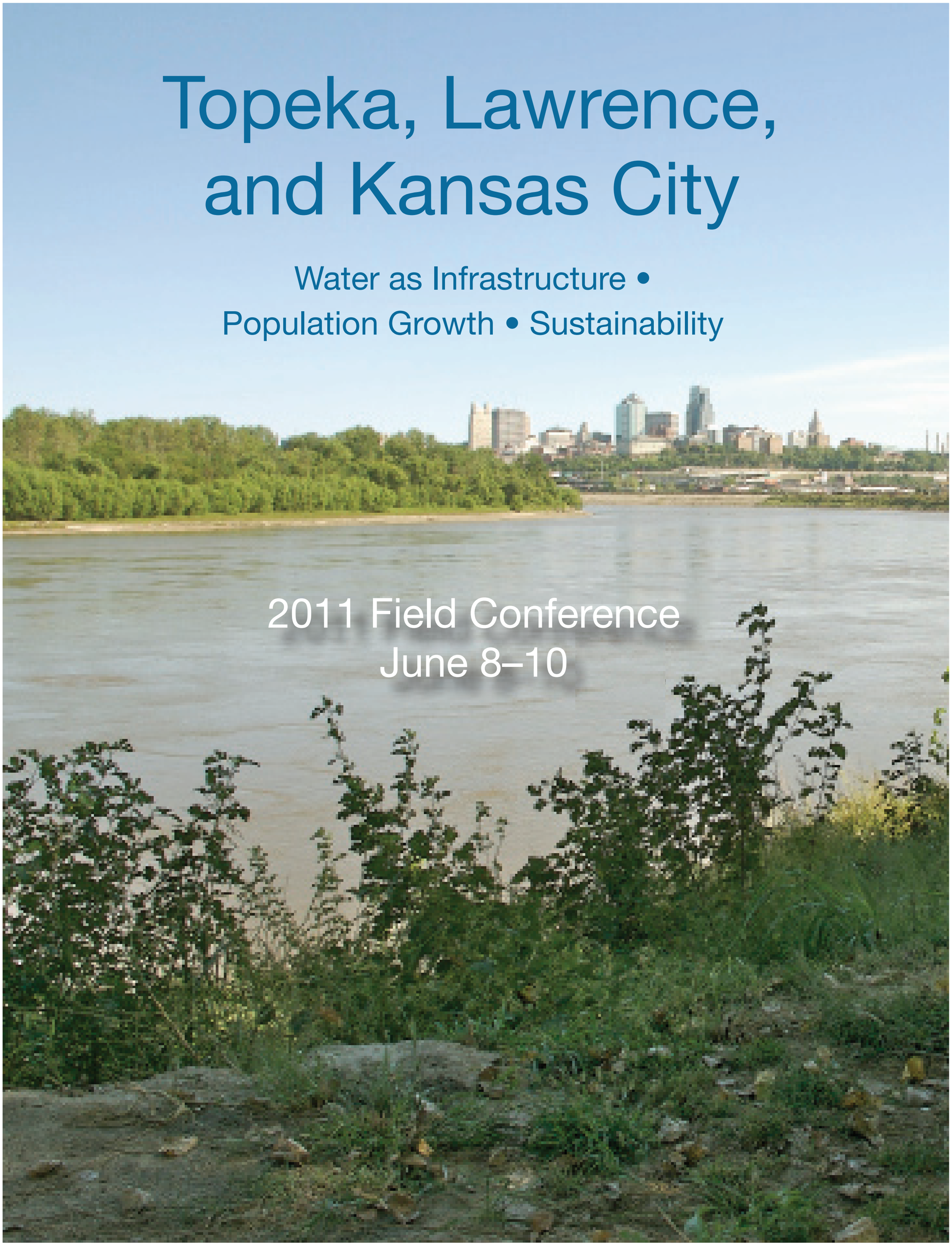
Kansas Field Conference

Topeka, Lawrence, and Kansas City

Water as Infrastructure • Population Growth • Sustainability



2011 Field Conference
June 8–10

Kansas Geological Survey
Kansas Water Office • Kansas Department of Transportation
Kansas Department of Wildlife and Parks

2011 Kansas Field Conference

June 8–10, 2011

Topeka, Lawrence, and Kansas City

Water as Infrastructure • Population Growth • Sustainability

Field Guide

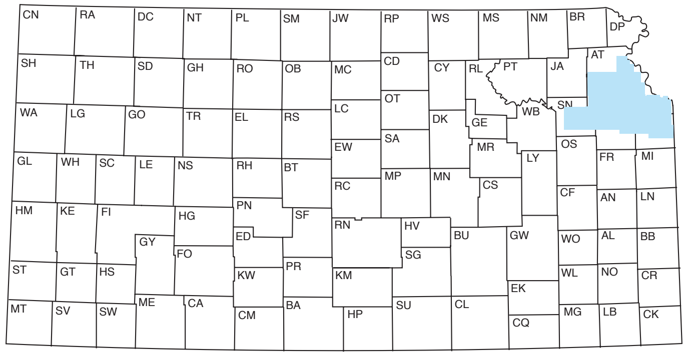
Edited by

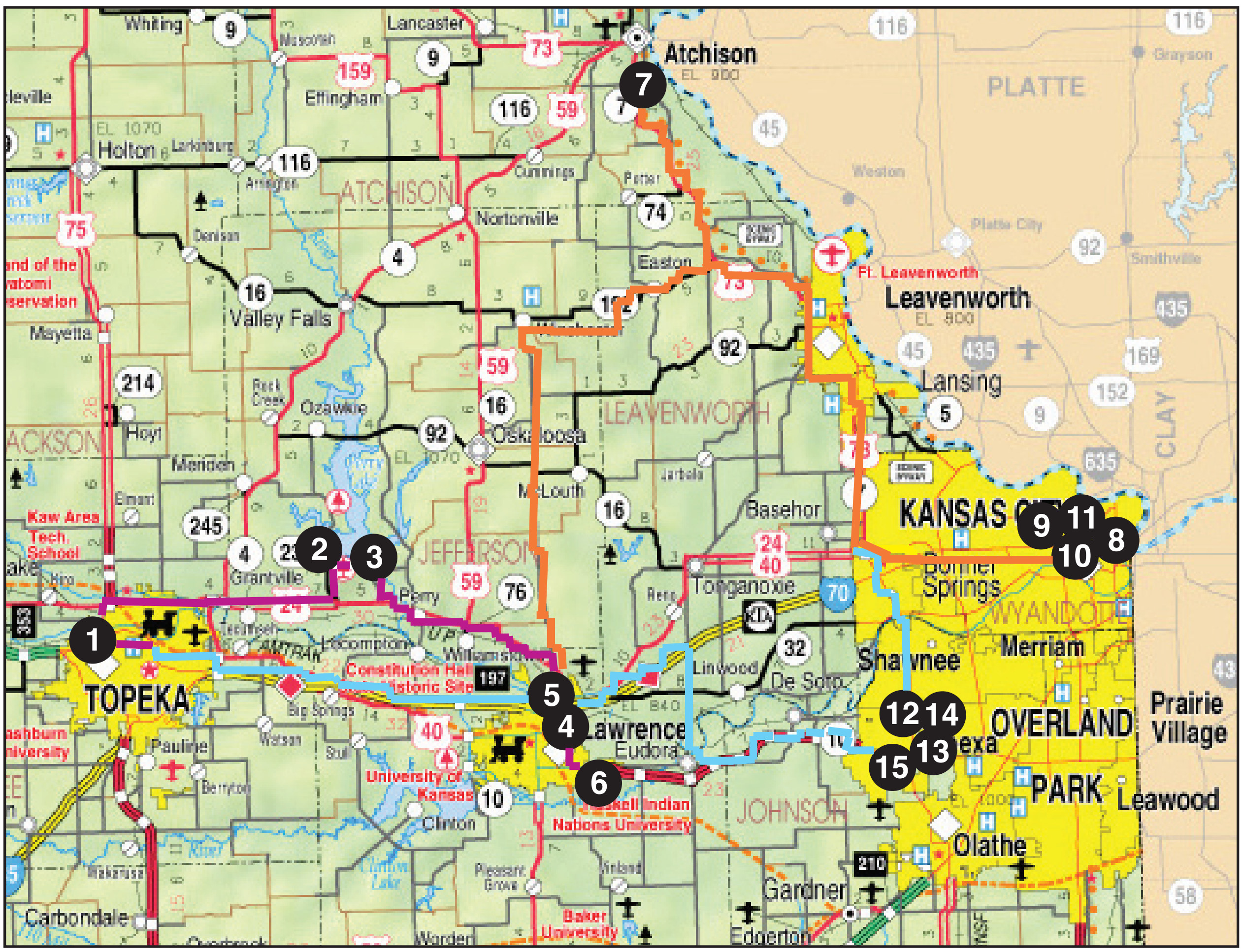
Shane A. Lyle
Catherine S. Evans
Rex C. Buchanan
Robert S. Sawin

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 and Parks

KGS Open-file
Report 2011–8

Kansas Geological Survey
Geology Extension
The University of Kansas
1930 Constant Avenue
Lawrence, KS 66047–3724
Telephone: 785–864–3965
www.kgs.ku.edu





Wednesday, June 8
Stops 1 – 6

Thursday, June 9
Stops 7 – 11

Friday, June 10
Stops 12 – 15

2011 Field Conference

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Acknowledgments

Thanks to Cathy Evans for preparation of the field conference brochure and to Marla Adkins–Heljeson for editing and preparation of this field guide.

Kansas Field Conference

Topeka, Lawrence, and Kansas City

Water as Infrastructure • Population Growth • Sustainability

June 8–10, 2011

PARTICIPANTS

Steve Adams, Natural Resource Coordinator, Kansas Department of Wildlife and Parks
David Barfield, Chief Engineer, Division of Water Resources, Kansas Department of Agriculture
Larry Biles, State Forester, Kansas Forest Service
Elaine Bowers, Representative, Concordia
Scott Carlson, Assistant Director, State Conservation Commission
Pete DeGraaf, Representative, Mulvane
Lon Frahm, Member, Kansas Water Authority
Marci Francisco, Senator, Lawrence
Stan Frownfelter, Representative, Kansas City
Raney Gilliland, Assistant Director for Research, Kansas Legislative Research Department
Bob Grant, Representative, Cherokee
Burke Griggs, Legal Counsel, Division of Water Resources, Kansas Department of Agriculture
John J. Grothaus, Chief, Planning Section, U.S. Army Corps of Engineers
Gary Harshberger, Chair, Kansas Water Authority
Dave Heinemann, Chair, Kansas Geological Survey Advisory Council (GSAC)
Bob Henthorne, Chief Geologist, Kansas Department of Transportation
Joe Heppert, Associate Vice Chancellor, Research and Graduate Studies, University of Kansas
Robin Jennison, Secretary, Kansas Department of Wildlife and Parks
Forrest Knox, Representative, Altoona
Annie Kuether, Representative, Topeka
Tamera Lawrence, Assistant Revisor of Statutes, Kansas Office of the Revisor of Statutes
Wayne Lebsack, President, Lebsack Oil Production, Inc.
Janis Lee, Chief Hearing Officer, Court of Tax Appeals
Earnie Lehman, President and General Manager, Midwest Energy, Inc.
Earl Lewis, Assistant Director, Kansas Water Office
Judith Loganbill, Representative, Wichita
Brad Loveless, Director, Biology and Conservation Programs, Westar Energy
Ed Martinko, Director, Kansas Biological Survey
Karma Mason, President, iSi Environmental Services
Peggy Mast, Representative, Emporia
Ray Merrick, Senator, Stilwell
Heather O'Hara, Principal Analyst, Kansas Legislative Research Department
Ralph Ostmeyer, Senator, Grinnell
Catherine Patrick, Director, Division of Operations, Kansas Department of Transportation
Don Paxson, Vice Chairman, Kansas Water Authority
Dale Rodman, Secretary, Kansas Department of Agriculture
Dennis Schwartz, General Manager, Kansas Rural Water District 8
Matt Sterling, Assistant Revisor of Statutes, Kansas Office of the Revisor of Statutes
Tracy Streeter, Director, Kansas Water Office
John Strickler, Trustee, The Nature Conservancy, Kansas Chapter
Josh Svaty, Senior Adviser to the Regional Administrator, EPA Region 7
Vern Swanson, Representative, Clay Center
Ruth Teichman, Senator, Stafford
Annie Tietze, Representative, Topeka
Brian Vulgamore, Member, Kansas Geological Survey Advisory Council (GSAC)
Vincent Wetta, Representative, Wellington

KANSAS GEOLOGICAL SURVEY STAFF

Shane Lyle
Rex Buchanan
Bob Sawin
Cathy Evans

Biographical Information

Steve Adams
Natural Resource Coordinator
Kansas Department of Wildlife and Parks
1020 S. Kansas Avenue
Topeka KS 66612
785–296–2281
steve.adams@ksoutdoors.com
Responsibilities and Experience
KDWP, 1989–present
Previous: Fisheries biologist, Florida Game and Freshwater Fish Commission, 1986–89
Northeastern State University – BS, 1980
Oklahoma State University – MS, 1983

David Barfield
Chief Engineer
Division of Water Resources, Kansas Department of Agriculture
109 SW 9th Street
Topeka KS 66612
785–296–3710
david.barfield@kda.ks.gov
Responsibilities and Experience
2007–present: Chief Engineer—directs Division of Water Resources staff over state's water resources, including four interstate compacts, more than 32,000 active water rights, and the safety of thousands of dams and other water structures. Appointed by Governor to Western States Water Council, State Conservation Commission, and Missouri River Recovery Implementation Committee
Previous: 1992–2007: DWR, Interstate Water Issues Technical Team Leader; 1987–1992: DWR, Head of Dam Safety Unit; 1984–1987: DWR, Tech Services Engineer; 1981–1984: Regional Engineer, Republic of Bophuthatswana, Dept. of Works and Water Affairs
University of Kansas – Civil Engineering, BS, 1978
University of Kansas – Water Resources Engineering, MS, 1991

Larry Biles
State Forester
Kansas Forest Service
2610 Claflin Road
Manhattan KS 66502
785–532–3309
lbiles@ksu.edu
Responsibilities and Experience
Previous: USDA–Community Forestry and Multiple Use Forestry Specialist, Atlanta, GA; USDA–Extension Service Program Leader, Washington, D.C.
University of Missouri – Forestry, 1967
Kansas State University – Ornamental Horticulture, 1974

Elaine Bowers
Representative, 107th District
1326 N. 150th Road
Concordia KS 66901
785–243–4256
elaine@concordiaautomart.com
Responsibilities and Experience
Agriculture and Natural Resources, Taxation, and Federal and State Affairs committees
Cloud County Community College – Travel/tourism business, 1983

Scott Carlson
Assistant Director
State Conservation Commission
109 SW 9th Street, Suite 500
Topeka KS 66612
785–296–6803
scott.carlson@scc.ks.gov
Responsibilities and Experience
Assistant Director; Mixed Land Reclamation Program Manager
Fort Hays State University – BS, 1979
University of Kansas – MPA, 2001

Pete DeGraaf
Kansas House of Representatives, 81st District
1545 E 119th Street
Mulvane KS 67110
316–777–1414
petedegraaf@att.net
Responsibilities and Experience
Appropriations Committee; Counselor and President, financial counseling ministry
Previous: Flew helicopters for U.S. Air Force
United State Air Force Academy – BS, Behavioral Science, 1979

Lon Frahm
Farmer and Kansas Water Authority member
375 S. Range Avenue
Colby KS 67701
785–460–6719
lfrahm@st-tel.net

Responsibilities and Experience
Own and manage 20,000 acre irrigated and dryland cash grain production farm in Thomas County
Previous: KGS Advisory Council; board chairman, Midwest Energy; GMD #4; Kansas Arts Commission
Kansas State University – BS, 1980
Kansas State University – MAB, 2002

Marci Francisco
Senator, 2nd District
1101 Ohio Street
Lawrence KS 66044
785–842–6402
maf@sunflower.com
Responsibilities and Experience
Agriculture, Natural Resources, Utilities, and Ways and Means committees; staff member of the KU Center for Sustainability
Previous: Former mayor of Lawrence
University of Kansas – B.E.D., 1973
University of Kansas – B.Arch, 1977

Stan Frownfelter
Kansas House of Representatives, 31st District
4527 Gibbs Road
Kansas City KS 66106
913–342–4030
stanfrownfelter@yahoo.com
Responsibilities and Experience
Energy and Utilities committees
Emporia State University – Business, 1976

Raney Gilliland
Assistant Director for Research, Kansas Legislative Research Department
300 SW 6th Street, Rm. 68–W
Topeka KS 66612
785–273–3181
raney.gilliland@klrd.ks.gov
Responsibilities and Experience
Kansas Legislative Research Department – 33 sessions; Staff, Agriculture and Natural Resources; Commerce and Economic Development; Administrative Rules and Regulations
Kansas State University – BS, 1975
Kansas State University – MS, 1978

Bob Grant
Kansas House of Representatives, 2nd District
407 W. Magnolia Street
Cherokee KS 66724
620–457–8496
grantbnl@ckt.net
Responsibilities and Experience
State Representative, 18 years; Agriculture and Natural Resources committees
Previous: 1967–1992, Kansas Army Ammunition Plant; Catering business, bar and grill owner, 1985–2005
Southeast High School – 1966
Labette Community College – AA, 1971
Pittsburg State University

Burke Griggs
Legal Counsel
Division of Water Resources, Kansas Department of Agriculture
109 SW 9th Street, 4th Floor
Topeka KS 66612
785–296–4616
burke.griggs@kda.ks.gov
Responsibilities and Experience
Represents DWR and Kansas in interstate water litigation and interstate river compacts; represents DWR in state court; advises KDA and DWR on water policy and legislation
Previous: Assistant Professor of history, Boston College, 1997–2003; Attorney, Stevens and Brand, LLP, Lawrence, 2006–08
Stanford University – BA, 1990
Yale University – PhD, 1998
University of Kansas Law School – JD, 2006

John J. Grothaus
Chief, Planning Section
U.S. Army Corps of Engineers
Bolling Federal Building
601 E. 12th Street, Rm 538
Kansas City MO 64106
816–389–3110
john.j.grothaus@usace.army.mil
Responsibilities and Experience
Chief, Planning Section, U.S. Army Corps of Engineers, Kansas City District
Colorado State University – B2, 1982
Colorado State University – MS, 1991

Gary Harshberger
Chair, Kansas Water Authority
Kansas Water Office
1302 University
Dodge City KS 67801
620–338–0888
gary@HE.kscoxmail.com

Responsibilities and Experience

Appointed by Governor Brownback to Chair the Kansas Water Authority. Operate Harshberger Enterprises, Double H Farms Inc., Harshberger Land LLC, Hatcher Holdings and Harshberger Seeds

Previous: Board member of Farm Credit of Southwest Kansas from 2001 to present; served as Chair. Serve on Board of Arkalon Energy Ethanol plant in Hayne, KS; Board of Bonanza BioEnergy Ethanol plant in Garden City, KS; chairman of Boothill Biofuels (2006–09)

Dodge City Community College – AA, 1984
Kansas State University – BS, 1987

Dave Heinemann

Chair, 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 Cancer Society, Stand Up For Kansas, High Plains Public Radio, and Smoky Hills Public Television

Previous: Special Assistant to the Secretary of Revenue, 5 years; Executive Director, KCC, 2 years; General Counsel, KCC, 2 years; State Representative, 27 years; Speaker Pro Tem, Kansas House Commission, 11 years

Augustana College – BA, 1967
University of Kansas – 1967–68
Washburn Law School – JD, 1973

Bob Henthorne

Chief Geologist
Kansas Department of Transportation
2300 Van Buren Street
Topeka KS 66611
785–291–3860
roberth@ksdot.org

Responsibilities and Experience

Head KDOT engineering geology section; 29 years at KDOT, starting from inspector

Marysville (KS) High School
University of Kansas – BS, 1983

Joseph A. Heppert

Associate Vice Chancellor, Research and Graduate Studies, University of Kansas
2901 Oxford Road
Lawrence KS 66049
785–864–8235
jheppert@ku.edu

Responsibilities and Experience

Associate Vice Chancellor for Research and Graduate Studies, 9/10 – present; sharing oversight for Research Administration, strategic planning and other responsibilities; specific oversight for Higuchi Bioscience Center, Information Telecommunications and Technology Center, CEBC, KGS, KBS, Animal Care Unit, and University Core laboratories. Also primary responsibility for issues related to research space and infrastructure.

Previous: Associate Vice Provost and Vice President, Research and Graduate Studies, KUCR, 9/09–9/10; Chair, KU Department of Chemistry, 7/05–9/09; Director, KU Center for Science Education, 7/00–7/09; Professor of chemistry, KU, 8/00–present; Associate Professor of chemistry, KU, 8/91–7/00

San Jose State University – BS, 1978
University of Wisconsin–Madison – PhD, 1982
Indiana University, post-doctoral, 1983–85

Robin Jennison

Secretary, Kansas Department of Wildlife and Parks
1020 S. Kansas, Rm 200
Topeka KS 66612
785–296–2281
robin.jennison@ksoutdoors.com

Responsibilities and Experience

Secretary, Kansas Department of Wildlife and Parks

Previous: Farmer–stockman, 30 years; Kansas Legislature, 10 years; outdoor radio, 4 years; lobbyist, 10 years

Fort Hays State University, animal science

Forrest Knox

Kansas House of Representatives, 13th District
17120 Udall Road
Altoona KS 66710
620–636–0051
repnox@gmail.com

Responsibilities and Experience

Vice-chair, Energy and Utilities Committee; Chair, Financial Institutions Committee; Vice-chair, NCSL Environment Committee; Joint Committee on Energy and Environment

Previous: Farmer/rancher; mechanical design engineer

Kansas State University – BSME, 1978
Technion–Israel Institute of Technology – MSME, 1989

Annie Kuether
Kansas House of Representatives, 55th District
1346 SW Wayne Avenue
Topeka KS 66604
785–296–7669
kuet@aol.com
Responsibilities and Experience
Ranking Member, Energy and Utilities Committee; Judiciary Committee
Webster Groves High School – 1970
Bowling Green State University, Ohio

Tamera Lawrence
Assistant Revisor of Statutes
Kansas Office of the Revisor of Statutes
2326 Surrey Drive
Lawrence KS 66046
785–296–5243
tamera.lawrence@rs.ks.gov
Responsibilities and Experience
Assistant Revisor of Statutes – primary revisor in the Senate Agriculture and Natural Resources committees; revisor on the House Agriculture and Natural Resources budget committee
University of Kansas – BS, 2006
University of Kansas – JD, 2010

Wayne Lebsack
President
Lebsack Oil Production, Inc.
603 S. Douglas Street
Lyons KS 67554
620–938–2396
Responsibilities and Experience
General Manager, Lebsack Oil Production, Inc.; Board Member, The Nature Conservancy, Kansas Chapter; oil and gas exploration, ground-water exploration, and pollution research
Colorado School of Mines – Geol. Eng., 1949
Colorado School of Mines – Geol. Eng. courses, 1951

Janis Lee
Chief Hearing Officer
Kansas Court of Tax Appeals
1008 SW Fleming Court #101
Topeka KS 66604
785–296–2388
jlee@ruraltel.net
Responsibilities and Experience
Chief Hearing Officer, Kansas Court of Tax Appeals
Previous: Served 23 years in Kansas Senate; served on Utilities, Ways and Means, Natural Resources, Agriculture, and Security committees; served on Kansas Electric Transmission Authority
Kansas State University – BS, Education, 1970

Earnie Lehman
President & General Manager
Midwest Energy, Inc.
P.O. Box 898
Hays KS 67601–0898
785–625–1400
elehman@mwenergy.com
Responsibilities and Experience
President and general manager of Midwest Energy, Inc., a customer-owned electric and natural gas utility serving 90,000 customers in 41 counties; vice chair, Kansas Electric Transmission Authority; chairs the Kansas Local Area I Workforce Investment Board; serves on the executive committee of the Kansas Chamber of Commerce; board member for Smoky Hills Public Television
Previous: Economist at Federal Energy Regulatory Commission in Washington, DC prior to an 18-year career with the former Kansas Gas and Electric Company in Wichita and Westar in Topeka
University of Wisconsin – BS
George Washington University – MBA

Earl Lewis
Assistant Director
Kansas Water Office
901 S. Kansas Avenue
Topeka KS 66610
785–296–0867
earl.lewis@kwo.ks.gov
Responsibilities and Experience
Oversees operations of Kansas Water Office, including coordinating planning, reservoir operations, and budget development
Previous: Seven years with DWR in water use compliance, subbasin management, and interstate water issues
University of Kansas – BS, 1992

Judith Loganbill
Kansas House of Representatives, 86th District
215 S. Erie Street
Wichita KS 67211
316–683–7382
JudithLoganbill@msn.com

Responsibilities and Experience
Member of Federal and State Affairs, ranking member of Joint House and Senate Security Committee; reading resource teacher, Wichita
Previous: Elementary teacher
Bethel College – BS, 1975
Northern Arizona University – MA Ed, 1981

Brad Loveless
Director, Biology & Conservation Programs
Westar Energy
818 S. Kansas Avenue
Topeka KS 66601
785–575–8115
brad.loveless@westarenergy.com
Responsibilities and Experience
Manages environmental siting for generation and line construction, carbon planning, endangered species, avian protection, and environmental stewardship programs; Kansas Association of Conservation and Environmental Education (KACEE) Board Member
The Ohio State University – BS, Zoology, 1981
University of Kansas – MS, Biology, 1985

Ed Martinko
Director
Kansas Biological Survey
Higuchi Hall
2101 Constant Avenue
University of Kansas
Lawrence KS 66047–3759
785–864–1505
martinko@ku.edu
Responsibilities and Experience
State Biologist and Director, Kansas Biological Survey; Professor of ecology and environmental studies; Ex-officio Kansas Water Authority
College of Emporia – BS, 1967
University of Colorado – MA, 1970
University of Kansas – PhD, 1976

Karma Mason
President
iSi Environmental Services
215 S. Laura
Wichita KS 67211
316–264–7050
kmason@isienvironmental.com
Responsibilities and Experience
Own and manage operations of a full-service environmental, health, and safety firm; member of Kansas Water Authority
Previous: Petroleum geologist until mid-1980s, then entered environmental field working for Vulcan Chemicals in Wichita. Started own firm in 1991 and now employ 130+.
Wichita State University – BA, 1977
Wichita State University – MS, 1984

Peggy Mast
Kansas House of Representatives, 76th District
765 Road 110
Emporia KS 66801
620–343–2465
Responsibilities and Experience
Assistant Majority Leader, Kansas House of Representatives; Appropriations and Legislative Post-Audit committees; mentor to freshmen legislators and dorm mom of Docking Building
Previous: Office manager for oil-field servicing company; office manager for construction company; telephone operator; branch manager for employment agency
Fort Hays State University – English composition
Emporia State University, Butler County Community College, and Flint Hills Vo-Tech – business courses

Ray Merrick
Kansas Senate, 37th District
6874 W. 164th Terrace
Stilwell KS 66085
785–897–4014
merrickrf@sbcglobal.net
Responsibilities and Experience
State Senator; serve on Commerce, Utilities, and Financial Institutions and Insurance committees
Previous: State representative; Vice-chair, Appropriations; Interstate Cooperation, and Legislative Budget committees; Sr. Vice President & General Manager, Kline Enterprises; sales manager, Folgers Coffee Company
Washburn University – BBA, 1965

Heather O'Hara
Principal Analyst
Kansas Legislative Research Department
300 SW 10th Avenue, Rm 68–W
Topeka KS 66612–1504
785–296–3181
heather.ohara@klrd.ks.gov
Responsibilities and Experience
Staff, Agriculture and Natural Resources, Utilities, Finanacial Institutions and Insurance committees, KETA

Previous: Various museums, Kansas Legislative Research Department–5 sessions
Simpson College – BA, 2001
University of Kansas – MA, 2003
University of Kansas – JD, 2007

Ralph Ostmeyer
Kansas Senate, 40th District
P.O. Box 97
Grinnell KS 67738–0097
785–824–3773
rostmey@ink.org
Responsibilities and Experience
Chair, Natural Resources Committee; farmer and rancher
Previous: Kansas House member; member, Agriculture Committee; Federal and State Affairs, Local Government, and Joint Administrative Rules and Regulations committees; county commission; school board member; Soil Conservation Board; FLBA board
Grinnell High School – 1961
Fort Hays State University

Catherine Patrick
Director, Division of Operations
Kansas Department of Transportation
700 SW Harrison Street
Topeka KS 66603
785–296–2235
cpatrick@ksdot.org
Responsibilities and Experience
Responsible for coordinating annual construction and maintenance programs to ensure consistency with operational objectives
Previous: Field Engineer, Asst. Bureau Chief, construction and maintenance, Topeka/Bonner Springs Metro Engineer, Northeast Kansas District Engineer
Kansas State University – Civil Engineering, 1987

Don Paxson
Vice Chair
Kansas Water Authority
2046 U.S. Highway 24
Penokee KS 67659
785–421–2480
dpaxson@ruraltel.net
Responsibilities and Experience
Vice Chair, Kansas Water Authority and Chair of KWA Budget Committee; Paxson Electric and Irrigation for 37 years; farming 1,600 acres dryland and center pivot irrigation
High School – 1956
Licensed electrician and licensed pump designer

Dale A. Rodman
Secretary, Kansas Department of Agriculture
109 SW 9th Street
Topeka KS 66612
785–296–3902
dale.rodman@kda.ks.gov
Responsibilities and Experience
Secretary, Department of Agriculture
Previous: Agribusiness executive—37 years at Cargill, Inc.; four years as president of Tramco, Inc. in Wichita; in 1990's served as board member of Kansas Agricultural Value-Added Center
Kansas State University – BS, 1963
Minnesota Management Institute

Dennis Schwartz
General Manager
Rural Water District 8
P.O. Box 95
Tecumseh KS 66542
785–379–5553
nrwadennis@aol.com
Responsibilities and Experience
Rural Water District #8, General Manager; Kansas Water Authority, member; National Rural Water Association, Director; Kansas Rural Water Association, Vice-president; Rural Water General Manager, 34 years; various other water and utility trade activities
Previous: Former member of EPA's National Drinking Water Advisory Council

Matt Sterling
Assistant Revisor of Statutes
Kansas Office of the Revisor of Statutes
200 W. 5th Street, Apt. 108
Kansas City MO 64105
785–368–6525
matt.sterling@rs.ks.gov
Responsibilities and Experience
Staff for the Senate Utilities and House Energy and Utilities committees and Joint Committee on Energy and Environmental Policy
Previous: Revisor of Statutes Fellow
University of Kansas – BA, 2005
University of Kansas School of Law – JD, 2009

Tracy Streeter
Director
Kansas Water Office
901 S. Kansas Avenue
Topeka KS 66612
785–296–3185
tracy.streeter@kwo.ks.gov
Responsibilities and Experience
KWO Director 2004–present; Development of Kansas Water Plan, drought management, water marketing in 13 Kansas reservoirs, and staff to Kansas Water Authority. Serve on Missouri River Association of States and Tribes (MORAST) and Western States Water Council. Chair GIS Policy Board
Previous: Executive Director of SCC, 1995–2004
Highland Community College – AA, 1983
Missouri Western State University – BS, 1985
University of Kansas – MPA, 1993

John Strickler
Trustee, The Nature Conservancy, Kansas Chapter
1523 University Drive
Manhattan KS 66502–3447
785–565–9731
jstrickl@ksu.edu
Responsibilities and Experience
Trustee, The Nature Conservancy, Kansas Chapter; Chair, Kansas Forest Service Advisory Council
Previous: Special Assistant for Environment and Natural Resources to Gov. Hayden, 2 years; Acting Secretary, Kansas Department of Wildlife and Parks, 1987 and 1995; Kansas Forest Service, KSU, 33 years; U.S. Forest Service, 4 years; Executive Director, Kansas Association for Conservation and Environmental Education, 5 years
University of Missouri – BS, 1957
Kansas State University – MS, 1968

Josh Svaty
Senior Adviser to the Regional Administrator
EPA Region 7
901 N. 5th Street
Kansas City KS 66101
913–551–7202
svaty.josh@epa.gov
Responsibilities and Experience
Senior adviser to the regional EPA administrator
Previous: Administrator for KDA regulations and policies; Secretary of Agriculture, 2010; advocate for agriculture; work with legislature for agriculture; Family farming; seven years as Kansas State Representative, 108th District
Sterling College – BA, 2002

Vern Swanson
Kansas House of Representatives, 64th District
1422 5th Street
Clay Center KS 67432
785–632–5322
svswan@twinvalley.net
Responsibilities and Experience
Energy and Utility and Transportation committees
Previous: Food sales for 31 years
Emporia State University – BS, 1966

Ruth Teichman
Kansas Senate, 33rd District
434 E. Old Highway 50
Stafford KS 67578
620–234–5159
rteichman@hughes.net
Responsibilities and Experience
Chair, Financial Institutions and Insurance Committee; Vice chair, Agriculture Committee; member Select KPERS, Joint Pension Investments and Benefits, Joint Health Policy Oversite, Organization Calendar and Rules, Natural Resources, Ways and Means, Education, and Legislative Education Planning committees; CFO, Teichman Farms and Richardson Farms; Board of Directors, Farmers National Bank
Previous: School board, 20 years; Stafford Hospital secretary for lab and medical records; Buyer for Pegues Department Store
Kansas State University – BS, 1965

Annie Tietze
Kansas House of Representatives, 56th District
329 SW Yorkshire Road
Topeka KS 66606
785–296–7648
atietze@cox.net
Responsibilities and Experience
Agenda Chairperson, House Minority Leadership Team
Previous: Classroom teacher, grades 7–12, 30 years
Emporia State University – BSE, 1972
University of Kansas – MA, 1986

Brian Vulgamore
Kansas Geological Survey Advisory Council
1213 Church Street
Scott City KS 67871
620–874–5075
brian@vffarms.com
Responsibilities and Experience
Part owner and manager of family farming operation; oversee 35,000 acres of crop production, 2,000-head feed yard, commercial manure business (Shallow Water Ag., LLC), and seed and consulting business (Precision Ag and Seed Services, LLC)
Kansas State University – BS, 1998
Kansas State University – MS, 1999

Vincent Wetta
Kansas House of Representatives, 80th District
1204 N. Poplar Street
Wellington KS 67152
785–296–7651
vmwetta@sutv.com
Responsibilities and Experience
State Representative
Previous: Engineer, BNSF Railway Co.
Wichita State University – BA, 1996

Kansas Geological Survey Staff

Rex Buchanan
Interim Director
Kansas Geological Survey
1930 Constant Avenue
University of Kansas
Lawrence KS 66047–3724
785–864–2106
rex@kgs.ku.edu
Responsibilities and Experience
Responsible for operations and direction of the Kansas Geological Survey; Kansas Geological Survey, 33 years
Previous: University-Industry Research, University of Wisconsin, 3 years; Salina Journal, 4 years
Kansas Wesleyan University – BA, 1975
University of Wisconsin–Madison – MA, 1978
University of Wisconsin–Madison – MS, 1982

Cathy Evans
Information Writer and Editor
Outreach and Public Service
Kansas Geological Survey
1930 Constant Avenue
University of Kansas
Lawrence KS 66047–3724
785–864–2195
cevans@kgs.ku.edu
Responsibilities and Experience
Write news releases and educational materials; edit publications; assist with field conference and guidebook
Previous: University Press of Kansas; Spencer Museum of Art
University of Kansas – BA, 1978
University of Kansas – MS, 1990

Shane Lyle
Senior Research Assistant
Geology Extension
Kansas Geological Survey
1930 Constant Avenue
University of Kansas
Lawrence KS 66047–3724
785–864–2063
slyle@kgs.ku.edu
Responsibilities and Experience
Geology Extension Coordinator; Kansas Field Conference; Kansas Geological Survey, 5 years
Previous: Environmental and Engineering Geology, 12 years
Kansas State University – BS, 1993
University of Kansas – MS, 2011

Bob Sawin
Senior Research Associate
Geology Extension/Stratigraphic Research
Kansas Geological Survey
1930 Constant Avenue
University of Kansas
Lawrence KS 66047–3724
785–864–2099
bsawin@kgs.ku.edu
Responsibilities and Experience
Geology Extension, Kansas Field Conference; Stratigraphic Research, geologic mapping, stratigraphic nomenclature committee chair; Kansas Geological Survey, 19 years
Previous: Petroleum Geology, 15 years; Engineering Geology, 6 years
Kansas State University – BS, 1972
Kansas State University – MS, 1977

2011 Kansas Field Conference

Topeka, Lawrence, and Kansas City

Water as Infrastructure • Population Growth • Sustainability

June 8–10, 2011

Welcome to the 2011 Field Conference, co-sponsored by the Kansas Geological Survey (a division of the University of Kansas), the Kansas Water Office, the Kansas Department of Transportation, and the Kansas Department of Wildlife and Parks. Previous Field Conferences have focused on specific topics, such as energy or water, or specific regions of the state. This year's Field Conference aims at a better understanding of a range of issues in one of the most heavily populated and rapidly growing parts of the state—the Kansas River valley from Topeka to Kansas City. The growing population, and the natural setting of this corner of the state, present a range of natural resource issues, some of which even extend outside of the Kansas River corridor. Kansans often think of themselves as a rural people, but they increasingly live in urban areas, and this trip will not only demonstrate that reality, but discuss the issues that arise as a result.

