Kansas Field Conference
June 17–18, 2025

Fundamentals for the Future: Water, Energy, and Infrastructure

Reno and Sedgwick Counties

Field Guide

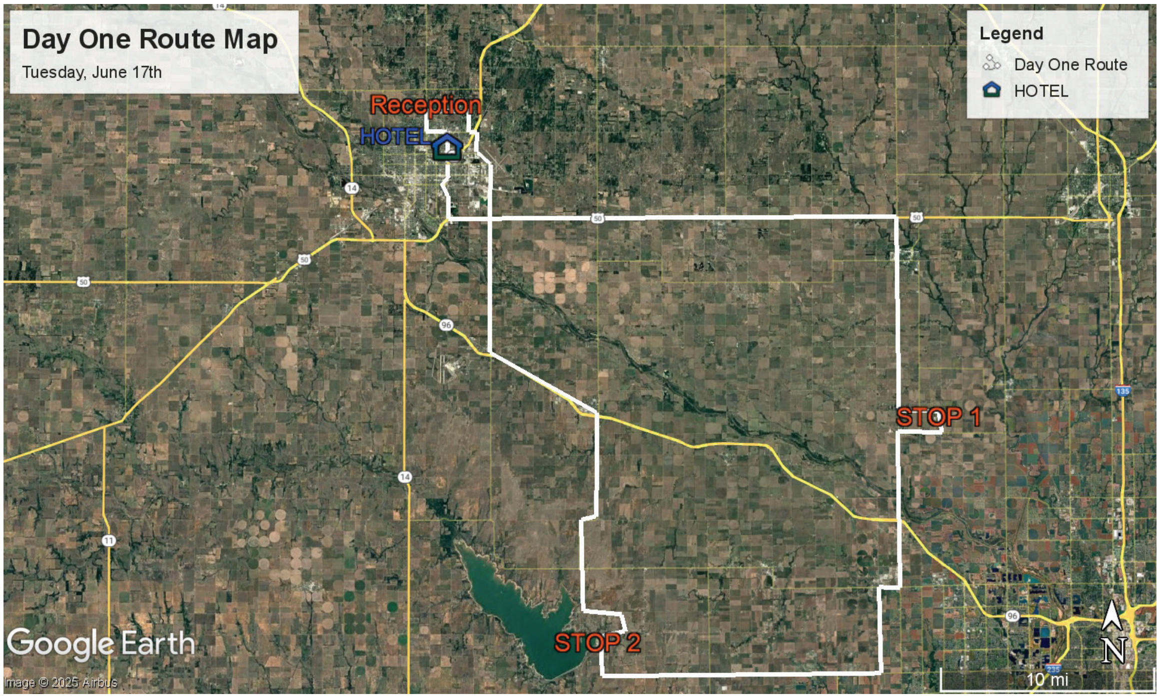
Blair Schneider, Coordinator
Julie Tollefson, Editor

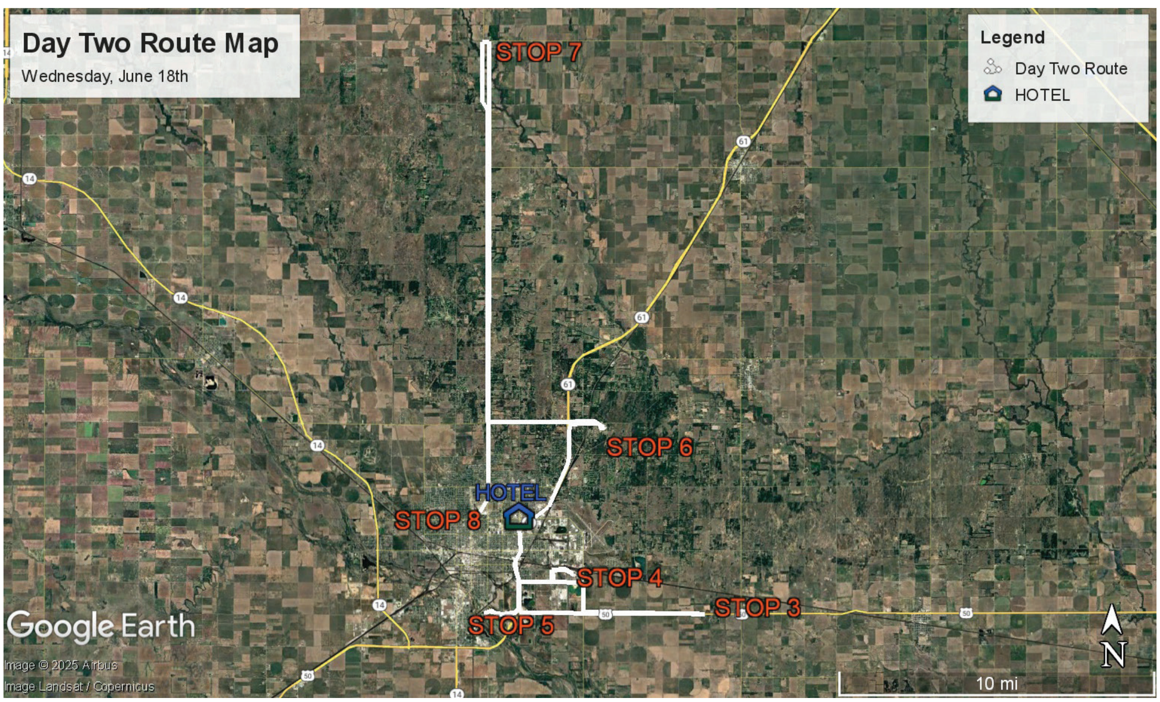
Kansas Geological Survey Open-File Report 2025-46

Contributors: Blair Schneider, Sunday Siomades, Ellie Biebesheimer, Andy Connolly, Hannah Horinek, and Ally Pruente, Kansas Geological Survey

This project is operated by the Kansas Geological Survey and funded, in part, by the Kansas Department of Health and Environment, Kansas Department of Transportation, Kansas Department of Wildlife and Parks, Kansas Department of Agriculture, Kansas Water Office, The Nature Conservancy, and Kansas Corporation Commission.

Kansas Geological Survey
The University of Kansas
1930 Constant Avenue
Lawrence, KS 66047-3724
785.864.3965
www.kgs.ku.edu


Day One Route Map
Tuesday, June 17th
Legend
Day One Route
HOTEL
Reception
HOTEL
STOP 1
STOP 2
Google Earth
Image © 2025 Airbus
10 mi
N


Day Two Route Map
Wednesday, June 18th
Legend
Day Two Route
HOTEL
STOP 7
STOP 6
HOTEL
STOP 8
STOP 4
STOP 3
STOP 5
Google Earth
Image © 2025 Airbus
Image Landsat / Copernicus
10 mi
N

Contents

NOTES

Participants

Elizabeth Adams, Kentucky Geological Survey

Victoria Asbury, Kansas Water Office

Kent Askren, Kansas Farm Bureau

Sara Baer, University of Kansas

Brad Barton, Equus Beds Groundwater Management District 2

Rick Billinger, Senator, District 40

Timothy Boese, Equus Beds Groundwater Management District 2

Lauren Bohi, Representative, District 15

Dawn Buehler, Kansas Water Authority

John Carmichael, Representative, District 92

Justin Cobb, The Nature Conservancy

Doug Curl, Kentucky Geological Survey

Brenda Densmore, U.S. Geological Survey

Luke J. Drury, Kansas Legislative Research Department

Rodney Eggleston, Equus Beds Groundwater Management District 2

Charlotte Esau, Representative, District 14

Marci Francisco, Senator, District 2

Kate Gleeson, Kansas Department of Health and Environment

Kyle Halverson, Kansas Department of Transportation

Jason Hartman, Kansas Forest Service

Dave Heinemann, Kansas Geological Survey Advisory Council

Kyle D. Hoffman, Representative, District 116

Ryan Hoffman, Kansas Corporation Commission

Nick Hoheisel, Representative, District 97

Shelley Hooks, University of Kansas

Christopher Kennedy, Kansas Department of Wildlife and Parks

Vanessa Lamoreaux, Kansas Department of Transportation

Earl Lewis, Kansas Department of Agriculture

Carolyn McGinn, Kansas Water Authority

Joshua McGinn, Kansas Department of Agriculture

Heidi Mehl, The Nature Conservancy

Jim Minnix, Representative, District 118

Brooklynne Mosley, Representative, District 46

Connie Owen, Kansas Water Office

Pat Pettey, Senator, District 6

Sandy Pickert, Representative, District 88

Katie Roby, The Nature Conservancy

Angel Roeser, Representative, District 67

Laura Rose Clawson, Kansas Department of Wildlife and Parks

Theresa Runnells, Kansas Corporation Commission

Ron Ryckman, Senator, District 38

Jim Schmidt, Kansas Farm Bureau

Joe Seiwert, Representative, District 101

Allan Soetaert, Rural Water District No. 7

Janet Stanek, Kansas Department of Health and Environment

Jean Steiner, Kansas Water Office

Mandy Stone, U.S. Geological Survey

Kyler Sweely, Representative, District 102

Matt Unruh, Kansas Water Office

Bill Waln, Kansas Forest Service

Dawn Wolf, Representative, District 107

Kansas Geological Survey Staff

Brendan Bream, Associate Director, Energy and Stratigraphy

Scott Ishman, Associate Director, Geohydrology and Geohealth

Jay Kalbas, Director and State Geologist

Richard Miller, Program Director, Geophysics Applications and Field Services

Ken Nelson, Associate Director, GIS and Information Technology

Nikki Potter, Associate Director, Libraries, Outreach, and Business Operations

Blair Schneider, Associate Researcher and Outreach Manager

Nick Schneider, Research Project Manager, Groundwater Quality Program

Brownie Wilson, Manager, Geohydrology Support Services

NOTES

Biographical Information

Elizabeth Adams
Engagement Division Director
Kentucky Geological Survey
859-323-0518 Business
elizabeth.adams@uky.edu
Roles and Experience: Former Geological Technician Senior, Geologist 1, Program Coordinator, and Research Administrative Coordinator Education at the Kentucky Geological Survey. Education: University of Kentucky, BS; University of Kentucky, MPA.

Victoria Asbury
Manager, Policy and Governmental Relations
Kansas Water Office
785-296-3185 Business
Victoria.Potts@kwo.ks.gov
Roles and Experience: Fiscal Analyst and Legislative Fellow for the Kansas Legislative Research Department 2018–2022. Education: William Jewell College, BA; The University of Memphis, MA.

Kent Askren
Director of Public Policy
Kansas Farm Bureau
785-587-6156 Business
askrenk@kfb.org
Roles and Experience: Served in administration roles for the Kansas Farm Bureau since 2003; prior work included 19 years as Assistant Water Commissioner and Environmental Scientist II for the Kansas Department of Agriculture Division of Water Resources. Education: Kansas State University, BS.

Sara Baer
Director
Kansas Biological Survey & Center for Ecological Research
785-864-1500 Business
sgbaer@ku.edu
Roles and Experience: Former Professor of Plant Biology, Southern Illinois University Carbondale. Education: University of North Texas, BS; University of Georgia, MS; Kansas State University, PhD.

Brad Barton
Hydrogeologist
Equus Beds Groundwater Management District 2
316-835-2224 Business
bbarton@gmd2.org
Roles and Experience: Former positions: Staff Geologist at Blaes Environmental Management; Staff Geologist at Geological Consultants Inc.; Professional Geologist at Stantec. Education: Missouri University of Science and Technology, BS.

Rick Billinger
Senator, District 40
Kansas State Senate
785-296-7399 Business
Rick.Billinger@senate.ks.gov
Roles and Experience: Committee Chair: Ways and Means; Higher Education Subcommittee; General Government Subcommittee; 2025 Special Committee on the State Budget. Committee Vice-chair: Legislative Budget Committee; Select Committee on Veterans Affairs. Committee Member: Corrections and Public Safety Subcommittee, Ways and Means; Joint Committee on State Building Construction; Government Efficiency. Education: Fort Hays State University, BGS.

Timothy Boese
Manager
Equus Beds Groundwater Management District 2
316-835-2224 Business
tboese@gmd2.org
Roles and Experience: Manager of GMD2 since 1992. Education: Fort Hays State University, BS.

Lauren Bohi
Representative, District 15
Kansas State House of Representatives
785-296-7658 Business
Lauren.Bohi@house.ks.gov
Roles and Experience: Committee Member: Judiciary; Transportation; Financial Institutions and Pensions; Energy, Utilities and Telecommunications. Education: MidAmerica Nazarene University, BA.

Dawn Buehler
Chair
Kansas Water Authority
785-979-8341 Cell
dawn.buehlerkwa@kwo.ks.gov
Roles and Experience: Kansas Riverkeeper and Executive Director of Friends of the Kaw; previously worked for Douglas County Conservation District and K-State Extension. Past-chair of the Kansas Regional Advisory Committee for the Governor's Water Vision; Member, Stakeholder Leadership Team for the Lower Kansas WRAPS Program, Topeka Riverfront Advisory Council, Governor Kelly's Oil and Gas Advisory Committee, Kansas Land Trust, Kansas Alliance for Wetlands and Streams. Education: Baker University, BBA; Oregon State University, BS.

John Carmichael
Representative, District 92
Kansas House of Representatives
785-296-7650 Business
john.carmichael@house.ks.gov
Roles and Experience: Ranking Minority Member: Joint Committee Administrative Rules and Regulations. Committee Member: Energy, Utilities and Telecommunications; J. Russell (Russ) Jennings Joint Committee on Corrections and Juvenile Justice Oversight; Corrections and Juvenile Justice; Judiciary; Alvin Sykes Cold Case DNA Task Force. Of counsel: Conlee, Schmidt & Emerson, LLP. Education: University of Kansas, BGS; Wichita State University, BS; University of Kansas, JD.

Justin Cobb
Government Relations Manager
The Nature Conservancy
785-233-4400 Business
justin.cobb@TNC.org
Roles and Experience: Former Management Analyst for U.S. Army Force Management Support Agency Education: University of Central Missouri, BS.

Doug Curl
Director of Information Management
Kentucky Geological Survey
859-323-0519 Business
doug@uky.edu
Roles and Experience: Worked as a Geologist (levels II, III, and IV) and the head of Geoscience Information Management Section at the Kentucky Geological Survey before current position. Education: Guilford College, BS; University of Tennessee, MS.

Brenda Densmore
Hydrologic Studies Supervisor
U.S. Geological Survey, Nebraska Water Science Center
402-328-4120 Business
bdensmore@usgs.gov
Roles and Experience: Has worked at the Nebraska Water Science Center since 2001, starting as a student trainee before becoming a hydrologist in 2003. Started current position in 2020. Education: University of Nebraska-Lincoln, BS; University of Nebraska-Lincoln, MS.

Luke J. Drury
Senior Fiscal Analyst
Kansas Legislative Research Department
785-296-3181 Business
Luke.Drury@ks.gov
Roles and Experience: Committee Assignments: Administrative Rules and Regulations; Agriculture and Natural Resources. Policy areas: Agriculture and Natural Resources; Utilities and Energy. Education: Emporia State University, BS; Kansas State University, MPA.

Rodney Eggleston
Director of Public Works
City of Valley Center
316-755-7320
reggleston@valleycenterks.org
Roles and Experience: Mobile Data Manager for Westar Energy from 2008 to 2012; Enterprise Services Supervisor for Westar Energy from 2012 to 2016; Mayor of the City of Sedgwick, Kansas, from spring of 2013 to fall of 2016.

Charlotte Esau
Representative, District 14
Kansas State House of Representatives
785-296-7688
Charlotte.Esau@house.ks.gov
Roles and Experience: Committee Vice-chair: Legislative Modernization. Committee Member: Joint Committee on Child Welfare System Oversight; Judiciary; Welfare Reform; Child Welfare and Foster Care.

Marci Francisco
Senator, District 2
Kansas State Senate
785-296-7364 Business
Marci.Francisco@senate.ks.gov
Roles and Experience: Ranking Minority Member: Joint Committee on State Building Construction; Utilities; Financial Institutions and Insurance. Committee Member: Joint Committee on Administrative Rules and Regulations; Joint Committee on Information Technology; Joint Committee on Pensions, Investments and Benefits; Agriculture and Natural Resources; Federal and State Affairs; Statewide Broadband Expansion Planning Task Force; 2025 Special Committee on Campaign Contributions and Transparency. Education: University of Kansas, BArch.

Kate Gleeson
Deputy Director of Environment
Kansas Department of Health and Environment
785-296-1535 Business
kate.gleeson@ks.gov
Roles and Experience: Previously held position as Senior Environmental Attorney for KDHE. Education: University of Kansas, BS; University of Kansas, JD.

Kyle Halverson
Chief Geologist
Kansas Department of Transportation
785-600-8165 Business
Kyle.Halverson@ks.gov
Roles and Experience: Professional Geologist for KDOT since 2008. Oversees geologic issues related to transportation and evaluation of quarry materials used for on grade aggregate, rip-rap, and ditch liner. Education: Emporia State University, BS.

Jason Hartman
State Forester
Kansas Forest Service
785-532-3309
hartmanj@ksu.edu
Roles and Experience: Previously Assistant Fire Management Officer for Kansas Forest Service. Education: Oklahoma State University, BS.

Dave Heinemann
Member
Kansas Geological Survey Advisory Council (GSAC)
785-213-9895 Home
Daveh123@cox.net
Roles and Experience: Kansas Geological Survey Advisory Council member; Former State Representative (Speaker Pro Tem, 1985–1988); Former Executive Director and General Counsel for KCC. Education: Augustana College, BA; University of Kansas; Washburn Law School, JD.

Kyle D. Hoffman
Representative, District 116
Kansas House of Representatives
785-296-7643 Business
Kyle.hoffman@house.ks.gov
Roles and Experience: House Assistant Majority Leader; Committee Chair: Joint Committee on Information Technology. Committee Member: J. Russell (Russ) Jennings Joint Committee on Corrections and Juvenile Justice Oversight; Interstate Cooperation; Calendar and Printing; Appropriations. Education: Kansas State University, BS.

Ryan Hoffman
Director of Conservation Division
Kansas Corporation Commission
316-337-6200 Business
r.hoffman@kcc.ks.gov
Roles and Experience: Conservation Division Director for the Kansas Corporation Commission (2013–present), Litigation Counsel for the Kansas Corporation Commission (2008–2013). Education: The University of Kansas, BA; Washburn University, JD.

Nick Hoheisel
Representative, District 97
Kansas House of Representatives
785-296-7689 Business
Nick.Hoheisel@house.ks.gov
Roles and Experience: House Majority Whip. Committee Chair: Joint Committee on Pensions, Investments and Benefits; Joint Committee on Fiduciary Financial Institutions Oversight; Financial Institutions and Pensions. Committee Member: 2025 Special Committee on Commerce; Energy, Utilities and Telecommunications; Interstate Cooperation; Taxation; Transportation. Former member of the Wichita City Council District IV Advisory Board. Graduate of the Wichita/Sedgwick County Citizens Police Academy. Education: Wichita State University, BA.

Shelley Hooks
Vice Chancellor for Research
University of Kansas, Office of Research
785-864-0966 Business
shelley.hooks@ku.edu
Roles and Experience: Previously worked at the University of Georgia in a variety of positions including Assistant Professor, Graduate Program Coordinator, Associate Professor, Director of the UGA Center for Drug Discovery, Associate Vice President for Research, Professor of Pharmaceutical and Biomedical Sciences, and Interim Department Head. Education: Clemson University, BS. University of Virginia, PhD.; University of North Carolina School of Medicine, Post-Doc.

Christopher (Chris) Kennedy
Secretary
Kansas Department of Wildlife and Parks
785-296-2281 Business
Chris.Kennedy@ks.gov
Roles and Experience: Previously an Assistant Director for the Missouri Department of Conservation and Fisheries Regional Supervisor in Missouri. Education: University of Arkansas at Pine Bluff, BS.

Vanessa Lamoreaux
Deputy Secretary
Kansas Department of Transportation
785-296-3285 Business
Vanessa.Lamoreaux@ks.gov
Roles and Experience: Former Strategic Planning Coordinator for the Kansas Department of Health and Environment, Associate Director of Communications at the Kansas Board of Regents, Project Manager of Special Projects at the Kansas Foundation for Medical Care, and VP of Administrative Service at the Kansas Association of Realtors. Education: University of Kansas, BA.

Earl Lewis
Chief Engineer
Kansas Department of Agriculture
785-564-6670 Business
Earl.Lewis@ks.gov
Roles and Experience: Lead Division of Water Resources staff in administration of state laws related to water rights, water structures, interstate water issues, and associated statutes. Previously served in leadership roles at the Kansas Water Office for 21 years. Education: University of Kansas, BS.

Carolyn McGinn
Member
Kansas Water Authority
316-655-3301 Business
mcginnfarm@gmail.com Business
Roles and Experience: Co-owner of Grapes and Grains Farming. Former Kansas State Senator, District 31. Education: Wichita State University, BA; Friends University, MA.

Joshua McGinn
Assistant Secretary
Kansas Department of Agriculture
785-564-6700 Business
Joshua.McGinn@ks.gov
Roles and Experience: Previous experience in the state's Office of Rural Prosperity and as a senior policy analyst and deputy director for budget and policy. Most recently served as policy director within the Kansas Governor's Office. Education: Kansas State University, BA.

Heidi Mehl
Freshwater Director, Great Plains Division
The Nature Conservancy
785-424-4164 Business
Heidi.Mehl@tnc.org
Roles and Experience: Former Director of Water and Agriculture for TNC in Kansas. Board Member of Friends of the Kaw Inc. and Kansas Alliance for Wetlands and Streams. Hydrologic Technician for the USGS 2006–2009. Education: The University of Kansas, BS and MS; Kansas State University, PhD.

Jim Minnix
Representative, District 118
Kansas House of Representatives
785-296-7384 Business
Jim.minnix@house.ks.gov
Roles and Experience: Committee Chair: Water. Committee Member: Transportation; Agriculture and Natural Resources. 4th generation Scott County farmer; Scott County Commissioner; Founding member of the Scott Community Foundation. Education: Kansas State University, BS and MBA.

Brooklynne Mosley
Representative, District 46
Kansas House of Representatives
785-296-7122 Business
Brooklynne.Mosley@house.ks.gov
Roles and Experience: Committee Member: 2025 Special Committee on Federal and State Affairs; Corrections and Juvenile Justice; Agriculture and Natural Resources; Federal and State Affairs. Education: University of Kansas, BA.

Connie Owen
Director
Kansas Water Office
785-296-3185 Business
Connie.Owen@kwo.ks.gov
Roles and Experience: Licensed attorney who has practiced Kansas water law for more than 25 years. Served as Acting Chair of the Kansas Water Authority 2019–2020. Previous position was as Administrative Hearing Officer in the Division of Water Resources for the Kansas Department of Agriculture 2003–2020. Education: Emporia State University, BS; University of Kansas, JD.

Pat Pettey
Senator, District 6
Kansas State Senate
785-296-7375 Business
Pat.Pettey@senate.ks.gov
Roles and Experience: Ranking minority member: Ways and Means; Legislative Post Audit Committee. Committee Member: Legislative Budget Committee; Education Funding Task Force; Joint Committee on Pensions, Investments and Benefits; Robert G. (Bob) Bethell Joint Committee on Home and Community Based Services and KanCare Oversight; Local Government, Transparency and Ethics; Education; Public Health and Welfare; Higher Education Subcommittee; Human Services Subcommittee; General Government Subcommittee, Ways and Means. Served as a Unified Governor commissioner and an educator in the Turner School District for 36 years. Education: University of Kansas, BS and M.Ed.

Sandy Pickert
Representative, District 88
Kansas House of Representatives
785-296-5016 Business
Sandy.Pickert@house.ks.gov
Roles and Experience: Committee Vice-chair: General Government Budget. Committee Member: Water; Welfare Reform; Child Welfare and Foster Care; 2025 Special Committee on Health and Social Services. Education: KU-Wichita School of Medicine, RN, BSN, and MPH.

Katie Roby
State Director
The Nature Conservancy in Kansas
785-233-4400 Business
katie.roby@tnc.org
Roles and Experience: Former Associate Director and Director of Philanthropy at the Nature Conservancy. Education: Kansas City Art Institute, BFA; University of Kansas, MS.

Angel Roeser
Representative, District 67
Kansas House of Representatives
785-296-7402 Business
Angel.Roeser@house.ks.gov
Roles and Experience: Committee Member: Welfare Reform; Financial Institutions and Pensions; Agriculture and Natural Resources; Child Welfare and Foster Care. Education: Kansas State University, BS.

Laura Rose Clawson
Chief of Public Affairs
Kansas Department of Wildlife and Parks
785-296-2015 Business
laura.roseclawson@ks.gov
Roles and Experience: Previously worked for The Nature Conservancy as a Philanthropy Specialist, Philanthropy Manager, and Director of Marketing and Outreach. Education: Baker University, BA; Cambridge Judge Business School, Executive Education program.

Theresa Runnells
Deputy Director
Kansas Corporation Commission
316-337-6231 Business
Theresa.Runnells@ks.gov
Roles and Experience: Former Public Service Executive and Executive Assistant for the Kansas Corporation Commission. Education: Newman University, BA.

Ron Ryckman, Sr.
Senator, District 38
Kansas State Senate
785-296-7359 Business
Ron.Ryckman@senate.ks.gov
Roles and Experience: Committee Vice-Chair: Local Government, Transparency and Ethics. Committee Member: Judiciary; Commerce; Agriculture and Natural Resources. Retired teacher and coach. Education: Bob Jones University, MS.

