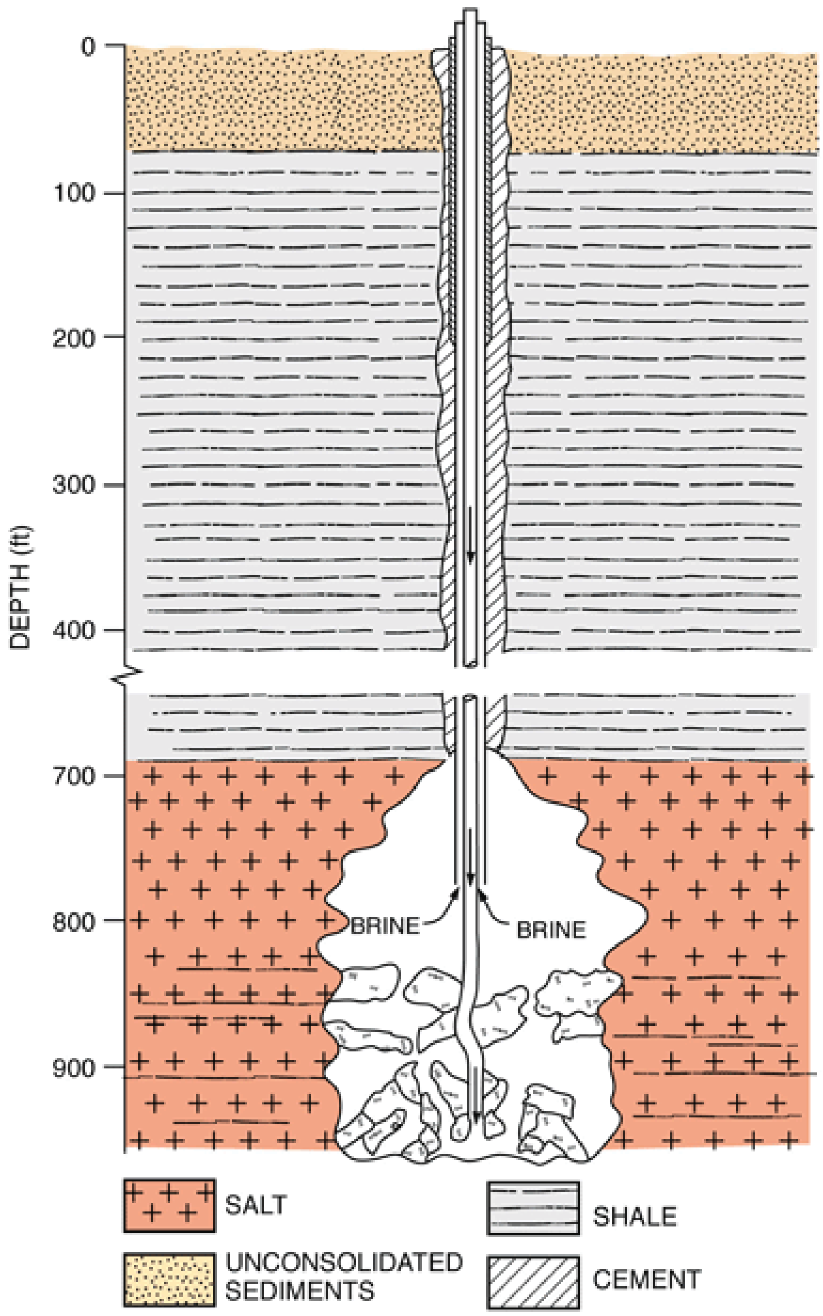

Figure 3–4. Example of a solution mine where water is injected into a salt formation and brine is withdrawn leaving a solution cavity or salt “jug” (modified from Lemenick, 1972).

Chemical products manufactured at the Wichita facility include sodium chlorite, chlorine, caustic soda, hydrogen, methyl chloride, chloroform, carbon tetrachloride, methylene chloride, and hydrochloric acid.

Sodium chlorite has a variety of applications in pulp and paper, textiles, electronics, water treatment, personal care, food processing, and metal finishing. Sodium silicates serve a wide range of end-use markets, including soap and detergent, paper adhesion, paint and pigments, catalysts, and metal cleaning.

Caustic soda is an essential ingredient in such industrial operations as paper and detergent manufacturing. Chlorine, one of the most abundant natural chemical elements, is used in the manufacturing of thousands of everyday products.

OxyChem's chlorinated organics also have a wide range of applications. Carbon tetrachloride is used in the manufacture of refrigerants, in catalyst regeneration, and incinerator testing. Methylene chloride is used in paint-remover formulations, solvent-vapor depressant in aerosol applications, general cleaning solvent, and as a foam-blowing agent. Methyl chloride is used in the manufacture of silicone products, butyl rubber, quaternary ammonium products, and agricultural chemicals. Chloroform is used in the production of pharmaceuticals and dyes.

As a component of OxyChem's manufacturing process, the Wichita facility operates and maintains six Class I underground-injection wells. Class I wells are technically sophisticated wells that are used to inject hazardous wastes or dispose of industrial and municipal fluids by injecting them into brine-containing aquifers about 4,000 feet below ground surface, where there is no significant probability that they will contaminate usable ground water. Although the details of well design and installation vary, the basic concepts and approaches are similar for almost all wells (fig. 3–5). The geology of the Gulf Coast, Great Lakes, and Kansas is well suited for these types of wells.

Class I wells are further subdivided by the type of material they can accept, hazardous or non-hazardous. Eleven states have Class I hazardous-waste injection wells; Texas has the most followed by Louisiana. Kansas ranks near the bottom of the remaining eight states on this list, because it has only six Class I hazardous-waste injection wells, all of which are located at the OxyChem facility. Nineteen states have Class I non-hazardous waste-injection wells; Florida has the greatest number of non-hazardous wells, followed by Texas and Kansas. One important note with regard to the Kansas Class I injection program is that the wastewater has to drain into the well; injection is limited to "gravity" feed and no pump pressure is allowed. No other EPA or state program in the nation has this requirement.

At the Wichita OxyChem facility, injected wastewater consists of storm-water runoff, contaminated ground water, and process wastewater. The wastewater consists primarily of sodium, calcium, and magnesium chloride brines that vary in pH. The average chloride concentration of these brines is approximately 20,000 ppm.

Sources

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Occidental Petroleum Corporation: www.oxychem.com

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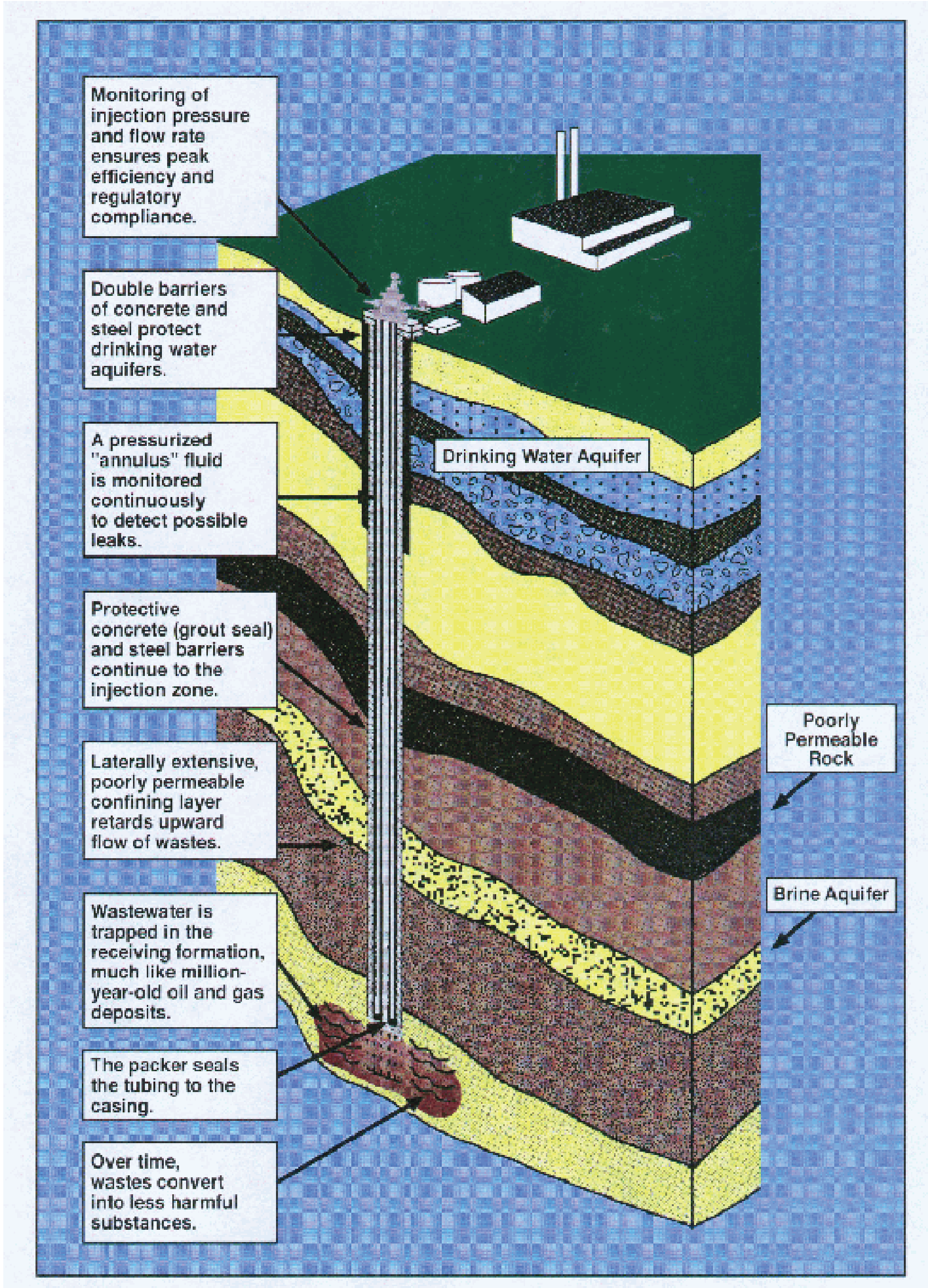

Figure 3–5. Conceptual diagram of a typical Class I injection well (modified from U.S. EPA, 2001).

The Gilbert and Mosley Project

Ground-water contamination was detected at an industrial site near downtown Wichita by the Kansas Department of Health and Environment (KDHE) in the late 1980s to early 1990s. Ultimately found to spread over thousands of acres, the area underlain by the contaminated aquifer was named the “Gilbert–Mosley Site” after the two streets that intersected near where the polluted water was first discovered. Tests showed the ground water was contaminated with tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (DCE), vinyl chloride, and other contaminants from historical industrial activities. The site covers approximately 3,850 acres that extend beneath approximately 8,000 parcels of land, and includes more than 550 business and hundreds of residential properties (fig. 3–6).

