Kansas Field Conference

# Northeast Kansas
## Energy, Land, and Water Resources

2000
FIELD CONFERENCE

June 7–9, 2000

Sponsored by Kansas Geological Survey
Kansas Forest Service, State Conservation Commission
and Kansas Corporation Commission

KANSAS FIELD CONFERENCE

# FIELD GUIDE

# 2000 FIELD CONFERENCE

## *Northeast Kansas*

***Energy, Land, and Water Resources***

***June 7-9, 2000***

**Edited by**

**Robert S. Sawin**

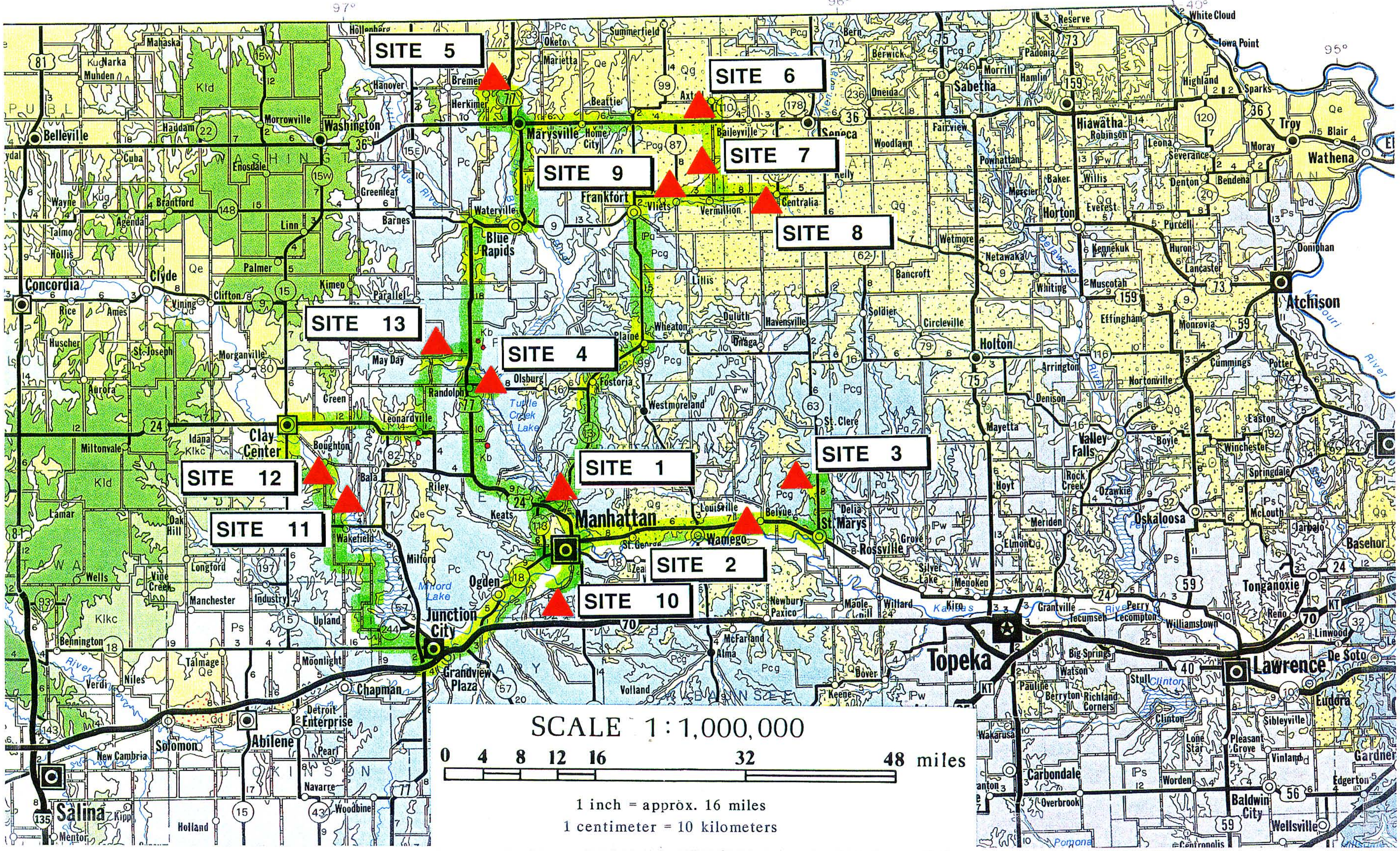
**Liz Brosius**

**Rex C. Buchanan**

***This project is operated by the Kansas Geological Survey and funded, in part, by the Kansas Forest Service, the Kansas Corporation commission, and the State Conservation Commission***