Jim Schmidt
7th District Director
Kansas Farm Bureau
785-587-6000 Business
Schmidtj@kfb.org
Roles and Experience: Former president of McPherson County Farm Bureau and multiple state committees, including Membership and Promotion, Resolutions and the Dairy Advisory. Education: Bethel College.

Joe Seiwert
Representative, District 101
Kansas House of Representatives
785-296-7647 Business
Joe.Seiwert@house.ks.gov
Roles and Experience: Committee Chair: Statewide Broadband Expansion Planning Task Force. Committee Member: Water; Corrections and Juvenile Justice; Agriculture and Natural Resources. Education: Friends University, BBA.

Allan Soetaert
Member
Kansas Water Authority
913-856-7375 Business
asoetaert@water7.com
Roles and Experience: Manager of Rural Water District No. 7 in Johnson County for more than 35 years; served on the Mariais des Cygnes Regional Advisory Committee; chaired the five-member supervisory committee that provided guidance and oversight to a rural water district in central Kansas on the verge of foreclosure by the federal government; and chaired the Hillsdale Area Water Cooperative.

Janet Stanek
Secretary
Kansas Department of Health and Environment
785-296-1500 Business
janet.k.stanek@ks.gov
Roles and Experience: Prior to KDHE, spent more than 35 years in various healthcare leadership positions in Pennsylvania, western New York, and Kansas, including 21 years at Stormont Vail Health Topeka where last served as chief operating officer and senior vice president. Education: State University of New York College of Technology, BS; Alfred University, MBA; Thomas Jefferson University, Graduate Certificate.

Jean Steiner
Member
Kansas Water Authority
405-694-0740 Home
jlsteiner@ksu.edu
Roles and Experience: Joined the U.S. Department of Agriculture, Agricultural Research Service in 1983. Laboratory Manager for the Grazinglands Research Laboratory in El Reno, Oklahoma 2006–2018. Co-Lead Author on the Agriculture and Rural Communities Chapter of the 4th National Climate Assessment; Fellow of four international scientific societies; President of two scientific organizations, the Soil and Water Conservation Society and the American Society of Agronomy. Education: Cornell College, BS; Kansas State University, MS, PhD.

Mandy Stone
Supervisory Hydrologist
U.S. Geological Survey, Kansas Water Science Center
785-832-3578 Business
mstone@usgs.gov
Roles and Experience: Previously worked with AmeriCorps surveying streams in Missouri. Education: Kansas State University, BS; Southern Illinois University, MS.

Kyler Sweely
Representative, District 102
Kansas House of Representatives
785-296-7695 Business
Kyler.Sweely@house.ks.gov
Roles and Experience: Committee Member: Judiciary; Financial Institutions and Pensions; High Education Budget. Served as a Sergeant in the U.S. Army.

Matt Unruh
Assistant Director
Kansas Water Office
785-296-3185 Business
Matt.Unruh@kwo.ks.gov
Roles and Experience: Leadership of all activities related to the Kansas Water Office. Development of the Kansas Water Plan and Long-Term Vision for the Future of Water Supply in Kansas. Kansas Water Office for 10 years. Prior to KWO, spent nine years at the Kansas Department of Health and Environment as an Environmental Scientist. Education: University of Kansas, BS; Emporia State University, MS.

Bill Waln
State Fire Management Officer
Kansas Forest Service
785-532-3314 Business
bwaln@kus.edu
Roles and Experience: Wildland firefighter since 1987, working for the U.S. Fish and Wildlife Service in Nebraska and Kansas. Currently serves as the Incident Commander for one of the 44 Complex Incident Management Teams. Education: Fort Hays State University, BA.

Dawn Wolf
Representative, District 107
Kansas House of Representatives
785-296-7644 Business
Dawn.Wolf@house.ks.gov
Roles and Experience: Committee Member: Education; Taxation; Local Government; 2025 Special Committee on Taxation. Education: Brown Mackie College, ABA.

Kansas Geological Survey Staff

Brendan Bream
Associate Director of Energy and Stratigraphy
785-864-1632 Business
bbream@ku.edu
Roles and Experience: Joined the KGS as Associate Director for Energy and Stratigraphy in 2023; Former Geoscientist for ExxonMobil for 15 years; Taught for five years as a Senior Lecturer for Vanderbilt University. Education: UC Santa Barbara, BS; University of Tennessee Knoxville, MS and PhD.

Scott Ishman
Associate Director of Geohydrology and Geohealth, Senior Scientist
785-864-1971 Business
sishman@ku.edu
Roles and Experience: Research specialty in micropaleontology; current president of the Cushman Foundation; former Dean of Southern Indiana University College of Science and Professor of Geology for 22 years; Research Geologist for the USGS for eight years. Education: Indiana University of Pennsylvania, BS; The Ohio State University, MS and PhD.

Jay Kalbas
Director
785-864-3965 Business
Jaykalbas@ku.edu
Roles and Experience: Director and State Geologist of Kansas; Professor of Geology in the KU Geology Department. Geologist, Manager, and Development Supervisor for ExxonMobil 2005–2022. Education: Furman University, BS; University of Tennessee, MS; Purdue University, PhD.

Richard Miller
Program Director for Geophysics Applications and Field Services
785-864-2091
Rdmiller@ku.edu
Roles and Experience: Program head who originally joined the survey in 1983; oversees operations and activities of the Kansas Geological Survey Geophysics Applications and Field Services program. Education: Benedictine College, BA; University of Kansas, MS; University of Leoben, PhD.

Ken Nelson
Associate Director of GIS & IT
785-864-2164
nelson@ku.edu
Roles and Experience: Kansas Geographic Information Officer and serves on the National States Geographic Information Council Board of Directors. Education: University of Kansas, BS.

Nikki Potter
Associate Director of Libraries, Outreach, and Business Operations
785-864-2098
Nikki-potter@ku.edu
Roles and Experience: Manages the KGS Drill Core Repository; oversees the Publications, Library/Archive, and Data Resource Library; former Archivist for the KGS. Education: University of Kansas, BGS; University of Michigan, MS.

Blair Schneider
Associate Researcher and Outreach Manager
785-864-0663
Blair.schneider@ku.edu
Roles and Experience: Near-surface geophysics focusing on archaeological and forensic applications. Oversees outreach and science communication efforts from the Kansas Geological Survey; Kansas Field Conference coordinator. Education: James Madison University, BS; University of Kansas, MS and PhD.

Nick Schneider
Research Project Manager, Groundwater Quality Program
785-864-0731
Nick.schneider@ku.edu
Roles and Experience: Coordinates the Aquifer Water Quality Assessment (AWQUA) Program, which tests wells (with well owner approval) for various water quality parameters, samples the wells, and reports results back to the owners. The program is developing an online database and mapper to display the results, so Kansans have a better understanding of groundwater quality in their area. Education: University of Kansas, BS.

Brownie Wilson
Application and Services Manager, Geohydrology Division
785-864-2118
Bwilson1@ku.edu
Roles and Experience: GIS application and development; GIS Data Management and Assessment; Kansas Water Rights Data; Environmental Scientist II for the Department of Agriculture; Environmental Scientist IV for the Kansas Water Office. Education: Kansas State University, BS and MA.

Fundamentals for the Future: Water, Energy, and Infrastructure

Reno and Sedgwick Counties

June 17–18, 2025

Welcome to the 2025 Kansas Field Conference! This year feels extra special because we are celebrating our 30th tour since the conference began in 1995! We have decided to try a new format this year, reducing the length of the trip from three days to two days to better accommodate summer travel schedules. Even with one fewer day, we hope that you walk away with deeper insights into the natural resources challenges that this region experiences and the creative solutions that state agencies and city departments are developing to address them. The theme of this year's conference is "Fundamentals," and our goal is that everyone leaves with a common understanding of why these problems exist and how the possible solutions work.

Many of the sites on the 2025 tour are inherently linked by two common factors: salt and drought. Reno County contains the remnants of an ancient seaway, which left behind beds of salt that are hundreds of feet thick and 1,000 feet below the land surface. These salt beds have served as an important economic contributor for the state. However, some of these underlying salt beds are also actively dissolving because they are interacting with groundwater, which has led to serious problems for surface infrastructure and water quality. Extreme drought conditions have persisted in this region, especially in Reno County, for the past decade (fig. 1). Drought conditions affect water quantity levels in the region and contribute to increased natural hazard conditions for wildfires.

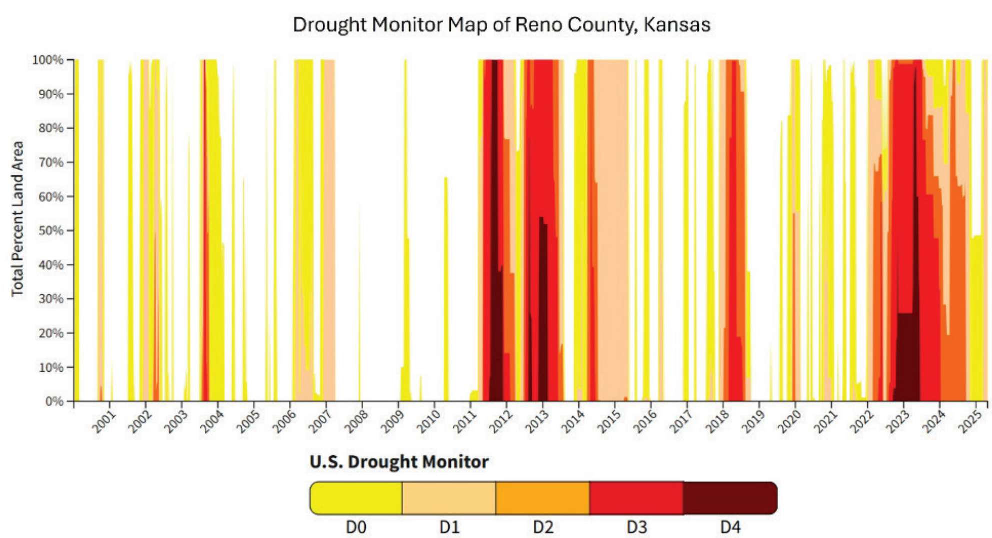


Figure 1. U.S. Drought Monitor for Reno County from 2000 to present. The USDM uses a five-category system: abnormally dry (D0; a precursor to drought, not actually drought) and moderate (D1), severe (D2), extreme (D3), and exceptional (D4) drought. Drought categories reflect experts' assessments of conditions related to dryness and drought, including observations of how much water is available in streams, lakes, and soils, compared to usual conditions for the same time of year. The U.S. Drought Monitor began in 2000 and is a collaboration of the National Drought Mitigation Center, National Oceanic and Atmospheric Administration, and the U.S. Department of Agriculture. The USDM publishes data weekly for the general public.[1]

Water

Three stops during this tour will focus on water and related challenges. We will begin on day one by visiting the city of Wichita's Aquifer Storage and Recovery project (ASR) in Sedgwick County. The ASR project diverts excess flows in the Little Arkansas River, treats the water, and stores it in the Equus Beds aquifer until needed. Presenters from the U.S. Geological Survey will give an update on the results of Phase II of this project, which began in 2013. After this stop, we will visit Cheney Reservoir and Cheney State Park. Cheney Reservoir has more than 9,000 acres of open water and serves as a water source for the city of Wichita.

The opening reception at the Sand Hills Event Center in Hutchinson on day one will include a panel presentation by Matthew Kirk of Kansas State University, Tim Boese of Groundwater Management District 2, and Nick Schneider of the Kansas Geological Survey. Panelists will discuss new and continuing projects aimed at measuring groundwater quality in the region. Day two will feature one more water quality stop at the Arkansas River, where the Kansas Department of Wildlife and Parks will showcase how macroinvertebrates — animals such as mussels and worms that don't have backbones but are large enough to see with the naked eye — can be studied as a measure of water quality.

Energy

Reno County has been a hot topic with respect to energy discussions in the last several years. Historically, Reno County has been active in the oil and gas industry with more than 95 active oil fields and one active gas storage field.[2] Since 1995, cumulative oil production has reached 111,470,322 barrels and cumulative gas production has reached 104,186,255 mcf (or 1,000 cubic feet) (fig. 2). Salt caverns, which are artificial underground chambers created by injecting freshwater down a well to dissolve salt in a process known as solution mining, have been used for hydrocarbon and natural gas storage since the 1950s.[3] Salt caverns are ideal environments for storage because the rock salt is impervious to liquid hydrocarbons and gases. The Kansas Department of Health and Environment developed basic regulations for the hydrocarbon storage industry in 1981, including requiring gamma-density logs to

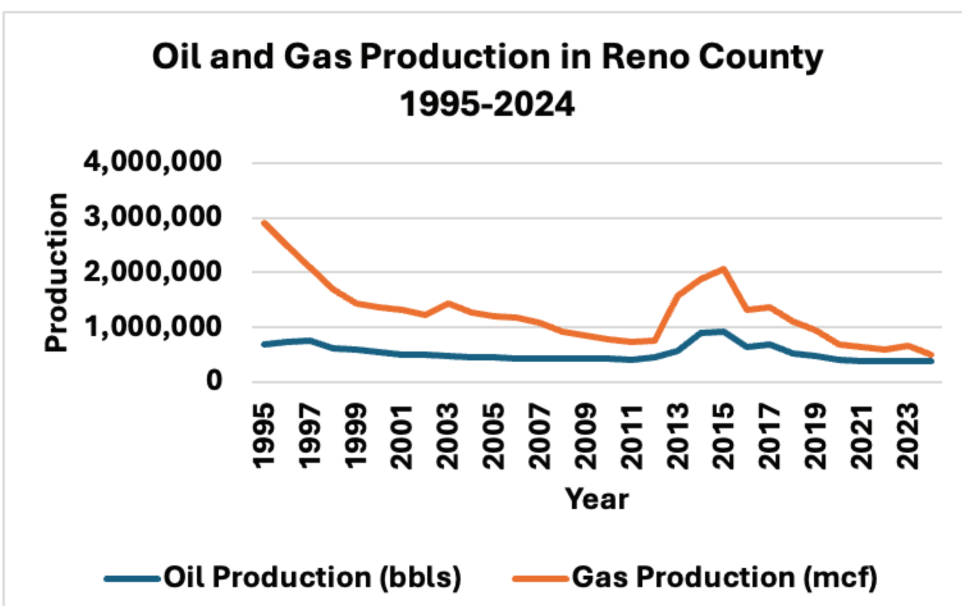


Figure 2. Oil and gas production in Reno County from 1995 to 2024. Bbls = barrels of oil; mcf = 1,000 cubic feet

monitor salt roof thickness, sonar surveys to monitor cavern capacity, annual summaries of storage pressures, and groundwater monitoring.[4] After a gas explosion in Hutchinson in 2001 killed two people and destroyed two downtown businesses,[5] the Kansas Legislature passed a statute (K.S.A. 55-1,117) that instructed and authorized KDHE to develop regulations for the safe and secure storage of hydrocarbons in salt caverns, overseen by KDHE's Underground Hydrocarbon Storage Program in the Division of Environment. To date, there are nine active storage facilities, 368 active-status storage wells and caverns with a storage capacity of about 73 million barrels, and 49 brine ponds.

Day two will conclude with two energy-related stops. The first will take us to the Knackstedt site 10 miles north of Hutchinson, where the KGS and the Kansas Corporation Commission are collaborating in a proof-of-concept study exploring the potential use of non-invasive remote sensing techniques to identify abandoned oil and gas wells. With this technology, the KGS can assist the KCC to locate abandoned oil and gas wells that need to be plugged. Our final stop will wrap up at the Kansas State Fairgrounds in Hutchinson where multiple speakers will provide hands-on demonstrations of a variety of energy-related topics in Kansas, including an update on recent models of underground rock layers developed by the Subsurface Dynamics Laboratory at the KGS.

Infrastructure

Issues related to salt and drought have affected the infrastructure in this region. Our second stop on day one at Cheney Reservoir will highlight the negative effects of drought conditions on the lake. As we leave the reservoir, the Kansas Department of Agriculture will discuss dam safety issues. Kansas has 6,490 dams, and 2,615 are managed by the state. The average age of these dams is 50 years old, and more than 500 of them are considered to have high hazard or significant hazard potential.[6] High intensity rainfall and flooding events, and resulting increases in erosion, significantly strain these structures.

Conversations relevant to infrastructure continue on day two. Reno County is one of a quarter of Kansas counties that are known to contain sinkholes. The Reno County sinkholes form when dissolution of salt beds underlying the surface forms voids that cause a change in subsurface pressure and may eventually lead to collapse. The first stop on day two will take us to Brandy Lake along U.S. Highway 50, where we will learn about the results of a partnership between the Kansas Department of Transportation and the KGS to better define the dissolution extent of the salt member at this site using seismic reflection techniques. During our lunch stop at Sand Hills State Park, Jason Hartman from the Kansas Forest Service will describe how the state is working to address the negative effects of increased wildfires in the area.

About the Kansas Field Conference

The Kansas Field Conference is designed to give policymakers the opportunity to explore and discuss natural resource issues. Participants have a chance to see what effects government and business decisions can have on natural resources and communities and to talk with government officials, business owners, researchers, and others who are directly involved with the various sites. We aim to provide a broad, informed perspective that will be useful in formulating policies and programs.

The annual field guide furnishes background about each site and can serve as a useful reference long after the conference is over. Field guides also are posted on the KGS website (www.kgs.ku.edu). You are encouraged to ask questions and contribute to the discussions. The bus microphone is open to everyone. Please remember that the intent of this conference is not to resolve policy or regulatory conflicts. By bringing together experts, we hope to go beyond merely identifying issues; we want the combination of firsthand experience and interaction among participants to result in a new level of understanding about the state's natural resources and concerns.

When possible, we attempt to provide a forum for all sides of a contentious issue. The opinions presented during the conference are not necessarily those of the Kansas Geological Survey or the field conference co-sponsors. Nonetheless, we believe it is important for participants to hear various viewpoints on complex issues. The Kansas Geological Survey and co-sponsors appreciate your attendance at this year's conference.

Sponsors

The Kansas Field Conference is made possible and kept affordable through the generous support of many groups. We thank them for their support.

Kansas Geological Survey

The KGS is a research and service division of the University of Kansas. Its mission is to study and report on the state's geologic resources and hazards. Much of the KGS focus is on energy, water, and a better understanding of the state's surface and subsurface geology. By statutory charge, the KGS role is strictly one of research and reporting. The KGS has no regulatory functions. Headquartered in KU's West District on the Lawrence campus, the KGS also has a Kansas Geologic Sample Repository in Wichita.

The following KGS staff are participating in the 2025 field conference:

- Blair Schneider, Geologist/Outreach Manager
- Jay Kalbas, Director
- Scott Ishman, Associate Director, Geohydrology and Geohealth
- Ken Nelson, Associate Director, GIS and Information Technology
- Nikki Potter, Associate Director, Libraries, Outreach, and Business Operations
- Brendan Bream, Associate Director, Energy and Stratigraphy
- Richard Miller, Program Director, Geophysics Applications and Field Services
- Nick Schneider, Research Project Manager, Groundwater Quality Program
- Brownie Wilson, Manager, Geohydrology Support Services

Kansas Geological Survey
1930 Constant Avenue
Lawrence, KS 66047-3724
785-864-3965

Kansas Geologic Sample Repository
4150 W. Monroe Street
Wichita, KS 67209-2640
316-943-2343

Kansas Department of Health and Environment

The Kansas Department of Health and Environment (KDHE) mission is to protect and improve the health and environment of all Kansans. KDHE has several divisions, including the Division of Environment, which has regulatory responsibility for air quality, environmental remediation, waste management, and water quality. The Division of Environment is the regulatory body that addresses harmful algal blooms, permits public water supply quality, permits industrial and municipal wastewater, and identifies quality-impaired lakes, streams, and wetlands. It also regulates underground hydrocarbon salt cavern storage and underground disposal wells unrelated to the oil and gas industry.

Kansas Department of Health and Environment
Curtis State Office Building
1000 SW Jackson Street
Topeka, KS 66612
785-296-1500

Kansas Department of Transportation

The Kansas Department of Transportation (KDOT) 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.

Kansas Department of Transportation
Dwight D. Eisenhower State Office Building
700 SW Harrison Street
Topeka, KS 66603-3754
785-296-3566
www.ksdot.org

Kansas Department of Wildlife and Parks

The Kansas Department of Wildlife and Parks (KDWP) is responsible for managing the state's living natural resources. Its mission is to conserve and enhance Kansas's natural heritage, wildlife, and wildlife habitats. Its responsibilities include protecting and conserving fish and wildlife and their habitats while providing for the wise use of these resources and associated recreational opportunities and providing public outdoor recreation opportunities through state parks, state fishing lakes, wildlife-management areas, and recreational boating on the state's public waters.

Kansas Department of Wildlife and Parks
1020 S. Kansas Avenue, Rm 200
Topeka, KS 66612-1327
785-296-2281
www.ksoutdoors.com

Kansas Department of Agriculture

The Kansas Department of Agriculture (KDA) has a mission to support the agriculture sector in Kansas, including farmers, ranchers, food establishments, and agribusiness, and the consumers they serve. KDA has several divisions, including the Division of Water Resources (DWR) and the Division of Conservation. DWR regulates how water is allocated and used, the construction of dams and levees, Kansas's Groundwater Management District Act, and the state's interstate river compacts. It also coordinates the national flood insurance program in Kansas. The Division of Conservation works with the county conservation districts, organized watershed districts, and other special-purpose districts to improve water quality, reduce soil erosion and flood potential, conserve water, and provide local water supply.

Kansas Department of Agriculture
1320 Research Park Drive
Manhattan, KS 66506
785-564-6700
agriculture.ks.gov

Kansas Water Office

The Kansas Water Office (KWO) is the water planning, policy, coordination, and marketing agency for the state. The KWO evaluates and develops public policies, coordinating the water-resource operations of agencies at all levels of government. The KWO administers the Kansas Water Plan Storage Act and the Water Assurance Act and advises the governor on drought conditions. The KWO develops the Kansas Water Plan, which addresses the management, conservation, and development of water resources in the state. The Kansas Water Authority, statutorily within and a part of the KWO, advises the governor, legislature, and director of the KWO.

Kansas Water Office
900 SW Jackson, Suite 404
Topeka, KS 66612-1249
785-296-3185
www.kwo.org

The Nature Conservancy

The Nature Conservancy is a global environmental nonprofit whose mission is to conserve the lands and waters on which all life depends. Founded in 1951, it has more than a million members and more than 400 scientists on staff and impacts conservation in 79 countries and territories. The Nature Conservancy has permanently protected 190,000 acres in Kansas, including five preserves that are open to the public: Little Jerusalem Badlands State Park, Cheyenne Bottoms Preserve, Konza Prairie, Tallgrass Prairie National Preserve, and Smoky Valley Ranch.

Kansas Field Office
The Nature Conservancy
PO Box 4345
Topeka, KS 66604
785-233-4400
Kansas@tnc.org

Kansas Corporation Commission

The KCC was originally established in 1883 to regulate railroad activity. The KCC was one of the first state regulatory bodies in the nation. In 1911, the Kansas Legislature created a three-member Public Utilities Commission to regulate telegraph and telephone companies, pipeline companies, common carriers, water, electric, gas, and all power companies with the exception of those owned by municipalities. The present regulatory body, the KCC, was established by the Legislature in 1933. Over the years, its jurisdiction was extended to include motor carriers, oil and gas conservation, and supervision of plugging abandoned wells to protect fresh and useable water from pollution.

Kansas Corporation Commission
1500 SW Arrowhead Road
Topeka, KS 66604-4027
785-271-3100
www.kcc.ks.gov

Tuesday, June 17, 2025

9–11 a.m. **Optional tour of Strataca Underground Salt Museum**
3650 East Avenue G
Hutchinson, KS 67501

2 p.m. Depart hotel
Fairfield Inn
1111 N. Lorraine St.
Hutchinson, KS 67501

Note: Hotel cannot guarantee rooms will be ready until 3 p.m. You will be able to store your luggage, if needed.

Bus Talk: Thirty Years of Managed Aquifer Recharge Cooperative Science: The Equus Beds Aquifer and Little Arkansas River
Mandy Stone, U.S. Geological Survey

2:45 p.m. **Stop 1: Wichita's Aquifer Storage and Recovery Project**
Shawn Maloney, City of Wichita

3:30 p.m. Bus to Cheney Reservoir

4:15 p.m. **Stop 2: Cheney Reservoir**
Tim Boese, Groundwater Management District 2
Ted Harris, Kansas Biological Survey

5 p.m. Bus to Sand Hills Event Center

Bus Talk: Dam Safety
Earl Lewis, Kansas Department of Agriculture

6 p.m. **Networking Dinner and Reception**
Sand Hills Event Center
4601 N. Plum St., Hutchinson

Welcome
Jay Kalbas, Director, Kansas Geological Survey
Blair Schneider, Outreach Manager, Kansas Geological Survey

Panel Presentation: Water Quality Issues in Kansas
Connie Owen, Kansas Water Office (moderator)
Matthew Kirk, Kansas State University
Tim Boese, Groundwater Management District 2
Nick Schneider, Kansas Geological Survey

8:30 p.m. Bus to hotel

NOTES

Wichita's Aquifer Storage and Recovery Project: A Successful Intervention to Aid the City in Times of Drought

Kansas Geological Survey

STOP 1

KEY FACTS

- Wichita's Aquifer Storage and Recovery project diverts excess flow in the Little Arkansas River, treats it, and stores it in the Equus Beds aquifer until needed.
- The USGS supports this project through water-quality monitoring efforts that provide data to characterize real-time and changing water-quality measurements, allowing the city to make informed municipal water-supply decisions.
- Wichita receives credits for the recharged water, which allows the city to pump from the aquifer when the water table is above a minimum elevation.
- Through 2024, the ASR project stored more than 5.7 billion gallons of recharge water.
- Construction costs for phase I and phase II of the project totaled about $277 million.