Although the pollutants in the ground water did not pose an immediate threat to drinking water, the presence of these chlorinated solvents raised concerns about their impact on public health, the environment, and the local economy. The EPA considered placing the Gilbert–Mosley Site on the Superfund List. Plans for downtown revitalization, including the Old Town entertainment and shopping district, were threatened along with future business prospects and home

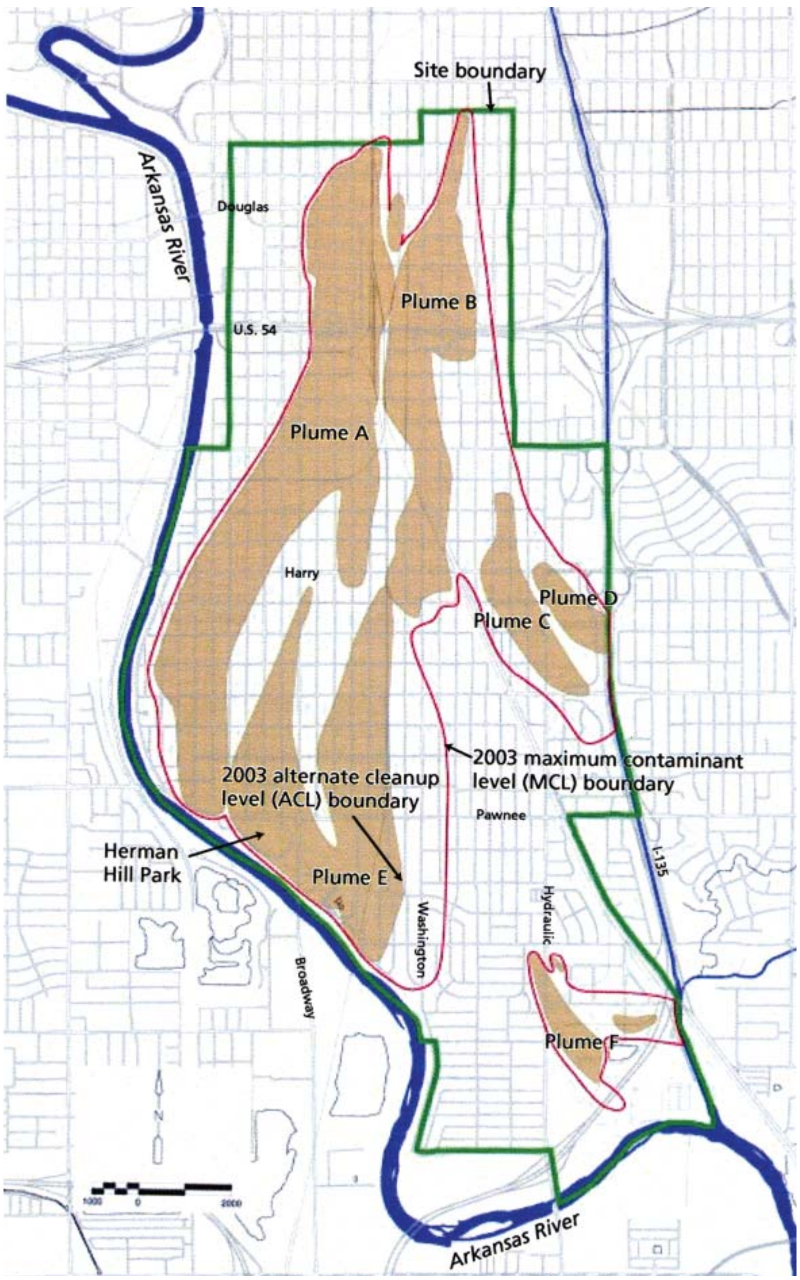

Figure 3–6. Gilbert–Mosley site (modified from Anderson, 2004).

values. Property values were predicted to plummet by 40%, and banks stopped lending to businesses and homebuyers in the affected area.

To avoid the lengthy process and stigma of Superfund, which threatened the local economy, the City of Wichita took the unprecedented step of accepting full responsibility for the clean up, which was estimated to cost approximately $20 million at the time. Wichita created a unique public-private partnership called the Gilbert and Mosley Project to clean up the ground water in the downtown area. The basis of the plan would be Wichita's acceptance of clean-up responsibility in exchange for funding from the public-private sector. The plan drew together Federal, State, county, and city government agencies as well as property-owners, banks, the real-estate community, industries responsible for the pollution, and other affected businesses. Wichita also reached an agreement with one of the responsible parties that had caused much of the pollution to help pay for the cleanup, and businesses in the area that had not contributed to the contamination were released from liability to revive lending by financial institutions.

The Gilbert and Mosley Project required permission from State and Federal agencies. Besides issuing certificates of release for environmental liability, Wichita established a Tax Increment Finance District (TIF) to partially fund cleanup costs that required changes in State law. TIF is a widely used economic-development tool that provides a secondary method of financing the cleanup. After improvements are made, the difference between the original property values and the new, higher restored values provides the tax base to pay for the improvements. With the approval of the KDHE, which was authorized to provide regulatory oversight on behalf of the EPA, Wichita went forward on their plans to build a ground-water-treatment system to capture and clean up contaminated ground water. The Gilbert and Mosley Project has been recognized nationally as a model for how a local community can solve its own environmental problems instead of depending on the Federal government.

Ground-Water-Treatment System

CDM, a consulting, engineering, construction, and operations firm, was hired to investigate and eventually design, construct, and initially operate the ground-water-treatment system. Based on investigations at Gilbert–Mosley, six ground-water plumes were defined. The plumes were found to be more than 4 miles long and 1.5 miles wide, with approximately 3 billion gallons of ground water having chlorinated hydrocarbon concentrations above maximum contaminant levels for drinking water. To capture the contaminated ground water, 13 extraction wells were drilled into the underlying aquifer. A 5.3-mile network of pipes transport contaminated water to a hydraulic-venturi air-stripper treatment system. The air stripper exposes the water to air so that the contaminants can escape from the water into the air, where they are vented away. Presently, approximately 1.2 million gallons of contaminated ground water are treated at the facility every day, and more than 1.5 billion gallons have been treated to date.

Treated water runs through park fountains, an aquarium, outdoor fish observatory, and stream—collectively called the WATER (Wichita Area Treatment, Education, and Remediation) Center—before eventually flowing into the Arkansas River. Treated effluent is also used by the park's irrigation system and the municipal park department's non-potable water supply.

The WATER Center

The prime objective of the WATER Center is to eradicate ground-water pollution in the downtown Wichita area. However, as the Center was being planned, the City of Wichita saw a unique opportunity to not only clean up its water but to enlighten the public about pollution and ground-water issues. As a result of this foresight, the WATER Center was designed to encompass both the ground-water-treatment system and an educational facility. Located in Herman Hill Park, the WATER Center is the result of the Gilbert and Mosley Project, which also funded a plaza area surrounding the treatment building and education facility and other improvements to the park.

Education Facility

The education facility—housing an aquarium, exhibits, and classroom space—offers a variety of ways for the public to learn about water. Visitors not only see the process of cleaning contaminated ground water, they learn about conservation, aquatic wildlife, pollution prevention, pollution-related health issues, and the interrelationship between ground water, surface water, and geology. The education facility also presents the story of the Gilbert and Mosley Project and impetus behind the WATER Center as a whole.

Outside visitors can see a variety of native aquatic-wildlife species living in the cleaned water of the outdoor fish observatory and follow a series of paths and bridges that lead to an artificial creek and eventually to the Arkansas River where the treated ground water joins the river.

National Recognition

The Gilbert and Mosley Project and the WATER Center have received much recognition, including the 2004 Superior Achievement for Excellence in Environmental Engineering Award from the American Academy of Environmental Engineers, the 2005 National Ground Water Association's Outstanding Project Award, and the 2005 American City & County Crown Community Award. The City of Wichita was presented the prestigious Ford Foundation's Innovations in State and Local Government Award from Harvard University's John F. Kennedy School of Government, and the WATER Center received the 2006–07 Kansas Association for Conservation and Environmental Education (KACEE) Government Award.

As a result of Wichita's proactive efforts, the Gilbert and Mosley Project successfully achieved the following social and economic benefits:

- Wichita's citizens have been protected.
- The environment has been protected for future generations.
- A significant educational resource and various community facilities have been created.
- Property values in the area and the city's tax base have been protected.
- Resolution of the environmental liabilities has revitalized commercial development.
- The city has recovered money from responsible parties through arbitration and litigation efforts. The remaining costs are being covered by tax increment financing.

Sources

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Arkansas River Public Access

The Kansas Department of Wildlife and Parks (KDWP) and the City of Wichita formed a Coalition to fund the development of a master plan for recreational access to the Arkansas River. The Arkansas River is one of only three public rivers in Kansas. It runs through over 5,000 acres of public land and has hundreds of miles of water where it is legal to canoe, kayak, hike, bike, view wildlife, fish, and hunt. While there are many potential recreational opportunities, there are few public-access sites.

The Coalition includes communities and interest groups along the Arkansas River corridor from the Rice/Reno County line to Oxford, Kansas (fig. 3–7). The Coalition includes the City of Wichita, KDWP, the Arkansas River Coalition, various user groups, several municipalities, and counties through which the river flows. Reflecting the regional interest of its members, the Coalition formed a guiding vision statement, “to establish the Arkansas River as a premiere recreational amenity for the state and for the region.”

To achieve this vision, representatives from the Coalition formed a Steering Committee to prepare a scope of work and select a consultant to assist in preparing a master plan to guide recreational access along the Arkansas River. The master plan, known as the Arkansas River Corridor Access Plan (ARCAP), will provide a comprehensive plan for developing river access points at desirable intervals to enhance recreational opportunities and encourage economic development while protecting the river’s natural resources and water quality along a roughly 100-mile reach of the river (fig. 3–7). Development of the ARCAP is currently underway, with completion of plan anticipated in May 2007.

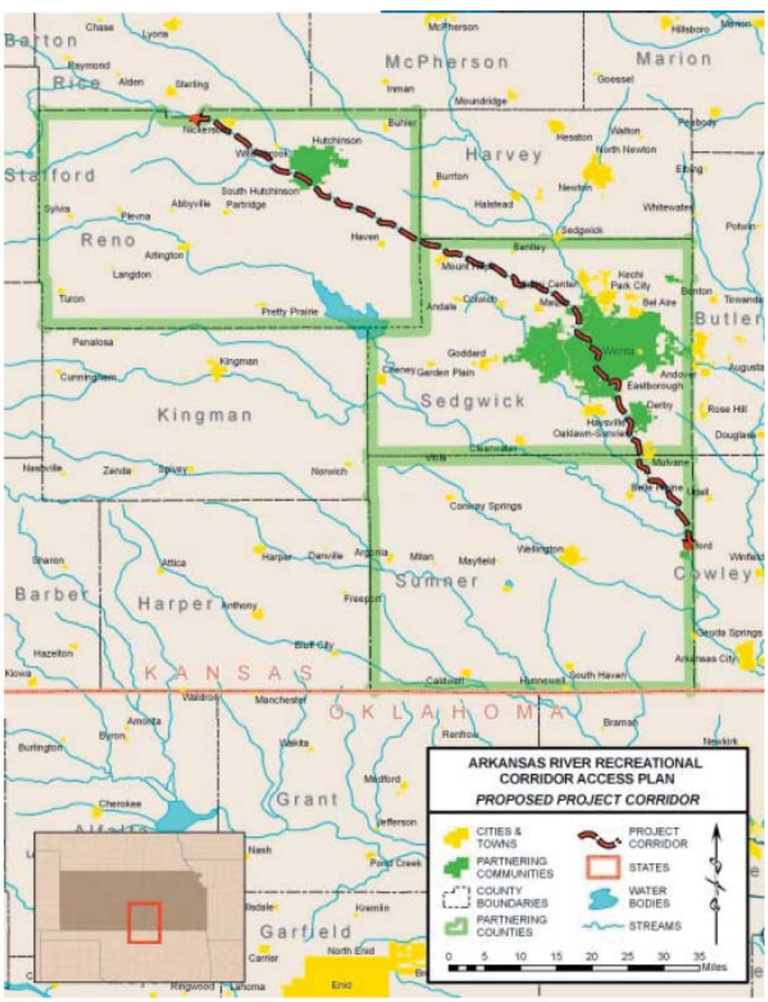

Figure 3–7. Arkansas River Corridor Access Plan (ARCAP) proposed project corridor (City of Wichita, 2007).

River Access Points

Before the Coalition was formed, there were only five public-access sites within the 100-mile project corridor. Of the five, three are concentrated within a 15-mile stretch and two are in disrepair, which, in effect, limits most of the river access to only a small portion of the corridor.

In support of the forthcoming ARCAP, two new sites, 71st Street Greenway Public Access project in Wichita and the re-development of the Cave Park Access next to the US–160 Highway bridge at Oxford, have recently been completed and initiated, respectively, by the City of Wichita and KDWP, and the City of Oxford. The 71st Street Greenway access included a new entry road, landscaping, vehicle-loading roundabout, retaining walls, and concrete pathway launching platforms. The Cave Park project will be completed in two phases. The first phase includes upgrading the drainage and pavement of the lower access road. In Phase II, the lower part of a boat ramp will be replaced and a shoreline fishing area with boat tie-ups will be added.