**KGS OPEN-FILE**
**REPORT 2000-27**

**KANSAS GEOLOGICAL SURVEY**
**Geology Extension**
**1930 Constant Ave. - Campus West**
**Lawrence, Kansas 66047-3726**
**Telephone: (785) 864 - 3965**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SITE 2
SITE 10
Manhattan
Topeka
Lawrence
Atchison
Junction City
Salina
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0 4 8 12 16 32 48 miles
1 inch = approx. 16 miles
1 centimeter = 10 kilometers

KANSAS FIELD CONFERENCE

# Northeast Kansas

*Energy, Land, and Water Resources*

## 2000 FIELD CONFERENCE

June 7-9, 2000

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KANSAS FIELD CONFERENCE

# Northeast Kansas

***Energy, Land, and Water Resources***

## 2000 FIELD CONFERENCE

June 7-9, 2000

## PARTICIPANTS LIST

| Name | Title | Affiliation | Business Address |
|---|---|---|---|
| **Ray Aslin** | State Forester | Kansas Forest Service | 2610 Claflin Road<br>Manhattan, KS 66502-2798<br>785/532-3309 |
| **Bob Atchison** | Rural Forestry<br>Coordinator | Kansas Forest Service | 2610 Claflin Road<br>Manhattan, KS 66502-2798<br>785/532-3310 |
| **Don Biggs** | Senator<br>3rd District | Kansas Senate/Energy and<br>Natural Resources Committee | 2712 Olde Creek Ct.<br>Leavenworth, KS 66048<br>913/682-1802 |
| **Mary Compton** | Representative<br>13th District | Kansas House of<br>Representatives/<br>Agriculture Committee | Route 3, Box 242<br>Fredonia, KS 66736<br>785/296-7684 |
| **Hank Ernst** | Environmental<br>Scientist IV | Kansas Water Office | 901 South Kansas Ave.<br>Topeka, KS 66612-1249<br>785/296-3185 |
| **Vaughn Flora** | Representative<br>57th District | Kansas House of<br>Representatives/<br>Environment Committee | 431 SE Woodland Ave.<br>Topeka, KS 66607<br>785/296-7647 |
| **Joann Flower** | Representative<br>47th District | Kansas House of<br>Representatives/<br>Agriculture Committee | P.O. Box 97<br>Oskaloosa, KS 66066<br>785/863-2918 |
| **Darrel Gale** | Chairman | State Conservation<br>Commission | R.R. 1, Box 78<br>Phillipsburg, KS 67661<br>785/638-2241 |
| **Lee Gerhard** | Principal Geologist | Kansas Geological Survey | 1930 Constant Ave.<br>Lawrence, KS 66047<br>785/864-2195 |
| **Raney Gilliland** | Principal Analyst | Kansas Legislative<br>Research Department | Rm 545-N, State Capitol<br>Topeka, KS 66612<br>785/296-3181 |
| **Bob Grant** | Representative<br>2nd District | Kansas House of<br>Representatives/<br>Fiscal Oversight Committee | 407 W. Magnolia<br>Cherokee, KS 66724<br>316/457-8680 |