The city of Wichita receives its water from Cheney Reservoir and the Equus Beds aquifer, which are both located in the state's Equus Beds Groundwater Management District 2 (fig. 1). Cheney Reservoir is a surface water source, and the Equus Beds aquifer is a groundwater source. Drought has affected this region since 2012. As a result, the city implemented its drought response plan and is currently in stage 2, triggered when the 12-month moving average of Cheney Reservoir's conservation pool level is between 50% and 69%. Stage 2 conservation plans include restrictions on outdoor watering for all non-crucial watering activities (fig. 2). The city is also working to reduce the amount of water it pulls from Cheney Reservoir. Today, it gets 60% of its overall water from Cheney Reservoir and 40% from the Equus Beds aquifer.[1]

This is not the first time that the city has experienced drought conditions. Historic low water levels in the Equus Beds aquifer near the city's wellfield resulted in a 1993 study to evaluate future projections of water quantity and water quality for the city. A master planning study determined that the city's water supplies would not be able to match the current growth rate into 2015. The water quality study, led by the U.S. Geological Survey, Equus Beds Groundwater Management District 2, and the federal Bureau of Reclamation, focused on the effects of salt-water contamination from a nearby oil field brine. The results of the study projected that at its current rate of water quantity

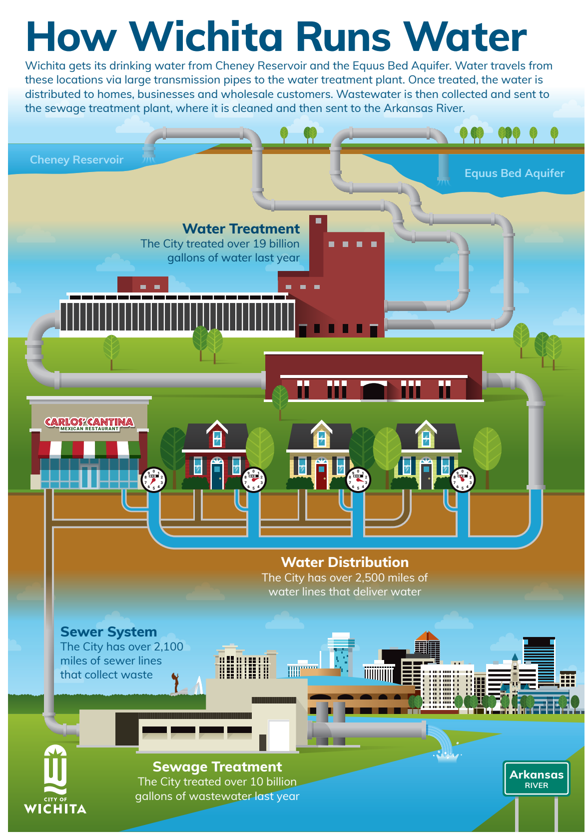


Figure 1. Wichita water sources, how the water is treated, and where it is distributed after treatment. Source: City of Wichita.

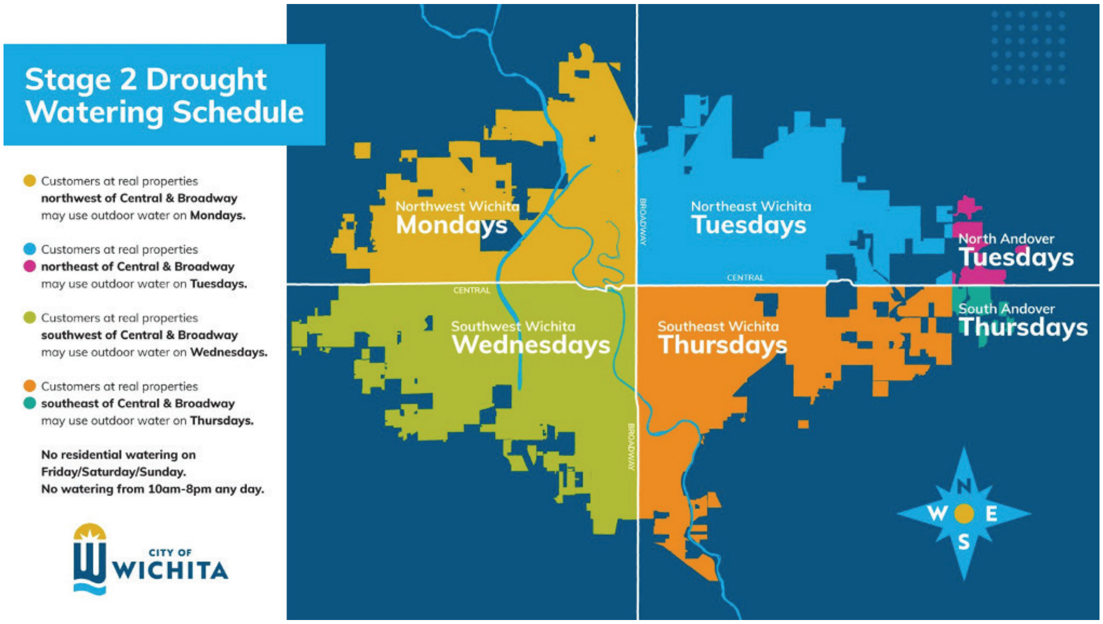


Figure 2: Stage 2 drought watering schedule for city of Wichita residents for any activities that are non-crucial water activities (such as watering lawns). Water activities are also suspended from 10 a.m. to 8 p.m. each day.

decline, chloride levels would be in excess of the 250 milligram per liter drinking water standard by 2050.[2]

In response to these results, Wichita adopted a multipronged Integrated Local Water Supply Plan (ILWSP), which included a proposal for a new Aquifer Storage and Recovery (ASR) project. ASR is an innovative strategy to capture excess streamflows in a region in which water rights are already fully appropriated. Now more than 20 years later, because of the ASR, the city has sufficient quantities of water to meet projected normal demands and growth but would still be at risk during an extended, severe drought.

The Basics

The city has permitted water rights of 40,000 acre-feet in its Equus Beds wellfield. During the 1990s, Equus Beds aquifer pumping for irrigation and municipal demands led to groundwater declines of up to 40 feet, and additional new appropriations were not an option. The ASR project provides a creative solution to the city's potential water shortfalls by diverting unappropriated high flows from the Little Arkansas River, treating the water, and storing it in the aquifer for later use.

Phase I of ASR was completed in 2006 with a focus on slowing the Burrton oil field chloride plume — groundwater contamination associated with oil field evaporation pits remaining from the 1930s — that was moving toward the city's wellfield (fig. 3). Additionally, the Wichita Equus Beds wellfield

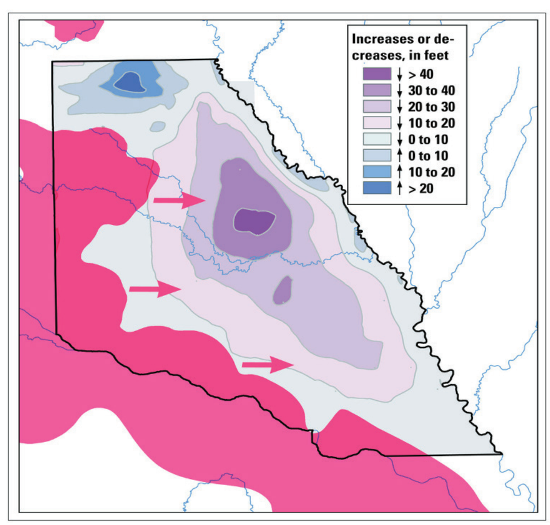


Figure 3: Water-level changes from predevelopment to 1993 in the Equus Beds ASR project study area and chloride plume (pink). Source: U.S. Geological Survey.

is susceptible to saltwater contamination from the Arkansas River, which naturally has higher concentrations of chlorides from the saltwater marshes and salt solution mining in the area.[3]

Phase II of ASR began in 2013 with goals of both slowing the plume and extending the longevity of the aquifer. Construction costs for phases I and II totaled about $277 million. Now operational, phase II of ASR has the capacity to process 30 million gallons of water per day when source water from the river is available. There is one point of diversion, one treatment plant, two active recharge basins, and 30 recharge wells (fig. 4). Water diverted from the river is sent to a settling basin, where the sediment is settled out and is returned to the river. The water is then treated using ultrafiltration membranes and advanced

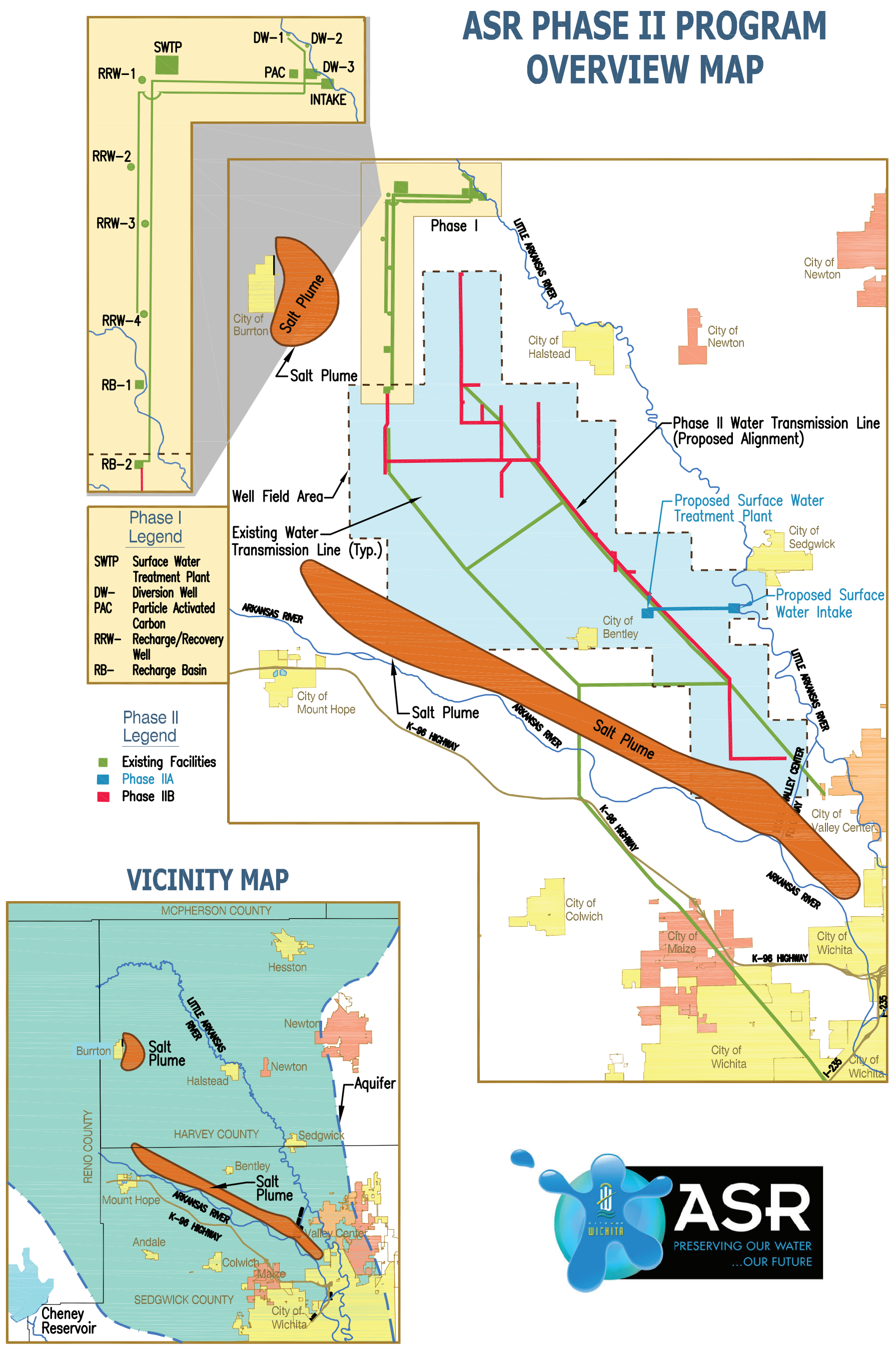


Figure 4. Wichita's Aquifer Storage and Recovery project. Source: City of Wichita.

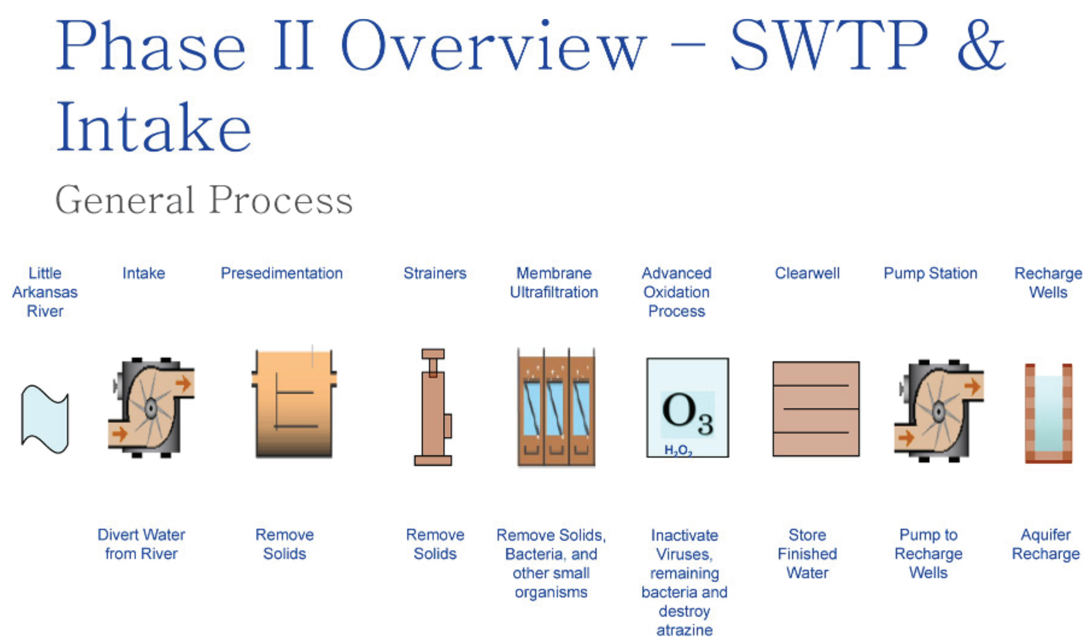


Figure 5. Wichita ASR process from river intake through surface water treatment plant (SWTP). Source: Burns & McDonnell.

oxidation techniques (fig. 5). The river water is treated for any constituents of concern, such as atrazine, before the water is put into the aquifer.

The city receives recharge credits for water recharged into the aquifer, which allows the city additional water to pump to meet its needs. A groundwater-flow model is used to estimate the storage changes that can be attributed to artificial recharging of the aquifer. The total accumulation of recharge credits cannot exceed 120,000 acre-feet, which was the amount of aquifer storage space available within the ASR project area in 1993. By 2017, the Equus Beds aquifer levels had risen to near predevelopment levels (98% full). This meant there would be limited storage options until drier times when the Equus Beds aquifer levels had been pumped down.

The city is allowed to pump its recharge credits as long as the water table is above the minimum standard set at the lowest measured aquifer level in 1993, which was 88% of the predevelopment water level. Below that level, the city cannot use recharge credits to pump from the aquifer. This drives the city to anticipate a need for extra water and pump it before a decline in the water table makes it no longer legally accessible. Because of the drought conditions, the city is currently pulling 60% of its water from Cheney Reservoir and 40% of its water from the Equus Beds aquifer.

A 2014 comprehensive water supply evaluation study indicated that the city had adequate water at that time to meet existing needs and future demands but was at risk during a 1% drought, which is a drought of such severity that there is only a 1 in 100 chance of it occurring in any given year. A 1% drought would trigger stage 4 of the city's drought response plan, the highest stage. The improved outlook for having sufficient water outside of the 1% drought was in part due to conservation through a revised water-use rate structure, a city-financed conservation outreach effort, and consumers using more efficient appliances.

Status

Through 2024, the ASR project stored more than 5.7 billion gallons of recharge water, generating more than 9,000 acre-feet of ASR credits. These credits may be critical as the drought conditions continue in south-central Kansas.

The city is currently pursuing improvements to the ASR project by conducting a study for the siting and design of two additional recharge basins. These recharge basins will allow for more efficient recharge operations to maximize the recharge water from each high river flow event. The USGS continues to support this project by providing current water-quality monitoring efforts that provide data to characterize real-time and changing water-quality measurements and that allow the city of Wichita to make informed municipal water-supply decisions. Congressional support for this project has included the award of a 25-percent matching grant through the federal Bureau of Reclamation.

CONTACTS

Shawn Maloney, P.G.
ASR/Wellfield Program Manager
City of Wichita
SMaloney@wichita.gov

Mandy L. Stone
Supervisory Hydrologist
U.S. Geological Survey
Central Plains Water Science Center
(Kansas and Nebraska)
mstone@usgs.gov
785-832-3578

NOTES

STOP
2

Cheney Reservoir

Hannah Horinek

KEY FACTS

- Cheney Reservoir supplies about half of the drinking water used by Wichita residents.
- Historically, Cheney Reservoir has struggled with over-enrichment through fertilizer runoff, which creates harmful algal blooms — contributing to decreased water quality and change in taste.
- Wichita announced a stage 2 drought in August 2024, signaling restrictions to municipal, industrial, and recreational water users.
- Drought harms wildlife, reduces water quality, affects recreational activities at the lake, and threatens the financial stability of businesses at the reservoir.

Introduction

Cheney Reservoir, commonly known as Cheney Lake, is an artificial reservoir in south-central Kansas (fig. 1). The lake, about 20 miles west of Wichita, and its associated drainage basin encompass parts of Reno, Stafford, Pratt, Sedgwick, and Kingman counties.[1] Cheney Reservoir is a significant supply of drinking water for Wichita, accounting for more than half of the city's total municipal use.[2]

Home to wildlife and visited annually by more than half a million people (590,598 in 2023, and 645,576 in 2024), Cheney Reservoir has had some challenges over the past few decades, notably algal blooms and receding water levels. Presently, local decision-makers are taking steps to mitigate further water recession by enacting drought stage responses to limit recreational, municipal, and industrial use of the remaining reservoir.

Figure 1. Drone imagery of Cheney Reservoir during normal conditions. Photo: Martin deBoer, KDWP.

History

The U.S. Bureau of Reclamation constructed the reservoir in 1965 primarily to supplement the municipal water supply for the city of Wichita, diverting pumping from the Equus Beds aquifer and regulating the flow of the North Fork of the Ninnescah River, which feeds the reservoir.[1, 2] The reservoir sits southwest of the Equus Beds aquifer. Cheney Reservoir spans approximately 9,500 acres of water surface and has about 67 miles of shoreline (fig. 2). The Kansas Department of Wildlife and Parks manages Cheney Reservoir and its surrounding areas.

Cheney State Park is home to various wildlife species. The Cheney Wildlife Area, located on the southeastern side of the reservoir, is a habitat for birds, including bald eagles, waterfowl, and shorebirds (especially during migration seasons); fish such as walleye, white bass, crappie, and channel catfish; and mammals, including white-tailed deer, beavers, opossum, and raccoons.[1]

Water Quality

Cheney Reservoir has historically struggled with efforts to decrease agricultural runoff of excess nitrates into the water — also known as over-enrichment, or eutrophication — to try to preserve water quality. In a balanced ecosystem, bacteria break down biological waste as it is deposited into the water. However, if nutrients are added in large excesses, such as downstream runoff from fertilizers, pesticides, and chemicals, without proper filtration or biological measures to break nutrients down, algal colonies proliferate and create harmful algal blooms (commonly shortened to HABs). When HABs are not remediated, they can negatively alter the quality of the water and produce harmful environments for fish and local wildlife.[3] HABs can even result in an unpleasant taste and odor-causing metabolites that are more costly for treatment centers to remedy.[3] Several efforts are underway to maintain and improve the water quality of

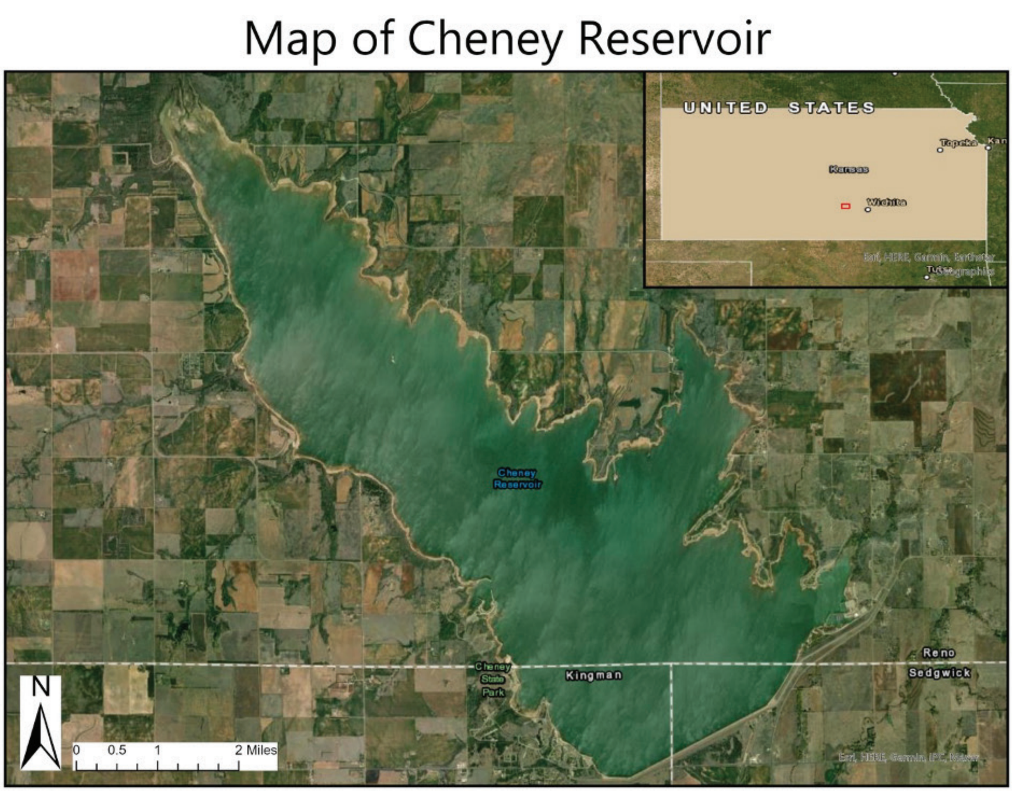


Figure 2. Cheney Reservoir. Map: Elizabeth Horinek, based on U.S. Geological Survey satellite imagery.

Cheney Reservoir, including regular testing for eutrophication and measuring sediment levels, both of which can affect water clarity and aquatic life. Some of the key efforts include riparian buffer restoration, watershed protection initiatives, and community education and involvement.

Riparian buffer restoration is a term used to describe efforts to stabilize the banks of rivers through biological means. Natural vegetation along streams and shorelines helps filter out pollutants before they enter the reservoir and prevents soil erosion. Vegetation also creates more surface area for natural bacteria to live and consume excess nitrates in the water. Additionally, conservation reserve programs incentivize farmers to set aside land for conservation, reducing runoff and improving soil health.

Community education programs play an essential role in water quality efforts. The KDWP measures the water quality of Cheney Reservoir and oversees public outreach and education efforts to promote responsible public engagement with the wildlife at the reservoir. They frequently host workshops in the area on topics such as boating education and invasive aquatic species. Grassroots movements also have cropped up to protect the reservoir's water levels and quality. One major initiative is Cheney Lake Watershed, Inc., a coalition of local farmers and landowners who reside along the Ninnescah River and Cheney Lake.[4] CLW works to reduce agricultural runoff by educating members on implementing no-till farming, cover crops, and buffer strips to prevent sediment, pesticides, and fertilizers from washing into the lake.

Because Cheney Reservoir aids in supplying Wichita's drinking water, the city has invested in advanced water treatment technologies and public-private partnerships to fund conservation projects upstream. These efforts have improved water clarity, reduced sedimentation, and increased awareness of responsible nutrient management.

Current Drought Conditions

In January 2023, when evaluating decreased water levels at Cheney Reservoir, drought concerns pushed Wichita officials to initiate voluntary water conservation measures (stage 1 of the city's drought response plan).