Arkansas River Corridor Access Plan

The project goals of ARCAP include the following:

- Protect the natural amenities and character of the Arkansas River corridor.
- Develop a Master Plan for recreational river access.
- Develop access points for recreation.
- Design access point types and supporting facilities.
- Develop a prioritized list of access points.
- Build public awareness and support for the project's vision.

To meet these goals, the Coalition solicited funds and its private consultants began preparation of the ARCAP with the assistance of the Steering Committee.

The ARCAP development process was a phased approach designed to solicit input from the Steering Committee and the general public to minimize recreational and landowner conflicts. Although the riverbed is public property, most of the surrounding land is privately owned and would have to be purchased or leased. In many cases, access roads would have to be built.

The consultants held a series of public meetings in Oxford, South Hutchinson, and Wichita to help formulate the ARCAP. Public comment was received from citizens, landowners, and stake-holders to identify potential issues and recreational uses for this public waterway. During the public meetings, residents were encouraged to share their concerns about the plan and their amenity wish lists. These meetings generated logistical questions which ranged on issues such as boat ramps, hiking trails, restroom facilities, security maintenance, vandalism, trespassing, the effect on property values, and landowner liability. Other issues included signage about access and private property boundaries and the responsibilities of participating parties.

Following the public meetings, a technical workshop was held to address the details of access through publicly owned property, different types of access and amenities associated with river stage, and recreational use through the Wichita section of the corridor.

Issues raised in the meetings were used to help identify potential access points. The consultants then completed a field survey to evaluate sites for features such as accessibility, obstructions, hazards, river flow, bank stability, ecological impact, and recreation potential. These data were recorded using GPS technology and a GIS database to help complete a site-suitability analysis for individual access points. The suitability analysis will rank and identify optimum locations and set priorities for construction.

Final public review meetings were held to demonstrate that public input was considered and implemented.

In addition to public input and site selection, a strategy will be developed to identify funding and partnership opportunities to defray the costs of implementing the ARCAP. Potential revenue streams will target economic-development activities and business sponsors willing to donate equipment, construction expertise, or volunteer groups.

The completed ARCAP should provide a simple master plan for the corridor at a regional and local level. The details of the ARCAP ranging from the public meetings, the technical workshop, field survey, site-suitability analysis, access locations, construction priorities, and cost opinions will be included in the private consultant’s final report expected by the end of May 2007.

Sources

Arkansas River Corridor Access Plan: http://www.visioneeringwichita.com/arkriveraccess/
City of Wichita: www.wichita.gov/CityOffices/Environmental/River/ARCAP
Arkansas River Coalition: http://www.arkriver.org/

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Arkansas River Water-Quality Campaign

The stability and future growth and development of the City of Wichita is linked to the protection and enhancement of the Arkansas and Little Arkansas rivers (fig. 3–8). Therefore, Wichita has initiated the Arkansas River Water-Quality Campaign. The Campaign is an effort organized by Wichita and its partners—the Kansas Department of Health and Environment (KDHE), EPA, and other local, State, and Federal agencies—to keep Wichita's rivers clean for many years to come. The Campaign will supplement the Federal Clean Water Act which currently sets standards for "point source" discharge from sewer and industry to waterways. Over the years, river-water quality has improved substantially with more effective treatment technologies, better land-management practices, and increasingly more stringent water-quality regulations. Presently, opportunity exists for additional improvement associated with "non-point source," or storm-water runoff.

Figure 3–8. Confluence of Arkansas and Little Arkansas rivers in downtown Wichita.

Storm-water runoff occasionally impacts the Arkansas River and the Little Arkansas River with fecal coliform bacteria, most generally after rain, and has the potential to impact recreational use. These findings have led the public to perceive the river-water quality as poor, or even dangerous.

Suitable water quality for recreational use is measured for regulatory purposes by the concentration of fecal coliform bacteria, which are used as indicators for the presence of potential human pathogens. The presence of fecal coliform bacteria, however, does not necessarily directly relate to actual human-health risk. These organisms can originate from a variety of sources other than humans, such as pets, livestock, migratory waterfowl, and other wildlife. Not all of these bacteria are harmful to humans, and the degree of actual human exposure is also a complicating variable. Fecal coliform levels above current regulatory standards usually result from precipitation-driven surface-runoff events and may result in the issuance of water-quality advisories, along with follow-up investigative actions.

Wichita, KDHE, and the U.S. Geological Survey have been pro-active in investigative efforts by collecting water-quality samples at key areas over a considerable period of time. During the past year the City of Wichita and KDHE have increased the monitoring frequency, sample numbers, and locations to better assess river-water quality. There are approximately 55 sampling sites along both the Arkansas and Little Arkansas rivers. This strategy will provide greater predictability of water quality for recreational uses such as the River Festival, North High School Water Carnival, and other events. These data and other criteria will be used to determine if river-use advisories are necessary in relation to these recreational activities.

To meet the goals of the Arkansas River Water-Quality Campaign, a strategic plan for protecting the Arkansas River and other environmental resources has been adopted. The plan includes the following principles:

- Monitor and, when necessary, regulate businesses and activities that may impact the environmental conditions in the community.
- Partner with the business community through pollution-prevention programs.
- Form coalitions with other communities that may be similarly affected by regional facilities and activities that could adversely affect the environment.

To sustain the stability and future growth of Wichita, future goals for keeping the Arkansas and Little Arkansas rivers clean have been adopted:

- Developing a remediation plan for addressing problem areas.
- Expanding the scope of water-quality improvement to include more area within the drainage basin.
- Developing and implementing more education programs.
- Enhancing wastewater processes, regardless of the fact that the City already meets or exceeds regulatory requirements.

In support of the Arkansas River Water Quality Campaign, the Wichita City Council has established the Arkansas River Advisory Committee and the Arkansas River Task Force. Both are citizen groups that assist in the development and implementation of environmental issues.

The Arkansas River Advisory Committee provides a two-way communication link to the diverse agricultural, environmental, urban, and academic interests within the community and river basin. The mission of the Arkansas River Advisory Committee is to focus on educational and public-awareness aspects of improving river-water quality.

The Arkansas River Task Force members are appointed by the City Manager with the approval of the City Council to examine technical and environmental investigation issues relating to the river. Both groups are coordinated by Wichita staff who attend all meetings and share technical and educational/public-awareness information.

Extensive water-quality testing continues through the efforts of Wichita, KDHE and the U.S. Geological Survey. This sampling provides data that further define the sources of contamination detrimental to the river. The testing involves dry- and wet-weather sampling. The dry-weather sampling determines how and where sewer- and septic-system leaks, cross connection to the storm sewers, and other similar pollution sources are causing problems. Wet-weather sampling helps to find pollution coming from surface runoff during rainy conditions. These sources can be animal-feeding operations, storm-sewer discharges, and general urban and rural runoff.

Sources

Arkansas River Water Quality Campaign: http://www.wichita.gov/CityOffices/Environmental/River/
Protecting the Arkansas River: http://www.wichita.gov/NR/rdonlyres/8A62EFA4-7496-493C-8E3C-A9E0619588B1/0/Arkansas_River.pdf

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SCHEDULE AND ITINERARY

Thursday, June 7, 2007

6:30 am	Breakfast at Ted's Montana Grill
8:00 am	**Bus leaves Candlewood Suites for Site 6**
8:15 am	**SITE 6** • Residential Development on Sand-Pit Lakes, Wichita *Carolyn McGinn*, Senate Natural Resources Committee *Don Carlson*, Kansas Dept. of Health and Environment *Rex Buchanan*, Kansas Geological Survey
9:00 am	Bus to Site 7
9:45 am	**SITE 7** • Equus Beds Aquifer Storage and Recovery Phase I, Halstead *Jerry Blain*, City of Wichita
11:45 am	**SITE 8** • Burrton Oil-Field-Brine Contamination, Burrton *Doug Louis*, Kansas Corporation Commission
12:15 am	Bus to Lunch
12:30 pm	Lunch at Senator Carolyn McGinn's
1:30 pm	Bus to Site 9
2:30 pm	**SITE 9** • Brine Well #19 Sinkhole, Hutchinson *Debbie Waters*, The Mosaic Company *Mike Cochran*, Kansas Dept. of Health and Environment *Reg Jones*, City of Hutchinson *Don Koci*, City of Hutchinson
4:00 pm	Bus to Site 10
4:15 pm	**SITE 10** • ONEOK Underground Natural-Gas Storage Facility, Hutchinson *Mike Cochran*, Kansas Dept. of Health and Environment *Carl Holmes*, Energy and Utilities Committee Chair
4:30 pm	Bus to motel
4:45 pm	Arrive at Grand Prairie Hotel & Convention Center
6:00 pm	Bus to dinner at Kansas Underground Salt Museum, Hutchinson
8:00 pm	Bus to motel

Residential Development on Sand-Pit Lakes

Sand and gravel is a key component in materials used in construction and road building, particularly asphalt and concrete. As opposed to some parts of the state, the Wichita area has considerable sand and gravel resources, most of it the result of alluvial deposition in the Arkansas River valley. This sand and gravel is beneath a thin layer of soil, and it is typically quarried by digging a pit down to ground-water level, then floating a dredge on the water in the pit. The dredge sucks up sand and water from the bottom of the pit, the material is piped from the dredge to a storage area for sorting and cleaning, and the product is transported to its final end use.

A number of these so-called sand and gravel pits have been developed in the Wichita area. Once the pits are no longer dredged for sand and gravel, they are generally considered desirable features for residential development. They provide places to swim and boat, and they are considered scenically desirable in an area that has relatively few surface-water bodies. Thus, housing developments are often constructed around the pits after quarrying has ceased.

The impact of these pits on water has long been a contentious issue in Kansas. In 2000, the Division of Water Resources, Kansas Department of Agriculture, implemented rules and regulations related to the water that evaporates from newly opened sand and gravel pits (KAR 5-13-1 et seq.). These regulations require a permit to account for the water that evaporates from pits in areas of the state where evaporation rates are high. These regulations pertain only to water quantity, however, and do not consider water-quality issues.

With the increasing use of these sand pits for residential development, there has been growing concern about their impact on water quality. In effect, the water in the sand pits is connected to the local aquifer, and regulatory entities began to raise the concern that contaminants could move with surface-water runoff from the surrounding landscape, into the pits, and then into the aquifer. Based on these concerns, the Wichita Area Builders Association and the Equus Beds Groundwater Management District No. 2 formed a Groundwater Quality Task Force in 2003. This Task Force was composed of representatives of various State and local governmental agencies, professional societies, and developers, and was chaired by Carolyn McGinn, then a Sedgwick County Commissioner. The Task Force was charged with studying the impact of sand pits on water quality, recommending management practices for protecting ground-water quality, and reviewing existing regulatory procedures. In addition, the 2004 Kansas Legislature passed Senate Bill 364, which charged the Division of Water Resources, Kansas Department of Agriculture, and the Kansas Geological Survey with studying and making recommendations on, among other items, “the pollution control and flood control impacts of diverting runoff into sand and gravel pits” (KSA 82a-738). The activities of the Task Force have been considered a major response to that Legislative directive.

For the most part, the impact of sand pits on water quality has been relatively little studied in Kansas. In the early 1990s, the Kansas Geological Survey undertook a very limited study of water-quality issues at two sites in Sedgwick County (Whittemore et al., 1993). In order to more definitively understand the connection between surface-water runoff and ground water in sand pits, the Task Force initiated a study by the U.S. Geological Survey to investigate the water quality with the collection and analysis of water and sediment samples from four sand pits in Sedgwick County. That study was completed in the spring of 2007, and a second round of sampling is scheduled at four more sites in 2008. At present, two general conclusions have come from the first round of sampling: 1) water and sediments in the pits generally contain very low levels of human-made contaminants, and many of those are related to common pesticides and herbicides, and 2) water in the pits is connected to water in the surrounding aquifer, and thus contamination that enters the pits can move into the surrounding aquifer (Whittemore, 2007).

