Kansas Field Conference
August 13–15, 2018

North-Central Kansas

New Developments in Agriculture, Water Management, and Local Economies

Field Guide

Susan Stover and Catherine S. Evans

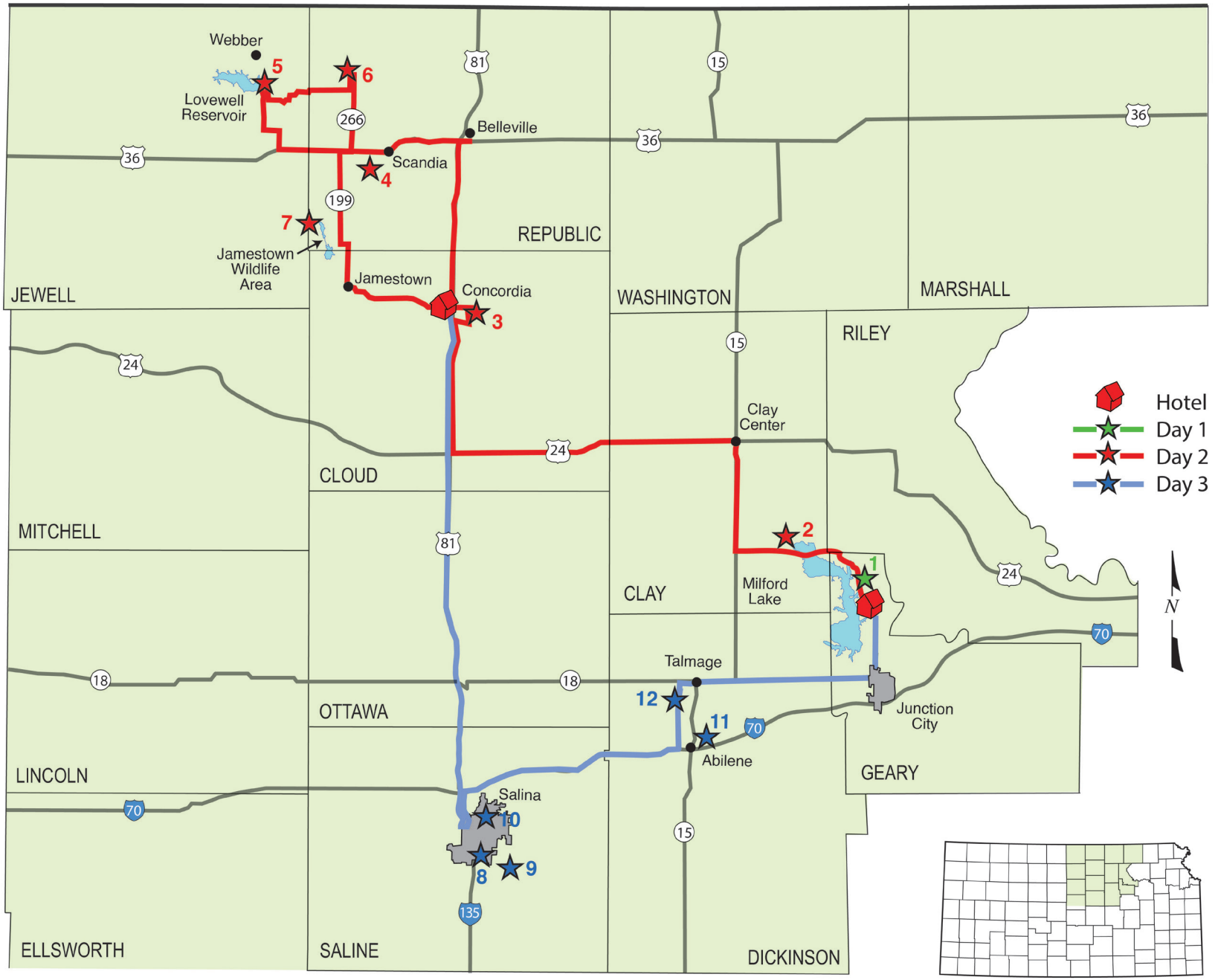
This project is operated by the Kansas Geological Survey and funded, in part, by the Kansas Water Office, the Kansas Department of Transportation, and the Kansas Department of Wildlife, Parks and Tourism.

KGS Open-File Report 2018-15

Kansas Geological Survey
The University of Kansas
1930 Constant Avenue
Lawrence, KS 66047-3724
785-864-3965
www.kgs.ku.edu

Cover photo: Tim Passmore

Route map.


Webber
Lovewell Reservoir
Belleville
Scandia
Jamestown Wildlife Area
Jamestown
Concordia
REPUBLIC
JEWELL
WASHINGTON
MARSHALL
RILEY
Clay Center
CLOUD
MITCHELL
CLAY
Milford Lake
Talmage
OTTAWA
Junction City
Abilene
GEARY
LINCOLN
Salina
ELLSWORTH
SALINE
DICKINSON
Hotel
Day 1
Day 2
Day 3
N
81
15
36
266
199
24
18
70
135

2018 Kansas Field Conference
North-Central Kansas: New Developments in Agriculture,
Water Management, and Local Economies

Contents

2018 Kansas Field Conference
North-Central Kansas: New Developments in Agriculture, Water Management,and Local Economies

Participants

Steve Adams, Chief of Planning, Kansas Department of Wildlife, Parks and Tourism

Jeff Andersen, Secretary, Kansas Department of Health and Environment

Larry Biles, State Forester, Kansas Forest Service

Richard Billinger, Senator, Goodland

Elaine Bowers, Senator, Concordia

Sydney Carlin, Representative, Manhattan

John Carmichael, Representative, Wichita

Lonnie Clark, Representative, Junction City (Monday only)

Susan Concannon, Representative, Beloit

Steve Crum, Representative, Haysville

Marci Francisco, Senator, Lawrence

Raney Gilliland, Director, Kansas Legislative Research Department

Dan Goddard, Senator, Parsons

Kyle Halverson, Chief Geologist, Kansas Department of Transportation

Kyle Hamilton, Assistant Revisor of Statutes, Kansas Office of Revisor of Statutes

BJ Harden, Deputy Secretary and Chief of Staff, Kansas Department of Transportation

Randall Hardy, Senator, Salina

Tom Hawk, Senator, Manhattan

Dave Heinemann, KGS Advisory Council

Leo Henning, Director of Environment, Kansas Department of Health and Environment

Larry Hibbard, Representative, Toronto

Kyle Hoffman, Representative, Coldwater

Eileen Horn, Representative, Lawrence

Robin Jennison, Secretary, Kansas Department of Wildlife, Parks and Tourism

Dan Kerschen, Senator, Garden Plain

Annie Kuether, Representative, Topeka

Lane Letourneau, Program Manager, Division of Water Resources, Kansas Department of Agriculture

Earl Lewis, Assistant Director, Kansas Water Office

Greg Lewis, Representative, St. John

Brad Loveless, Executive Director, Environmental Services, Westar Energy

Rob Manes, State Director, The Nature Conservancy in Kansas

Tracey Mann, Lieutenant Governor (Monday only)

Ed Martinko, Director and Professor, Kansas Biological Survey

Carolyn McGinn, Senator, Sedgwick

Heidi Mehl, Beals Healthy Streams Initiative Manager, The Nature Conservancy

Cindy Neighbor, Representative, Shawnee

Patrick Parke, CEO, Midwest Energy and KGS Advisory Council

Jason Probst, Representative, Hutchinson

Ken Rahjes, Representative, Agra

Rob Reschke, Executive Director, Division of Water Resources, Kansas Department of Agriculture

Josh Roe, Deputy Secretary, Kansas Department of Agriculture

Melissa Rooker, Representative, Fairway

Tracy Streeter, Director, Kansas Water Office

Susie Swanson, Representative, Clay Center

Kansas Geological Survey Staff

Susan Stover, Geologist and Outreach Manager

Rolfe Mandel, Director

Cathy Evans, Communications Coordinator

Tony Layzell, Assistant Research Professor/ Stratigraphic Research

NOTES

Biographical Information

Steve Adams
Chief of Planning
Kansas Department of Wildlife, Parks and Tourism
1020 S. Kansas Avenue, Topeka KS 66612
785-296-2281 Business
steve.adams@ks.gov
Responsibilities and Experience: KDWPT, 1989–present. Education: Northeastern State University, BS; Oklahoma State University, MS

Jeff Andersen
Secretary
Kansas Department of Health and Environment
Curtis State Office Building
1000 SW Jackson, Suite 540, Topeka KS 66612-1368
785-296-7253 Business
jeff.andersen@ks.gov
Responsibilities and Experience: 30 years in healthcare field. Oversees environmental management and health services. University of Kansas, BS, Business; University of Missouri-Kansas City, MS, Health Care Administration

Larry Biles
State Forester
Kansas Forest Service
2610 Claflin Road, Manhattan KS 66502
785-532-3300 Business
lbiles@ksu.edu
Responsibilities and Experience: Leadership for agency's rural, community, fire management, conservation trees, forest health, and wood utilization programs; Education: University of Missouri, BS, Forestry; Kansas State University, MS, Ornamental Horticulture

Richard Billinger
Senator, District 40
Box 594, Goodland KS 67735
785-899-4700 Business
Rick.Billinger@senate.ks.gov
Responsibilities and Experience: Vice Chair, Ways and Means, Financial Institutions, Insurance and Pensions, and Joint Committee on State Building Construction; Member, Agriculture and Natural Resources Committee. Farmer and retired businessman; Army veteran; Former Goodland mayor and city council member; Education: Colby Community College; Fort Hays State University, General Business Studies

Elaine Bowers
Kansas State Senate, District 36
1326 N. 150th Rd, Concordia KS 66901
785-243-4380 ext. 0 Business
785-614-1415 Cell
elaine@concordiaautomart.com
Responsibilities and Experience: Majority Whip; Chair, Ethics, Election and Local Government Committee; Member, Utilities, Judiciary, Joint Post Audit, and Capitol Preservation committees; Senate Rural Agricultural Chair. Co-owner Concordia Auto Mart Inc. and Concordia Chevrolet/Buick. Education: Cloud County Community College

Sydney Carlin
Kansas House of Representatives, District 66
1650 Sunny Slope, Manhattan KS 66502
785-341-7455 Cell
sydcar44@gmail.com
Responsibilities and Experience: Ranking minority member, Agriculture and Agriculture and Natural Resources Budget committees; Member, Appropriations Committee and Joint Committee on Corrections and Juvenile Justice Oversight. Education: Kansas State University, BS

John Carmichael
Kansas House of Representatives, District 92
1475 N Lieunett St, Wichita KS 67203
785-264-3300 Business
316-250-0969 Cell
john.carmichael@house.ks.gov
Responsibilities and Experience: Member, Energy, Utilities and Telecommunications and Commerce, Labor and Economic Development committees. Of counsel, Conlee, Schmidt & Emerson, LLP. Education: University of Kansas, BGS; Wichita State University, BS; University of Kansas, JD

Lonnie Clark
Kansas House of Representatives, District 65
1221 Country Club Ln, Junction City KS 66441
785-296-7483 Business
lgclark6266@yahoo.com
Responsibilities and Experience: Vice Chair, Veterans and Military Committee; Member, Agriculture and Agriculture and Natural Resources Budget committees. Interests: Hunting, fishing, trapping, gardening

Susan Concannon
Kansas House of Representatives, District 107
921 N. Mill Street, Beloit KS 67420
785-296-7677 Business
785-738-8087
sconcannon@nckcn.com
Responsibilities and Experience: Vice Chair, Health and Human Services; Member, Appropriations and Taxation committees; Member, Bob Bethel KanCare Oversight Committee; House Majority Caucus Chair. Established and served as executive director for a community health foundation. Legislative interest is health policy with focus on rural issues; outside interests are family activities, travel, reading, and golf. Education: Bethany College, BA, Psychology

Steve Crum
Kansas House of Representatives, District 98
315 Linden Ln, Haysville KS 67060
316-491-1977 Home
crumforkansas@gmail.com
Responsibilities and Experience: Water and Environment, Education, and Health and Human Services committees. City Council member. Elementary and computer teacher; swim coach. Education: Newman University, BS, Elementary Education

Marci Francisco
Kansas State Senate, District 2
1101 Ohio Street, Lawrence KS 66044
785-766-1473 Cell
785-842-6402 Home
marci.francisco@senate.ks.gov
maf@sunflower.com
Responsibilities and Experience: Ranking member, Agriculture and Natural Resources Committee; Member, Utilities and Assessment and Taxation committees; Member, Joint committees on Information Technology and State Building Construction. Farm worker, harvesting chestnuts. Education: University of Kansas, Bachelor's of Architecture

Raney Gilliland
Director
Kansas Legislative Research Department
300 SW 10th Ave, Rm 68–West
Topeka KS 66612-1504
785-296-3181 Business
raney.gilliland@klrd.ks.gov
Responsibilities and Experience: Director, KLRD. Staff for Senate Agriculture and Natural Resources Committee and Joint Committee on Administrative Rules and Regulations. Education: Kansas State University, BS, Political Science; Kansas State University, MS, Agricultural Economics

Dan Goddard
Kansas State Senate, District 15
3420 Mosher Rd, Parsons KS 67357
620-423-0407 Home
dwgaddard@cableone.net
Responsibilities and Experience: Vice Chair, Transportation Committee; Member, Ways and Means, and Assessment and Taxation committees; Member, Select Committee on Education Funding. Retired Air Force Colonel. Education: University of Wisconsin, BA Geology

Kyle Halverson
Chief Geologist
Kansas Department of Transportation
700 SW Harrison St, Topeka KS 66603
785-291-3860 Business
kyle.halverson@ks.gov
Responsibilities and Experience: Oversee KDOT geology section; Communication coordinator for Transportation Research Board (TRB) committee on geotechnical site characterization; Secretary, Shallow Exploration Drillers Clinic. Education: Emporia State University, BS, Earth Science

Kyle Hamilton
Assistant Revisor of Statutes
Kansas Office of Revisor of Statutes
300 SW 10th Ave., Suite 24-E, Topeka KS 66612
785–296–2321 Business
kyle.hamilton@rs.ks.gov
Responsibilities and Experience: Drafts and briefs bills for the House Standing Committee on Agriculture. Was a legal intern for the Kansas Department of Agriculture. Education: Washburn University, JD

BJ Harden
Deputy Secretary of Transportation and Chief of Staff
Kansas Department of Transportation
700 SW Harrison St, Topeka KS 66603
785-291-2481 Business
byron.j.harden@ks.gov
Responsibilities and Experience: Formerly Deputy Assistant Secretary and Chief of Staff, Office of the Kansas Secretary of State. Mentoring program at the Topeka Rescue Mission. Interests: Hiking, running, and CrossFit. Education: Washburn University, JD

Randall Hardy
Kansas State Senate, District 24
816 Highland Ave, Salina KS 67401
785-296-7369 Business
785-823-7968 Home
randall.hardy@senate.ks.gov
Responsibilities and Experience: Member, Ethics, Elections and Local Government, Transportation,

Judiciary, and Utilities committees. Salina City Commissioner, 2013–2017. Interests: Grandkids, photography, golf, hiking, camping, grilling. Education: Oral Roberts University, BA, Psychology; University of Kansas, MBA

Tom Hawk
Kansas State Senate, District 22
2600 Woodhaven Ct, Manhattan KS 66502
785-537-8000 Business
tom@tomhawk.com
Responsibilities and Experience: Ranking Democrat, Financial Institutions and Insurance committee; Member, Agriculture and Natural Resources Transportation, Utilities, and Ways and Means committees; Governor's Blue Ribbon Task Force, 2016. Education: Kansas State University, BS, MS, and PhD

Dave Heinemann
Kansas Geological Survey Advisory Council (GSAC)
3826 SW Cambridge Court, Topeka KS 66610
785–213–9895
daveh123@cox.net
Responsibilities and Experience: Legislative representative for American Heart Association, High Plains Public Radio, Schools for Quality Education, and Smoky Hills Public Television. Education: Augustana College, BA; University of Kansas; Washburn Law School, JD

Leo Henning
Director of Environment
Kansas Department of Health and Environment
1000 SW Jackson, Ste 400, Topeka KS 66612-1367
Leo.henning@ks.gov
Responsibilities and Experience: Responsible for implementation of all environmental programs at KDHE. Professional geologist. Education: Wichita State University, BS and MS, Geology

Larry Hibbard
Kansas House of Representatives, District 13
858 EE 75 Road, Toronto KS 66777
620-583-3334 Business
620-637-2454
larryphibbard@gmail.com
Responsibilities and Experience: Member, Agriculture and Natural Resources, Agriculture and Natural Resources Budget, and Water committees. Active cattle rancher. Education: Kansas State University, Animal Science

Kyle Hoffman
Kansas House of Representatives, District 116
1318 Avenue T, Coldwater KS 67029
620-635-5844
kyle@kylehoffman.net
Responsibilities and Experience: Chair, Agriculture Committee; Member, Joint K-12 Education Budget and Appropriations committees. Member, 911 Coordinating Council and Pratt Community College Foundation Board. Education: Kansas State University, BS, Agriculture

Eileen Horn
2121 Vermont St, Lawrence KS 66046
913-708-3929 cell
eileen.horn@gmail.com
Responsibilities and Experience: Member, Agricultural committee. Previously, sustainability director for the City of Lawrence and Douglas County. Education: University of Vermont, BS, Biology

Robin Jennison
Secretary
Kansas Department of Wildlife, Parks and Tourism
1020 S. Kansas Ave, Room 200, Topeka KS 66612
785-296-2282 Business
robin.jennison@ksoutdoors.com
Responsibilities and Experience: Secretary, Kansas Department of Wildlife, Parks and Tourism, 2011–present. Education: Fort Hays State University, Animal Science

Dan Kerschen
Kansas State Senate, District 26
645 S 263 W, Garden Plain KS 67050
254-813-9313 Business
316-535-2310 Home
dnkerschen@gmail.com
Responsibilities and Experience: Chair, Agriculture and Natural Resources Committee; Vice Chair, Assessment and Taxation Committee; Member, Ways and Means Committee; Chair, Claims against the State Advisory Board. Member Kansas Geological Survey Advisory Council. Owner and operator, D&D Farms Partnership/3K Holstein Farm Inc. Interests: Military history books, hunting, and fishing. Education: Kansas State University, BS, Agriculture

Annie Kuether
Kansas House of Representatives, District 55
1346 SW Wayne Ave, Topeka KS 66604
785-633-4555 Cell
kuet@aol.com
Responsibilities and Experience: Ranking Member, Energy, Utilities and Telecommunication Committee; Member, Water and Environment, Corrections and

Juvenile Justice, and Judiciary committee. Education: Bowling Green State University, Ohio

Lane Letourneau
Water Appropriation Program Manager
Kansas Dept of Agriculture, Div of Water Resources
1320 Research Park Dr, Manhattan KS 66502
785-564-6636 Business
lane.letourneau@kda.ks.gov
Responsibilities and Experience: Manager, Water Appropriation Program, which administers the Kansas Water Appropriation Act (provides a framework for water allocation to ensure full beneficial use of water resources while protecting private property rights). Education: Fort Hays State University, BS, Geology

Earl Lewis
Assistant Director
Kansas Water Office
900 SW Jackson, Suite 404, Topeka KS 66612
785-296-0867 Business
earl.lewis@kwo.ks.gov
Responsibilities and Experience: Oversees operations of the KWO, including water planning development and implementation and reservoir operations. Education: University of Kansas, BS, Engineering

Greg Lewis
Kansas House of Representatives, District 113
910 NE 30th Ave, St. John KS 67576
620-546-4177 Cell
620-458-3541 Home
greg.lewis@house.ks.gov
Responsibilities and Experience: Vice-chair, Government Technology and Security Committee; Member, Agriculture, Local Government, and Water and Environment committees. Fourth generation farmer/rancher. Landscape architect. Member, Stafford County Farm Bureau and Kansas Livestock Association. Education: Kansas State University, BLA, Landscape Architecture

Brad Loveless
Executive Director
Environmental Services, Westar Energy
818 S Kansas Ave, Topeka KS 66612
785-575-8115 Business
brad.loveless@westarenergy.com
Responsibilities and Experience: Responsible for air, water, waste, environmental compliance as well as environmental protection, infrastructure siting, impact avoidance. Member, Kansas Forest Service Advisory Council, Kansas Water Authority. Chair, Kansas Alliance for Wetlands and Streams (KAWS). Education: Ohio State University, BS; University of Kansas, MS

Rob Manes
State Director
The Nature Conservancy in Kansas
2420 NW Button Rd, Topeka KS 66618
620-233-4400 Business
rmanes@tnc.org
Responsibilities and Experience: Strategic leadership and support for the Conservancy's conservation planning and overall conservation priorities for Kansas and major initiatives; Expanded Kansas' outreach and protected critical lands, raised millions of dollars in private money for conservation, and brings together various interests to conserve Kansas' landscapes and focus on cross-border conservation issues; Leader on guiding wind energy development. Early career included work as a musician; studio experience as session guitar player, guitar instructor, and songwriter. Interests: Livestock, fishing, hunting, camping, and his children.

Edward Martinko
Director and Professor
Kansas Biological Survey, University of Kansas
2101 Constant Ave, Lawrence KS 66047
785–864–1505
martinko@ku.edu
Responsibilities and Experience: State Biologist and Director, Kansas Biological Survey; Professor of Ecology and Evolutionary Biology; Ex-officio member, Kansas Water Authority. Education: College of Emporia, BS; University of Colorado, MA; University of Kansas, PhD

Carolyn McGinn
Kansas State Senate, District 31
PO Box A, Sedgwick KS 67135
316-655-3301 Cell
mcginnfarm@gmail.com
Responsibilities and Experience: Chair, Ways and Means and Legislative Budget committees; Member, Agriculture and Natural Resources, Confirmation Oversight, and Senate Select Committee on Education Finance committees; Member, Administrative Rules and Regulations and State Building Construction joint committees. Co-owner of family farm; Interested in agritourism and vineyard production; Charter member, Harvey County Food and Farm Council. Education: Wichita State University, BA, Business Administration; Friends University, MS, Environmental Studies

Cindy Neighbor
Kansas House of Representatives, District 18
10405 West 52nd Terr, Shawnee KS 66203
816-225-0580 Cell
cindyneighbor@aol.com
Responsibilities and Experience: Ranking member, Insurance committee; Member, Agriculture, Insurance,

and General Government Budget committees. Worked for Shawnee Mission School District then on Shawnee Mission School Board for 21 years. Former medical administrator; COO and worked with sedation patients at dental practice. Education: Johnson County Community College; Kansas City, Kansas, Community College

Patrick Parke
CEO
Midwest Energy, Inc.
PO Box 898, 1330 Canterbury Dr.
Hays KS 67601
785-625-1405 Business
patparke@mwenergy.com
Responsibilities and Experience: CEO for Midwest Energy, Inc., an electric and natural gas cooperative headquartered in Hays. Board of director for Hays Medical Center Foundation, Ellis County Coalition for Economic Development, High Plains Public Radio, United Ways of Ellis County, and Trego County Hospital Board.

Jason Probst
Kansas House of Representatives, District 102
1202 Prairie, Hutchinson KS 67501
620-259-3972 Business
620-664-4772
thatguyinhutch@gmail.com
Responsibilities and Experience: Member, Water and Environment, Government, Technology and Security, Higher Education Budget, and Commerce, Labor and Economic Development committees. Former newspaper reporter and editor; avid cyclist and outdoor recreation supporter.