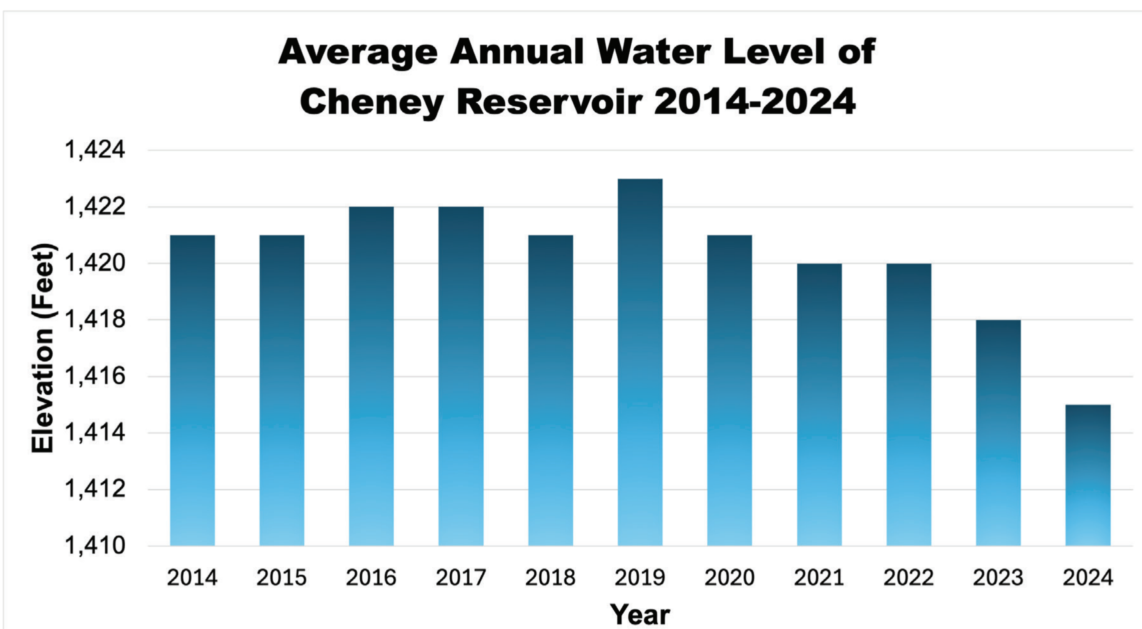


Figure 3. Cheney Lake water levels as measured by the U.S. Geological Survey. Data retrieved from the USGS website.[7]

By late July 2024, the crisis had worsened, prompting the city to escalate to stage 2 of the drought plan, which introduced mandatory water restrictions, including limiting outdoor watering to one day per week.

On July 1, 2024, Cheney Reservoir water levels were measured at 66.4% full. By late August 2024, the reservoir's levels declined to below 60%, triggering continued enforcement of stage 2 restrictions. Despite experiencing slight rainfall in fall 2024, the reservoir remained approximately 8 feet below its normal level in November, indicating that substantial additional rainfall was necessary to alleviate the drought conditions.[5]

Heavy rainfall in late May 2025 replenished several feet of water. As of June 2025, Cheney Reservoir measured about 76% full — roughly 4 feet below normal levels.[6] Despite the recent rain, the drought has visibly affected the reservoir, with receding waters exposing more shoreline and hindering recreational activities. Of note, the boating marina lies completely exposed, resulting in the loss of revenue as boaters do not renew their leases. Although the drought unquestionably harms wildlife, reduces water quality, and impacts Wichita water use, it also threatens the financial stability of local businesses at the reservoir, which rely heavily on visitation and foot traffic to meet expected sale quotas for the year. Wichita city officials have emphasized the importance of continued water conservation efforts and may have to take more drastic measures as the drought continues.

CONTACTS

Martin deBoer
Chief of Staff
Kansas Department of Wildlife and Parks
Martin.deBoer@KS.GOV

Ted Harris
Associate Scientist
Kansas Biological Survey
tedharris@ku.edu

Tim Boese
Manager
Equus Beds Groundwater Management District 2
Tboese@gmd2.org

Dam safety

Ellie Biebesheimer

The Cheney Reservoir dam is owned and managed by the U.S. Bureau of Reclamation. Construction began in 1962 and was completed in 1965. It is one of 6,490 dams listed in the National Inventory of Dams in Kansas[1] — the second highest number of dams in the country.[2] Of these, 2,615 are regulated by the state,[1] 8 (like the Cheney Reservoir dam) are regulated by the Bureau of Reclamation, and 16 are regulated by the U.S. Army Corps of Engineers. The remaining dams, more than half the total, have no regulatory oversight.[3]

The majority of dams in Kansas are privately owned, while the remaining dams are owned by local governments, the state, the federal government, or public utilities[2] (fig. 1). Most dams in Kansas are found in the eastern half of the state, but almost every county has at least one dam (fig. 2).

Each dam is unique and designed based on specific site conditions, but several structural features are common to most designs. Basic features include the crest, spillway outlet, and an auxiliary spillway (fig. 3). The crest of a dam is the upper section of the dam used as a roadway or walkway. The spillway is designed to control the release of water downstream from the dam. It is an important safety feature and intended to protect the dam from erosion. Larger dams may also have an auxiliary spillway, previously called emergency spillways, that provide additional dam safety protection during large flood events.

Dams like the one at Cheney Reservoir and their lakes play key roles in the storage and delivery of municipal and industrial water supplies, flood control, and public recreational opportunities, such as fishing, camping, and boating. Dams also can result in the creation of more or new habitat for wildlife, and one Kansas dam — the Bowersock dam in Lawrence — is a source of hydroelectric power.[5]

Dams can have one of three classifications, based on the potential danger posed to property and life downstream should the dam fail: low hazard, significant hazard, and high hazard.[3] In Kansas, these classifications are also referred to as class A, class B, and class C, respectively.[6] Figure 2 shows the locations of all dams in the state as well as their hazard level.

KEY FACTS

- 2,615 of 6,490 dams in Kansas are regulated by the state.
- 181 of the state-regulated dams are classified as significant hazard (class B) and 327 are classified as high hazard (class C).
- The Kansas Department of Agriculture's Division of Water Resources has established the Dam Safety Program to reduce the risks to life and property from dam failure.
- Challenges facing Kansas dams include hazard creep, aging infrastructure, and cost of maintenance and updating.

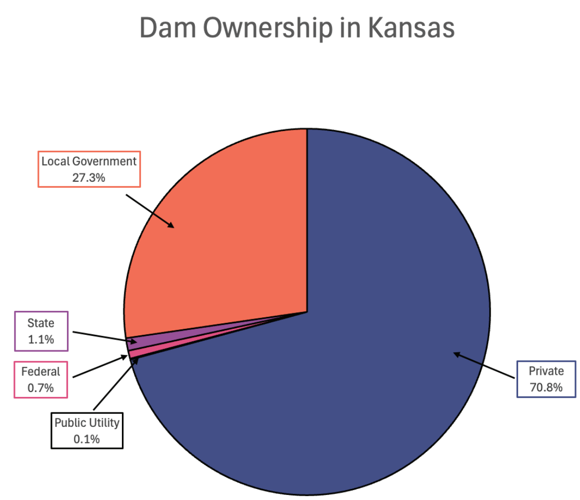


Figure 1. Breakdown of dam ownership in Kansas.

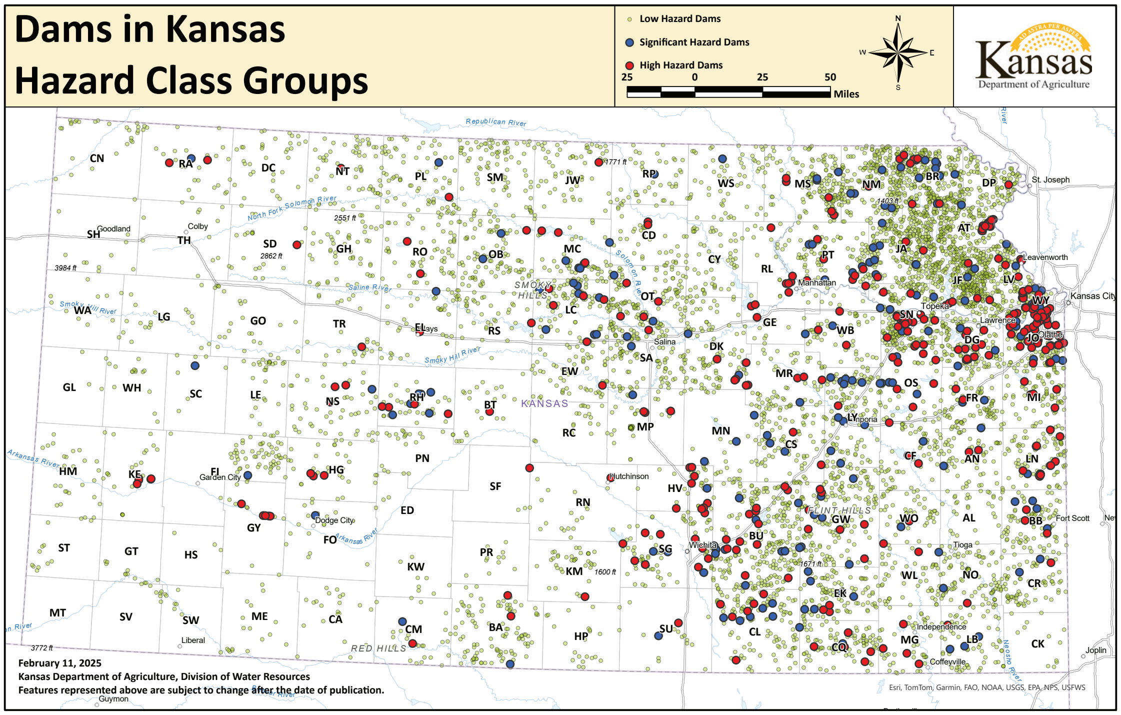


Figure 2. Location of dams in Kansas and their hazard level classifications.[3]

The state regulates 2,107 low hazard dams (class A), 181 significant hazard dams (class B), and 327 high hazard dams (class C).[1]

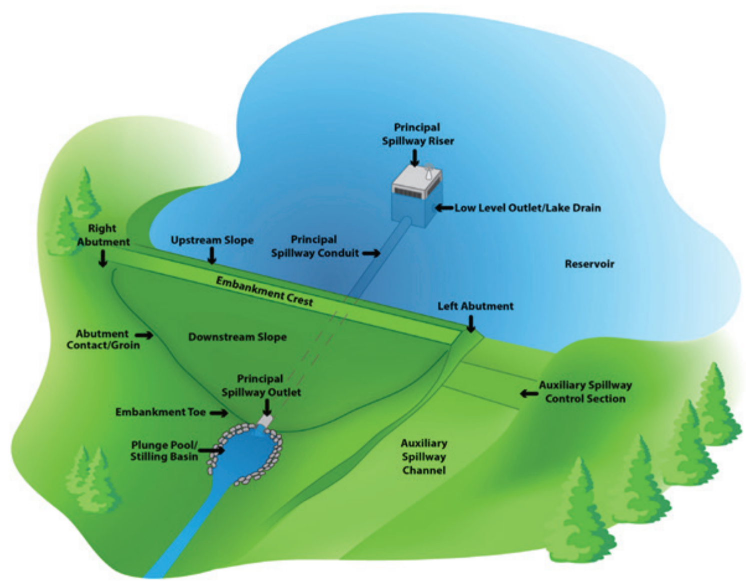


Figure 3. Anatomy of a dam structure. Though each dam has unique characteristics specific to the site setting, all have several common features.[4] Source: Association of State Dam Safety Officials.

History of Dam Regulation in Kansas

Dams have been regulated by the state of Kansas since 1929, when the Obstructions in Streams Act first passed. This act mandated the inventory of dams that were 10 feet or higher in height and had 15 acre-feet of storage.[7] In the first 20 years of regulation, more than 1,500 dams were inventoried. These requirements have changed over time, and in 2013 legislators re-defined a state jurisdictional dam as one that is either 25 feet or taller in height or one that is six feet or taller in height with the capacity to hold 50 acre-feet of water before water starts flowing down its auxiliary spillway.[7]

Today, the Department of Agriculture's Division of Water Resources has formed the Dam Safety Program. The goal of this program is to reduce the risks to property and life that may occur due to dam failure through review and approval of dam construction and modification, oversight of quality control during construction, and monitoring dams that pose a risk to life and property or that could cause disruptions to public utilities or services.[6] The Division of Water Resources also provides dam safety information to the public through such programs as the Water Structures Program's Kansas Dam Safety Conference, held yearly since 2003. This conference covers research, legislative updates, case studies, environmental impacts, DWR program news, and other dam-related topics to increase stakeholder knowledge of dam safety and state regulations. DWR also offers two free seminars: the Small Dam Owner Seminar and the Significant and High Hazard Dam EAP Seminar.[7]

Challenges

Several challenges face Kansas dams today, including those that are classified as high or significant risk. First, the average dam age in Kansas is 54 years,[2] and although each dam is unique in its design, construction, operation, and maintenance, many are reaching the end of their design life.[9] These dams can suffer from various issues, including corrugated metal pipe failure, soil erosion, and sedimentation plugging the primary spillway.[9] The cost of updating and maintaining these dams can be burdensome to land owners. For example, the city of Wichita approved $13.85 million in 2024 for repairs to Cheney Reservoir. Additionally, dams may experience "hazard creep" — the slow increase of a dam's hazard classification due to development downstream. A small dam in Johnson County near Pflumm Road and Blackfish Parkway, for example, was considered a low hazard dam (class A) in 1991, but because of development downstream, it has become a high hazard dam (class C) and is out of compliance with DWR's hydrologic regulations (fig. 4).

The Division of Water Resources also faces funding and personnel challenges in handling state-regulated dams. The state of Kansas receives some federal funding through the Federal Emergency Management Agency's National Dam Safety Program and its High Hazard Potential Dam Grant Program. An additional surplus of funding was received in FY2024 because of the Investing in America Agenda and the Bipartisan Infrastructure Law. State funding for dam safety is about $500,000 through the Water Structures Program budget. This funding supports regulation of the construction, operation, and maintenance of dams in Kansas. Kansas falls below the national average of funding per regulated high hazard dam ($1,300 per dam compared to a national average of $4,500 per

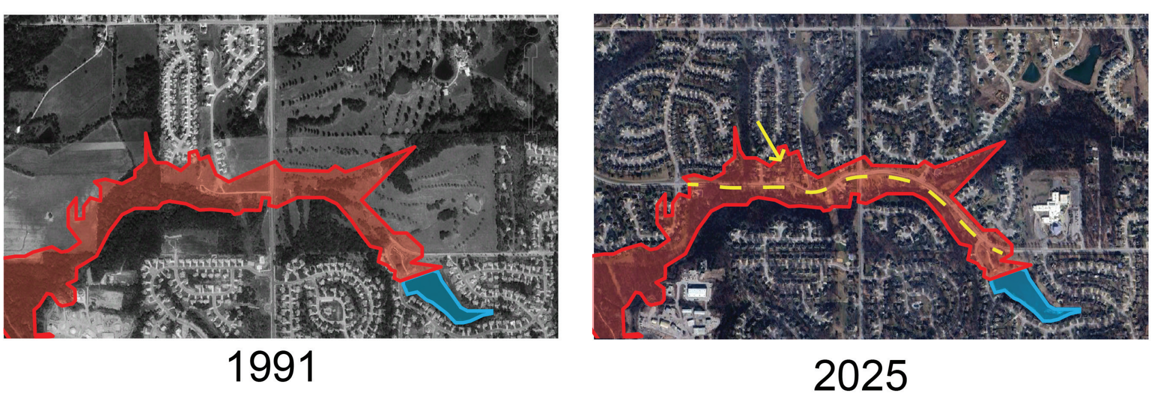


Figure 4. Case study of hazard creep. Left: The breach inundation area (red) of the dam and its reservoir (blue) as it was in 1991. Development is minimal, and the dam is classified as low hazard. Right: The same dam and its breach inundation area in 2025. Note the large amount of development. The addition of multiple houses (yellow arrow) and a major road (dashed yellow line) would reclassify this dam as high hazard.

dam).[8] Additionally, regulatory staff members in Kansas are responsible for a greater number of dams than their counterparts nationwide, with one full-time equivalent employee in Kansas for every 700 regulated dams compared to a national average of one to 200.[9]

CONTACT

Earl Lewis
Chief Engineer
Kansas Department of Agriculture
Division of Water Resources
earl.lewis@ks.gov

Wednesday, June 18, 2025

8 a.m.	Breakfast at hotel and check out
8:30 a.m.	Bus to Stop 3
8:55 a.m.	**Stop 3: U.S. Highway 50 Subsidence Features** Kyle Halverson, Kansas Department of Transportation Rick Miller, Kansas Geological Survey
9:45 a.m.	Bus to Stop 4
10 a.m.	**Stop 4: Hutchinson Salt Company Mill** Jim Barta, Hutchinson Salt Company
10:30 a.m.	Bus to Stop 5
10:45 a.m.	**Stop 5: Arkansas River** Chris Berens and Mark Van Scoyoc, Kansas Department of Wildlife and Parks
11:30 a.m.	Bus to Stop 6
	Bus Talk: Fighting Fire with Strategy: Wildland Fire Management Today Jason Hartman, Kansas Forest Service
11:45 a.m.	**Stop 6: Sand Hills State Park**
	Continued Wildfire Discussion Jason Hartman, Kansas Forest Service Steve Beer, Fire Chief, City of Hutchinson
	Botanist Trail Walk Craig Freeman, Kansas Biological Survey
	Lunch
12:45 p.m.	Bus to Stop 7
1:05 p.m.	**Stop 7: Knackstedt Site Demonstration of Aeromag and UAS LiDAR** Jeff Klock, Kansas Corporation Commission Rick Miller, Kansas Geological Survey

1:45 p.m. Bus to Stop 8

Bus Talk: The Future of Energy in Kansas
Jay Kalbas, Kansas Geological Survey

2:05 p.m. **Stop 8: Fundamentals for the Future Poster Session: Energy and Natural Resource Projects in Kansas**

Oil and Gas in Kansas
Jennifer Mull, Mull Companies
Doug Louis, Kansas Geological Survey

Subsurface Resource Assessment
Brendan Bream and Souvik Bhattacharjee, Kansas Geological Survey

Salt Storage and Energy
Jay Kalbas, Kansas Geological Survey

Critical Minerals
Blair Schneider and Nikki Potter, Kansas Geological Survey

On-Farm Solar Arrays
Mark Horst, King Solar
Hanna Szydlowski, Kansas Geological Survey

Energy and Water Efficiency in Farming Practices
Connie Owen and Matt Unruh, Kansas Water Office

3:15 p.m. Bus back to hotel

3:30 p.m. Arrive hotel, end of trip

STOP
3

Land Subsidence and Salt Dissolution in Reno County

Hannah Horinek

Reno County is a unique geological province shaped by ancient seas, buried salt deposits, and an ever-evolving history of natural and artificial hydrologic activity. This story's center is the Hutchinson Salt Member, a thick Permian halite (salt) deposit that lies 400–1,000 feet below the surface in central Kansas. The dissolution of this salt, whether caused naturally or by human activity, can present a hazard in the form of land subsidence when cavities formed in the salt can no longer support overlying rocks and sediment. In 1974, for example, a 300-foot-wide sinkhole related to decades of salt mining in the area damaged railroad tracks in Hutchinson (fig. 1). A more recent example of this process is noticeable today near Brandy Lake, where U.S. Highway 50 continues to experience damage from subsidence.

KEY FACTS

- The Hutchinson Salt Member was deposited by a shallow inland sea about 250 million years ago.
- The Hutchinson Salt Member spans approximately 37,000 square miles across Kansas, with a thickness of up to 515 feet in some areas and provides most of the economic opportunity for salt mining and archival underground storage in the state.
- The Hutchinson Salt Member is a rock layer sandwiched between shaly layers of the Wellington Formation and is most easily accessed around Reno County.
- Salt dissolution is contributing to elevation change along U.S. Highway 50 by Brandy Lake. Studies indicate that by 2050, the highway will drop by two feet — enough to cause seasonal or permanent inundation of the roadway.

Figure 1. Filling the 1974 Cargill sinkhole caused by salt removal in Hutchinson in Reno County. Around humanmade infrastructure, sinkholes are not just hazardous; they can cause immense economic damage and block transport channels.

Geologic Context: The Hutchinson Salt Member

The Hutchinson Salt Member spans approximately 37,000 square miles across Kansas, with a thickness of up to 515 feet in some areas, and provides most of the economic opportunity for salt mining in the state.[1] In addition to mining, the salt is foundational for a number of industries in central Kansas, including liquid petroleum gas storage, film and document storage, and tourism. The Hutchinson salt is part of a larger salt basin underlying portions of Oklahoma and the Texas Panhandle.[2] It was deposited approximately 275 million years ago during the Permian Period, when a shallow inland sea evaporated, leaving behind thick beds of halite interbedded with shale, anhydrite, and dolomite.[1]

Overlying the salt are Pleistocene-age sands and gravels of the Equus Beds (a significant regional freshwater aquifer). These unconsolidated beds are highly permeable, and the aquifer supplies municipal and industrial water in Hutchinson and surrounding areas. In some areas — Brandy Lake is an example — groundwater from the aquifer can infiltrate faults or fractures through the shale bedrock, triggering salt dissolution and leading to ground instability (fig. 2).[3,4]

Salt Dissolution Mechanisms: Natural and Artificial Processes

Salt is highly soluble in freshwater. Natural salt dissolution occurs when unsaturated groundwater flows through or near salt beds, dissolving halite and mixing it to form brine. The brine then transports salt away from the site, potentially polluting the local water supply.[3] Three conditions are necessary for the dissolution process: a freshwater source, an outlet for brine, and an active flow system. In Reno County, these criteria are met along the eastern edge of the Hutchinson Salt Member (known as the dissolution front), where groundwater from the Equus Beds aquifer enters void channels caused by overlying shale fractures in the Wellington Formation (the Hutchinson Salt Member is part of the Wellington and can be found sandwiched between layers of Wellington

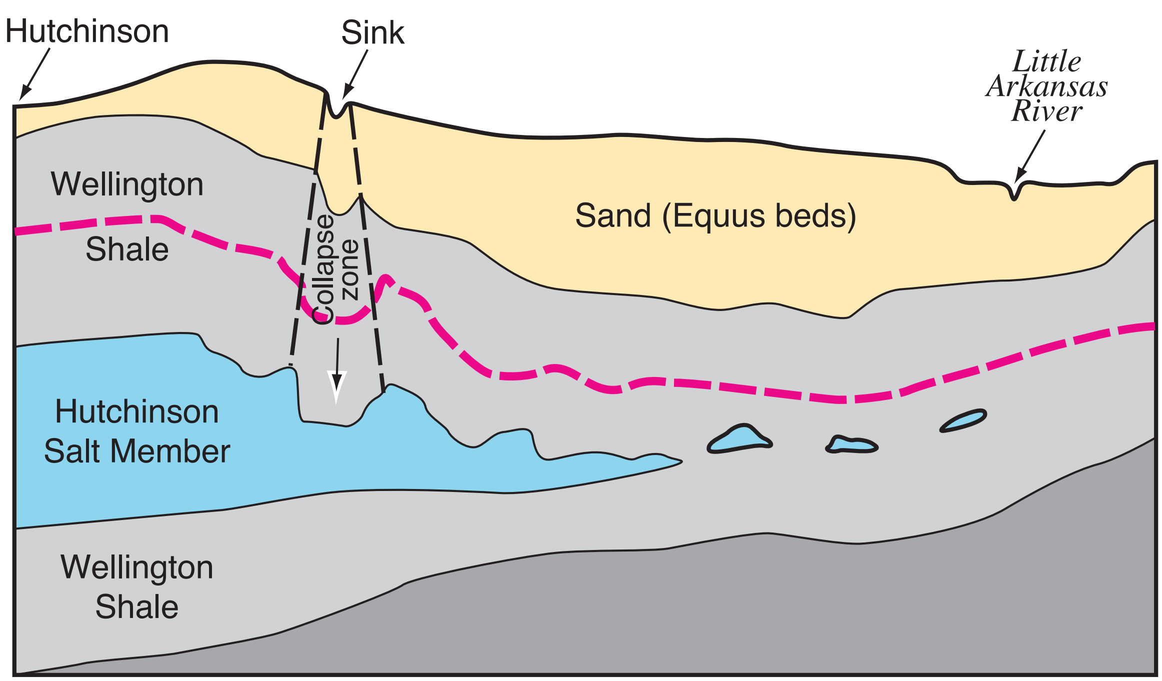


Figure 2. Schematic of how a sinkhole forms.[4]

shale). Over 250 million years, this has led to the retreat of the salt front by several miles, resulting in observable subsidence features such as dissolution cavities and collapse valleys. Subsidence also can affect roads and other anthropogenic geographic features, as is the case with U.S. Highway 50 near Brandy Lake, where years of gradual subsidence has repeatedly caused damage, followed by repair to road infrastructure.[3,5,6]

Brandy Lake is thought to have been naturally formed from salt dissolution. Underground channels in the Hutchinson Salt Member dissolved, leaving voids where overlying rock layers sank, causing a depression on the surface that filled with water over time. Many of these kinds of lakes have formed in parts of Reno County (fig. 3). Today, this subsidence process remains active beneath the Brandy Lake site and continues to affect surface features.[5]

Using elevation data from surveys conducted in 2009 and 2021, researchers estimate the land around Brandy Lake and U.S. Highway 50 continues to subside at an average annual rate of 0.061 feet per year (about 0.73 inches per year), with some areas showing rates as high as 0.068 feet per year.[5,7] If this rate continues, the elevation of the highway in the most affected zones could decline by two feet by 2050. Though this doesn't sound like a significant issue now, the highway directly cuts across the middle of the lake and is nearly level with the lake at high-water stages. A two-foot drop in highway elevation would result in seasonal or permanent inundation of the roadway — unless it undergoes routine rebuilding and elevating of the road surface.

Seismic Monitoring and Geospatial Analysis

To monitor subsidence, researchers from several Kansas-based organizations, including the Kansas Geological Survey, the Kansas Department of Transportation, and the University of Kansas, have employed a variety of methods to measure subsidence

Figure 3. Aerial view of a water-filled sinkhole in Reno County. Photo: Bill Johnson, University of Kansas

rates. In the past, elevation records, well logs, and seismic reflection data proved helpful in tracking trends for hyperlocal depression features. Today, new advances in high-resolution seismic reflection and LiDAR (light detection and ranging) can help researchers more accurately map and predict both current and potential cavities before they collapse.[3] LiDAR uses remote sensors to create 3-D models of Earth's surface. LiDAR imagery allows researchers to closely study surface features as well as track topographical changes, as is the case with Brandy Lake.