With this region's population and industry, the need for reliable, high-quality water sources is obvious, and we'll spend much of the next three days on water issues. That includes time spent on less apparent, but equally important, water-supply challenges, like invasive species or reservoir siltation. In addition, this area faces questions about the impact of population growth on energy and the environment; far-reaching issues related to air quality; recreational opportunities for an increasingly urban population; and the need for long-term planning to hande transportation and traffic.

Just a word of geologic background. Virtually all of the trip will be spent in the glaciated region of Kansas, the part of the state—bounded roughly by the Kansas River on the south and the Big Blue River on the west—that was covered by glaciers about 700,000 years ago. The effects of that glaciation are still visible, both in the large red quartzite boulders that dot many of the fields (there's even one standing on a pedestal at the south end of the Kansas River bridge in Lawrence) and the thick deposits of a wind-blown silt called loess, which lines many of the major roads, like Interstate 70 in the Kansas City area, and forms the rounded hills that line the Missouri River. The bedrock here is much older, deposited during the Pennsylvanian Subperiod of geologic history about 300 million years ago. Shallow seas that covered this area left behind alternating sequences of limestones and shales, along with occasional thin layers of coal. In a few places, ancient river channels left behind sand that has subsequently been turned into sandstone.

In terms of vegetation, this is an area of transition between the oak/hickory forest to the east and the tallgrass prairie to the west, so remnants of both vegetation patterns are found here today, along with floodplain forests along the streams and rivers. And because this area has a high average annual precipitation, as much as 36 inches per year in Lawrence, it is rich in surface water. We'll see evidence of that throughout the trip, in the form of lakes, rivers, and streams. Some of these rivers, like the Kansas and the Missouri, have meandered across their floodplain for eons, leaving behind cutoffs, old river channels, natural wetlands, and even small natural lakes, such as Lakeview northwest of Lawrence.

Day 1

Our first day begins with a look at Kaw River State Park on the west edge of Topeka. The Kansas River (also known as the Kaw) carries more water than any other river in the state and is one of only three Kansas rivers that the Corps of Engineers recognizes as navigable, thus legally accessible to the public. In spite of that, the Kansas River has not been easily accessible for canoeists and kayakers until recently. This park, the most recent addition to the State park system, offers river access, along with hiking trails. As the only urban State park in Kansas, it is important in serving the increasingly urbanized population of northeastern Kansas.

From Topeka we'll head east and north to Perry Lake to talk about an ongoing theme of the past several Field Conferences—reservoir sustainability. Perry was completed in 1970 and is undergoing siltation, as are several other reservoirs that we've visited in the past. In addition, the lake has been infested with zebra mussels, a small and prolific invader (originally from Russia) that creates a variety of problems both for water supply and recreation.

It's no accident that many of the largest cities in Kansas are perched on the banks of the Kansas River, which remains an important source of water. On the way to Lawrence we'll have a discussion of efforts by businesses and municipalities to band together and assure themselves of water from the Kaw.

Next, we'll travel to Lawrence to examine the water-air-energy nexus with visits to the Bowersock dam as well as Westar's Lawrence Energy and Service Center. At Bowersock dam, the only dam on the Kansas River, we'll have a conversation about energy, engineering issues, and the only hydroelectric facility in Kansas, which is being expanded. At the Lawrence Energy Center, we'll hear about zebra mussel migration from Perry Lake, which has led to the infestation of facilities that supply the region's energy and drinking water. We'll also hear about industry air emissions in the river corridor. To address these concerns, we'll hear how area utilities are designing ways to cope with zebra mussels and to improve the region's air quality. Westar Energy is installing so-called "smart grid" technology that will allow Lawrence residents to more carefully monitor their energy use and to make conservation efforts easier. We'll travel to the Lawrence Service Center, a LEED Silver Certified green building, to talk about energy conservation to close out the day.

This marks the first time the Field Conference has stopped in Lawrence, and we'll spend part of the evening at a Lawrence landmark, the KU Natural History Museum, a division of the KU Biodiversity Research Institute. The Museum is located in historic Dyche Hall. This building, completed in 1903 and recently named a finalist for the 8 Wonders of Kansas Architecture, is named for Lewis Lindsay Dyche, a KU professor and explorer. We'll have dinner in the museum's Panorama Gallery, under the watchful gaze of the animals that Dyche preserved, originally for an exhibit at the 1893 World's Fair in Chicago. Dyche was also a Kansas fish and game warden in 1909, and thus a precursor to today's Secretary of Wildlife and Parks Robin Jennison. Like many museums, this one has extensive research collections that dwarf the number of specimens on display. We'll get a behind-the-scenes look at some of specimens. Also, be sure to see the museum's collection of Cretaceous vertebrate fossils from the Niobrara Chalk of western Kansas. A cast of one of those Cretaceous animals, a 45-foot-long mosasaur, graces the museum's lobby.

Day 2

We now move from the Kansas River watershed into the Missouri River watershed to talk about a range of issues associated with the mighty Missouri River. While other rivers in Kansas suffer from a surplus of silt, which is then trapped behind and fills up reservoirs, this reach of the Missouri suffers from too little silt, which causes the river to pick up silt by eroding away its banks and scouring its bottom. At the Dalbey Bottoms in Atchison County, we'll look at efforts by the Kansas Department of Wildlife and Parks and the U.S. Army Corps of Engineers to restore some of the habitat here, which should improve flood control, increase fish habitat, and provide for human recreation. Later in the day, we'll also talk more about dredging from the river.

On the 2010 Field Conference, we talked about air-quality issues created by spring burning in the Flint Hills, examining the issue from the ranching perspective in Chase County. This year we'll look at the urban side of the issue in Kansas City, Kansas, where Region VII of the U.S. Environmental Protection Agency and Wyandotte County monitor air quality. We'll see one of their monitoring stations, in the heart of KCK, and we'll tour the labs where EPA does a variety of analyses for air and water contaminants. Two EPA representatives here, among other dignitaries, have participated in previous Field Conferences: Ron Hammerschmidt, former head of the Division of Environment of the Kansas Department of Health and Environment, and Josh Svaty, former Secretary of Agriculture in Kansas, and thus a precursor to today's Secretary Dale Rodman.

We'll end the afternoon at Kaw Point on the confluence of the Kansas and the Missouri, where Lewis and Clark camped on their way west in 1804. Previous participants may remember visiting here in 2003 when this point was relatively undeveloped. With the 200-year anniversary of the Lewis and Clark expedition, it's been turned into a publicly accessible park. We'll use this spot to talk about another invasive species—Asian carp; weather permitting, we'll get out on the Kansas River to see the fish first-hand. We'll finish the evening at the KU Medical Center to talk about bioscience initiatives in the state.

Day 3

Now we'll head south from Wyandotte County to Johnson County, the state's most populous and rapidly growing county. Nearly a quarter of the state's population lives in one of these two counties today, and by 2030, projections show that more than a quarter of the state's population will live in Johnson County alone. Johnson County has 20 incorporated cities, including Lenexa, named for the wife of a Shawnee Indian chief. At Lake Lenexa we'll look at watershed management for water quality and at attempts to conserve forests in this relatively urban setting.

From here we'll go to a truly urban setting, the intersection of Kansas Highway 10, Interstate 35, and Interstate 435 in central Johnson County. This is a focal point for traffic on the southwest side of metropolitan Kansas City, a location that the Kansas Department of Transportation (KDOT) is calling the *Johnson County Gateway*. This area, sometimes informally called the Johnson County triangle, carries up to 230,000 vehicles per day and is expected to handle up to 380,000 per day by 2040. To deal with this increased traffic, KDOT is overhauling the interchange and adding lanes, projects that will require several years and hundreds of millions of dollars to complete. One issue here is shallow underground limestone mines, some of which do not have the sufficient support to handle the overlying rock above the mine. We'll look at one of these mines and talk about the challenges they present in terms of highway construction and subsidence.

Our final stop is at the new Kansas State–Olathe. Kansas State recently dedicated the first building on this campus, the International Animal Health and Food Safety Institute, which makes it an appropriate location to continue the bioscience conversation. And KSU's Ron Wilson will walk us through the demographic challenges the state faces, an appropriate way to summarize some of the things we've seen and the issues we've discussed during the previous two and a half days.

About the Kansas Field Conference

Some issues are best understood by seeing them firsthand. The 2011 Field Conference marks the 17th year the Kansas Geological Survey (KGS) has worked with co-sponsors to give policymakers the opportunity to see and experience some of the natural-resource issues with which they grapple. Participants have been selected to provide a range of legislative, government, education, and private-business expertise. Local and regional experts in natural-resource issues will meet us at each site and describe the location and the issues related to it. The objective is to let participants see the results of their decisions and to talk with local, State, and Federal governmental officials, environmental groups, business people, and citizens' organizations. The result should give participants a broader, more-informed perspective useful in formulating policies. In addition, the Field Guide you are holding provides background on sites and issues and serves as a handy reference long after the Field Conference is over.

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

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

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

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

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

The KGS Field Conference has been recognized by

- The National Institute of Standards and Technology as among 50 Best Practices for Communication of Science and Technology for the Public, 2001; and
- The Division of Environmental Geosciences of the American Association of Petroleum Geologists, which presented the Field Conference with its Public Outreach Award in 1998.

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

Sponsors

Kansas Geological Survey

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

By statutory charge, the KGS role is strictly one of research and reporting. The KGS has no regulatory function. It is a division of the University of Kansas. The KGS employs more than 65 scientific researchers and technical staff and 25 graduate research assistants and hourly student employees. It is administratively divided into research and research-support sections. KGS programs can be divided by subject into water, energy, geology, and information dissemination.

Water—Water issues affect the life of every Kansan. Western Kansas agriculture and industry rely heavily on ground water; in eastern Kansas, growing populations and industry generally use surface water. KGS water research and service include an annual water-level-measurement program (in cooperation with the Kansas Department of Agriculture, Division of Water Resources), modeling the impact of regulatory decisions, studies of recharge rates, phreatophytes, water quality in the Arkansas River, depletion of the Ogallala aquifer, and the interaction between streams and aquifers. Much of that work is done with funding from the Kansas Water Plan, the National Science Foundation, and the state's groundwater management districts. The Survey also collects, archives, and disseminates water-well logs in cooperation with the Kansas Department of Health and Environment.

Energy—Kansas produced more than $6 billion worth of oil and natural gas last year. Because much of the state has long been explored for oil and gas, maintaining that production takes research and information. The KGS does research on the state's petroleum reservoirs, new methods of providing information, and new methods of exploring for and producing oil and gas. The KGS recently completed a multi-year study of the resources of the Hugoton Natural Gas Area, a study that resulted in the drilling of a substantial number of additional wells. Researchers also are characterizing the subsurface for possible sequestration of carbon dioxide. Unconventional natural gas, such as coalbed methane or low-BTU gas, and horizontal drilling techniques are also a focus of ongoing research. The KGS works with the Kansas Corporation Commission to enable online reporting of oil and gas information, and has a branch office in Wichita, the Wichita Well Sample Library, that stores and loans rock samples collected during the drilling of oil and gas wells in the state. Much of the KGS energy research is funded by the U.S. Department of Energy.

Geology—Much of the KGS's work is aimed at producing basic information about the state's geology that can be applied to a variety of resource and environmental issues. The KGS develops and applies methods to study the subsurface, such as high-resolution seismic reflection; undertakes mapping of the surficial geology of the state's counties; and studies specific resources, such as road and highway materials. The KGS reports on nonfuel minerals (such as salt, gypsum, aggregates, etc.) and is charged with studying geologic hazards, including subsidence, earthquakes, and landslides. Much of this work is funded through the U.S. Geological Survey, the U.S. Army Corps of Engineers, the Kansas Department of Transportation, and the Department of Defense. The KGS also maintains a program in geoarcheology, studying the early peopling of the Great Plains.

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

KGS staff participating in the 2011 Field Conference include the following:

Shane Lyle, Senior Research Assistant, Geology Extension
Cathy Evans, Writer/Editor, Public Outreach
Bob Sawin, Senior Research Associate, Public Outreach/Stratigraphic Research
Rex Buchanan, Interim Director
Kansas Geological Survey
1930 Constant Avenue
Lawrence, KS 66047–3724
785–864–3965
785–864–5317 (fax)
www.kgs.ku.edu

Kansas Department of Transportation

The Kansas Department of Transportation (KDOT) was founded in 1917. It is charged with providing a statewide transportation system to meet the needs of Kansans. Its primary activities are road and bridge maintenance; transportation planning, data collection, and evaluation; project scoping, designing, and letting; contract compliance inspection of material and labor; Federal program funding administration; and administrative support. In addition to dealing with roadways for automobile traffic, KDOT is responsible for other modes of transportation, including aviation, rail, and bicycles/pedestrians. KDOT has more than 3,000 employees. KDOT's headquarters are in Topeka with six district offices, 26 area offices, and 112 sub-area offices across the state. KDOT is responsible for maintenance of about 9,600 miles of State highway.

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

KDOT's current transportation program, called T-Works, will undertake about $1.7 billion worth of highway improvements. After a series of meetings in the fall of 2010, KDOT announced the first three projects under T-Works: U.S. Highway 69 in Overland Park (which will relate to this year's conversation about highway construction and population growth in Johnson County), Kansas Highway 18 near Manhattan (which relates to Field Conference conversations about bioscience initiatives), and U.S. Highway 50 in Hutchinson (which relates to the impact of the wind-energy industry, a previous topic of Field Conference conversations). Additional expansion and modernization projects will be announced soon.

The current Secretary of the Kansas Department of Transportation is Deb Miller, the first female director in the agency's history.

Kansas Department of Transportation
Dwight D. Eisenhower State Office Building
700 SW Harrison Street
Topeka, KS 66603–3754
785–296–3566
785–296–0287 (fax)
www.ksdot.org

Kansas Department of Wildlife and Parks

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

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

In 1987, two State agencies, the Kansas Fish and Game Commission and the Kansas Park and Resources Authority, were combined into a single, cabinet-level agency operated under separate comprehensive planning systems. Then, in 2011, the state's Division of Travel and Tourism was moved from the Department of Commerce to the Department of Wildlife and Parks by executive order of Governor Sam Brownback (in July, the department's name will change to Wildlife, Parks, and Tourism). The Department operates from offices in Pratt, Topeka, five regional offices, and a number of State park and wildlife area offices. The Department employs about 420 people in five divisions: Executive Services, Administrative Services, Fisheries and Wildlife, Law Enforcement, and Parks. It operates 24 State parks, four nature centers, four fish hatcheries, and 63 wildlife areas.

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

Kansas Department of Wildlife and Parks
Office of the Secretary
Landon State Office Building
1020 S. Kansas Avenue
Topeka, KS 66612–1327
785–296–2281
785–296–6953 (fax)

Kansas Department of Wildlife and Parks
Operations Office
512 SE 25th Avenue
Pratt, KS 67124–8174
316–672–5911
316–672–6020 (fax)
www.kdwp.state.ks.us

Kansas Water Office

The mission of the Kansas Water Office (KWO) is to provide the leadership to ensure that water policies and programs address the needs of all Kansans. 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, the Kansas Weather Modification Act, and the Water Assurance Act. It also reviews plans of any State or local agency for the management of water and related land resources in the state. The KWO advises the Governor on drought conditions and coordinates the Governor's drought-response team. The Drought Monitoring Program collects climate data from a variety of sources, monitors drought activities, and publishes a weekly Drought Report during periods of drought.

The KWO develops the Kansas Water Plan, which is revised periodically and addresses the management, conservation, and development of water resources in the state. Numerous water-related public and private entities, as well as the general public, are involved in its preparation and planning. The Water Plan is approved by the Kansas Water Authority, a 13-member board whose members are appointed, along with 11 nonvoting *ex officio* members who represent various State water-related agencies. Besides approving the Water Plan, the Authority approves water-storage sales, Federal contracts, administrative regulations, and legislation proposed by the KWO. Much of the input for the Water Plan comes from 12 Basin Advisory committees that are composed of volunteer members from each of the state's drainage basins. During this year's Field Conference, we will be in the Kansas and Missouri river basins.

Current programs and projects at the KWO include

- Public water-supply system GIS mapping assistance
- The Upper Arkansas River Conservation Reserve Enhancement Program
- Reservoir sustainability initiative
- Watershed unit projects
- Water planning
- Water conservation
- Water conservation education
- Water assurance
- Drought monitoring
- Water marketing
- Weather modification

Tracy Streeter is the Director of the KWO.

Kansas Water Office
901 S. Kansas Avenue
Topeka, KS 66612–1249
785–296–3185
www.kwo.org

Schedule and Itinerary

Wednesday, June 8, 2011

6:00 a.m.	Breakfast at Capitol Plaza Hotel
7:15 a.m.	Conference Overview *Rex Buchanan*, Interim Director, Kansas Geological Survey
8:00 a.m.	**Bus leaves Capitol Plaza Hotel for Site 1**
8:15 a.m.	**SITE 1** – Kaw River State Park, Topeka Urban Outdoor Recreation *Robin Jennison,* Secretary, KS Dept. of Wildlife and Parks *Jeffrey Bender,* Kaw River State Park Manager, KS Dept. of Wildlife and Parks
9:00 a.m.	Bus to Site 2
9:30 a.m.	**SITE 2** – Perry Lake Perry Lake Operations *Kenneth Wade*, Operations Project Manager, U.S. Army Corps of Engineers
9:30 a.m.	Break – Rock Creek Park
10:15 a.m.	**SITE 2** – Perry Lake Perry Lake Outlet Tower Operations *Bunnie Watkins,* Resource Manager, U.S. Army Corps of Engineers Reservoir Sustainability *Tracy Streeter,* Director, Kansas Water Office *David Combs,* Chief, Planning Branch, U.S. Army Corps of Engineers
11:15 a.m.	Bus to Lunch
11:30 a.m.	Lunch at Perry Lake
12:30 p.m.	Bus to Site 3
12:30 p.m.	**SITE 3** – Perry Lake Marina Zebra Mussel Ecology *Jason Goeckler,* Aquatic Nuisance Species Coordinator, KS Dept. of Wildlife and Parks
1:00 p.m.	Bus to Site 4 Bus Session – Water Assurance Program *Tracy Streeter,* Director, Kansas Water Office
1:30 p.m.	**SITE 4** – Bowersock Dam, Lawrence Hydroelectric Power Generation *David Corliss,* City Manager, City of Lawrence

River Scour and Bridge Design
Bob Henthorne, Chief Geologist, KS Dept. of Transportation

2:15 p.m. Bus to Site 5

2:30 p.m. **SITE 5** – Westar Lawrence Energy Center, Lawrence
Zebra Mussel Management and Control
Brad Loveless, Director, Biology and Conservation Programs, Westar Energy
Jason Goeckler, Aquatic Nuisance Species Coordinator, KS Dept. of Wildlife and Parks

3:15 p.m. Bus to Site 6

3:30 p.m. **SITE 6** – Westar Lawrence Service Center, Lawrence
Smart Grid Technology
Hal Jensen, Director, SmartStar Programs

4:15 p.m. Bus to Oread Hotel

4:30 p.m. Arrive at Oread Hotel, Lawrence

5:30 p.m. Social Gathering at the University of Kansas Museum of Natural History
(walk four blocks south along Oread/Jayhawk Blvd, past Student Union, to museum near 14th and Jayhawk Blvd)

6:00 p.m. Supper and behind-the-scenes museum tour

7:30 p.m. Return to Oread for after-hours social at The Nest on the Ninth Terrace

Kaw River State Park

Following authorization of the first State park (at Kanopolis Reservoir) by the Kansas Legislature in 1958, all but four of the succeeding State park areas were built adjacent to humanmade lakes and reservoirs (the exceptions being Mushroom Rock State Park in Ellsworth County, Sand Hills State Park in Reno County, Prairie Spirit Trail State Park in eastern Kansas, and Kaw River State Park in Topeka). Kaw River State Park, the newest addition, is water-based but the first to access a river rather than lake or reservoir (fig. 1). Situated on the former grounds of the Menninger Clinic in west Topeka, Kaw River State Park is also the only urban-related State park in Kansas (KDWP, 2011).

The process of creating Kaw River State Park began in the early 2000s when the Menninger board of directors sold property to a private group that donated it to the Kansas Department of Wildlife and Parks by the end of 2005. After a boat dock, a railroad crossing, roads, parking, and trails were constructed, the park officially opened to public use in September 2010 (Bush, 2010).

The second smallest park in the state (Mushroom Rock State Park is only 5 acres), Kaw River State Park covers 76 acres south of the Kansas River. The area is mostly oak and hickory forest overlooking the river and is adjacent to both MacLennan Park and the governor's mansion Cedar Crest to the east. The

Figure 1. Kaw River State Park is adjacent to the Kansas River in Topeka (photo by Ron Kaufman, KDWP).

Kansas Department of Wildlife and Parks Region 2 office is on the west side of the park.

Kaw River State Park is a day-use-only park. River access is available for canoes, kayaks, and other small craft (fig. 2). Portage Park, 2 miles downstream, provides a portage around the Topeka water weir (low-head dam). Double-wide gravel surface trails and dirt surface single-track trails, some connecting with MacLennan Park trails, are being developed in the park (figs. 3, 4, and 5). All trails are accessible for walking, hiking, running, and mountain biking, and the single-track trails are being built for a variety of skill levels.

Sources

Bush, A. M., 2010, Take a hike along the kaw: Cjonline.com, http://cjonline.com/news/state/2010-08-28/take_a_hike_along_the_kaw.

KDWP, 2011, Kansas state parks: Kansas Department of Wildlife and Parks, http://www.kdwp.state.ks.us/news/State-Parks/Locations/Kaw-River**.**

Contacts

Robin Jennison, Secretary
Kansas Department of Wildlife and Parks
1020 S. Kansas Ave., Rm. 200
Topeka KS 66612–1327
785–296–2281
robin.jennison@ksoutdoors.com

Jeff Bender, Park Manager
Kansas River State Park
300 S.W. Wanamaker Rd.
Topeka, KS 66606
Park Office: 785–273–6740
Jeff.bender@ksoutdoors.com

Figure 2. River access is available at the Kaw River State Park boat ramp (photo by Ron Kaufman, KDWP).

Figure 3. Rocks are hand placed in gabions, or wire cages (upper), to create a level double-wide trail in Kaw River State park (lower) (photos by Jeffrey Bender, KDWP).

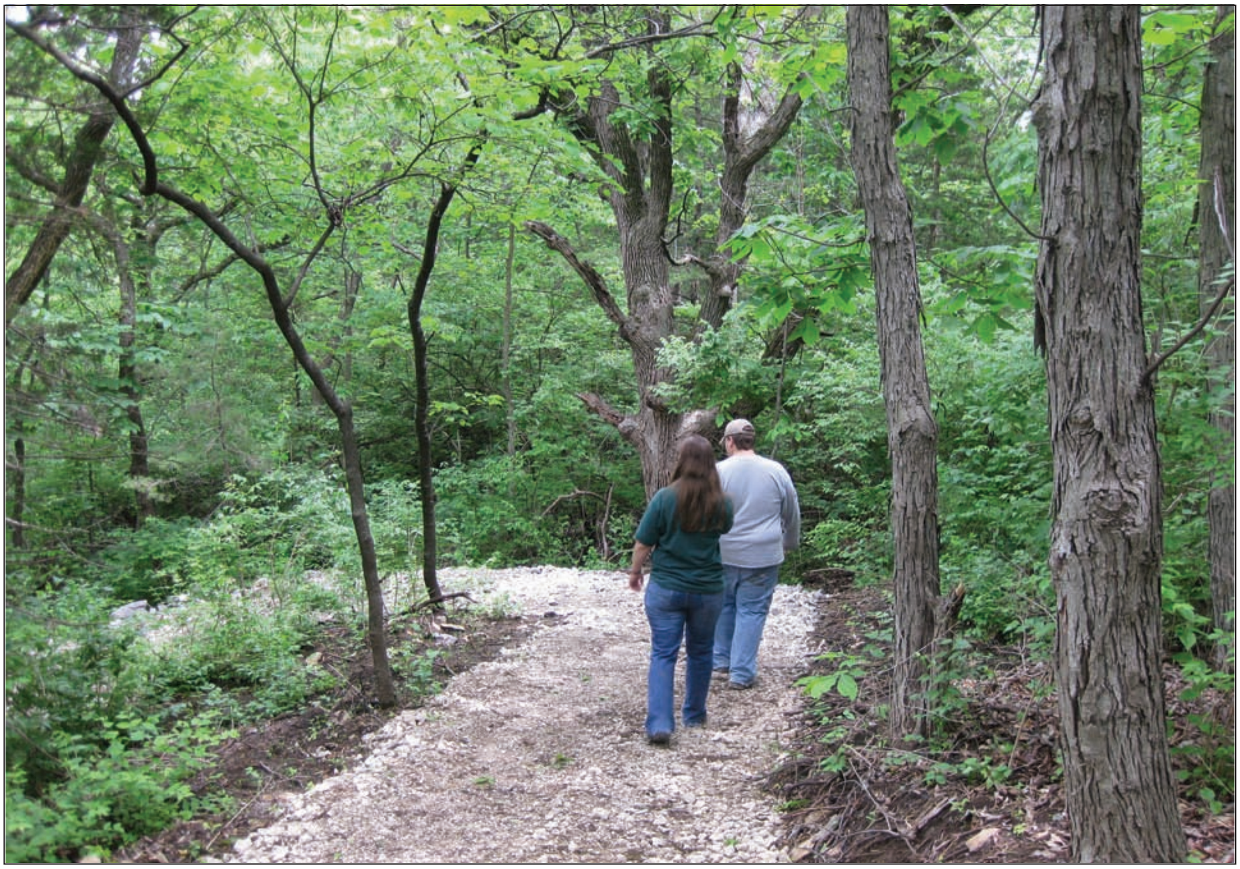


Figure 4. Kaw River State Park trail (photo by Jeffrey Bender, KDWP).

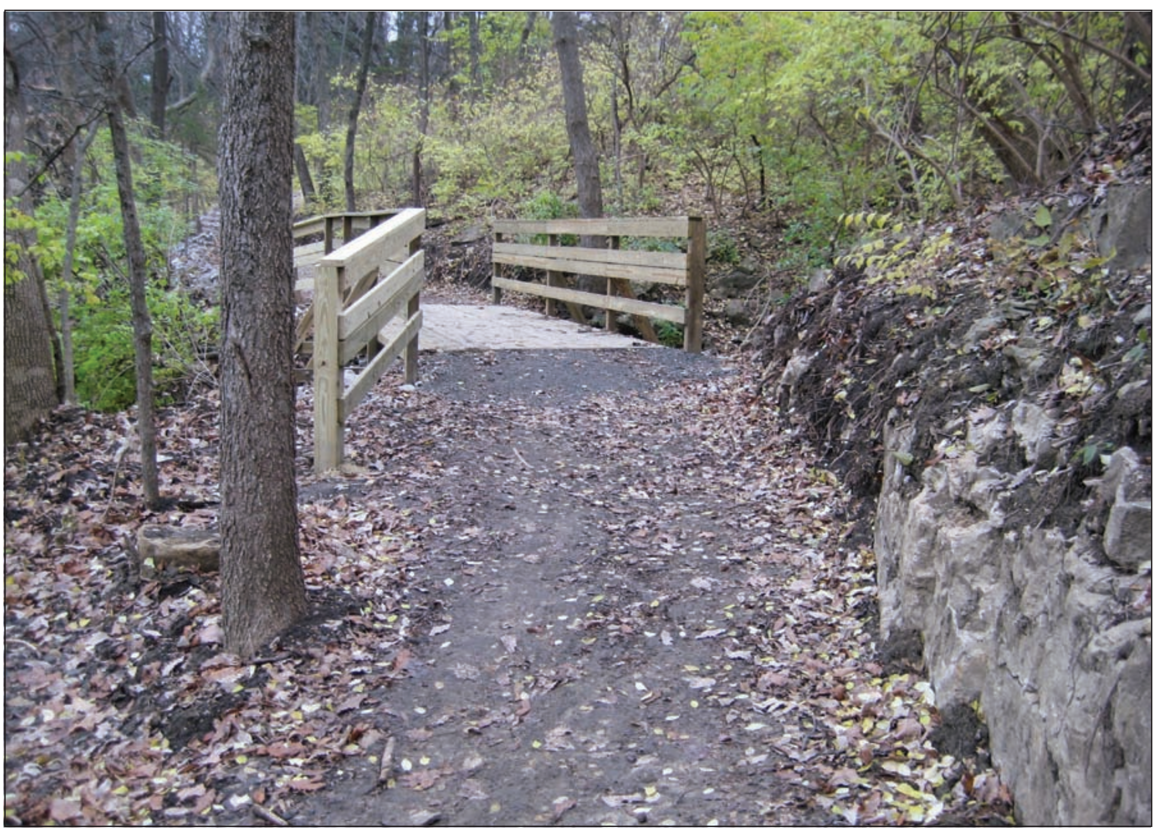


Figure 5. Bridge on Kaw River State Park trail (photo by Jeffrey Bender, KDWP).

Perry Lake Operations

The US Army Corps of Engineers constructed and operates Perry dam. Located on the Delaware River in Jefferson County, Perry Lake is the fourth largest lake in Kansas. The lake has over 160 miles of shoreline, 25,389 acres of flood-control pool, and 11,150 surface acres of multipurpose pool. Nearly 39,311 acres of land are available for recreation and wildlife management. Over 11,000 acres are available for fisheries management.