Ken Rahjes
Kansas House of Representatives, District 110
1798 E 900 Rd, Agra KS 67621
785-302-8416 Cell
kenrahjes@gmail.com
Responsibilities and Experience: Vice Chair, Water and Environment Committee; Member, Taxation and Transportation committees. Editor of AgView.net, a multi-media agriculture communication company. Education: Colby Community College and Kansas State University

Rob Reschke
Executive Director
Division of Conservation
Kansas Department of Agriculture
1320 Research Park Drive, Manhattan KS 66502
785-564-6621 Business
Responsibilities and Experience: Administers cost-share and incentive programs, focusing on soil and water conservation and associated best management practices.

Josh Roe
Deputy Secretary
Kansas Department of Agriculture
1320 Research Park Drive, Manhattan KS 66502
785-564-6701 Business

Melissa Rooker
Kansas House of Representatives, District 25
4124 Brookridge Dr, Fairway KS 66205
913-961-1555 Cell
melissa@melissarooker.com
Responsibilities and Experience: Member, Federal and State Affairs, K–12 Budget, and Education committees; Member, Kansas Forestry Advisory Council and Johnson County Education Research Authority Board; Member, Shawnee Indian Mission Advisory Board. Retired film executive (VP of development for Clint Eastwood Malpaso Productions). Education: University of Kansas, BFA, Art History

Tracy Streeter
Director
Kansas Water Office
900 SW Jackson, Suite 404, Topeka KS 66612
785-296-3185 Business
tracy.streeter@kwo.ks.gov
Responsibilities and Experience: Agency head since 2004; Represents Kansas on Western States Water Council and Missouri River Association of States and Tribes (MoRAS); Chair, Governor's Drought Response Team and Kansas GIS Policy Board. Private pilot. Interests include hunting, golf, fishing, camping, and flying. Education: Highland Community College, AS; Missouri Western State University, BS, Agricultural Economics; University of Kansas, MPA

Susie Swanson
Kansas House of Representatives, District 64
1422 5th St, Clay Center KS 67432
785-587-7483 Business
svswan@twinvalley.net
Responsibilities and Experience: Vice-chair, Higher Education Budget committee; Member, Water and Environment and Correction and Juvenile Justice committees; Member, State EMS Board; Member, Community Corrections Advisory Board, Head Start Board, and Clay County Arts Council Board. Education: Emporia State University, BA, Sociology; University of Kansas, MSW, Social Work

Kansas Geological Survey Staff

Susan Stover
Geologist/Outreach Manager
Kansas Geological Survey
1930 Constant Ave, Lawrence KS 66047-3724
785-864-2063
sstover@kgs.ku.edu
Responsibilities and Experience: Outreach manager; Kansas Field Conference coordinator; Professional licensed geologist. Education: University of Nebraska, BA, Geology; Louisiana State University, graduate work, Geology; University of Arizona, graduate work, Hydrology; University of Kansas, MS, Geology

Rolfe Mandel
Director
Kansas Geological Survey
1930 Constant Ave, Lawrence KS 66047-3724
785-864-2171
mandel@kgs.ku.edu
Responsibilities and Experience: Responsible for operations and direction of the KGS; Executive Director, Odyssey Research Program; KGS Senior Scientist; Distinguished Professor, KU Department of Anthropology. Education: University of Texas, BA, Geography; University of Kansas, MA, Geography, and PhD, Special Studies Quaternary Research Program

Cathy Evans
Writer/Communications Coordinator
Kansas Geological Survey
1930 Constant Ave, Lawrence KS 66047-3724
785-864-2195
cevans@kgs.ku.edu
Responsibilities and Experience: Write news releases and educational materials; oversee writing and editing aspects of KGS Outreach and Public Service. Education: University of Kansas, BA, Art History, and MS, Journalism

Tony Layzell
Assistant Research Professor/Stratigraphic Research
Kansas Geological Survey
1930 Constant Ave, Lawrence KS 66047-3724
785-864-7767
alayzell@kgs.ku.edu
Responsibilities and Experience: Quaternary geology, fluvial geomorphology, stratigraphic research, geologic mapping. Education: University of Nottingham, BSc, Geography; University of North Carolina-Charlotte, MS, Geology; University of Kansas, PhD, Geography

North-Central Kansas

New Developments in Agriculture, Water Management, and Local Economies

August 13–15, 2018

Welcome to the 2018 Kansas Field Conference in north-central Kansas. During the conference, participants will visit a diversity of sites—many not accessible without special permission—and interact with a variety of experts from private industries, government agencies, and other organizations about issues important to the future of the state's economy and natural resources. The Kansas Geological Survey, Kansas Water Office, Kansas Department of Transportation, and Kansas Department of Wildlife, Parks and Tourism are sponsors of the 2018 field conference and provided ideas for issues, sites, and speakers.

Water

As with most areas of Kansas, water plays a significant role in the region's economy and environment. Milford Lake, the state's largest reservoir, is famous for the diversity and abundance of its fish. On Monday afternoon, conference participants can tour the lake by pontoon boat and learn about fisheries and lake management. Afterward, we will enjoy a social and dinner, with discussion about the lake's importance to recreation and the regional economy. The Milford Fish Hatchery will be open for a tour after dinner.

Milford Lake is experiencing serious water quality problems with episodic outbreaks of harmful algal blooms. Tuesday morning, we visit the upper end of Milford Lake at Wakefield, Kansas, where some of the worst outbreaks have occurred. Federal, state, and local officials and researchers will discuss what is being done to reduce the amount of nutrients entering the lake, to mitigate blooms when they occur, and to better define conditions that trigger algal bloom outbreaks.

Sufficient water is a concern all along the lower Republican River. Recent agreements related to the Republican River Compact—which divides the river's water among Colorado, Nebraska, and Kansas—calls for storing Kansas water in Harlan County Lake, Nebraska, and improves Kansas's ability to receive its legal share of the compact water when it is needed. The Kansas Bostwick Irrigation District (KBID) is legally entitled to the majority of the compact water. As KBID's efficiencies improve, and during wetter years when less water is needed from Harlan County Lake, excess water could be available to junior water users along the Republican River through a proposed new access district.

Flood protection led to re-routing of the Smoky Hill River around Salina decades ago. The original channel that winds through the city became a trap for mud, sand, and trash. The City of Salina and Friends of the River have initiated a revitalization plan to restore the old channel for wildlife habitat, recreational uses, and aesthetics as well as to build river walkways and outdoor plazas.

Wildlife and Historical Areas

Jamestown and Talmo are wetlands managed by the Kansas Department of Wildlife, Parks and Recreation. In public-private partnerships, the managed wetlands cover nearly 10,000 acres in Republic, Cloud, and Jewell counties and are an important stop for birds on the Central Flyway. During migration, a half million ducks and geese, 200,000 shorebirds, and the endangered whooping crane have been spotted here. The wetlands are valued recreational sites for bird watching and hunting.

North-central Kansas was home to the Pawnee Indian Nation. One band, known by

French traders as the Republican Pawnees, had a settlement in what is now Republic County, Kansas. Our tour will visit the Pawnee Indian Museum and hear from archaeologists about their history and culture.

Industries and Agriculture

Cloud Ceramics, outside Concordia, is one of only two brick manufacturers remaining in the state. It has stayed economically competitive with upgrades to its kiln and processing technologies. Clays quarried from the Dakota Formation form the basis for structural bricks.

An emerging industry is Nesika Energy, an ethanol producer near Scandia, which was recently purchased by Butamax, a joint venture by BP and DuPont. The plant will become a demonstration site for an advanced biofuel, with the goal of marketing the proprietary technology. Advanced biofuels have lower carbon emissions over their life cycles ("crop to car"), which makes them good for the environment and attractive to blenders that must meet renewable fuel standards.

Talk to anyone in the environmental field in Kansas, and they'll likely have used a Geoprobe to investigate soil and groundwater conditions. Geoprobe Systems started and remains in Salina. Geoprobe tools are used throughout the United States and internationally. The company continues to expand its array of equipment, sensors, and tools used to define soil and sediment layers, soil gas, and groundwater quality and to meet other subsurface exploration needs.

The Land Institute, a world-renowned independent research farm outside Salina, has a vision for more sustainable agriculture. Botanists and plant geneticists will discuss some of their latest successes and current efforts to select desirable traits from wild grasses blended with valuable traits of traditional annual crops as they work to develop drought-resistant perennial crops.

The tour's last stop will be at a black walnut plantation. Black walnut trees take several decades before they can be harvested. They are considered legacy trees, as the benefits from harvesting often go to a future generation.

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 in the course of the conference, we do not seek to resolve policy or regulatory conflicts. By bringing together experts, we hope to go beyond merely identifying issues; we want the combination of first-hand 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. In addition to the co-sponsors listed below, the 2018 field conference received support for socials and meals from the Geary County Convention and Visitors Bureau, Ducks Unlimited, Cloud County Tourism, and Westar Energy (Evergy). 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 on KU's west campus, the KGS also has a Well Sample Library in Wichita.

The following KGS staff are participating in the 2018 field conference:

Susan Stover, Geologist/Outreach Manager
Cathy Evans, Writer/Communications Coordinator
Rolfe Mandel, Director
Tony Layzell, Assistant Research Professor/ Stratigraphic Research
Eugene Holubnyak, Petroleum Engineer

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

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, Parks and Tourism

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

Kansas Department of Wildlife, Parks and Tourism
Operations Office
512 SE 25th Avenue
Pratt, KS 67124-8174
620-672-5911
www.ksoutdoors.com

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

Acknowledgments

The following people helped make this an informative and successful field conference: Director Tracy Streeter and Assistant Director Earl Lewis, Kansas Water Office; Secretary Robin Jennison and Chief of Planning Steve Adams, Kansas Department of Wildlife, Parks and Tourism; and Secretary Richard Carlson and Chief Geologist Kyle Halverson, Kansas Department of Transportation. Mark Schoneweis, KGS graphic designer, prepared the route map. Special appreciation goes to Julie Tollefson, KGS editor, for her extensive help editing and laying out the field guide.

The KGS extends our appreciation to the presenters at each of the stops, without whom this conference would not have been possible. Our thanks also to John Chase and family for permission to visit their walnut plantation.

Monday August 13, 2018

3 p.m. Check into cabins/lodge rooms at Acorns Resort. Keys at main office.

4:15 p.m. Meet at boat dock/slips. Load onto pontoon boats.

4:30 p.m. **Site 1: Tour Lower Milford Lake**
Robin Jennison, Secretary, and others with the Kansas Department of Wildlife, Parks and Tourism

5:45 p.m. Return from boat tour

6 p.m. **Social at The Cove** (patio unless the weather is inclement)

Welcome
Rolfe Mandel, Director, Kansas Geological Survey
Tracey Mann, Lieutenant Governor

Recreational Uses and Economic Benefits of Milford Lake
Robin Jennison, Secretary, Kansas Department of Wildlife, Parks and Tourism
Mike Harris, Owner, Acorns Resort

6:45 p.m. **Dinner at The Cove**

7:30 p.m. **Milford Fish Hatchery Tour** (carpool)

9 p.m. Return to cabins/lodge rooms

NOTES

STOP 1

Milford Lake's Value

KEY FACTS

- Milford Lake is the largest reservoir in Kansas.
- Completed in 1967, Milford Lake is managed by the U.S. Army Corps of Engineers.
- Milford Lake storage has a huge impact on the Kansas River, contributing to the public water supply of nearly one million Kansans.
- The State of Kansas has contracted for all of the multipurpose storage in Milford and has called a third of it into service. The remaining storage is termed "future use" water supply storage.
- In 2017, Milford Lake had an estimated recreational economic impact of $12.75 million.

Lake Basics

Milford Lake is the largest reservoir in Kansas, with 15,700 surface acres of water, 163 miles of shoreline (fig. 1), and more than 33,000 acres of land around the lake managed for recreation, for wildlife, and as natural areas. Located on the Republican River above the confluence with the Smoky Hill River, it was built by the U.S. Army Corps of Engineers (Corps) under the authority of the Flood Control Act of 1954. Milford is a multipurpose lake, although its foremost purpose is to provide flood protection; the Corps estimates that Milford Lake and dam have prevented $165 million in flood damages since their construction. The reservoir also provides benefits related to water supply, water quality, river navigation, recreation, and wildlife. Releases from the lake affect not only in-lake uses but also flows in the Kansas River. Downstream users include the cities of Junction City, Manhattan, Topeka, Lawrence, Olathe, Bonner Springs, and those served through Johnson County WaterOne, as well as several industries and Bowersock Dam and Hydropower.

Water storage in reservoirs is divided into different pools for different designated purposes: a dead pool (the water below the lowest river outlet in the reservoir), an inactive pool, an active pool, and flood storage space at the top (fig. 2). Water in the active pool, commonly called "multipurpose storage," is designated to meet the authorized purposes of the reservoir during normal and drought periods. At construction, the storage capacity in the multipurpose pool at Milford was 415,403 acre-feet. By 2010, sedimentation reduced that storage capacity by roughly 17%, according to an estimate by the Kansas Water Office.

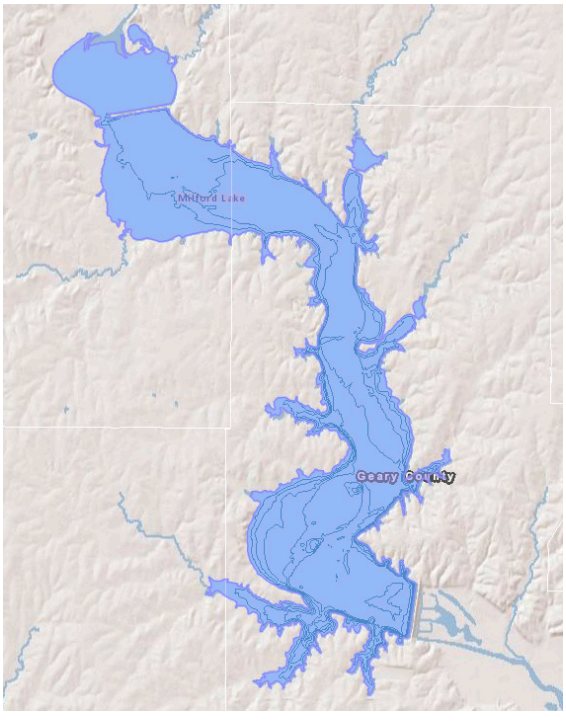


Figure 1: Milford Lake. Source: Kansas Biological Survey, 2018

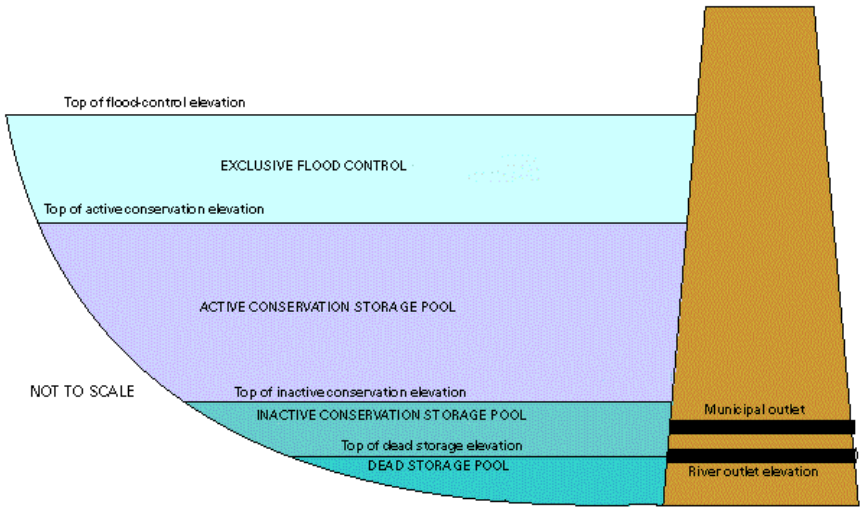


Figure 2: Conceptual storage pools within a reservoir. Source: Bureau of Reclamation, 2000

State-Owned Storage

The Kansas Water Office has contracted for 100% of Milford's multipurpose storage. To date, roughly one-third of that quantity has been put into use through two programs: the Water Marketing Program and the Water Assurance Program.

The state sells water to municipalities and industries through multiyear contracts in the Water Marketing Program. Jeffrey Energy Center in St. Marys is the only customer in the Milford Water Marketing Program. Its contract expires in 2022 and is not expected to be renewed.

A water assurance district operates one or more reservoirs as a system to meet downstream needs; members of the district pay water storage costs. The Kansas River Water Assurance District comprises 15 cities and industries, including Jeffrey Energy, and consists of storage in Milford, Tuttle Creek, and Perry reservoirs. When low flows in the Kansas River are insufficient to meet members' water needs, a call can be made for releases from an upstream reservoir account to supplement flows.

Approximately two-thirds of the quantity the state contracted to purchase in Milford Lake is considered "future use," water that has not yet been called into service (fig. 3). Until there are customers for the future use water to pay for the cost of that storage, it is an unfunded liability.

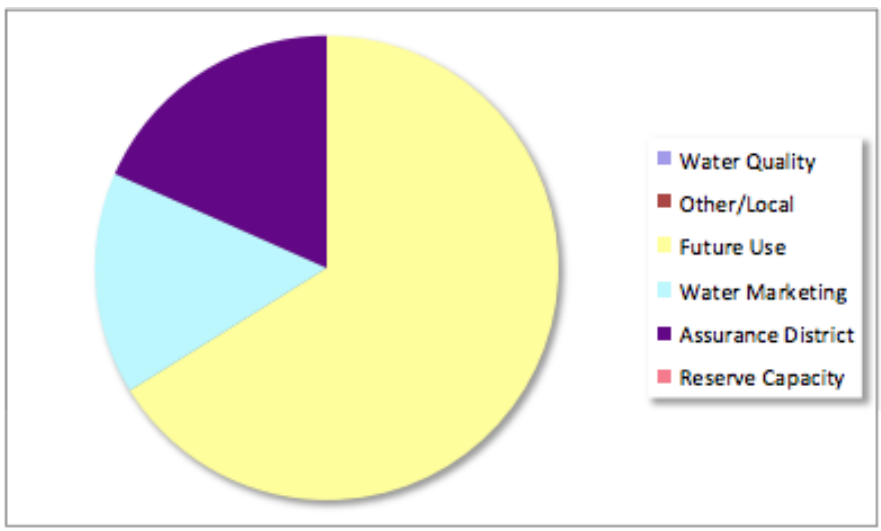


Figure 3: Allocation of state-owned multipurpose storage at Milford Lake. Source: Kansas Water Office, 2017

Because there are no current customers, the Corps has allowed Kansas to defer payments, with interest. The contract includes an option to reallocate a portion of the future use pool to be used for water-quality efforts, a use that is paid for by the Corps. The Kansas River Water Assurance District expects to need additional storage by 2034, the last year the state could still call into service and pay for future use storage under the current contract. In the meantime, the Corps retains control of future use storage and can release water from this pool for Missouri River navigation or other needs.

Recreational Benefits

Milford Lake is known for its fishing and is the site of many fishing tournaments. The lake contains such a variety of fish—smallmouth bass, blue catfish, walleye, wiper, crappie, and white bass—that people are advised to bring three types of rods and reels to handle the different weights.

The lake's size and open waters make it attractive for a number of recreational activities: boating, sailing, waterskiing, and swimming. Land around the lake also provides recreation. Hunters have access to 19,000 acres of land, the largest area in the state managed by the Kansas Department of Wildlife, Parks and Tourism (KDWPT) for hunting. Trails around the lake are open for hiking, biking, horseback riding, and motorcycling.

Recreation associated with reservoirs provides significant economic benefits. The 2017 Outdoor Industry Association report indicated outdoor recreation in Kansas supported 71,000 jobs and generated $7.3 billion in consumer spending. The report noted that 61% of Kansans participate in outdoor recreation and are more likely to camp and fish than the average American.

An estimated 850,000 visitors made use of Milford Lake in 2017. The Geary County Convention and Visitors Bureau (CVB) estimates Milford Lake visitors' recreational spending at $30 per day. If only half the visitors spent $30 a day, a conservative estimate, they contributed $12.75 million to the local economy.

Camping at Milford accounts for more than half the visits. Campgrounds are managed by the Corps (five campgrounds), the KDWPT (Milford State Park), city and county park campgrounds (such as at Wakefield), and commercial facilities. Visitors also can find cabin rentals, boat rentals, fishing and boating supplies, fishing and hunting outfitters, beaches, and restaurants.

Wetlands provide important wildlife habitat and water-quality benefits near the lake. Milford wetlands restoration projects began in 1991, with several influxes of funds since then. These projects created eight wetland areas that cover 2,300 acres along the Republican River north of Milford Lake. These wetlands surround the Steve Lloyd Refuge area and are a stop for migrating birds along the Central Flyway. The wetlands provide opportunities for photographing birds and other wildlife as well as for waterfowl hunting.

NOTES

Tuesday, August 14, 2018

6:30 a.m. Breakfast buffet at The Cove, Acorns Resort

7:30 a.m. **Welcome and Orientation** at The Cove
Susan Stover, Outreach Manager, Kansas Geological Survey
Rolfe Mandel, Director, Kansas Geological Survey

8 a.m. Bus leaves Acorns Resort
(park cars on upper end of conference center parking lot)

Bus Talk: Harmful Algal Bloom Research
Ted Harris, Research Biologist, Kansas Biological Survey, University of Kansas

8:20 a.m. **Site 2: Harmful Algal Blooms,** Upper Milford Lake, Wakefield
Mike Carney, Park Manager, Cloud County
Trevor Flynn, Chief, Watershed Section, Kansas Department of Health and Environment
Marvin Boyer, Lake Water Quality Program Coordinator, Kansas City District, U.S. Army Corps of Engineers

9 a.m. Bus to Site 3

Bus Talk: KDOT's Proposed Modification and Rehabilitation of US-24 in Cloud County and Its Geologic Setting
Kyle Halverson, Chief Geologist, Kansas Department of Transportation

Bus Talk: Geology of the Dakota Clay
Tony Layzell, Research Scientist, Kansas Geological Survey

10:15 a.m. **Site 3: Cloud Ceramics,** Concordia
Shawn Kling, Cloud Ceramics

11:10 a.m. Bus to Site 4

Bus Talk: Safety Review
Dave Woods, Chief Operating Officer, Nesika Energy

11:50 a.m. **Site 4: Nesika Energy, Scandia**
Dave Woods, Chief Operating Office
Lisa Strnad, Chief Fiscal Officer

12:40 p.m.	Bus to lunch
	Bus Talk: Minimum Desirable Streamflows Lane Letourneau, Division of Water Resources, Kansas Department of Agriculture
1:15 p.m.	**Lovewell Marina Lunch**
	Panel: Republican River Water Management Changes Earl Lewis, Assistant Director, Kansas Water Office Pete Giles, Superintendent, Kansas Bostwick Irrigation District
2:15 p.m.	Bus to Site 5
2:25 p.m.	**Site 5: Lovewell Reservoir** Republican River Water Management (discussion continued)
	Site 5: Mammoth Fossils at Lovewell Rolfe Mandel, Director, Kansas Geological Survey
3:10 p.m.	Bus to Site 6
3:40 p.m.	**Site 6: Pawnee Indian Museum** Jack Hofman, Associate Professor, Anthropology, University of Kansas Richard Gould, Site Administrator (retired), Pawnee Indian Museum
4:20 p.m.	Bus to Site 7
4:50 p.m.	**Site 7: Jamestown Wildlife Area** Rob Unruh, Wildlife Area Biologist, Kansas Department of Wildlife, Parks and Tourism Matt Farmer, Wildlife Area Manager, Kansas Department of Wildlife, Parks and Tourism
5:50 p.m.	Bus to dinner
6:15 p.m.	**Dinner at Jamestown Community Center**
7:30 p.m.	Bus to hotels
8 p.m.	Holiday Inn Express and Suites, Concordia

STOP 2

Harmful Algal Blooms in Kansas

The Problem

Cyanobacteria, often called blue-green algae, are a normal part of a lake's ecosystem. Harmful algal blooms (HABs) occur when colonies of cyanobacteria grow out of control, producing toxins that are harmful to humans, mammals, birds, fish, and shellfish. HABs also produce compounds that alter taste and odor in drinking water supplies and compromise public confidence in the affected water. HABs, which can occur in lakes and rivers, are a growing, global problem. Cyanobacteria stay near the top of the water surface and look like green paint or green scum (fig. 1). Microcystin—a liver toxin—is the most commonly detected toxin produced by HABs in Kansas lakes. Not all algal blooms have harmful toxins, and we do not understand why toxins are produced.