In 2003 and 2010, scientists used LiDAR along a 14-mile stretch of U.S. Highway 50 to capture detailed subsurface data related to the Hutchinson Salt Member and dissolution-related features.[7,8] These seismic surveys revealed patterns inconsistent with the previously accepted model of a simple east-to-west dissolution front. Instead, the imaging revealed dissolution channels that cut west in a cross-grained direction, leading researchers to believe that the leaching process is highly irregular and locally influenced by the overlying Ninnescah Shale and Equus Beds aquifer. Using seismic reflection imaging, a 2015 study confirmed that the front where salt is dissolving along the western flank of Brandy Lake has the possibility to grow in the coming decades.[3,7,8] The high-resolution seismic reflection data also confirmed that the dissolution front and associated solutioning activity extends for up to 10 miles west of the defined dissolving, subsurface salt face.

Three KDOT-sponsored LiDAR surveys were conducted in 2009 with data updated in 2021 to observe changes in surface features. These studies revealed that during that 13-year span, the highway centerline elevation decreased by nearly one foot over a 457-meter stretch, with the most severe subsidence concentrated in a 366-meter zone on the lake's western side.[5,7]

CONTACT

Kyle Halverson
Chief Geologist
Kansas Department of Transportation
kyle.halverson@ks.gov

Richard Miller
Program Director
Geophysics Applications and Field Services
Kansas Geological Survey
rdmiller@ku.edu

Conclusion

Salt dissolution in Reno County is not just a geological curiosity. Subsidence around U.S. Highway 50 presents a continuing challenge to maintaining infrastructure, ensuring groundwater quality, and effectively managing roads. The irregular pattern of leaching from east to west across the western flank of Brandy Lake, resulting from dissolution channels that infiltrate the Hutchinson Salt Member from overlying formations, creates unique opportunities for study. Recent advancements in seismic monitoring and geospatial analysis offer potential solutions for identifying future collapses and opportunities to target any vertical migration of voids that might result in catastrophic sinkhole development.

As the natural dissolution front continues its slow march westward, proactive planning and investment in scientific monitoring will be essential to safeguard central Kansas's built environment and public resources.

STOP
4

KEY FACTS

- Salt production in Kansas dates back to the mid-1800s.
- The United States accounts for 15% of the world's salt production, and Kansas is one of the top salt-producing states.
- The Hutchinson Salt Company produces bulk salts that can be used for de-icing and agriculture and livestock feed salts.
- UV&S leases salt caverns from the Hutchinson Salt Company to store a range of items from art to business documents but specializes in film storage for the movie industry.

Salt Mining in Kansas

Kansas Geological Survey
KGS student outreach assistant Ally Pruente contributed to this report

Salt production in Kansas dates back to the mid-1800s in Miami, Dickinson, and Republic counties, where brine collected from seeps was boiled or salt scale formed in marshes was processed to produce salt. People searching for coal, gas, oil, and a variety of other minerals discovered rock salt in central Kansas. Between 1891 and 1923, salt mining operations began to pop up, with underground salt mines in Lyons, Kingman, and Kanopolis.[1]

In Kansas, companies use one of two methods to mine salt: an underground room-and-pillar method or solution mining.[2]

In the room-and-pillar method, salt is removed in a checkerboard pattern so that roughly 40-foot-wide caverns alternate with thick pillars of salt left in place to support the rock above. Miners blast the salt into manageable pieces, which are then crushed and taken to the surface through the shaft in large buckets. This method of salt collection produces salt used for animal feed and road salt.

Solution mining consists of freshwater being forced down a well to mix with salt, creating brine (water highly saturated by salt after dissolving). That brine is brought to the surface, and

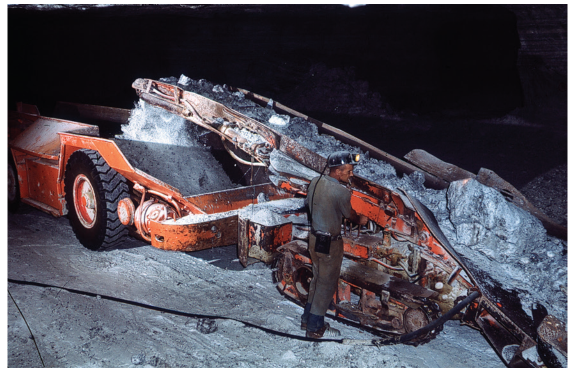
The Carey Salt Company began operation in Hutchinson in 1923. In 1990, Hutchinson Salt Company purchased Carey Salt.

the water is evaporated to collect the salt. This process produces pure salt to be used as table salt and in food processing, animal feeds, and water softeners. Solution mining is the oldest form of salt mining in the state and is still used today.

Economics of Salt

The United States accounts for approximately 15% of the world's salt production each year.[3] In 2024, salt commodities were valued at more than $1 billion dollars, with production of 39,000–42,000 million tons. Salt is produced in 16 states; the top producing states are Kansas, Louisiana, Michigan, New York, Ohio, Texas, and Utah.

The majority of salt produced is used to de-ice highways, which accounted for 41% of total salt use in 2024. The next major salt consumer (39%) is the chemical industry, which uses salt in brine for chemical feedstock, chlorine water treatment, and caustic soda manufacturers. The remaining salt is primarily used for food processing, agriculture, and water treatment.



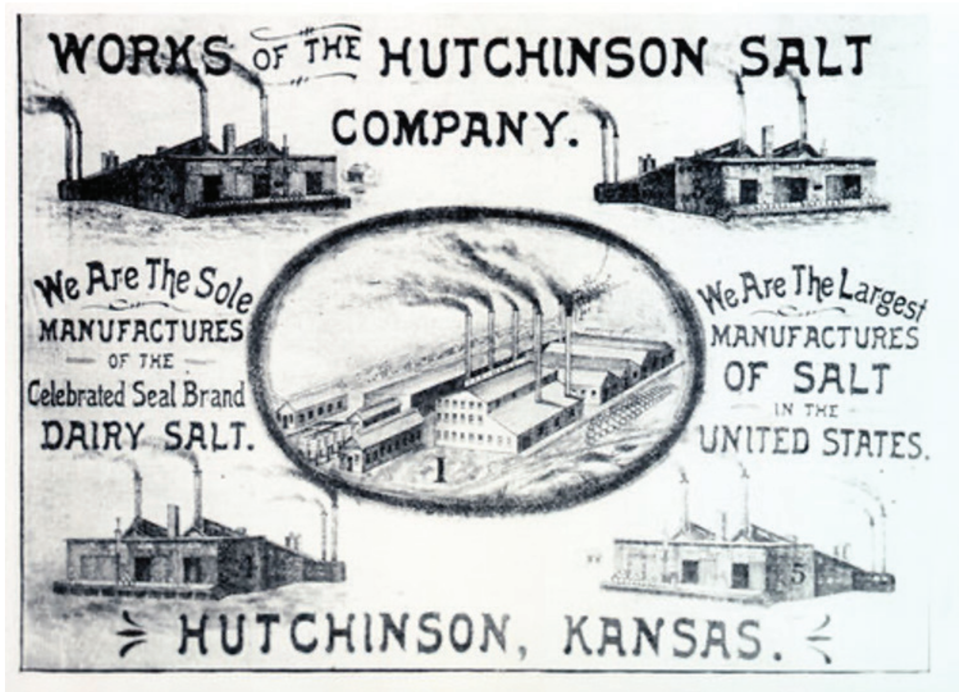
A salt mine conveyor moves mined rock salt in Reno County.

Hutchinson Salt Company

The family-owned Hutchinson Salt Company in Reno County began operation in 1990 after purchasing the Carey Salt Mine, which had begun underground mining of rock salt in 1923. Since 2003, the company has adopted green practices, including using B100 biodiesel fuel, a high-level biodiesel blend made from vegetable oils, used cooking oils, animal fats, and the like that greatly reduces some toxic emissions.[4]

The Hutchinson Salt Company's main products are bulk salts that can be used

Carey Salt Company exhibit at the Kansas State Fair, Hutchinson, Kansas. Photo taken between 1940 and 1960. Source: KansasMemory.org, Kansas Historical Society.



Advertisement for the Hutchinson Salt Company of Kansas in 1892. Source: KansasMemory.org, Kansas Historical Society.

for de-icing and agriculture and livestock feed salts.[5] The company focuses on six salt products: Kansas fine and Kansas dried fine salts, which can be used for soil stabilization as well as road salt; Kansas medium, which is used mostly for road salt; bulk RP-09 and oversized RP-09, which can be used for feed and pet food; and ASTM grade 1 road salt, used for snow and ice removal. The Hutchinson Salt Company also produces certified organic products.

At its mine, about 75% of the salt is mined and 25% is left as pillars. To mine the salt, a gash is cut into the wall face near the bottom, then a series of holes 6- to 9-foot deep drilled across the wall are filled with blasting caps and ammonium nitrate. The caps are tied to one fuse and sequenced, so an entire wall is blasted at a time. The salt rock is then crushed and put on a conveyor belt to haul to the surface.[6]

Storage Caverns in Salt

The room-and-pillar mining method used at the Hutchinson Salt Company means large open areas are left 650 feet below Hutchinson. These caverns are ideal for humidity- and temperature-controlled storage. In 1959, Underground Vaults and Storage (now UV&S) entered a 99-year lease with Carey Salt (now Hutchinson Salt Company) for the space. The privately owned and operated company now has 1.7 million square feet of underground storage space, or the equivalent of about 35 football fields, and stores a range of items from art to business documents but specializes in film storage for the movie industry.[7]

CONTACT

Jim Barta
General Manager
Hutchinson Salt Company
jim.barta@hutchsalt.com
620-856-3332

NOTES

Finding Clues to Water Quality in Nature

By Andy Connolly

STOP
5

KEY FACTS

- Infrequent flow causes the Arkansas River to be the saltiest river in the state.
- A high abundance of sulfates in water can cause health problems for local human and biological communities.
- KDWP biologists use the Macroinvertebrate Biotic Index scale to assess stream quality.
- The index can be used to determine sources of pollution and inform policy makers and citizens about habitats with low health quality.
- The disappearance of perennial streams is one of the biggest issues facing our state aquatic life.

Grasslands, by far, are the most dominant habitat in Kansas, from tallgrass prairie in the east transitioning to shortgrass prairie in the west. Sharing the landscape are eastern woodlands and freshwater systems like wetlands, rivers, streams, and reservoirs

Freshwater systems across Kansas are a haven for water-loving animals and plants: frogs, turtles, and crayfish at the water's edge; bass, catfish, and sunfish in stream waters; and migratory birds, such as waterfowl and the endangered whooping crane, at wetlands like Cheyenne Bottoms and Quivira National Wildlife Refuge.[1] The diversity of animal life in our aquatic systems enhances the recreational experience of Kansans who canoe, fish, birdwatch, hunt, and camp at these freshwater habitats. However, freshwater systems are sensitive to human activities such as groundwater pumping, habitat destruction, and dumped pollutants. The Arkansas River has experienced all three of these forces at play.

The Arkansas River is one of only three legally navigable rivers in the state, the two others being the Kansas and Missouri rivers. Known as "the Ark," this river begins in eastern Colorado but dries on the surface in western Kansas because of aquifer depletion and doesn't flow again in any significant way until the Great Bend region. From there, the river travels through Kansas until it exits at the Oklahoma border, southeast of Arkansas City.

The river's low and sometimes infrequent flow can cause salinity levels to rise, making the Ark the saltiest river in Kansas. A study done by the Kansas Geological Survey in the 1990s found that during low flow, sulfate concentrations can be as high as 2,400 parts per million (or milligrams per liter). The Environmental Protection Agency sets the maximum level for sulfate in drinking water as 400 parts per million. Even in periods of high flow, the water in the river can only dilute contaminants to 700 parts per million. High concentrations of sulfate can impact the health of humans and biological communities. In humans, sulfate poisoning can result in diarrhea, headaches, skin rashes, and kidney stones.[2] In wetlands, high sulfate concentrations lead to acidification, hindering the growth of — or outright killing — fish and other aquatic life.[3, 4]

Assessing Biodiversity

The Kansas Department of Wildlife and Parks assesses the biodiversity of the Ark and other freshwater systems across the state by cataloging the organisms that live in its waters. In addition to fish, they survey macroinvertebrates, or animals without backbones that are large enough to be seen by the naked eye. Biologists use macroinvertebrates — mussels, crayfish, worms, and the like — as one of the indicators of water quality in a stream.

To study the species in an area, KDWP biologists begin by using special equipment to briefly stun fish with non-lethal amounts of electricity. They then use a long net called a seine (fig. 1) to collect fish and aquatic organisms, then identify and release them back into the river. To study macroinvertebrates, biologists seek riffles, runs, and pools and use a sieve to capture them for identification. If mussels are present, biologists often crawl through shallow water to collect mussels by hand in a process known as "grubbing." The biologists also document features of the habitat, such as water flow and vegetation, and compile all the information they collect into a snapshot of the river's health.

Figure 1. Kansas Department of Wildlife and Parks scientists use a seine to capture and identify aquatic animals. Photo: KDWP.

KDWP uses a simple scale, called the Macroinvertebrate Biotic Index, to assess the water quality in a stream. Certain animals are more susceptible to pollutants in the water as well as to the amount of oxygen dissolved within the system (fig. 2). Stonefly larvae are an excellent example of a species found in high-quality streams. Their gills are less efficient in poor water quality conditions so cool flowing streams can better oxygenate their gills. Finding these larvae is a good indication that the stream is low on pollutants.

As oxygen levels decrease and pollutant levels increase, fewer macroinvertebrates are documented. Only the hardiest can survive in low-oxygen, high-pollutant conditions. One such animal is the bloodworm, named for the bright red hue it can obtain. In healthy aquatic habitats, bloodworms occupy niches in areas of low water flow and are kept in check by other invertebrates. But when conditions worsen, bloodworms spread out and occupy areas that once held a thriving, diverse community.

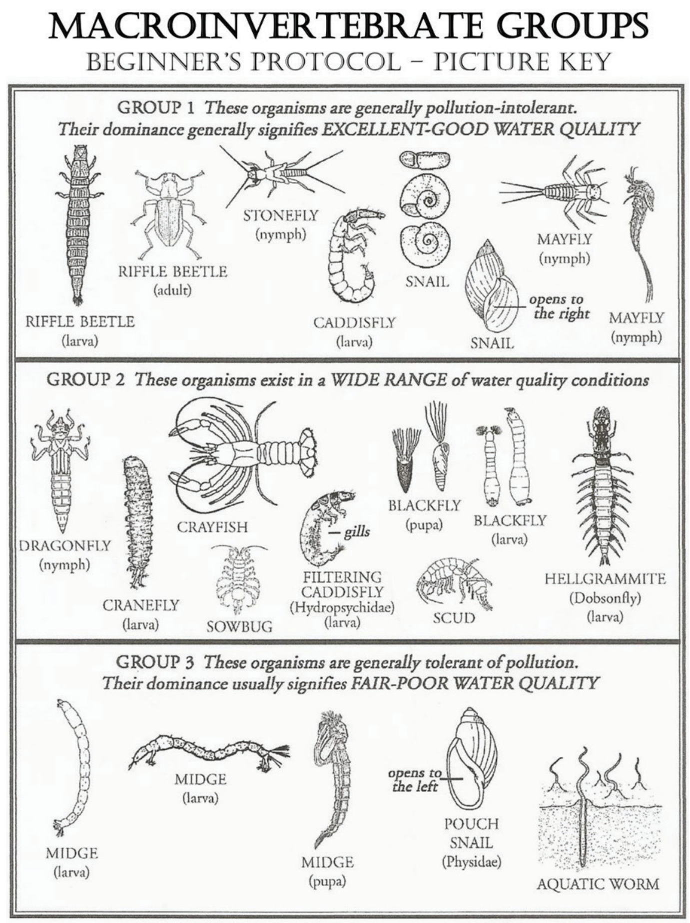


Figure 2. Pollutant tolerance of macroinvertebrates in freshwater environments. Source: National Park Service.

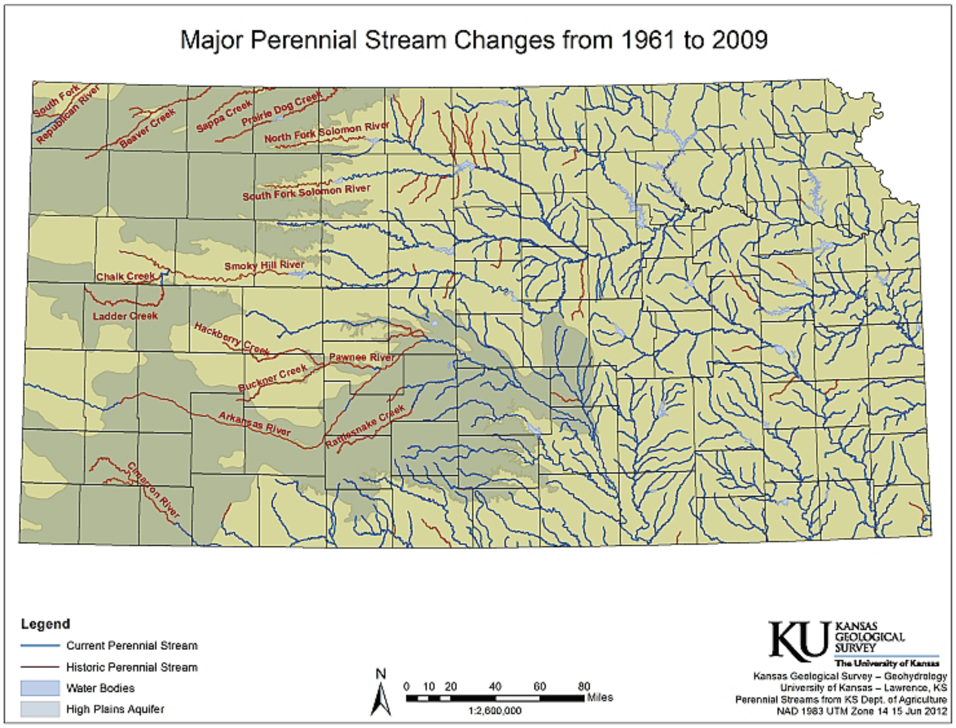


Figure 3. Major perennial stream changes in Kansas from 1961 to 2009. Note that many streams that overlie the High Plains aquifer are particularly susceptible to flow loss due to pumping of underground water.

Using the Macroinvertebrate Biotic Index, biologists can alert the Kansas Department of Health and Environment to streams potentially exhibiting poor water quality conditions. Additionally, when robust data are collected up and down various streams, the Macroinvertebrate Biotic Index can alert biologists to areas that are suddenly hit by pollution and help to uncover that pollution source. The opposite can also be true. If new policies are implemented or private industries enact stronger anti-pollution measures, biologists can quantify habitat and species recovery.

Disappearing Fish of the Arkansas River

KDWP's data collection over more than 30 years has given biologists critical insight into the health of rivers and streams. Salt isn't the only factor debilitating the state's rivers, streams, and wetlands. Human-caused habitat destruction has resulted in declines in the number and diversity of fish, such as the plains minnow (threatened) and silver chub (endangered). Small-bodied minnows like these rely on perennial streams that flow all year to move upstream to spawn and then move downstream to release massive amounts of eggs. Perennial streams in western Kansas have almost ceased to flow due to over-pumping of groundwater and diverting surface water to farms (fig. 3). On top of this, dams

Figure 4. The endangered Arkansas River shiner was once a plentiful freshwater fish across the southern Great Plains but has seen a radical decline in numbers due to a loss of connective passageways. Photo: U.S. Fish and Wildlife Service.

Figure 5: Lincoln Street dam in Wichita. Fish ladders on the sides of the passageway allow fish to gradually swim upstream while the central channel allows kayakers to travel down the stream without stopping. Photo: http://www.kansastravel.org/wichita/lincolnstreetdam.htm

prevent fish from moving up or down stream to other freshwater systems. Without miles of connective passages, some fish species cannot complete their lifecycle. The Arkansas River shiner (fig. 4), once widespread across the southern Great Plains, is now identified at both the state and federal levels on threatened and endangered species lists.

One way to minimize human impact and rebuild these lost flowing connections is to construct bridges that allow aquatic life to move both upstream and downstream. A relatively recent example is at the Lincoln Street dam on the Arkansas River in Wichita.[5] When the dam was rebuilt in 2013, fish ladders were installed to allow fish to travel upstream (fig. 5). A channel through the fish ladders provides a way for kayakers to paddle downstream without interference from the dam.

CONTACT
Mark Van Scoyoc
Biodiversity Survey Coordinator
Kansas Department of Wildlife and Parks
Mark.VanScoyoc@ks.gov
620-672-0710

BUS TALK

Fire Management in Kansas: What's Changed?

Sunday Siomades

The Burning Problem

Kansas experiences at least 5,000 reported wildfires a year, which puts the state in the top five for wildfire occurrence in the United States. This does not account for unreported Kansas wildfires, of which there are estimated to be more than 2,000 annually. The majority (nearly 30%) of all wildfires in Kansas can be directly attributed to private land burning, and escaped prescribed burns are responsible for almost 25% of the acres burned annually in wildfires.[1] Most wildfires occur in the spring and in the fall, but in recent years this has started to change.

Winds of Climate Change

On December 15, 2021, storm winds (up to 100 mph) downed power lines across north-central Kansas, sparking a multitude of fires. One of those fires developed into the "Four County Fire" in Ellis, Osborne, Rooks, and Russell counties. Numerous buildings and homes were destroyed, hundreds of livestock perished, and 163,000 acres burned.[2] In Reno and Harvey counties, the Cottonwood Wildfire Complex of March 2022 burned more than 12,000 acres; destroyed 35 homes, 92 outbuildings, and 110 vehicles; and killed one person (fig. 1).[3]

In 2023, *Earth's Future,* a journal of the American Geophysical Union, released a report projecting that the Kansas wildfire season would increase by more than 40 days per year by the end of the century, largely driven by increased temperatures. Temperatures throughout the

KEY FACTS

- Kansas is one of the most wildfire-prone states in the country, experiencing at least 5,000 reported fires every year, and an additional estimated 2,000 unreported fires. Most of these fires occur on private land.
- Historically, there was a clear wildfire season in Kansas; now, fires are a year-round problem that require year-round readiness for mitigation and management.
- The Kansas Forest Service's Wildfire Risk Assessment Portal is an informational resource to help individuals to take action and protect their homes from fire.
- The Community Wildfire Defense Grant program is a financial resource for fire management entities to fund the implementation of Community Wildfire Protection Plans and other wildfire response initiatives.

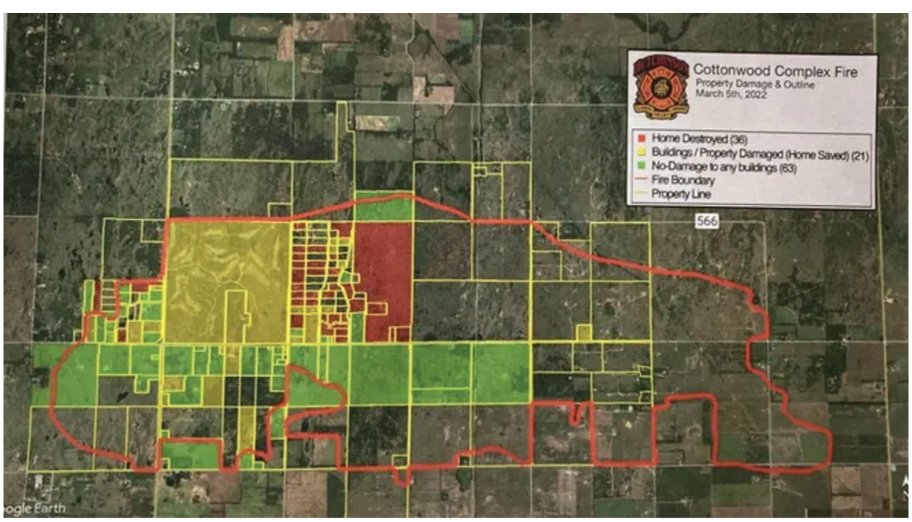


Figure 1. The Cottonwood Wildfire Complex burned more than 12,000 acres in Reno and Harvey counties, killed one person, and destroyed numerous buildings and other property. Source: Hutchinson Fire Department.