The Delaware River and its tributaries provide the water inflow forming the lake (fig. 1). Flood protection from this watershed includes over 3,000 acres downstream of the dam along the Delaware River and contributes to the protection of the Kansas River, Missouri River, and the Mississippi River. The communities of Perry, Lawrence, Bonner Springs, and Kansas City benefit from the flood-control protection. The initial cost of the dam and reservoir was approximately $48.4 million (excluding supplemental recreation development). Since the lake's construction, flood-damage prevention has been estimated at $5.4 billion.

Current Federally authorized purposes for Perry Lake include flood control, navigation, water supply, water quality, recreation, fish, and wildlife. The Kansas Water Office is charged by the State Water Planning Act with negotiating and entering into agreements with the Corps of Engineers regarding operation or releases of water from Federal projects.

The State of Kansas has under contract 196,394 acre-feet of the conservation pool to be used for water supply purposes. Only a portion of this storage (32,739 acre-feet) has been called into service by the State.

Dam and Outlet Works

The dam consists of a rolled earth-fill embankment about 7,750 feet long, constructed to an elevation approximately 95 feet above the streambed with gated outlet works and a gated chute-type spillway in the left abutment. The outlet works is located in the center of the dam and includes several features. The outlet conduit, which is about 23 feet in diameter and 564 feet long, extends through the earth embankment with approach and outlet channels. It is preceded by two rectangular passages about 12 feet wide and 23 feet high. Each passage contains an emergency gate and a service gate. Both gates are hydraulically operated. Discharges enter a concrete stilling basin immediately downstream of the outlet conduit. Two rows of staggered baffle blocks reduce the velocity of the water before it goes into the outlet channel. The intake structure and control tower contain all of the operating machinery and equipment.

Sources

Bosworth, M. K., 2007, Delaware River watershed restoration and protection strategy: Delaware River Watershed Restoration and Protection Strategy (WRAPS), 114 p.

CDM, 2011, Kansas reservoir assessment final report, W912DQ-08-D0048, March 23, 2011, 167 p.

Perry Lake Website, http://www.nwk.usace.army.mil/pe/index.cfm, accessed May 4, 2011,

Contacts

David Combs
Chief, Planning Branch
Kansas City District
U.S. Army Corps of Engineers
601 E 12th Street
Kansas City, MO 64106
816–389–3157

Kenneth Wade
Operations Project Manager
Perry Lake Project Office
10419 Perry Park Drive
Perry, KS 66073
785–597–5144
Kenneth.Wade@usace.army.mil

Bunnie Watkins
Natural Resource Manager
Perry Lake Project Office
U.S. Army Corps of Engineers
10419 Perry Park Drive
Perry, KS 66073
816–389–3921
Bunnie.A.Watkins@usace.army.mil

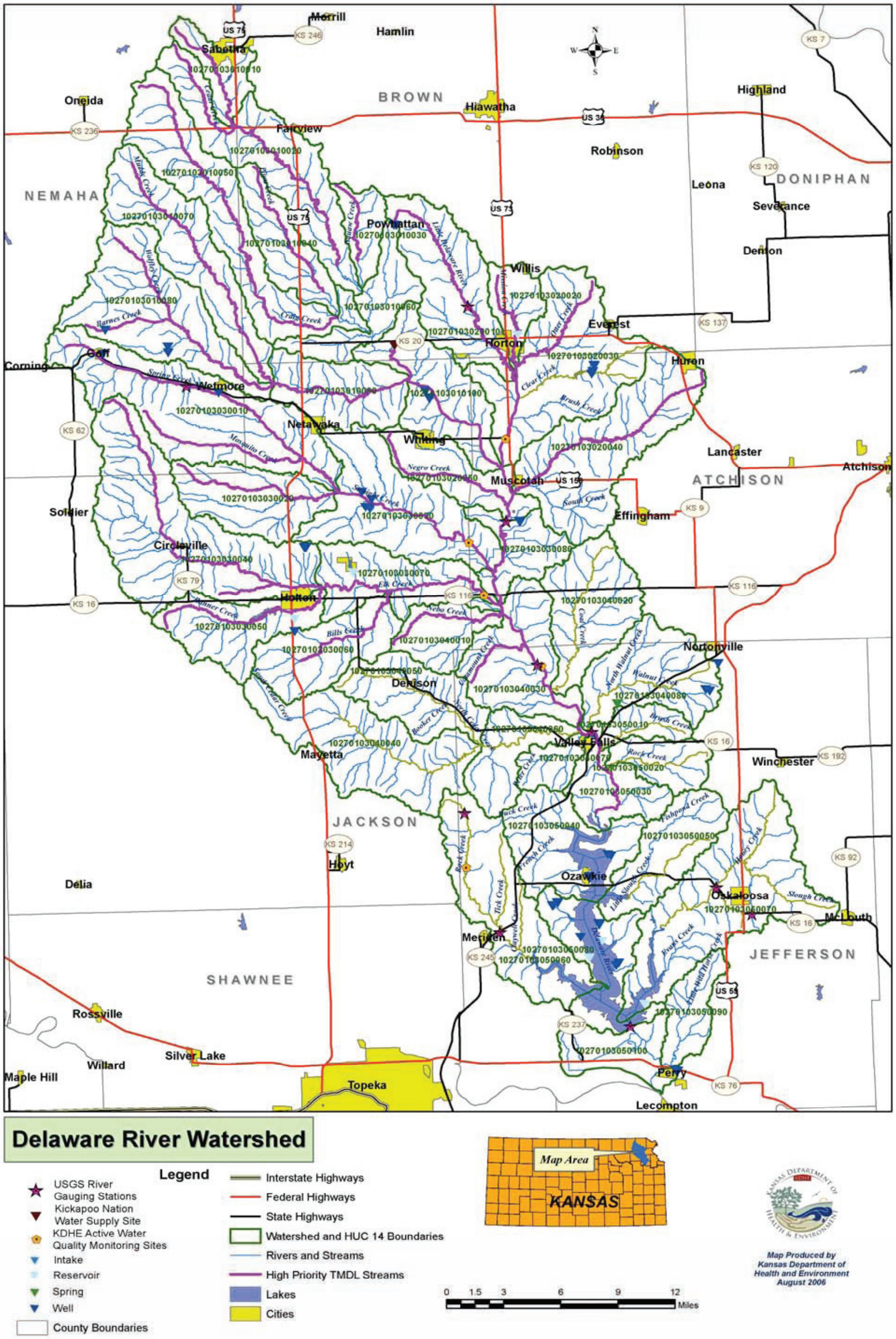


Figure 1. Perry Lake location and drainage basin (Bosworth, 2007).

Reservoir Sustainability

KWO conducts water planning, policy coordination, water marketing and facilitates public input throughout the state.

Federal reservoirs in Kansas serve as the source of municipal and industrial water for more than two-thirds of the state's population. They are a recreational destination and provide a reserve for stream flow for water quality, aquatic life and related activities.

The reservoirs are an integral part of the infrastructure of water supply in Kansas. Like all infrastructure, reservoirs age. They fill with sediment, reducing their capacity to meet our needs. While erosion is a natural process, it is accelerated by our actions.

Protecting and making the best use of reservoirs today will take an investment to assure that they will be sustained for generations to come.

Your Involvement is Needed. Learn More at www.kwo.org

Kansas' landscape is changing. A viable economy depends on well-managed natural resources. Too often we take for granted that the foundation of our lives and livelihoods always will be there.

We've learned

The federal reservoirs were built from the 1940s through the 1980s by the U.S. Army Corps of Engineers and the Bureau of Reclamation primarily for flood control. State and local users saw value in adding water supply storage. Use of that storage space now is being compromised by sedimentation.

Preliminary studies indicate that during a severe drought the diminished supply could cause water supply shortages in the foreseeable future for several basins. Models are being developed to optimize the use of reservoir water to meet current and future needs.

Many of the reservoirs have been measured to determine the amount of storage that has been lost to sedimentation. Scientists are developing methods to better determine the sources of sediment, whether it be stream banks, construction sites or farm fields. This allows for targeting of appropriate management practices to reduce erosion to get the most value for dollar spent.

We've taken positive action

Millions of private, state and federal dollars have been spent putting in watershed and land treatment structures.

Local stakeholder driven watershed groups, known as WRAPS (Watershed Restoration and Protection Strategy) are engaged in restoring and protecting their watersheds. WRAPS groups are active in the watersheds of 19 of the state's 20 federal reservoirs that provide public water supply benefits.

Mission Lake in Horton Kansas is the object of a pilot project underwritten by the State Water Plan Fund to determine the best alternatives to restore and extend the reservoir's life. Practices to reduce further erosion are in place or being implemented.

We have to do more

An unprecedented level of local, state and federal cooperation is needed to sustain and manage reservoirs.

Our water future may depend on our ability to recover lost storage, protect stream banks, build new reservoirs and push-to-shove, decrease demand.

Developing the funding to assure reservoir sustainability is essential.

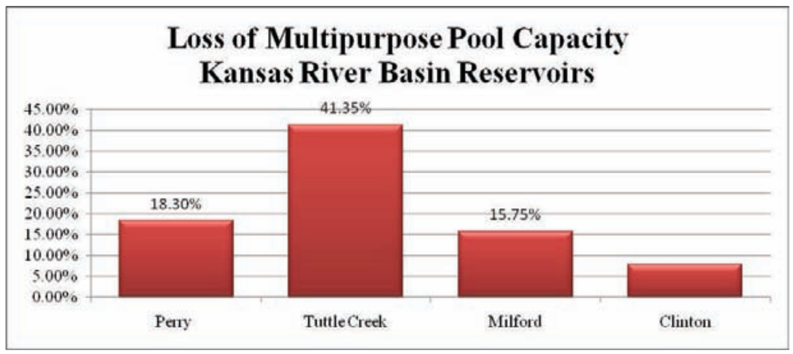
Kansas Water Office

Reservoir Sustainability

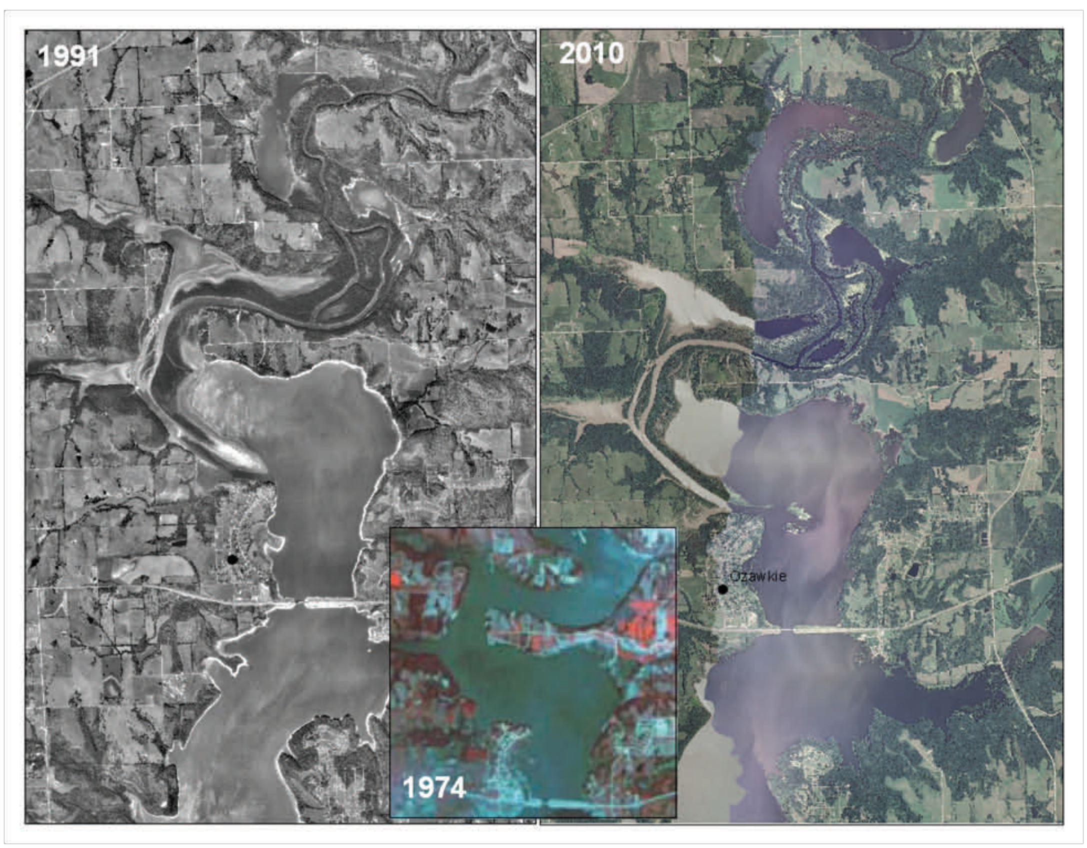
KWO conducts water planning, policy coordination, water marketing and facilitates public input throughout the state.

Kansas River Basin Reservoirs - Sedimentation Impacts

Sedimentation has greatly impacted each of the reservoirs of the Kansas River basin, from a loss of 7.8% of the multipurpose pool in Clinton Reservoir to more than 41% loss of storage in Tuttle Creek Reservoir. Approximately 18% of the original multipurpose pool of Perry Reservoir, which is one of the largest reservoirs in Kansas and was constructed in 1969 with a 12,200-acre operation pool and a 25,300 acre flood control pool, has been lost to sediment deposition.



Near complete siltation of the north end of Perry Reservoir led to abandoned recreation areas and boat ramps and loss of fish habitat.



Kansas Water Office

Reservoir Sustainability

KWO conducts water planning, policy coordination, water marketing and facilitates public input throughout the state.

Economic Impact

Each reservoir in the Kansas River basin is an important recreational and water supply asset that contributes substantially to the local and regional economy. The following table summarizes the annual economic benefits of Perry, Tuttle Creek, and Milford Reservoirs.

Reservoir	Recreation (Direct Spending)	Hunting & Fishing License Revenue	Habitat Value	Water Supply
Perry	$15.8 million	$5.5 million	$10.1 million	$24.8 million
Tuttle Creek	$12.4 million	$1.3 million	$2.4 million	$74.9 million
Milford	$17.1 million	$4.3 million	$8.1 million	$88.8 million

Where is the Sediment Coming From?

In 2011, KWO assessed the annual tons of sediment contributed from streambank erosion in the Tuttle Creek, Perry, and Clinton watersheds. Each assessment identified streambank erosion sites, quantified the annual amount of sediment transported from these sites, and estimated the cost for stabilization. For the Perry Reservoir Watershed, a total of 115 streambank erosion sites were identified, covering 68,178 feet of unstable streambank and transporting 126,428 ton of sediment downstream each year, accounting for roughly 79.2-acre feet per year of sediment accumulation in Perry Reservoir. Conducting streambank stabilization practices for the entire watershed would cost about $4.9 million.

What is being done to address sedimentation in the basin?

With funding through the American Recovery and Reinvestment Act (ARRA) and Kansas Clean Water Revolving Loan Fund (KCWRLF), the Glacial Hills RC&D has already begun addressing many of these streambank erosion sites. Additional funding is needed to continue this work.

Nemaha River north of Seneca, streambank before stabilization, 2005 →

Nemaha River north of Seneca, streambank after stabilization. 2006

Zebra Mussel Ecology

Aquatic ecosystems are particularly vulnerable to introduction and proliferation of non-native species. The occurrence and spread of zebra mussels (*Dreissena polymorpha*) illustrates the significant ecological and economic impacts associated with an aggressive invasive species. Zebra mussels are a native to the Black, Caspian, and Azov seas and were likely transported to North America in the ballasts of transoceanic ships where they were first discovered in Lake St. Clair near Detroit in 1988. By 1990, zebra mussels expanded their range to include all the Great Lakes and major water bodies and rivers in the eastern United States. Kansas and surrounding states are now on the front of their expanding range (fig. 1). The economic impact to municipal water suppliers, power plants, and other water-related business due to the spread of this species will be $1 billion a year.

Zebra mussels are small shellfish named for the striped pattern of their shells (fig. 2). Their color patterns can vary to the point of having only dark or light colored shells and no stripes. They are typically found attached to objects, surfaces, or each other by threads underneath the shells.

Under natural water temperatures, zebra mussels develop eggs in autumn with their release and fertilization in spring or summer, depending on water temperature. Over 40,000 eggs can be laid in a single reproductive cycle and up to one million in a spawning season. In thermally polluted or warm water areas, reproduction can occur continually throughout the year. After the eggs are fertilized, the larvae (veligers) emerge within three to five days and are free-swimming for up to a month. Larvae are

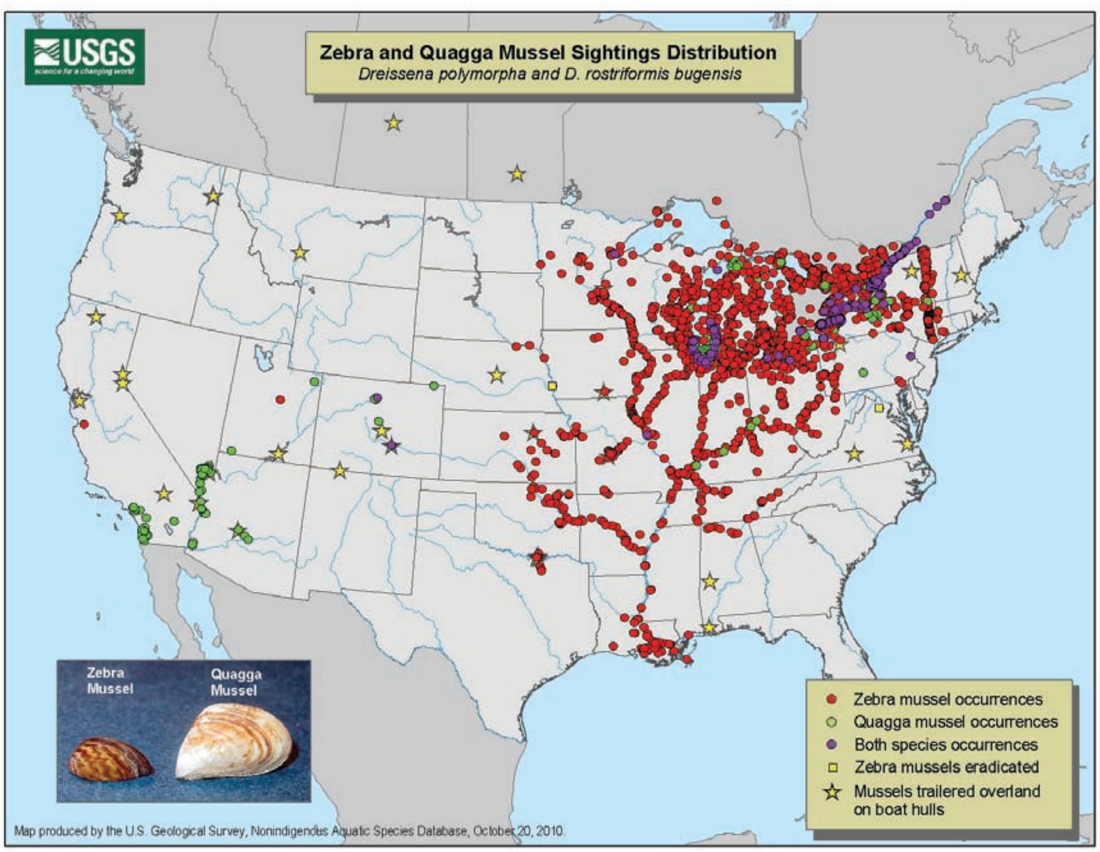


Figure 1. Current distribution of zebra mussels in the United States as of October 2010. The distribution of zebra mussels is updated daily by the U.S. Geological Survey (USGS, 2011).

Figure 2. Adult zebra mussel (photo U.S. Geological Survey).

usually carried with the water flow in a lake or river. The larvae begin their juvenile stage by settling to the bottom where they crawl about with a “foot” for a suitable surface to attach, preferably a hard or rocky surface (fig. 3). The juvenile larvae attach themselves to the surface by means of a byssus, an “organ” outside the body consisting of many threads. Adults have difficulty staying attached in fast-moving water and once detached they can be carried some distance with water flow.

The rapid invasion of North American waterways has been facilitated by the zebra mussel’s ability to disperse during all its life stages. Passive drift of large numbers of pelagic larval veligers allows invasion downstream. Yearlings are able to detach and drift

Figure 3. Zebra mussel, an aquatic nuisance species that threatens the state’s water resources, shown at El Dorado Reservoir (photo by Jason Goeckler, KDWP).

for short distances. Adults routinely attach to boat hulls and floating objects and are thus transported to new locations. Even unconnected waterways are susceptible to boats from infested waters. Under cool, humid conditions, zebra mussels can stay alive for several days out of water, so trailering recreational boats disperses zebra mussels between inland lakes. They have very few natural predators, so their numbers grow exponentially. Zebra mussels can reach densities of approximately 700,000 to 1 million per square meter in some instances.

Zebra mussels are filter feeders, primarily on phytoplankton, which is the primary food source at the base of the aquatic food chain upon which native fish depend. Capable of filtering about 1 liter of water per day while feeding, zebra mussels can significantly disrupt the food chain of an entire lake. In Kansas, biologists have documented a decrease in health and abundance of several game fish species after infestation of zebra mussels. Filter feeding may also be linked to blue-green algal blooms, which can have important implications for drinking-water quality because some algal species produce toxins (e.g., microcystin) and odor compounds (e.g., geosmin) that are difficult and expensive to remove by water-treatment facilities. Therefore, because of the cost associated with biofouling civil infrastructure and risk to state fisheries and water quality, it is important to understand zebra mussel ecology to plan and treat for future zebra mussel infestation.

Zebra Mussels at Perry Lake

Zebra mussels were discovered at Perry Lake in 2007. The proliferation of zebra mussels in Perry Lake will continue to peak in the next few years. Filter feeding of organic food from the lake deplete the supply of food available to shad and other native fish species in the lake. Their notorious biofouling capabilities lead to infestation of anything firm, including boat motors, trim tabs, shoreline rocks, and water-intake pipes. Colonization of intake pipes constricts flow and reduces the capacity of structures such as the lake flood gates, pumping stations, and reservoir-release structures. Continued attachment of zebra mussels can cause corrosion of steel and concrete affecting its structural integrity. Downstream migration of veligers and mussels through the lake floodgates contributes to the colonization within public utilities and industries that have raw-water intakes on the Kansas River.

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Contact

Jason Goeckler
Aquatic Nuisance Species Coordinator
KS Dept. of Wildlife and Parks
1830 Merchant St
PO Box 1525
Emporia, KS 66801–1525
620–342–0658
jason.goecklerg@ksoutdoors.com

Water Assurance Program

KWO conducts water planning, policy coordination, water marketing and facilitates public input throughout the state.

Background

During periods of mild to severe drought, natural streamflow on regulated streams (those with reservoirs) may be significantly reduced. Municipal and industrial water users along the stream who hold valid appropriation rights to the natural flow may find their ability to use the stream severely limited, at a time when demand for water is at its highest. In the past, water in storage from upstream reservoirs was available to these users only under terms of the State Water Marketing Program. In order to participate in the Water Marketing Program, municipal and industrial water users were required to sign a long-term (up to 40 years) contract with the state.

This allows for state-controlled water storage space in federal reservoirs in a designated basin to satisfy downstream municipal, industrial and water right holders water during drought times.

Learn More at www.kwo.org

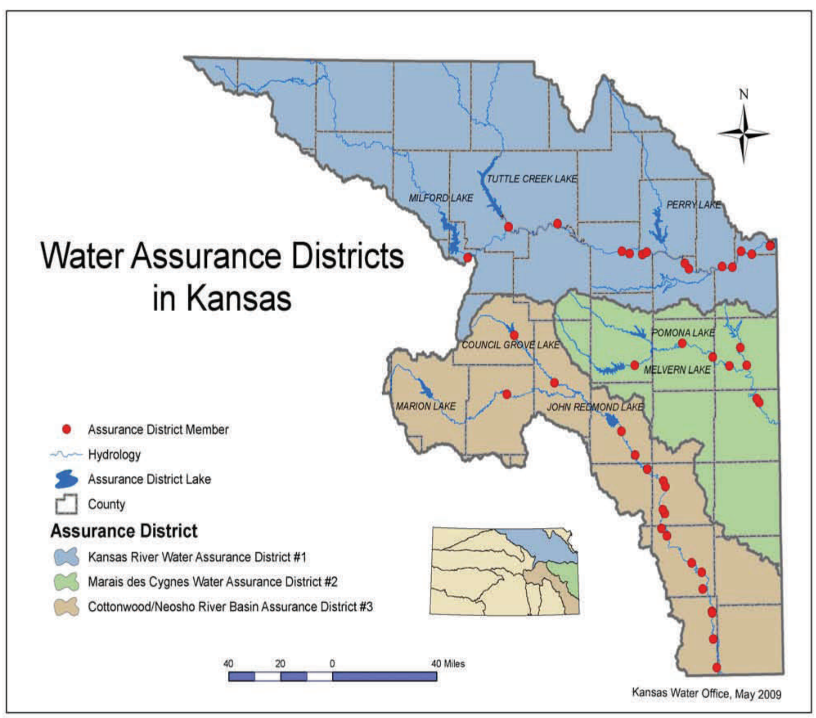
The state recognized the Water Marketing Program might not meet the needs of many municipal and industrial water right holders on rivers below federal reservoirs that may only need releases during low flow periods.

Purpose

The *Water Assurance Program* allows for coordinated operation of state-owned or controlled water storage space in federal reservoirs to satisfy downstream municipal and industrial water rights during drought conditions.

The Program

The Water Assurance Program Act (K.S.A. 82a-1330 *et seq.*) was enacted in 1986 allowing assurance districts to be organized by eligible water right holders.



An assurance district allows municipal and industrial water right holders to purchase state owned storage in Corps' reservoirs and improve the reliability of their water supply. A key element of the approach is an operations agreement between the state and the assurance district describing how the reservoirs will be operated during drought conditions to meet member's needs.

To date, three assurance districts have been formed and are operational:

- *Kansas River Water Assurance District No.1*
- *Marais des Cygnes River Water Assurance District No. 2*
- *Cottonwood/Neosho River Basins Assurance District No. 3.*

Water Assurance Program

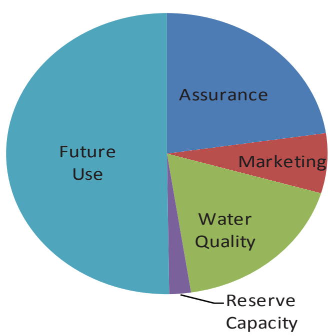
KWO conducts water planning, policy coordination, water marketing and facilitates public input throughout the state.

The Kansas River Assurance District provides water to 1,049,606 *citizens (2007 population), four power plants and four industrial businesses.*

In August 2006, Kansas River flow at DeSoto was 1,180 cfs. Without the assurance district, flow would have been 362 cfs making it difficult if not impossible to meet the needs of the cities and industries on the Kansas River.

Kansas River Water Assurance District Storage Break Out (Acre/Feet)

	Milford	*Tuttle Creek*	*Perry*	**Total**
Assurance	63,273	80,628	32,549	**176,450**
Marketing	53,677			**53,677**
Water Quality		140,415		**140,415**
Reserve Capacity		16,868		**16,868**
Future Use	228,238		162,703	**390,941**
Total	**345,188**	**237,911**	**195,252**	**778,351**



- Water Assurance is the storage owned by the assurance district.
- Water Marketing is the storage dedicated to the Marketing Program.
- Water Quality storage is utilized to maintain minimum releases benefiting in stream needs.
- The Reserve Capacity is storage which has been purchased but not yet dedicated to either program.
- Future Use Storage is under contract but with payment deferred and under Corps control until needed.

Future use storage has been the subject of discussion during recent legislative sessions. Typically it has been referred to in terms of what the state's "unfunded liability" is regarding water supply storage. The table below shows the current unfunded liability at Milford and Perry reservoirs as of October this year. The annual payment columns show the increased cost to the state if we began payment now, while the final column shows the balloon payment that will be due if we do not act before the contracts with the Corps expire in 2040.

	Oct. 1, 2011 Balance	Annual P&I Payment	Additional Est. Annual O&M	Balance at 2040 w/o Payments
Milford	$ 16,741,424	$ 813,795	$ 130,000	$ 36,951,533
Perry	$ 17,395,283	$ 893,240	$ 340,000	$ 29,966,434
Total	$ 34,136,707	$ 1,707,035	$ 470,000	$ 66,917,967

Hydroelectric Power and Bowersock Dam

"Hydropower," traditionally defined, is any type of waterpower used to run machinery or generate electricity. Today the word is often used interchangeably with hydroelectric power. Hydroelectric facilities vary greatly in structure and capacity but all rely on turbines and generators to convert kinetic energy from flowing or falling water into electricity. Hydropower is by far the most widely used form of renewable energy. In the United States, hydropower facilities produce enough electricity for 28 million households, the same number of homes that would be serviced by electricity generated with nearly 500 million barrels of oil (Energy.gov, 2011).

Hydroelectric facilities, or projects, vary in size from large to small to micro. The Department of Energy (DOE) generally defines a large facility as having a capacity of more than 30 megawatts (MW), a small facility as having a capacity of 100 kilowatts (KW) to 30 MW, and a micro facility as having a capacity up to 100 KW, just enough to power a single home, ranch, or perhaps a small town (DOE, 2005). Others sources define a small facility as one having a capacity of 10 MW or less.

Bowersock Mills and Power Company, a small project on the Kansas River in Lawrence (fig. 1), has a generating capacity of 2.35 MW. In comparison, Hoover dam has a capacity of 2,074 MW and the world's largest, Itaipu Dam on the Brazil–Paraguay border, has a capacity of 12,600 MW (Bureau of Reclamation, 2004).

Dam design and function vary significantly from project to project. Hoover, Itaipu, and other large impoundment dams store massive quantities of water that can be released to meet electricity needs or to maintain a constant water level. On a more limited scale, Bowersock dam is a small diversion dam at a run-of-river (ROR) facility. Much less intrusive

Figure 1. Bowersock Mills and Power Company (low building on river) and dam (photo by Cathy Evans).

on the environment than impound projects, ROR projects use the flow of water within the natural range of the river and require little or no impoundment. (Other ROR diversion projects with natural water drops do not even require dams.) Typically, ROR plants can have large flow rates with low head or small flow rates with high head (INL, 2007). Bowersock dam is an overflow type of low-head dam with flashboards (fig. 2) that collapse during periods of high inflows. Upstream flows are maintained within the natural channel elevation of the Kansas River in what is referred to as the “Mill Pond,” which extends 5.2 miles upstream from the dam (U.S. Army Corps of Engineers, 2010).

A family-owned company, Bowersock is the only functioning hydroelectric plant in Kansas. The current facility on the south end of the dam, built in 1905, houses seven turbines. The company broke ground May 17, 2011, to build a $20 million expansion across the river at the north end of the dam that will have four new turbine generators and increased capacity of approximately 5 MW. The expansion was licensed by the Federal Energy Regulatory Commission (FERC) in August 2010, a faster-than-normal six months after the application was submitted. In April 2010, FERC had introduced a new licensing program to help applicants of small hydropower projects, such as Bowersock, complete the process more quickly (Ray, 2011).

Figure 2. Flashboards on Bowersock dam (photo by Cathy Evans).

Besides the north-end powerhouse, proposed changes include expanding the Mill Pond from 5.2 miles to 5.9 miles upstream, raising the height of the existing flashboards on the lowhead dam from 4 feet high to 5.5 feet, and constructing a 150-foot-long canoe portage and fishing platform along the north bank of the Kansas River (U.S. Army Corps of Engineers, 2010).

Bowersock is certified through 2014 as a low impact facility by the Low Impact Hydropower Institute, a non-profit organization focused on reducing the impact of hydropower generation. The criteria standards for certification are typically based on the most stringent mitigation measures recommended, although not required, by pertinent State and Federal resource agencies (Low Impact Hydropower Institute, 2011).

Bowersock's History

A dam on the Kansas River at Lawrence was first completed in 1874 (flooding led to later reconstructions), and the facility was taken over by J. D. Bowersock in 1876. By 1885 the operation had 12 water wheels providing mechanical power for two flour mills, a paper mill, two elevators, a twine factory, a shirt factory, two machine shops, the Leis chemical works, two printing offices, and the barbwire works (fig. 3). After damage from flooding in the late 19th century, Bowersock added four dynamos to turn raw power into electrical energy. When Bowersock Mills and Power Company ceased its milling operation in 1968, several local businesses continued using water-generated electricity from the dam until 1972. For several years after that, Bowersock sold energy exclusively to Kansas Power and Light, now Westar Energy (Bowersock Mills & Power Co., 2009).

By the mid 1970s, Bowersock Mills and Dam Company could not afford necessary repairs on the dam, which was masonry block construction on the southern third and timber crib construction on the northern two-thirds. In 1977 the company entered into a public/private partnership with the City of Lawrence (City of Lawrence, 2010). The City took over maintenance of the dam, still technically owned by the company, because the dam provided benefits beyond power production. It created the pool of water needed for the intake crib at the City's water treatment plant, contributed to riverbed stability,

Figure 3. Fishing off Bowersock dam, 1895 (photo courtesy of the Watkins Community Museum of History).

helped prevent bridge scour (erosion of sand and sediment around abutments by fast moving water), and provided a barrier to invasive species migrating upstream. In exchange for maintaining the dam, the City was given six acres of Bowersock land for $1.00 for a new City Hall, which helped revitalize the north end of downtown Lawrence. Most recently, maintenance on the dam has included a $2.2 million project completed in April 2010 to eliminate water flowing through the dam face (City of Lawrence, 2010).