KEY FACTS

- Harmful algal blooms (HABs) produce toxins harmful to animals and humans.
- Excess nutrients are a primary cause of blue-green algae (cyanobacteria) blooms.
- In 2017, 26 lakes were on watch, warning, or closure status due to HABs.
- Repeated HABs at Milford Lake have affected its recreational uses.
- In-lake treatments are being tested to minimize HAB development.
- Best management practices can reduce nutrient runoff in the Milford Lake watershed.

Figure 1. Algal bloom at Milford Reservoir, 2017. Photo: T. Harris, 2017

Figure 2. Rough fish removal at Milford Reservoir, 2017. Photo: D. Nygen, 2017

Harmful Algal Blooms in Kansas

The Kansas Department of Health and Environment listed 26 lakes in Kansas under HABs watch, warning, or closure status in 2017. HABs have been documented back to the 1830s, but the number and frequency of outbreaks have been creeping upward. Milford Lake in Clay and Geary counties has had harmful algal blooms annually since 2011. More lakes in western Kansas are also beginning to be affected, including Sebelius Lake, Norton County, in June 2018. There have been cases of dogs dying after swimming in and ingesting HAB-infested waters in Kansas. Algal blooms also may cause fish kills, often due to indirect dissolved oxygen depletion. Because HABs can cause health problems, use of recreational reservoirs are restricted or closed during bloom events. In addition to the health risk, HABs smell bad; that alone has affected lakeside recreation. Blooms also can cause taste problems for public water supplies.

Causes of Harmful Algal Blooms

Just as fertilizers feed plants on land, phosphorus and nitrogen in the water feed algal growth. A sudden influx of nutrients leads to over feeding, and a bloom is more likely to develop. The ratio of total nitrogen to total phosphorus also influences development of HABs. A ratio of 30:1 or less total nitrogen to total phosphorus favors a bloom. Among the Kansas lakes that develop HABs, Milford Lake usually has one of the highest levels of total phosphorus. The total phosphorus levels in Milford Lake have risen since the 1990s, in part due to greater use of more soluble forms of phosphorus in fertilizers. The form of nitrogen used may also be a factor; ammonium and urea provide nitrogen in a form cyanobacteria can more easily convert into biomass (colony growth). By comparison, non-toxic algae cannot use that form of nitrogen as readily.

A lot is still unknown about bloom triggers. Conditions that encourage a bloom include high temperatures, slow-moving or stagnant water, and water clarity, which influences how deep sunlight can penetrate into the water. The size, shape, and depths of most lakes in Kansas make them vulnerable. They generally are less than 8 feet deep in the upper end, which causes them to warm quickly and become a "bloom nursery ground" for cyanobacteria. The orientation of a lake in relation to prevailing winds can lead to waves that resuspend nutrient-rich sediment. Scale of the water body is also an important variable because the ratio of surface area to total volume may affect bloom occurrence.

What Are the Solutions?

Keeping nutrients from getting into streams and lakes is the long-term solution to preventing HABs. One goal is to reduce the amount of sediments with nutrients bound on them that get into the reservoirs. It is also necessary to reduce the amount of dissolved nutrients, particularly phosphorus, that enter Kansas streams and lakes. In 2018, the USDA Natural Resources Conservation Service awarded the Kansas Water Office $2.8 million for a Resource Conservation Partnership Program to reduce nutrient runoff within the Milford Lake watershed (fig. 3). The funds will be used to support landowners who implement livestock and cropland best management practices that reduce nutrient loading.

Best management practices include improved nutrient management (the right rate, right time, right source, and right location), cover crops during the off-season, no-till farming, and buffer strips along streams that feed into reservoirs. Nutrient management at feedlots involves diverting upstream water away from the feedyard and capturing and treating dirty water on the lot. Treatment includes settling ponds (catchments for sediment), prevention of overflows, and buffers such as filter strips or constructed wetlands.

Releases of water from reservoirs as part of a lake-level management plan can move nutrients and algae down lake and downstream, which damps the effect of high nutrient inflows. Release of water at a moderate flow rate to lower Milford's lake level in the spring may reduce favorable bloom conditions for cyanobacteria that over-wintered in the reservoir. Kansas Department of Health and Environment proposes that a five-foot drawdown before July 1 may help mitigate algal biomass. After a drawdown, the newly exposed lake bed can be planted with native plants to produce a pre-treatment wetland. However, the U.S. Army Corps of Engineers (Corps) faces constraints on lake-level releases

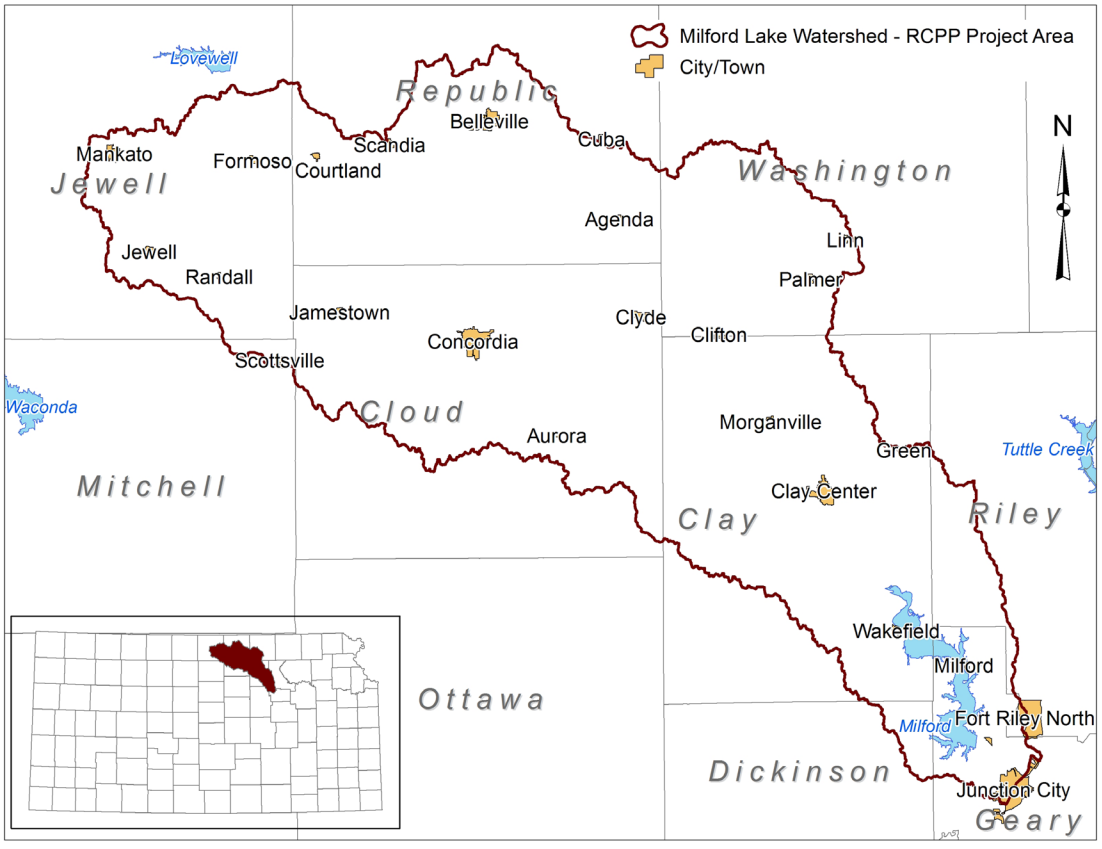


Figure 3. Milford Lake watershed. Source: M. Unruh, 2018

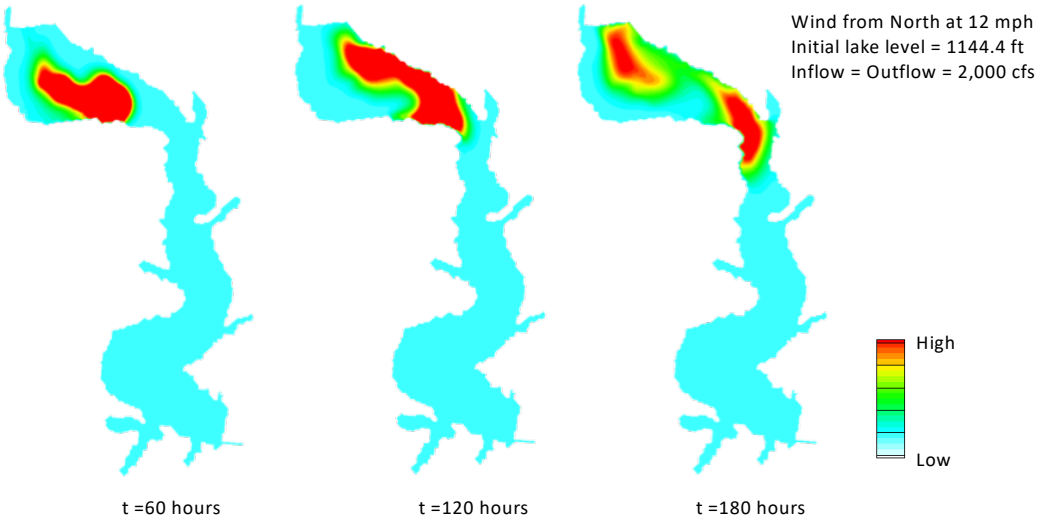


Figure 4. Modeled movement of a projected HAB at Milford Reservoir under certain wind and lake conditions. Source: B. Young, 2018

because it also manages the lake for recreation (access to boat ramps and beaches), for fisheries (no release when fish are spawning), to hold water supplies needed during a drought, and to supply water for Missouri River navigation.

One type of in-lake remediation is ultrasonic vibration, which may rupture the gas vesicles inside blue-green algae cells causing the cells to sink to the bottom of the lake. Early trials in Kansas on small areas of 6.5 surface acres or less, such as the Central Park Lake in Topeka, had only partial success. This spring, the Corps installed ultrasonic devices at the Military Marine Cove at Milford Lake and at the river pond below Melvern Lake in Osage County. Different types of algal blooms at the two lakes may respond differently to the systems.

At Milford and Marion (Marion County) reservoirs, an active program removes "rough" fish, such as buffalo, gizzard shad, and carp. These fish stir up lake sediment, which can lead to an increase in dissolved nutrients. In 2017, roughly 340,000 pounds of rough fish were removed. Another proposed HAB control effort would introduce Trojan YY male carp, produced using a genetic technique. When the Trojan YY male carp breed with wild carp, the carp population would skew toward 100% male offspring.

Research

The Kansas Biological Survey (KBS) is establishing historical cyanobacterial trends in Milford Lake by analyzing lake sediment cores for cyanobacterial and phytoplankton pigments. The KBS also studies how different nutrient regimes and nutrient forms affect cyanobacteria and their toxins in large tanks at the KU Field Station near Lawrence.

The U.S. Geological Survey conducts integrated monitoring to understand and quantify HABs using satellite imagery, water-quality monitors, algal fluorescence, and underwater time-lapse photography. The USGS also is working to develop an early warning system for potential HAB events that could affect the public water supply.

Bryan Young at the University of Kansas and his colleagues are modeling bloom movement in Milford based on lake levels, wind conditions, and flow rates. The model can help state and federal agencies make decisions about the risk to a downstream zone of Milford Lake if it experiences a bloom at the upper end (fig. 4).

STOP 3

Kansas Clay and the Brick Industry

Rocks remember when they were mountains.
And what do mountains remember?
When they were ocean floors.
—The House of Broken Angels, Luis Alberto Urrea

KEY FACTS

- Clay from the Dakota Formation is quarried to make bricks for buildings, fireplaces, bread ovens, and pottery.
- Cloud Ceramics and Kansas Brick & Tile are the only in-state brick manufacturers.
- Bricks from Cloud Ceramics are known for
  - weight-bearing strength
  - color, size, and style matching
  - wholesale production for industry in the eastern United States.

Geologic resources make a significant contribution to the state's economy, with Kansas ranking in the top 10 states for oil and gas production. Minerals quarried in Kansas include aggregates (sand, gravel, limestone), gypsum, salt, volcanic ash, shale, and clay. In the early 1900s, clay used to make bricks was once mined in Wilson County in southeast Kansas, in part due to nearby sources of inexpensive natural gas (necessary for the manufacturing process) (fig. 1). Clay was also mined in eastern Kansas for manufacturing brick and tile and is still mined in open-pit quarries in central Kansas.

Cloud Ceramics and the Brick Industry in Kansas

Although several brick manufacturing plants have operated in Kansas over the years, the 2007–2009 Great Recession narrowed the number to two: Cloud Ceramics in Concordia, which has

Figure 1. Men loading bricks into a kiln at Excelsior Brick Company, Fredonia, Kansas. Photo: kansasmemory.org, Kansas Historical Society

manufactured bricks since 1946, and Kansas Brick & Tile in Hoisington. Both plants are under the same ownership.

Dakota clay is mined throughout the Midwest. Cloud Ceramics has three quarries, mining five different clay beds in the Dakota Formation (fig. 2). The clay beds have distinct chemical and physical properties that are useful for refractory bricks (fire clay bricks), structural bricks, pottery, and other high-grade products. Each clay bed requires different handling for manufacturing, such as removing impurities, minimizing oxidation, and controlling moisture content. Specific colors and finishes are obtained by mixing the clays or adding chemicals such as manganese or iron. Silt is added to control shrinkage. Firing temperatures and oxygen levels in the kiln influence the final brick properties, including its strength.

Cloud Ceramics is a wholesaler, primarily for industry use in the eastern United States. It is known for its ability to produce structural bricks—those that can support walls and roofs as compared to those suitable only for use as a façade. This plant is also able to manufacture large bricks and is very good at matching colors. In 2005, Cloud Ceramics invested in a major technological upgrade with more automation and advancements in the firing kiln. The new technology doubled the company's production capacity. Cloud Ceramics produces an estimated 40 million bricks annually. Another 20 million bricks are produced at the Kansas Brick & Tile plant in Hoisington. The two plants together employ 70 to 75 full-time employees.

Geology of the Dakota Formation

The Dakota Formation extends through the western two-thirds of Kansas (fig. 3). It consists of claystone, mudstone, siltstone, and sandstone. The water-bearing sandstones in the Dakota Formation and the underlying Kiowa Formation and Cheyenne Sandstone collectively form the Dakota aquifer, an important groundwater source. The Dakota Formation in Kansas is

Figure 2. Clay beds in the Dakota Formation. Photo: S. Stover, 2018

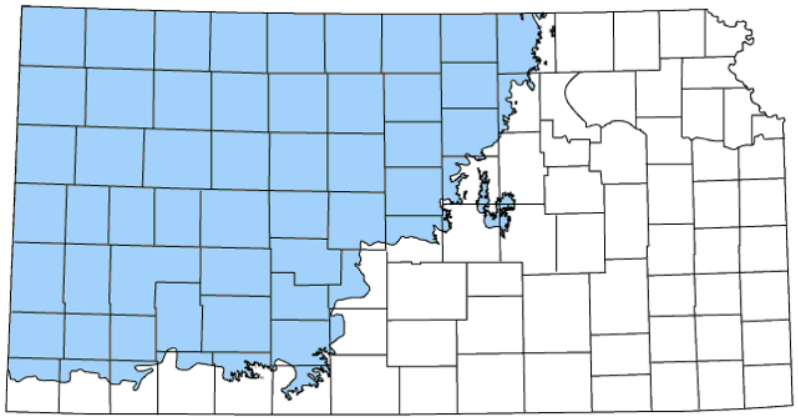


Figure 3. Extent of the Dakota Formation in Kansas. Source: Macfarlane, 1996

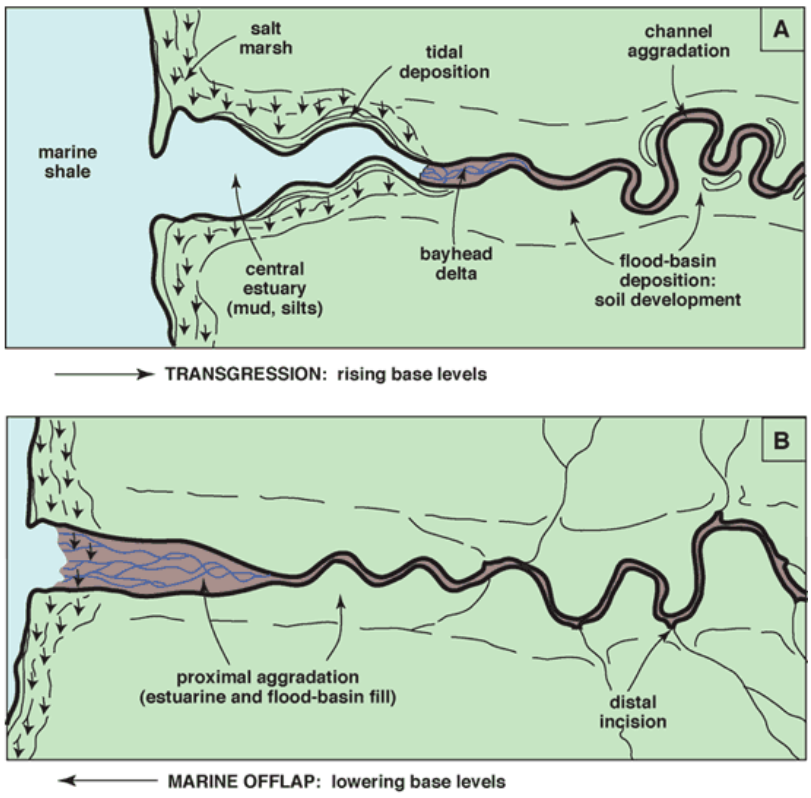


Figure 4. Schematic of fluvial-estuary conditions with sea level rise or fall during the Cretaceous Period, indicated by the sediment found in the Dakota Formation. Source: Ludvigson et al., 2010

subdivided into the Terra Cotta Clay Member and the Janssen Clay Member.

Pollen, old soil layers, and other evidence indicate the clays, silts, and sands were deposited in a series of fluvial-estuarine cycles during the Cretaceous Period, roughly 100 million years ago. Flooding of the coast and up old river systems caused by rising levels of the Western Interior Sea is evident in sediments, sedimentary structures, geochemistry, and marine fossils. When sea levels dropped, river sediments were deposited, deltas filled former estuaries, sediment was added to coastlines, and upstream river channels became more incised (fig. 4). The paleo-environment in central Kansas would have been primarily moist, with swampy forests along the broad, coastal plain edging the Western Interior Seaway. The warm "greenhouse" period of the Cretaceous is considered one of the most important episodes in the history of life on Earth and is when flowering plants (angiosperms) appeared and the plant community rapidly diversified and blossomed.

NOTES

STOP 4

Ethanol and a New Biofuel at Nesika Energy

Public Policy and Ethanol Production

Public policy and the desire for lower greenhouse gas emissions have been the catalysts behind the growth in U.S. ethanol and other biofuel production. Congress provided significant momentum when it created the first renewable fuel standards (RFS) in 2005. The standards mandate blending domestic transportation fuels with biofuels in generally increasing volumes through 2022. In 2018, Congress continues to debate the role of public policy on ethanol and other biofuel production as well as a policy's influence on farm markets and the energy refinery industry.

In 2017, ethanol contributed about 10% of the U.S. gasoline supply. The Environmental Protection Agency

KEY FACTS

- Nesika Energy has the capacity to produce 10 million gallons of ethanol annually.
- Though Butamax acquired the company in 2017, its name remains Nesika Energy.
- Butamax plans to expand Nesika to showcase production of the advanced biofuel bio-isobutanol.
- Bio-isobutanol advantages over ethanol include higher energy value, higher blending ratio with gasoline, and low water solubility—meaning it can be transported via pipeline.
- Nesika Energy employs 26 people.

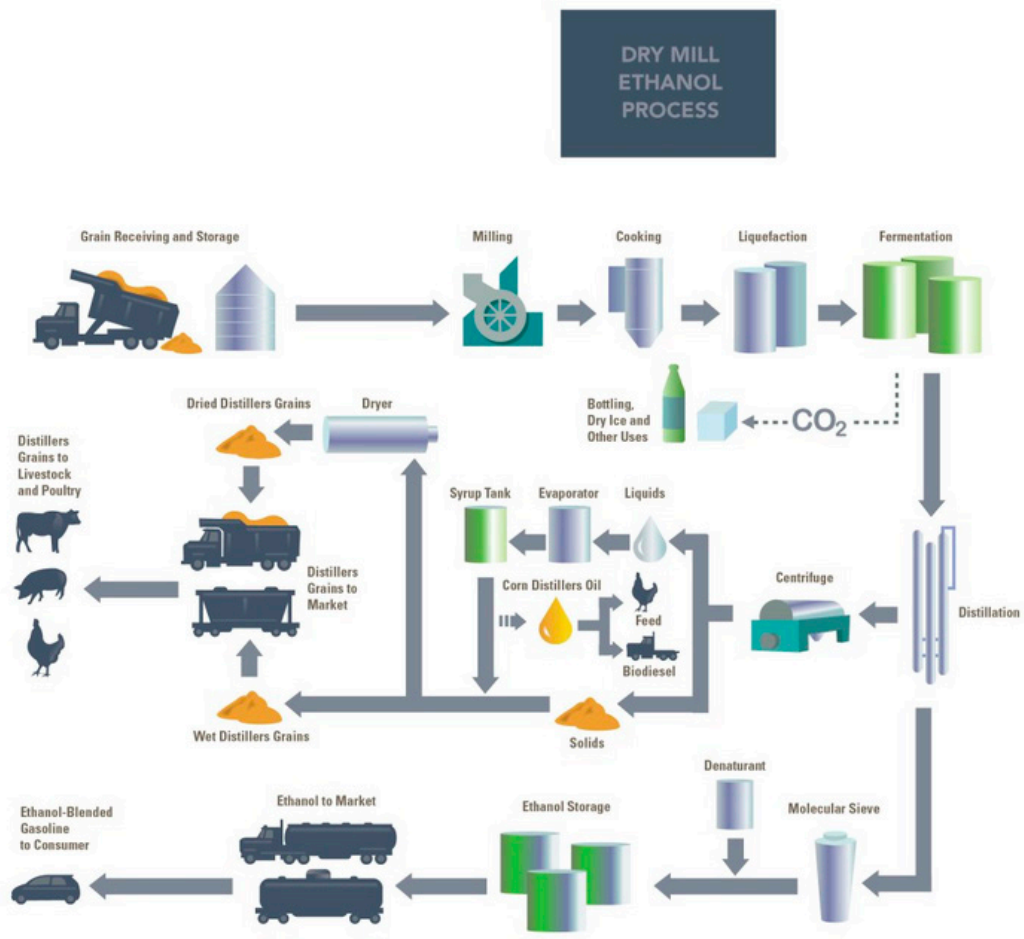


Figure 1: Schematic of ethanol production process. Source: Renewable Fuels Association

(EPA) set the 2018 RFS for ethanol—the amount to be blended with gasoline stock—at 19.29 billion gallons. Of that volume, 15 billion gallons is corn-based ethanol and 4.29 billion gallons is advanced biofuels. An advanced biofuel can be made from non-food biomass such as corn stover (the stalk, cob, and leaves) or wheat straw.