The Task Force is currently studying the results of the 2007 sampling, funding a second year of studies, and beginning the process of recommending best management practices so that sand pits can continue to be developed and incorporated into housing developments in an environmentally acceptable manner.

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Whittemore, D. O., Hathaway, L. R., Skelton, L. H., McClain, T. J., Dealy, M. T., Fisher, B. G., and Buddemeier, R. W., 1993, Assessment of the impact of storm-water recharge from unlined earthen pits on ground-water quality in the Wichita area: Kansas Geological Survey, Open-file Report 93–47, 90 p.

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Wichita's Water Supply

The City of Wichita's (Wichita) primary water-supply sources are the well field in the Equus Beds aquifer and Cheney Reservoir (fig.4–1). While these two sources have met Wichita's needs in the past, they are not sufficient to meet Wichita's future water demand, which is projected to double by 2050. Water appropriations and treatment costs limit reliance solely on Cheney Reservoir. Additionally, excess pumping by municipal and agricultural users has caused water levels in the Equus Beds aquifer to decline around the well field. Declining water levels affect both the water quantity and quality of the Equus Beds aquifer due to lack of water storage and the induced encroachment of saline water into the well field.

To address its long-term water-supply issues, Wichita has implemented a unique Integrated Local Water Supply Plan (Water Supply Plan) that is intended to meet its municipal needs through the year 2050. The Water Supply Plan identifies and adopts a variety of local water resources rather than relying on other proposed alternatives, such as a remote reservoir in northeast Kansas.

Major components of the Water Supply Plan follow:

- Greater use of Cheney Reservoir.
- Conservation.
- An Aquifer Storage and Recovery system in the Equus Beds aquifer (100 million gallons per day [mgd] production capacity).

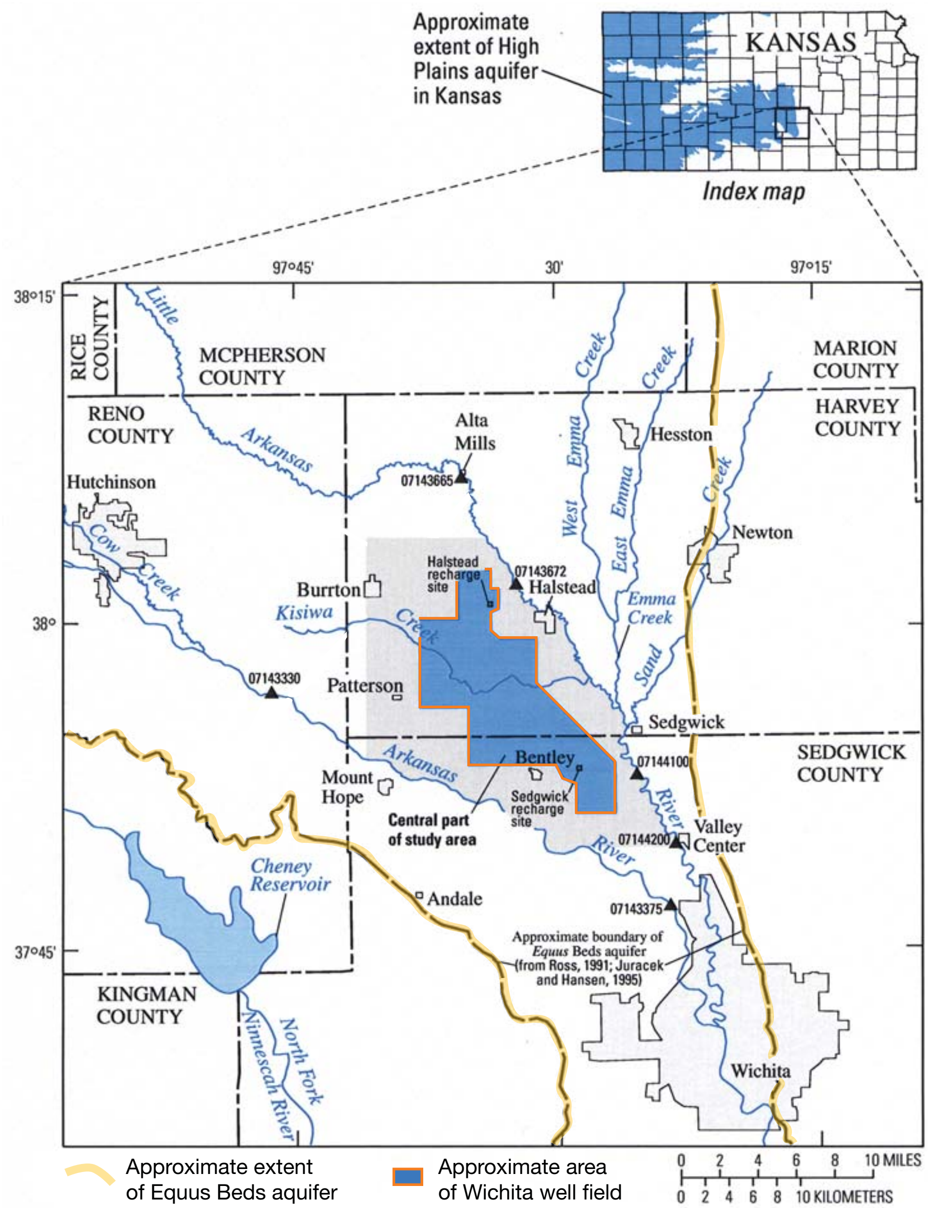

Figure 4–1. Location of Cheney Reservoir, Wichita well field, and part of the Equus Beds aquifer (modified from Stramel, 1967; Ross, 1997; and Hansen, 2007).

- Re-development of the Bentley well field (10-mgd production capacity).
- Expansion of the Local well field (45-mgd production capacity).
- Additional raw water pipelines.
- Additional water-treatment plant (65-mgd production capacity).

Historically, pumping from Wichita's Equus Beds well field began on September 1, 1940, and because of its good water quality, it remains the largest component of the Water Supply Plan. The Equus Beds aquifer consists of unconsolidated silt, sand, and gravel deposits that store water that infiltrates primarily from the land surface. In the Wichita well field, the aquifer consists of about 80% solid materials and about 20% open pore space where ground water is stored.

After pumping began, water levels and storage capacity in the aquifer declined. In 1965, surface water from Cheney Reservoir was first used to supplement water from the Equus Beds aquifer at a ratio of about 40:60, respectively. Supplemental water slowed or reversed the general decline of aquifer water levels.

However, increased agricultural and municipal water-supply demands in the late 1970s and early 1980s resulted in increased pumping and renewed aquifer decline. To offset some of this demand and extend use of the Equus Beds aquifer, Wichita changed the water ratio between the reservoir and aquifer to about 60:40, respectively. This resulted in localized water level and aquifer storage recovery, but ongoing demand has sustained the general decline of the aquifer.

If water levels continue to decline, the reliability of water from the well field could be in jeopardy because of quantity and quality concerns. When water is removed by pumping faster than the natural infiltration rate, water levels decline around each well and can combine to form a larger area of decline and aquifer storage loss. Overall, pumping by municipal and agricultural users caused aquifer decline up to 40 feet from pre-development levels (fig. 4–2).

In addition to decreased water in storage, intensive pumping also threatens water quality in the aquifer. Sufficiently low water levels induce flow of both natural and human-made saline-water flow from the Arkansas River and an oil-field-brine plume near Burrton toward the Wichita well field area (fig. 4–2). Ground-water modeling by the Bureau of Reclamation indicates that the chloride levels, an indicator of salinity, could surpass 300 mg/L by the year 2050, exceeding the 250 mg/L drinking-water standard.

Ground-water Recharge Demonstration Project

While pumping has lowered water levels and depleted water storage, almost 65 billion gallons of unused storage volume is now available, which is comparable to the amount of water stored in Cheney Reservoir. In 1995, a cooperative effort between Wichita, Bureau of Reclamation, U.S. Geological Survey (USGS), and the Equus Beds Groundwater Management District No. 2 initiated the Equus Beds Ground-Water Recharge Demonstration Project (Demonstration Project) near Halstead to evaluate aquifer recharge as a potential new means to meet Wichita's water needs through at least 2050. Aquifer recharge, in addition to water-storage benefits, could form a hydraulic barrier and prevent saline-water encroachment from the Burrton oil-field-brine plume to the east and the Arkansas River to the south (fig. 4–2).

The purpose of the Demonstration Project was to evaluate the feasibility of treating and recharging surface water diverted from the Little Arkansas River at high river stage. During high river stage periods, excess surface water recharges the aquifer next to and under the river. These recharge events, called bank storage, occur only briefly after rainfall. Because bank storage has no prior water appropriations, it is a potential new and unused water supply source.

The Demonstration Project consisted of a diversion well located next to the Little Arkansas River, which diverted surface water during high-river stage (fig. 4–3). After diversion, the water was pumped to three different pilot technologies (an infiltration basin, an infiltration trench, and an injection well) to evaluate different recharge techniques and their effects on water quality in the aquifer.

In 1998, the Demonstration Project was expanded to the Sedgwick site. Instead of being pumped into a well, surface water was directly diverted with a surface-water intake and sent through a powder-activated carbon filter to evaluate surface-water treatment options necessary to reduce turbidity (i.e., the reduced clarity of water from suspended matter) and remove organic compounds such as the herbicide atrazine. After treatment, water was pumped to an infiltration basin to recharge the aquifer (fig. 4–3).

At its completion in 2000, the Demonstration Project had recharged over 1 billion gallons of water, and approximately 4,000 water samples had been collected and analyzed for 400 different potential contaminates. The project successfully demonstrated that excess flow from the Little Arkansas River could