FERC rulings since the late 1970s have allowed Bowersock to sell to utilities other than Westar. In 1978 the Public Utility Regulatory Policies Act (PURPA) mandated that public electric utilities had to buy excess power generated by small producers at the utility's avoided cost—the incremental cost a utility would have to pay if it generated its own electricity. In 2008 the company began selling energy to the Kansas Power Pool (KPP), a consortium of small Kansas municipal utilities. Under Kansas law, Bowersock is only allowed to wholesale its energy. In the fall of 2010, Kansas City Board of Public Utilities (BPU) signed a contract with Bowersock to purchase 7 MW of hydroelectric power over the next 25 years (BPU, 2010).

Hydropower Potential in Kansas

Most dams in the United States were built for purposes other than generating electricity (fig. 4). In 1989 the U.S. DOE initiated development of a National Energy Strategy and, in conjunction, the Idaho National Engineering Laboratory (INL), designed software to assess undeveloped hydropower potential state by state. In Kansas, 18 sites were identified and assessed for hydropower potential. Although the capacity of the sites ranged from 30 KW to 18 MW, most sites were found to have potential capacity under 5 MW.

Sites in the study were classified as developed (already having an impoundment or diversion structure) or undeveloped. Bowersock was the only developed site with an active hydropower facility. Developed sites with hydropower potential were Oxford mill, Clinton dam, Melvern dam, Wilson dam, Elk City dam, Kanopolis, John Redmond, Glen Elder, Riverton (Lowell), Perry, Milford, and Tuttle Creek. Undeveloped sites with hydropower potential were all in the Kansas River basin, at Topeka, Tecumseh, Lecompton, Eudora, and Edwardsville (Francfort, 1993).

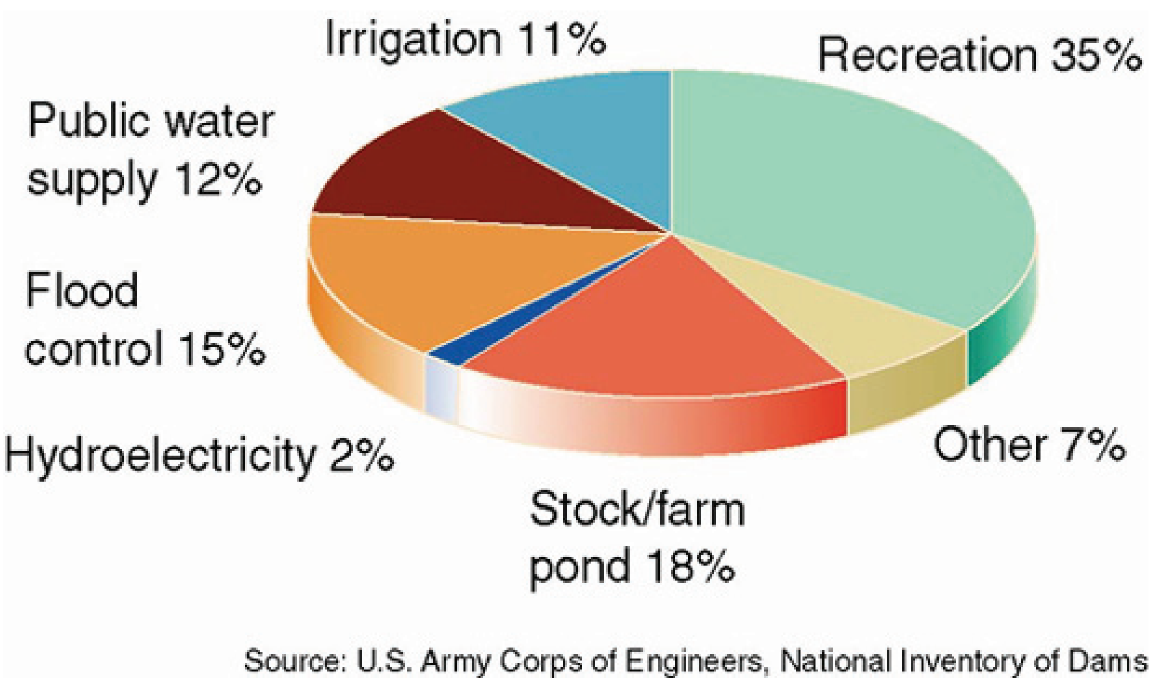


Figure 4. Primary purposes or benefits of U.S. dams. Source U.S. Army Corps of Engineers, National Inventory of Dams (INL, 2007).

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Contact

David Corliss
City Manager
City of Lawrence
City Hall
6 East 6th Street
Lawrence, KS 66044
785–832–3403
dcorliss@lawrenceks.org

Zebra Mussel Management and Control

Since their introduction in 1988, zebra mussels have spread throughout the Great Lakes and the Mississippi River drainage basin, and threaten to extend their range to the river basins and water-supply systems of the western states. The zebra mussel (*Dreissena polymorpha*) has become the most serious nonindigenous biofouling pest ever to be introduced into North American freshwater systems. Public facilities susceptible to zebra mussels include water intakes, raw-water systems, pumping stations, instrumentation, and reservoir-level control structures. At infested facilities, colonization continues until equipment is so fouled or encrusted with mussels that it becomes unusable (fig. 1).

Mussels can render inoperable miter gates on locks, fire-prevention systems that use raw water, reservoir-release structures, navigation dams, pumping stations, water-intake structures, dredges, and commercial and recreational vessels. Materials and equipment such as small-diameter pipes, valves, screens, trash racks, chains, and wire ropes are all vulnerable. When a thick layer of zebra mussels covers a metallic surface, it can cause anoxia and pH reduction, further exacerbating corrosion rates of structures and equipment.

To the facilities that depend upon water intake, zebra mussel fouling can have a serious economic impact. Infestations have caused temporary power outages and difficulties in obtaining water for cooling, waste removal, and public-water supply. Many power plants along Lake Erie now spend more than $250,000 each year (as of 1997) on zebra mussel mitigation. The estimated economic impact to municipal water suppliers, power plants, and other water-related business is $1 billion a year.

Control Strategies

Prevention is the best weapon against initial infestation, because once a water body is infested with a zebra mussel population, there is virtually no eliminating it. Once zebra mussels threaten a civil infrastructure, three different strategies can be adopted to protect water systems, generally classified as either preventive, reactive, or prospective control methods.

Figure 1. Water jetting being used to clean pump room at a condenser cooling unit of a power plant (photo courtesy of Aquatic Nuisance Species Information System [ANSIS]).

Preventive strategies reduce the ability of zebra mussels to infest a facility. Examples include toxic construction materials such as copper pipe, antifouling coatings, thermal treatment, and mechanical filtration systems. Often these are retrofit into an existing facility or included in the design of new facilities.

Reactive strategies are typically utilized after a facility is infested. Reactive methods include component replacement, mechanical cleaning, high-pressure water jetting, carbon dioxide pellet blasting, and freezing or desiccation, as well as chemical control methods.

Prospective strategies are technological innovations or specifically designed equipment to prevent zebra mussel infestation. They are typically engineered for existing or future facilities. Prospective control methods include water-intake retrofits, infiltration intakes, pulse acoustics, electric fields, and ultraviolet light (UV light).

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Contacts

Jason Goeckler
Aquatic Nuisance Species Coordinator
Kansas Department of Wildlife and Parks
1830 Merchant St
PO Box 1525
Emporia, KS 66801–1525
620–342–0658
jason.goeckler@ksoutdoors.com

Brad Loveless
Director, Biology and Conservation Programs
Westar Energy
818 S. Kansas Ave.
Topeka, KS 66601
785-575-8115
brad.loveless@westarenergy.com

Smart Grid Technology and Westar Energy's SmartStar Lawrence Program

Mushrooming since its beginnings in the 1890s, our current electrical grid is an expansive network of transmission lines, substations, and transformers that delivers electricity from power plants to millions of homes and business. Today the network includes more than 9,200 electric generating units, 1 million megawatts of generating capacity, and 300,000 miles of transmission lines (DOE, 2011b). To meet the accelerating demands of digital and computer technology now taxing the grid, government and private entities are pursuing a new type of system, the smart grid.

As part of that effort, Westar Energy (Westar) has received one of 100 Smart Grid Investment Grants awarded by the U.S. Department of Energy (DOE) to implement a smart-grid program in Lawrence. In March 2010 Westar launched SmartStar Lawrence, which will eventually provide virtually all of the company's Lawrence customers with smart metering, supporting technology, and next-generation customer services. The project includes the Advanced Metering Infrastructure network, Meter Data Management System, an online customer energy dashboard (fig. 1),

Figure 1. Westar's online customer energy dashboard will provide customers with up-to-date information on their energy consumption and costs, along with other details about their accounts.

distribution automation equipment, and a new smart-grid-enabled outage management system.

At the heart of the program are smart meters, state-of-the-art digitized electric meters. Unlike current meters, the smart meters being installed in Lawrence have two-way communication modules that allow data to flow to and from Westar. Each customer's smart meter reports daily energy usage information to Westar, which is available to the user on the "my electric account" page at WestarEnergy.com. Smart meters can monitor electric usage in short time increments, even minutes, to give virtually real-time feedback (Westar, 2011).

Using smart-meter technology, Westar will be able to offer peak usage reduction programs, often called demand-side management plans. These programs are voluntary and may include controllable thermostats and time-of-use pricing plans. Smart metering and the smart grid do not allow Westar to control customer electricity usage, although it will improve Westar's ability to offer voluntary programs that encourage customers to lower usage during periods of peak generation (Westar, 2011).

Because of its two-way interactive capacity, the smart grid will allow for automatic rerouting when equipment fails or outages occur. Smart grid technology is able to detect and isolate outages, containing them before they become large-scale blackouts, and can ensure that electrical service resumes quickly and strategically after an emergency—routing electricity to emergency services first (DOE, 2011b).

Primary objectives of Westar's SmartStar Lawrence project are to identify best practices for customer engagement and the business process changes necessary with smart grid technology. The project will include testing of pilot customer product offerings and multi-media communication channels. SmartStar is a three-year implementation project with customer service and program development beyond that period. Supporting information technology was installed throughout much of 2010, approximately 1,500 meters were installed in a pilot neighborhood in January 2011, and citywide meter exchange begins in late June 2011. Meter exchange has been timed so that residential customers will have access to their energy dashboard shortly following meter exchange. Business customers are scheduled for dashboard support in August 2011.

Westar chose Lawrence for the pilot project, in part, because of its size (population 90,000) and diverse composition that includes a mobile student population, commercial and industrial customers, and educational institutions. While Lawrence customers will be the first to receive smart meters, the systems and equipment the company plans to install are sized to ultimately accommodate system-wide smart meter deployment for all of Westar's 685,000 customers (Westar, 2011).

The Federal Smart Grid Task Force and Smart Grid Investment Grants

To coordinate and bring awareness to Federal smart grid activities, the Federal Smart Grid Task Force was established under Title XIII of the Energy Independence and Security Act of 2007 (EISA). The DOE's Office of Electricity Delivery and Energy Reliability (OE) leads the Task Force. Members include representatives from DOE's Office of Energy Efficiency and Renewable Energy and National Energy Technology Laboratory as well as the Federal Energy Regulatory Commission, Department of Commerce, Environmental Protection Agency, Department of Homeland Security, Department of Agriculture, and Department of Defense. The Task Force will collaborate with DOE's Electricity Advisory Committee (EAC) and other relevant Federal agencies and programs (DOE, 2011a).

The American Recovery and Reinvestment Act of 2009 (Recovery Act) provided DOE with $4.5 billion to fund projects aimed at modernizing the electric power grid. The two largest DOE initiatives, the Smart Grid Investment Grant program and the Smart Grid Demonstration program, were first authorized by Title XIII and later modified by the Recovery Act (DOE, 2011b).

Kansas Smart Grid Investment Grant Recipients

Although none of the Smart Grid Demonstration projects is in Kansas, two Kansas companies—Westar and Midwest Energy, Inc. in Hays—were awarded Smart Grid Investment Grants (SGIGs). Projects receiving the grant were selected through a merit-based, competitive solicitation. Successful projects received Federal financial assistance for up to 50% percent of costs (DOE, 2011b).

Westar received $19 million in SGIG funding for its $41 million SmartStar project. As a condition of the grant, Westar is required to file quarterly project progress and financial reports that will be available to the public at www.recovery.gov. Midwest Energy, Inc., is using its $712,000 grant to install new micro-processor-based protective relays and communications equipment at its Knoll Substation, which will increase transmission system reliability, enhance synchrophasor measurement and concentration, and facilitate the integration of renewable energy. The total budget for Midwest Energy, Inc.'s project is $14.2 million (DOE, 2011b).

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Westar Energy, 2011, SmartStar: http://smartstarlawrence.com.

Contact

Hal Jensen
Director, SmartStar Programs
Westar Energy, Inc.
818 S. Kansas Ave.
Topeka KS 66612
785–575–1842
Hal.Jensen@westarenergy.com

KU Natural History Museum and the Biodiversity Institute

Two years after the University of Kansas was founded in 1864, entomologist and zoologist Francis H. Snow was charged with establishing a cabinet of specimens in a room in North College, the first building on campus. From there the collection grew. In 1893, the Panorama of North American Mammals, featuring more than 120 specimens from the collections prepared by Professor Snow's student Lewis Lindsay Dyche, was the highlight of the Kansas Pavilion at the World's Columbian Exposition in Chicago. From 1903 to 1908, students helped Dyche, by then a professor, install the Exposition exhibit in a permanent panorama at KU's new $75,000 Venetian Romanesque-style Natural History Museum. The building, named for Dyche following his death in 1915, is now listed on the National Register of Historic Places (KU Natural History Museum, 2010).

Gradually the role of the museum and its staff became two-fold—to educate the public with displays and programs and to further our understanding of the world through scientific study. By 1995, four independent, collection-based biodiversity research entities at KU—the Museum of Natural History (fossil and recent vertebrates), the Snow Entomological Museum (arthropods), the Museum of Invertebrate Paleontology (fossil invertebrates), and the McGregor Herbarium (plants)—merged into a single Natural History Museum. In 2003, the museum became a unit of the newly formed Biodiversity Institute, one of the University's several research centers (KU Biodiversity Institute, 2011).

More than 120 scientists, staff, and graduate students of the Biodiversity Institute study the history and diversity of life on earth by examining the world's species, ecosystems, and cultures.

Figure 1. Smilodon*, often called saber-toothed tiger, at the KU Natural History Museum (courtesy of the KU Natural History Museum).*

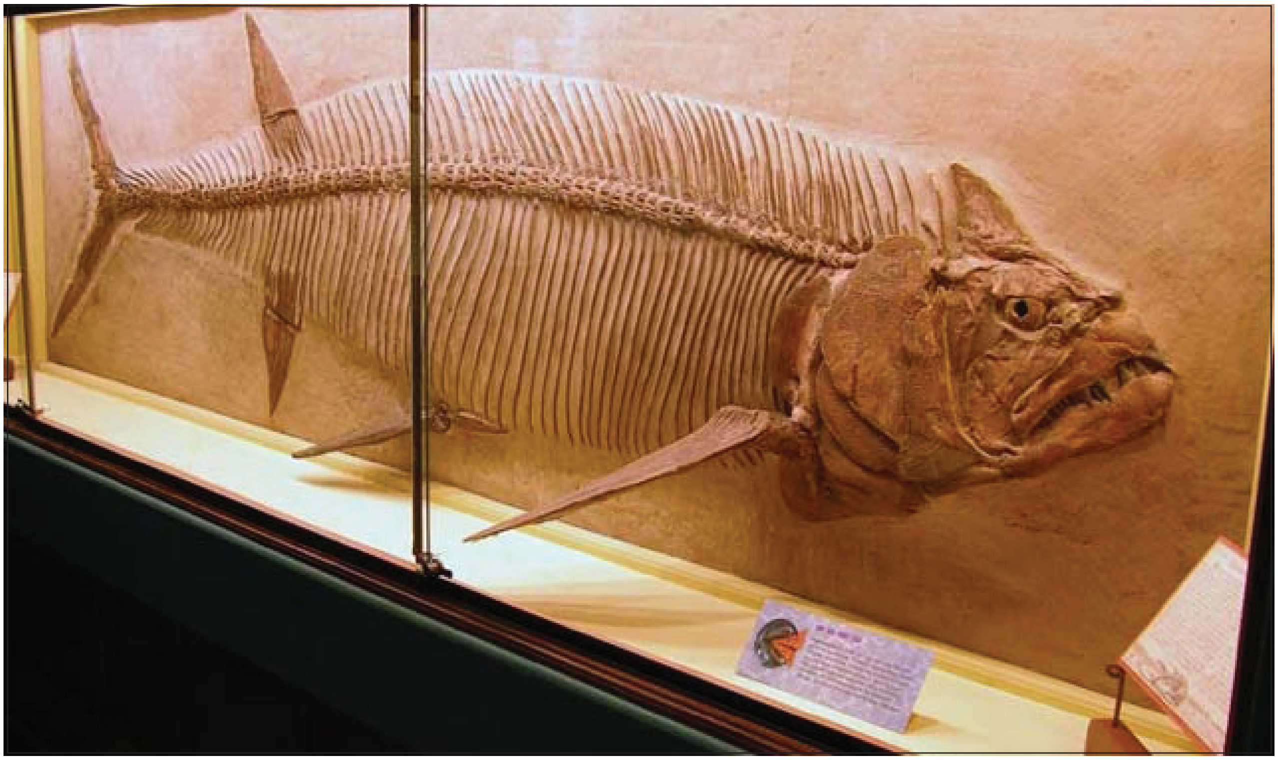

Figure 2. Xiphactinus*, a fish from the Late Cretaceous sea, at the KU Natural History Museum (courtesy of the KU Natural History Museum).*

Besides the museum collection, the Biodiversity Institute encompasses 14 research-related divisions—archeology, botany, biodiversity modeling and policy, ichthyology, herpetology, entomology, informatics, paleobotany, invertebrate zoology, invertebrate paleontology, mammalogy, ornithology, parasitology and vertebrate paleontology—many based at the Museum (KU Biodiversity Institute, 2011).

Altogether, the collection of the Institute includes more than 8 million plant and animal specimens collected worldwide and 1.2 million archeological artifacts. Students and staff are distributed across seven buildings on campus and conduct research on all continents. Their research in such areas as biodiversity science, evolution, environmental change, and cultural variations is supported by millions of dollars in Federal research grants (KU Natural History Museum, 2010).

Besides pursuing its research mission, the Natural History Museum continues to meet the educational goals of its founders. Since 2003 more than 20,000 students in grades 1–12 have participated in museum education programs. Educational displays in the four-floor, 50,000-square-foot exhibition space feature Dyche's panorama of North American wildlife—one of the largest and oldest dioramas in the world—as well as flora and fauna of the Great Plains, vertebrate and invertebrate fossils, and live snakes, insects, and bees (KU Natural History Museum, 2010).

Sources

KU Natural History Museum, 2010: http://naturalhistory.ku.edu.

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Contacts

Leonard Krishtalka, Director
KU Natural History Museum
1345 Jayhawk Boulevard
Lawrence KS 66045–7505
785–864–4540
krishtalka@ku.edu

Jen Humphrey, Coordinator
Biodiversity Institute
1345 Jayhawk Boulevard
Lawrence KS 66045–7505
785–864–2344
jenhumphrey@ku.edu

Schedule and Itinerary

Thursday, June 9, 2011

6:00 a.m. Breakfast starts at Oread Hotel, Lawrence

8:00 a.m. **Bus leaves Oread Hotel for Site 7**

Bus Session – Federal Reserved Water Rights for Indian Tribes in Kansas
Burke Griggs, Counsel, KS Dept. of Agriculture – Division of Water Resources

9:00 a.m. Break, Easton

9:45 a.m. **SITE 7** – Dalbey Bottoms, Atchison
Missouri River Mitigation
Steve Adams, Natural Resource Coordinator, KS Dept. of Wildlife and Parks
Mark Frazier, U.S. Army Corps of Engineers

10:15 a.m. Bus to Site 8

11:15 a.m. **SITE 8** – Mid-America Regional Council (MARC)
Missouri Riverbed Degradation, Kansas City, MO
David Warm, Executive Director, MARC

12:00 a.m. Lunch at MARC

1:00 p.m. Bus to Site 9

1:15 p.m. **SITE 9** – Wyandotte Air Monitoring Station, Kansas City, KS
Urban Air Quality and Monitoring
Michael Davis, Laboratory Director, EPA Region VII

1:45 p.m. Bus to Site 10

2:00 p.m. **SITE 10 –** EPA Region VII Laboratory, Kansas City, KS
Laboratory Tour
Ronald Hammerschmidt, Director, Environmental Services Division

Missouri River Dredging
David Hibbs, U.S. Army Corps of Engineers

3:15 p.m. Bus to Site 11

3:30 p.m. **SITE 11** – Kaw Point
Asian Carp Migration in the Missouri and Kansas Rivers
Jason Goeckler, Aquatic Nuisance Species Coordinator, KS Dept. of Wildlife and Parks

4:30 p.m. Bus to Hotel

5:00 p.m.	Arrive at Holiday Inn Express, Village West, Kansas City, KS
6:00 p.m.	Bus to University of Kansas Medical Center
6:30 p.m.	Social Gathering at Robert Hemenway Life Sciences Innovation Center *Dr. Barbara Atkinson,* Executive Vice Chancellor, University of Kansas Medical Center *Dr. Roy Jensen,* Director, Kansas Masonic Cancer Research Institute, University of Kansas Medical Center
7:00 p.m.	Supper at Robert Hemenway Life Sciences Innovation Center
8:00 p.m.	Bus to Holiday Inn Express

Missouri River Mitigation

Prior to 1900, the Missouri River had a diverse braided channel structure and wide meander reaches. Beginning in 1912, the U.S. Congress established the Bank Stabilization and Navigation Project (BSNP), which was implemented by the U.S. Army Corps of Engineers (USACE) and completed in 1981. The BSNP effectively channelized the Missouri River from Sioux City, Iowa, to St. Louis (735 miles), controlling the river's movement and geometry for navigation and flood-control purposes.

While the project was successful at creating a navigation channel, there were unintended consequences. Due to channelization, about 100,000 acres of Missouri River aquatic habitat within the channel and 420,000 acres of floodplain or seasonally flooded habitat were lost. Along with the lost habitat, the channel was changed from a wide braided channel with many islands and sandbars to a much narrower, high-velocity channel that has a uniform shape (fig. 1). As a result, native fish and wildlife populations declined dramatically. By some accounts, more than 60 documented species have declined to the point of entry onto State watch lists or listed as threatened or endangered. In addition, three species—the pallid sturgeon, least tern, and piping plover—declined to the point that they were Federally listed as threatened or endangered. To mitigate habitat loss, Congress authorized a project to replace a portion of the river habitat. In addition, the U.S. Fish and Wildlife Service (USFWS) outlined mitigation alternatives to restore shallow-water habitat (SWH) for the pallid sturgeon by either constructing suitable habitat or making flow modifications to the river. Engineered or constructed SWH methods were chosen as the primary alternative to restore habitat.

Shallow Water Habit Construction

In general, three types of engineered alternatives commonly are used to create SWH on the Missouri River: in-river structure modification, increased bank area, and constructed chutes/side channels. The structure modification involves either removing or creating structures in the river channel to create habitat without increasing river area (fig. 2). Increased bank area involves opening the existing bank to the river allowing the river to access new areas or the removal of structures that confined the channel (fig. 3). Constructed chutes/side channels create a new channel(s) parallel to the river and form an island between the main channel and new side channel. The excavated channels mimic the historic

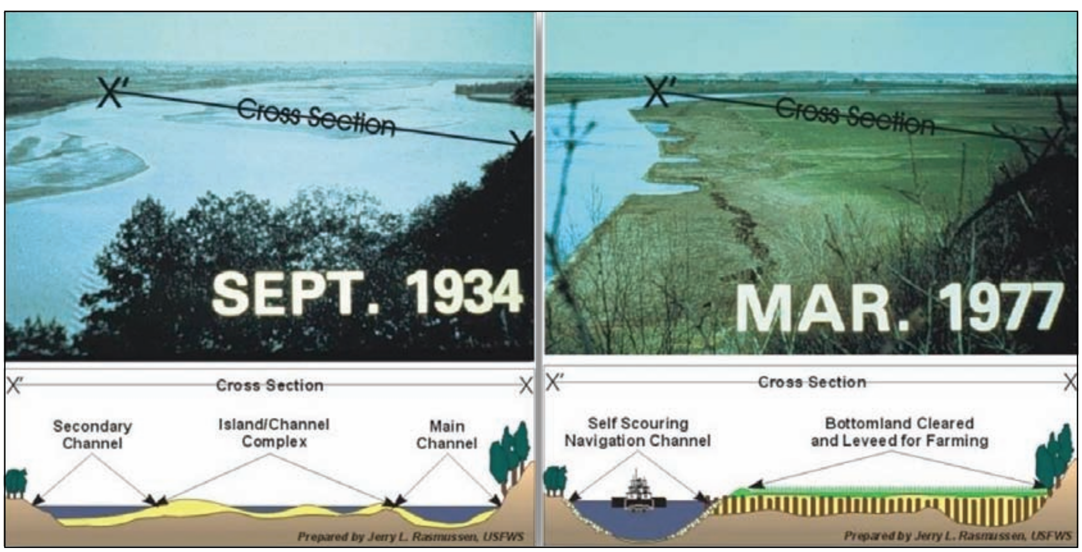

Figure 1. Example of an engineered river channel illustrating the loss of terrestrial and aquatic habitat in the Missouri River (USACE, 2011).

braided geomorphology of the Missouri River (fig. 4). The Dalbey Bottoms Mitigation Project is an engineered chutes/side channel through an artificial point bar on the river.

Dalbey Bottoms Mitigation Project

Dalbey Bottoms is located approximately 5 miles southeast of Atchison, Kansas. The site is 1,610 acres of land created by BSNP channelization efforts dating back to the 1930s. The property was purchased by the USACE from willing sellers in 2007 and 2010. The 5 miles run along the right descending bank of the Missouri River between river miles 415 and 420 (fig. 5). The Dalbey Bottoms project has two purposes, to mitigate the loss of fish and wildlife habitat due to BSNP and to comply with the USFWS to restore river habitat for threatened and endangered species.

The project is managed under the Missouri River Recovery Program (MRRP), which is responsible for shallow water habitat mitigation and other river features. The Dalbey Bottoms project meets several requirements of the MRRP, including restoration

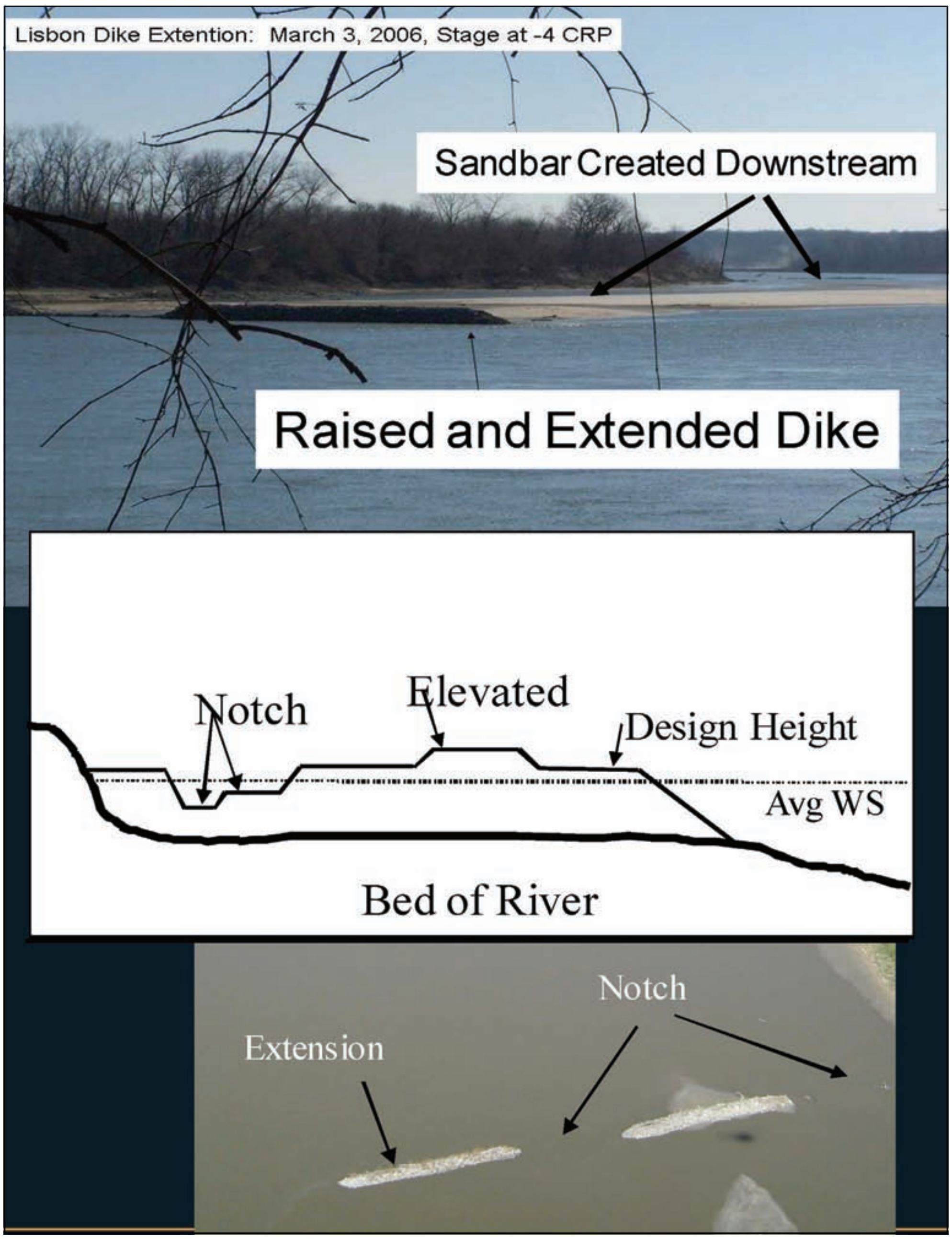

Figure 2. Structure modification to create shallow water habitat (Grossenauer, 2009).

of the river's meander belt and to have no adverse impacts on navigation or existing flood-carrying capacity.

Project Scope

The project will consist of three flow-through chutes, each initially 75 feet wide and 20 feet deep (fig. 6). The chutes will be open to the natural forces of the river. The project also will create a scour hole, realign Walnut Creek, place a stop-log structure near Owl Creek, and notch the agricultural levee to maximize shallow-water habitat and wetland development. The Kansas Department of Wildlife and Parks manages the USACE-owned site.

Construction will consist of land-based excavators and side-casting spoil, as well as rock placement to control flow in the chutes. Chute construction will be closed to the river (excavating the ends last) to minimize sediment exposure to the river.

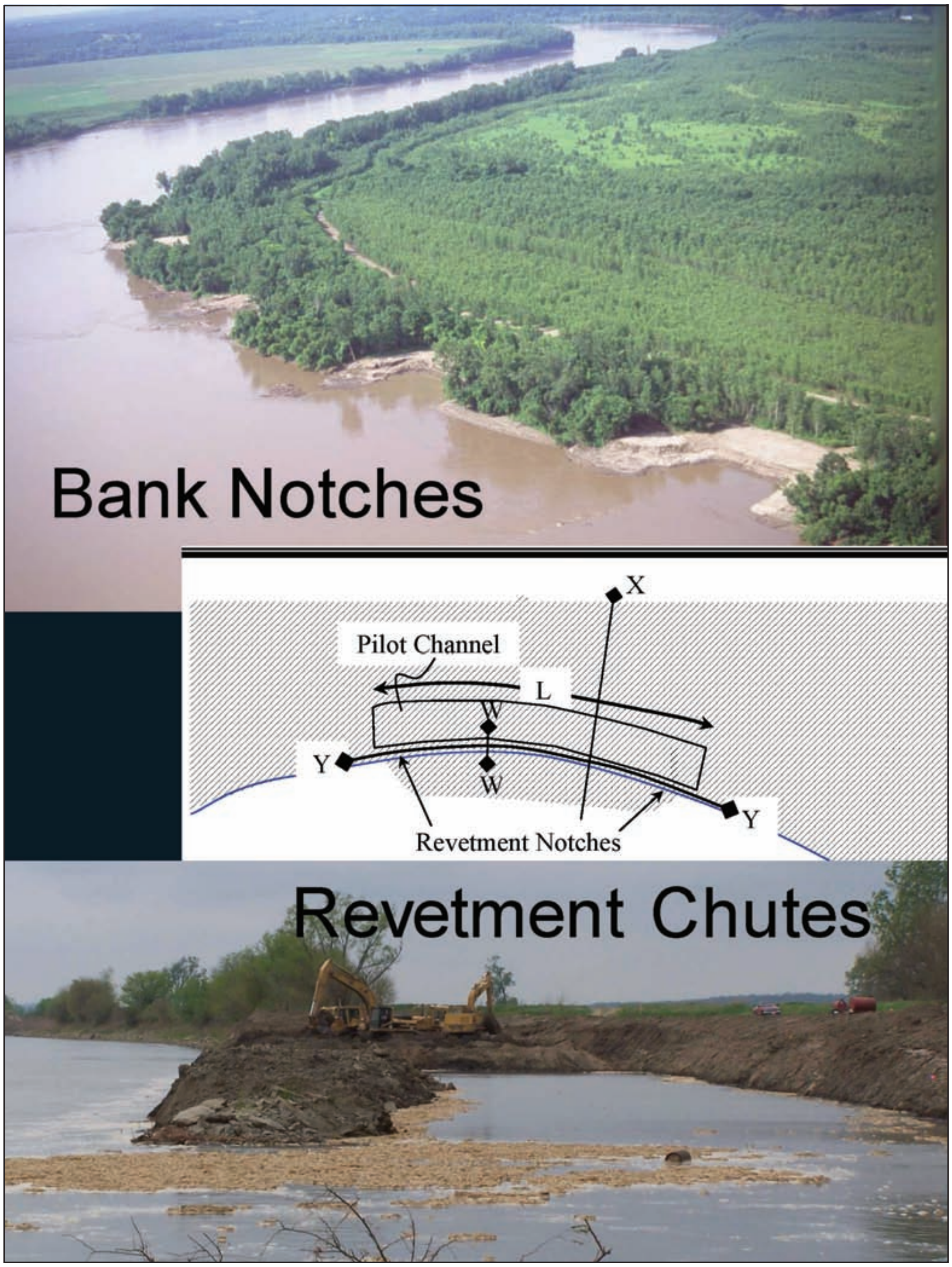

Figure 3. Increased bank area to increase shallow-water habitat (Grossenauer, 2009).