Under the RFS, the EPA created a system to track the volume of renewable fuels produced by assigning each batch a unique number. These numbers are called renewable identification numbers (RINs) and are the "currency" of the RFS program. Refineries use RINs to account for the volume of renewable fuels blended into conventional fuels. The EPA allows refineries to trade or sell compliance credits of RINs with other refiners, providing flexibility for refiners to meet their annual renewable fuel obligations.

Production of ethanol and other biofuels has had a major influence on U.S. crop and feed markets. Production mandates, tax credits, and tariffs on foreign production all provided support for domestic biofuel production and brought economic growth to rural areas. Ethanol production has been especially strong in the Midwest. Plants typically locate close to sources of corn, and to a lesser extent grain sorghum, as well as near feedlots that use distiller grains, a byproduct of production. Kansas, with 11 operating ethanol biorefineries, ranks eighth in the nation for total ethanol production capacity and ninth in operating production.

Nesika Energy and Advanced Biofuel Bio-Isobutanol

Nesika Energy, LLC, incorporated in 2001 and located near Scandia, has the capacity to produce 10 million gallons of ethanol annually. In 2017, Butamax Advanced Biofuels, LLC, acquired Nesika Energy, which now operates as a subsidiary but retains the Nesika name. Butamax was formed as a joint venture between BP and Dupont to perfect the technology needed to commercially produce bio-isobutanol as a renewable, advanced biofuel.

Isobutanol, a chemical cousin of ethanol, is produced from fossil fuels. Bio-isobutanol is similar but produced from renewable feedstock. Bio-isobutanol is a lower-carbon alternative to ethanol and can be mixed with gasoline in higher concentrations—up to 16% without compromising performance. It also is less corrosive and can be transported in existing fuel pipelines.

Butamax began production of bio-isobutanol in 2010 at a demonstration plant in England. The company then retrofitted an ethanol plant in Lamberton, Minnesota, to make bio-isobutanol. Butamax plans for Nesika to be a demonstration facility for commercial-scale bio-isobutanol production for potential licensees of Butamax's proprietary technology.

Developing a Market for Bio-Isobutanol

Economics are a major driver behind retro-fitting an ethanol plant to produce bio-isobutanol. The RIN price for an advanced biofuel, for which bio-isobutanol would qualify, is higher than the corn-based ethanol RIN price. The higher price reflects the greater reduction of greenhouse gas emissions by advanced biofuels over the entire lifecycle (the "well to wheel" or "crop to car" emissions). In June 2018, the EPA registered Butamax isobutanol as a fuel additive. As the technology is proved successful and economically favorable, Butamax aims to license its technology to ethanol producers that want to switch to a potentially more profitable product. Higher oil prices would also spur interest in expanding the biofuel market.

The Nesika plant will continue to produce ethanol while Butamax adds capacity to the plant for production of the new biofuel. Production of bio-isobutanol is projected to begin in 2019.

STOP 5

The Lower Republican River Basin: Compact Changes for Improved Water Management

KEY FACTS

- The Republican River Compact legally allocates the river's water among three states.
- The Kansas Lower Republican River Basin has repeatedly been shorted its allocation of compact water or received water when it cannot be used.
- The Kansas Bostwick Irrigation District (KBID) has the senior, largest right to the compact water.
- New compact agreements provide for storage of Kansas water in Harlan County Lake, Nebraska, to be released at Kansas's request if conditions allow.
- An access district to supply water for junior water-right users is under development.

The Republican River Compact

The Republican River Compact—signed by Colorado, Nebraska, and Kansas in 1942—divides the river basin virgin water supply among the three states. Virgin water is the water that originates in the basin, undepleted by such human activity as pumping or diversion for agriculture. Approximately 11% is allocated to Colorado, 49% to Nebraska, and 40% to Kansas (for both the upper and lower portions of the basin). A Republican River Compact Administration (RRCA) develops methods to measure the virgin water supply and consumptive uses within the basin. The compact allows for modification, and the rules are complex and dynamic.

The Republican River basin has historically experienced severe droughts and floods. To improve water management, beginning in the 1940s, nine federal reservoirs were constructed along the river. The ninth structure, Milford Lake, was built in 1962 in Clay and Geary counties, Kansas, at the lower end of the basin. The two structures that most influence water supply of the lower Republican basin in Kansas are Harlan County Lake in Nebraska and Lovewell Reservoir in Jewell County, Kansas. Both Milford and Lovewell reservoirs are outside compact considerations (fig. 1).

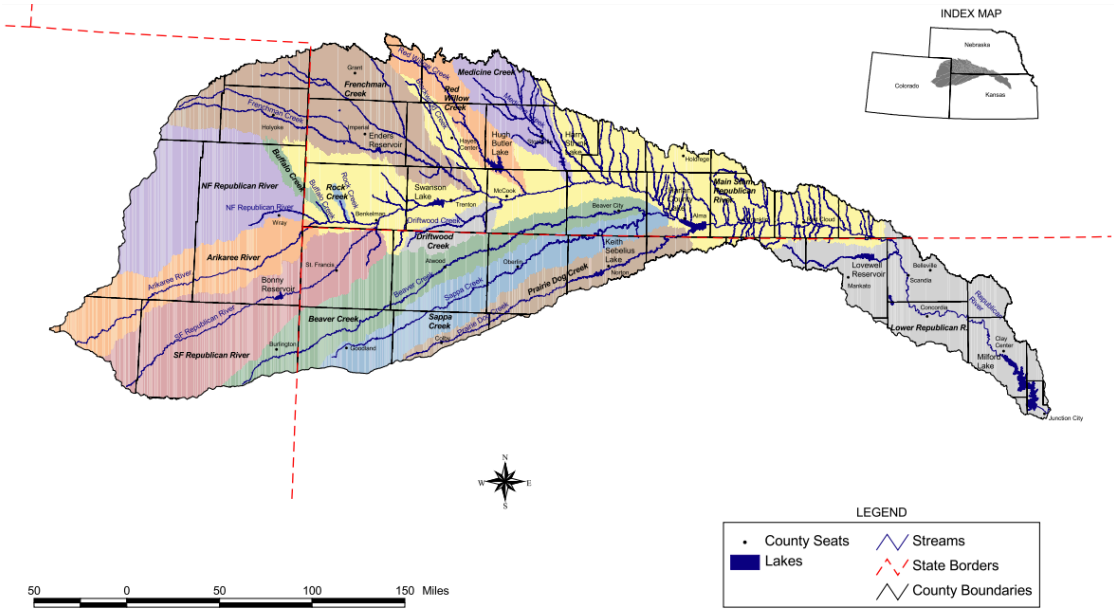


Figure 1. Republican River basin with sub-basins and streams. Source: Republican River Compact Administration, 2005

Problems in the Lower Republican River Basin

The lower Republican River basin in Kansas has repeatedly been shorted its allocation of water due under the compact. The shortages have affected the Kansas Bostwick Irrigation District (KBID), which could irrigate about 42,500 acres. KBID holds a very senior water right (no. 385 out of 33,670 active rights as of March 2018) and accounts for virtually all of the Kansas compact diversions in the lower basin. It gets water from storage in Harlan County Lake and Lovewell Reservoir, which is filled by releases from Harlan County Lake and natural flow water. Nearly a third of KBID acreage is upstream from Lovewell Reservoir; only the acreage below it benefits from storage in Lovewell (fig. 2).

Conflicts over Republican River Compact compliance stretch back decades. Kansas made efforts to correct the problems through the RRCA but ended up filing suit in the U.S. Supreme Court in 1998 over compact compliance. That lawsuit was settled in 2002, and a final settlement stipulation (FSS) was established to define how future compliance would occur. Additional litigation arose in 2010 when Nebraska violated the FSS; that case was settled in 2015 when the Supreme Court ruled that Nebraska had violated the compact. Nebraska was ordered to pay Kansas $5.5 million in damages and take additional steps to assure compliance. KBID was granted $2.5 million of the damage award for conservation projects, including the conversion of open lateral canals to buried pipes to reduce losses through evaporation, seepage, and spills.

Other surface water and groundwater right holders in the lower Republican basin have even less water security than KBID. Minimum desirable streamflow (MDS) was made part of the Kansas Water Appropriation Act to provide a base flow in certain streams to protect downstream water rights as well as in-stream needs for water quality, aquatic life, and recreation. MDS values specific to each stream gage location and month are set in statute (K.S.A. 82a-703). Kansas has 33 MDS designations on 23 streams, including two MDS gages on the Republican River, one near Concordia and the other near Clay Center (fig. 2). Many water rights along the Republican River are junior in priority to an MDS, meaning wells could be turned off or pumping reduced to meet a downstream flow (fig. 3). The Kansas Department of Agriculture, Division of Water Resources,

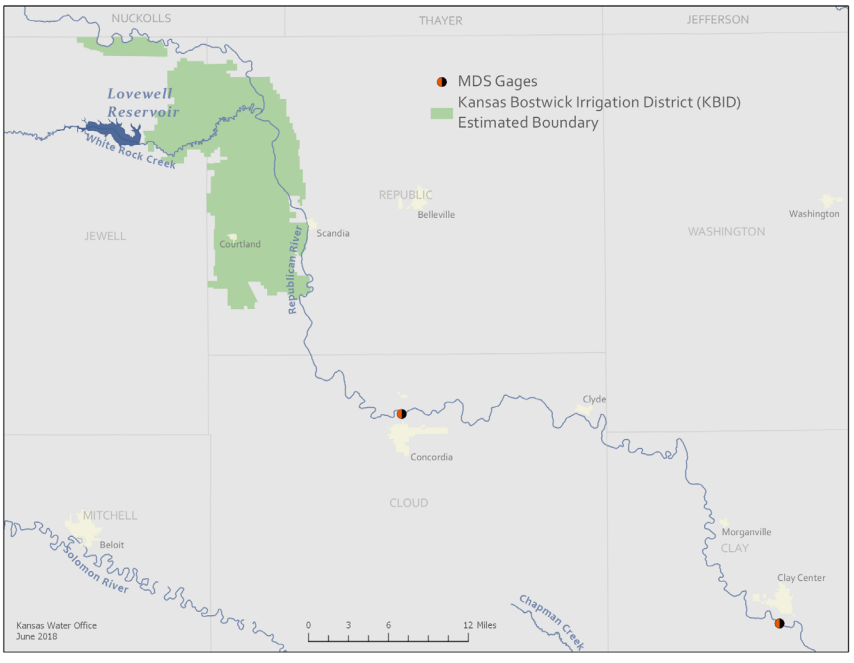


Figure 2. Kansas Bostwick Irrigation District service area in relation to Lovewell Reservoir, and two minimum desirable streamflow gages. Source: K. Goff, Kansas Water Office, 2018

enforces administration action on MDS-junior water right wells in the lower Republican River basin when two criteria are met:

1. streamflow has been below the established MDS for seven days or more; and
2. a streamflow of 150% of the daily average MDS value has not been met the preceding 60 days.

Most junior water-right holders are irrigators but some junior water rights are held by the cities of Morganville, Concordia, and Clay Center. To improve reliability of water availability, some irrigators have built ponds to store their water until it is needed; if it has been stored for at least two weeks, it is not subject to release to meet MDS flows.

What Has Changed?

In 2016, Kansas, Nebraska, and Colorado signed resolutions to improve interstate water management. The parties agreed to increased transparency and flexibility and to provide more assurance to Kansas water users that a viable amount of irrigation water would be available in dry periods.

The new resolutions changed the terms for holding Kansas's compact compliance water in Harlan County Lake or other upstream storage sites, including leaving it in the ground. Releases by Nebraska of compact water will be limited to what Kansas indicates it actually needs. In previous years, Nebraska sometimes released water to meet compact obligations when water couldn't be used or stored in Kansas. Clear procedures for forecasting and identifying water needs in advance of an irrigation season were established by resolution. The new agreement also could benefit Nebraskans because it might result in fewer restrictions on their water use and lower requirements for streamflow augmentation when Kansas doesn't request water.

Kansas and Nebraska have worked with the Bureau of Reclamation to establish water storage accounts in Harlan County Lake: a Kansas Account for water stored exclusively

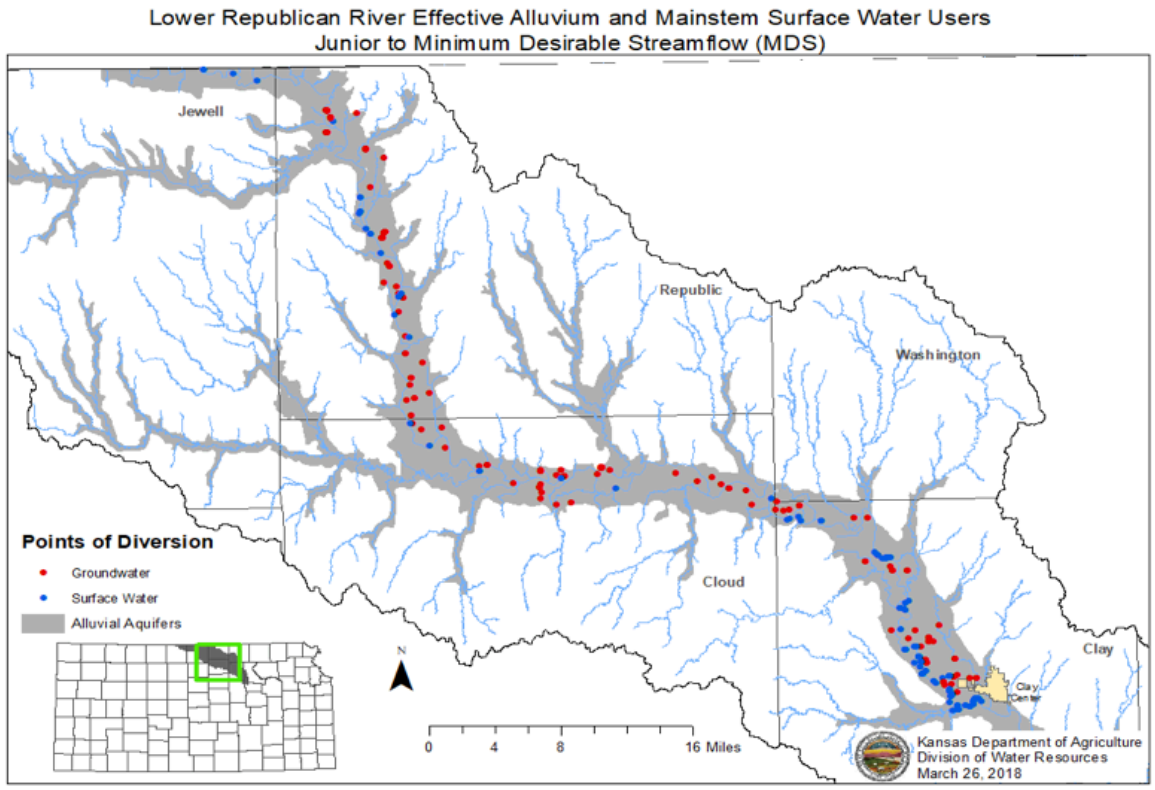


Figure 3. Water rights junior to minimum desirable streamflow along the lower Republican River. Source: Kansas Department of Agriculture, Division of Water Resources, 2018

for use by KBID and a Kansas Supplemental Account for water supplies not in the Kansas Account and for Kansas use outside of KBID. Nebraska will make good faith efforts to ensure that by June 1 of each year, the Kansas Account contains the amount of water needed for the coming year as discussed by Kansas and Nebraska the previous fall (October 1 deadline). This quantity is based in part on the forecasted volume available, Nebraska's operational capacity, and any Kansas compact water retained from a previous year in Harlan County Lake. Nebraska will get 100% credit for compact compliance activities that provide Kansas water users their share.

Access District for Junior Water-Right Holders

To improve water reliability for more users, efforts are underway to create a Lower Republican Basin Access District that would be open to junior water-right holders in the basin. The district would purchase water from the Kansas Supplemental Account. The cost for the water would cover its storage and the reservoir's maintenance expenses.

Kansas has the option to move any compact water it does not use in the Kansas Account (for KBID's use) to the Kansas Supplemental Account (for users outside KBID). As KBID improves its efficiencies, it may have irrigation water it is willing to provide to the supplemental account or directly to a new access district. The quantity available would fluctuate in any given year and may not always offset MDS restrictions. However, it could improve the water assurance for junior water-right holders along the Republican River, further maximizing the river's beneficial uses.

STOP 5

Mammoth Fossils at Lovewell Reservoir

KEY FACTS

- Evidence of seven mammoths have been found in close proximity at Lovewell Reservoir.
- The fossils, about 20,000 years old, include skulls, tusks, ribs, limbs, and molars.
- Lovewell has the highest concentration of individual mammoth finds in the Central Great Plains.
- Some archaeologists argue evidence shows human association with the mammoths. Others disagree.
- Mammoths and modern elephants shared a common ancestor millions of years ago.

Local residents first found evidence of mammoths at Lovewell reservoir in 1969 when they discovered a skull exposed during low water levels due to drought conditions. Upon further investigation, the Kansas Historical Society found more associated remains in the fine-grained alluvial deposits along a beach. However, after a consulting geologist declared the reddish sediment containing the specimen to be more than 100,000 years old—far too old for human contact—the archaeologists left the bones and concluded their investigation. Many of the bones were eventually collected by a high school class, and by the time it was determined through further geologic studies and radioactive dating that the bones were closer to 20,000 years old, most of the evidence was lost.

For the next 22 years, the site was back underwater and not exposed again until water levels dropped in 1991, 2002, and 2004. The discovery of the first mammoth, known as Lovewell Mammoth I (fig. 1), was followed by the excavation of Lovewell Mammoth II (fig. 2). Eventually three more mammoths were excavated and the partial remains of two more were found on the surface. The concentration of seven individual sites within a segment of shoreline spanning just more than one mile gives Lovewell the distinction of having the highest concentration of single

Figure 1. 1969 excavation of Lovewell Mammoth I. Photo: Kansas Historical Society

Figure 2. 1991 excavation of Lovewell Mammoth II. Photo: Rolfe Mandel

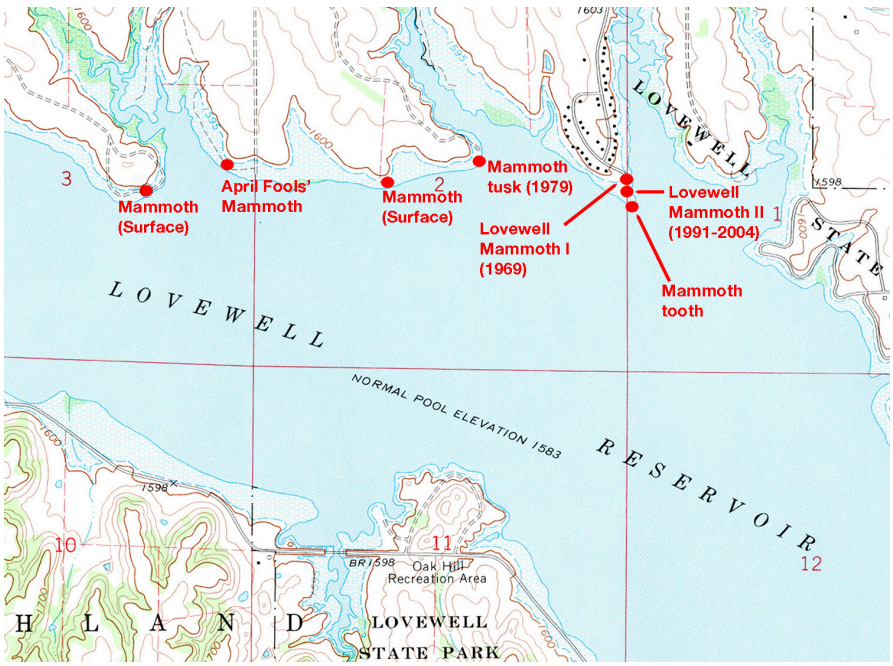


Figure 3. Location of mammoth sites at Lovewell Reservoir. Modified from Holen, 2006

Figure 4. Bone flake recovered at the Lovewell Mammoth II site. Photo: Steve Holen

Figure 5. Tip of a highly polished bone tool recovered at the Lovewell Mammoth II site. Photo: Steve Holen

adult mammoth death sites in the Central Great Plains (fig. 3).

Evidence found at the Lovewell sites includes nearly whole and partial skulls, tusks, ribs, limbs, and molars. The remains of other animals at the sites include bison, camel, dire wolf, horse, llama, sloth, gophers, mouse, prairie dog, vole, hognose snake, garter snake, and toad. Monitoring of the erosion along the north shoreline and fossil collecting continues.

Searching for a Link Between Mammoths and Early People

The mammoths found at Lovewell lived about 18,000 to 21,000 years ago during the Pleistocene Epoch, several thousand years before humans are known to have been in the area. The earliest known contact between people and mammoths in the Central Plains occurred about 13,000 years ago, an estimate verified in Kansas by evidence found at an excavation site near Kanorado on the Colorado border. Whether there is archaeological evidence associating early people with the Lovewell mammoths, as some researchers have argued, is up for debate. The scant remaining evidence found at the Lovewell Mammoth I site after the water receded in 1991, 2002, and 2004 provided possible, but not definitive, clues.

Arguments that humans and mammoths existed in the Lovewell area at the same time are based primarily on bone breakage patterns and the position in which the bones were found. Some archaeologists maintain the cut marks, spiral fractures, and percussion marks on some of the bones could only have been caused by human activities. Others argue the marks and fractures could have been caused by natural processes or scavenging animals. Several bone artifacts, including bone flakes (fig. 4) and the tip of a highly polished bone tool (fig. 5), were recovered from the Lovewell Mammoth II location and present the best argument of human-mammoth contact.

Mammoths

Mammoths and modern elephants share a common ancestor dating back a few million years. Of the two types of mammoth known in North America—woolly and Columbian—Kansas mammoths are likely Columbian (fig. 6). Woolly mammoths are thought to have stayed generally to the north. Some scientists think, however, that there were hybrids of the two. Columbian mammoths weighed about 10 tons, while woolly mammoths weighed 4 to 6 tons. (In comparison, a car weighs 1.5 to 2 tons.) All species are now extinct.

Pleistocene

The Lovewell mammoths lived near the end of the Pleistocene Epoch, also sometimes referred to as the ice age. The Pleistocene lasted from about 1.8 million to 10,000 years ago and encompassed many different glacial events and warm and cool climates. Glaciers reached the northeast corner of Kansas at least twice during the Pleistocene, about 600,000 years ago.

Based on the fossil evidence, the ecological setting of the White Rock Creek valley where Lovewell Reservoir is located was able to sustain large and diverse animal species. Spring-fed, continuously flowing White Rock Creek would likely have been able to provide enough moisture for lush vegetation, even during the relatively dry late Pleistocene. The numerous channel deposits of small gravel along the north shore indicate the creek was a dynamic stream with a significant flow.

Lovewell Reservoir, State Park, and Wildlife Area

White Rock Creek, a tributary of the Republican River, was dammed by the U.S. Bureau of Reclamation in the mid-1950s to form Lovewell Reservoir for irrigation, flood control, and recreation. Fluctuating lake levels eroded the north shoreline and exposed a rich collection of Pleistocene fossils.