| | | | |
|---|---|---|---|
| **Stefanie Hanna** | Science Teacher | Shawnee Heights<br>High School | 1812 E. 29th<br>Lawrence, KS 66046<br>785/397-5860 |
| **Bill Hargrove** | Director | KCARE/<br>Kansas State University | 44 Waters Hall<br>Kansas State University<br>Manhattan, KS 66502<br>785/532-7419 |
| **Carl Holmes** | Representative<br>125th District | Kansas House of<br>Representatives/Utilities<br>Committee | P.O. Box 2288<br>Liberal, KS 67905<br>316/624-7361 |
| **Becky Hutchins** | Representative<br>50th District | Kansas House of<br>Representatives/<br>Environment Committee | 700 Wyoming<br>Holton, KS 66436<br>785/296-7698 |
| **Dick Koerth** | Assistant Secretary<br>for Administration | Kansas Department of<br>Wildlife and Parks | Room 502 N. Landon<br>State Office Building<br>900 SW Jackson<br>Topeka, KS 66612<br>785/296-2281 |
| **Wayne Lebsack** | President/<br>Trustee | Lebsack Oil Production Inc./<br>The Nature Conservancy | P.O. Box 489<br>Hays, KS 67601<br>316/938-2396 |
| **Al LeDoux** | Director | Kansas Water Office | 901 South Kansas Ave.<br>Topeka, KS 66612-1249<br>785/296-3185 |
| **Janis Lee** | Senator<br>36th District | Kansas Senate/<br>Utilities Committee | R.R. 2, Box 145<br>Kensington, KS 66951<br>785/476-2294 |
| **Laura McClure** | Representative<br>119th District | Kansas House of<br>Representatives/<br>Environment Committee | 202 South 4th<br>Osborne, KS 67473<br>785/296-7680 |
| **Jim Roberts** | Associate Vice<br>Chancellor for<br>Research and<br>Public Service | University of Kansas | University of Kansas<br>203 Youngberg Hall<br>2385 Irving Hill Road<br>Lawrence, KS 66044<br>785/864-7298 |
| **Mary Jane Stattelman** | Assistant Secretary | Kansas Department of<br>Agriculture | 901 SW 9th<br>Topeka, KS 66612<br>785/296-3558 |
| **Tracy Streeter** | Executive Director | State Conservation<br>Commission | Mills Building<br>109 SW 9th, Ste. 500<br>Topeka, KS 66612-1299<br>785/296-3600 |
| **John Strickler** | Executive Director | KACEE (Kansas Association<br>for Conservation and<br>Environmental Education) | 2610 Claflin Rd.<br>Manhattan, KS 66502<br>785/532-3314 |
| **Mary Torrence** | Assist. Revisor<br>of Statutes | Revisor of Statutes<br>Office | 300 SW 10th, Suite 322S<br>Topeka, KS 66612-1592<br>785/296-5239 |

| | | | |
|---|---|---|---|
| **Jim Triplett** | Chairman | Dept. of Biology, Pittsburg State University | 1701 S. Broadway<br>Pittsburg, KS 66762-7552<br>316/235-4730 |
| **Sid Warner** | Managing General Partner | Warner Ranches, L.P. | P.O. Box 309<br>Cimarron, KS 67835<br>316/855-2282 |
| **Tom Warner** | Department Head | Dept. of Horticulture, Forestry & Recreation Resources, Kansas State University | 2021 Throckmorton<br>Kansas State University<br>Manhattan, KS 66506-5506<br>785/532-6170 |
| **Dave Williams** | Production Supervisor/Geologist | Kansas Corporation Commission | 130 S. Market #2078<br>Wichita, Kansas 67202<br>316/337-6218 |
| **David Wunsch** | Geologist V | Kentucky Geological Survey | 228 Mining and Mineral Res. Bldg.<br>University of Kentucky<br>Lexington, KY 40506-0107<br>859/257-5500 |

# BIOGRAPHICAL INFORMATION

**Ray Aslin**
Title
State Forester
Affiliation
Kansas Forest Service
Address and Telephone
2610 Claflin Road
Manhattan, KS 66502-2798
785/532-3309
Current Responsibilities
State Forester
Experience
24 years with Kansas Forest Service (District Forester, Fire Control Specialist, State Forester)
Education
University of Missouri - BS, 1972
University of Missouri - MS, 1975

**Bob Atchison**
Title
Rural Forestry Coordinator
Affiliation
Kansas Forest Service
Address and Telephone
2610 Claflin Road
Manhattan, KS 66502-2798
785/532-3310
Current Responsibilities
Coordinate rural forestry issues through District and Field Foresters
Experience
Arkansas Forestry Commission, 3 years; District Forester, Kansas, 7 years; Rural Forestry Coordinator, 3 years
Education
University of Missouri - BS, 1981

**Don Biggs**
Title
Senator, 3rd District
Affiliation
Kansas Senate
Address and Telephone
2712 Olde Creek Ct.
Leavenworth, KS 66048
913/682-1802
Current Responsibilities
State Senate
Experience
Mutual Savings Association (retired)
Education
Kansas State University - BS, 1952