Project Status

Project funds for the two northern chutes are expected to be available for award in late May or early June 2011. Construction of these chutes should be complete within a year of award.

The southern chute will be constructed using USACE-internal hired labor and will begin in Spring 2011.

Sources

Grossenauer, M., 2009, Missouri River program—progress and challenges in creating shallow water habitat for the endangered pallid sturgeon: AWRA 2009 Annual Water Resources Conference, November 9-12, 2009, Seattle Washington, http://www.awra.org/seattle2009/presentations/Session%2051/2009%20AWRA%20presentation%20-%20Gossenauer1.pdf.

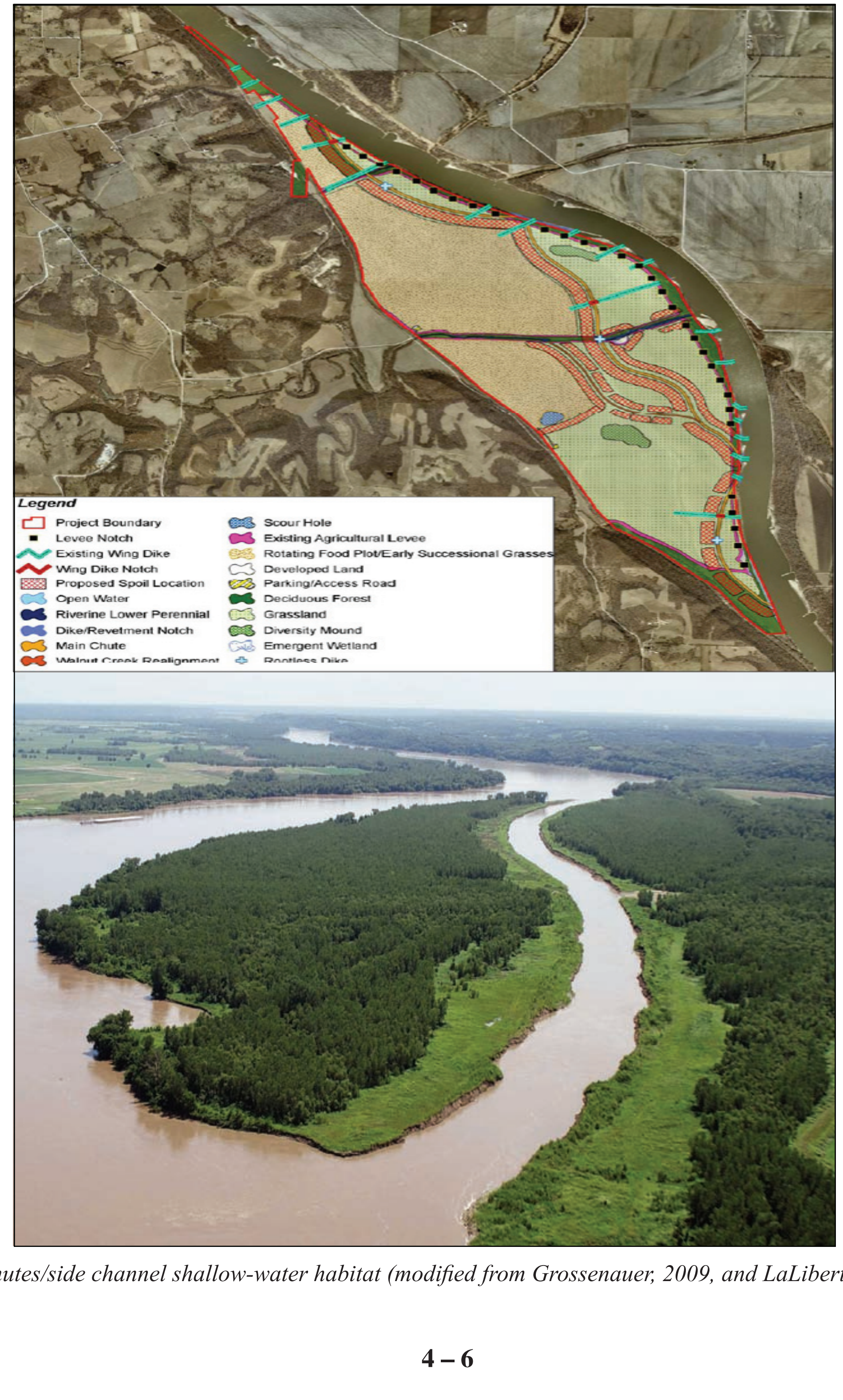

Figure 4. Chutes/side channel shallow-water habitat (modified from Grossenauer, 2009, and LaLiberty, 2010).

Figure 5. Dalbey Bottoms project location south of Atchison, Kansas.

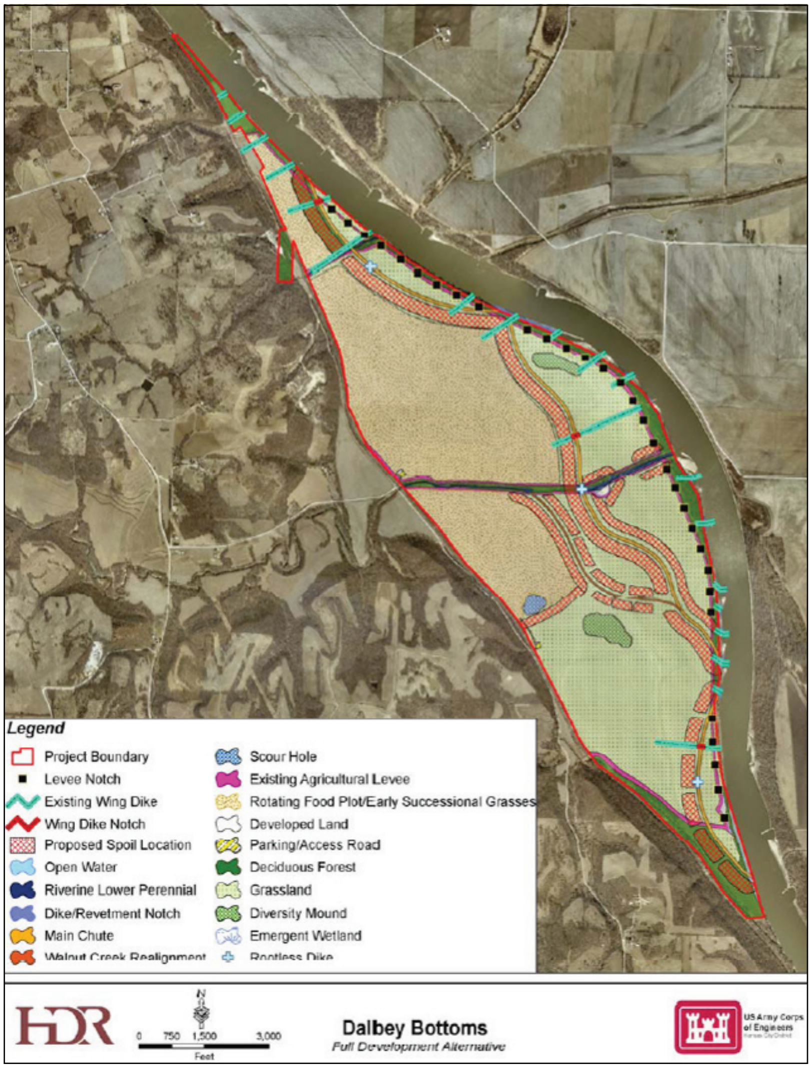

Figure 6. Dalbey Bottoms chute construction and development options (USACE, 2011).

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Science Daily, 2010, Understanding Missouri River's sediment dynamics key to protecting endangered species: Science Daily, Sept. 28, 2010, http://www.sciencedaily.com/releases/2010/09/100928135049.htm.

Contacts

Steve Adams
Natural Resource Coordinator
Kansas Department of Wildlife and Parks
1020 S. Kansas Avenue
Topeka, KS 66612
785–296–2281
steve.adams@ksoutdoors.com

Chance Bitner, PE
Missouri River Recovery Program
Kansas City District Corps of Engineers
601 E. 12th Street
Kansas City, MO 64106
816–389–3482
Chance.J.Bitner@usace.army.mil

Steve Fisher
Senior Program Manager
Missouri River Recovery Program
US Army Corps of Engineers
816–389–3220 (Kansas City)
402–995–2636 (Omaha)
Steven.A.Fischer@usace.army.mil

Missouri Riverbed Degradation

The Missouri Riverbed levels have degraded or dropped between St. Joseph and St. Louis, with the most serious degradation occurring around the Kansas City reach. The problem continues to intensify, with impacts on water supply, industry, and public infrastructure due to low river levels and other factors. Degradation has required area water suppliers to invest tens of millions of dollars on new water-intake facilities. Other utilities and industries face similar costs to protect facilities and maintain operations. Public investments in wildlife-habitat restoration and flood-prevention infrastructure are also threatened.

Problem and Need

Missouri Riverbed degradation or downcutting causes river-bank instability and undermines structures that depend on stable river banks. Degradation has been occurring for at least 60 years around Kansas City and appears to have worsened in recent years. Degradation is also evident to a lesser extent in other reaches of the Missouri River around St. Charles, Jefferson City, St. Joseph, and Sioux City. As the Missouri River degrades, head cuts, which are the advancing edge of a downcutting stream, also migrate up tributary streams in Kansas and Missouri. Head cutting undermines bridges, utility crossings, and other structures at locations far removed from the Missouri River.

The problem potentially threatens a wide range of wildlife habit, municipal, and Federal infrastructure. Some of the degradation impacts threaten major bridge piers and the huge Federal investment in critical Missouri River habitat restoration. It is a direct and imminent threat to the U.S. Army Corps of Engineers (USACE) Bank Stabilization Project and the Federal levee system (fig. 1). The degradation significantly impacts the public infrastructure of Kansas City, Missouri, and Kansas City, Kansas, and causes the need to rebuild sophisticated intake structures at the river's edge for municipal, commercial, and industrial water users (fig. 2). Stream-bank erosion can result in compromised use and value of adjacent riparian property, and fish and wildlife habitats. Smaller sediment loads in the river reduce nesting habitats for piping plover and

Figure 1. Example of a levee failure due to loss of foundation sediments removed by degradation (Shelley, 2011).

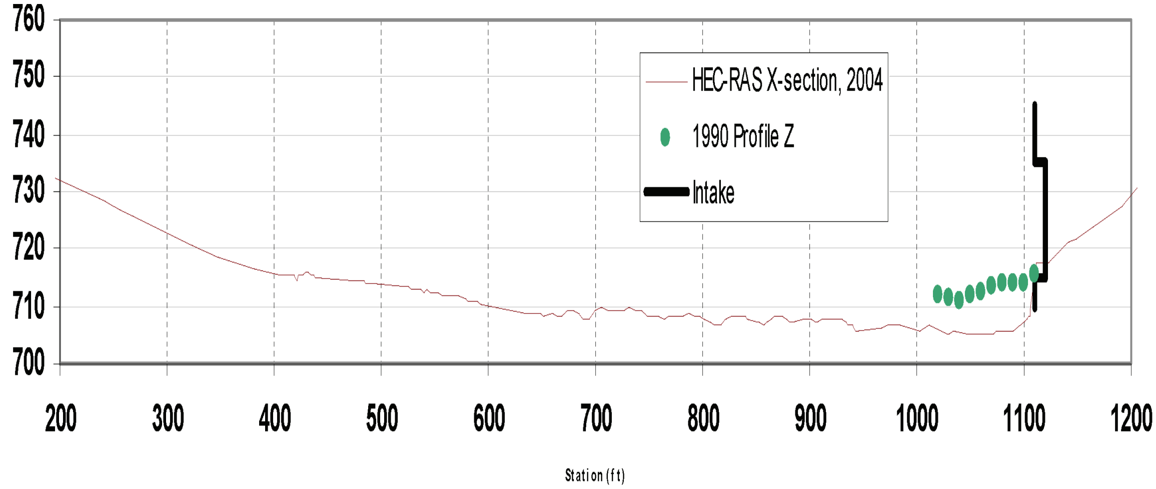

Figure 2. 1990 and 2004 Missouri Riverbed cross section relative to Kansas City Board of Public Utilities Quindaro Power Station Intake #3 in Kansas City, Kansas (Cassidy, 2007).

least tern and suitable spawning habitat for the pallid sturgeon.

To address degradation, the USACE is working with the Mid-America Regional Council and local partners to fund and perform a feasibility study on solutions to the riverbed loss problem, particularly in the Kansas City reach of the river. The investigation would determine the causes of the problem and then allow USACE to determine possible actions to mitigate the problem.

Riverbed Degradation in the Lower Missouri River

The loss of sediment and increased flow channelization on the Missouri River has altered the way the river dissipates or balances energy through water and sediment transport. Construction of the Bank Stabilization and Navigation Project (BSNP) for barge traffic and navigational improvements has resulted in a deeper river with a single predominant channel that tends to prevent sediment accumulation in the channel bottom. Flow is generally faster due to removal of meandering waterways and shallows. Upstream water capture in reservoirs has changed the period and amounts of seasonal flows. Upstream dams and reservoirs and bank-stabilization projects also trap large amounts of sediments that previously moved downstream with normal water flow. Commercial dredging operations also have removed sediment. The effect is generally a sediment-starved, faster-moving river with more erosive energy, especially during high-flow periods. In the absence of sediment load and channel area to dissipate energy, the river will downcut to dissipate energy and maintain a stable gradient or energy balance.

Associated with bed degradation, the average low-flow surface-water elevation has dropped approximately 10–15 feet in some locations over the past 50 years. Dropping water levels have resulted in river-bank erosion, tributary degradation, and head-cutting away from the river into Kansas.

Missouri River Geomorphology

The nature of the Missouri River has changed dramatically during the 20th century and to understand river degradation, it is helpful to consider the river without engineered constraints. Prior to European settlement, the river migrated freely across the floodplain and transported about five times the amount of suspended sediment as the modern river. Snags and trees along its banks obstructed river flow, dissipating flow energy. The river-channel width was variable with chutes, bars, and secondary channels. The high sediment load and variable channel width all helped balance the erosive energy of the river.

Maps from the Lewis and Clark expedition (1804–1806) and late 1800s surveying provide historical information on the river geomorphology prior to engineered navigation channels (fig. 3). In the early 1800s, the Missouri River at Kansas City was much wider and less sinuous than the modern channel form. The main channel was approximately 1,300 feet wide, with some side channels around islands

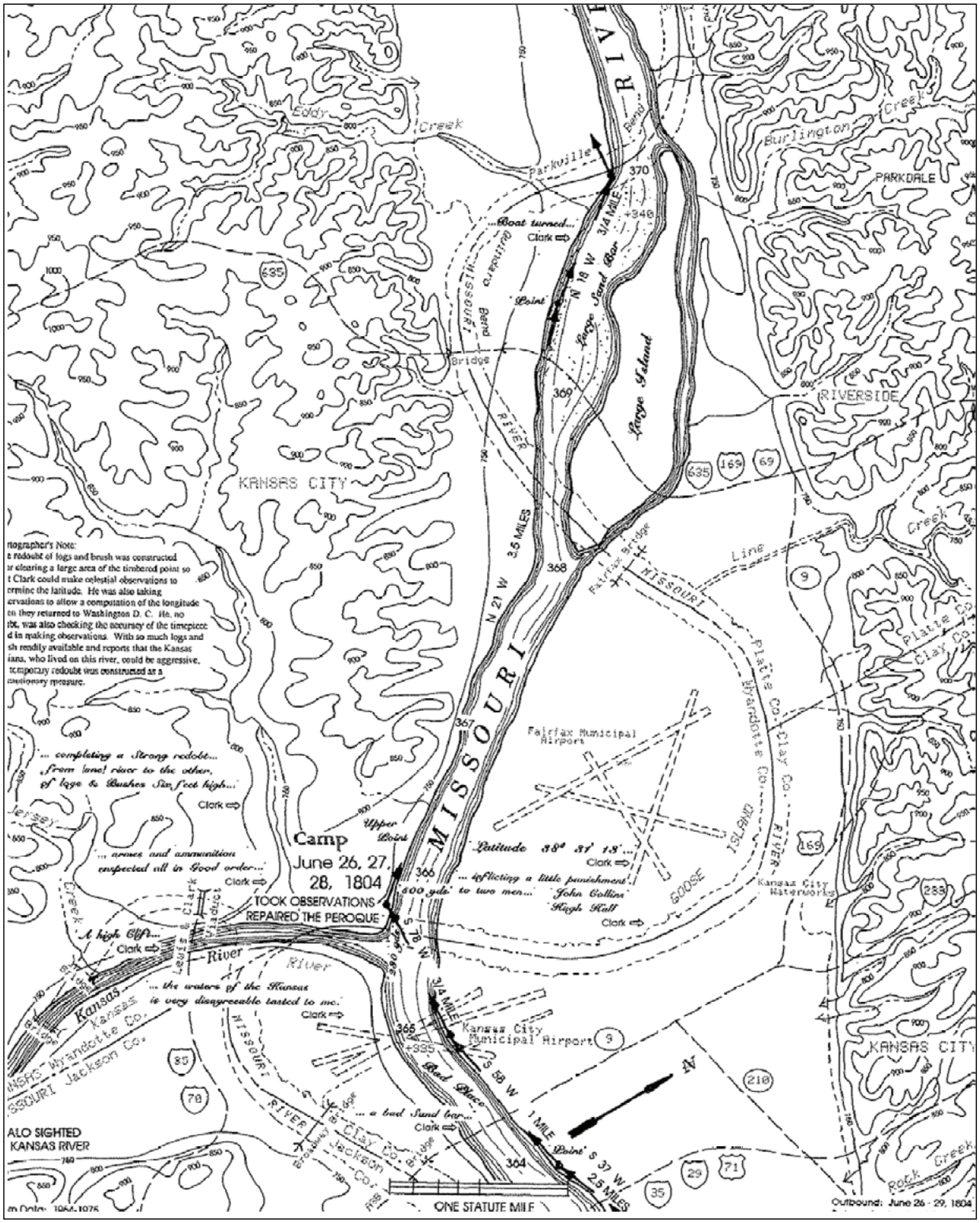

Figure 3. Map of the Missouri River near its confluence with the Kansas River at Kaw Point at the time of the Lewis and Clark Expedition. The modern, channelized Missouri River is overlain for reference (Cardno Entrix, Inc, 2011).

that were up to 1 mile wide. During floods, the wide sediment-laden Missouri River at times extended up to 5 miles across its floodplain.

In contrast, since the Lewis and Clark expedition, the modern channel is much narrower and constrained due to upstream dams, commercial dredging, bank stabilization, and navigation projects. After these engineered changes, the river was converted into an approximate 600-foot-wide navigation channel designed to efficiently convey river traffic and require little maintenance dredging (fig. 4).

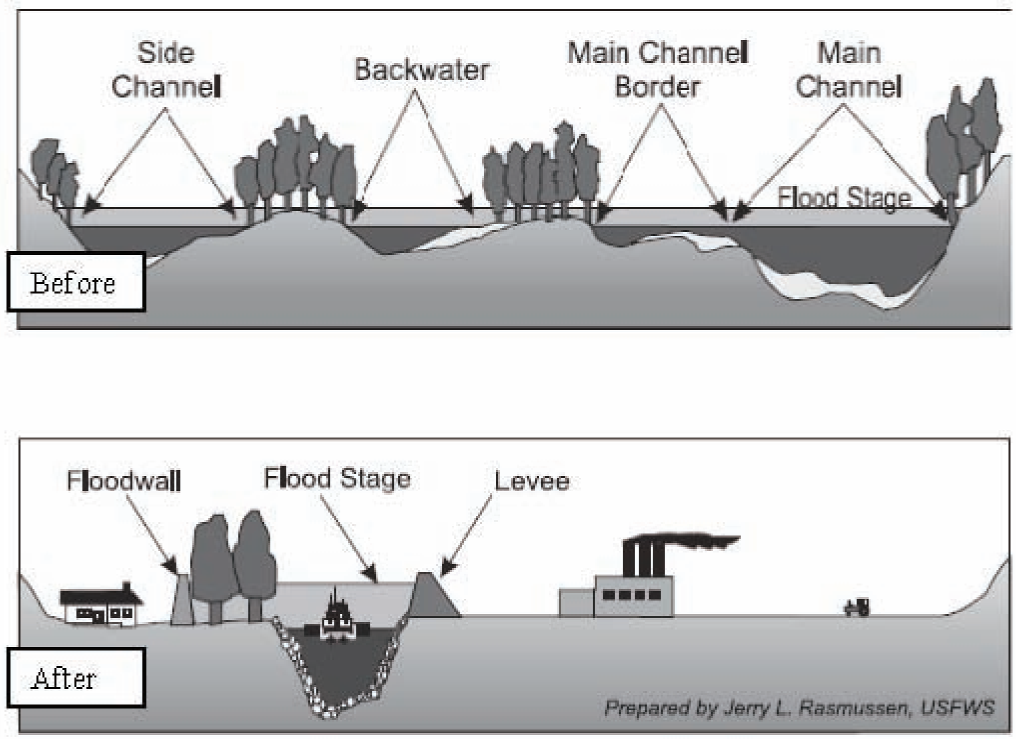

Figure 4. Typical cross section before and after the Missouri River bank stabilization and navigation project (Cardno Entrix, Inc, 2011).

Channelization Methods

The Missouri River was channelized using a system of oxbow cutoffs, revetments, and levees. Since about 1890, the Missouri River between Sioux City and the Mississippi River has been shortened by cutting off oxbow bends, reducing its length by approximately 75 miles, or 10 percent of its original length. Most of the shortened reaches occurred between Sioux City and Omaha and between Waverly and Kansas City. These shortened reaches cause local head cutting and downstream aggradation as the river adjusts to a new slope or grade.

Revetments, woven willow mats covered with rock, were one of the first methods used in the 1900s to protect river banks from erosion and to channelize the river (the rock was sometimes called “one man stone” because they were as big as a single man could physically carry). The Kansas City reach of the Missouri River has the highest average number of miles of revetment.

Other channel modifications include levees. Levees are engineered dikes that prevent river flow into the floodplain. During flood events, levees increase the height of floodwater and prevent flood energy dissipation by the floodplain.

An example of engineered river channel is presented in Figure 5. It chronologically depicts the redirection of the main river channel at Indian Cave Bend in southeast Nebraska. The wide, somewhat braided channel has narrowed considerably and illustrates how the engineered structures constructed in the mid-1930s defined the present-day channel conceptually depicted in fig. 4.

Sources

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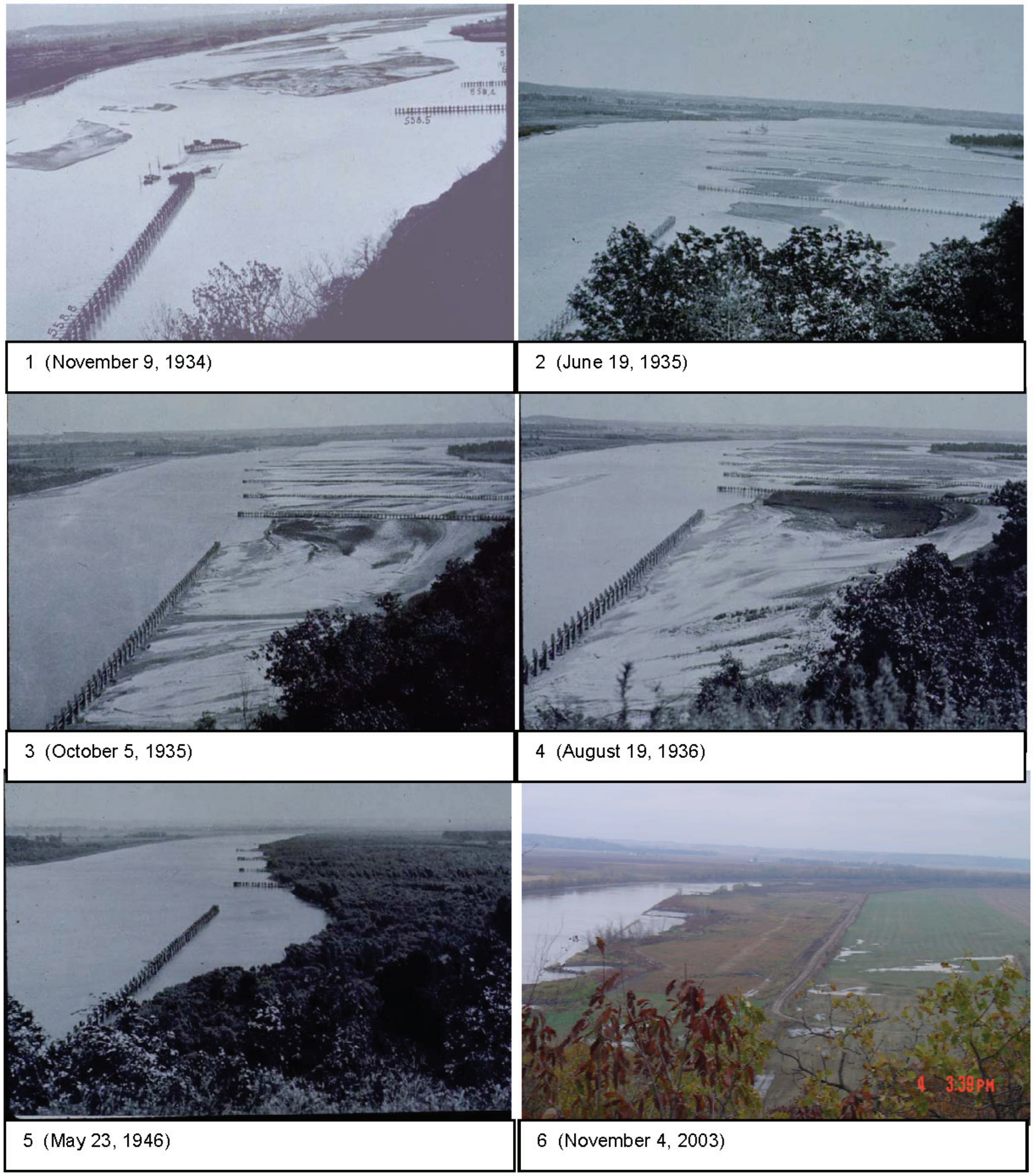

Figure 5. Time series of photos over a period of 69 years showing construction and filling of a dike field (Cardno Entrix, Inc., 2011).

USACE, 2011, Missouri River commercial dredging website: U.S. Army Corps of Engineers, http://www.nwk.usace.army.mil/regulatory/Dredging/MO/MOdredging.htm, accessed May 7, 2011.

Contacts

David Warm
Executive Director
Mid-America Regional Council
600 Broadway, Suite 200
Kansas City, MO 64105
816–474–4240
dwarm@marc.org

Tom Jacobs
Environmental Program Director
Mid-America Regional Council
600 Broadway, Suite 200
Kansas City, MO 64105
816–474–4240
tjacobs@marc.org

Urban Air Quality and Monitoring

History of the Clean Air Act

In October 1948, a thick cloud of air pollution formed above the industrial town of Donora, Pennsylvania. The cloud, which lingered for five days, killed 20 people and sickened another 6,000 of the town's 14,000 people. In 1952, over 3,000 people died in what became known as London's "Killer Fog." The smog was so thick that buses could not run without guides walking ahead of them carrying lanterns.

In response to events like these, several Federal and State laws were passed, including the original Clean Air Act of 1963, which provided funding for the study and the cleanup of air pollution. However, no comprehensive Federal response addressed air pollution until Congress passed a stronger Clean Air Act in 1970. The U.S. Environmental Protection Agency (EPA) was created the same year and given the primary role in carrying out the law.

In 1990, Congress dramatically revised and expanded the Clean Air Act, providing EPA even broader authority to implement and enforce regulations reducing air pollutant emissions. The 1990 amendments also placed an increased emphasis on more cost-effective approaches to reduce air pollution.

Clean Air Act Roles and Responsibilities

The Clean Air Act is a Federal law covering the entire country. However, states, tribes, and local governments do a lot of the work to meet the Act's requirements. For example, representatives from these agencies work with companies to reduce air pollution. They also review and approve permit applications for industries or chemical processes.

EPA's Role

Under the Clean Air Act, EPA sets limits on certain air pollutants, including setting limits on how much can be in the air anywhere in the United States. This helps to ensure basic health and environmental protection from air pollution for all Americans. The Clean Air Act also gives EPA the authority to limit emissions of air pollutants coming from sources like chemical plants, utilities, and steel mills. Individual states or tribes may have stronger air pollution laws, but they may not be weaker than those set by EPA. EPA must approve State, tribal, and local agency plans for reducing air pollution. If a plan does not meet the necessary requirements, EPA can issue sanctions against the state and, if necessary, take over enforcing the Clean Air Act in that area. EPA assists State, tribal, and local agencies by providing research, expert studies, engineering designs, and funding to support clean air progress.

State and Local Governments' Role

It is beneficial for State and local air pollution agencies to take the lead in carrying out the Clean Air Act. They are able to develop solutions for pollution problems that require special understanding of local industries, geography, housing, and travel patterns, as well as other factors. For instance, Kansas developed the Flint Hills Smoke Management Plan in response to air-quality impacts from prescribed burning in the Flint Hills region of the state.

State, local, and tribal governments also monitor air quality, inspect facilities under their jurisdictions and enforce Clean Air Act regulations (fig. 1).

States have to develop State Implementation Plans (SIPs) that outline how each state will control air pollution under the Clean Air Act. A SIP is a collection of the regulations, programs, and policies that a state will use to clean up polluted areas. The states must involve the public and industries through hearings and opportunities to comment on the development of each State plan.

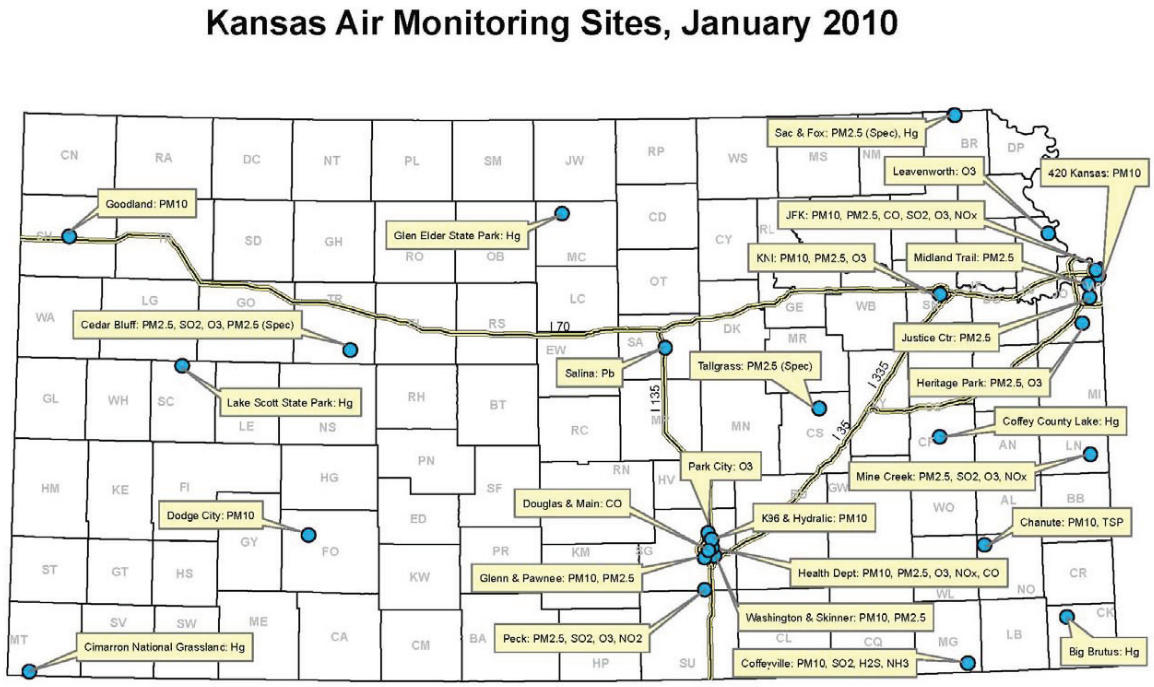

Figure 1. Ozone and particulate matter monitoring locations in Kansas (KDHE, 2010).