Approximately 3,000 surface acres of water are stored in Lovewell Reservoir, which is fed by White Rock Creek and the Courtland Canal. Water in the canal is diverted from the Republican River near Guide Rock, Nebraska. The U.S. Bureau of Reclamation manages the lake and the Kansas Department of Wildlife, Parks and Tourism manages the 1,160-acre Lovewell State Park on the north shore and the 2,215-acre Lovewell Wildlife Area.

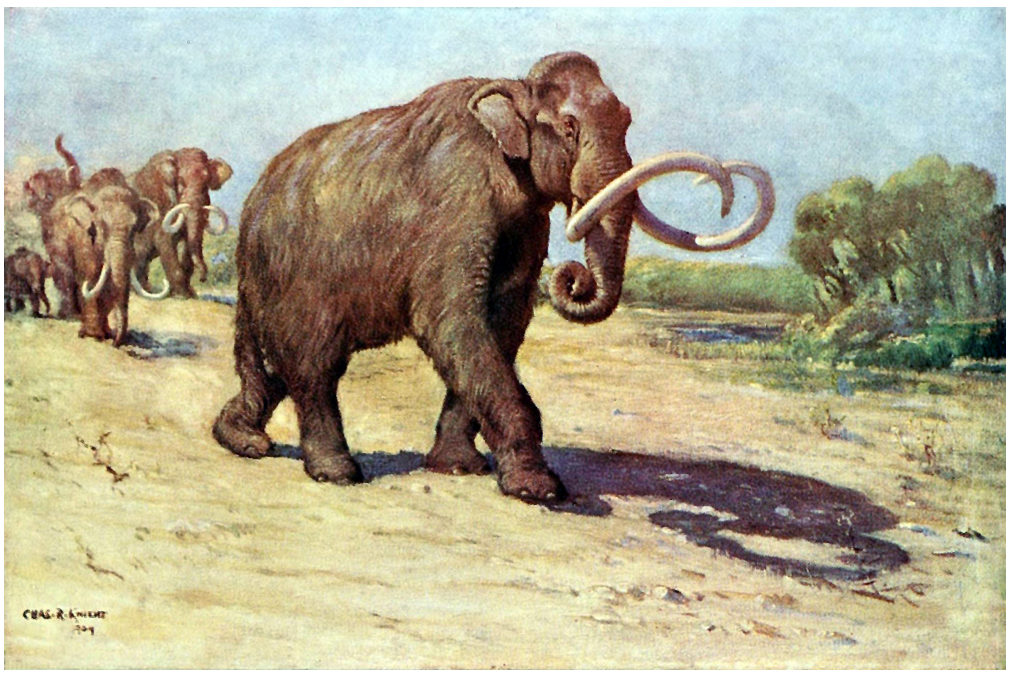


Figure 6. Columbian mammoth restoration based on a fossil specimen at the American Museum of Natural History. Illustration: Charles R. Knight, 1909

STOP 6

Kitkahahki (Republican) Pawnee Village Excavation and Museum

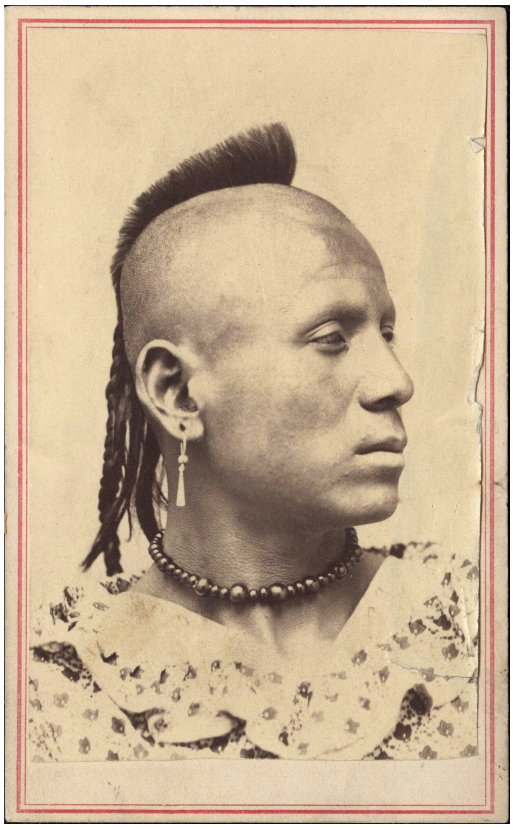
KEY FACTS

- The Pawnee Indian Museum is built over an excavated Kitkahahki village earth lodge.
- The village, with up to 75 earth lodges, was occupied in the late 18th century.
- Remnants of 26 of the lodges are on the Pawnee Indian Museum State Historic Site grounds.
- Artifacts found at the site include tools, a gun barrel, knife fragments, beads, and ceramics.
- The Kitkahahkis are also called the Republican Pawnees—a name given by French trappers.

Alternating between transient hunting and sedentary farming lifestyles, the Kitkahahki pursued bison across the plains during the hot summer and cold winter months then returned to semi-permanent villages to plant and harvest corn, beans, squash, and watermelon in the spring and late summer.

Also known as the Republican Pawnees, the Kitkahahkis built villages of dome-shaped earth lodges along the Republican River valley of northern Kansas and southern Nebraska in the late 18th and early 19th centuries. A village might be inhabited for years, even decades, before the band moved to a new location. One village occupied during the late 18th century lay at the confluence of White Rock Creek and the Republican River—now the location of the Pawnee Indian Museum State Historic Site in Republic County. Nearly a century of amateur and professional excavations at the site have turned up evidence of 26 earth lodges within the six-acre historic site. Up to 50 more are just outside of the historic site's boundaries.

The Kitkahahkis on the Republican River lived in earth lodges similar to this Loup River valley Pawnee lodge photographed by William H. Jackson in 1873. Photo: National Archives



A formal portrait of an unidentified Pawnee man with a hairstyle in the shape of a buffalo horn unique to the Pawnee. Photo: kansasmemory.org, Kansas Historical Society

Who Were the Kitkahahkis?

The Kitkahahkis, or Republican Pawnees, were one of four bands within the Pawnee tribe, a powerhouse on the central plains during early historical times. The native name "Kitkahahki" translates as "on the hill." French trappers and traders called them the Panis Républicain (Republican Pawnee). By the mid-1700s, the French and Spanish were trading with the Pawnee bands and other plains tribes, and American explorers were soon to come. In 1806, Lt. Zebulon Pike visited a Kitkahahki village on the Republican River, replacing the Spanish flag there with an American flag.

In the late 18th and early 19th centuries, three of the four Pawnee bands lived in villages mainly along the Loup and Platte rivers in what is now east-central Nebraska. The Kitkahahkis, however, settled in farther south along the Republican River in present-day southern Nebraska and northern Kansas. Generally, the whole band would occupy one village and move as a group from place to place.

The excavation site at the Pawnee Indian Museum is the larger of two known Kitkahahki villages in Kansas. Archaeologists

Pawnee Nation members at Kansas Monument site celebration, ca. 1933. Photo: kansasmemory.org, Kansas Historical Society

Pottery recovered from the Kansas Monument site during University of Nebraska excavations in the 1930s. Photo: kansasmemory.org, Kansas Historical Society

refer to it as site 14RP1 or, less formally, the Kansas Monument site. The other, the Bogan site near Milford Lake in Geary County, is less thoroughly excavated. A third Kansas location—Waconda Spring near Cawker City in Mitchell County—was of spiritual importance to the Pawnee, although it was never a residential site. The spring is now submerged under Glen Elder Reservoir.

From time to time, the Kitkahahkis were driven from their villages by other tribes, especially the Kansa. As a result, a village might be abandoned and reoccupied by the Kitkahahkis several times. The exact usage history of the village at the Kansas Monument site is not known, but it was likely established in the 1770s and permanently abandoned by the end of the century. A later Republican River Kitkahahki village, upriver at what is now known as the Hill site in Nebraska, was in place by the early 1800s and permanently abandoned in 1831.

In 1871, a land surveyor discovered evidence of the Kitkahahki village at the Kansas Monument site. Near the end of the century, locals linked the site to Zebulon Pike's 1806 visit through historical documents and began promoting its historical significance. The State of Kansas promptly acquired six acres at the site, and the governor showed up in 1901 to lay the cornerstone of a monument in honor of Pike. Later, however, archaeologists debunked the Pike narrative when further review of the evidence proved that he had stopped at the Nebraska Hill site village instead. Although the invalidation of the Pike connection was a disappointment to the site's boosters, a great deal of historical evidence ended up being preserved that might otherwise have been lost.

The Pawnees

By the time of European contact, the Pawnee were divided into two main groupings—the Skiri (or Wolf) band and the south bands. The latter encompassed the Kitkahahki band, the Chawi (or Grand) band, and the Pitahawirata (or Tapage) band. The larger Skiri band dominated the Loup River valley, and the other

bands lived mainly south of them, including along the south bank of the Platte River and on the Republican River. Most of what is known about the Pawnee bands' time on the plains has been reconstructed through archaeological evidence; historic French, Spanish, and early American maps and documents; observations by government officials, soldiers, missionaries, and artists; and Pawnee oral history.

Pawnee villages, often protected with fortifications in later years, were estimated to contain 40 to 200 earth lodges and 800 to 3,500 inhabitants. Evidence shows that prehistoric villages may have been smaller and more numerous. During western expansion in the 19th century, the Pawnees faced conflicts with incoming settlers and with Sioux and other tribes being pushed by settlement into Pawnee territory. Introduced diseases and loss of Pawnee lands through negotiations with the U.S. government also took a toll.

Just two years after the Kitkahahkis permanently abandoned the Hill site in 1831, the Pawnee gave up rights to all land south of the Platte River. In 1875, they ceded their remaining land and moved to Oklahoma territory. The Pawnee population, which had been 10,000 or more around 1800, was down to about 600 by 1900. Today, the Pawnee Nation of Oklahoma has more than 3,000 members.

Excavations at the Kansas Monument Site

Archaeological evidence at the Kansas Monument site includes earth lodge depressions, external storage pits, and a portion of fortification trench. Thousands of artifacts and materials also have been found, including native ceramics, beads, lithic tools, animal bones, shells, and charcoal and plant remains. Metal artifacts indicative of trade with Europeans and Americans include a gun barrel, knife fragments, and a square nail.

Numerous excavations at the Kansas Monument site since the 1920s include one in 1949 when Carlyle Smith from the University of Kansas excavated two lodges. In the mid-1960s, Tom Witty of the Kansas Historical Society excavated the floors of nine lodges, including the one now inside the museum. Starting in 2008, Jack Hofman and Mary Adair from KU, with the assistance of archaeologist Donna Roper, conducted several investigations. They analyzed the existing collections generated by Smith and Witty and conducted more extensive excavation on the earth lodge known as House 13. Their goal was to fill in gaps in the literature about the site's chronology, Pawnee lifeways and subsistence, and the role of the Kansas Monument site among the Pawnee.

The Museum

The Pawnee Indian Museum, built in 1968, is owned by the State of Kansas and operated by the Kansas Historical Society. The exhibits include an exposed excavation with objects and structural remains displayed where they were found by archaeologists. Other items on display include rare Pawnee sacred bundles, a star chart painted on buckskin, European metal trade items, a bison robe, articles made from bison bones, and George Catlin paintings. Numerous earth lodge depressions also are visible on the historical site grounds.

STOP 7

Jamestown Wildlife Area Restoration Public-Private Partnership

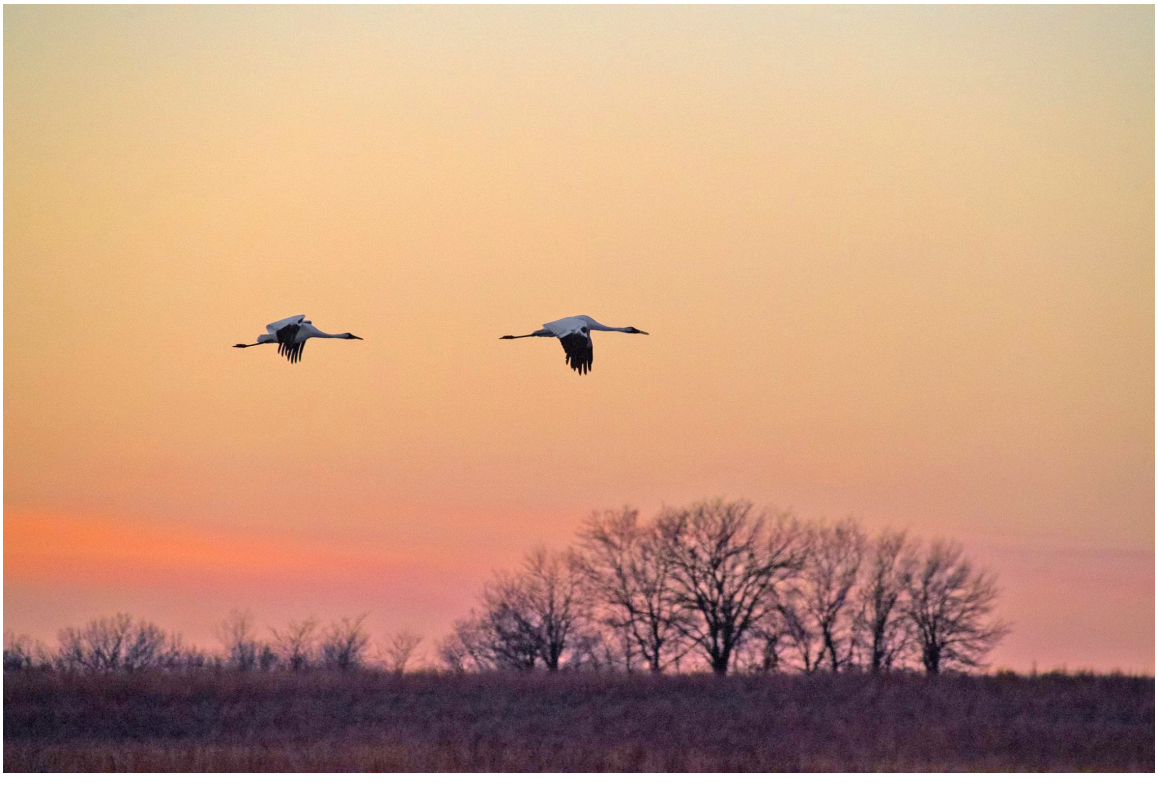
KEY FACTS

- Jamestown Wildlife Area is a stopover for migratory birds in the North American Central Flyway.
- More than 200 species of waterfowl, shorebirds, wading birds, raptors, and songbirds have been recorded there.
- KDWPT and 13 other public and private entities have partnered to restore and enhance the wildlife area.
- Restoration includes reconstructing levees, installing water-control structures, and planting native grasses.
- Adjacent areas of interest have been purchased from landowners willing to sell.

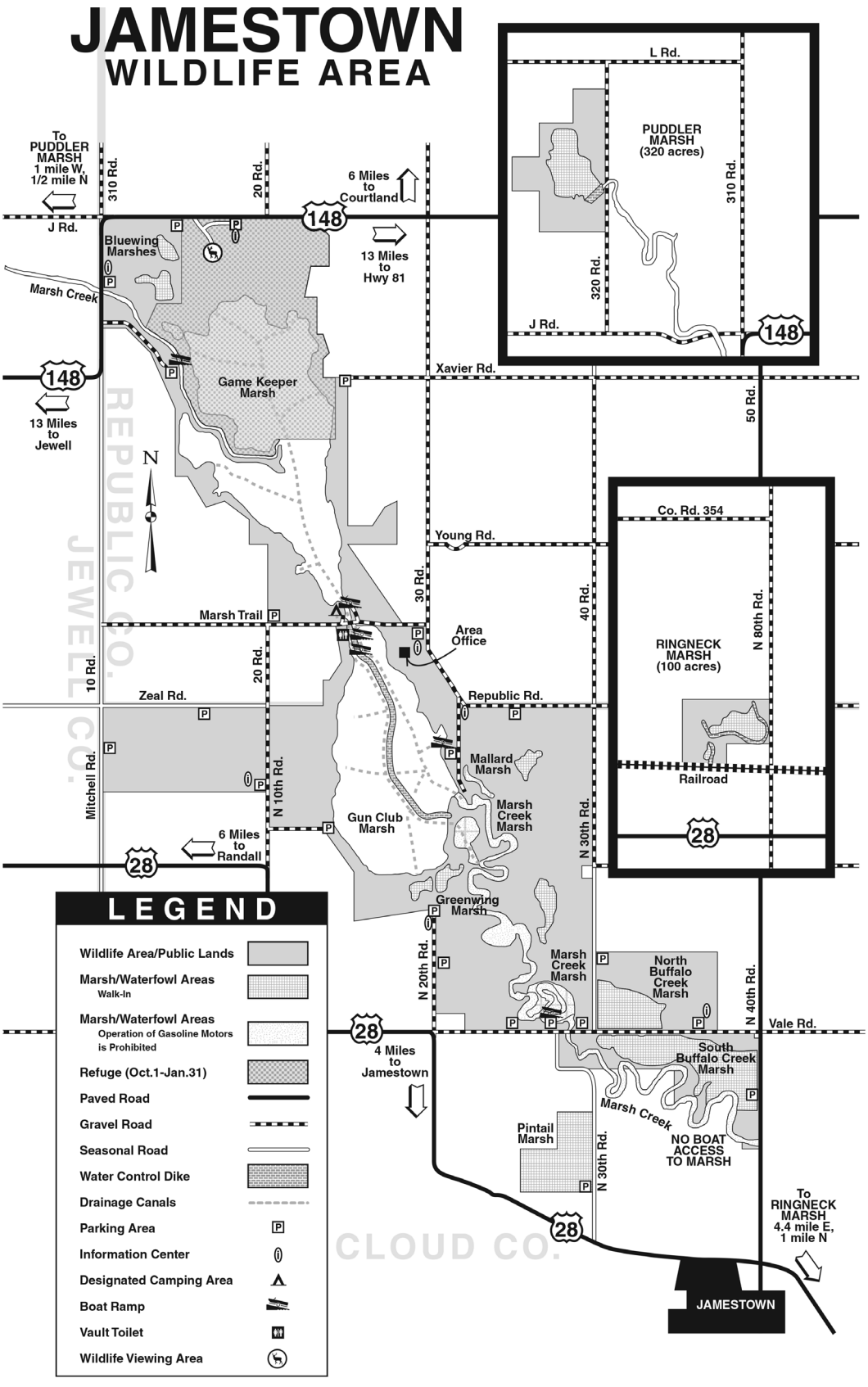
Encompassing a series of marshes, the Jamestown Wildlife Area is an important resource for local wildlife and migratory birds in the North American Central Flyway. Stretching into Republic, Cloud, and Jewell counties, the wetland provides a stopover between northern breeding grounds and southern wintering grounds. Regionally, Jamestown links the Nebraska Rainwater Basins with Cheyenne Bottoms, Quivira National Wildlife Refuge, and McPherson Valley Wetlands.

More than 200 bird species, including waterfowl, shorebirds, wading birds, raptors, and songbirds, have been recorded along Marsh Creek, the main waterway running through the wetlands. During waterfowl surveys, as many as 500,000 ducks and geese and 20,000 shorebirds have been recorded at Jamestown, and 26 endangered whooping cranes were spotted there in 2016.

The Kansas Department of Wildlife, Parks and Tourism (KDWPT) manages the 5,214-acre wildlife area, which includes 1,900 acres of wetlands associated with the 158-square-mile



Whooping cranes at the Talmo Marsh Wildlife Area near the Jamestown Wildlife Area. Photo: Tim Passmore



Jamestown Wildlife Area. Source: Kansas Wildlife, Parks and Tourism.

Jamestown Wildlife Area during high water in 2008.

watershed of Marsh Creek, a tributary of the Republican River. Over decades, dams and other structures built by private and government entities to manage water levels have altered the marsh environment. In 2006 and 2007, KDWPT and several partner organizations received federal matching grants to acquire adjacent land from willing landowners and restore thousands of acres of wetlands and grasslands. Ultimately, Jamestown and nearby Talmo Marsh Wildlife Area—also undergoing restoration—will encompass nearly 10,000 acres.

Early History of Jamestown Marsh

Presettlement, the naturally occurring marshland was used by Native Americans as a hunting ground and source of salt. In the early 1900s, local residents erected dams along Marsh Creek to establish a longer wet season for the ephemeral marshes and to form a lake. As a result, two main marshes—now known as Gun Club Marsh and Game Keeper Marsh—were created. In 1932 the Kansas Forestry, Fish and Game Commission (predecessor of KDWPT) purchased and developed Gamekeeper Marsh, then known as Republic County State Lake, as a public recreational area for fishing, hunting, and boating regattas.

Gun Club Marsh, originally known as Sportsman Lake, was privately owned and leased by local hunters who formed the Jamestown Gun Club. The lessees built a dam to raise water levels and create a small lake for hunting and, for a time, powerboat racing regattas. In the 1960s, the Kansas Fish and Game Commission acquired much of the area. After the state's acquisition of the area, more adjoining lands were acquired from willing sellers at locally appraised values.

Restoration and Land Acquisition

Sediment eroded off fields surrounding the wetlands eventually built up behind the dams, leading to a significant reduction in the water storage capacity of the marshes and artificial lakes. Many acres in the degraded wetland system were taken over by cattails, adversely affecting wildlife habitat and hunting opportunities. In 1970, an engineering firm recommended raising the dams to offset the water storage loss due to sedimentation but determined the logistics of removing the sediment buildup from the basin, including

agricultural chemicals and hunters' lead shot, would be both economically and environmentally detrimental.

At the beginning of the 21st century, numerous government and private partners signed on to help the Kansas Department of Wildlife and Parks (now KDWPT) and major partner Ducks Unlimited with technical and financial support for restoration of the wetland. The goals were to provide optimum wildlife habitat; restore wetland function and water quality; acquire and restore additional wetlands and grasslands along Marsh Creek and its tributaries; and restore minimum stream flows to the lower Republican River. Work was to include reconstructing levees and berms, installing water-control structures, and planting native vegetation.

Restoration Project Phase I

The project was broken into phases, and partners sought and received a North America Wetlands Conservation Act (NAWCA) grant for phase I. The 1989 Act provides matching grants to partnerships pursuing wetlands conservation projects that benefit migratory birds and other wetland wildlife in the United States, Canada, and Mexico. The nearly $1 million grant was awarded in March 2006, and the project partners provided nearly $2.2 million more.

The goal of phase I was to enhance Gun Club Marsh and the adjacent area. That included acquiring additional property, restoring the marsh and nearby grasslands, and seeding adjacent croplands with native warm-season grasses. By the end of phase I, KDWPT owned and managed 4,650 acres.

Restoration Project Phase II

In September 2007, the project partners received a second NAWCA grant of nearly $500,000, and the Jamestown partners provided nearly $1 million. The state provided support from the Waterfowl Stamp Funds to help match the grant, and partners also secured federal Pittman-Robertson (Wildlife Restoration) Act funding. Phase II, still in progress, focuses mainly on Game Keeper Marsh. Improvements are to include subdivision of the marsh and raising the height of the existing concrete dam by 18 inches. Those changes are being made to ensure seasonal storage of water, improve wetland and waterfowl management, and expand hunting opportunities. Approximately 300 acres of wetland will be enhanced and another 430 acres will be restored when the project reaches full pool storage.

Partners

In addition to KDWPT and Ducks Unlimited, project partners are Pheasants Forever, Inc., The Nature Conservancy, Westar Energy, CloudCorp, Cloud County Board of Commissioners, City of Jamestown, Cloud County Tourism, Republic County Board of Commissioners, Jewell County Board of Commissioners, Kansas Wildlife Federation, Kansas Alliance for Wetlands and Streams, and U.S. Fish and Wildlife Service. A Jamestown Task Force, made up of government and private natural resource specialists, reviews plans and selects alternatives.