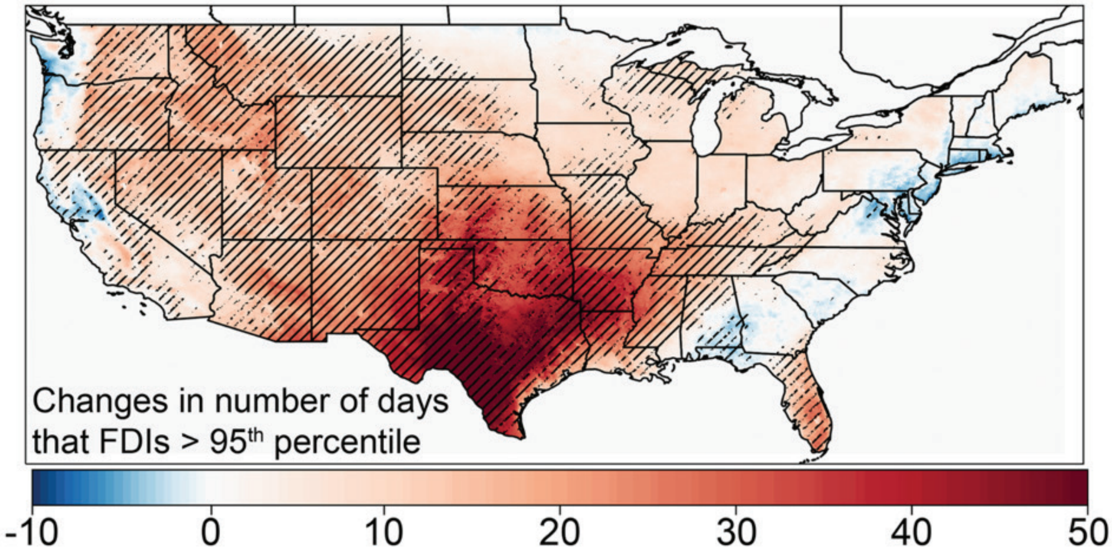


Figure 2. The number of days, on average, a given location experiences high risk of fire (exceeds the 95th percentile of four fire danger indices). Kansas, in shades of red, has been experiencing an increasing number of high-risk days.[4]

Great Plains have already risen over the last few decades, particularly during the winter months in the northern states; fewer cold days occur, and hot days are becoming more common. Temperatures are anticipated to continue climbing in future decades, and extreme, fire-exacerbating events such as drought will increase in frequency.[4,5]

How the Kansas Forest Service is Adapting

Fire "season" is no more — fires are now a year-round problem that require constant readiness from fire mitigation teams (figs. 2–3). The Kansas Forest Service has implemented several key initiatives in response to these increased demands on fire management practices and training.

In 2023, the KFS unveiled the Wildfire Risk Assessment Portal. This free online service helps Kansas landowners, fire protection districts, communities, and other similar organizations determine wildfire risk to their property and obtain recommended area-specific risk mitigation strategies.

For example, in the case of the Cottonwood Wildfire Complex, fire spread and fire intensity were exacerbated by windborne embers from eastern redcedars (fig. 4), which are highly flammable and dominate the Kansas landscape. These trees — which are actually junipers, not true cedars — are the only evergreens native to Kansas. They are a hardy, long-lived, drought-resistant species that require little water. The low-growing, oily foliage of the eastern redcedar makes it easily ignitable by grass fires.[6] Since their population exploded in the 1930s–1970s from intentional planting due to their usefulness as farmstead windbreaks and accent plants, eastern redcedars are liable to create a path for fire to spread onto homes. WRAP identifies this type of risk (flammable, near-home vegetation), among others, and provides recommended mitigation procedures (for example, removing flammable or dead vegetation from the immediate proximity of the home) for users.[7]

Also in 2023, Kansas Secretary of Agriculture Mike Beam coordinated the Governor's Wildfire Task Force to create recommendations for how Kansas can better prevent, respond to, and recover from wildfires. The task force included the Kansas Forest Service, legislators, fire council

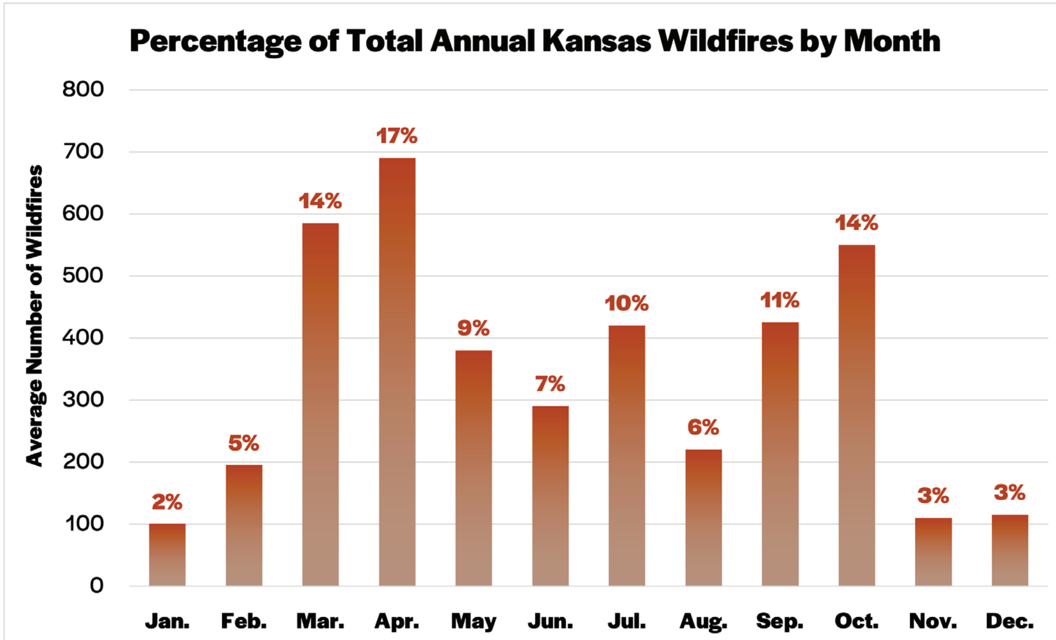


Figure 3. Kansas monthly wildfire occurrence as a percentage of the state's average annual wildfire total. Most fires experienced by the state (more than 50% annually) occur during the months of March, April, September, and October. Source: Kansas Forest Service.

and firefighting associations, agricultural landowners, and state agency representatives. Members exchanged concerns and suggestions that culminated in a comprehensive report on proposed best practices.[1]

In its final report in November 2023, the task force detailed 27 individual recommendations for mitigation, prevention, response, and recovery, presented alongside information about major wildfires in Kansas, wood plant encroachment, financial recommendations, and funding resources.[1] In 2025, the Kansas Forest Service's budget request to act on the recommendations included in the final report was not approved, and it remains unfunded.

Resources to Reduce Risks

The Kansas Forest Service works with communities and counties to submit applications to the Community Wildfire Defense Grant program, a national initiative funded by the Infrastructure Investment and Jobs Act of 2021. This $1 billion, five-year grant program prioritizes communities "that are in an area identified as having high wildfire hazard potential, are low income, or have been impacted by a severe disaster within the previous 10 years which increased wildfire risk or hazard."[8] Awarded funds can be used

Figure 4. Eastern redcedar. Note the low-growing foliage and how it contacts the grasses. Photo: Kansas Forest Service.

to develop, amend, and implement projects described in Community Wildfire Protection Plans, wildfire response strategies created by communities that outline local fire mitigation priorities.[8]

The Kansas Forest Service has been working with communities and counties that have shown interest and meet the criteria to submit applications to this grant program. In 2024, $340,200 in CWDG grants were awarded in Kansas and allocated to Butler, Chase, and Leavenworth counties, each receiving $113,400 to fund local wildfire protection plans.[9] In 2025, five grants were submitted for review.

CONTACT

Bill Waln
State Fire Management Officer
Kansas Forest Service
bwaln@ksu.edu
620-899-6604

STOP 6

Sand Hills State Park

Ellie Biebesheimer

KEY FACTS

- Sand Hills State Park is 1,123 acres and located northeast of Hutchinson.
- The park includes 14 miles of hiking and multiuse (horseback riding) trails.
- The dunes in the park were formed by sediment from the Rocky Mountains that was carried by streams and then wind before being deposited in Kansas.
- The park had 98,000 visitors in 2023 and 112,000 in 2024.
- Sand Hills State Park is one of the best places in Kansas to see and walk through sand dunes on public land.

Sand Hills State Park, six miles northeast of Hutchinson in Reno County, is one of the best publicly accessible places in Kansas to see sand dunes (fig. 1). The 1,123-acre park in the Arkansas River Lowlands has 14 miles of hiking and horseback riding trails with interpretive signs for visitors.[1,2] The park became the 22nd state park in Kansas after the state acquired 640 acres from the Kansas State Industrial Reformatory in 1974. A short time later, the Dillon family of Hutchinson donated an additional 320 adjacent acres. The park reached its current size when the state's Parks and Resources Authority acquired another 163 acres with Federal Land and Water Funds.[1]

Sand Hills State Park is home to a variety of plants and wildlife and encompasses four main ecosystems: tallgrass prairie, woodlands, marshlands, and sand dunes.[2,1] Each has its own assemblage of plants and animals that call it home. For example, the tallgrass prairie is home to various native wildflowers and bluestem grass whereas cottonwood trees and dogwood bushes can be found in the woodlands. Ducks, geese, songbirds, turkeys, and quails are common as are deer, muskrats, coyotes, and other small mammals.[2,1]

Figure 1. Aerial view of Sand Hills State Park in Reno County.

Sand Hills State Park offers a variety of activities for park visitors. Of its eight trails, three are designated strictly for hiking and the five others are multiuse, including horseback riding. Rolling Hill Trail is perfect for wildflower hikes and horseback rides in the spring when the flowers bloom and cover the landscape in a kaleidoscope of color.[2] Two wildlife observation blinds allow visitors to watch the various critters that call the park home or the migratory birds that use it as a waypoint during their travels. Fishing at the five-acre pond[3] and archery deer and upland game hunting are allowed, though permits are required.[2,1] Visitors can stay at the park's 64-site campground. All sites have water and electricity and 14 include horse pens for those bringing their horses with them. Outside of the campground, the park is walk-in only to protect the natural features of the area.[2]

Geologic History of Sand Hills State Park

The dunes that make up Sand Hills State Park began forming millions of years ago. As the Rocky Mountains grew, streams that created the Arkansas River Valley flowed down the mountains and across the landscape.[2] These streams carried sand and other sediment east, all the way to Kansas. The sediment was then picked up and carried by southwesterly winds until it was eventually deposited in a narrow band of large dunes. These dunes were unstable and shifted and moved with the wind until vegetation gained a foothold.[2,4] Today, the dunes are stabilized by the strong, deep roots of the tall-grass prairie vegetation that grows on them.[4] The dunes today range from 10 to 40 feet tall.[2]

Sand Hills State Park serves tens of thousands of visitors each year. In 2023, 98,000 people visited the park, and visitation increase to 112,000 people in 2024.

CONTACT

Conner O'Flannagan

Director, State Parks

Kansas Department of Wildlife and Parks

Conner.O'Flannagan@ks.gov

316-542-3664

STOP
7

Using Remote Sensing Techniques to Locate Orphaned and Abandoned Oil and Gas Wells

Blair Schneider and Alan Peterson

KEY FACTS

- The KGS operates two unmanned aerial systems that can be used to identify the locations of abandoned oil and gas wells.
- KGS researchers conducted a feasibility study in 2024 and 2025 at the Knackstedt site in McPherson County to test aeromagnetic and LiDAR technology.
- The KCC Abandoned Wells database lists 4,566 orphan wells in the state that require action.
- 98% of the orphan wells in the KCC database are in the eastern half of the state.

Abandoned oil and gas wells are a problem across the United States (fig. 1). The U.S. Geological Survey recently compiled a dataset that found 117,672 unplugged orphaned oil and gas wells across 27 states.[1] A well is considered orphaned when it has been taken out of production but not plugged. A similar report compiled in 2021 by the Interstate Oil and Gas Compact Commission documented 97,213 orphaned wells within its 32 IOGCC member and associate member states and five Canadian provinces.[2] The report also found 372,010 "idle wells" — wells that have not yet been plugged and are not producing, injecting, or otherwise being used for their intended purposes. Many idle wells have potential for future oil or gas production or associated uses, but if they are not properly maintained, they may pose a risk to the environment, public health, and safety.

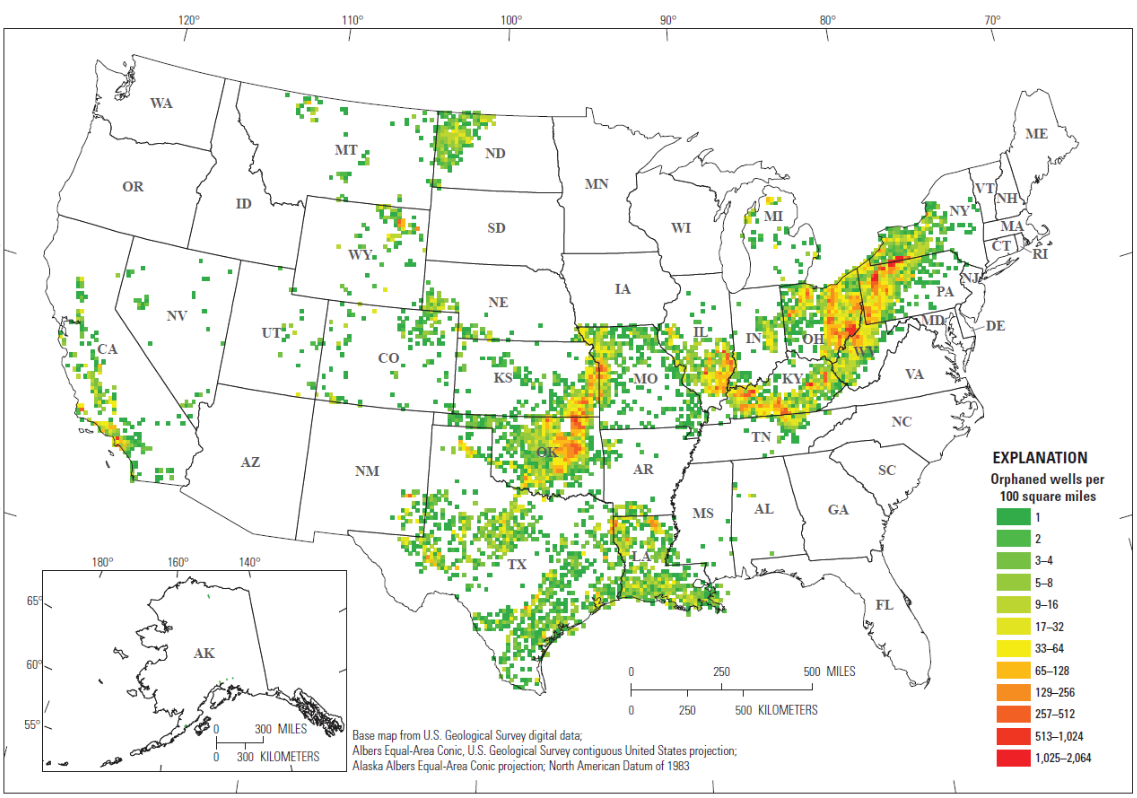


Figure 1. Unplugged orphaned wells per 100 square miles in the continental United States. The documented orphaned oil and gas well dataset contains 117,672 unplugged orphaned wells in the 27 states.[1] Illustration: U.S. Geological Survey.

In 1996, the Kansas Legislature created the Abandoned Well Plugging and Site Remediation Fund. The legislation established an annual reporting procedure whereby the Kansas Corporation Commission must account for the number of abandoned wells in Kansas, detail the funds available to plug abandoned wells, and present a multiyear plan for addressing abandoned wells by creating a prioritization schedule.[3] A well is considered "abandoned" when it has been permanently taken out of production, it is not properly plugged to prevent possible air or groundwater pollution, and the rightful legal owner cannot be determined or located to take responsibility. At the close of 2024, the KCC Abandoned Well database listed 4,566 wells that require action. Of these, 98% are located in the eastern half of the state.[3]

Detailed production records were not kept for oil and gas discoveries before 1944 and comprehensive regulation of the industry didn't begin until the mid-1980s. This means that thousands of wells drilled from the late 1800s through the 1970s were abandoned without being properly plugged. Without detailed records, we know that there are abandoned wells in the state, but we don't know their exact locations. Over time, trees and brush have grown over these locations, agricultural activities have buried them, and other processes have made them increasingly difficult to find, posing a serious risk to public health.

Two geophysical and remote sensing technologies — aeromagnetic and LiDAR (light detection and ranging) surveys — represent potential cost-effective tools to help identify the locations of these unknown orphan wells. Aeromagnetic methods sense the presence of steel in the ground, while LiDAR images the ground surface where disturbances might be associated with old installations.

Aeromagnetic Surveys

An aeromagnetic survey is a geophysical technique that collects magnetic field data using airborne instruments.

Earth's magnetic field, measured in nanoteslas, ranges from 25,000 nanoteslas at the equator to 60,000 nanoteslas at its north and south poles, but its strength can fluctuate depending on local conditions. A highly magnetic rock beneath the surface can increase the magnetic field within a region. Metal objects or burned features at or below Earth's surface also can increase the magnetic field.

Magnetic surveys have been used for geological, archaeological, and physics research for decades. The Kansas Geological Survey began collecting aeromagnetic data in Kansas in the 1970s. The results of these surveys have been used to study the buried Precambrian rocks in Kansas. They also have been used to improve our understanding and interpretations of structural features that exist in the state, such as the midcontinent geophysical anomaly in northeastern Kansas. These interpretations have been used to support oil and gas exploration across the state.

Research conducted in other states has successfully used magnetic surveying techniques to identify oil and gas wells, because the metal casing used to construct a well produces a higher magnetic reading than the surrounding area.[4]

The KGS recently partnered with the Kansas Corporation Commission to test similar techniques at a location in McPherson County nicknamed the Knackstedt site.[5] The KCC knew the location of four wells at the site but withheld this information to determine whether the KGS could delineate the correct locations from the aeromagnetic results. Using a newly acquired Geometrics Mag Arrow system, the KGS surveyed the property and successfully identified the correct locations of all four wells based on anomalously high magnetic readings (fig. 2).

LiDAR

LiDAR is a remote sensing technique that uses laser pulses to determine the distance

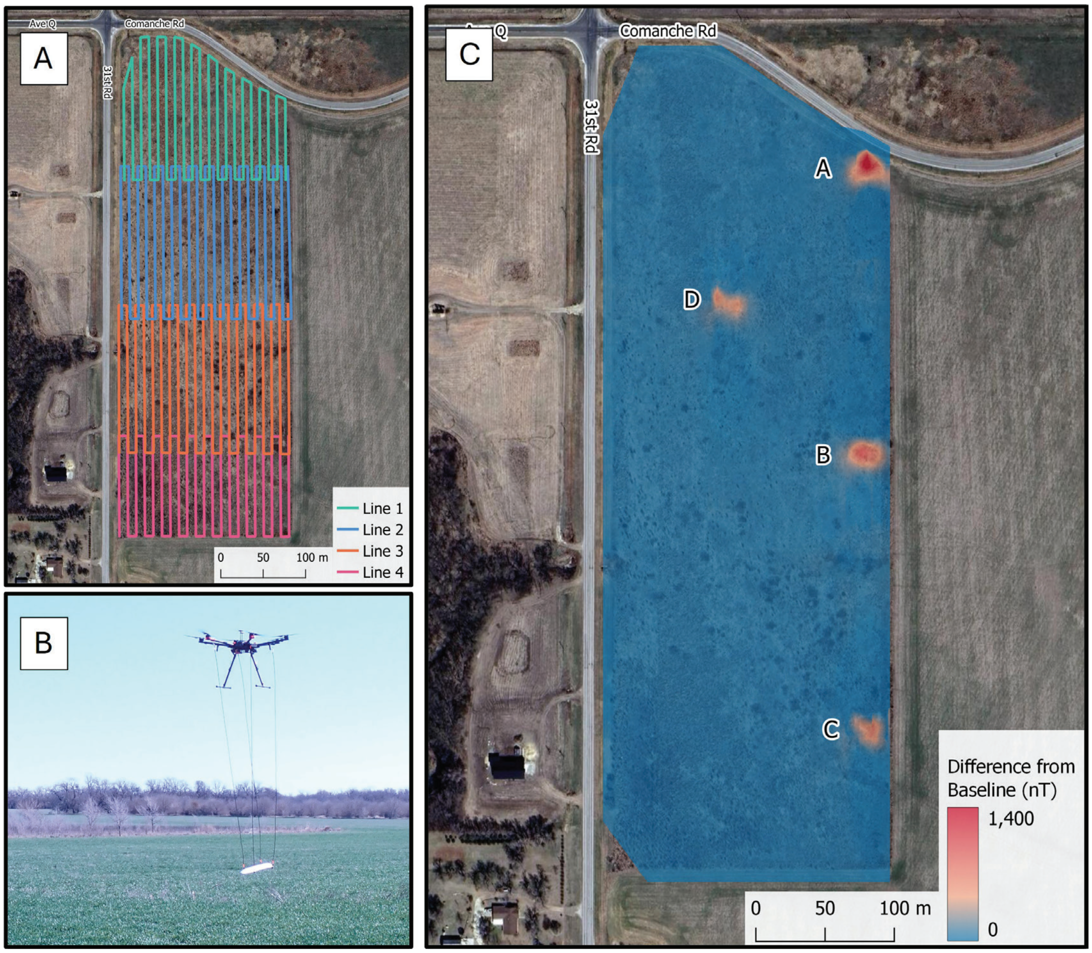


Figure 2: Results of the aeromagnetic survey of the Knackstedt site. A) Outline of the four flight lines flown by the drone for data collection. B) Photo of the Geometrics Arrow Mag in flight. C) Results of the magnetic data collection. The four wells are shown in red and have a higher magnetic value than the background of the site.

between the LiDAR sensor and a target, such as Earth's surface. The technology has a number of uses, including high-resolution mapping of topography and land features. Like aeromagnetic surveys, LiDAR can help identify anomalies that may be associated with abandoned oil and gas wells.

In mapping applications, the LiDAR instrument emits a laser pulse, which travels through the air and reflects off an object on the ground. Because light travels at a known, constant speed, researchers can calculate the distance between the object and the LiDAR detector.

Due to the physical phenomenon of reflection and refraction, each laser pulse is capable of up to five reflections back to the sensor. As the laser beam travels through the air and encounters a target, a portion of the laser beam reflects to the sensor while the remainder of the laser beam will refract, or allow the light to pass through. This allows users to filter unwanted returns — when a laser pulse reflects a signal back from a tree canopy instead of the ground, for example. Removing unwanted returns, or "noise," results in a more accurate reconstruction of the ground surface.

The KGS maintains a LiDAR instrument, mounted on an unmanned aerial system (commonly referred to as a drone), that can emit 240,000 laser pulses per second. This rate of data collection allows a rapid digital topographic reconstruction of the land surface. Specialized calculations pinpoint the location of the LiDAR sensor when it emits

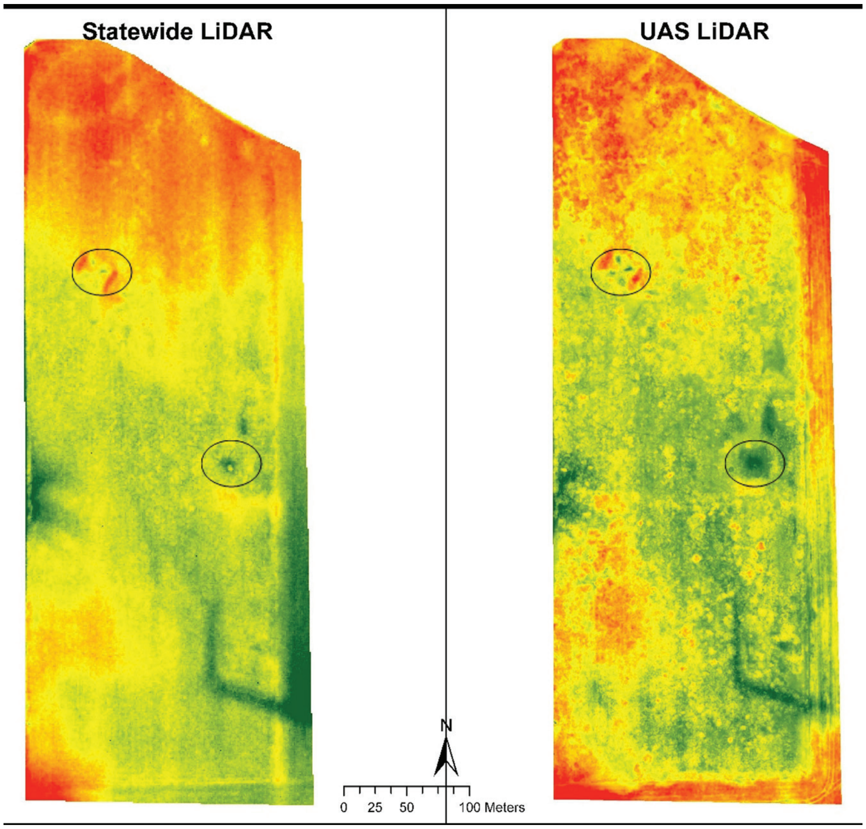


Figure 3. Comparison of the statewide LiDAR and KGS UAS LiDAR system at the Knackstedt site. Red colors indicate an increase in surface topography and green colors indicate a decrease in surface topography. The features circled in black are attributed to containment basins next to the well locations.

each laser pulse and ensure the accuracy of the reconstruction imagery.

LiDAR surveys result in a large data "point cloud." Each return represents the distance between an object and the LiDAR sensor, allowing researchers to build precise three-dimensional models in a relatively short amount of time. This technology can provide an alternative to aeromagnetic technology in an area where there is high magnetic noise across the land surface.

The state of Kansas has collected LiDAR data for all 105 counties with USGS 3D Elevation Program funding support from 2015 to 2018. These data are publicly available through the Kansas Data Access and Support Center (DASC) portal.[6]

Comparing results of LiDAR data at the Knackstedt site from the statewide survey and from the KGS UAS LiDAR system (fig. 3), the main difference is resolution, or the level of detail the image shows. The statewide survey data have a resolution of about 1 meter, whereas the KGS UAS system has a resolution of about 5 centimeters. Though both surveys can capture some features that are evidence of the well features, the UAS system's improved resolution is evident. For example, the black circles on fig. 3 highlight two containment basins directly adjacent to the well locations. The improved resolution in the UAS LiDAR dataset allows for a more direct calculation of the actual size and shape of the containment basins.