**Mary Compton**
Title
Representative, 13th District
Affiliation
Kansas House of Representatives
Address and Telephone
Route 3, Box 242
Fredonia, KS 66736
785/296-7684
Current Responsibilities
Agriculture, Utilities, Economic Development Committees
Education
Fredonia High School - 1951

**Hank Ernst**
Title
Environmental Scientist IV
Affiliation
Kansas Water Office
Address and Telephone
901 South Kansas Ave.
Topeka, KS 66612-1249
785/296-3185
Current Responsibilities
Information and Education Specialist
Experience
Editor, Kansas Farmer magazine, 18 years
Education
University of Missouri - BS, 1968

**Vaughn L. Flora**
Title
Representative, 57th District
Affiliation
Kansas House of Representatives
Address and Telephone
431 Woodland Ave.
Topeka, KS 66607
785/296-7647
Current Responsibilities
Environment, Taxation, Transportation, Financial Institutions Committees
Experience
President, Non-profit Affordable Housing Corp.; CEO Topeka City Homes; Farmer
Education
Kansas State University - BS, 1968

**Joann Flower**
Title
Representative, 47th District
Affiliation
Kansas House of Representatives
Address and Telephone
P.O. Box 97
Oskaloosa, KS 66066
785/863-2918
Current Responsibilities
Agriculture, Transportation, Local Government, Committees
Experience
Legislature, 10 years; Nursing; Community Volunteer
Education
Johns Hopkins University - BS, 1958

**Darrel Gale**
Title
Chairman
Affiliation
State Conservation Commission
Address and Telephone
R.R. 1, Box 78
Phillipsburg, KS 67661
785/638-2241
Current Responsibilities
Chairman, SCC
Experience
Retired Farmer/Stockman and Army National Guard Colonel
Education
Kansas State University - BS, 1956

**Lee Gerhard**
Title
Principal Geologist
Affiliation
Kansas Geological Survey
Address and Telephone
1930 Constant Ave.
Campus West
Lawrence, KS 66049
785/864-2195
Current Responsibilities
Geologic research at the KGS
Experience
Kansas Geological Survey, 12 years; Colorado School of Mines, 5 years; North Dakota Geological Survey, 6 years; W. Indies Lab., Fairleigh Dickinson Univ., 3 years; Univ. of Southern Colorado, 6 years; Sinclair, 2 years
Education
Syracuse University - BS, 1958
University of Kansas - MS, 1961
University of Kansas - PhD, 1964

**Raney Gilliland**
Title
Principal Analyst
Affiliation
Kansas Legislative Research Department
Address and Telephone
Rm 545-N, State Capitol
Topeka, KS 66612
785/296-3181
Current Responsibilities
Staff - House and Senate Agriculture Committees; House Environment Committee; and Senate Energy and Natural Resources Committee
Experience
Legislative Research, 20 years.
Education
Kansas State University - BS, 1975
Kansas State University - MS, 1979

**Bob Grant**
Title
Representative, 2nd District
Affiliation
Kansas House of Representatives
Address and Telephone
407 W. Magnolia
Cherokee, KS 66724
316/457-8680
Current Responsibilities
State Representative
Education
Labette Community College - AA, 1971
Pittsburg State University

**Stefanie Hanna**
Title
Science Teacher
Affiliation
Shawnee Heights High School
Address and Telephone
1812 E. 29th
Lawrence, KS 66046
785/397-5860
Current Responsibilities
Teach Biology, Field Geology, Chemistry, and Physical Science, grades 9-12
Education
University of Kansas - BS, 1992
University of Kansas - Cert., 1994

**Bill Hargrove**
Title
Director
Affiliation
KCARE

Address and Telephone
44 Waters Hall
Kansas State University
Manhattan, KS 66502
785/532-7419
Current Responsibilities
Administer research and extension programs on environmental issues related to agriculture
Experience
Professor, University of Georgia; Director, International Project On Natural Resources Management
Education
Baylor University - BS, 1975
Texas A&M University - MS, 1977
University of Kentucky - PhD., 1980

**Carl Holmes**
Title
Representative, 125th District
Affiliation
Kansas House of Representatives
Address and Telephone
P.O. Box 2288
Liberal, KS 67905
316/624-7361
Current Responsibilities
Chairman, Utilities and Fiscal Oversight Committees
Experience
Chairman, House Energy & Natural Resources Committee
Education
Colorado State University - BS, 1962