Wednesday, August 15, 2018

6:30–7:30 a.m.	Breakfast buffet at hotel
7:45 a.m.	Bus to Site 8
8:40 a.m.	**Site 8: Geoprobe Systems, Salina** Tom Christy, Vice President, Geoprobe Systems
9:40 a.m.	Bus to Site 9
10 a.m.	**Site 9: The Land Institute and Alternative Agriculture** Fred Iutzi, President, The Land Institute Tim Crews, Director of Research, Ecology Program, The Land Institute
11 a.m.	Bus to Site 10
11:15 a.m.	**Site 10: Friends of the River Office, Salina** Martha Tasker, Utilities Director, City of Salina, and Project Manager, Smoky Hill River Renewal Jane Anderson, Executive Director, Friends of the River Foundation
Noon	Bus to lunch and Site 11
	Bus Talk: Legal, Regulatory, and Public Policy Issues with Carbon Capture Susan Stover, Geologist, Kansas Geological Survey
12:35 p.m.	**Site 11 and Lunch: Brookville Hotel, Abilene**
	Carbon Capture, Utilization and Storage Potential in Kansas Eugene Holubnyak, Petroleum Engineer, Kansas Geological Survey
1:45 p.m.	Bus to Site 12
2 p.m.	**Site 12: Chase-Riatt Black Walnut Plantation** Bob Atchison, Rural Forestry Program Coordinator, Kansas Forest Service
2:45 p.m.	Bus to Acorns Resort
3:45 p.m.	Return to cars and adjourn

NOTES

STOP 8

Geoprobe® Systems: Subsurface Exploration Tools and Technology

KEY FACTS

- Headquartered in Salina, Geoprobe Systems employs about 100 people.
- Geoprobe machines are used to extract soil, groundwater, and rock samples.
- Geoprobe sensors record high-resolution well-log data.
- Geoprobe Systems leads in direct push technology used to explore the shallow subsurface.

Founded in Salina in 1987, Geoprobe Systems® built the first Geoprobe brand machine—for the Environmental Protection Agency—in 1988. Today, the company designs and manufactures a full line of technical drilling and probing machines and tools used by environmental, geotechnical, exploration, water well, and construction industries around the world. More than 100 people are employed at Geoprobe Systems in Salina, including founders Mel Kejr (president) and Tom Christy (vice president, PE).

Geoprobe products are used to extract high-quality soil, groundwater, and rock samples with direct push, rotary, and sonic methods. The machines range in size from compact limited-access machines that can fit into tight indoor spaces to large platform and big-performance rotary sonic rigs. Typically mounted on tracks or heavy-duty trucks, Geoprobe machines often combine direct push, rotary, and sonic technologies so that different probing and sampling capabilities needed for a job can be accomplished with a single piece of equipment.

Figure 1. A Geoprobe high-capacity direct push machine used for installing a monitoring well. Photo: Geoprobe Systems

Direct Push Technology

Geoprobe Systems is the world leader in direct push technology for environmental applications. The company's direct push machines are designed to gather information about unconsolidated subsurface material at a speed and level of detail not previously possible (fig. 1). These machines and the accompanying sensors and tools can be used to obtain soil, groundwater, and vapor samples, continuous soil cores, and a variety of high-resolution well-log data. Direct push technology is generally used at depths of 50 to 100 feet, although it has been used at depths exceeding 200 feet.

Unlike drills, which rotate through rocks and sediment, direct push machines push sediment aside so that no material has to be brought to the surface for disposal. Hydraulic rams supplemented with vehicle weight and high-frequency percussion hammers rapidly advance the small-diameter probe rods and attached tools and sensors into the subsurface. Advantages of direct push over drilling

GEOPROBE PRODUCTS ARE USED FOR A VARIETY OF APPLICATIONS

- Alternative fuels exploration
- Animal feedlot soil sampling
- Bridge evaluations
- Earthquake studies
- Geological field studies
- Golf course maintenance
- Groundwater sampling and monitoring
- Landfill management
- Mine infilling and rehabilitation
- Mining exploration
- Natural gas leak detection
- Pavement cutting
- Permafrost sampling
- Radon testing and remediation
- Rural groundwater contaminant detection
- Sand and gravel exploration
- Seawall investigation
- Shallow oil and gas exploration
- Sinkhole evaluation
- Soil sampling
- Streambed gold exploration
- Superfund site sampling
- Tunnel verification
- Water wells
- Wind farm foundation footings investigation

Figure 2. Landshark Drilling uses a Geoprobe high-capacity direct push machine with a narrow platform for limited access areas at an intersection in downtown Toronto, Canada. Photo: Geoprobe Systems

include cost-effectiveness, less site disturbance, ability to get into areas inaccessible to most drill rigs (fig. 2), and the incorporation of various tools and sensors into just one piece of equipment.

The Kansas Geological Survey has used Geoprobe direct push machines to develop new ways to assess the potential for contaminant movement in groundwater, the viability of artificial recharge and temporary storage of water in aquifers, and the nature of the connection between Kansas rivers and streams and adjacent aquifers (a topic that was covered in the 2017 Kansas Field Conference).

Rotary Sonic Drilling and Geotechnical Exploration

In the last decade, Geoprobe has become a leader in rotary sonic drilling, which combines the traditional rotary method with sonic technology (fig. 3). Rotary sonic rigs are used, among other things, to sample consolidated rock, glacial till, and backfill rubble, which are too dense for

direct push machines. Geoprobe also has a variety of rigs designed for geotechnical exploration, which involves drilling to collect data needed for engineering the foundations of roadways, buildings, tunnels, levees, and other structures.

Tools and Tooling Systems

Geoprobe brand tooling options range from small to large diameter casing, rods, samplers, bits, and accessory parts. The Geoprobe Direct Image tooling systems provide innovative technologies for the field of high-resolution site characterization. These systems are used to vertically log in-situ soil characteristics, including lithology, electrical conductivity, permeability, and contaminants. The various logs can then be combined to create accurate, highly detailed conceptual site models—the critical first step in any site investigation.

Figure 3. An on-site geologist examines soil cores retrieved using a full-size Geoprobe sonic rig that can continuously sample and set casing in excess of 300 feet. Photo: Geoprobe Systems

NOTES

STOP 9

KEY FACTS

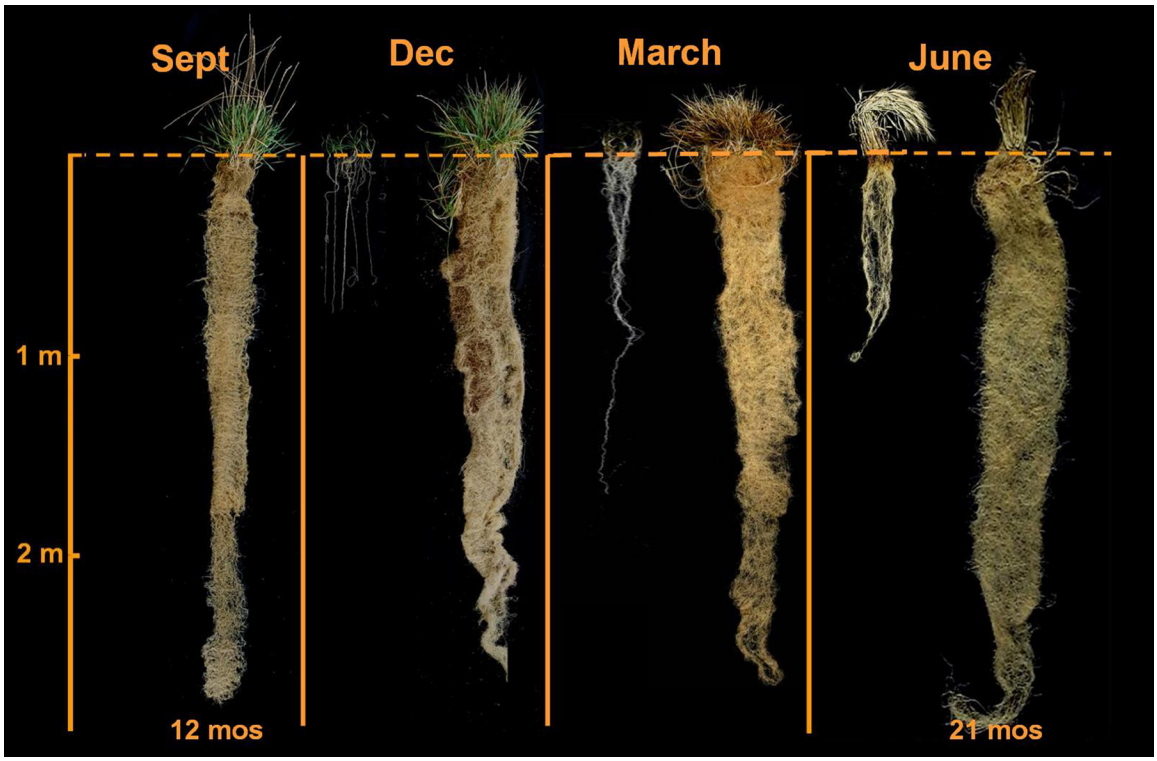
- The Land Institute develops perennial crops by domesticating wild perennials and perennializing annual crops.
- Perennial crops require fewer chemicals than annuals and alleviate erosion.
- Deep-rooted perennial plants have greater access to water than shallow-rooted annuals.
- Products containing The Land Institute's perennial Kernza are sold by restaurants and breweries.
- General Mills has committed to buying Kernza for use in organic products.

The Land Institute and Alternative Agriculture

Over the past 10,000 years, people have increasingly cultivated land to grow crops that complete their life cycle in one growing season. Today, 80% of agricultural land worldwide is planted in annual grain, legume, and oilseed (peanut, soybean, etc.) crops. Those crops include wheat, first domesticated in the Middle East's Fertile Crescent, and sunflowers, first domesticated by Native Americans. Annuals, however, take a long-term toll on soil and have short roots that make them susceptible to drought.

Although annuals dominate agriculture, 85% of native plants in North America are perennials—deep-rooted, drought-resistant plants with life cycles that span years, even decades. Despite those advantages, perennials have not been a major source of food for humans. They lack the favorable traits bred into annual crops, including high seed yields, large grain size, synchronized flowering and seed maturation, and non-shattering tendencies that prevent seeds from dispersing like a dandelion as soon as they ripen.

Field of ripening intermediate wheatgrass at The Land Institute. Photo: Lee R. DeHaan/The Land Institute



Four-season comparison between short annual wheat roots (on left by month) and long perennial intermediate wheatgrass roots (on right). Photo: Lee R. DeHaan/The Land Institute

In 1976, The Land Institute (TLI) was launched in Salina with a mission to develop sturdy, ecologically friendly perennial crop plants that could replace the ubiquitous annuals. TLI ecologists and breeders went to work developing perennials that match annuals in terms of productivity and other favorable traits while retaining their longevity and other perennial advantages. TLI is experimenting with perennial wheat, legume, rice, sorghum, and sunflower crops, searching for those that could best feed the growing world population while protecting the environment.

Natural Systems Agriculture

Through an initiative it calls Natural Systems Agriculture, TLI promotes mutually beneficial relationships among a variety of perennial crops and natural ecological systems, including fertility and nutrient cycles, pest-control processes, and water management. TLI advocates polyculture agriculture in which a variety of species are planted together to mimic natural systems, as opposed to a monoculture system, where different plant types are grown in separate fields.

TLI's objectives include the following:

- curtailing the use of plowing, tilling, fertilizers, pesticides, and herbicides
- mitigating erosion, water contamination, and reservoir sedimentation
- building up soil nutrients
- sequestering carbon—the main ingredient of soil organic matter
- enabling soil formation to keep up with erosion
- reducing use of surface water and irrigation
- developing drought-resistant crops
- providing more wildlife habitat

TLI's teams are approaching the development of potential perennial crop plants from two directions—through the domestication of wild perennial plants and through the perennialization of annual crop plants.

Domesticating Wild Perennials and Success with Kernza

Domesticating wild perennials is the most direct route to breeding perennial crops. Using that method, breeders at TLI are growing large, diverse populations of perennials from which they select individual plants with superior traits and cross-pollinate them. They then repeat the process through successive generations.

Kernza is TLI's first perennial grain to be introduced into the agriculture and food markets. TLI started a program in 2003 to convert intermediate wheatgrass, a Eurasian forage, into a perennial crop plant. After multiple rounds of selecting and intermating, TLI registered a promising perennial under the trademark Kernza.

Kernza products are available in niche restaurants and breweries around the country, including in San Francisco, Minneapolis, and Los Angeles. In Salina, Blue Sky Brewery serves the Kernza beer Crankcase. In 2017, General Mills gave the University of Minnesota $500,000 to study the potential of Kernza, particularly how it stores carbon and organic matter in the soil. The university started collaborating with TLI in 2011.

General Mills is hoping Kernza can help it reach a goal of sustainable emission levels by 2050. Cascadian Farm, a division of General Mills, aims to have Kernza organic products available by late 2019. Because Cascadian Farm also has agreed to purchase a set amount of the perennial grain, TLI can make arrangements with farmers to plant Kernza in commercial-scale fields. Currently, Kernza is grown on test-size plots.

Perennializing Annual Crops

Perennials also can be bred through hybridization—crossing an existing annual grain crop with a wild perennial cousin. Successful hybridization produces plants that inherit their life cycle from a perennial parent and seed yield and other qualities from an annual parent. One TLI undertaking involves crossing annual wheats—especially

Individual intermediate wheatgrass plants are bundled to select plants with the highest yield and largest seed. Photo: Lee R. DeHaan/The Land Institute

Seed heads of individually bundled intermediate wheatgrass plants are passed into the combine for threshing and cleaning. Photo: Lee R. DeHaan/The Land Institute

durum wheat used for making pasta—with wheatgrass species. Another has resulted in hybridized sorghum trials in several sub-Saharan African countries to test their drought resistance.

Collaboration and Education

TLI, an educational and research nonprofit, collaborates with, funds, and exchanges data and plant material with more than three dozen research groups in the United States, Canada, South America, Europe, Asia, Africa, and Australia, including the University of Kansas and Kansas State University. The Perennial Agriculture Project, a joint project of the Malone Family Land Preservation Foundation and The Land Institute, underwrites many of the initiatives and awards grants to graduate students and postdoctoral fellows at partner institutions throughout the United States.

The Global Inventory Project is a large-scale, global collaboration between The Land Institute, the Missouri Botanical Garden (one of the world's largest research botanical gardens), and Saint Louis University. Project researchers identify wild, herbaceous perennial species for pre-breeding and eventual use in perennial crop polycultures in temperate and tropical climates.

Ecosphere Studies at TLI provides educational and cultural opportunities with a perennial perspective. Ecosphere Studies, which emphasizes the connection between human communities and their surrounding ecosystems, regularly provides collaboration among researchers and educators. Participants range from farmers, scientists, economists, and historians to artists, activists, and writers associated with universities, interdisciplinary consortiums, and adult education non-profits.

STOP 10

Revitalizing the Smoky Hill River in Salina

KEY FACTS

- A Smoky Hill River bypass channel was completed in 1961 to protect Salina from floods.
- Left with little flow, the original river channel silted in with sand, mud, and debris.
- The Smoky Hill River Renewal Project will restore flows, improve water quality and habitat, and create destination locations along a seven-mile stretch in Salina.
- A master plan is approved, final design will be completed in 2019, and construction is slated to begin in 2020.

The Smoky Hill Renewal Plan

The Smoky Hill Renewal Project is a multiyear plan to restore river flow and reinvigorate Salina's downtown and neighborhoods along the Smoky Hill River channel that winds through the city. This original alignment of the river became neglected after levees and a bypass channel were completed by the U.S. Army Corps of Engineers (Corps) in 1961 to control floods (fig. 1). Historically, the natural channel carried flows from 8,000 square miles; now it catches the runoff from only 5 square miles and 73 storm sewer outlets. With no sustained flows, the channel sedimented in and became a catch basin for debris and brush.

As part of the project, flow will be restored to the river's original channel, which will enhance the river's function, restore critical habitat, and improve water quality. A revitalized river will be an asset to the city, drawing visitors downtown, expanding recreational opportunities, and promoting economic redevelopment.

The City of Salina established a steering committee and, with the Friends of the River, conducted extensive public outreach to ensure community desires were considered and reflected.

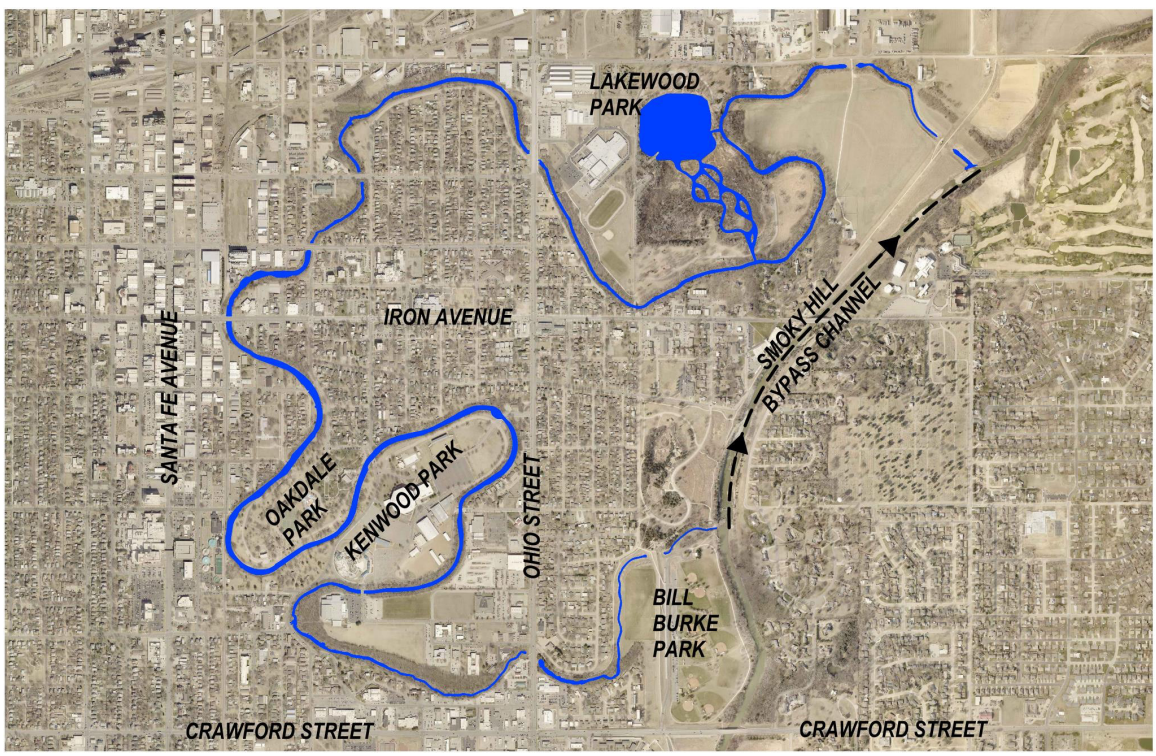
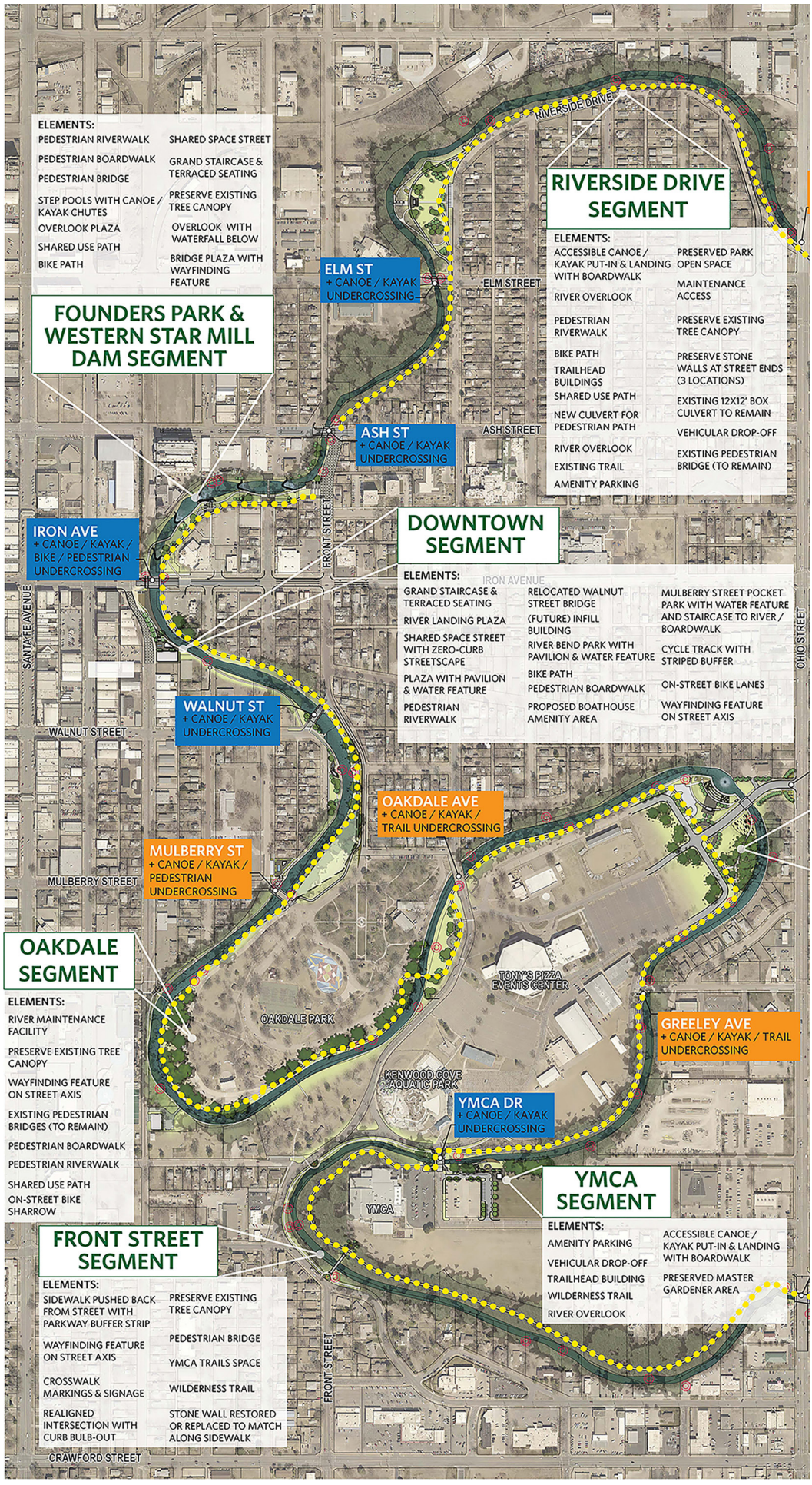


Figure 1. Map showing the original Smoky Hill River channel and bypass in Salina, 2017. Source: Martha Tasker, City of Salina, 2017