CONTACTS

Rick Miller
Program Director
Geophysics Applications and Field Services
Kansas Geological Survey
rdmiller@ku.edu

Jeff Klock
Regional District Supervisor
Kansas Corporation Commission
Jeff.Klock@ks.gov

ABOUT THIS STOP

STOP
8

- This stop will provide participants an opportunity to rotate through a hands-on poster session that will highlight multiple active energy and natural resources projects in our state.

Old Meets New: The Future of Energy and Natural Resources in Kansas

Oil and natural gas are the most significant energy resources produced in Kansas and are principal drivers of our state's economy (fig. 1). Hydrocarbon production, however, is by its nature a depletion business and faces challenges, including hard-to-find reservoirs, labor shortages, and commodity price uncertainty. And demand for all forms of energy — for transportation, industrial production, and electricity — continues to grow statewide, nationally, and globally, placing stress on supply chains. Evergy, for example, anticipates the need to double its total electrical generation capacity to meet new demand in the coming decade. Our energy future will almost certainly need to include a mix of existing sources (wind, solar, oil and gas, nuclear), new sources such as hydrogen, and new technologies such as subsurface energy storage and advanced geothermal to meet the demands of our state and country. Existing and new technologies will also require much greater demand in natural resources, such as critical minerals and access to fresh water.

Scientists and staff at the Kansas Geological Survey, Kansas Department of Health and Environment, Kansas Corporation Commission, and Kansas Water Office are working on a variety of projects with citizens, private industry, and non-profits to continue advancing our understanding of these topics.

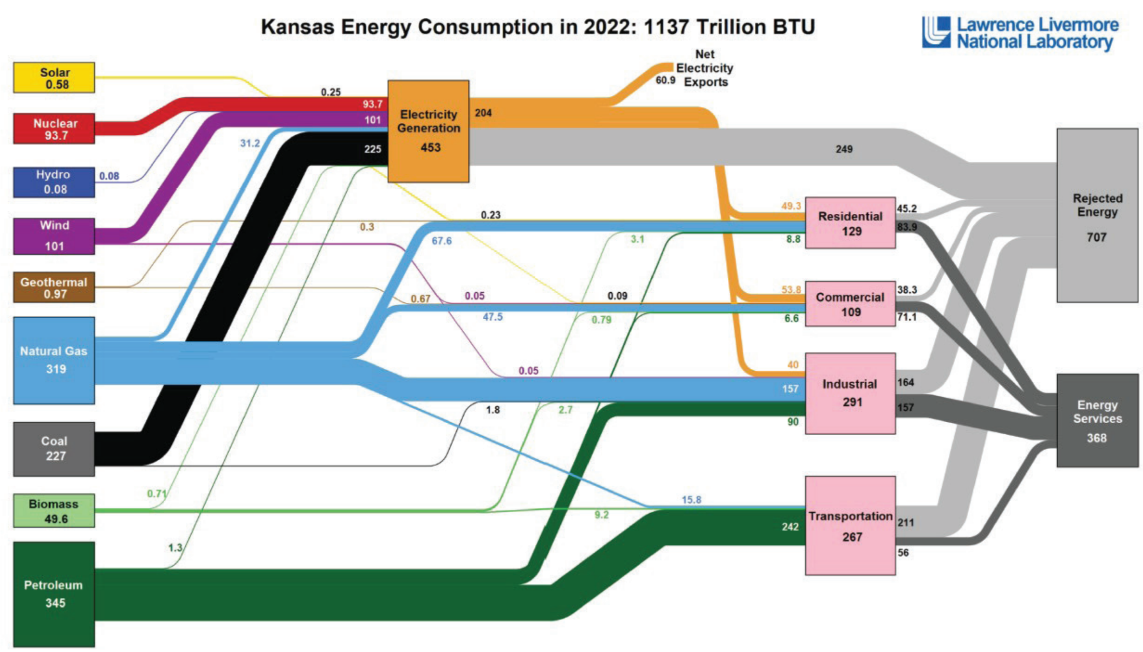


Figure 1: Energy production and use rates in Kansas. These flow charts are developed by Lawrence Livermore National Laboratory to depict energy resources and their use. Energy resources included are solar, nuclear, hydroelectric, wind, geothermal, natural gas, coal, biomass, and petroleum. Source: Lawrence Livermore National Laboratory, 2022.

Oil and Gas in Kansas

The petroleum industry is a major contributor to the Kansas economy. Hundreds of thousands of oil and natural gas wells drilled in the state since the late 19th century have produced more than 6.9 billion barrels of oil and 42.1 trillion cubic feet of natural gas. Today, more than 7,440 oil and gas fields are active across the state (fig. 2).

In 1860, just one year after the world's first commercially successful oil well was drilled in Pennsylvania, Kansas's first oil well was drilled in what is now Miami County. Although the well was only a marginal success, it demonstrated the potential for oil production in the Sunflower State. Commercial success followed in 1892, with exploration near Neodesha (southeastern Kansas), and ramped up significantly when the El Dorado field near Wichita was discovered in 1915. From that point on, Kansas became and still remains a significant oil-producing state.

KEY FACTS: OIL AND GAS

- More than 7,440 active oil and gas fields are active across the state.
- The modes of drilling that companies undertake and the kinds of risks they are willing to take reflect the current state of the oil and gas industry.
- Wildcat exploration is a high-risk venture but can produce significant rewards.

Natural gas was discovered in southwestern Kansas in 1922, but it was not until the 1930s that construction of major pipelines allowed full-scale development of the Hugoton natural gas resource — once considered one of the world's largest natural gas fields. With natural production declines, the Hugoton field today produces only about 13 percent of what it did in 1966.

One indicator that gives insight into the current state of the oil and gas industry is the type of active exploratory drilling going on

Oil and Gas Fields in Kansas

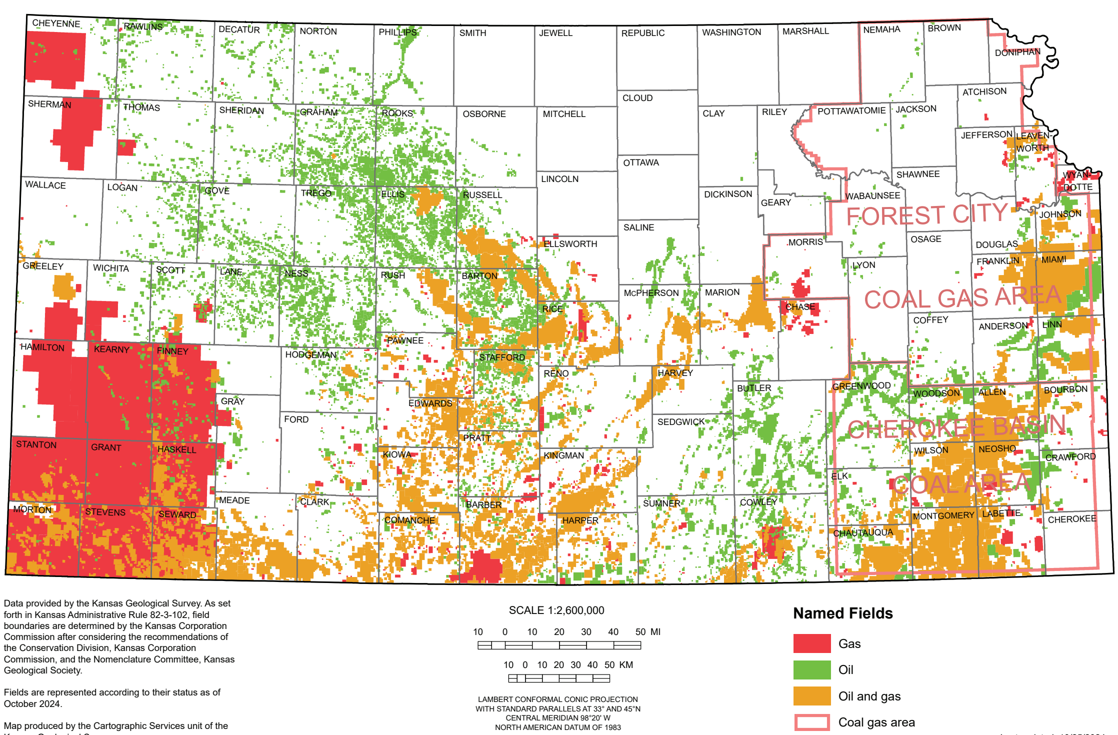


Figure 2: Active oil and gas fields in Kansas as of October 2024. Coal gas areas in eastern Kansas are outlined in pink.

at any given time. The modes of drilling that companies undertake and the kinds of risks they are willing to take reflect uncertainties and magnitudes of potential reward. Oil and gas exploration drilling can be separated into two general categories: wildcat exploration and offset (brownfield) development.

Wildcat exploration is inherently a high-risk venture that uses limited information, such as seismic reflection data, to find new reservoirs. Using various subsurface techniques, prospects are identified and drilled in hopes of making new oil and gas discoveries. If successful and a discovery can be developed into a commercially attractive venture (meaning, for example, it will yield positive cash flow when accounting for commodity sales prices, less development costs, taxes, and royalties), the rewards will outweigh the risks and a development can move forward. Wildcat prospects usually take years to develop, however, because of the complexity of conducting subsurface analysis and obtaining new mineral leases.

Offset (brownfield) drilling carries lower risk because the operator is drilling adjacent to proven reserves. Drilling and production information from the proven reservoir wells helps inform the offset location. The well is usually drilled where a company has already obtained a mineral lease and where infrastructure such as saltwater disposal wells and tanks is already in place. This existing infrastructure reduces average well costs and takes advantage of economies of scale. Offset wells usually produce at a lower rate and pressure in a reservoir that has produced oil and gas for a period of time. Therefore, although the risk is lower, all other things being equal, so too is the reward.

CONTACT

Jennifer Mull
CEO, Mull Companies
jen@mullcompanies.com

Doug Louis
Manager
Kansas Geologic Sample Repository
Kansas Geological Survey
doug.louis@ku.edu

Subsurface Resource Assessment for Carbon Sequestration

Greenhouse gases, particularly carbon dioxide, and their link to the unusually rapid warming of the Earth's atmosphere are of international concern. Worldwide carbon dioxide (CO_2) emissions from human activity have increased from an insignificant level two centuries ago to more than 37 billion tons annually in 2024.[1] In 2024, CO_2 concentrations in the atmosphere set a record high of 423 parts per million.[1] Ensuring the availability of energy resources essential to our economy and our way of life while reducing the concentration of atmospheric CO_2 presents a dual challenge.[2]

KEY FACTS: SUBSURFACE

- Geologic sequestration of carbon dioxide is a viable solution for reducing CO_2 emissions into the atmosphere.
- The Arbuckle Group, a rock formation that has produced about 40% of petroleum in Kansas, is a prospective environment for CO_2 sequestration.
- The Subsurface Dynamics Laboratory at the KGS is developing 3-D storage models of the Arbuckle for all 105 Kansas counties.

Geologic sequestration of carbon dioxide — injecting CO_2 into deep underground rock formations — is a viable solution for reducing CO_2 emissions into the atmosphere. Geologists and engineers in Kansas have deep experience evaluating the state's geology and industrial infrastructure for carbon dioxide injection, whether for long-term storage or to recover hard-to-reach oil.

CO_2 produced from stationary point sources — coal-fired electrical power stations, refineries, and cement and ethanol plants—can be captured for various uses or for secure containment. The process of capturing and sequestering CO_2 is sometimes referred to as carbon capture and storage, or CCS.

Geologic sequestration of CO_2 is the most efficient at depths greater than 2,400 feet (about 800 meters) where CO_2 fluid densities increase to a supercritical state. Supercritical fluids take up less space and diffuse more easily through the pore spaces in rock formations than either gases or ordinary liquids.[2]

The Arbuckle Group, a series of rock layers found only in the subsurface in Kansas, is a prospective environment for CO_2 sequestration. Consisting mainly of dolomite, the rocks of the Arbuckle Group were deposited about 480 million years ago during the Cambrian and Ordovician periods of geologic history. They are found at depths ranging from less than 250 feet (75 meters) in southeast Kansas to 8,000 feet (2,500 meters) in southwest Kansas. In parts of the state, large amounts of oil have been produced from rocks in the Arbuckle Group, accounting for about 40% of the petroleum production in Kansas. Brine from thousands of oil wells has already been successfully placed in the Arbuckle and other aquifers, indicating the aquifers might safely contain CO_2 as well.[3]

The Subsurface Dynamics Laboratory at the Kansas Geological Survey is working to develop a better understanding of the presence or absence, thickness, and structural elements of the Arbuckle Group. Though it has been producing for more than 100 years, the last detailed structural and stratigraphic statewide Arbuckle Group map was generated in the 1960s. Since then, thousands of wells have been drilled, full log suites and cores acquired, and better 2-D and 3-D seismic data acquired.

KGS team members used this new data to generate a 3-D model of the subsurface of the state. Initial statewide products have focused on the Precambrian basement and Arbuckle Group (fig. 3). The current model uses 70,000 Arbuckle and 5,000 Precambrian basement well tops — interpretations of subsurface geology based on well cuttings, core, or wireline logs — to build the subsurface model. Additional data — including well logs; earthquake hypocenter data; seismic data; new wells, core, and cuttings; and gravity data — will be used to update and improve the model. The KGS team is working on a county-by-county analysis of Arbuckle reservoir bulk

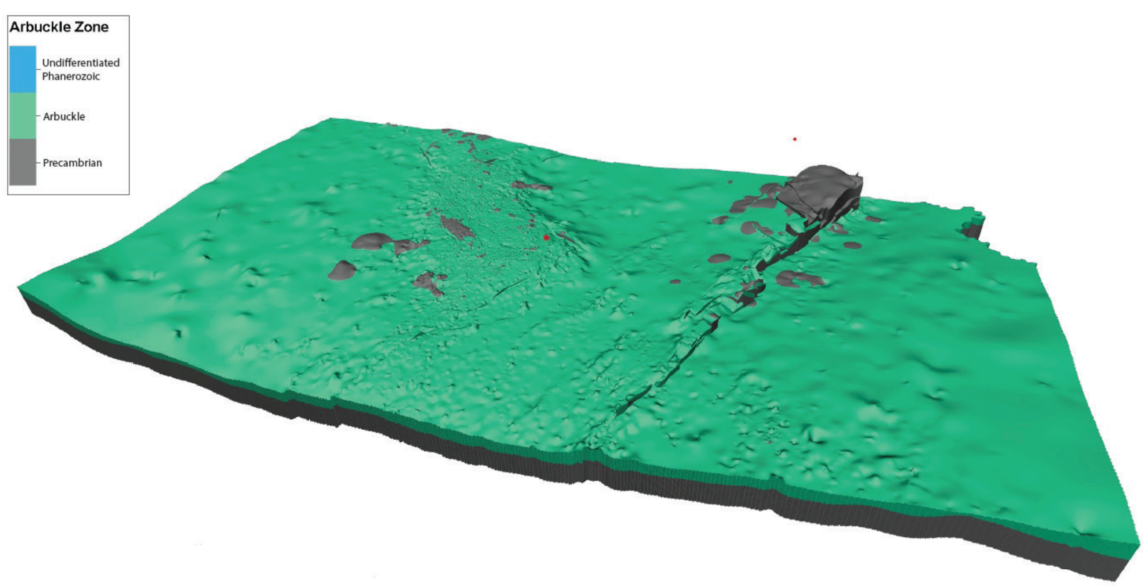


Figure 3: 3-D model of the Arbuckle Group (green) and Precambrian basement (gray) across the state of Kansas.

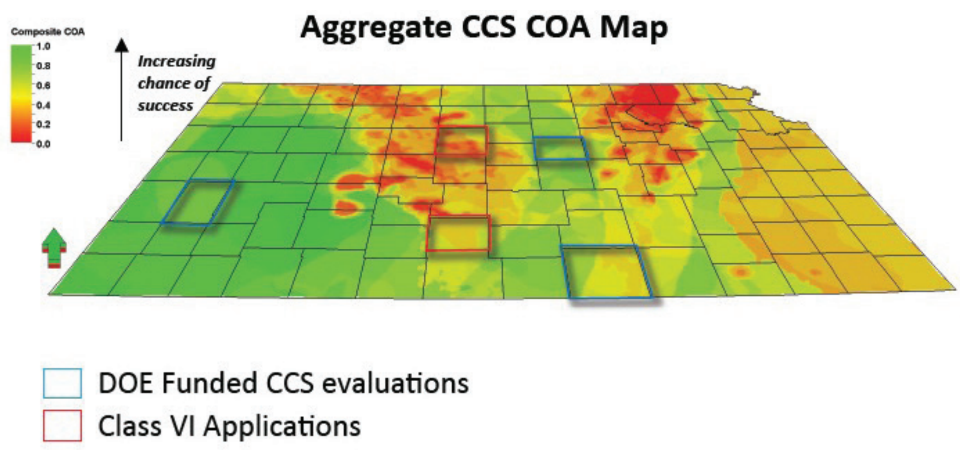


Figure 4: Sample product of the 3-D Arbuckle Group model. This model incorporated Arbuckle reservoir bulk volume, porosity, seal presence, seal quality and thickness, and depth below surface to identify which regions of the state have an increased chance of success for CCS projects. The blue boxes outline counties where the KGS has already investigated the application of CCS and the red boxes outline counties where Class VI applications have been submitted for future CCS projects.

volume, porosity, seal presence, seal quality and thickness, and depth below surface for all 105 counties in the state. The goal of this work is to provide a statewide basis for evaluation and comparison of the primary geologic elements necessary for a successful carbon sequestration project within the Arbuckle Group (fig. 4).

CONTACT
Brendan Bream
Associate Director and Senior Scientist
Kansas Geological Survey
bbream@ku.edu

Can Permian Salt Deposits Play an Outsized Role in Our Energy and Economic Future?

Bedded salt deposits — thick layers of salt minerals found hundreds of feet underground — in central Kansas comprise an important sector of our economy (fig. 5). Production of food- and road-grade salt from hard rock excavation and solution mining began in the Hutchinson area in the late 19th century.[4] In the 1950s, producers discovered that bedded salt was not only a mineable commodity but an ideal medium for storage of hydrocarbons, such as liquid petroleum gas. Fresh water could be cycled underground through wellbores and used to dissolve salt (a process known as solution mining) to make open storage voids with specific dimensions and almost perfect sealing qualities. Caverns specifically designed for hydrocarbon storage were developed across the eastern flank of the Hutchinson Salt Member of the Permian Wellington Formation (fig. 6).

The unique properties of salt deposits — they are non-reactive, impermeable, self-annealing, and have high compressive strength similar to concrete — make them well suited

KEY FACTS: SALT STORAGE

- Production of food- and road-grade salt from hard rock excavation and solution mining began in the Hutchinson area in the late 19th century.
- In the 1950s, producers discovered that bedded salt was not only a mineable commodity but an ideal medium for storage of hydrocarbons, such as liquid petroleum gas.
- A typical salt cavern can hold 100,000 to 300,000 barrels of liquid petroleum gas.

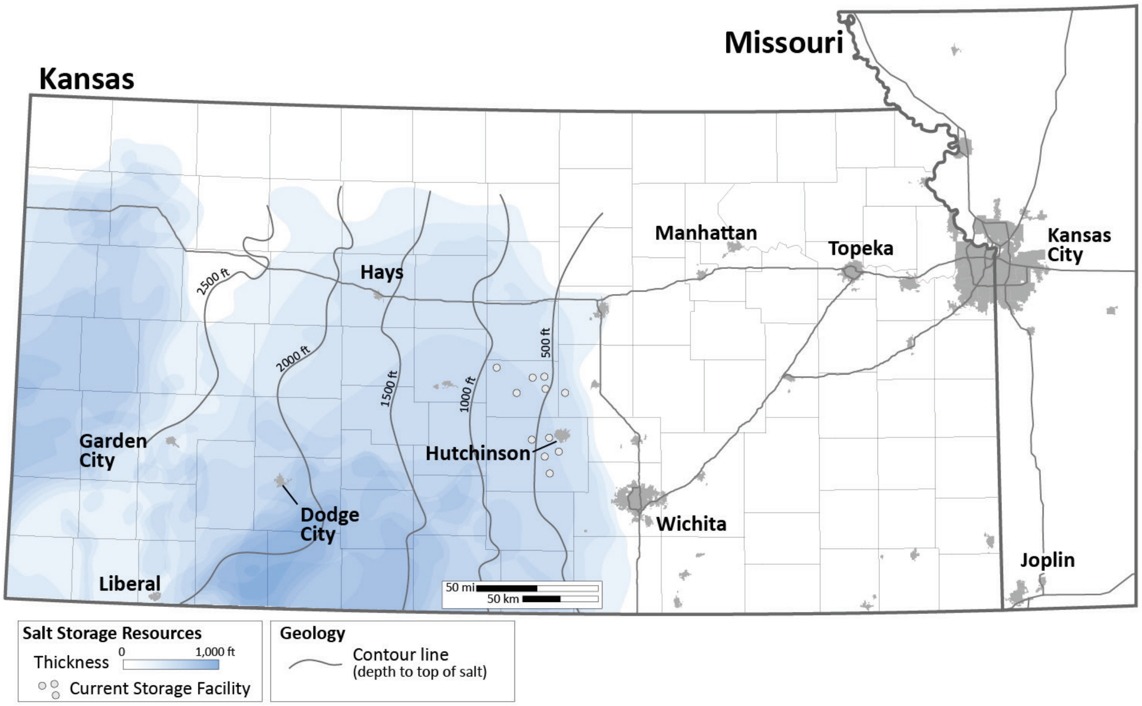


Figure 5: Extent and thickness of the salt deposits across the western half of Kansas.

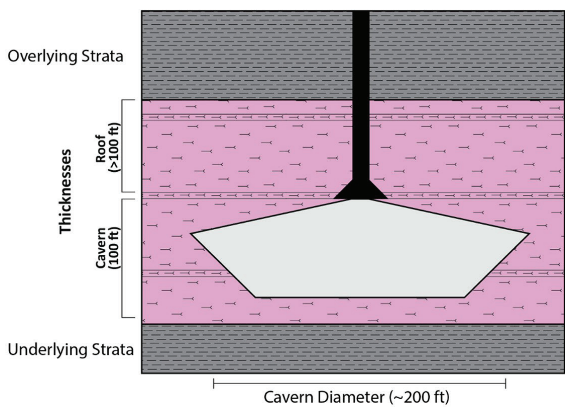


Figure 6: Schematic of an underground salt cavern produced by solution mining.

for hydrocarbon storage. A typical salt cavern can hold 100,000 to 300,000 barrels of liquid petroleum gas.

Though maximum burial depths are modest (500–600 feet) in central Kansas, bedded salt deposits of the same unit are buried to between 2,000 and 3,000 feet in western Kansas and present an opportunity for deep energy storage there as well.

Kansas is home to a mature salt storage industry with an experienced workforce and robust regulatory framework. Since the development of the Safe Drinking Water Act by the Environmental Protection Agency, solution mining has been regulated under the Underground Injection Control program. The Kansas Department of Health and Environment oversees implementation of state and federal storage regulations.[5] Ten liquified gas storage facilities and a number of natural gas storage facilities — all in bedded salt — are permitted in the state. More than 350 caverns exist today and are in various states of use.

Harnessing Kansas's Vast Storage Assets

Although Kansas's salt deposits have historically been used for long-term storage of gaseous and liquid hydrocarbons, they may prove ideal for meeting the needs of an expanded energy industry in the state. Kansas has a vast portfolio of energy assets, including oil and gas, wind, solar, and nuclear. And it has the new opportunities of hydrogen and utility-scale advanced geothermal energy on the horizon. Energy portfolio growth and diversification will be essential to meet the demand of new load growth. But the intermittency of assets such as wind and solar coupled with transmission constraints have created distribution bottlenecks.

Though yet unproven, the KGS and University of Kansas have established collaborative research initiatives with international exploration companies to evaluate potential sources of natural hydrogen in the state. Storage of hydrogen energy may be an important tool for balancing energy supply and demand. Multiple bedded salt formations lie under the western half of the state. Even using conservative assumptions, Kansas salt represents a vast potential for safe and low-cost hydrogen storage throughout western and central Kansas. Manufactured salt caverns here could host megatons of gaseous hydrogen, leading to the development of a centrally located strategic hydrogen reserve.

CONTACT
Jay Kalbas
Director and State Geologist
Kansas Geological Survey
jaykalbas@ku.edu

Critical Mineral Resources in Kansas: A Regional Research Initiative

Critical minerals are non-fuel minerals and elements vital for the manufacture of semiconductors and magnets used in electronics, cars, medical imaging devices, and advanced manufacturing. These minerals are dominantly imported into the United States from China, India, and Chile and present considerable supply chain risk. As of 2022, the U.S. Geological Survey has designated more than 50 minerals as “critical” because of economic impact in combination with domestic supply chain limitations.

Several KGS studies are investigating possible sources for critical minerals in Kansas. Understanding the distribution of these resources, estimating their abundance and concentration, and developing sustainable methods of extraction are expected to be important for national security as well as for supply chain stability. Moreover, if successful, these studies could lead to increased industrial activity in Kansas and surrounding states.

Targets of these studies include the rocks of eastern Kansas, water produced from oil and gas wells, mines and mine waste in southeast Kansas, and the thick layers of salt in central and western Kansas. Early results suggest some salt layers contain elevated amounts of sulfur, vanadium, and some rare earth elements. Confirmation of the potential to recover critical minerals from these layers could add value to existing salt mining operations.