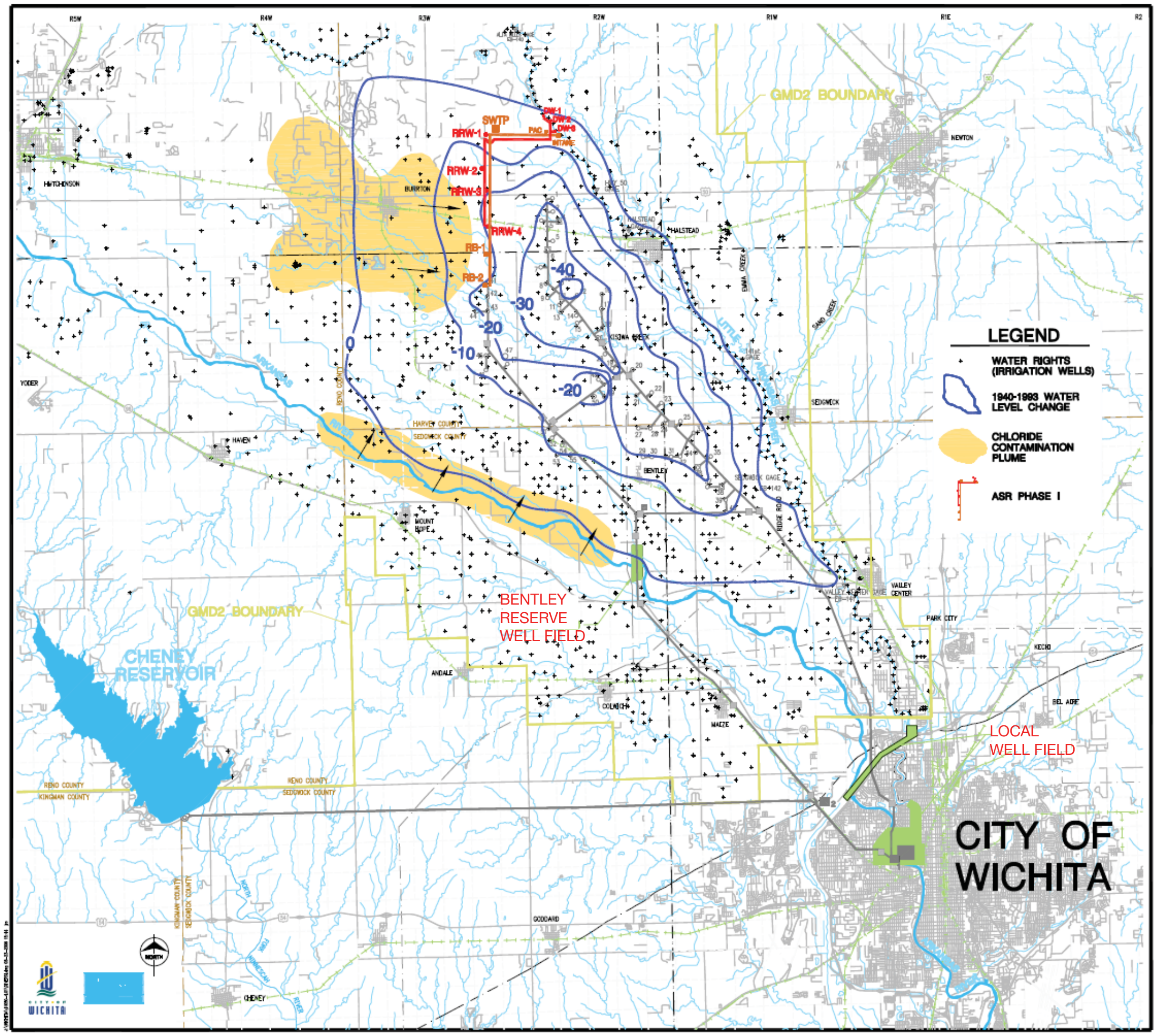

Figure 4–2. Wichita regional water-supply sources are drawn from Cheney Reservoir and the Wichita well field in the Equus Beds aquifer. Declining water levels around the well field reduce aquifer-storage capacity and induce saline ground-water flow from the Burrton oil-field-brine plume and the Arkansas River (modified from City of Wichita public meeting graphic illustration, Burns and McDonnel, 2006b).

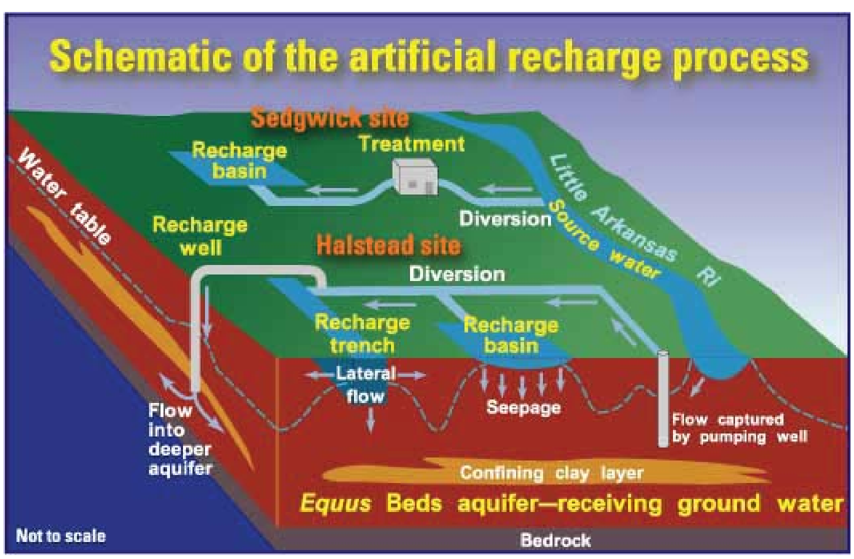

Figure 4–3. Schematic of Equus Beds Ground-Water Recharge Demonstration Project near Halstead, Kansas. Bank storage from the Little Arkansas River was diverted during high-river stage to evaluate potential aquifer recharge and surface-water treatment technologies to recharge the Equus Beds aquifer (modified from Ziegler, 2007).

be captured and recharged without harm to the Equus Bed aquifer.

Aquifer Storage and Recovery Project

In 2006, the largest component of the Water Supply Plan, the Equus Beds Aquifer Storage and Recovery Project (ASR) Phase I, was initiated. The ASR Phase I project has a capacity to capture and recharge up to 10 mgd, which should begin to form a hydrologic barrier to the chloride plume to the east. This is the first water that will go into the aquifer and the last to be removed.

ASR Phase I consists of three bank-storage diversion wells, a 7-million gallons per day (mgd) surface-water intake, a 7-mgd surface-water treatment plant, four injection wells, two recharge basins, and 14 miles of new water lines and overhead power lines (fig. 4–4). On average, the ASR Phase I is projected to operate about 120 days per year, which would allow about 1.2 billion gallons of recharge per year.

Water from the surface-water intake is pumped through a powder-activated carbon unit to remove organic compounds and turbidity before final treatment in a water-treatment plant. All of the water that is recharged into the aquifer is required to meet drinking-water standards.

After treatment, surface water is pumped to two recharge basins where the overlying clay soil has been excavated to allow direct infiltration into the underlying

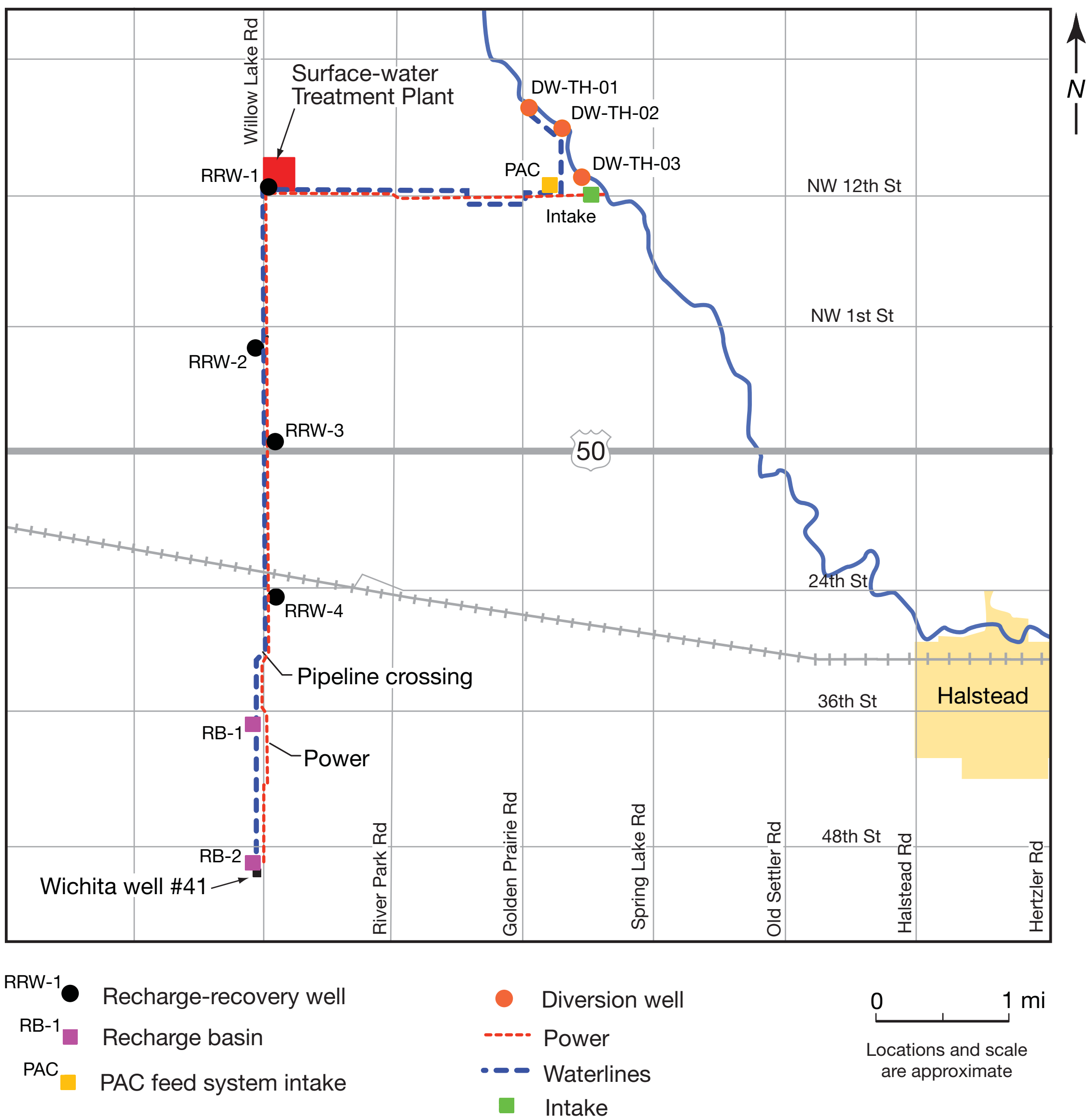

Figure 4–4. Aquifer Storage and Recovery Project Phase I facility locations. The ASR Phase I consists of a surface-water intake, three diversion wells, a powder-activated carbon-filtration system, water-treatment plant, four recharge wells, and two infiltration basins and associated piping (modified from Burns and McDonnel, 2006a).

aquifer. Water captured from the diversion wells is pumped directly to the surface-water treatment plant before direct injection into the aquifer by four Class V Injection Wells. The injection wells were specially permitted by the Kansas Department of Health and Environment to inject water for aquifer storage and later recovery for the purpose of forming a hydraulic barrier to the Burrton oil-field-brine plume west of the ASR (fig. 4–2).

Construction of the full-scale ASR is planned over four phases. Upon completion it will have the design capacity to capture and recharge 100 mgd. This will ultimately add approximately 65 billion gallons of water to storage in the Equus Beds aquifer, which is comparable to the amount of water stored in Cheney Reservoir. The full-scale ASR should meet Wichita's projected water-supply needs through 2050 and protect the Wichita well field from saline-water intrusion. The water-treatment processes for Phase II and Phase III have not yet been determined. The completed project will cost an estimated $137 million.

Bentley Reserve Well-Field and Local Well-Field Expansion

The Bentley Reserve well-field and Local well-field expansion (fig. 4–2) are two proposed water-supply sources that would further ease demand on the Wichita well field.

The proposed location of the Bentley well field is adjacent to the Arkansas River south of Bentley. The water source is primarily the Arkansas River, and water wells will be considered bank-storage wells. Prior to any diversion, minimum river flow must be sustained, and Wichita must demonstrate that the water source is taken from the river without impairing any other water users. This water source will have very high chlorides (approximately 700 ppm), and the Bentley well field will only be used during peak summer months when it is feasible to blend this water into the rest of the Wichita water supply for treatment.

A proposed Local well-field expansion will consist of bank-storage wells next to the Little Arkansas River. These wells will also divert water without impairment to other users while maintaining minimum flow in the Little Arkansas River. This water source would be transported directly to the Wichita water-treatment plant rather than being used to recharge the Equus beds.

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Burrton Oil-Field-Brine Contamination

The Burrton oil field, one of the largest in the Kansas, was found by wildcat drillers in the early 1930s. The small town of Burrton, Kansas, is surrounded by the field, which extends northeast from the Arkansas River to the Little Arkansas River (fig. 4–5). In its heyday, between 1932 and 1937, Burrton became an oil-field boom town in the midst of the Great Depression. Today, oil-field brine from the Burrton oil field is northwest of Wichita's water-well field in the Equus Beds aquifer and has the potential to degrade the water quality of the aquifer.

As oil was pumped from the field, saltwater brine was also produced. During the early years of oil production in Kansas, saltwater brine was released at the surface without regard to pollution, resulting in the contamination of streams. When this method of disposal became a problem, brine was stored in surface ponds. The surface ponds (sometimes called evaporation ponds) increased the rate of infiltration to shallow ground water, particularly in areas underlain by permeable materials, such as in the Burrton area, where sand and gravel are at or very near the surface. Oil-field-brine disposal in surface ponds continued into the 1940s. Spills and leaks from brine-distribution systems also contributed to shallow subsurface contamination. Ultimately, industry switched to disposing of oil-field brines in deep subsurface formations that already contained saltwater.