RIVERSIDE DRIVE
ELM STREET
ASH STREET
FRONT STREET
IRON AVENUE
SANTA FE AVENUE
WALNUT STREET
MULBERRY STREET
OHIO STREET
OAKDALE PARK
TONY'S PIZZA EVENTS CENTER
KENWOOD COVE AQUATIC PARK
YMCA
CRAWFORD STREET
ELEMENTS:
PEDESTRIAN RIVERWALK
PEDESTRIAN BOARDWALK
PEDESTRIAN BRIDGE
STEP POOLS WITH CANOE / KAYAK CHUTES
OVERLOOK PLAZA
SHARED USE PATH
BIKE PATH
SHARED SPACE STREET
GRAND STAIRCASE & TERRACED SEATING
PRESERVE EXISTING TREE CANOPY
OVERLOOK WITH WATERFALL BELOW
BRIDGE PLAZA WITH WAYFINDING FEATURE
FOUNDERS PARK & WESTERN STAR MILL DAM SEGMENT
ELM ST
+ CANOE / KAYAK UNDERCROSSING
RIVERSIDE DRIVE SEGMENT
ELEMENTS:
ACCESSIBLE CANOE / KAYAK PUT-IN & LANDING WITH BOARDWALK
RIVER OVERLOOK
PEDESTRIAN RIVERWALK
BIKE PATH
TRAILHEAD BUILDINGS
SHARED USE PATH
NEW CULVERT FOR PEDESTRIAN PATH
RIVER OVERLOOK
EXISTING TRAIL
AMENITY PARKING
PRESERVED PARK OPEN SPACE
MAINTENANCE ACCESS
PRESERVE EXISTING TREE CANOPY
PRESERVE STONE WALLS AT STREET ENDS (3 LOCATIONS)
EXISTING 12X12' BOX CULVERT TO REMAIN
VEHICULAR DROP-OFF
EXISTING PEDESTRIAN BRIDGE (TO REMAIN)
ASH ST
+ CANOE / KAYAK UNDERCROSSING
IRON AVE
+ CANOE / KAYAK / BIKE / PEDESTRIAN UNDERCROSSING
DOWNTOWN SEGMENT
ELEMENTS:
GRAND STAIRCASE & TERRACED SEATING
RIVER LANDING PLAZA
SHARED SPACE STREET WITH ZERO-CURB STREETSCAPE
PLAZA WITH PAVILION & WATER FEATURE
PEDESTRIAN RIVERWALK
RELOCATED WALNUT STREET BRIDGE
(FUTURE) INFILL BUILDING
RIVER BEND PARK WITH PAVILION & WATER FEATURE
BIKE PATH
PEDESTRIAN BOARDWALK
PROPOSED BOATHOUSE AMENITY AREA
MULBERRY STREET POCKET PARK WITH WATER FEATURE AND STAIRCASE TO RIVER / BOARDWALK
CYCLE TRACK WITH STRIPED BUFFER
ON-STREET BIKE LANES
WAYFINDING FEATURE ON STREET AXIS
WALNUT ST
+ CANOE / KAYAK UNDERCROSSING
OAKDALE AVE
+ CANOE / KAYAK / TRAIL UNDERCROSSING
MULBERRY ST
+ CANOE / KAYAK / PEDESTRIAN UNDERCROSSING
OAKDALE SEGMENT
ELEMENTS:
RIVER MAINTENANCE FACILITY
PRESERVE EXISTING TREE CANOPY
WAYFINDING FEATURE ON STREET AXIS
EXISTING PEDESTRIAN BRIDGES (TO REMAIN)
PEDESTRIAN BOARDWALK
PEDESTRIAN RIVERWALK
SHARED USE PATH
ON-STREET BIKE SHARROW
GREELEY AVE
+ CANOE / KAYAK / TRAIL UNDERCROSSING
YMCA DR
+ CANOE / KAYAK UNDERCROSSING
YMCA SEGMENT
ELEMENTS:
AMENITY PARKING
VEHICULAR DROP-OFF
TRAILHEAD BUILDING
WILDERNESS TRAIL
RIVER OVERLOOK
ACCESSIBLE CANOE / KAYAK PUT-IN & LANDING WITH BOARDWALK
PRESERVED MASTER GARDENER AREA
FRONT STREET SEGMENT
ELEMENTS:
SIDEWALK PUSHED BACK FROM STREET WITH PARKWAY BUFFER STRIP
WAYFINDING FEATURE ON STREET AXIS
CROSSWALK MARKINGS & SIGNAGE
REALIGNED INTERSECTION WITH CURB BULB-OUT
PRESERVE EXISTING TREE CANOPY
PEDESTRIAN BRIDGE
YMCA TRAILS SPACE
WILDERNESS TRAIL
STONE WALL RESTORED OR REPLACED TO MATCH ALONG SIDEWALK

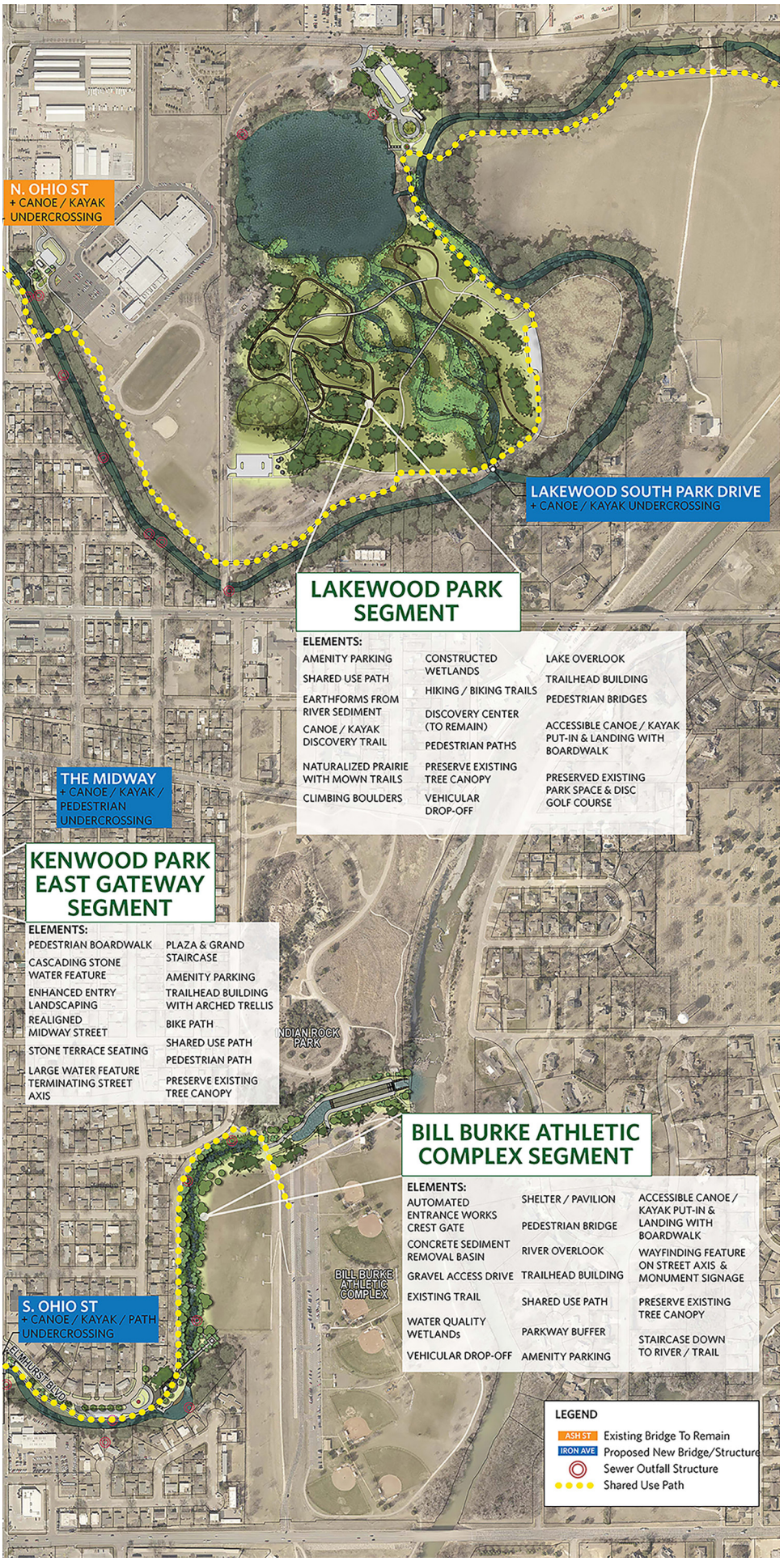


Figure 2. Planned improvements for Smoky Hill River channel in Salina. Source: HDR Engineering, 2018

The Friends of the River, a non-profit organization, remains an integral part of the project planning and implementation. Plans include wide multiuse trails, an urban river walk, improved bridges and pedestrian roadway crossings, a plaza for entertainment and shopping, and canoe and kayaking opportunities (fig. 2). Restoration will require land and easement acquisition, sediment removal, tree and brush removal, utility relocation, construction of a river intake and sediment basins, and wetlands and stream mitigation.

The City of Salina has a water-right permit with a maximum diversion rate of 100 cubic feet per second (cfs) and an annual quantity up to 28,952 acre-feet. Recreational seasonal flows will be 80 cfs with a lower winter flow rate of 10 cfs. The Smoky Hill River has experienced extended periods of drought and low flow. When water cannot be diverted from the Smoky Hill River main channel, flow in the original channel would be supplemented from Kanopolis Lake with water available through the Lower Smoky Access District.

The estimated budget for the Smoky Hill Renewal Project is $27 million, which will be financed through a voter-approved sales tax for city improvements. A city water park will be fully paid in 2019; the $1.35 million annual allocation will then be redirected to the river renewal project for 20 years. In addition, the project qualifies for federal funds through the Corps' ecosystem restoration program. Funding provided under Section 1135 of the Water Resources Development Act for this program can be used to alleviate damage caused by prior Corps projects, such as the Salina bypass channel and flood control levees that led to degradation of the original channel. Ecosystem restoration funds, which can be as much as $10 million, require a non-federal cost share, which could be in-kind services, the value of land already owned, or cash payments. If Corps funding is obtained for the Salina project, it could be used on channel excavation, intake gates, improved vegetation, and water-quality measures.

TIMELINE

- 1980s – City envisions improving original river channel.
- 2010 – City Council approved the master plan.
- 2011 – Water-right permits approved to proceed; perfection period—a demonstration to the state that the quantity of water will be put to beneficial use under the conditions described in the permit—extended to 2021.
- 2015 – Executive Director Jane Anderson hired by Friends of the River Foundation.
- 2016 – Voters approved a 20-year city sales tax increase of 0.35%; a portion will be used for the river renewal project.
- 2017 – Martha Tasker, City of Salina utilities director and project manager of the renewal project, began work with consulting firm HDR on design of in-channel features and a greenway trail.
- 2018 – Corps and City of Salina signed a Feasibility Phase Cost Share Agreement.
- *In Review* – Eligibility for and availability of Section 1135 ecosystem restoration program funds.
- 2019 – Final design and right of way acquisition to be completed for the first phase of construction.
- 2020 – Construction to begin with a goal of completing the first phase of the renewal project in three years. The federal related construction elements may be offset based on federal funding availability and timeline.

STOP 11

Carbon Capture and Storage: The Potential for Kansas

KEY FACTS

- Carbon dioxide emissions can be captured and stored in geologic formations.
- Kansas has the potential to store large volumes of carbon in deep rock formations.
- Carbon can be injected to flood old oil fields to extract additional oil; a high percentage of the carbon remains bound in the rock formation.
- Federal tax credits were raised in 2018 for carbon capture and storage (CCS) and carbon capture, utilization, and storage (CCUS).
- Legal and regulatory clarifications are needed before CCS will occur in Kansas.

Carbon capture and storage (CCS) is a process used to remove carbon dioxide (CO_2) from the atmosphere. Although CO_2 is a natural and essential component of the atmosphere, it is also a greenhouse gas—a byproduct of fossil fuel emissions from vehicles and such stationary sources as electric plants. Too much CO_2 can be detrimental to Earth's climate, and the goal of permanently removing excess CO_2 is to slow warming. During CCS, CO_2 is captured from large point sources, such as coal-based electrical generating plants, cement factories, refineries, and ethanol plants. The CO_2 is compressed and transported to where it can be permanently stored underground in a deep saline aquifer, a depleted oil and gas reservoir, or other deep porous rock layer (fig. 1). Geologic reservoirs used for storage are first evaluated to assure secure containment with thick, stable barriers of rock that have very low permeability sealing the reservoir. CO_2 is stored at depths that provide high enough pressures and temperatures to keep the CO_2 as a supercritical fluid, a state that is neither a distinct gas nor liquid but has properties of both. Like a gas, supercritical CO_2 will diffuse readily into tiny pore spaces of solids, but like

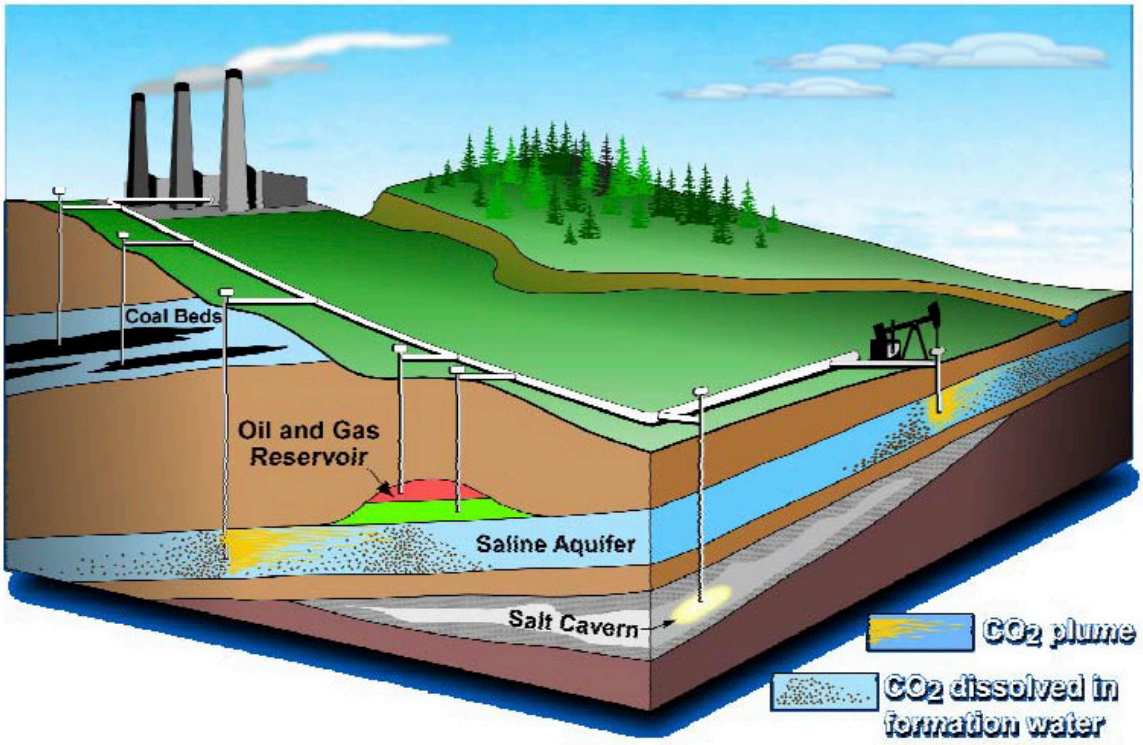


Figure 1. Geologic storage of CO_2 schematic. Source: D. Lawton, 2010

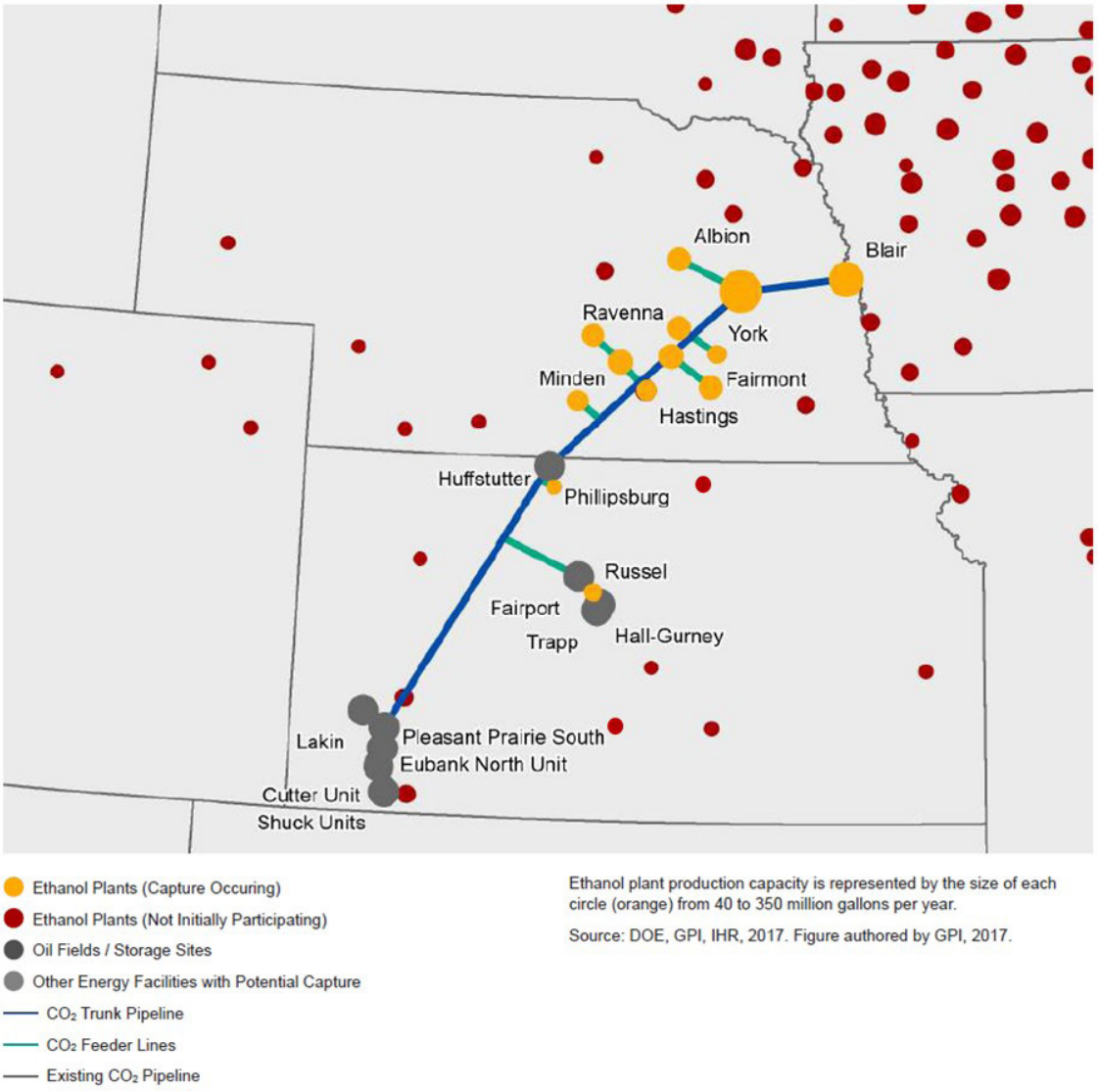


Figure 2: Potential piping network to transport captured CO_2 from ethanol plants to potential storage sites in Kansas. Source: Great Plains Institute, 2017, modified M. Dubois, 2018

liquid, it takes up much less space than gases. If the CO_2 is injected into old oil fields to recover oil or for other purposes before storage, the process is referred to as carbon capture, utilization, and storage (CCUS).

CCUS with Enhanced Oil Recovery

Enhanced oil recovery (EOR) involves injecting CO_2 into a mature oil field to extract oil that is otherwise not recoverable. During EOR, pure CO_2 is injected into the oil reservoir in a supercritical form (not as a gas). The CO_2 flood displaces, dissolves, and mixes with the oil, which can then be pumped out. In the process, a high percentage of the injected CO_2 remains in the geologic formation. The carbon that remains stored in the geologic formation offsets carbon brought back to the surface with the oil, creating an energy source that adds little to no net increase in atmospheric carbon after the oil is combusted.

In Texas, EOR technology produces 80 million barrels of oil annually that could not be produced from conventional methods. In Kansas, where a number of oil fields have been pumped nearly dry through conventional

methods, an injected CO_2 flood could extract an estimated additional 10 million barrels of oil annually (Dubois, 2017). When oil is at $60 a barrel, that would generate $600 million in gross oil sales. Despite this potential, however, EOR has not been widely used in Kansas because it is not yet economical, in part because reliable and affordable sources of pure CO_2 are needed to make the process feasible.

Carbon Capture and Storage: The Kansas Study

Kansas has a number of potential CO_2 storage locations, particularly deep, highly saline aquifers and depleted oil reservoirs. The Kansas Geological Survey (KGS) has studied potential storage sites for sufficient pressures, geologic seals, and storage capacity. A current study—supported by the U.S. Department of Energy (DOE) CarbonSAFE program—evaluates the potential for commercial-scale capture, transport, and permanent storage of 50 million metric tons of CO_2. The most suitable geologic storage sites for commercial-scale volumes are in southwest Kansas. In the first phase of this study, researchers evaluated the feasibility of capturing, transporting, and permanently storing CO_2 from Jeffrey Energy Center, a coal-based power plant near St. Marys, Kansas. The study also included a preliminary examination of legal, regulatory, and policy issues related to CCS.

In May 2018, the DOE awarded a grant for phase two of the study to Battelle (a global research organization), the Energy and Environment Research Center in North Dakota, and the KGS. This phase will evaluate a larger area and the potential for infrastructure development (fig. 2).

Economics of CCS and CCUS

Public policy can drive decisions on CCS implementation, which was the case a few years ago with the Clean Power Plan (CPP) under the Obama Administration. The CPP goals would require states, including Kansas, to implement aggressive programs to reduce carbon emissions from power plants; CCS would be a method to achieve the federally mandated reductions. Under the Trump Administration, the CPP is proposed to be repealed. Economics, aside from public policy, also play a large role. The cost of capturing CO_2 and then transporting it in pipelines to fields where it can be used for EOR or to geologic reservoirs for permanent storage is expensive. Economies of scale are important to consider when determining the amount of pipeline needed to link various sources of CO_2 with storage locations (fig. 2).

The source of CO_2 is another economic consideration for EOR. Coal-powered electrical plants are major emitters, but the CO_2 they produce contains a lot of impurities that must be taken out for the CO_2 to be effective in mixing with the remaining crude oil, enabling its extraction. Ethanol plants produce high purity CO_2, making it a less expensive choice for EOR use.

Recent changes in federal tax credits that make the economics of commercial-scale CCUS more feasible has provided momentum for CCS and CCUS research and implementation.

The FUTURE Act and 45Q CCS Tax Credit

The 2018 federal budget bill expanded and increased a carbon tax credit called 45Q, part of the FUTURE Act legislation of 2017. This legislation received broad bipartisan support, including from Kansas Governor Jeff Colyer.

Key reforms in the bill:

- A 10-year ramp up from $10 to $35 per ton of tax credit for CO_2 stored geologically through EOR.
- A 10-year ramp up from $20 to $50 per ton for CO_2 stored geologically not through EOR.
- The tax credit is adjusted to increase with inflation after 2026.
- The tax credit can be claimed for 12 years.

Legal and Regulatory Issues

Issues that need clarification before a CCS program is operational in Kansas include the following:

- Pore space ownership; judicial precedent indicates it likely resides with the owner of the surface estate.
- Aggregation of pore space to acquire sufficient space for CO_2 storage.
- Right of way for pipelines.
- CO_2 ownership through each step of capture, transportation, and storage.
- Post-closure, long-term ownership; North Dakota proposes transferring ownership from a private entity to the state after a post-closure storage site is determined stable.
- Underground Injection Control Well Class VI permitting and monitoring process.

Years of technical studies, legal and regulatory clarifications, and outreach for public acceptance will be required before CCS is an actuality in Kansas. The state is in a good position, though, to benefit economically and environmentally from CCUS.