Tribal Nations' Role

In its 1990 revision of the Clean Air Act, Congress recognized that Indian Tribes have the authority to implement air-pollution control programs. EPA's Tribal Authority Rule gives tribes the ability to develop air-quality management programs, write rules to reduce air pollution, and implement and enforce their own rules. While State and local agencies are responsible for all Clean Air Act requirements, tribes may develop and implement only those parts of the Clean Air Act that are appropriate for their lands.

Criteria Air Pollutants

Six common air pollutants (also known as "criteria pollutants") are found all over the United States. They are particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. These pollutants can harm human health and the environment and cause property damage. Of the six pollutants, particle pollution and ground-level ozone are the most widespread health threats.

EPA calls these pollutants "criteria" air pollutants because it regulates them by developing human-health-based and/or environmentally based criteria (science-based guidelines) for setting permissible levels. The set of limits based on human health is called primary standards. Another set of limits intended to prevent environmental and property damage is called secondary standards. A geographic area with air quality that is cleaner than the primary standard is called an "attainment" area; areas that do not meet the primary standard are called "nonattainment" areas.

Flint Hills Burning and Urban Air Monitoring

The Flint Hills region of Kansas is the last large expanse of unplowed tallgrass prairie in North America (fig. 2). A long tradition of fire management by private ranchers to improve rangeland productivity has prevented the intrusion of woody and other undesirable plants into the prairie. Burning of the tallgrass prairie in the Flint Hills generally occurs in early to late-April to stimulate warm season grasses, particularly big bluestem, and to control undesirable woody species; burning earlier in the spring does not control resprouting woody species. With the majority of prescribed fire activities occurring during this time period, a large amount of particulate matter and ozone precursors are released into the air during a relatively short time.

Figure 2. Kansas Flint Hills ecosystem outlined in black (KDHE, 2010).

The burning in the Flint Hills and the potential impacts that burning has on public health first gained publicity in 2003. In 2003, air-quality monitors that measure ozone in the Kansas City area recorded very high readings on April 12 and 13, and air quality also was impacted several states east of Kansas. Three monitors in Kansas City, Missouri, recorded readings that exceeded the Federal 8-hour ozone standard. The Kansas Department of Health and Environment (KDHE) received numerous complaints from cities and states as far away as Tennessee about poor air quality and high ozone readings. In a more recent burning event over April 8-11, 2010, smoke plumes stretched from Kansas to the eastern seaboard (fig. 3). Smoke migration caused elevated ozone values in eastern Kansas, Missouri, Arkansas, and western Illinois. Ozone levels increased to exceedance levels in the St. Louis metro area and parts of Ohio as smoke continued to drift over the area.

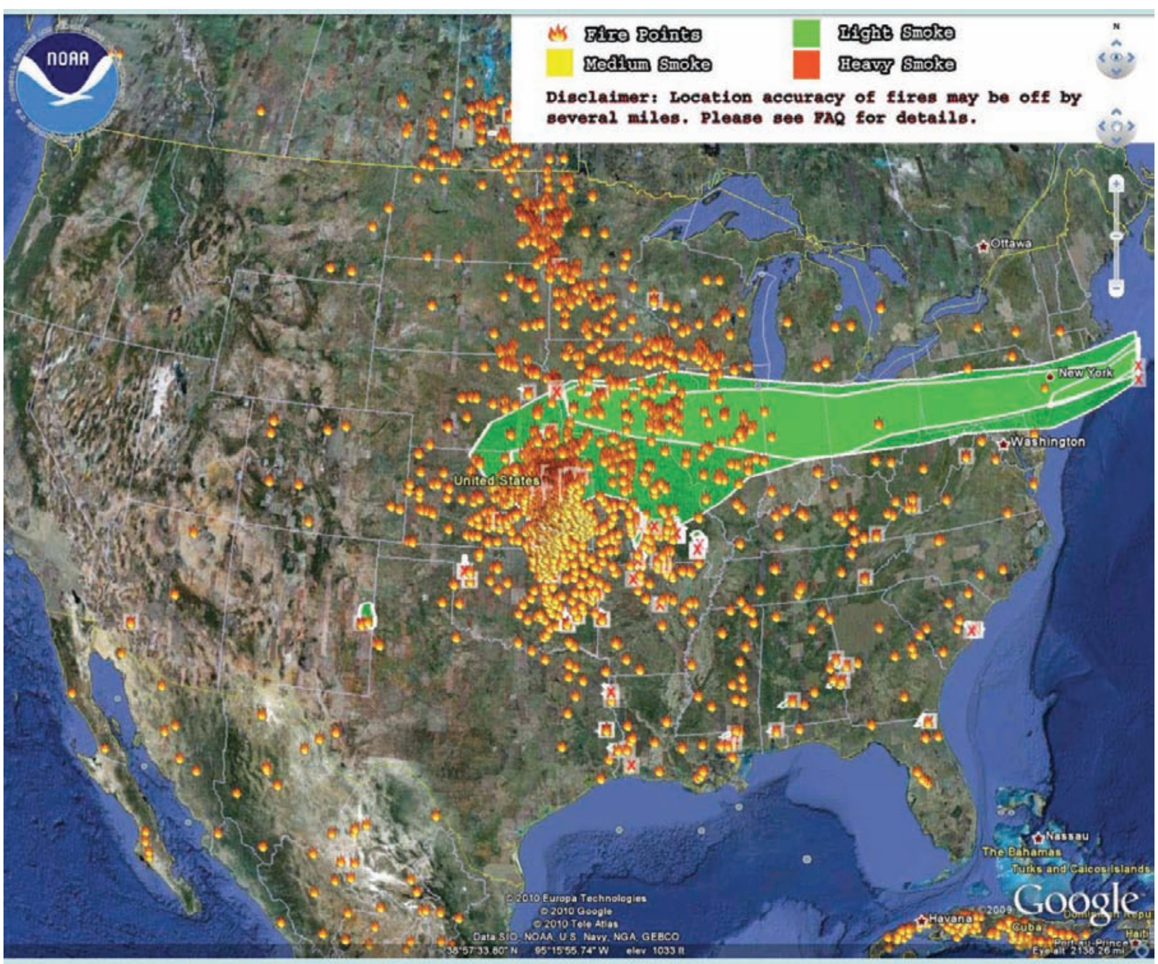

Figure 3. April 11, 2010, smoke plume from three days of Flint Hills burning (KDHE, 2010).

More recently, the ambient-air-monitoring network in Kansas has recorded elevated concentrations of both particulate matter and ozone as well as other pollutants downwind of the Flint Hills region. This has led to an increased interest in the air-quality impacts of fires, not only in Kansas, but throughout the downwind states during the time frame in which the majority of prescribed fire activities occur.

Flint Hills Smoke Management Plan

To address air-quality concerns caused by the annual burning of the tallgrass prairie in the Flint Hills, the State of Kansas, with the assistance of many stakeholders, has developed a smoke management plan. Key elements of the Flint Hills smoke management plan include an interactive website with a predictive, decision-making tool for producers and local fire officials. The tool will allow prescribed burns to be planned to account for smoke management based on real-time weather and air-quality conditions. Fire data will be collected to characterize burning using ambient air and satellite imagery. These data will be used to manage the timing and restrictions of non-prairie burning during April. The management plan will incorporate an extensive outreach program to adopt proscribed burning practices that improve downwind air quality. A pilot program was completed in Spring 2011 in Greenwood and Chase counties to try out the predictive computer-modeling tool and fire management practices. Results from this pilot program will be applied to the rest of the Flint Hills area.

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Contacts

Michael Davis
Laboratory Director
U.S. EPA Region VII
300 Minnesota Avenue
Kansas City, KS 66101
913–551–5042
Davis.Michael@epa.gov

Ronald Hammerschmidt, Ph.D.
Director, Environmental Services Division
U.S. EPA Region VII
901 North 5th Street
Kansas City, KS 66101
913–551–7566
hammerschmidt.ron@epa.gov

Missouri River Dredging

The Missouri River has been commercially dredged for at least 100 years to supply sand and gravel for concrete and asphalt used in construction and road building. River dredging is commercially attractive because the river flow sorts the sand and gravel and negates the need for certain additional types of aggregate processing. Dredging operations are usually concentrated around a dredging company's land-based processing, storage, and distribution facilities, which are geographically situated around construction areas. Accordingly, most commercial sand and gravel dredging on the lower Missouri River primarily occurs near Kansas City, Jefferson City, and St. Charles (fig. 1). As these communities along the Missouri River grew, the demand for sand grew, and dredging increased from 250,000 tons per year in 1935 to a peak of nearly 9 million tons in 2002.

Dredging is one of several factors contributing to riverbed degradation, which can threaten bank stability, erode levee foundations, eliminate adjacent wetlands, and threaten wildlife and habitat. The removal of sand and gravel from the river channel has been closely associated with degradation or channel incision, particularly in segments of the river where dredging is most concentrated. Channel incision occurs when more sediment leaves a section of river than enters it. As a consequence, the incision lowers the riverbed and nearby ground-water levels, leaving surrounding wetlands and surface-water intakes dry or exposed (fig. 2). Sediment removal can also undermine structural foundations of river levees, bridges, and dams on the Missouri and Kansas rivers.

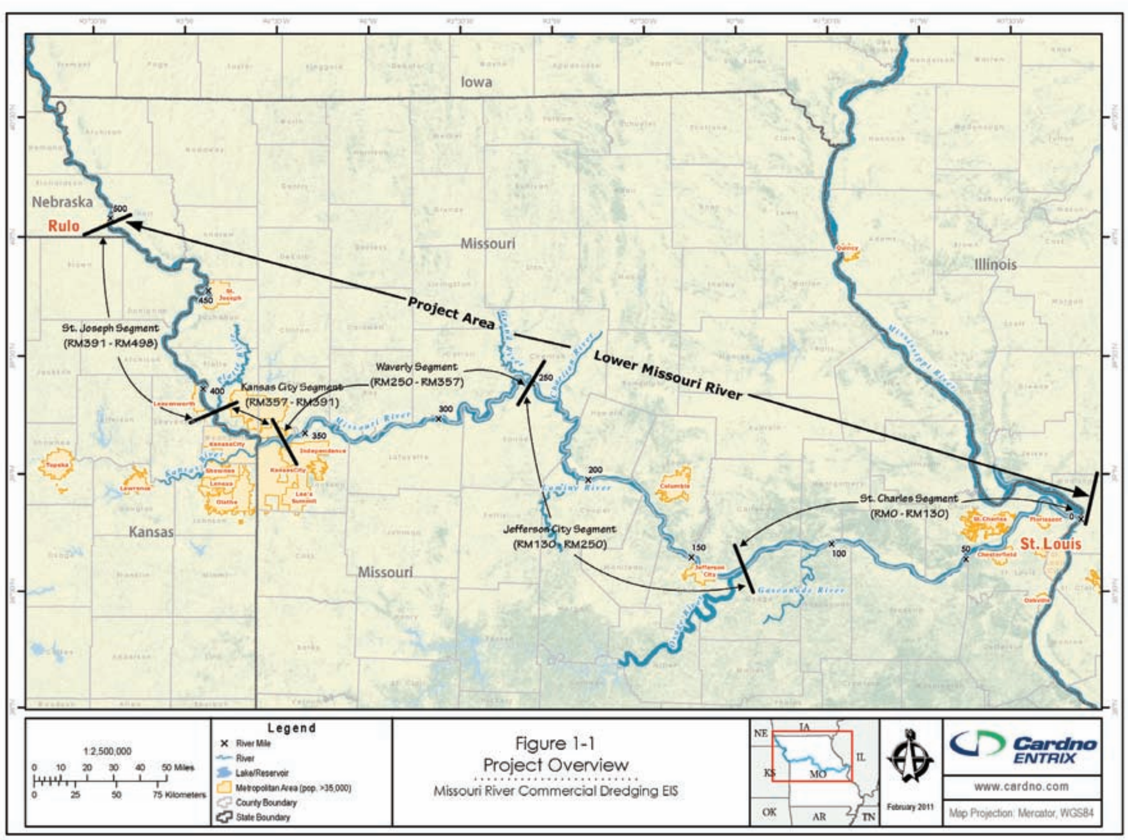

Figure 1. Lower Missouri River dredging segment. Commercial dredging is concentrated around population centers, such as Kansas City, Jefferson City, and St. Louis (USACE, 2011).

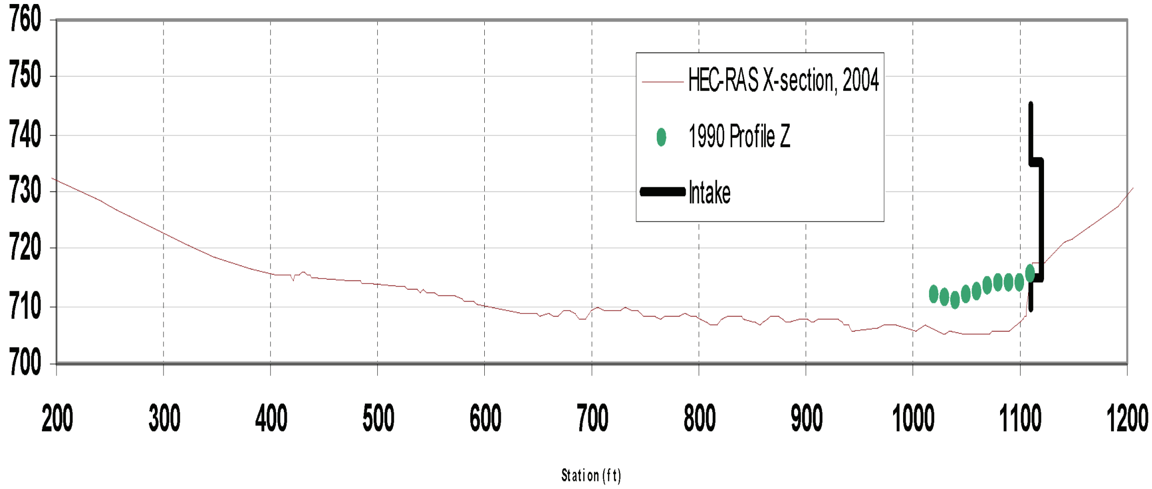

Figure 2. 1990 and 2004 Missouri River riverbed cross section relative to Kansas City Board of Public Utilities Quindaro Power Station Intake #3 in Kansas City, Kansas (Cassidy, 2007).

Dredging Regulation

The U.S. Army Corps of Engineers (USACE) is required under Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act to regulate dredging and filling activities in waters of the United States, including the Missouri River (figs. 3 and 4).

Under those laws and the National Environmental Policy Act, USACE is required to prepare an Environmental Impact Statement (EIS) that fully evaluates and discloses the potential environmental impacts of dredging permits issued by USACE.

A completed final EIS on commercial dredging in the Missouri River was issued by USACE in February 2011. USACE determined that the bed of the Missouri River has degraded or lowered a significant amount over the past several decades. The areas that have degraded the most are also the areas where dredging was most concentrated. In the Kansas City segment, the riverbed and dry-period surface-water elevations have dropped 10–15 feet over the past 50 years, with one-half of the degradation occurring in the past 15 years.

The final EIS identifies the Environmentally Preferred Alternative, which would authorize a

Figure 3. Suction-head dredge with elevated boom and suction head (USACE, 2011).

Figure 4. Stern view of a cutter-head dredge with a loaded barge on the left and an empty barge on the right (USACE, 2011).

level of dredging that USACE believes would best protect the biological and physical environment and minimize the socioeconomic impacts to the local and regional economy and the sand and gravel industry.

Under the Environmentally Preferred Alternative, commercial dredgers would be authorized to continue to extract up to 5,880,000 tons of aggregate per year from the Missouri River for another five years upon the condition that dredging operations are spread farther away from the existing land-based facilities. This authorized amount would be divided between the five distinct river segments (St. Joseph, Kansas City, Waverly, Jefferson City, and St. Charles segments). USACE also denied three applications for new or expanded operations in the Missouri River.

This approach would allow extraction to increase in the slightly degraded and stable St. Joseph and Waverly segments, keep extraction at the average amount in the moderately degraded Jefferson City and St. Charles segments, and further reduce extraction in the most heavily dredged and severely degraded Kansas City segment. The riverbed and surface-water elevations would be monitored by USACE during the five-year permit period and reevaluated before the commercial dredging permits could be reauthorized.

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Contact

David R. Hibbs
Assistant Chief, Regulatory Branch
U.S. Army Corps of Engineers, Kansas City District
601 E. 12th Street, Room 402
Kansas City, Missouri 64106
816–389–3136
david.r.hibbs@usace.army.mil

Kaw Point and Lewis and Clark Historic Park, Kansas City, Kansas

When Meriwether Lewis saw the confluence of the Kansas and Missouri rivers in June 1804, he noted that the "Countrey about the mouth of this river is verry fine on each Side" (University of Nebraska, 2003). As the bicentennial of the Lewis and Clark expedition approached in 2001, the point of the confluence—now shifted a quarter mile downstream from the original location and surrounded by industrial development (fig. 1)—was filled with overgrown brush, rusted steel drums, barges, old equipment and, at one point, 31 semitrailers and 13 abandoned cars (Tarwater, 2005). The once-thriving bison and wolves were long gone and the "Parrot queets" (Carolina Parakeet) extinct.

Today the confluence, Kaw Point, has been revamped into the 6-acre Lewis and Clark Historic Park featuring an education pavilion, trails, picnic areas, interpretive signs, and a boat ramp and docking area for river access (figs. 2 and 3 [Friends of Kaw Point Park, Inc., 2008]). Development of the park was serendipitous, growing out of the plan of a local committee formed in 2001 to host what was intended to be a one-day event commemorating the expedition's bicentennial. As the scope of the project grew, the Wyandotte County Lewis and Clark Task Force was founded. The Task Force then partnered with Friends of the Kaw, Inc. (FOK), which was interested in developing more public access and environmentally friendly recreation along the Kansas River. Serving as an umbrella organization, FOK provided nonprofit status for the Task Force (Tarwater, 2005).

Over the next three years the Task Force carried out an aggressive fundraising campaign that provided the resources for several organizations and agencies—particularly the Unified Government of Wyandotte County/Kansas City, Kansas, the Lewis and Clark Task Force, and the Friends of the Kaw, Inc.—to organize a multi-day bicentennial event and turn an urban wasteland into a first-class park (Tarwater, 2005). In 2006 the Task Force incorporated as the Friends of Kaw Point Park, Inc., to continue park improvements and plan events (Friends of Kaw Point Park, Inc., 2008).

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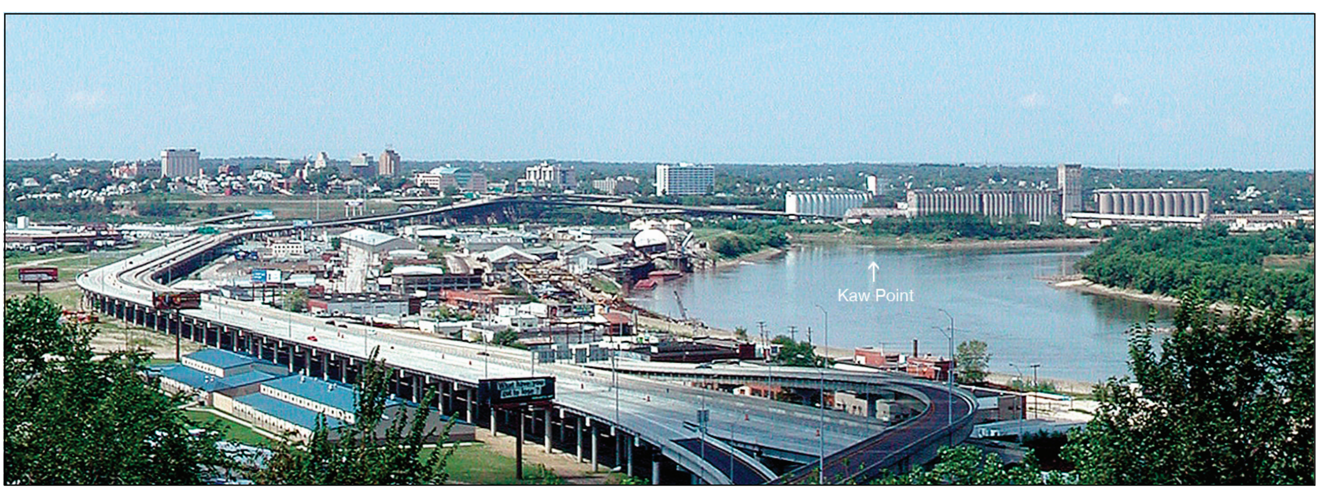

Figure 1. Kaw Point at the confluence of the Missouri and Kansas rivers in July 2002. Photo by John Charlton.

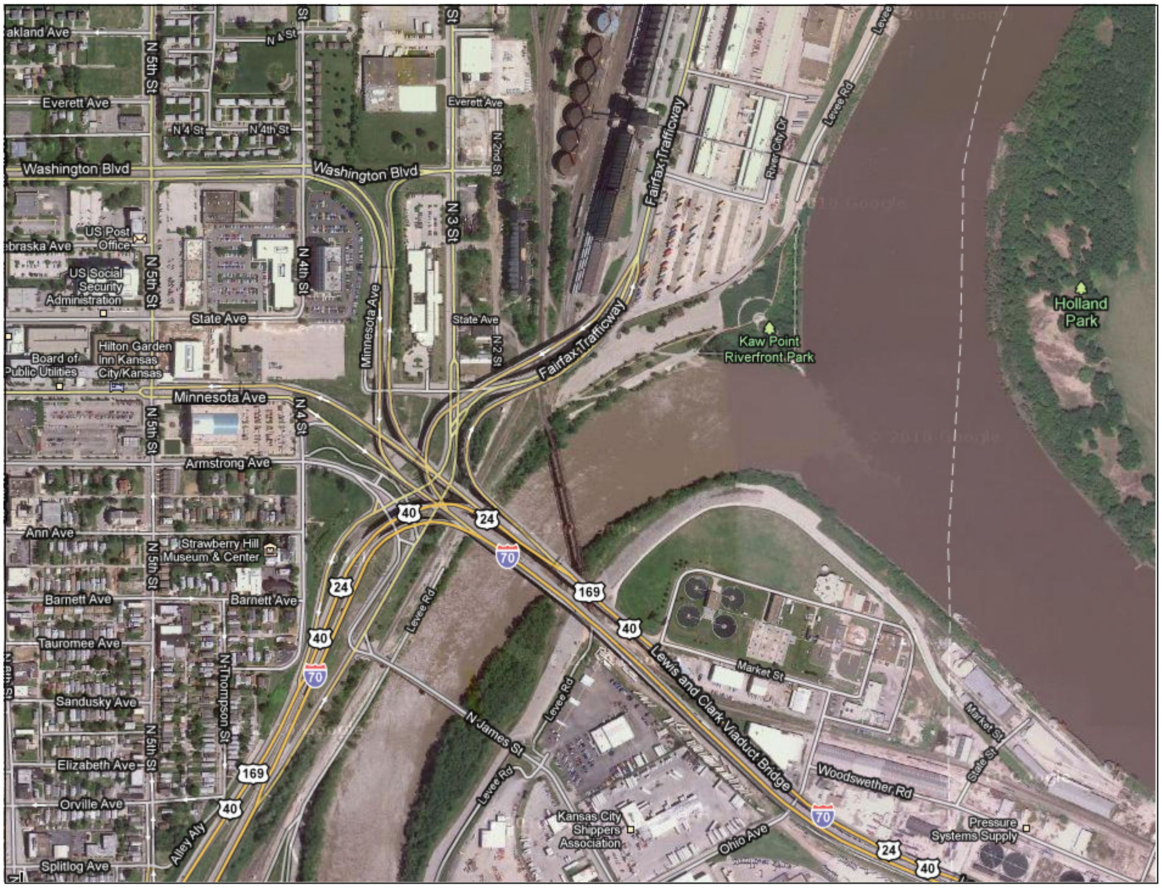

Figure 2. Aerial view of Kaw Point, Wyandotte County, Kansas (©2011 Google Imagery - ©2011 Digital Globe, USDA Farm Service Agency, GeoEye, Mapdata).

Figure 3. Missouri River looking toward Kaw Point and the confluence with the Kansas River (from Friends of Kaw Point Park, Inc.).

Asian Carp Migration in the Missouri and Kansas Rivers

Asian carp refers to five related species of fish originating from eastern Russia, China, and Vietnam. In particular, two of these species, the bighead (*Hypophthalmichthys nobilis*) and silver (*Hypophthalmichthys molitrix*) carp, are threatening to overwhelm aquatic ecosystems in the Great Lakes and Mississippi and Missouri River systems. The two species' enormous spawning rate and feeding habits outcompete and dominate native fisheries to the point of exclusion of other native fish. The silver carp grows quite large, and its habit of leaping out of the water in shock response to boat traffic makes it a safety hazard to recreational water-craft operators and water skiers.

The species were first introduced to the United States in the early 1970s by the aquaculture industry in the southern United States as a food source and to improve water quality in sewage-treatment facilities. Fish escapes from impoundments and hatcheries lead to its establishment in the Missouri and Mississippi River systems. Upstream migration of the carp threatens the Great Lakes and its annual $7 billion commercial- and sport-fishing industry (figs. 1 and 2).

Asian Carp Ecology

The Asian carp is a sub-tropical to temperate species, native to large rivers and lakes in eastern Russia and China. The carp reach sexual maturation at about 4–7 years, depending on the climate. In general, they require large, low-gradient, turbid rivers to complete their life cycle. Generally, their life cycle starts with a prespawn upstream migration of adults in the spring or summer, typically triggered by increasing water temperature and flow. Spawning usually takes place in somewhat turbulent water such as downstream from the confluence of two rivers or tributaries. Asian carp broadcast spawn, and the fertilized eggs drift downstream with the current. Fecundity of an Asian carp ranges from about 265,000 to 2,000,000 eggs.

Post spawning adults migrate back downstream in late summer. Eggs hatch in the flowing river, and the larvae move into nursery areas such as floodplain lakes or backwater areas.

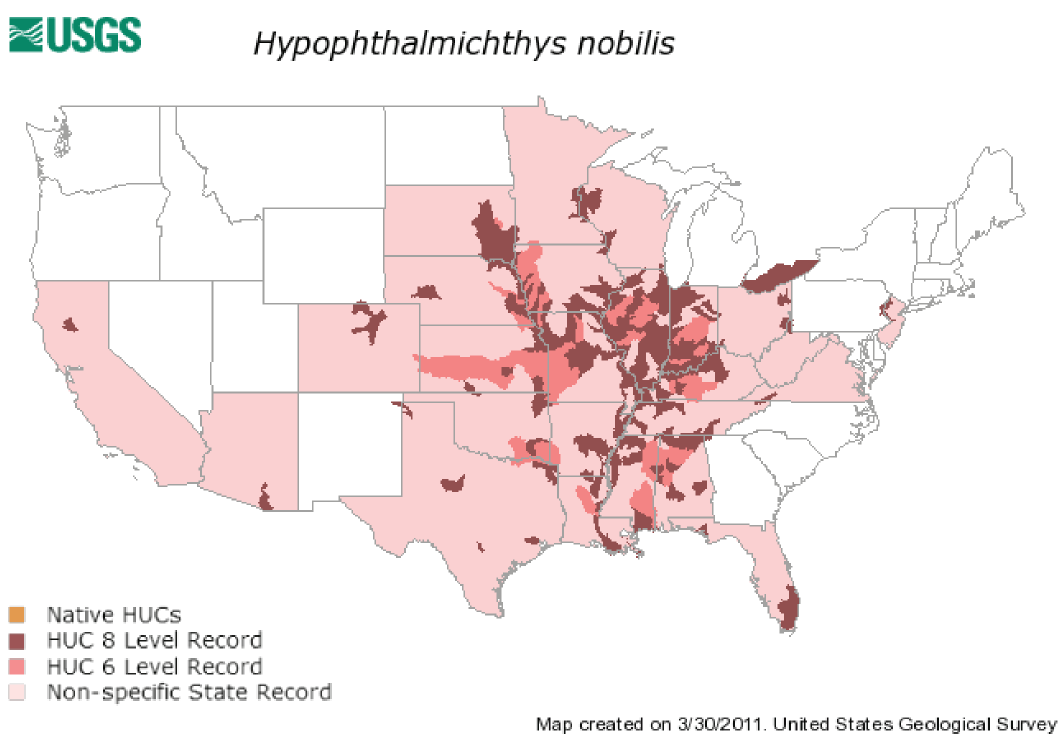

*Figure 1. Bighead carp (*Hypophthalmichthys nobilis*) distribution (USGS NAS, 2011b).*

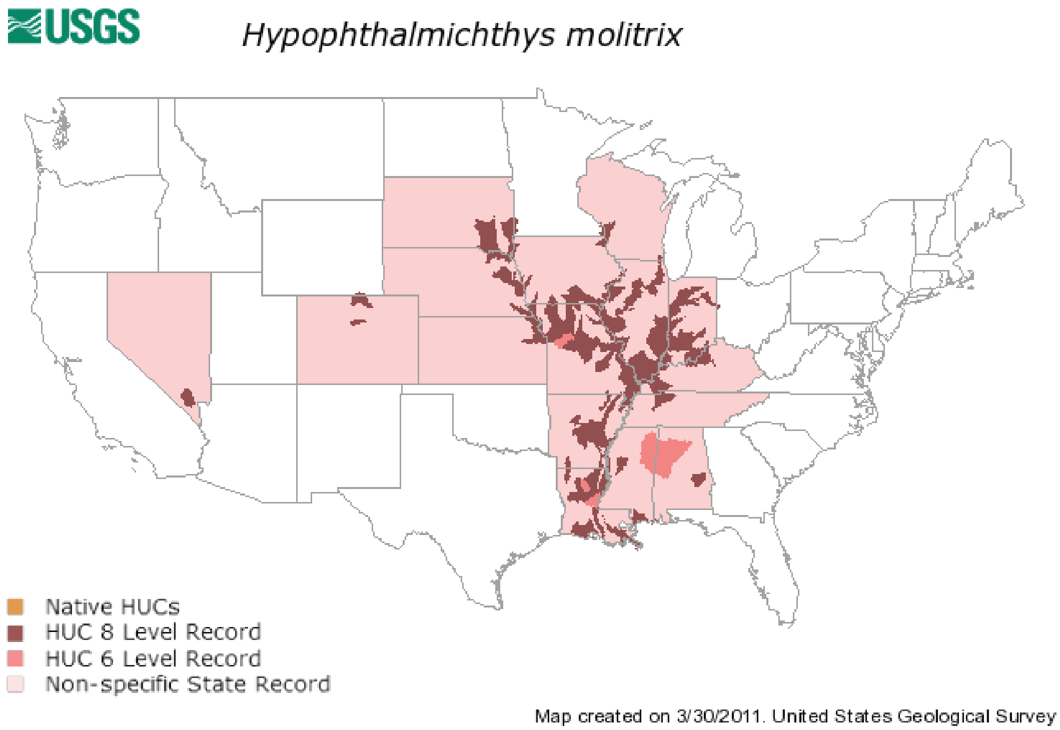

*Figure 2. Silver carp (*Hypophthalmichthys molitrix*) distribution (USGS NAS, 2011a).*

Adults and subadults feed in riverine and backwater habitats. Asian carp strongly compete with juvenile native fish species and adult gizzard shad for food found at the base of the aquatic food chain and, coupled with their spawn rate, have the potential to cause enormous damage to native fisheries.

Asian Carp In Kansas

In Kansas, the bighead and silver carp were first documented in 1993 and 2006, respectively, within the lower Kansas and Missouri rivers. A few Asian carp have been found in the Verdigris and Neosho rivers in south-central Kansas. In 2010, the Kansas Department of Wildlife and Parks first recorded spawning fish during spring flood events. The flood conditions mimicked the preferred spawning habitat of the species and lead to a population explosion in the Kansas River. Biologists estimated that 300,000 young Asian carp in one school of fish congregated below the Johnson County Water One weir in Kansas City.

Because the juvenile carp resemble native bait fish (fig. 3), biologists worry that anglers will inadvertently use the carp for fishing bait, leading to the species introduction into Kansas' lakes and reservoirs.

Because of their immense spawning capability, it is imperative that the carp stay out of Kansas's lakes and reservoirs. Favorable spawning conditions could be duplicated in a reservoir, leading to an established Asian carp population that quickly overcomes the native fish in the lake, effectively altering its ecosystem and displacing the recreational and economical opportunities associated with the lake.

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Figure 3. Juvenile bighead carp (top), silver carp (middle), and gizzard shad (bottom). Because of the resemblance between juvenile Asian carp and the native bait fish gizzard shad, fisheries biologists are concerned that anglers collecting fish bait will inadvertently transport and introduce the carp to reservoirs (photo by Jason Goekler, KDWP).