In 1935, the Kansas Legislature passed statutes pertaining to oil- and gas-field wastes, which covered

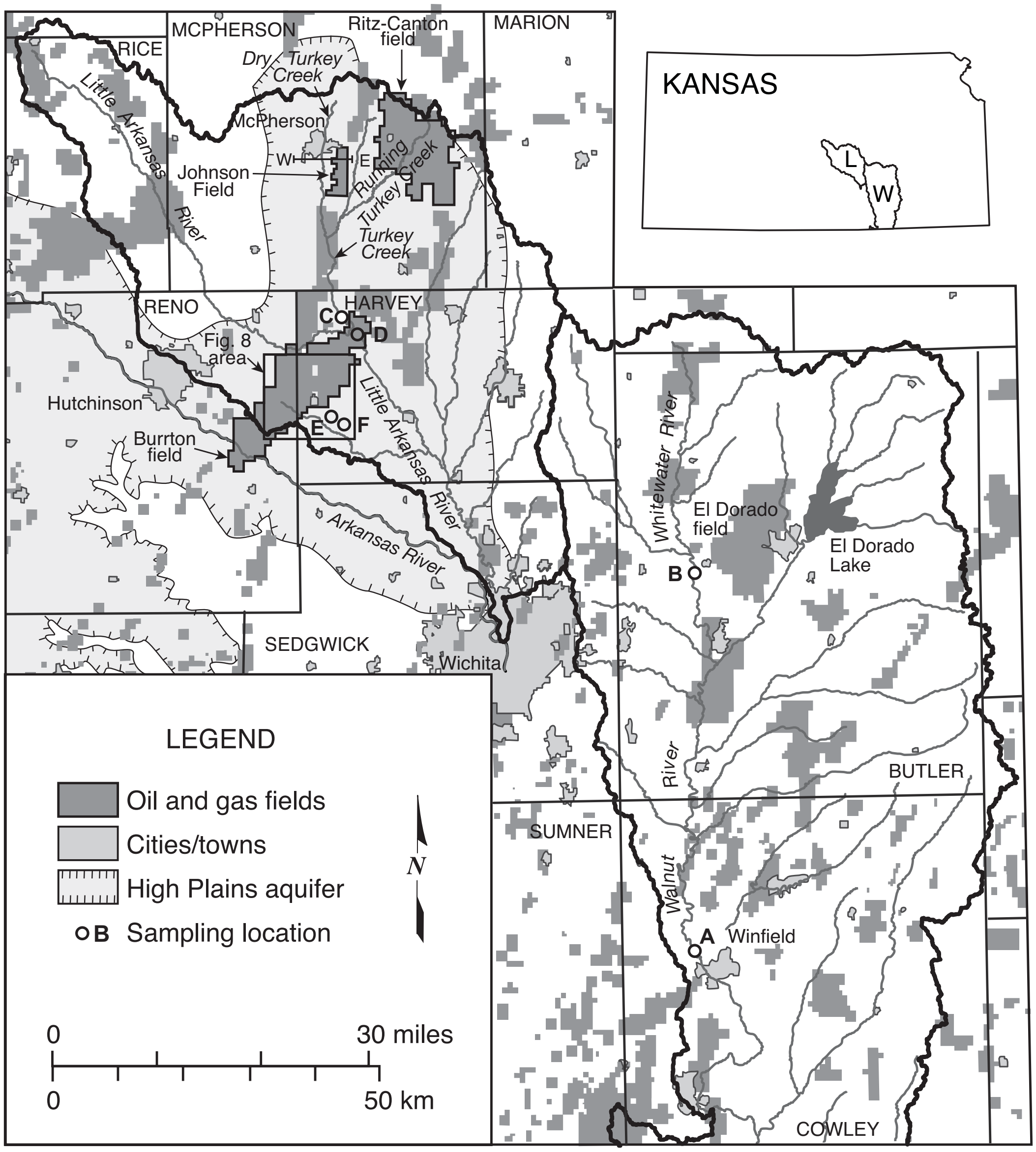

Figure 4–5. Area of Burrton oil field.

the prevention of brine escape from wells and the protection of fresh ground water. The Legislature passed supplementary laws in the late 1940s regarding the construction of oil and gas wells, saltwater disposal, the plugging of abandoned wells, and the control of stream and fresh ground-water pollution. Increased regulation and prevention of oil-field-brine pollution in Kansas from the 1930s into the 1950s, along with the general acceptance and compliance by the operators, reduced the amount of saltwater contamination.

The Burrton oil field is located in western Harvey and eastern Reno counties in an area of the Equus Beds aquifer where the saturated thickness generally exceeds 100 feet and is as thick as 320 feet. The general quality of the water in the Equus Beds aquifer prior to the surface disposal of brine in the Burrton oil field was fresh. Chloride concentration in most of the oil-field area was less than 50 milligrams per liter (mg/L) (drinking-water limits are 250 mg/L). By 1948, contamination by oil-field brine increased the chloride concentration in shallow (less than 50 feet) and middle (50–150 feet) depths of the aquifer to greater than 250 mg/L in much of the area. The chemical signature of the brine in the aquifer matched that of the saltwater produced from the oil field (fig. 4–6).

The regional direction of ground-water flow in the Burrton area is to the southeast, which carries the saltwater plume toward the large well field that supplies water to Wichita. Pumping of municipal and irrigation wells has caused water levels to decline in the area, which increases the rate of plume advancement. Some of the future discharge of brine contamination will eventually leave the aquifer with water pumped by the city, which uses water from other sources to dilute the saline water. In addition, the aquifer storage and recovery project that utilizes surplus water from the Little Arkansas River will help slow the rate of saltwater advancement and dilute the salinity near the injection wells.

Although some of the saline water could leave the aquifer by municipal pumping, discharge to the Little Arkansas and Arkansas rivers, a distance of more than 10 miles from the front of the current plume, could eventually occur. Based on the current regional ground-water-flow rates, flushing of chloride pollution to levels approaching the pre-contamination concentration will probably take a few centuries.

The Kansas Corporation Commission's (KCC) responsibility is to monitor the brine's progression and

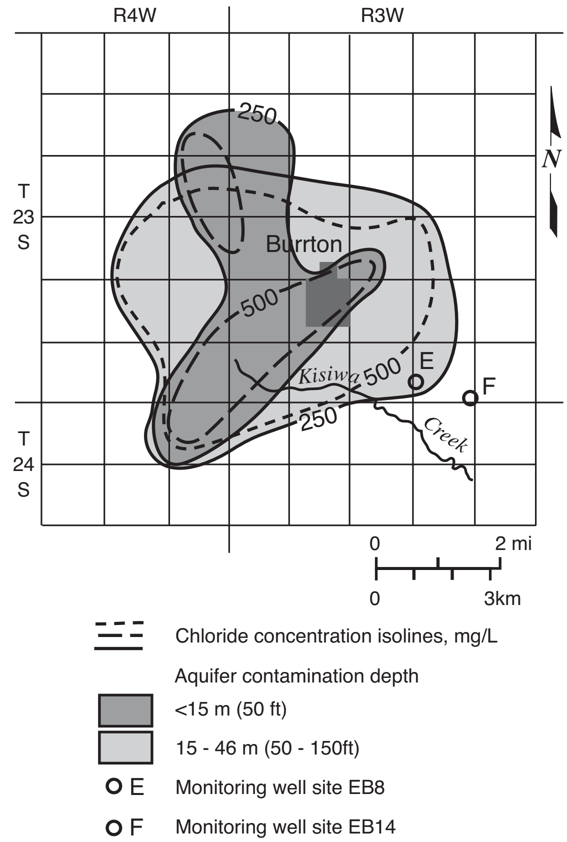

Figure 4–6. Chloride ground-water concentration map of the Burrton oil-field-brine plume.

present cost/benefit analysis to stakeholders. Current KCC efforts include expenditures of $5,000 annually to sample ground-water quality, develop a pilot withdrawal study, and update ground-water modeling.

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US–50 and Victory Road Sinkhole

Monitoring of the sinkhole at the intersection of US–50 and Victory Road in Reno County (approximately 6 miles east of Hutchinson) began in 1998 after the highway sank about a foot. Since then, the highway has subsided at a rate of about 10 inches per year, or about 3.5 feet in 4 years. The symmetrical, bowl-shaped, sinkhole is about 300 feet in diameter and centered about 100 feet northwest of the intersection. Water stands here most of the year.

High-resolution seismic reflection, a technique widely employed in the petroleum industry, was used to map the upper 1,000 feet of the subsurface around and below the sinkhole. Seismic reflection can provide images of the underground rocks without disturbing the ground. The technique uses a vibration, either from an explosion or a truck equipped with a special vibrating pad, that is put into the earth's surface. The vibrations move underground, bounce off the different rock layers, and travel back to the surface where they are recorded by microphone-like devices called geophones. The results, processed by computers, are images of the underground rock layers.

The seismic-reflection data show voids in the 135-feet-thick Hutchinson Salt Member. The top of the salt is about 400 feet below the earth's surface. The rock layers above the salt have collapsed into these voids, forming a chimney-like feature that narrows upward from the top of the salt to surface.

The US–50 sinkhole is probably a reactivation of an ancient sinkhole (paleosinkhole) that formed over a million years ago. This paleosinkhole is about 1,000 feet wide and filled with sediment. Renewed salt dissolution—either from natural or human-induced sources—has probably reactivated this sinkhole, but this seismic technique cannot identify the fluid source or its pathway. However, the positions of the modern sinkhole and the paleosinkhole relative to surrounding oil and gas wells suggest the new sinkhole is likely a result of natural processes.

Surface subsidence will probably continue at a gradual rate along the northern and eastern edges of the new sinkhole at a rate of about 1 foot per year for years to come. Until the highway started to sink sometime before 1998, this paleosinkhole had been inactive for over 500,000 years. This localized, rapid subsidence suggests that other small sinkholes could form over the next several years above the larger paleosinkhole.

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Brine Well #19 Sinkhole

A sinkhole formed in early January 2005 around Brine Well #19 on the southeast side of Hutchinson (fig. 4–7). Brine Well #19 was a solution-salt mining well where salt was mined by dissolving a subsurface salt layer with water and bringing the resulting brine to the surface. Brine Well #19 was installed in 1917, closed in 1922, and abandoned in 1932. The well mined brine for only a short while, as it was not an effective salt producer. The brine well was then used as a disposal well for residuals from the solution mining operation until 1922 and then abandoned.

The sinkhole, approximately 85 feet in diameter and about 80 feet from the railroad tracks. Salt beds here are about 400 feet deep and about 300 feet thick and are overlain by a thick shale. Because the sinkhole is close to railroad tracks in the area, local and State agency officials and businesses were concerned that further development of the sinkhole might affect rail traffic. The sinkhole eventually grew to about 200 feet in diameter until it was only 14 feet from the railroad tracks.

The sinkhole is located on property now owned by the Mosaic Company near the railroad line operated by Burlington Northern Santa Fe (BNSF) Railroad. The Mosaic Company retained RMT, Inc., as its consultant to do the sinkhole investigation, remedial design, and remedial strategy. RMT collaborated closely with Mosaic, the Kansas Department of Health and Environment (KDHE), the City of Hutchinson, and the BNSF Railroad to maintain safety and keep the railroad operational. A draft Sinkhole Remediation Design Plan to plug the sinkhole was submitted to KDHE in May 2005. KDHE's Bureau of Water is monitoring the remediation activity.

Hutchinson Brine Wells

Brine (salt-solution mining) wells have been used in the Hutchinson area since the late 1880s to extract salt from the subsurface. Before the enactment of KDHE brine-well regulations in 1979, these wells were constructed and operated in a manner that resulted in the wells being susceptible to subsidence.