STOP 12

The Chase-Riat Black Walnut Plantation and Black Walnut Trees in Kansas

Among its responsibilities, the Kansas Forest Service provides professional forestry advice to farmers and ranchers about managing their woodlands for wildlife, water quality, timber products, and other objectives. The Chase-Riat black walnut plantation in Dickinson County is a prime example of how landowners capitalize on Kansas Forest Service resources to manage their timber and increase the value of their overall farming operations.

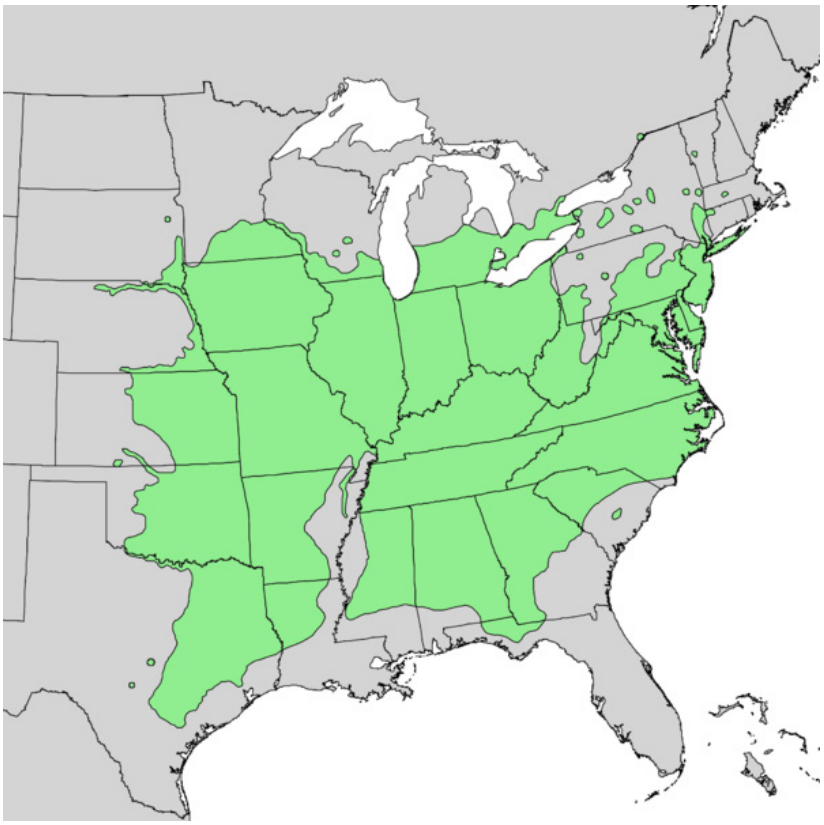
KEY FACTS

- About 7% of Kansas is classified as woodlands.
- Black walnuts have the highest commercial value of all Kansas trees.
- Black walnut wood is used for fine furniture, veneers, gunstocks, and more.
- Most of the Chase-Riat trees were planted in 1974 to supplement native ones.
- Black walnut trees take up to 80 years to mature.

The Chase-Riat Black Walnut Plantation

Most of the black walnut trees in the 17-acre Chase-Riat plantation were planted in 1974 to supplement black walnut trees growing naturally along a creek. Since the 1970s, poorer quality trees have been thinned out to make more room for the healthy trees and ensure maximum productivity. Following a Forest Stewardship management plan prepared by the Kansas Forest Service, the plantation's manager has implemented periodic thinning, pruning, and weed and grass control.

Chase-Riat black walnut plantation. Photo: Bob Atchison



Natural range of black walnuts (Juglans nigra). *Source: USGS Geosciences and Environmental Change Science Center, after a drawing in* Atlas of United States Trees *by Elbert L. Little, Jr.*

The plantation is owned by John Chase—who also owns a grain, feed, and hay transport business—and his sister, Mary Haun. Larry Riat, former Dickinson County agriculture and natural resources extension agent, manages the plantation. He and his daughter, Robin Riat, have a 99-year lease agreement that includes a share of the profits as the trees are sold.

Black Walnut Trees in Kansas

Of the estimated 840 million live trees in Kansas (measuring one inch or more in diameter), about 23.6 million are black walnut. (In comparison, there are 114.5 million hackberry trees and 9.5 million eastern cottonwoods). Although less than 3% of trees in Kansas are black walnuts, they rank first in terms of overall commercial value.

Black walnut wood—straight grained, strong, heavy, and resistant to decay—is used for fine furniture, veneers, interior finishings, and carvings. The most common commercial use of black walnut wood from Kansas is as gunstocks. The large husk-covered nuts, which ripen in September or October, are a food source for people and wildlife, and their shells can be used as abrasives.

Native to the eastern half of Kansas, black walnut trees grow about two to three feet per year and reach heights of 70 to 90 feet with spreads of 30 to 40 feet. The black walnut, which has adapted statewide, grows best in deep, fertile soils in bottomlands not subject to prolonged flooding. Trees growing on uplands away from streams do not generally grow to a size adequate for timber production but can provide wildlife habitat.

Black walnuts.

Walnut plantations are a long-term investment. Because the wood of a black walnut tree may not be at its prime for as much as 80 years, planting costs are most often borne by one generation while the income from wood sales is earned by another. Financial incentives to help cover initial costs are often available through government programs.

Kansas Woodlands

All wooded areas in Kansas combined cover about 3.8 million acres, or about 7% of the state. Varying in size, these areas include naturally occurring and planted stands. About 2.5 million of the acres are classified as forestland, which is defined as an area of at least one acre that is 120 feet or more in width and has at least a 10% live-tree canopy cover. The other 1.3 million acres are windbreaks, riparian forests along river banks, and smaller woodlands.

About 95% of Kansas forestland is classified as timberland, defined as an area that produces or is capable of producing more than 20 cubic feet of industrial wood per acre per year and that is not withdrawn from use by statute or regulation. Oak/hickory and elm/ash/cottonwood hardwood forests are the

Chase-Riat black walnut plantation. Photo: Bob Atchison

most common timberlands in Kansas. Less than 5% of the total timberlands in the state are dominated by softwood trees, almost exclusively eastern red cedar.

In Kansas, 95% of land with tree cover is privately owned, and most of that is incorporated into farms. The rest is mainly owned and managed by the Kansas Department of Wildlife, Parks and Tourism, the U.S. Department of Defense, and the U.S. Army Corps of Engineers.

The Kansas Forest Service

Kansas Forest Service programs provide support for fighting wildfires, educate the public, and help landowners manage the state's riparian forests. Well-maintained riparian forests improve water quality, stabilize streambanks, provide wildlife habitat, enhance recreational use, and can be a source of income for landowners.

Kansas wildfires have become more frequent and severe in recent years, with the two largest wildfires in the last 50 years occurring in 2016 and 2017. The Kansas Forest Service—one of three state entities with wildfire suppression responsibilities—provides firefighting equipment and staff support to state emergency operations and local officials. In 2018, the Legislative Division of Post Audit, after a requested audit, recommended that the Kansas Legislature designate a single state entity and increased funding to make the state's response more effective.

Sources and Contacts

STOP 1: MILFORD LAKE'S VALUE

Kansas Water Office, 2017, Public water supply program comprehensive capital development plan: https://bit.ly/2NSvAgz.

Kansas Water Office, 2017, Surplus water available in Water Marketing Program lakes calendar year 2018: https://bit.ly/2mWsD36.

National Recreation Lakes Study Commission, 1999, Reservoirs of opportunity, final report of the National Recreation Lakes Study: Washington, D.C., National Recreation Lakes Study Commission.

Outdoor Industry Association, 2017, Kansas: https://outdoorindustry.org/state/kansas/.

Platt, J., 2001, Reservoir recreation use estimation modeling with water level fluctuation: U.S. Department of Interior, Bureau of Reclamation, Technical Memorandum No. EC-2001-02, https://www.usbr.gov/tsc/techreferences/economics/WLpaper.pdf.

Mike Harris
Owner, Acorns Resort
Acornsresort@acorns.com
785-210-5567

Michele Stimatze
Director, Geary County Convention and Visitors Bureau
michele.stimatze@gearycounty.org
785-238-2885

Nathan Westrup
Kansas Water Office
nathan.westrup@kwo.ks.gov
785-296-0689

STOP 2: HARMFUL ALGAL BLOOMS IN KANSAS

Great Lakes HABs Collaboratory, 2017, Linking science and management to reduce harmful algal blooms, https://www.glc.org/wp-content/uploads/HABS-Role-of-Nitrogen-20170912.pdf.

Harris, T., 2018, HAB Research Coordination Group, General information and historical timeline of activities: Navigating a Kansas Water Future: A Research and Collaboration-Networking Event, University of Kansas, Lawrence, Kansas.

Kansas Water Office, 2018, Milford Lake Regional Conservation Partnership Program. https://kwo.ks.gov/projects/milford-rcpp.

Sontheimer, W., 2018, 2017 Kansas HAB summary statistics: Multi-Agency HAB Symposium, Kansas Department of Health and Environment, Topeka, Kansas. http://www.kdheks.gov/algae-illness/HAB_Symposiums.htm.

Stahl, T., and Stiles, T., 2018, Management strategies to control algal bloom biomass for Milford Lake: Multi-Agency HAB Symposium, Kansas Department of Health and Environment, Topeka, Kansas. http://www.kdheks.gov/algae-illness/HAB_Symposiums.htm.

Young, B. C., Zheng, Z. C., and Liu, H., 2018, Modeling cyanobacteria movement in Milford Lake, Part II: Multi-Agency HAB Symposium, Kansas Department of Health and Environment, Topeka, Kansas. http://www.kdheks.gov/algae-illness/HAB_Symposiums.htm.

Marvin Boyer
Lake Water Quality Program Coordinator
U.S. Army Corps of Engineers, Kansas City District
816-520-5425
marvin.g.boyer@usace.army.mil

R. Trevor Flynn
Chief, Bureau of Water, Watershed Planning, Monitoring and Assessment Section
Kansas Department of Health and Environment
785-296-8791
trevor.flynn@ks.gov

Ted Harris
Assistant Research Professor
Kansas Biological Survey
785-864-4258
ted.daniel.harris@gmail.com

STOP 3: KANSAS CLAY AND THE BRICK INDUSTRY

Shawn Kling
Cloud Ceramics
785-614-1338
shawnk@cloudceramics.com

Ludvigson, G. A., Witzke, B. J., Joeckel, R. M., Ravn, R. L., Phillips, P. L., Gonzalez, L. A., and Brenner, R. L., 2010, New insights on the sequence stratigraphic architecture of the Dakota Formation in Kansas-Nebraska-Iowa from a decade of sponsored research activity; in, Current Research in Earth Sciences: Kansas Geological Survey, Bulletin 258, part 2. http://www.kgs.ku.edu/Current/2010/Ludvigson/00_summary.html.

Mafarlane, P. A., 1996, Dakota Aquifer Program, Kansas Geological Survey http://www.kgs.ku.edu/Dakota/vol1/intro/extent.htm

Plummer, N., Swineford, A., Runnels, R. T., and Schleicher, J. A., 1954, Chemical, petrographic, and ceramic properties of four clays from the Dakota Formation in Kansas: Kansas Geological Survey, Bulletin 109, Part 10. http://www.kgs.ku.edu/Publications/Bulletins/109_10/index.html.

STOP 4: ETHANOL AND A NEW BIOFUEL AT NESIKA ENERGY

Lisa Strnad
CFO, Nesika Energy
785-335-2054
lstrnad@nesikaenergy.com

David Wood
COO, Nesika Energy
785-335-2054
dwood@nesikaenergy.com

Biofuels Digest, 2017, Butamax is back on the radar and Kansas is the place as BP/DuPont JV heads for commercial-scale biobutanol: http://www.biofuelsdigest.com/bdigest/2017/04/03/butamaxs-back-on-the-radar-and-kansas-is-the-place/.

EPA, 2017, EPA finalizes RFS volumes for 2018 and biomass based diesel volumes for 2019, https://www.epa.gov/newsreleases/epa-finalizes-rfs-volumes-2018-and-biomass-based-diesel-volumes-2019.

Farm Futures, 2017, Butamax acquires Nesika Energy, April 4, 2017, http://www.farmfutures.com/energy/butamax-acquires-nesika-energy.

McGinnis, M., 2018, Is the goal to end ethanol's RFS?: Successful Farming; https://www.agriculture.com/news/business/is-the-goal-to-end-ethanols-rfs.

Renewable Fuels Association, http://www.ethanolrfa.org/consumers/. Access June 13, 2018.

STOP 5: THE LOWER REPUBLICAN RIVER BASIN: COMPACT CHANGES FOR IMPROVED WATER MANAGEMENT

Republican River Compact Administration, 2006, Forty-fifth annual report for the year 2005. http://www.republicanrivercompact.org/reports/RRCA_2005.pdf.

Republican River Compact Administration, 2016, Resolution approving long-term agreements related to the operation of Harlan County Lake for compact call years. https://bit.ly/2OvXtfh.

Republican River Compact Administration, 2017, Accounting procedures and reporting requirements. https://bit.ly/2Apfl31.

Tjelmeland, K., 2018, Lower Republican basin access district information sheet: Kansas River Advisory Committee, Kansas Water Office.

David Barfield
Chief Engineer, Kansas Department of Agriculture, Division of Water Resources
david.barfield@ks.gov

Jared "Pete" Gile
Superintendent, Kansas Bostwick Irrigation District
785-374-4514

Earl Lewis, P.E.
Assistant Director
Kansas Water Office
785-296-0867
earl.lewis@ks.gov

STOP 5: MAMMOTH FOSSILS AT LOVEWELL RESERVOIR

Holen, S. R., 2006, The age and taphonomy of mammoths of Lovewell Reservoir, Jewell County, Kansas, USA: Quaternary International, v. 142–43, p. 30–43.

Kansas Department of Wildlife, Parks and Tourism, 2018, Lovewell Reservoir: https://ksoutdoors.com/KDWPT-Info/Locations/Wildlife-Areas/Northwest/Lovewell.

Osborn, H. F., 1942, Proboscidea: A monograph of the discovery, evolution, migration and extinction of the mastodonts and elephants of the world, New York: J. Pierpont Morgan Fund, https://commons.wikimedia.org/wiki/File:Columbian_mammoth.jpg.

Rolfe Mandel
Director
Kansas Geological Survey
785-864-2171
mandel@kgs.ku.edu

STOP 6: KITKAHAHKI (REPUBLICAN) PAWNEE VILLAGE EXCAVATION AND MUSEUM

Adair, M., 2018, Pawnee research project: Biodiversity Institute & Natural History Museum, University of Kansas, https://biodiversity.ku.edu/archaeology/research/pawnee.

Adair, M. J., and Hofman, J. L., 2014, Pawnee archaeology: 2011-2014 investigations of the late eighteenth century Kansas Monument site (14RP1), preliminary report for the Kansas Historical Society.

Adair, M. J., Roper, D. C., and Hofman, J. L., 2007, Kitkahahki archaeology—Investigations at the Pawnee Indian village, 14RP1: Current Archaeology in Kansas, no. 7, p. 40–52, http://www.ksarchaeo.info/documents/CAK2007.pdf.

Biodiversity Institute and Natural History Museum, 2018, Pawnee research project: University of Kansas, https://biodiversity.ku.edu/archaeology/research/pawnee.

Kansas Historical Society, 2010, Pawnees: Kansapedia, https://www.kshs.org/kansapedia/pawnees/15611.

Parks, D. R., 2018, Pawnee (tribe), in The Encyclopedia of Oklahoma History and Culture: Oklahoma Historical Society, http://www.okhistory.org.

Price, J. C., (1900) 2013, The Republican Pawnee Indian Village. With introduction and archaeological and historical commentary by Donna C. Roper. Price's original handwritten manuscript: http://www.kansasmemory.org/item/219582.

Wedel, W. R., and Parks, D. R., 1985, Pawnee geography—historical and sacred: Great Plains Quarterly, v. 5, no. 3, p. 143–176, https://digitalcommons.unl.edu/greatplainsquarterly/1853.

Jack Hofman
Associate Professor
of Anthropology
University of Kansas
785-864-2634
hofman@ku.edu

Mary Adair
Curator
Archaeological Research Center
University of Kansas
madair@ku.edu

Richard Gould
Site Administrator (retired)
Pawnee Indian Museum State Historic Site
785-262-1561
rp.dodge1@gmail.com

STEP 7: JAMESTOWN WILDLIFE AREA RESTORATION PUBLIC-PRIVATE PARTNERSHIP

Ducks Unlimited, http:/ducks.org

Kansas Wildlife, Parks and Tourism, 2018, Jamestown Wildlife Area: https://ksoutdoors.com/KDWPT-Info/Locations/Wildlife-Areas/Northwest/Jamestown

Personal communication with Rob Unruh, Wildlife Area Biologist, Kansas Department of Wildlife, Parks and Tourism.

U.S. Fish and Wildlife Service, 2013, Division of Bird Habitat Conservation. https://www.fws.gov/birdhabitat/grants/NAWCA/Standard/US/Kansas_Std.shtm.

Rob Unruh
Wildlife Area Biologist
Brzon, Griswold, Jamestown, Lovewell and Talmo Wildlife Areas
Kansas Department of Wildlife, Parks and Tourism
785-753-4971
rob.unruh@ks.gov

STOP 8: GEOPROBE® SYSTEMS: SUBSURFACE EXPLORATION TOOLS AND TECHNOLOGY

Butler, J. J., Jr., Dietrich, P., Wittig, V., and Christy, T., 2007, Characterizing hydraulic conductivity with the direct-push permeameter: Ground Water, v. 45, no. 4, p. 409–419.

Geoprobe®, 2018, https://geoprobe.com.

Liu, G., Butler, J. J., Jr., Reboulet, E., and Knobbe, S., 2012, Hydraulic conductivity profiling with direct push methods: Grundwasser, v. 17, p. 19–29.

Liu, G., Knobbe, S., Reboulet, E. C., Whittemore, D. O., Händel, F., and Butler, J. J., Jr., 2016, Field investigation of a new recharge approach for ASR projects in near-surface aquifers: Ground Water, v. 54, no. 3, p. 425–433.

Tom Christy
Vice President
Geoprobe Systems
785-825-1842
christyt@geoprobe.com

STOP 9: THE LAND INSTITUTE AND ALTERNATIVE AGRICULTURE

Canine, C., 2005, 35 who made a difference—Wes Jackson: Smithsonian, v. 36, no. 8, p. 81–82, https://www.smithsonianmag.com/science-nature/35-who-made-a-difference-wes-jackson-114333178/.

Glover, J. D., Cox, C. M., and Reganold, J. P., 2007, Future farming: A return to roots?:
Scientific American, v. 297, no. 2, p. 82–89, https://landinstitute.org/wp-content/uploads/2007/08/Glover-et-al-2007-Sci-Am.pdf.

Ostrander, M., 2017, The grain that tastes like wheat, but grows like a prairie grass: The Nation, October 30, 2017, https://www.thenation.com/article/the-grain-that-tastes-like-wheat-but-grows-like-a-prairie-grass/.

The Land Institute, 2018, https://landinstitute.org/.

Tim Crews
Director of Research
The Land Institute
785-823-5376
crews@landinstitute.org

Fred Iutzi
President, The Land Institute
785-823-5376
iutzi@landinstitute.org

STOP 10: REVITALIZING THE SMOKY HILL RIVER IN SALINA

City of Salina, 2018, Smoky Hill River Renewal Project (including master plan. http://www.salina-ks.gov/riverrenewal.

Friends of the River Foundation, 2018,
http://www.smokyhillriver.org/.

Greater Salina Community Foundation, 2018, Friends of the River Foundation. http://gscf.org/friends-of-the-river-foundation/.

Tasker, Martha, 2016, Smoky Hill River Restoration and other Kansas drought planning measures: American Water Resources Association, v. 18, no. 2, p. 16–18. https://bit.ly/2Oszi1r.

Jane Anderson
Executive Director
Friends of the River Foundation
785-493-8491
janea@smokyhillriver.org

Martha Tasker
Director of Utilities
City of Salina
785-309-5725
martha.tasker@salina.org

STOP 11: CARBON CAPTURE AND STORAGE: THE POTENTIAL FOR KANSAS

Martin Dubois
Improved Hydrocarbon Recovery, LLC
mdubois@ihr-llc.com

Yevhen "Eugene" Holubnyak
Kansas Geological Survey
785-864-2070
eugene@kgs.ku.edu

Susan Stover
Kansas Geological Survey
785-864-2063
sstover@kgs.ku.edu

Carbon Capture Coalition, 2018, U.S. budget bill includes landmark carbon capture tax credit to benefit economy, jobs and the environment, https://bit.ly/2KavRsK.

Christensen, J., 2018, Before & after: How the FUTURE Act reformed the 45Q carbon capture and storage tax credit: Great Plains Institute, http://www.betterenergy.org/blog/future-act-reformed-45q-carbon-capture-storage-tax-credit/.

Dubois, M., 2017, Overview on integrated CCS for Kansas and other DOE-funded projects: Carbon Capture, Utilization and Storage in Kansas Forum, September 21, 2017, Wichita Kansas.

Great Plains Institute, 2017, Capturing and utilizing CO2 from ethanol: Adding economic value and jobs to rural economies and communities while reducing emissions: State CO2-EOR Deployment Work Group white paper. http://www.betterenergy.org/wp-content/uploads/2017/12/Capturing-and-Utilizing-CO2-from-Ethanol.pdf.

Lawton, D., 2010, Carbon capture and storage: Opportunities and challenges for geophysics: Recorder, Canadian Society of Exploration Geophysicists, v. 35, no. 6. https://csegrecorder.com/articles/view/carbon-capture-and-storage-opportunities-and-challenges-for-geophysics.

U.S Department of Energy, 2017, Carbon capture, utilization, and storage: Climate change, economic competitiveness and energy security. https://bit.ly/2KedALc.

STOP 12: THE CHASE-RIAT BLACK WALNUT PLANTATION AND BLACK WALNUT TREES IN KANSAS

Bob Atchison
Rural Forestry Coordinator
Kansas Forest Service
785-532-3310
atchison@ksu.edu

Atchison, B., and Rhodes, T., personal communication

Atchison, R. L., 2005, Planting black walnut: Kansas State University Agricultural Experiment Station and Cooperative Extension Service, 4 p., https://www.bookstore.ksre.ksu.edu/pubs/L731.pdf.

Kansas Forest Service, 2018, Black walnut: http://www.kansasforests.org/conservation_trees/products/deciduous/blackwalnut.html.

Kansas Forest Service, 2018, Forests of Kansas: http://www.kansasforests.org/kansas_forest_services/forestsinkansas.html.

Legislative Division of Post Audit, 2018, Kansas wildfire management—Evaluating the adequacy of Kansas' wildfire suppression system: State of Kansas, http://www.kslpa.org/media/files/reports/r-18-007.pdf.

Meneguzzo, D. M., 2017, Forests of Kansas, 2016: Resource Update FS-84, Newtown Square, Pennsylvania, U. S. Department of Agriculture, Forest Service, Northern Research Station, 5 p., https://www.nrs.fs.fed.us/pubs/55297.

Moser, W. K., Hansen, M. H., Atchison, R. L., Butler, B. J., Crocker, S. J., Domke, G., Kurtz, C. M., Lister, A., Miles, P. D., Nelson, M. D., Piva, R. J., and Woodall, C. W., 2013, Kansas' forests 2010: Resource Bulletin NRS-85, Newtown Square, Pennsylvania, U.S. Department of Agriculture, Forest Service, Northern Research Station, 63 p., https://www.fs.fed.us/nrs/pubs/rb/rb_nrs85.pdf.