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Contact

Jason Goeckler
Aquatic Nuisance Species Coordinator
Kansas Department of Wildlife and Parks
1830 Merchant St
PO Box 1525
Emporia, KS 66801-1525
620–342–0658
jason.goeckler@ksoutdoor.com

Schedule and Itinerary

Friday, June 10, 2011

6:00 a.m. Breakfast at Holiday Inn Express, Village West, Kansas City, KS

8:00 a.m. **Bus leaves Holiday Inn Express for Site 12**

8:15 a.m. **SITE 12** – Lake Lenexa
Urban Forestry and Green Infrastructure
Larry Biles, State Forester, Kansas Forest Service
Tom Jacobs, Director, Environmental Programs, Mid-America Regional Council (MARC)
Rob Beilfuss, Stormwater Program Administrator, City of Lenexa
Kim Bomberger, District Community Forester, Kansas Forest Service

9:00 a.m. Bus to Site 13

9:15 a.m. **SITE 13** – Johnson County Gateway, Lenexa
Sec. Deb Miller, KS Dept. of Transportation
Joe Brand, HNTB Corporation
Bob Henthorne, Chief Geologist, KS Dept. of Transportation

10:00 a.m. Bus to Site 14

10:05 a.m. **SITE 14** – Meritex Mine, Lenexa
William E. Seymour, Sr. Vice President, Meritex

11:00 a.m. Bus to Site 15

11:15 a.m. **SITE 15** – Kansas State University, Olathe
Rural to Urban Population Trends
Ron Wilson, Director, Huck Boyd National Institute for Rural Development

National Bio and Agro-Defense Facility (NBAF)
Dr. James A. Guikema, Associate Vice President for Research, Kansas State University, Manhattan

12:30 p.m. Bus to hotel

1:45 p.m. Arrive at Capitol Plaza Hotel, Topeka

Urban Forestry and Green Infrastructure

Introduction

The Kansas City region historically framed its identity and urban-design pattern around a “City Beautiful” vision of environmental design. These design practices are inherent to green infrastructure. Green infrastructure is an urban-design approach to stormwater management that is cost-effective, sustainable, and environmentally friendly. Green infrastructures infiltrate, evapotranspire, capture, and reuse stormwater to maintain or restore a region’s natural surface-water hydrology. Approximately 22% of the metro area contains natural resources of good to high ecological value, with forests and woodlands comprising 18% of the total (fig. 1). These ecological resources are the critical component of the Kansas City region’s green infrastructure.

Figure 1. Approximately 22% of the Kansas City region’s land area has significant environmental conservation or restoration potential. Most of these ecological resources are forests and woodlands which help manage stormwater runoff in urban areas (photo courtesy MARC).

The Kansas City area population is projected to grow by 350,000 by 2030, consuming about 400,000 acres with suburban development. This development fragments urban forests and threatens the environmental quality in the nine-county metro area. When communities construct buildings, sidewalks, and paved parking lots, replacing vegetation and covering soil, the ground can no longer moderate the impacts of heavy rain by slowing down and absorbing rainwater. Concentrated runoff causes bank erosion, channel cutting, flooding, and destruction of civil infrastructure such as buried utilities, pipelines, bridges, and culverts. To complicate urban flooding issues, communities and counties are now required by Federal law to treat stormwater discharges for water quality. Green infrastructure is a cost-effective way to manage these issues. And because most of the high-quality ecological resources in the region are forests, understanding the value of forest ecosystem is a critical first step to utilizing the region’s green infrastructure.

Green Infrastructure

At the largest scale, green infrastructure includes the preservation and restoration of natural landscape features (such as forests, floodplains, and wetlands) for stormwater management. By protecting these ecologically sensitive areas, communities can improve water quality and protect civil infrastructure while providing wildlife habitat and opportunities for outdoor recreation. On a smaller scale, green infrastructure practices include rain gardens, porous pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting for non-potable uses such as toilet flushing and landscape irrigation.

Green infrastructure is associated with a variety of economic, health, and environmental benefits. The natural retention capability of vegetation and soils increases the infiltration of stormwater runoff, thereby reducing the volume of water entering sewer systems. Retention and infiltration help prevent pollutants from being transported to nearby surface waters. Once runoff infiltrates into soils, plants and microbes naturally filter and break down many common pollutants found in stormwater.

Green infrastructure also improves urban air quality. The plants and soils serve as carbon sequestration sinks, capturing and removing carbon dioxide from the atmosphere via photosynthesis and other natural processes. This process mitigates urban heat islands that form when cities replace natural land cover with pavement, buildings, and other surfaces that absorb and retain heat. The natural cooling effect of vegetation lowers the demand for air-conditioning energy, thereby decreasing power-plant air emissions. Trees and vegetation absorb certain air pollutants through leaf uptake and contact removal. And, if widely planted throughout a community, trees and plants can even cool the air and slow the temperature-dependent reaction that forms ground-level ozone pollution (i.e., smog).

A number of case studies suggest that green infrastructure can also increase property values. In Philadelphia, a green retrofit program that converted unsightly abandoned lots into "clean & green" landscapes resulted in economic impacts that exceeded project expectations. Vacant land improvements led to an increase in surrounding housing values by as much as 30%. This translated to a $4 million gain in property values through tree plantings and a $12 million gain through lot improvements.

In addition to the economic benefits, green infrastructure such as greenways, parks, urban forests, wetlands, and vegetated swales increase access to recreational space and wildlife habitat, and improve human health. Recent research has linked the presence of trees, plants, and green space to reduced levels of inner-city crime and violence, a stronger sense of community, and improved human health.

Rain to Recreation – Lake Lenexa

Lenexa, Kansas, is a growing Kansas City suburb with increasing residential areas, roads, and other impervious surfaces that create more stormwater runoff. Overall, Lenexa implements a comprehensive local and watershed-scale approach to managing stormwater. Rain gardens, bioswales, and other forms of green infrastructure are incorporated in private development projects. At the same time, through the Rain to Recreation program, Lenexa invests in large land preservation and restoration projects that provide key neighborhood and watershed-scale green infrastructure to protect civil and private utilities, buildings, and structures.

Lenexa's Vision 2020 plan initiated Rain to Recreation, which is an innovative and nationally recognized stormwater-management program. The program includes both regulatory and non-regulatory aspects as well as major capital projects and land acquisitions. The program protects watershed natural-resource areas, and created riparian greenways through a stream-setback ordinance and specified green-infrastructure practices for the city.

In addition to ordinances, Lenexa purchased land in priority areas to provide flood mitigation, stream protection, water-quality improvements, and recreational amenities. The largest project in Lenexa is a $26 million project called Lake Lenexa, which includes a 35-acre lake at the center of a nearly 350-acre public park (fig. 2). The comprehensive design for Lake Lenexa includes wetlands, rain gardens, stream restorations, trails and boardwalks, recreational space, and art and education areas.

Lenexa uses creative and long-term funding for major land purchases and projects, as well as management of the Rain to Recreation program. In 2000, Lenexa taxpayers voted to add a 1/8 of a cent sales-tax levy to support building stormwater facilities that protect against future flooding events. Lenexa also established a stormwater utility to provide sustainable funding for its programs, which charges a rate based on the amount of surface runoff from a land parcel.

In 2004, the Lenexa City Council adopted the Systems Development Charge to require new developments to pay a one-time fee at the time of building as a means to recover costs for stormwater-improvement activities. This charge works like a fee-in-lieu mechanism, where developers pay Lenexa to manage additional stormwater created from the impervious surfaces in new development.

Funding is also supplied by State and Federal sources, such as Clean Water Act Section 319 Nonpoint Source funds for park construction and Surface Transportation Project funding for roadway projects, which have assisted with capital and demonstration projects like Lake Lenexa. Other funding sources include Johnson County Stormwater Management Advisory Council funds, which are supported by a 1/10th cent sales tax and basic permitting fees charged to developers. Together, these funding sources ensure long-term watershed protection through the continued creation, operation, and maintenance of green infrastructure practices.

Figure 2. Lake Lenexa Rain to Recreation stormwater-management program provides flood control, improved water quality, stream preservation, recreation, and educational opportunities.

Kansas City Regional Forestry Assessment

The Mid-America Regional Council in cooperation with the Kansas Forest Service, the USDA Forest Service, Missouri Department of Conservation, and Davey Resource Group are partnered in an i-Tree Eco assessment of the woodland resources in the metro Kansas City area. The i-Tree Eco is a state-of-the-art USDA Forest Service software, modeling, and assessment program designed to collect and analyze information on urban forests. Analysis tools in the i-Tree Eco program along with other modeling and GIS applications are designed to quantify urban-forestry benefits. The metro Kansas City study is designed to assess the quantitative and qualitative values of the metro area's urban forests.

Importantly, this bi-state project is a regional case study for the development of a scientifically sound process for assessing community forest benefits. Results will be used to develop reasonable management objectives and community-based strategies for managing urban forest for economic and environmental benefit.

In Fall 2010, a sample inventory was conducted on 340 randomly selected plot locations across the Kansas City region. The plots are 1/10 acre in size and consist of private- and public-owned trees within the nine-county region. Project staff recorded information on species, condition, tree height, trunk diameter, and canopy density, among other criteria. Due to impending forest loss from the emerald ashborer beetle, ash trees will be removed from the data sets.

Modeled field data will assess the urban forest structure so that local municipalities, regional planners, and State and national agencies can develop forest-management and protection programs. Future forest growth will be used to create a regional policy and planning framework. Modeling is proposed to support high-level policy debates about the role of green infrastructure in meeting EPA regulations for combined sewer overflows, water quality, and for complying with tighter ozone standards. Inventory data are currently being analyzed and results will be available in mid-2011.

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Contacts

Larry Biles
State Forester
Kansas Forest Service
2610 Claflin Road
Manhattan, KS 66502
785–532–3309
lbiles@k-state.edu

Rob Beilfuss
Stormwater Program Administrator
City of Lenexa, Municipal Services Department
12350 West 87th Street Parkway
Lenexa, KS 66215–2882
913–477–7666
rbeilfuss@ci.lenexa.ks.us

Tom Jacobs
Director, Environmental Programs
Mid-America Regional Council
600 Broadway, Suite 300
Kansas City, MO 64105–1659
816–701–8352
tjacobs@marc.org

Kim Bomberger
District Community Forester
2610 Claflin Road
Manhattan, KS 66502
795–532–3315
kbomberg@ksu.edu

Johnson County Gateway Project

The I–435/I–35/K–10 interchange is one of the most congested interchanges in the state, and the economic vitality of the region relies on the continuity and efficiency of the transportation system. The Kansas Department of Transportation (KDOT) study team developed a design concept and recommendations for improving the interchanges by analyzing traffic, land use, and stakeholder input. The team prioritized improvement recommendations and developed a phased construction plan to allow the selected route alignment to be completed over time. The study is expected to be completed by mid-2011. Coordination with the US–69 project located to the east of the Gateway Project will create additional efficiency and cost savings.

Traffic Growth

Approximately 230,000 vehicles drive through the interchange each day and that number is projected to increase 60% to 360,000 vehicles by 2040. Drive time without congestion through the interchange during peak traffic is designed to take three minutes, but it actually takes four minutes today and is projected to take 16 minutes by 2040. The interchange operates in congested conditions 10% of the time today with that percentage growing to 50% by 2040. To address current and future safety and traffic concerns, KDOT has developed the Johnson County Gateway Project.

Corridor Alignment

The Gateway Project utilizes a phased approach to create construction efficiency and cost savings. There are four color-coded phases to the project: yellow, orange, green, and red (fig. 1).

The Yellow Project will address the back-up of traffic on the existing west bound I–435 to south bound I–35 flyover ramp. It will also address the heavy south bound and north bound I–35 traffic between 119th Street and I–435.

The Orange Project will address the east bound traffic congestion between where K–10 and I–435 come together to where vehicles exit to I–35. It will also address the heavy traffic on north bound I–35 just north of I–435.

The Green Project in combination with the Orange and Yellow Projects addresses nearly 80% of the future anticipated problems within the interchange area.

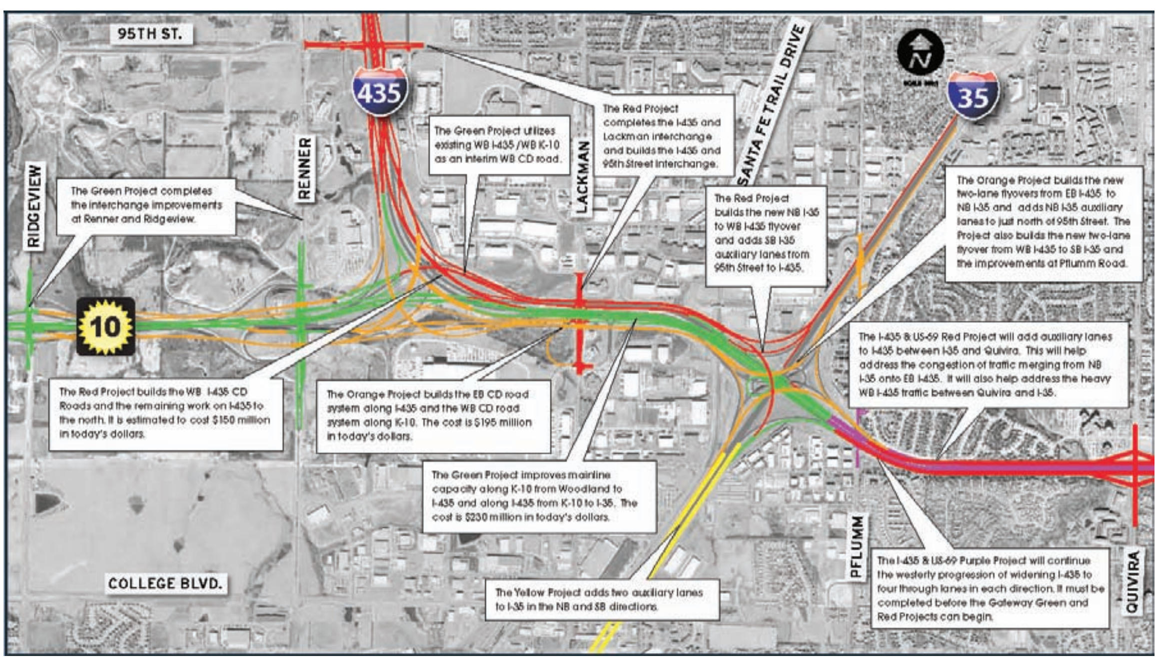

Figure 1. The Johnson County Gateway corridor alignment phasing approach (map courtesy of jocogateway.com).

The Red Project completes the improvements addressing all the remaining traffic issues identified within the interchange area.

Economic Benefits

An analysis for the Gateway Project evaluated its economic impact to the region. Analysis indicates that it is expected to have a positive economic benefit for the urban areas around the project alignment. The Yellow Project is expected to generate more that $800 million of additional Gross Regional Product and create more than 1,300 jobs. The total Gateway Project will generate $1.2 billion of additional Gross Regional Product plus the creation of at least 3,500 jobs. These will be the benefits in year 2035, but are reported in 2010 dollars. The jobs created by the project are permanent positions due to the regional economic growth from the improved highway infrastructure. Additional construction jobs created by the project are not included in this assessment. The employment projections are attributable to improved travel time, congestion relief, safety improvements, improved reliability, and expansion of market areas.

Proposed Mine Remediation Alternatives

The Gateway Project crosses an underground limestone mine with portions of three collector-distributor ramps along K–10 highway (fig. 2). The limestone was mined for aggregate in the late 1970s and 1980s.

The mine openings vary from 16 to 20 feet in height with the roof supported by limestone columns. The mines are located in three of the four quadrants of the K–10–Renner Road interchange (fig. 2). Mining has not taken place in the northeast portion of the intersection. The mines are relatively stable except for those in the southeast quadrant. While collapses have occurred in both of the southern quadrants, the southeast mine quadrant has had numerous catastrophic collapses that have reached the ground surface. The floor of the mine is not strong enough to support the weight of the overburden material. The collapses are due to what is termed pillar punch-through. These are also the deepest mines, approximately 100 feet below the surface and are completely full of water.

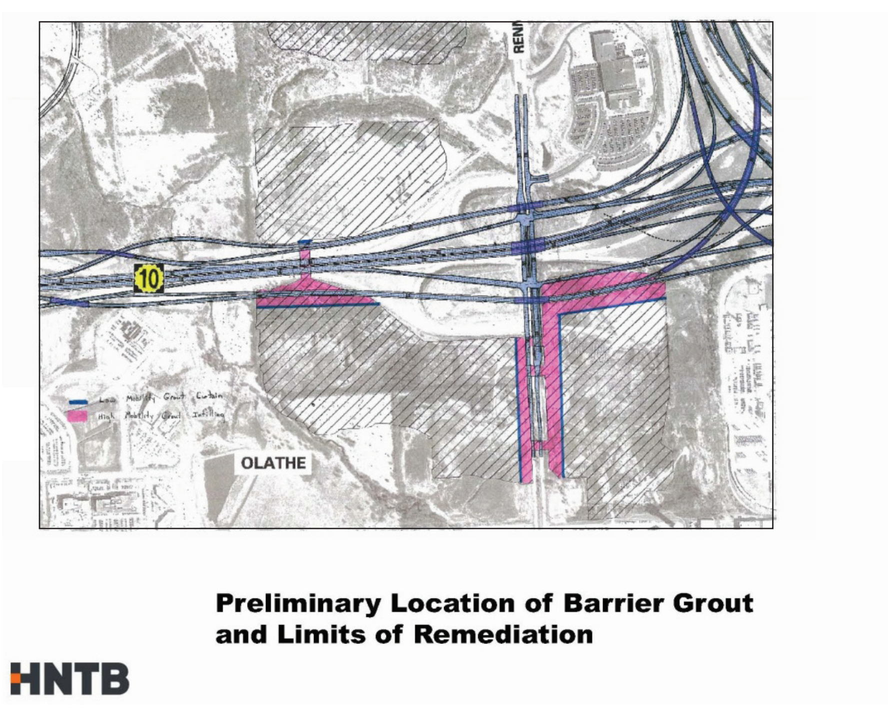

Figure 2. Proposed mine stabilization areas (photo courtesy HNTB).

Prior to construction, the proposed roadway that crosses void space will have to be stabilized. KDOT is evaluating a remedial option which would either stabilize or completely grout the mines closed. This is a common practice and has been done throughout Missouri and Kansas in similar mines. Prior to injecting grout, a barrier wall is constructed and then the mine is grouted completely full inside the barrier walls (fig. 3). The grout is typically a coal fly-ash by-product from electric generating plants that is mixed with water and sometimes cement to form a slurry. The grout slurry fills the void and hardens

Figure 3. Containment wall for grout backfill (photo courtesy HNTB).

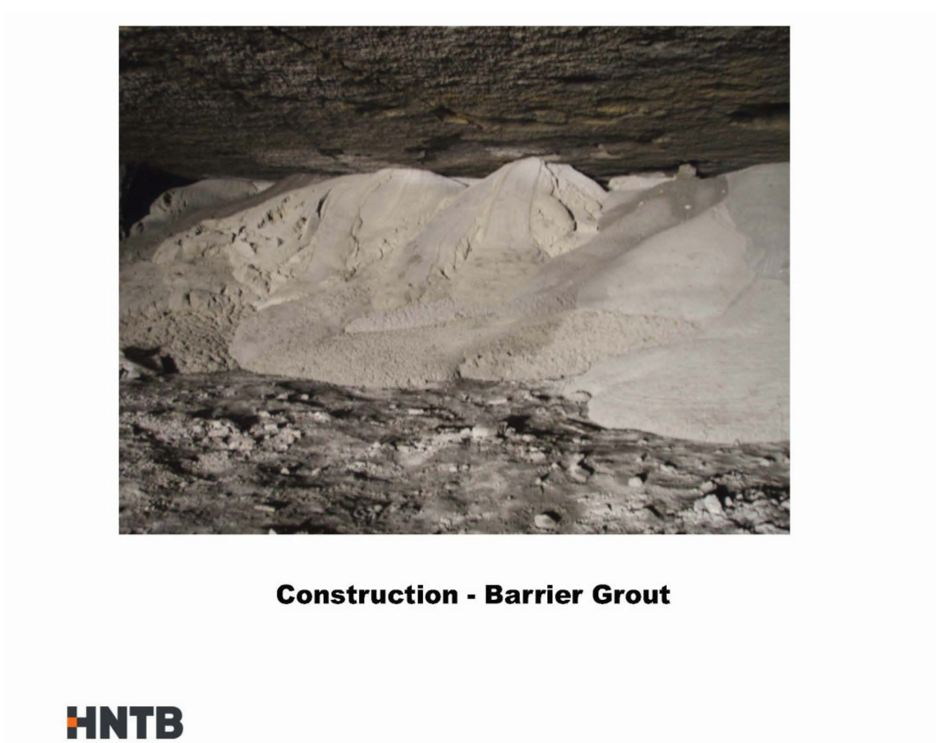

Figure 4. Injected grout slurry (photo courtesy HNTB).

to a concrete-like consistency and strength (fig. 4). The mine passage beneath K–10 will remain open. A constructed block wall with grout behind the wall will support the roadway. The grouting is a required portion of the project to ensure the safety of the traveling public. The estimated cost to remediate the limestone mines is approximately 18 million dollars.

Source

Johnson County Gateway Website, http://www.jocogateway.com/index.php, accessed May 17, 2011.

Contacts

Bob Henthorne, P.G.
Chief Geologist
Kansas Dept. of Transportation
2300 Van Buren St
Topeka, KS 66611
785–291–3860
RobertH@ksdot.org

Joe Brand
HNTB Corp.
715 Kirk Drive
Kansas City, MO 64105
913–491–9333
jbrand@HNTB.com

Meritex Mine

Kansas City is the number-one city in the world in terms of re-use of underground mine space. The Kansas City area has a large reserve of limestone rock that is a valuable construction commodity for concrete aggregate, cement manufacturing, rip rap, and construction. This ready availability of high-quality limestone is one of the main factors supporting the region's industrial growth. Much of the area's limestone mines were designed with sustainability of the resource in mind and is a worldwide example of planned utilization of underground space. These facilities contribute to Smart Growth urban development principles that prevent urban sprawl and revitalize urban cores. The space created by the mining operations is now a secondary use of the mines (fig. 1).

Mining History

In particular, the physical thickness, structure, and chemical characteristics of two limestones around Kansas City, the Bethany Falls Limestone Member and Argentine Limestone Member, make them especially valuable and suitable for underground mining operations. As such, they are actively mined for aggregate in much of the greater Kansas City area. Because of their relative stratigraphic position and regional dip, most of the Argentine is eroded away in Missouri and the Bethany Falls is typically too deep to be economically mined in Kansas. As such, most Missouri mines are in the Bethany Falls and a smaller number of Kansas mines are in the Argentine.

Limestone production around Kansas City started with quarrying activities in the middle 1880s for building stone. As near-surface limestone quarries were exhausted, limestone production turned to underground mining. Limestone was mined with a room and pillar method where large pillars are left in place to support the roof and void space of the mine. The first underground storage facility was developed

Figure 1. Portal entrance to the Meritex facility in Lenexa, Kansas, within the Argentine Limestone Member (photo courtesy Meritex).

at Atchison, Kansas, in 1944. This development led to mining practices specifically designed for sustainable re-use for storage and office space. After about 1950, mines had regular pillar spacing to provide structurally stable void spaces (fig. 2). In Kansas City, a typical roof height is about 16 feet and the span between pillars is about 25 to 40 feet, depending on the limestone unit. Generally, limestone units mined with square pillars that are 20 to 30 feet on a side and spaced on a 50-foot grid allow about 85% material recovery. A 30-foot room with about 2,000 square feet of viable storage space is left behind.

About 10 square miles of limestone mines are found at different locations around the Kansas City area. Beginning in the 1960s, mined space was converted into secondary space at an annual rate of about 97,000 square feet for warehousing, manufacturing, offices, retail, and service-operations facilities. More than 10% of the greater Kansas City industrial space, about 25 million square feet, is in converted limestone mines. Approximately eight or so business complexes are developed in a portion of this space. The world's largest underground business complex in Kansas City, Missouri, has leased 5 million square feet for storage, industry, and offices. The Meritex site in Lenexa, Kansas, has 3 million square feet of underground space (fig. 2).

Sustainability

Underground business's environmental footprints are smaller because fewer trees, wetlands, and energy-intensive construction materials, such as steel and aluminum, are needed. The constant ambient 65 to 70 degree temperature leads to greatly reduced energy demands for heating and air-conditioning, which is about 85% lower than a surface building. The Meritex facility recently qualified for the EPA's Energy Star with a score of 96. It is only the second non-refrigerated warehouse facility in Kansas to meet Energy Star qualifications.

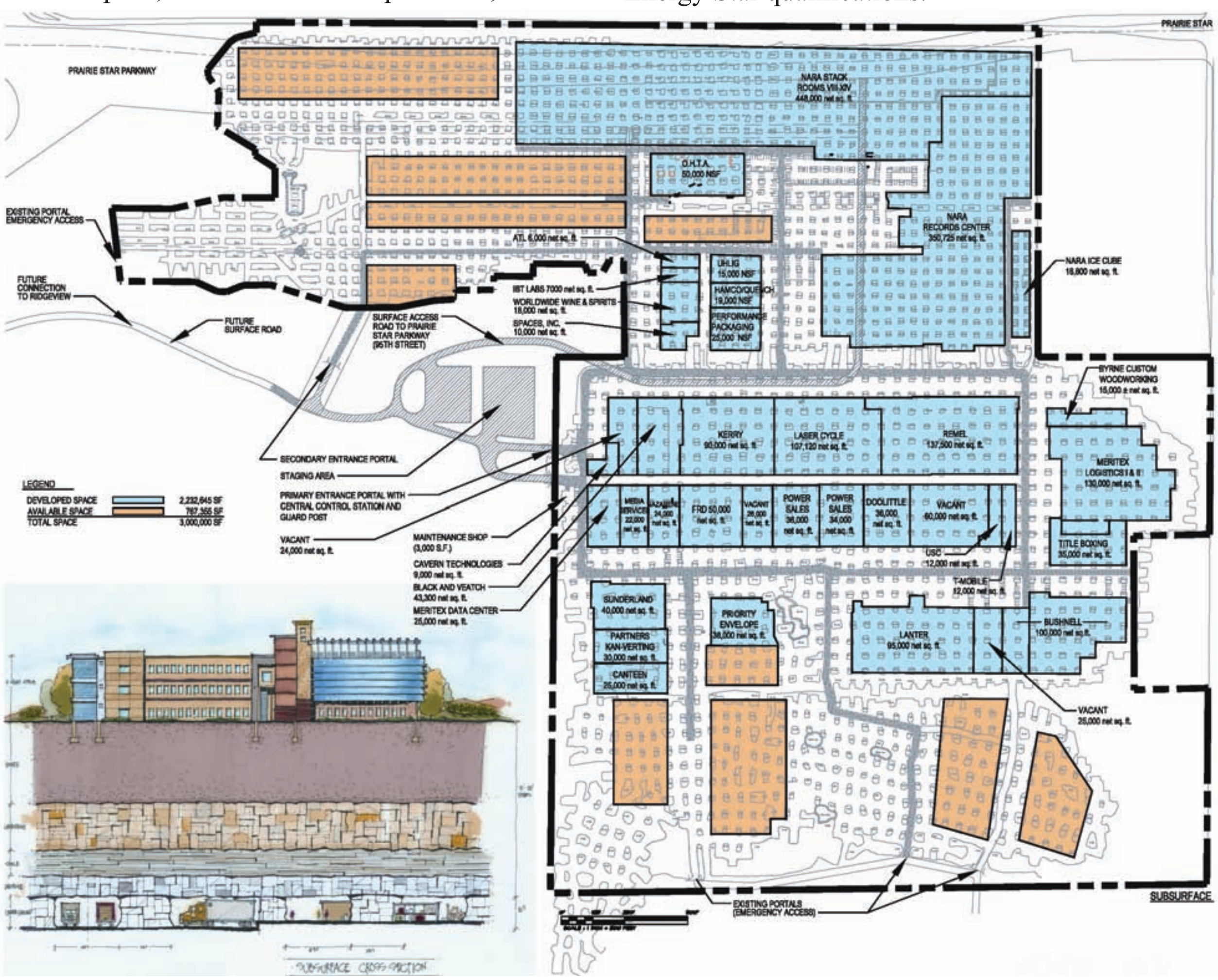

Figure 2. Conceptual plan of the Meritex facility in Lenexa, Kansas, with room and pillar mine configuration. Below-ground development aids Smart Growth urban planning strategies (photo courtesy Meritex).

Underground space also aids urban planning and Smart Growth development strategies. These strategies reduce urban sprawl by creating a denser city grid and provide more transportation choices, which increases regional economic development while still reducing energy demands associated with truck and commuter traffic. Smart Growth strategies include reducing impervious surfaces, preserving riparian corridors and open spaces, and using environmentally friendly green infrastructure. With 3 million square feet of underground development at Meritex and the nearby Gateway to Johnson County transit project, municipalities such as Lenexa are able to develop a greater mix of above-ground housing, commercial, and retail uses, and surrounding communities are more transit- and pedestrian-friendly (fig. 2).

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Contacts

Lonnie Cannon
Leasing and Property Manager
17501 West 98th Street #26–32
Lenexa, KS 66219
913–888–0601
lcannon@meritex.com

William E. Seymour
Senior Vice President
17501 West 98th Street #26–32
Lenexa, KS 66219
913–888–0601
bseymour@meritex.com

Rural to Urban Population Trends

While nearly 95% of the U.S. population was rural in 1790, today more than 80% of Americans live in metropolitan areas covering less than 20% of the nation's land area (U.S. Census Bureau, 1993; Auch et al., 2004). Changes in manufacturing, agriculture, consumption, transportation, communication, and technology, as well as immigration and retirement patterns, have contributed to the onward, if not always smooth, advance from a predominantly rural existence to a mostly urban then mixed urban-suburban way of life. Rural areas, particularly in the central United States, have suffered a significant loss of inhabitants during the transition (fig. 1).

Over the past several decades, the largest population gains in Kansas, by far, have been in the Kansas City to Topeka corridor and Wichita metropolitan area (fig. 2). At the same time, low growth, stagnation, or decline has been the norm for most rural counties (those defined as nonmetropolitan by the U.S. Census Bureau). The northwest to west-central, north-central, and Chautauqua Hills regions as well as the area impacted by the devastating Greensburg tornado were the hardest hit over the past decade (fig. 3). Several rural counties with lower losses in the 2000s nonetheless sustained high population declines in the 20 years between 1990 and 2010 due to high losses in the 1990s (table 1).

Between 2000 and 2010, 35 states had a higher percentage increase in population than Kansas, whose population rose 6.1% compared to the national average of 9.7% (U.S. Census Bureau, 2010). Geary County, boosted by the return of the 1st Infantry Division to Fort Riley in 2006, had the highest percent population change at 23% followed by Johnson County at 20.5%. In the two decades between 1990 and 2010, Johnson County's population increased 53.3% while Miami, Butler, and Douglas counties all had increases above 30% (table 1).