With funding from the USGS and the Department of Energy, the KGS is leading a study of the coal and black shales found in the eastern half of Kansas. These ancient layers of organic-rich rock stretch across the central United States and are known to contain critical minerals. In Kansas, these rocks are found deep underground, particularly in the Cherokee and Forest City

KEY FACTS: CRITICAL MINERALS

- As of 2022, the USGS has designated more than 50 minerals as “critical” because of their economic importance in combination with domestic supply chain limitations.
- KGS is investigating possible sources of critical minerals, including the rocks of eastern Kansas, water produced from oil and gas wells, mines and mine waste in southeast Kansas, and the layers of salt in central and western Kansas.
- Understanding the distribution of these resources, estimating their abundance and concentration, and developing sustainable methods of extraction are expected to be important for national security as well as for supply chain stability.

basins, and date back to the Pennsylvanian geologic period (fig. 7).

Using drill cores from the KGS archives and samples from surface outcrops and former mine sites, the KGS team is examining hundreds of samples for valuable elements: rare earth elements, vanadium, nickel, and platinum-group elements. The projects use cutting-edge core analysis and geochemical techniques to gather detailed data about the compositional makeup of these rocks. This information will help scientists map where these minerals are concentrated and assess their potential for future extraction.

This project also supports broader efforts to improve how geologists correlate rock layers across state lines, helping create more accurate maps and better regional resource assessments. By building a reliable, shared database of mineral content, thickness, stratigraphic distribution, and other geological associations, the project will contribute to smarter exploration strategies and reduce future dependence on foreign mineral imports.

The findings from this study will directly support federal efforts to secure critical mineral resources and help determine whether Kansas's underground black shales and coal deposits could become a domestic source for these strategically important materials. Though the project is still in its research phase, it lays crucial groundwork for potential economic development opportunities tied to critical minerals in Kansas. The huge amount of geochemical data generated by these studies will be integrated with all other archived geological information by the KGS and made available to the public, industry, and government agencies through the Survey's easy-to-use online portals.

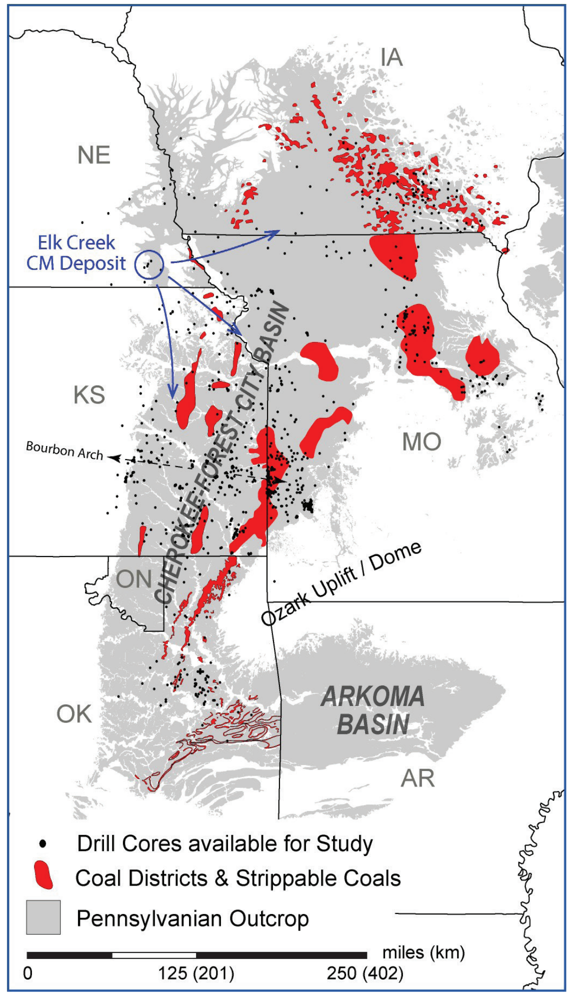


Figure 7: Geological basins for critical mineral assessment in Kansas and surrounding states, focusing on Pennsylvanian-aged black shales and coal deposits.

CONTACTS

Brendan Bream
Associate Director and Senior Scientist
Kansas Geological Survey
bbream@ku.edu

Blair Schneider
Associate Researcher
and Science Outreach Manager
Kansas Geological Survey
blair.schneider@ku.edu

On-Farm Solar Arrays to Enhance Recharge, Produce Energy, and Diversify Farm Income

Agriculture in Kansas is confronted with interconnected challenges involving water resources, climate change, and economic pressures. Groundwater levels across much of the High Plains aquifer have declined, with some locations experiencing depletion so severe that remaining water supplies are projected to last for a few years to a few decades. Climate change worsens the issue by causing more frequent and intense droughts, leading to the increase in irrigation needs and other management actions to be taken to sustain crop production. Simultaneously, agriculture itself contributes to climate change, acting as a source of greenhouse gas emissions due in part to carbon-intensive energy use. These linked issues create significant socioeconomic consequences for farming communities, and the continuing groundwater depletion threatens the $3.5 billion worth of agricultural production sustained by irrigation from the HPA.

To address these interconnected challenges, the KGS has launched a novel pilot project with partners in the farm, energy, municipal, and groundwater management communities. The project's goal is to use the low-productivity non-irrigated corners of center pivot fields for the installation of on-farm solar arrays outfitted with rain collection gutters to direct water into below-ground infiltration tiles (fig. 8). These infiltration tiles collect excess irrigation water and funnel it out of fields so crops don't get waterlogged. They are similarly used in basements and crawl spaces for the same reason. In this project, though, the goal is to directly funnel water into the ground to enhance groundwater recharge.

The project involves installing a pilot-scale pivot-corner solar recharge system in a heavily depleted portion of the HPA in southwestern Kansas to test the team's hypotheses that these systems can enhance water sustainability by increasing groundwater recharge, increase energy system resiliency through distributed energy generation, reduce the agricultural climate footprint through

KEY FACTS: ON-FARM SOLAR

- Ongoing groundwater depletion threatens the $3.5 billion worth of agricultural production sustained by irrigation from the High Plains aquifer.
- A novel pilot project has been launched in collaboration with partners in the farm, energy, municipal, and groundwater management communities to address this.
- The project aims to use the non-irrigated corners of center pivot fields for the installation of on-farm solar arrays outfitted with rain collection gutters to direct water into below-ground infiltration tiles.

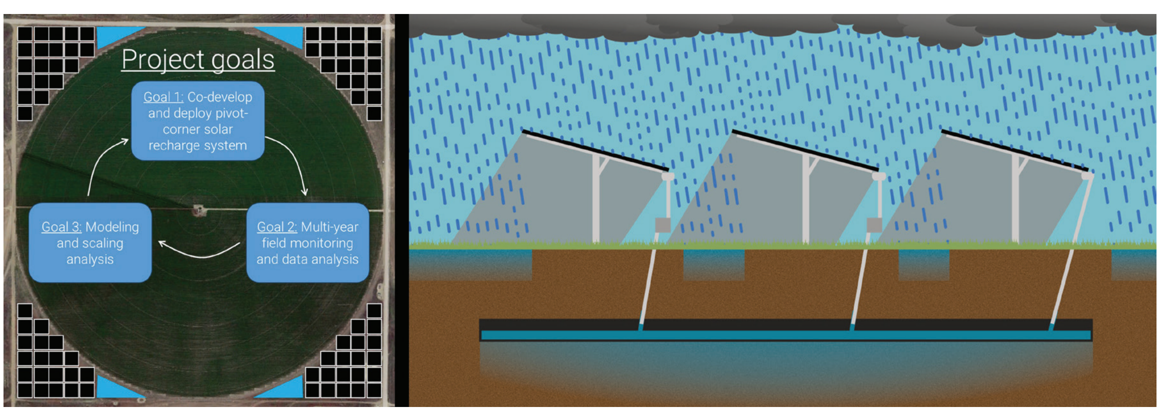


Figure 8: Aerial shot of a center pivot with the location of the solar panels in the corners (left). Schematic of the rain collection gutters that will circumvent water into below-ground infiltration tiles (right).

renewable energy production, and provide economic benefits to farmers through reduced energy costs and sales of produced electricity as well as an increase in long-term water supply sustainability.

Solar installation is scheduled to begin in late summer (early August), at which time the project team will begin conducting detailed hydrological and energy monitoring to assess potential hydrologic, climate, energy, and economic benefits for the farm. Results at the farm level will be scaled up to model regional-scale benefits and identify locations where these systems could provide the greatest benefits. Data on background hydrologic properties have been collected since late summer 2024 to serve as a baseline for benefit analysis.

CONTACT
Sam Zipper
Assistant Scientist
Kansas Geological Survey
samzipper@ku.edu

Forward Thinking: Improving Energy and Water Efficiency in Farming Practices

Agricultural practices have dominated the Kansas landscape since the early 19th century, with new technologies in the mid-20th century leading to dramatic increases in large-scale pumping of the Ogallala aquifer. Some areas in western Kansas have seen up to 60% decline in aquifer levels because of irrigation, and rivers and streams that used to run year-round are now dry. The future of agriculture in Kansas must adapt or irrigation practices will be untenable in our lifetime.

Kansans are working together to address these major challenges. The future of energy and water isn't solely dependent on production — it also involves significant advancements in conservation. The Kansas Water Office's Water Innovation Systems and Education (WISE) program is a public/private partnership program that focuses on fostering the implementation of field practices, technology, and management strategies for industrial, agricultural, and municipal water applications. Its goal is measurable and scalable groundwater conservation, improved water quality, and overall soil and ecological health. This program is an expansion of KWO's legacy Water Technology Farms and PACE Farm programs.

Examples of water conservation practices employed by WISE farms include irrigation water management, water harvesting, and wastewater treatment systems. A variety of irrigation technologies available today, such as more efficient sprinkler nozzles or pivot controllers, reduce the amount of water dispersed. Water harvesting techniques, such as collecting and storing rainwater for later use, can significantly reduce groundwater pumping. A unique example of wastewater treatment is being implemented by Westside Dairy in Stanton County, which is using filtration systems to treat its stock water on site so it can be recycled and reused for barn water.

Examples of energy conservation employed by WISE farms include investing in energy-efficient equipment and renewable energy sources, such as solar-powered soil moisture probes and irrigation systems.

KEY FACTS: WATER AND ENERGY

- The future of energy and water isn't solely dependent on production — it also involves significant advancements in conservation.
- The Kansas Water Office's Water Innovation Systems and Education (WISE) program supports farmers and landowners in implementing energy and water conservation practices.
- A new program that provides certified evaluations of irrigation systems has identified 14% to 32% reductions in wasted irrigation water at more than 100 sites.

Modern tractors are designed to be more energy efficient, with some estimates as high as 50% in efficiency gains and reduced fuel consumption. Implementing practices such as no-till farming reduces overall fuel consumption and simultaneously improves soil health.

A new element of the WISE program is irrigation system evaluations. Certified system evaluations have been performed and calibrated at 104 WISE sites thanks to a state cost-share program for producers (fig. 9). Results of the evaluations to date have shown 14%–32% reductions in wasted water after sites receive an irrigation system evaluation. This is the standard evaluation being deployed now through the Kansas Department of Agriculture Division of Conservation Irrigation Technology Initiative and the DOC-KWO HPA Regional Conservation Partnership Program cost share programs. All producers enrolling for cost-share through those programs must have their systems evaluated by one of the WISE certified system evaluators to qualify.

Figure 9: A certified system evaluator provides an irrigation system evaluation at a WISE farm in 2025.

CONTACT

Weston McCary

Technology Projects Coordinator

Kansas Water Office

weston.mccary@kwo.ks.gov

NOTES

Sources

Introduction: Fundamentals for the Future: Water, Energy, and Infrastructure

1 **Drought Conditions for Reno County**
National Integrated Drought Information System
https://www.drought.gov/states/kansas/county/Reno#historical-conditions

2 **Reno County — Oil and Gas Production**
Kansas Geological Survey, 2024
https://www.kgs.ku.edu/PRS/County/rs/reno.html

3 **A Review on Underground Hydrogen Storage: Insight into Geological Sites, Influencing Factors and Future Outlook**
N. Salahu Muhammad, B. Haq, D. Al Shehria, A. Al-Ahmed, M. M. Rahman, and E. Zaman, Energy Reports, 2022, v. 8, p. 461–499.

4 **Bureau of Water Geology & Well Technology Unit Underground Hydrocarbon Storage Program Overview**
Kansas Department of Health and Environment, 2019
https://www.kdhe.ks.gov/DocumentCenter/View/1130/Underground-Hydrocarbon-Storage-Program-Overview-2019-PDF.

5 **Hutchinson Natural Gas Explosion**
GeoKansas, Kansas Geological Survey
https://geokansas.ku.edu/hutchinson-natural-gas-explosion

6 **Division of Water Resources Update**
Earl Lewis, Kansas Dam Safety Conference, Manhattan, Kansas, 2025
https://www.agriculture.ks.gov/about-us/ag-growth-project/dam-safety-conference-2025

Stop 1: Wichita's Aquifer Storage and Recovery Project

1 **Managing Supply**
City of Wichita
https://www.wichita.gov/506/Managing-Supply

2 **Equus Beds Aquifer Storage and Recovery (ASR) Project**
Kansas Water Science Center, 2025
https://www.usgs.gov/centers/kansas-water-science-center/science/equus-beds-aquifer-storage-and-recovery-asr-project

3 **Preliminary Simulation of Chloride Transport in the Equus Beds Aquifer and Simulated Effects of Well Pumping and Artificial Recharge on Groundwater Flow and Chloride Transport Near the City of Wichita, Kansas, 1990 through 2008**
B. J. Klager, B. P. Kelly, and A. C. Ziegler, U.S. Geological Survey Open-File Report 2014-1162, 2014
http://dx.doi.org/10.3133/ofr20141162.

Stop 2: Cheney Reservoir

1 **Cheney State Park**
Kansas Department of Wildlife and Parks, 2025
https://ksoutdoors.com/State-Parks/Locations/Cheney

2 **Water Quality in the Equus Beds Qquifer and the Little Arkansas River Before Implementation of Large-Scale Artificial Recharge, South-Central Kansas, 1995–2005**
Andrew C. Ziegler, Christi V. Hansen, and Daniel A. Finn, U.S. Geological Survey, 2010
https://pubs.usgs.gov/sir/2010/5023/

3 **Predicting Cyanobacterial Abundance, Microcystin, and Geosmin in a Eutrophic Drinking-Water Reservoir Using a 14-Year Dataset**
Ted D. Harris and Jennifer L. Graham, Lake and Reservoir Management, 2017
DOI: 10.1080/10402381.2016.1263694

4 **Cheney Lake Watershed, Inc.**
https://www.cheneylakewatershed.org/

5 **Drought Updates**
City of Wichita Public Works and Utilities Department, 2025
https://www.wichita.gov/501/Drought-Update

6 **National Water Prediction Service**
NOAA Website, 2025
Water.noaa.gov

7 **Water-Year Summary for Site USGS 07144790**
U.S. Geological Survey website, 2025
https://waterdata.usgs.gov/nwis/inventory/?site_no=07144790&agency_cd=USGS

Bus Talk: Dam Safety

1 **Division of Water Resources Update**
Earl Lewis, Kansas Department of Agriculture Dam Safety Conference, 2025

2 **National Inventory of Dams**
United States Army Corp of Engineers, 2025
https://nid.sec.usace.army.mil/#/

3 **Managing Dams**
United States Army Corp of Engineers, 2025
https://nid.sec.usace.army.mil/#/dam-basics/managing-dams

4 **Anatomy of Dams**
Association of State Dam Safety Officials, ASDSO Dam Safety Toolbox, 2023
https://damtoolbox.org/wiki/Anatomy_of_Dams

5 **About Bowersock**
Bowersock Mills and Power Company, 2025
https://bowersockpower.com/about/

6 **Dam Safety Program**
Kansas Department of Agriculture Division of Water Resources, 2025
https://www.agriculture.ks.gov/divisions-programs/division-of-water-resources/water-structures/dam-safety-program

7 **Dam History in Kansas**
Kansas Department of Agriculture Division of Water Resources
https://www.agriculture.ks.govhome/showpublisheddocument/5246/638467149548230000

8 **Dam Safety Resources**
Kansas Department of Agriculture Division of Water Resources Dam Safety Program, 2025
https://www.agriculture.ks.gov/divisions-programs/division-of-water-resources/water-structures/dam-safety-program/dam-safety-resources

9 **House Committee on Water Presentation on Kansas Department of Agriculture Division of Water Resources Water Structures Program**
Earl Lewis, Kansas Department of Agriculture, 2022
https://www.kslegislature.gov/li_2022/b2021_22/committees/ctte_h_water_1/documents/testimony/20220131_02.pdf

Stop 3: Land Subsidence and Salt Dissolution in Reno County

1 **Part I: Salt Deposits of Kansas: Regional Geology**
Kansas Geological Survey, Bulletin 214
https://www.kgs.ku.edu/Publications/Bulletins/214/03_salt.html

2 **Stability of Salt in The Permian Salt Basin of Kansas, Oklahoma, Texas, and New Mexico**
George O. Bachman and Ross B. Johnson, U.S. Geological Survey, 1973
https://pubs.usgs.gov/of/1973/0014/report.pdf

3 **High Resolution Seismic Reflection to Characterize Small Scale Mechanisms of Large Scale Natural Dissolution in the Hutchinson Salt Member**
Brett E. Judy, Doctoral Dissertation, University of Kansas, 2015

4 **Salt in Kansas**
Robert S. Sawin and Rex Buchanan, Kansas Geological Survey Public Information Circular 21, 2002
https://kgs.ku.edu/salt-kansas

5 **Mitigation Alternatives for Salt Dissolution Subsidence Impacting US Highway 50 at Brandy Lake, Reno County, Kansas**
Jeffrey R. Keaton and Shanmugam J. Pannalal, 72nd Highway Geology Symposium, 2023

6 **Part II: Land Subsidence Areas Associated with Salt Mining**
Kansas Geological Survey, Bulletin 214
https://www.kgs.ku.edu/Publications/Bulletins/214/04_land.html

7 **Quantifying Surface Subsidence along US Highway 50, Reno County, KS, Using Terrestrial LiDAR**
Andrew J. Herrs, University of Kansas, 2010

8 **Detailed Mapping of the Upper Hutchinson Salt and Overlying Permian Strata Beneath Hutchinson, Kansas**
Susan Nissen and W. Lynn Watney, , Kansas Geological Survey Open File Report 2003-66, 2003
https://www.kgs.ku.edu/PRS/publication/2003/ofr2003-66/index.html

Stop 4: Salt Mining in Kansas

1 **Salt in Kansas**
Robert S. Sawin and Rex C. Buchanan, Kansas Geological Survey Public Information Circular 21
https://kgs.ku.edu/salt-kansas

2 **Salt Mining**
GeoKansas, Kansas Geological Survey
https://geokansas.ku.edu/salt-mining

3 **Salt Statistics and Information**
U.S. Geological Survey National Minerals Information Center
https://www.usgs.gov/centers/national-minerals-information-center/salt-statistics-and-information

4 **Biodiesel Production and Distribution**
Alternative Fuels Data Center, U.S. Department of Energy
https://afdc.energy.gov/fuels/biodiesel-production

5 **Hutchinson Salt Company**
https://hutchinsonsalt.com/

6 **South-Central Kansas: Oil, Salt, Wetlands, and Other Regional Resources; 2019 Kansas Field Conference Field Guide**
Susan Stover and Catherine S. Evans, Kansas Geological Survey, Open-File Report 2019-5
http://www.kgs.ku.edu/Field/Reports/KGS_OF_2019-5.pdf

7 **About Us**
UV&S
https://uvsinc.com/contact-us/about-us/

Stop 5: Finding Clues to Water Quality in Nature

1 **Cheyenne Bottoms**
The Nature Conservancy
https://www.nature.org/en-us/get-involved/how-to-help/places-we-protect/cheyenne-bottoms-preserve/

2 **Sulfate in Drinking-Water**
World Health Organization, 2004
https://cdn.who.int/media/docs/default-source/wash-documents/wash-chemicals/sulfate.pdf?sfvrsn=b944d584_4

3 **Water Quality, Not Just Quantity, a Problem in the Arkansas River**
Rex Buchanan, Kansas Geological Survey, 1996
https://www.kgs.ku.edu/General/News/96_releases/arkriver.html

4 **Acid Sulfate Soils and Human Health — A Millennium Ecosystem Assessment**
Karin Ljung, Fiona Maley, Angus Cook, and Philip Weinstein, Environmental International, 2009
https://www.sciencedirect.com/science/article/pii/S0160412009001500

Bus Talk: Fire Management in Kansas: What's Changed?

1 **Governor's Wildfire Task Force Final Report**
Kansas Forest Service, November 2023

2 **Remembering the 'Four County Fire' Three Years Later**
Ryan Newton, Kansas State News, December 2022.

3 **Hutchinson Fire Chief Asks Residents for Help after Devastating Cottonwood Complex Fire**
John Green, The Hutchinson News, March 2022.

4 **Performance of Fire Danger Indices and Their Utility in Predicting Future Wildfire Danger Over the Conterminous United States**
G. Yu, Y. Feng, J. Wang, and D. B. Wright, Earth's Future, October 2023
doi:10.1029/2023EF003823

5 **Global Climate Change Impacts in the United States: A State of Knowledge Report**
Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, Cambridge University Press, 2009

6 **Eastern Redcedar**
Kansas Forests, Kansas Forest Service

7 **Kansas Wildfire Risk**
Kansas Wildfire Risk Assessment Portal, Kansas Forest Service

8 **Community Wildfire Defense Grant Program**
US Forest Service, April 2024

9 **Community Wildfire Defense Grants — Funded Proposals**
U.S. Forest Service, April 2024

Stop 6: Sand Hills State Park

1 **Sand Hills State Park**
Kansas Department of Wildlife and Parks, 2025
https://ksoutdoors.com/State-Parks/Locations/Sand-Hills

2 **Sand Hills State Park Brochure**
Kansas Department of Wildlife, Parks, and Tourism, 2016
https://ksoutdoors.com/content/download/13572/88149/file/SAND%20HILLS%20SP.pdf

3 **Kansas State Park Guide**
Kansas Department of Wildlife and Parks, 2023
https://ksoutdoors.com/Services/Publications/State-Parks/2023-Kansas-State-Park-Guide-B-W

4 **Activation History of the Hutchinson Dunes in East-Central Kansas, USA During the Past 2200 Years**
Alan F. Halfen, William C. Johnson, Paul R. Hanson, Terri L. Woodburn, Aaron R. Young, and Gregory A. Ludvigson, Aeolian Research, 2012
https://www.kgs.ku.edu/General/Personnel/klm/GAL/Halfen_etal_2012_Hutchinson_dunes_AR.pdf

Stop 7: Using Remote Sensing Techniques to Locate Orphaned and Abandoned Oil and Gas Wells

1 **Analysis of the United States Documented Unplugged Orphaned Oil and Gas Well Dataset**
Matthew D. Merrill, Claire A. Grove, Nicholas J. Gianoutsos, Philip A. Freeman, U.S. Geological Survey, 2023
https://www.usgs.gov/publications/analysis-united-states-documented-unplugged-orphaned-oil-and-gas-well-dataset

2 **Idle and Orphaned Oil and Gas Wells: State and Provincial Regulatory Strategies**
Interstate Oil and Gas Compact Commission, 2021
https://oklahoma.gov/content/dam/ok/en/iogcc/documents/publications/iogcc_idle_and_orphan_wells_2021_final_web.pdf

3 **Abandoned Oil and Gas Well Status**
Kansas Corporation Commission, KCC Legislative Reports, 2025
https://www.kcc.ks.gov/images/PDFs/legislative-reports/2025_Abandoned_Oil_Gas_Well_Status.pdf

4 **UAV-Based Aeromagnetic Surveys for Orphaned Well Location: Emerging Best Practices**
Alex Nikulin and Timothy Smet, The Leading Edge, 2023
https://doi.org/10.1190/tle42120817.1

5 **A Feasibility Study using Aeromagnetic Surveys to Locate Orphaned Wells in McPherson, Kansas**
M. Tamburro, S. L. Peterie, R. Kieffer, and R. D. Miller, 2025, Kansas Geological Survey Open-File Report 2025-2, 12 p.

6 **LiDAR**
Kansas Data Access and Support Center, 2025
https://gisresources.kansasgis.org/

Stop 8: Old Meets New: Thw Future of Energy and Natural Resources in Kansas

1 **Climate Change: Atmospheric Carbon Dioxide**
Rebecca Lindsey, National Oceanic and Atmospheric Administration 2025
https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide

2 **Geologic Sequestration of Carbon Dioxide in Kansas**
Rex Buchanan and Timothy R. Carr, Kansas Geological Survey Public Information Circular 27, December 2008; revised March 2011
https://kgs.ku.edu/geologic-sequestration-carbon-dioxide-kansas

3 **Use of Relational Databases to Evaluate Regional Petroleum Accumulation, Ground-water Flow, and CO_2 Sequestration in Kansas**
T. R. Carr, D. F. Merriam, and J. D. Bartley, 2005, American Association of Petroleum Geologists, Bulletin, v. 89, no. 12, p. 1,607–1,627.

4 **The Science and Industry of the Permian Hutchinson Salt**
M. K. Schulmeister, A. S. Andeskie, and K. C. Benison, 2019, in Schulmeister, M. K., and Aber, J. S., eds., Exploring Extreme and Unusual Geology in the Stable Midcontinent: Field Excursions for the 2019 GSA South-Central, North-Central, and Rocky Mountain Sections Joint Meeting: Geological Society of America Field Guide 52, p. 25–35.

5 **KDHE Underground Hydrocarbon Storage Program Overview**
Kansas Department of Health and Environment, 2019
https://www.kdhe.ks.gov/DocumentCenter/View/1130/Underground-Hydrocarbon-Storage-Program-Overview-2019-PDF.