**Becky Hutchins**
Title
Representative, 50th District
Affiliation
Kansas House of Representatives
Address and Telephone
700 Wyoming
Holton, KS 66436
785/296-7698
Current Responsibilities
Environment, Tourism, and Federal and State Affairs Committees
Experience
Second term in Kansas House of Representatives, 50th District.
Education
Washburn University - BA, 1986

**Dick Koerth**
Title
Assistant Secretary for Administration
Affiliation
Kansas Department of Wildlife and Parks
Address and Telephone
Room 502 N. Landon
State Office Building
900 SW Jackson
Topeka, KS 66612
785/296-2281
Current Responsibilities
Administrative affairs of KDWP include accounting, budgeting, personnel, engineering, and licensing.
Experience
Kansas Division of the Budget, 1972-1989.
Education
University of Kansas - BA, 1971
University of Kansas - MPA, 1973

**Wayne Lebsack**
Title
President
Affiliation
The Nature Conservancy
Lebsack Oil Production Inc.
Address and Telephone
P.O. Box 489
Hays, KS 67601
316/938-2396
Current Responsibilities
Trustee, TNC; Direct and manage oil and gas exploration and development
Experience
Oil and gas exploration; Ground-water exploration and pollution research.
Education
Colorado School of Mines - Geol. Eng., 1949
Colorado School of Mines - Geol. Eng., 1951
Colorado School of Mines - 2 years grad. studies

**Al LeDoux**
Title
Director
Affiliation
Kansas Water Office
Address and Telephone
901 South Kansas Ave.
Topeka, KS 66612-1249
913/296-3185
Current Responsibilities
Plan, market, develop, implement, and evaluate policies/programs for current and future water needs.
Experience
Sr. Govt. Affairs Liaison, Gov. Graves; Adm. Assist. to Maj. Leader, KS. Sen., Lt. Gov. Frahm; Legis. Liaison and Ag. Advisor, Gov. Hayden; Admin. Assist. to the Maj. Leader, KS. House; Farmer and Stockman.

Education

Baker University - BA, 1969
University of Kansas - Graduate School

**Janis Lee**

Title

Senator, 36th District

Affiliation

Kansas Senate

Address and Telephone

R.R. 2, Box 145
Kensington, KS 66951
785/476-2294

Current Responsibilities

State Senate; Assistant Minority Leader; Utilities Committee

Experience

Involved in family ranching and farming operation; USD #238 Board of Education

Education

Kansas State University - BS, 1970

**Laura McClure**

Title

Representative, 119th District

Affiliation

Kansas House of Representatives

Address and Telephone

202 South 4th
Osborne, KS 67473
785/296-7680

Current Responsibilities

Environment, Utilities Committees

Experience

Owner/operator flower and antiques shop; Nutrition site manager, Beloit Senior Center; Grassroots Lobbyist.

Education

Mankato High School - 1968

**Jim Roberts**

Title

Associate Vice Chancellor for Research and Public Service

Affiliation

University of Kansas

Address and Telephone

203 Youngberg Hall
2385 Irving Hill Road
Lawrence, KS 66044
785/864-7298

Current Responsibilities

Associate Vice Chancellor, KU; Vice President, KU Center for Research; Professor, Electrical Engineering and Computer Science, KU

Experience

RCA; ESL Inc; TRW Systems Integration Group; Chairman, Electrical and Computer Engineering, KU (1990-93)

Education

University of Kansas - BS, 1966
Mass. Institute of Technology - MS, 1968
Santa Clara University - PhD., 1979

**Mary Jane Stattelman**

Title

Assistant Secretary

Affiliation

Kansas Department of Agriculture

Address and Telephone

109 S.W. 9th
Topeka, KS 66612
785/296-3558

Current Responsibilities

Assistant Secretary for Administration

Experience

Assistant Attorney General, Kansas Attorney General's Office; Assistant Director of Public Affairs, Kansas Farm Bureau; Dept. of Agriculture, 1995-present

Education

Washburn University - BA, 1984
Washburn University - JD, 1988

**Tracy Streeter**

Title

Executive Director

Affiliation

State Conservation Commission

Address and Telephone

Mills Building
109 SW 9th, Ste. 500
Topeka, KS 66612-1299

Current Responsibilities

Agency Head

Experience

Field Coordinator, Assistant Director, Executive Director, SCC, 1985-present; involved in family farm until 1990