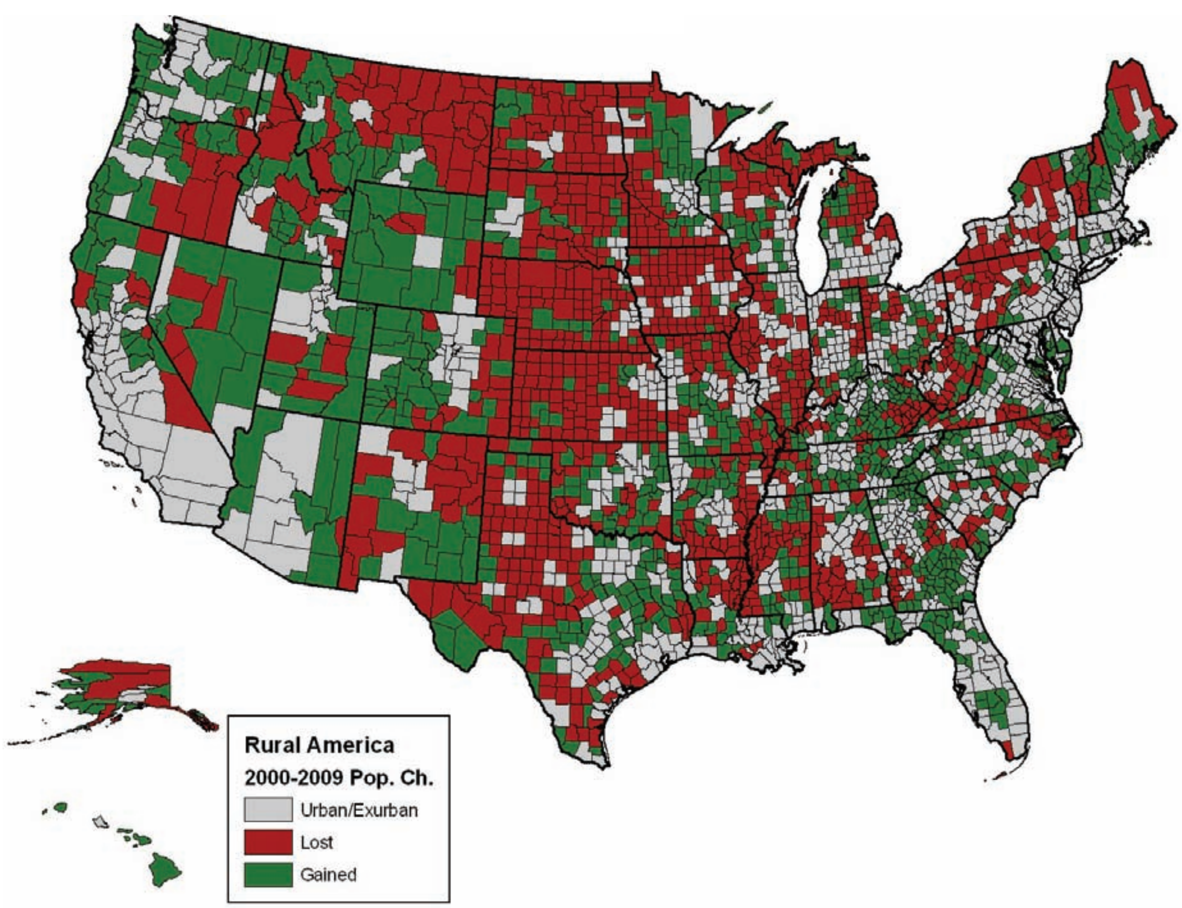

Figure 1. Rural population change from 2000 to 2009, from Rural America in the 2000s *(Gallardo, 2010).*

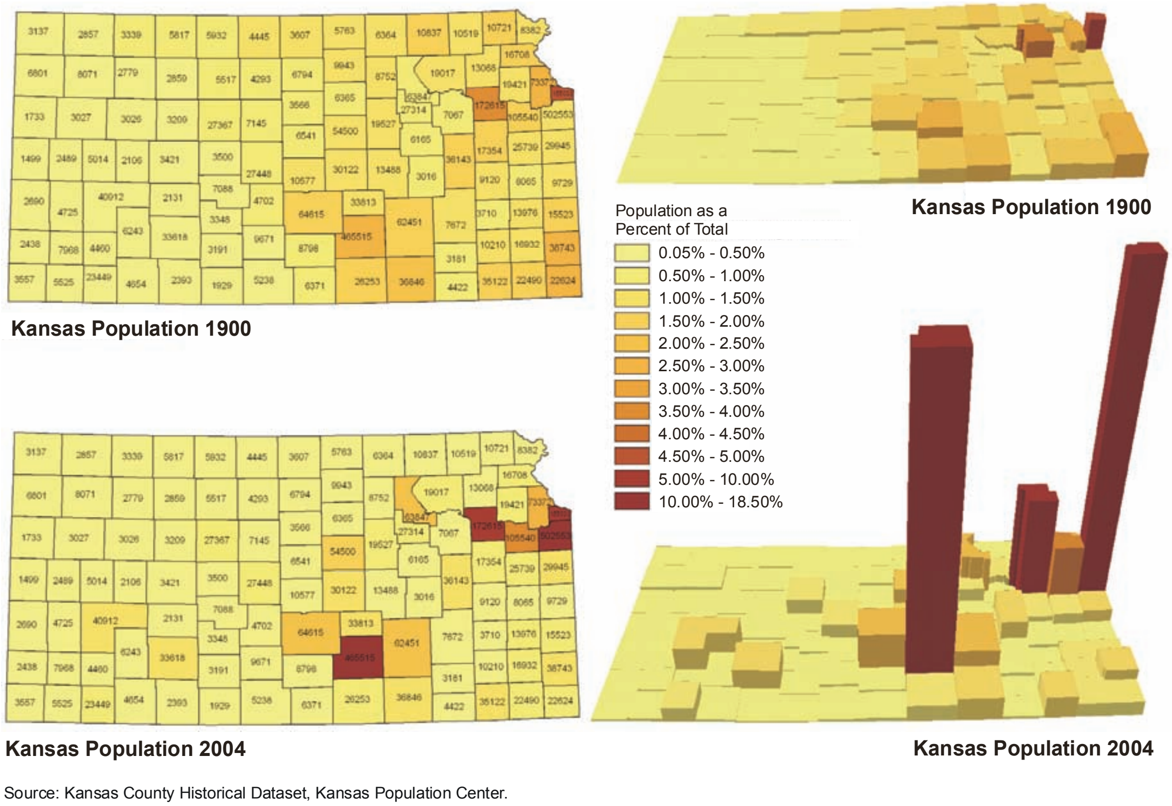

Figure 2. Kansas county population in 1900 and 2004 as a percentage of the state's population from Baby boomers and immigrants on the range *(Kulcsár, 2007).*

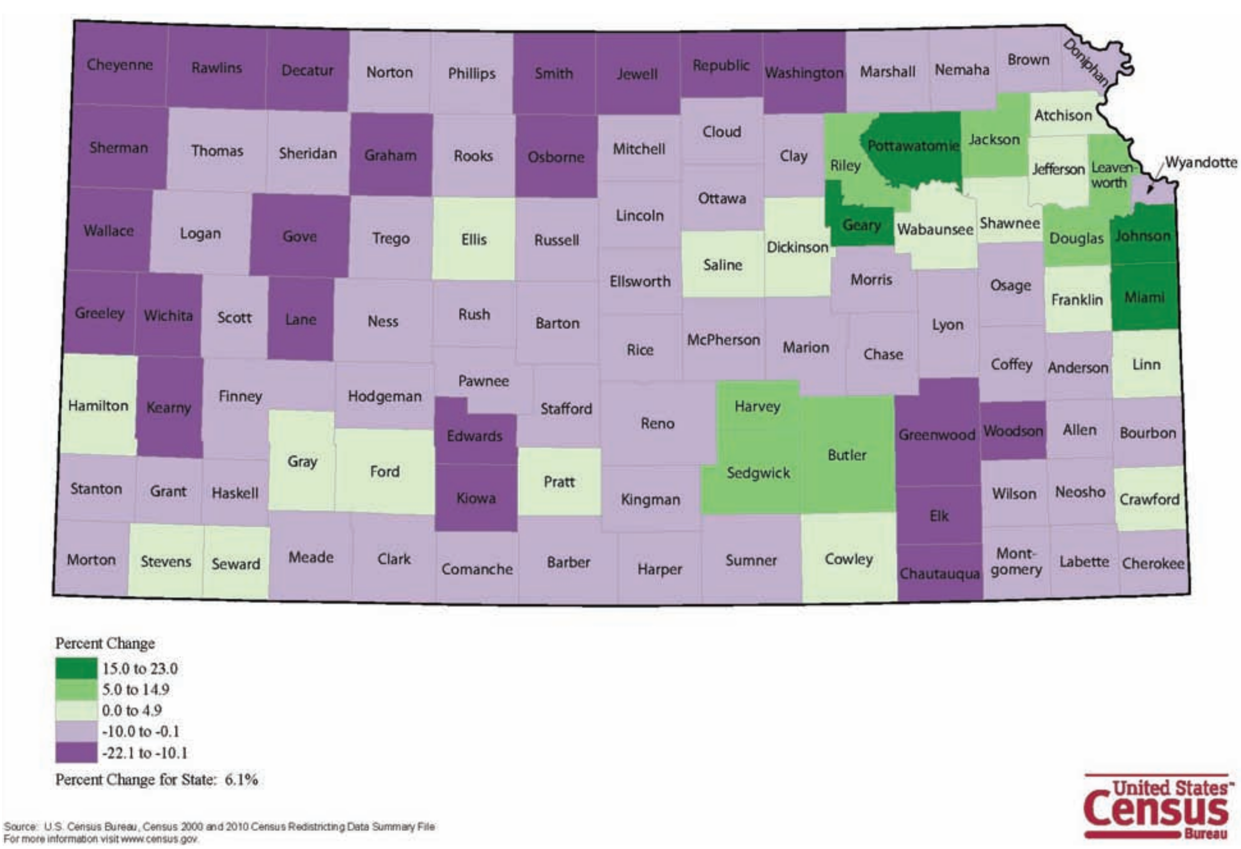

Figure 3. Percent population change in Kansas counties: 2000 to 2010 (U.S. Census Bureau, 2011).

Table 1. Population and population change for Kansas counties, 1990, 2000, and 2010 (IPSR, 2011).

County	1990	2000	2010	Percent Change 1990-2010	Percent Change 2000-2010	Increase or Decrease 1990-2010
Allen	14,638	14,385	13,371	-8.7	-7.0	-1,267
Anderson	7,803	8,110	8,102	3.8	-0.1	299
Atchison	16,932	16,774	16,924	0.0	0.9	-8
Barber	5,874	5,307	4,861	-17.2	-8.4	-1,013
Barton	29,382	28,205	27,674	-5.8	-1.9	-1,708
Bourbon	14,966	15,379	15,173	1.4	-1.3	207
Brown	11,128	10,724	9,984	-10.3	-6.9	-1,144
Butler	50,580	59,484	65,880	30.2	10.8	15,300
Chase	3,021	3,030	2,790	-7.6	-7.9	-231
Chautauqua	4,407	4,359	3,669	-16.7	-15.8	-738
Cherokee	21,374	22,605	21,603	1.1	-4.4	229
Cheyenne	3,243	3,165	2,726	-15.9	-13.9	-517
Clark	2,418	2,390	2,215	-8.4	-7.3	-203
Clay	9,158	8,822	8,535	-6.8	-3.3	-623
Cloud	11,023	10,268	9,533	-13.5	-7.2	-1,490
Coffey	8,404	8,865	8,601	2.3	-3.0	197
Comanche	2,313	1,967	1,891	-18.2	-3.9	-422
Cowley	36,915	36,291	36,311	-1.6	0.1	-604
Crawford	35,582	38,242	39,134	10.0	2.3	3,552
Decatur	4,021	3,472	2,961	-26.4	-14.7	-1,060
Dickinson	18,958	19,344	19,754	4.2	2.1	796
Doniphan	8,134	8,249	7,945	-2.3	-3.7	-189
Douglas	81,798	99,962	110,826	35.5	10.9	29,028
Edwards	3,787	3,449	3,037	-19.8	-11.9	-750
Elk	3,327	3,261	2,882	-13.4	-11.6	-445
Ellis	26,004	27,507	28,452	9.4	3.4	2,448
Ellsworth	6,586	6,525	6,497	-1.4	-0.4	-89
Finney	33,070	40,523	36,776	11.2	-9.2	3,706
Ford	27,463	32,458	33,848	23.2	4.3	6,385
Franklin	21,994	24,784	25,992	18.2	4.9	3,998
Geary	30,453	27,947	34,362	12.8	23.0	3,909
Gove	3,231	3,068	2,695	-16.6	-12.2	-536
Graham	3,543	2,946	2,597	-26.7	-11.8	-946
Grant	7,159	7,909	7,829	9.4	-1.0	670
Gray	5,396	5,904	6,006	11.3	1.7	610
Greeley	1,774	1,534	1,247	-29.7	-18.7	-527
Greenwood	7,847	7,673	6,689	-14.8	-12.8	-1,158
Hamilton	2,388	2,670	2,690	12.6	0.7	302
Harper	7,124	6,536	6,034	-15.3	-7.7	-1,090
Harvey	31,028	32,869	34,684	11.8	5.5	3,656
Haskell	3,886	4,307	4,256	9.5	-1.2	370
Hodgeman	2,177	2,085	1,916	-12.0	-8.1	-261
Jackson	11,525	12,657	13,462	16.8	6.4	1,937
Jefferson	15,905	18,426	19,126	20.3	3.8	3,221
Jewell	4,251	3,791	3,077	-27.6	-18.8	-1,174
Johnson	355,021	451,479	544,179	53.3	20.5	189,158
Kearny	4,027	4,531	3,977	-1.2	-12.2	-50
Kingman	8,292	8,673	7,858	-5.2	-9.4	-434
Kiowa	3,660	3,278	2,553	-30.2	-22.1	-1,107
Labette	23,693	22,835	21,607	-8.8	-5.4	-2,086
Lane	2,375	2,155	1,750	-26.3	-18.8	-625
Leavenworth	64,371	68,691	76,227	18.4	11.0	11,856
Lincoln	3,653	3,578	3,241	-11.3	-9.4	-412
Linn	8,254	9,570	9,656	17.0	0.9	1,402
Logan	3,081	3,046	2,756	-10.5	-9.5	-325

Table 1 continued

County	1990	2000	2010	Percent Change 1990-2010	Percent Change 2000-2010	Increase or Decrease 1990-2010
Lyon	34,732	35,935	33,690	-3.0	-6.2	-1,042
McPherson	27,268	29,554	29,180	7.0	-1.3	1,912
Marion	12,888	13,361	12,660	-1.8	-5.2	-228
Marshall	11,705	10,965	10,117	-13.6	-7.7	-1,588
Meade	4,247	4,631	4,575	7.7	-1.2	328
Miami	23,466	28,351	32,787	39.7	15.6	9,321
Mitchell	7,203	6,932	6,373	-11.5	-8.1	-830
Montgomery	38,816	36,254	35,471	-8.6	-2.2	-3,345
Morris	6,198	6,104	5,923	-4.4	-3.0	-275
Morton	3,480	3,496	3,233	-7.1	-7.5	-247
Nemaha	10,446	10,717	10,178	-2.6	-5.0	-268
Neosho	17,035	16,997	16,512	-3.1	-2.9	-523
Ness	4,033	3,454	3,107	-23.0	-10.0	-926
Norton	5,947	5,953	5,671	-4.6	-4.7	-276
Osage	15,248	16,712	16,295	6.9	-2.5	1,047
Osborne	4,867	4,452	3,858	-20.7	-13.3	-1,009
Ottawa	5,634	6,163	6,091	8.1	-1.2	457
Pawnee	7,555	7,233	6,973	-7.7	-3.6	-582
Phillips	6,590	6,001	5,642	-14.4	-6.0	-948
Pottawatomie	16,128	18,209	21,604	34.0	18.6	5,476
Pratt	9,702	9,647	9,656	-0.5	0.1	-46
Rawlins	3,404	2,966	2,519	-26.0	-15.1	-885
Reno	62,389	64,790	64,511	3.4	-0.4	2,122
Republic	6,482	5,835	4,980	-23.2	-14.7	-1,502
Rice	10,610	10,761	10,083	-5.0	-6.3	-527
Riley	67,139	62,852	71,115	5.9	13.1	3,976
Rooks	6,039	5,685	5,181	-14.2	-8.9	-858
Rush	3,842	3,551	3,307	-13.9	-6.9	-535
Russell	7,835	7,370	6,970	-11.0	-5.4	-865
Saline	49,301	53,597	55,606	12.8	3.7	6,305
Scott	5,289	5,120	4,936	-6.7	-3.6	-353
Sedgwick	403,662	452,869	498,365	23.5	10.0	94,703
Seward	18,743	22,510	22,952	22.5	2.0	4,209
Shawnee	160,976	169,871	177,934	10.5	4.7	16,958
Sheridan	3,043	2,813	2,556	-16.0	-9.1	-487
Sherman	6,926	6,760	6,010	-13.2	-11.1	-916
Smith	5,078	4,536	3,853	-24.1	-15.1	-1,225
Stafford	5,365	4,789	4,437	-17.3	-7.4	-928
Stanton	2,333	2,406	2,235	-4.2	-7.1	-98
Stevens	5,048	5,463	5,724	13.4	4.8	676
Sumner	25,841	25,946	24,132	-6.6	-7.0	-1,709
Thomas	8,258	8,180	7,900	-4.3	-3.4	-358
Trego	3,694	3,319	3,001	-18.8	-9.6	-693
Wabaunsee	6,603	6,885	7,053	6.8	2.4	450
Wallace	1,821	1,749	1,485	-18.5	-15.1	-336
Washington	7,073	6,483	5,799	-18.0	-10.6	-1,274
Wichita	2,758	2,531	2,234	-19.0	-11.7	-524
Wilson	10,289	10,332	9,409	-8.6	-8.9	-880
Woodson	4,116	3,788	3,309	-19.6	-12.6	-807
Wyandotte	162,026	157,882	157,505	-2.8	-0.2	-4,521
Kansas	**2,477,588**	**2,688,824**	**2,853,118**	**15.2**	**6.1**	**375,530**

Source: U.S. Census Bureau, 1990 Census of Population, *General Population Characteristics: Kansas* (1990 CP-1-18); 2000 Census, *Profile of General Demographic Characteristics* (DP-1); 2010 Census (PL94-171); CQR, http://www.census.gov/prod/cen2000/notes/cqr-ks.pdf (accessed December 1, 2005).

In the past decade Kiowa County had the greatest loss at -22.1% followed by Lane and Greeley counties with -18.8% and -18.7% declines, respectively. In the two decades between 1990 and 2010, Decatur, Graham, Greeley, Jewell, Kiowa, Lane, and Rawlins all had losses greater than -25% (table 1).

On the whole, the state's population has risen every decade since the 1860s except in the 1940s. However, the Kansas population as a percentage of the U.S. population peaked early—in 1890 when 2.27% of Americans were Kansans—and has been falling ever since (table 2). After 1890 the population

Table 2. Population growth in Kansas and the U.S. for selected years between 1860 and 2010 (IPSR, 2011).

	Resident Population[1]		Rates of Growth[2]		Kansas Population as a Percentage
Year	Kansas	U.S.	Kansas	U.S.	of U.S. Population
1860	107,206	31,443,321	-	-	0.34
1870	364,339	39,818,449	239.8	26.6	0.92
1880	996,096	50,189,209	173.4	26.0	1.98
1890	1,428,108	62,979,766	43.4	25.5	2.27
1900	1,470,495	76,212,168	3.0	21.0	1.93
1910	1,690,949	92,228,496	15.0	21.0	1.83
1920	1,769,257	106,021,537	4.6	15.0	1.67
1930	1,880,999	123,202,624	6.3	16.2	1.53
1940	1,801,028	132,164,569	-4.3	7.3	1.36
1950	1,905,299	151,325,798	5.8	14.5	1.26
1960	2,178,611	179,323,175	14.3	18.5	1.21
1970	2,249,071	203,302,031	3.2	13.4	1.11
1980	2,364,236	226,542,199	5.1	11.4	1.04
1981	2,384,813	229,466,391	0.9	1.3	1.04
1982	2,401,220	231,665,106	1.6	2.3	1.04
1983	2,415,565	233,792,697	2.2	3.2	1.03
1984	2,424,119	235,825,544	2.5	4.1	1.03
1985	2,427,428	237,924,311	2.7	5.0	1.02
1986	2,432,638	240,133,472	2.9	6.0	1.01
1987	2,445,422	242,289,738	3.4	7.0	1.01
1988	2,462,057	244,499,776	4.1	7.9	1.01
1989	2,472,864	246,819,839	4.6	9.0	1.00
1990	2,477,588	248,718,301	4.8	9.8	1.00
1991	2,498,722	252,980,941	0.9	1.7	0.99
1992	2,532,394	256,514,224	2.2	3.1	0.99
1993	2,556,547	259,918,588	3.2	4.5	0.98
1994	2,580,513	263,125,821	4.2	5.8	0.98
1995	2,601,007	266,278,393	5.0	7.1	0.98
1996	2,614,554	269,394,284	5.5	8.3	0.97
1997	2,635,292	272,646,925	6.4	9.6	0.97
1998	2,660,598	275,854,104	7.4	10.9	0.96
1999	2,678,338	279,040,168	8.1	12.2	0.96
2000	2,688,824	281,424,603	8.5	13.1	0.96
2001r	2,701,456	285,081,556	0.5	1.3	0.95
2002r	2,712,598	287,803,914	0.9	2.3	0.94
2003r	2,721,955	290,326,418	1.2	3.2	0.94
2004r	2,730,765	293,045,739	1.6	4.1	0.93
2005r	2,741,771	295,753,151	2.0	5.1	0.93
2006r	2,755,700	298,593,212	2.5	6.1	0.92
2007r	2,775,586	301,579,895	3.2	7.2	0.92
2008r	2,797,375	304,374,846	4.0	8.2	0.92
2009	2,818,747	307,006,550	4.8	9.1	0.92
2010	2,853,118	308,745,538	6.1	9.7	0.92

Source: U.S. Bureau of the Census, *Statistical Abstract of the United States,* various issues; Population Estimates, http://www.census.gov/popest/estimates.php (accessed December 23, 2009); Count Question Resolution (CQR), http://www.census.gov/dmd/www/CQR.htm (accessed January 3, 2008); 2010 Census (PL94-171).

[1] Includes armed forces residing in the state. **r - revised, December 2009**

[2] Rate of growth from the previous Decennial Census.

Single dash (-) indicates not applicable.

of Kansas increased (except in the 1940s when it dropped) at a rate slower than the national average. By 1950 the Kansas population was down to 1.53% of the country's total and, 60 years later, the 2.85 million Kansans (fig. 4) accounted for only 0.92% of the U.S. population.

With 34.9 inhabitants per square mile, Kansas ranks 40th in population density among the states (U.S. Census Bureau, 2010). Density within Kansas varies widely from Johnson County at 1,134 persons per square mile to Wallace County at 1.6 persons per square mile (fig. 5).

Even though the overall rural population throughout the country has dropped, the decline has been uneven, with some states suffering greater losses than others. In the last decade, none of the 50 fastest growing U.S. rural (or non-metropolitan) counties was in Kansas. Of the 50 rural counties with the greatest percentage of population loss in the United States, seven were in Kansas—Kiowa (4th), Greeley (35th), Wallace (36th), Jewell (37th), Gove (38th), Lane (39th), and Rawlins (48th) (Gallardo, 2010).

The majority of Kansas's rural counties, which individually seldom account for more than 0.5% of the state's population, lost ground. This was largely due to improved transportation and highway systems as well as mechanization of agriculture processes. Between 1950 and 2000 the number of farms in Kansas declined more than 50% while their average size doubled. During the same period, the Kansas farm population declined from nearly 440,000 to under 90,000 (table 3; Kulcsár, 2007).

Other major factors influencing the changing demographics of rural Kansas include an increase of immigrant labor in some areas and an aging population. The Institute for Policy and Social Research (IPSR) at the University of Kansas has available an array of data on Kansas and its shifting population, including the annual *Kansas Statistical Abstract*.

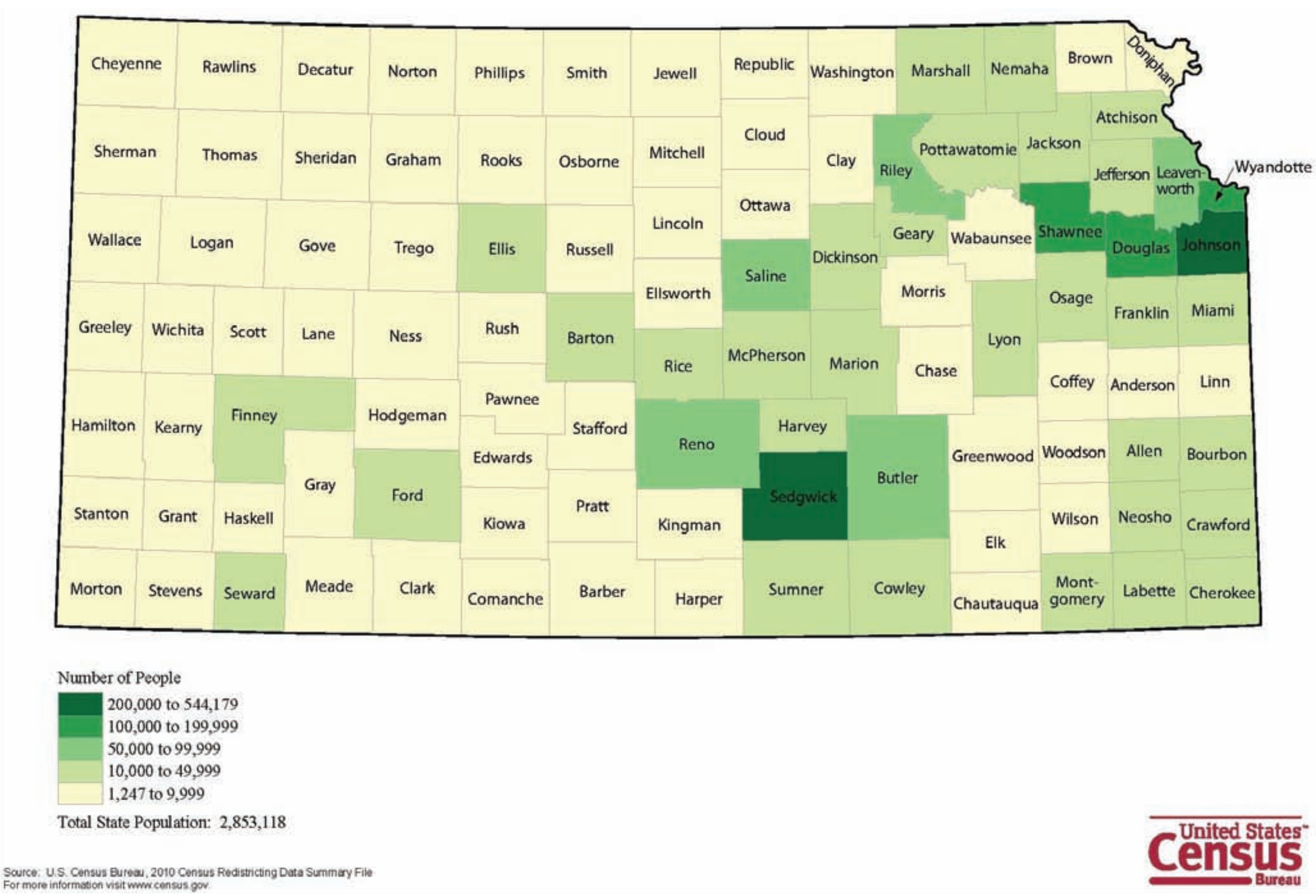

Figure 4. Population of Kansas counties, 2010 (U.S. Census Bureau, 2011).

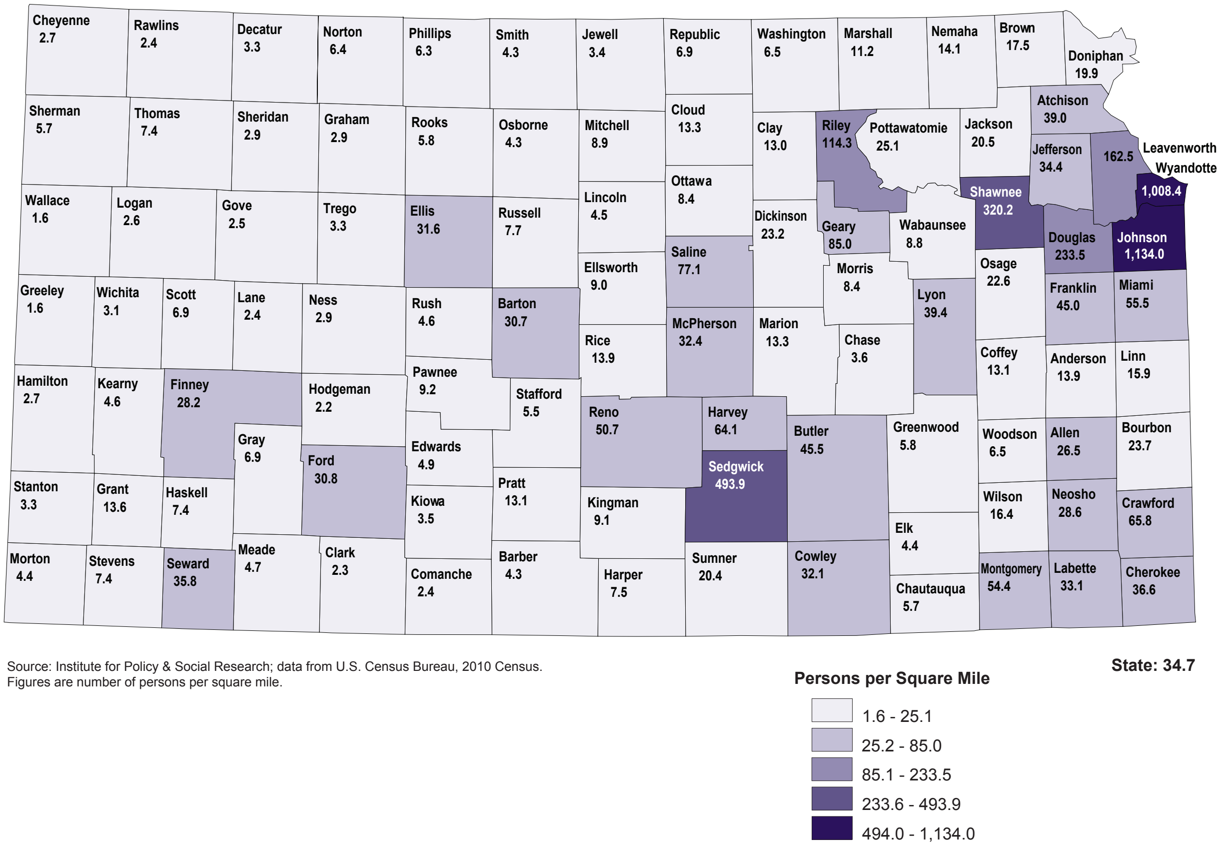

Figure 5. Population density in Kansas counties, 2010 (U.S. Census Bureau, 2011).

Table 3. Agricultural change in Kansas, 1950–2000 (Kulcsár, 2007).

Year	Number of Farms	Average Size of Farms (acres)	Farm Population	Farm Population as a Percent of State Population	Percent Urban Population
1950	135,000	374	443,739	23.3	52
1960	110,000	456	320,508	14.7	61
1970	87,000	574	252,529	11.2	66
1980	75,000	644	172,901	7.3	67
1990	69,000	694	108,083	4.4	69
2000	64,000	742	89,758	3.3	71

Source: Kansas County Historical Dataset, Kansas Population Center.

Huck Boyd National Institute for Rural Development

Efforts are ongoing to address the changes ahead for rural Kansas. One such endeavor is the Huck Boyd National Institute for Rural Development, a unique combination of a public-private partnership spearheaded by the Kansas Department of Commerce, Kansas State University (KSU), and the Huck Boyd Foundation. Founded in 1989, the Institute is funded by KSU with support from the Foundation.

McDill "Huck" Boyd (1907–1987), a long-time Phillipsburg, Kansas, newspaper publisher who attended KSU, was a backer of economic development in his community and a strong national advocate for rural people and values. He was chairman of the Kansas Board of Regents, a delegate to the United Nations Economic and Social Council in Geneva, Switzerland, president of the Kansas Press Association, and a two-time gubernatorial candidate who represented Kansas on the Republican National Committee for 20 years. The Huck Boyd Foundation was founded after his death in 1987.

The Huck Boyd National Institute for Rural Development is designed to boost entrepreneurship and local leadership in rural development, encourage cooperation among rural development providers, identify emerging rural policy needs, and communicate strategies for the future through public outreach. It promotes the benefits of agriculture and rural life, the concept of rural self-help, and the use of strategic alliances and partnerships to enhance rural development (K-State Research and Extension, 2010).

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Contact

Ron Wilson
Director
Huck Boyd National Institute for Rural Development
101 Umberger Hall
Manhattan, KS 66506–3405
785–532–7690
rwilson@ksu.edu

National Bio and Agro-Defense Facility (NBAF)

The Department of Homeland Security (DHS) is building a $650 to $725 million, 500,000-square-foot laboratory to research and develop countermeasures to animal, human, and zoonotic diseases in Manhattan, Kansas. The National Bio and Agro-Defense Facility (NBAF) will replace an antiquated facility in New York and serve as the nation's premier research center for combating agriculture's vulnerability to naturally occurring diseases or agro-terrorism. U.S. agriculture represents a roughly $1 trillion business sector that accounts for 15% of the U.S. economy and 18% of the jobs in the country. Protecting this food supply is a national defense priority.

NBAF Design and Site Selection

The NBAF will be a highly secure biosecurity level 3 and 4 facility on the Kansas State University campus (fig. 1). The NBAF level 4 lab design employs a box-in-box principle with a pressure-controlled buffer. Air-pressure differentials between zones of containment and directional airflow will be exhausted toward high-efficiency particulate air (HEPA) filters. The exhaust air will not be recirculated. All water and air leaving the lab will be purified (i.e., no research microorganism would enter the sewage system or outside air). All critical functions will have redundant systems.

Manhattan was selected for the NBAF after three years of competitive DHS review of 29 interested sites around the country, a phase-two evaluation of 18 sites in 11 states, and an environmental impact statement process involving six finalist sites. Kansas is considered the ideal location for the NBAF. At Kansas State University, research can be conducted in cooperation with academic researchers and other public and private research business partners. Kansas' leadership in bioscience situates the NBAF in a corridor between Manhattan and Kansas City that complements the facility with a full range of public and private facilities for disease surveillance, diagnosis, prevention, treatment, and research for both human and animal health-related sciences. The animal health industry in this area alone accounts

Figure 1. Conceptual design of the National Bio and Agro-Defense Facility (NBAF) in Manhattan, Kansas (illustration courtesy Kansas State University).

for about a third of the $19 billion in total sales for the global animal health market and is a critical component to the Manhattan site location.

In April 2011, Congress approved $40 million of funding for the next phase of NBAF. The funding will go toward building the lab's central utility plant. Construction is slated to begin in November 2011. Another $150 million is proposed for the next phase in the FY 2012 Congressional budget. It is expected the NBAF will be operational by 2015.

Economic Growth

NBAF is considered a once-in-a-lifetime opportunity for Kansas. It is expected to be a significant economic driver responsible for growth to the region and the Kansas economy. Starting with construction of the facility and continuing with the ongoing employment of a highly educated workforce, NBAF will create 1,500 construction jobs and 450 permanent jobs at the lab. And it is projected to have an estimated $3.5 billion economic impact in the first 20 years of the facility's use.

Additionally, the NBAF will serve as a magnet for private industry. The NBAF will attract new jobs to Kansas as private biotechnology companies, professionals, and support infrastructure relocate in order to capitalize on the concentration of animal health and plant science assets in the state. Key components will be Kansas State University's new Olathe Innovation Campus and a proposed University of Missouri facility in Blue Springs, Missouri.

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Contact

James A. Guikema, Ph.D.
Associate Vice President
Office of Research and Sponsored Programs
102 Fairchild Hall
Kansas State University
Manhattan, KS
785–532–6195
guikema@k-state.edu