Figure 4–7. Aerial photo (looking to the south) of brine well #19 sinkhole at the former ICM Salt Facility in Hutchinson, Kansas (photo courtesy of KDHE, 2005).

Brine wells were commonly completed by setting the bottom of a metal casing in the shale layer above the salt about midway between the surface and the top of the salt. The well was then drilled to the bottom of the salt layer and left uncased through the shale below the metal casing and through the salt. Freshwater was injected down a tubing string to the bottom of the salt layer, and brine was forced back up the well through the annulus (the space between the tubing string and the sides of the well). The well could also be operated in reverse with the water injected down the annulus and the brine returned to the surface through the tubing.

This method of construction and operation often caused dissolution to occur in the shallower salt beds causing removal of salt from the roof of the cavern. It also exposed the shale layers between the salt and the metal casing to injection pressures, freshwater, and brine, causing the shale layers overlying the salt to collapse into the cavern, which ultimately results in a sinkhole at the surface.

Sinkhole Remediation

Remediation of Brine Well #19 focused on protecting the nearby railroad lines. Holes were drilled between the railroad tracks and the sinkhole and filled with concrete grout to stabilize the soils in the area. In addition, over 9,000 tons of ballast were delivered by railcar and placed on the face of the sinkhole closest to the tracks. During the spring, most of the ballast disappeared and the sides of the sinkhole continued to expand. Additional investigations, utilizing slant borings and sonar techniques, revealed an opening (or "throat") that led to a cavern below what was originally thought to be the bottom of the sinkhole. It was suspected the railroad ballast had fallen through this opening.

RMT proposed a plan to fill the lower cavern and throat with brine-contaminated soils obtained from historical spills and brine releases around the site, which not only provided fill material but also addressed a soil-contamination problem. A conveyor system installed on barges transferred the fill material through the cavern throat to the lower cavern. A sheet pile box was installed (with the aid of underwater divers) around the cavern throat to allow simultaneous filling of the cavern and the side of the sinkhole closest to the railroad tracks. So far, nearly 38,000 cubic yards of contaminated soil have been placed in the cavern.

The remediation plan and implementation has stabilized the sinkhole. The sides of the sinkhole were sloped and graded and a security fence added for safety. The fill material in the cavern beneath the sinkhole is being monitored for settling and additional material may be added if necessary. Information continues to be collected on the sinkhole to determine if any additional corrective actions might be warranted. RMT earned the 2006 Engineering Excellence Honor Award from the American Council of Engineering Companies of Illinois for its role in developing and implementing the remedial solution for the Hutchinson sinkhole.

Anthropogenic Sinkholes

In Kansas, natural salt subsidence differs from anthropogenic, or human-made, subsidence. Natural sinkholes generally occur on a regional basis along the edge of the Hutchinson Salt Member where it comes in contact with freshwater in the subsurface. Sinkholes resulting from natural dissolution are usually irregular in shape and grow at irregular rates with alternating periods of active dissolution, dormancy, and re-activation.

Anthropogenic-induced sinkholes occur from the unintended dissolution of salt cavities, most often produced by freshwater entry from well bores or casings. These dissolution events are accelerated and often result in catastrophic failure and surface collapse when the roof rock is undermined and fails. In Kansas these events typically occur in oil-well fields or salt-solution mines.

Solution mining of salt first began around Hutchinson in 1888 with underground mining starting around 1923. Unexpected sinkhole occurrences within solution-mine fields have been reported for more than 90 years in and around Hutchinson. These sinkholes have generally formed as a result of roof-rock failure associated with a single solution-well installation. Generally, failure occurs at a well that has overproduced salt near the salt/shale caprock interface, which exposes a span that is unable to support the overlying load of the shale roof (fig. 4–8). When a dissolution-well field is completed on a grid pattern, a gallery can form when a solution cavity or salt "jug" from a single well laterally propagates along the roof rock until it reaches an adjacent jug in the grid. Galleries between single wells are particularly prone to failure because the spans between the voids are quite large and do not support the roof rock (fig. 4–9).

Modern solution-mining practices have sufficient levels of monitoring and regulatory oversight, which results in voids that are suitable for long-term stability, but many of these safeguards were generally lacking in solution mines that were active during the early half of the century. Based on the large number of boreholes that penetrate salt in Kansas, along with increased time, ongoing dissolution, and increasing fatigue on overburden rock, problems associated with anthropogenic-induced sinkholes can escalate.

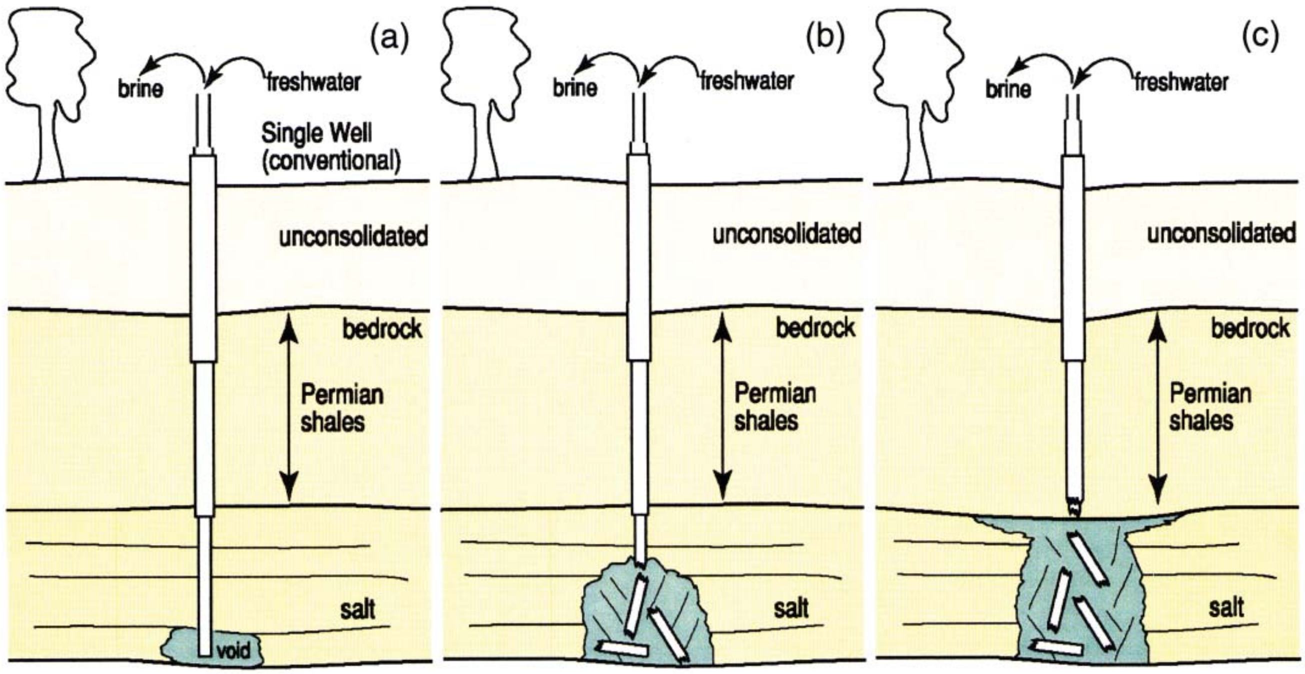

Figure 4–8. Historic progress of single-well solution mining from base of salt: a) through over-production, b) failure of non-soluble layers in proximity of the well bore, and c) development of morning-glory structure at the top of the salt (modified from Miller, in preparation).

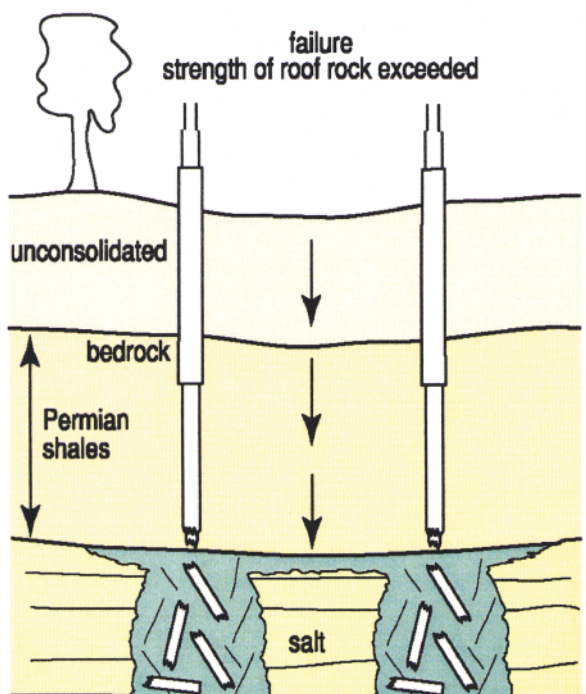

Figure 4–9. Inadvertent formation of a gallery from the joining of two morning-glory structures from adjacent wells and resulting sag (modified from Miller, in preparation).

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ONEOK Underground Natural-Gas Storage Facility

In several places in Kansas, natural gas and propane are stored in human-made void spaces in underground salt layers. One field of these so-called salt jugs was created northwest of Hutchinson, near the small town of Yaggy. It originally was used for propane storage, then was closed for a time and reopened for the storage of natural gas. In January 2001, natural gas escaped through a hole in a pipe into one of these jugs, allowing natural gas to escape, move beneath the City of Hutchinson, then come back to the surface through old wells, where it resulted in two explosions, two deaths, an evacuation of part of the population, and an extensive drilling program to release the remaining gas. As a result of those explosions, the Kansas Department of Health and Environment has revised the regulations that apply to natural gas storage in salt. Now, the caverns at Yaggy are no longer actively used for natural gas storage, but are filled with only enough gas and saltwater to support the cavern roofs.

At least one proposal for a future use of this storage area is inclusion within the Federal government's Strategic Petroleum Reserve (SPR) program. Operated by the U.S. Department of Energy (DOE), the SPR currently stores up to 700 million barrels of crude oil in underground salt caverns along the Gulf of Mexico (these caverns have been developed in salt domes, which are somewhat different from the bedded salt layers in central Kansas). The Gulf area was selected because, in addition to the salt caverns, it is the location of a number of refineries and pipelines. The program allows competitive sale of the petroleum in the reserve under the authorization of the President in times of energy emergency. Withdrawals have been made twice: in 1991 during Operation Desert Storm and in 2005 after Hurricane Katrina.

The Energy Policy Act of 2005 directed the expansion of the program to one billion barrels. In February 2007, the DOE announced its final decision to create a new storage location in salt domes near Hattiesburg, Mississippi, and at two existing locations: Big Hill, Texas, and Bayou Choctaw, Louisiana. The current program is managed through DOE offices in New Orleans and is operated by contractors and sub-contractors.

During the 2007 Legislative session, the Kansas House of Representatives passed Resolution 6011, urging the DOE to consider storage sites within the state of Kansas for an expanded petroleum-reserve program. Resolution 6011 argued that several things made Kansas a good location for the storage program, including Midwestern oil production and refineries, its distance from hurricane activity along the Gulf Coast, and a new pipeline under construction from Canada.

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Kansas Underground Salt Museum

Rock salt was discovered by speculators drilling for oil, gas, coal, or anything else worth mining in Reno County in 1887. Soon 26 processing plants sprung up in the area. All used the evaporation method in which water was forced down a well into the salt deposit to dissolve sodium and create a brine solution, which was then pumped to the surface. Although underground mining started elsewhere in Kansas in the early 1890s, it didn't come to Hutchinson until 1923 when Carey Salt Company dug a shaft and sent miners 600 feet down. Still operated today by the Hutchinson Salt Company, the underground room-and-pillar mine now encompasses 67 miles of caverns. A portion of the mine no longer in operation has served as an underground storage unit—now the world's largest—for several decades, and recently, the Kansas Underground Salt Museum was created in another unused section to allow the public a glimpse of the miner's subterranean world.