Education

Highland Community College - AA, 1983
Missouri Western State College - BS, 1985
University of Kansas - MPA, 1993

**John Strickler**

Title

Executive Director

Affiliation

KACEE (Kansas Association for Conservation and Environmental Education)

Address and Telephone
2610 Claflin Rd.
Manhattan, KS 66502
785/532-3314
Current Responsibilities
Executive Director, KACEE.
Experience
Special Assistant for Environment and Natural Resources to Governor Mike Hayden, 2 years; Acting Secretary, Kansas Department of Wildlife and Parks, 1987 and 1995; Kansas State and Extension Forestry, KSU, 33 years; U.S. Forest Service, 4 years.
Education
University of Missouri - BS, 1957
Kansas State University - MS, 1968

**Mary Torrence**
Title
Assistant Revisor of Statutes
Affiliation
Revisor of Statutes Office
Address and Telephone
300 SW 10th, Suite 322S
Topeka, KS 66612
785/296-5239
Current Responsibilities
Legislative staff; drafting legislation; and legal advisor
Experience
Revisor of Statutes Office, 22 years.
Education
University of Kansas - BA, 1971
University of Kansas - JD, 1974

**Jim Triplett**
Title
Professor
Affiliation
Pittsburg State University
Address and Telephone
1701 S. Broadway
Pittsburg, KS 66762
316/235-4730
Current Responsibilities
Statewide Council of Basin Advisors Comm., Chair; Neosho Basin Advisory Comm., Chair; Governor's Advisory Council for Solid Waste Grants; Governor's Task Force 2000 - Water Issues; Professor and Chair, Biology Dept.
Experience
Chairman, Biology Dept., PSU, 12 years; Assistant Professor, PSU, 4 years; Assistant Professor, Ohio State University, 5 years.
Education
Kansas State College of Pittsburg - BA, 1966
Kansas State College of Pittsburg - MS, 1968
University of Kansas - PhD, 1976

**Sid Warner**
Title
Managing General Partner
Affiliation
Warner Ranches, L.P.
Address and Telephone
P.O. Box 309
Cimarron, KS 67835
316/855-2282
Current Responsibilities
Managing General Partner of Warner Ranches, L.P.
Experience
Farming, Ranching, Insurance, Commercial cattle feeding; Kansas Board of Regents
Education
Kansas State University - BS, 1956

**Tom Warner**
Title
Professor/Dept. Head
Affiliation
Kansas State University
Address and Telephone
2021 Throckmorton
Kansas State University
Manhattan, KS 66506-5506
785/532-6170
Current Responsibilities
Head, Dept. of Horticulture, Forestry, and Recreation Resources
Experience
Dept. Head, Forestry, KSU, 1988-91; Dept. Head, Horticulture, Forestry, and Recreation Resources, 1991-present
Education
Indiana State University - BS, 1971
Michigan State University - MS, 1974
Michigan State University - PhD., 1976

**David Williams**
Title
Production Supervisor/Geologist
Affiliation
Kansas Corporation Commission
Address and Telephone
130 S. Market #2078
Wichita, KS 67202
316/337-6218
Current Responsibilities
Production supervisor for regulation (permits, completions, prorations, plugging); Technical advisor to KCC on oil and gas matters
Experience
KCC, 1989-present; Consulting Petroleum Geologist/Operator, 10 years; Adjunct Instructor; Exploration/Exploitation Geologist.

Education
Fort Hays State University - BS, 1974

**David Wunsch**
Title
Geologist V
Affiliation
Kentucky Geological Survey
Address and Telephone
228 Mining and Mineral Res. Bldg.
University of Kentucky
Lexington, KY 40506-0107
859/257-5500
Current Responsibilities
Coordinator, Coal-Field Hydrology Program; Manager, Water and Reclamation Projects-Mined Areas
Experience
American Geological Institute Congressional Science Fellow, 1998-99
Education
SUNY at Oneonta - BS, 1980
University of Akron - MS, 1982
University of Kentucky - PhD., 1992