Carey Salt Company had offered tours of the mine starting in 1923, but in 1965 the underground caverns were closed off to the general public. Then in 2005 construction began on a new public-access elevator shaft. The Kansas Underground Salt Museum opened to the public in May 2007.

Tiny in comparison to the mine as a whole, the Museum's allotted space is still hefty by museum standards, covering a spot the size of a football field. The storage facility, operated by Underground Vaults and Storage in another section of the mine, is much larger—the equivalent of 73 football fields. Even that takes up only a fraction of the mine. Mining operations have long since moved away from where the Museum is situated. The nearest current activity is a 2-mile underground trip away and, like the storage area, is not accessible to the public.

The underground portion of the Museum is accessible now and an above-ground visitor's center is under construction. To help recreate the mining experience, the museum tram takes visitors on a dark ride through the underground caverns, illuminated only by headlights and flashlights, and to galleries that tell the story of salt from its earliest known discovery. Exhibits address such topics as geology, mining techniques, history, culture, and the many ways salt mines are being used today. The Museum has classroom space for school tours and adult education programs, an events room, and a catering area. Year round, the temperature is naturally 68° with 40% humidity.

The Kansas Underground Salt Museum is the first operation of its kind in the western hemisphere. Museum supporters hope it will emulate the success of similar attractions in Poland, Austria, and Switzerland. According to projections, the Museum could attract 150,000 people per year and make at least an $11 million impact on the region's economy. It is designed to be self-supporting. The Museum staff is developing a proposal to become an affiliate of the Smithsonian Institution, which would give it access to traveling displays of the Smithsonian's national treasures.

The Mine

The Hutchinson Salt Member of the Wellington Formation was deposited in Permian seas around 275 million years ago. In the Hutchinson vicinity it is about 400 feet thick and mined 600 feet beneath the surface. The Hutchinson salt underlies about 37,000 square miles of Kansas and then extends into Oklahoma and Texas. Two other mines are operated in Kansas from the Hutchinson Salt Member—in Lyons and Kanopolis—where the salt is about 1,000 feet beneath the surface.

Using a room-and-pillar construction in the Hutchinson mine, the miners left behind large, square pillars of salt to support the overhead rock. The rooms range in size from 2,500 to 15,000 square feet and the ceilings are from 11 to 17 feet high (fig. 4–10).

Salt from the mine is not manufactured for human consumption. The rock salt cut, drilled, and blasted from the mine walls is composed of the mineral halite (salt) and impurities, mainly shale. It is used mainly to deice roads and also is added to cattle supplements. Table salt is produced from the Hutchinson Salt Member, but only through solution mining.

Underground Vaults and Storage

During the height of the Cold War, a storage area was created in the mine to hold and protect public and personal treasures. In 1959, Underground Vaults and Storage moved in. Today, in a 3-million-square-foot zone, it houses millions of health-care, legal, financial, insurance, cultural, oil and gas, and entertainment documents, and other assets for government, private industry, and individuals. Among the items stored in the facility is the world's largest collection of movies and television films.

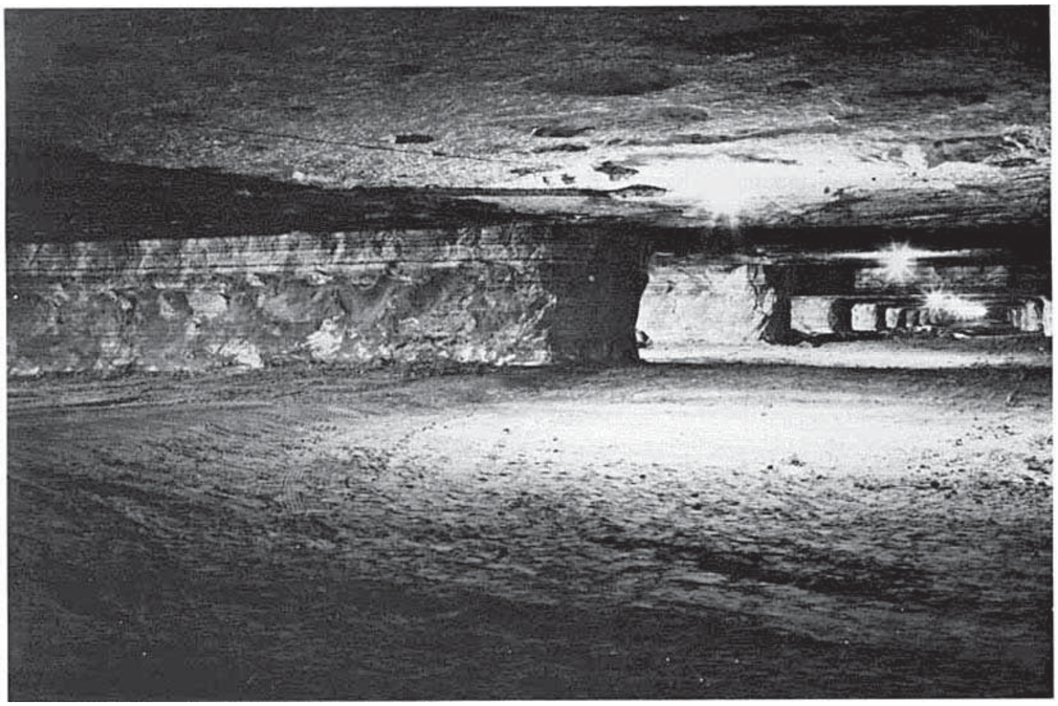

Figure 4–10. Carey Salt Company mine, Hutchinson, Kansas, showing light and dark banding in the Hutchinson Salt Member (from Walters, 1978). Photograph courtesy of Underground Vaults and Storage, Inc.

Both Underground Vaults and Storage and the Hutchinson Salt Company support the Museum. Underground Vaults and Storage provided financial resources, and the Hutchinson Salt Company donated land and services.

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SCHEDULE AND ITINERARY

Friday, June 8, 2007

6:30 am	Breakfast at Grand Prairie Hotel & Convention Center
8:00 am	**Bus leaves Grand Prairie Hotel & Convention Center for Site 11**
9:00 am	**SITE 11** • Abengoa Ethanol Plant, Colwich *Craig Kramer*, Abengoa Bioenergy
10:30 am	Bus to Site 12
11:00 am	**SITE 12** • Kansas Ethanol Issues, Great Plains Nature Center, Wichita *Greg Krissek*, ICM, Inc. *Carl Holmes,* House Energy and Utilities Committee Chair *Mike Hayden,* Kansas Dept. of Wildlife and Parks *Tracy Streeter,* Kansas Water Office
12:30 pm	Bus to motel
12:40 pm	Arrive at Candlewood Suites, Wichita

Ethanol

Ethanol is a clear, colorless liquid, also known as grain alcohol. Because ethanol burns relatively cleanly, and because it can be manufactured from renewable resources, such as corn, it has been promoted as a partial solution to the nation's need for liquid energy. Most ethanol production is made by fermenting corn; a bushel of corn produces about 2.8 gallons of ethanol, and the remaining by-product can generally be used to feed livestock. To encourage domestic ethanol production, ethanol is exempt from the $0.52 per gallon Federal tax on gasoline, and there is a $0.54 per gallon tariff on imported ethanol. Energy policies such as these have helped lead to a quadrupling of U.S. production since 1999. As of November 2006, 107 grain refineries were operating in the U.S., with a capacity of 5.1 billion gallons of ethanol per year. An additional 56 construction projects currently underway in the U.S. may add another 3.8 billion gallons of capacity over the next 18 months (for perspective, the U.S. uses about 140 billion gallons of gasoline per year). Eight plants currently operate in Kansas: at Garnett, Atchison, Phillipsburg, Russell, Colwich, Campus, Leoti, and Garden City. Four more plants are under construction and another 17 have been proposed.

Ethanol is not without its critics. There is disagreement about whether the production of ethanol from corn is a net energy producer or net energy loser (recent articles in *Science* magazine and *Scientific American* estimated that ethanol made from corn is a net energy producer, when the energy content of its by-products are factored in). Each gallon of ethanol produced requires about three gallons of water, and ethanol plants are a source of carbon dioxide, a matter of concern in these times of global climate change. There is also concern about the public health risk posed by the ozone created by the burning of ethanol. A gallon of ethanol produces about 30% less energy per unit volume than petroleum. Replacing gasoline with ethanol would require the planting of millions of acres to corn.

The increased demand for corn to produce ethanol has had a dramatic impact on commodity prices. By the spring of 2007, corn prices topped $4.00 per bushel. While this price increase has had a small impact on the cost of food, it has had a greater impact on livestock producers who use corn for feed and cannot automatically pass those increased costs along to consumers. Not too surprisingly, high prices have led to a dramatic increase in corn planting this spring. Nationally, the U.S. Department of Agriculture estimates that about 15% more acres will be planted to corn in the U.S. this year, up to 90 million acres, the largest total since 1944. In Kansas, the Kansas Corn Growers Association estimates that planting will be up about 15%, to 3.7 million acres. Based on these estimates, corn prices have dropped, and are currently in the upper $3.00 per bushel range.

Increased corn plantings have raised concerns about the unintended consequences of increased ethanol production. One concern is water. Much of the Kansas corn crop is irrigated, and increased corn acres would likely lead to increased use of the state's already stressed ground-water supply. Another concern is the use of fragile land to grow corn, and the possibility that land currently in the Conservation Reserve Program might be broken out to plant to corn (or other crops which have also seen increased prices).

Abengoa

In light of issues about making ethanol from corn, one promising area of research is the use of cellulosic ethanol, or ethanol produced from plant fibers. Sources of cellulose include the stalks and leaves from corn, switchgrass, wheat straw, wood chips, milo stubble, and other waste products. Fermentation, using special enzymes or microorganisms, can be used to produce ethanol from cellulose. The production of cellulosic ethanol is, however, still in its infancy and has only recently begun on a commercial scale in plants in China and Canada.

One company that is working toward commercialization of cellulosic ethanol is Abengoa Bioenergy, headquartered in St. Louis. Abengoa Bioenergy is a subsidiary of Abengoa S.A., headquartered in Spain. Abengoa S.A. is present in over 70 countries where it operates through its five business units: solar, bioenergy, environmental services, information technology, and industrial engineering and construction. Abengoa S.A. is currently building a 5-million gallon per year cellulosic ethanol facility in Spain, and is working with Canada's largest ethanol producer to build several large-scale plants. Its research and development activities are devoted to producing bioethanol from cellulose biomass and the development of new bioethanol-based products.

In February 2007, the U.S. Department of Energy (DOE) awarded Abengoa Bioenergy a financial assistance grant up to $76 million to design, construct, and operate the first commercial facility to produce ethanol from lignocellulosic biomass. This is biomass composed primarily of lignin and cellulose, such as trees, grasses, agricultural residues, sugarcane, and straw. The award is part of the DOE program to promote the demonstration and commercial deployment of lignocellulosic conversion technology for ethanol production. The award will be used by Abengoa Bioenergy to lower the initial risk of developing and building the first generation of lignocellulosic plants dedicated to ethanol production. Abengoa Bioenergy applied for this program with a production goal of 11.4 million gallons of ethanol annually. The new facility will be in Kansas, but the exact location has not been determined. Construction on the $300 million plant will begin in 2008 and should be completed by 2010. It will use about 700 tons per day of corn waste, wheat straw, milo stubble, switchgrass, and other feedstocks.

Abengoa operates an existing ethanol plant at Colwich, about 20 miles northwest of Wichita. This plant was constructed in 1982, and produces 25 million gallons of fuel alcohol, 6,700 tons of dried distillers grain, 193,000 tons of wet distillers grain, and 43,750 tons of food-grade carbon dioxide annually. The plant was originally designed for 10 million gallons-per-year anhydrous ethanol production and was upgraded to 16 million gallons-per-year capacity in 1988. Additional modifications increased output to 19.5 million gallons per year in 2001. A plant expansion in 2003 increased capacity to its current rate. The Colwich facility employs 43 people in maintenance, operations, material handling, engineering, logistics, and marketing.

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