## KANSAS GEOLOGICAL SURVEY STAFF

**Lee Allison**
Title
Director and State Geologist
Affiliation
Kansas Geological Survey
Address and Telephone
1930 Constant Ave.
Campus West
Lawrence, KS 66049
785/864-2108
Current Responsibilities
Director of administration and geologic research
Experience
Kansas Geological Survey, 1 year; Director and State Geologist, Utah Geological Survey, 10 years; Western Earth Science Technologies, Inc., 6 years; University of Utah Research Institute, 3 years; SOHIO, 3 years
Education
University of California, Riverside - BA, 1970
San Diego State University - MS, 1974
University of Massachusetts - PhD, 1986

**Rex Buchanan**
Title
Associate Director
Affiliation
Public Outreach, Kansas Geological Survey
Address and Telephone
1930 Constant Ave.
Campus West
Lawrence, KS 66049
785/864-2106
Current Responsibilities
Supervise publication and public outreach activities, media relations, and non-technical communications.
Experience
Kansas Geological Survey, 22 years; University-Industry Research, University of Wisconsin, 3 years; Salina Journal, 4 years.
Education
Kansas Wesleyan University - BA, 1975
University of Wisconsin-Madison - MA, 1978
University of Wisconsin-Madison - MS, 1982

**Liz Brosius**
Title
Research Assistant
Affiliation
Editing and Geology Extension, Public Outreach Section, Kansas Geological Survey
Address and Telephone
1930 Constant Ave.
Campus West
Lawrence, KS 66049
785/864-2063
Current Responsibilities
Editor, Current Research bulletin; Editor and Writer, Geology Extension; Manager, GeoKansas website
Experience
Kansas Geological Survey, 5 years; Paleontological Institute, KU, 10 years
Education
University of Kansas - BA, 1980
University of Kansas - MA, 1985

**Tim Carr**
Title
Senior Scientist
Affiliation
Chief, Petroleum Research Section, Kansas Geological Survey
Address and Telephone
1930 Constant Ave.
Campus West
Lawrence, KS 66049
785/864-2135
Current Responsibilities
Chief, Petroleum Research Section; Co-Director, Energy Research Center; Adjunct Professor of Geology.

Experience

Kansas Geological Survey, 8 years; ARCO Oil and Gas Company, 12 years; Petroleum research, exploration, and operations.

Education

University of Wisconsin - BS, 1973
Texas Tech University - MS, 1977
University of Wisconsin - PhD, 1980

**Bill Harrison**

Title

Deputy Director and Chief Geologist

Affiliation

Kansas Geological Survey

Address and Telephone

1930 Constant Ave.
Campus West
Lawrence, KS 66049
785/864-2070

Current Responsibilities

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

Experience

Kansas Geological Survey, 3 years; Lockheed Martin Idaho Technologies; EG&G Idaho, Inc.; ARCO Exploration & Technology; University of Oklahoma/Oklahoma Geological Survey, Faculty/Staff Geologist

Education

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

**Jim McCauley**

Title

Assistant Scientist

Affiliation

Geologic Investigations Section, Kansas Geological Survey

Address and Telephone

1930 Constant Ave.
Campus West
Lawrence, KS 66049
785/864-2192

Current Responsibilities

Geologic mapping, remote sensing, and public inquiries

Experience

Kansas Geological Survey, 24 years; KU Remote Sensing Laboratory, 6 years.

Education

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

**Bob Sawin**

Title

Research Associate

Affiliation

Geology Extension, Public Outreach Section, Kansas Geological Survey

Address and Telephone

1930 Constant Ave.
Campus West
Lawrence, KS 66049
785/864-2099

Current Responsibilities

Geology Extension, Kansas Field Conference, geologic mapping

Experience

Kansas Geological Survey, 8 years; Petroleum Geology, 15 years; Engineering Geology, 6 years.

Education

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

**Tom Weis**

Title

Assistant Scientist

Affiliation

Kansas Geological Survey

Address and Telephone

1930 Constant Ave.
Campus West
Lawrence, KS 66049
785/864-2186

Current Responsibilities

Geophysicist for Geological Investigations group

Experience

Kansas Geological Survey, 2 years; Mining and oil and gas industries, 20 years

Education

Michigan Technological University - BS, 1975
Michigan Technological University - MS, 1977
University of Utah/University of Kansas - graduate studies

**Scott White**

Title

Assistant Scientist

Affiliation

Energy Research Center, Kansas Geological Survey

Address and Telephone

1930 Constant Ave.
Campus West
Lawrence, KS 66049
785/864-2073

Current Responsibilities

Analysis of Energy Economics

Experience

Energy Research Center, 2 years; High School Mathematics teacher, 2 years.

Education

Central Michigan University - BS, 1990
University of Wisconsin-Madison - MS, 1995
University of Wisconsin-Madison - PhD, 1998

# KANSAS FIELD CONFERENCE

# Northeast Kansas

### *Energy, Land, and Water Resources*

## 2000 FIELD CONFERENCE

June 7-9, 2000

Welcome to the 2000 Field Conference, co-sponsored by the Kansas Geological Survey, the Kansas Forest Service, the State Conservation Commission, and the Kansas Corporation Commission. Previous field conferences have focused on specific natural-resource issues, such as water or energy, or specific regions. This year the field conference moves to northeastern Kansas.

Northeastern Kansas faces far different natural resource issues than other parts of the state. Much of the time on the field conference will be spent within the Flint Hills physiographic province, an area of interbedded limestones and shales that were deposited during the Permian Period of geologic history. Because of the rocky soils, much of the Flint Hills remains in native grass. We will also be in the glaciated region of Kansas, the portion of the state that was covered by a thick ice sheet about 600,000 years ago. Much of this glaciated area is mantled by thick soils that are heavily cultivated.

The geology is not the only thing that is different about this corner of the state. This area receives, in an average year, more than 30 inches of precipitation. That is generally enough for vegetation and for raising crops without irrigation. Surface water also provides fairly reliable water sources in the form of reservoirs and rivers. However, ground water is less plentiful here than in much of the rest of the state. The major sources of ground water are aquifers along the large rivers, such as the Kansas.

Because this corner of Kansas includes a number of the state's large metropolitan areas and industries, water is a major issue here. Many of the major cities in northeastern Kansas—Junction City, Manhattan, Topeka, Lawrence, and Kansas City—are perched on the banks of the Kansas River. The river supplies water for a drinking and other uses. In addition, several of the towns in this area use reservoirs as a water supply.

Because so much of the population relies on surface water, maintaining water quality is extremely important. One of the primary lessons of the past few decades has been the importance of pollution prevention—it is far easier to prevent contamination than to clean it up. Pollution prevention is a key component of the Governor's Water Quality Initiative, which attempts to decrease the amount of contamination entering surface waters. In addition, because of the reliance on reservoirs for water supply and recreation, siltation of reservoirs is a major issue.

Supplying a large and growing population with energy is also an issue. As part of the field conference, we will spend much of a day at the Jeffrey Energy Center near St. Marys. This coal-fired plant provides power for many of the homes and business of northeastern Kansas. In addition, Jeffrey has begun a wind-energy demonstration project. This location is also an opportunity to discuss issues related to carbon dioxide and the environment.

Two of the state's major research universities, Kansas State University and the University of Kansas, are located in northeastern Kansas. During the field conference, we will draw on the expertise of the staff of both universities and spend time at the Konza Prairie Research Natural Area, operated by Kansas State University.

### About the Kansas Field Conference

The 2000 Field Conference is the sixth in a series of the Survey's annual field conferences. The purpose of the Field Conference is to provide first-hand, on-site experience on natural-resource issues to the state's decision makers. Local and regional experts in resource development will describe each site and the resource issues related to it. In addition, this comprehensive Field Guide provides background on the sites and the issues, serving as a handy reference long after the Field Conference is over.

When possible, participants will interact with county, state, and regional officials, environmental groups, and citizens' organizations. This information base will provide participants with new and broader perspectives useful in formulating policies. During the Field Conference, participants are expected to be just that—participants. You are encouraged to make contributions to the discussions, ask questions, and otherwise participate in deliberations. **The bus microphone is open to everyone, and everyone is encouraged to contribute.**

In the course of this Field Conference, we do not seek to resolve policy or regulatory conflicts. Instead, we are trying to provide opportunities to acquaint decision-makers and policy-makers with resource problems and issues. We want to go beyond merely identifying issues; we want to bring together experts who examine the unique technical, geographical, geological, environmental, social, and economic realities of the region. 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.

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

The Kansas 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 Kansas Geological Survey appreciates the support of Dr. Erling Brostuen, Director of the Energy and Minerals Field Institute, in helping develop the Kansas project.

**Kansas Geological Survey**

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

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

*Water.*—Water issues directly affect the life of every Kansan. Water supplies are crucial for domestic and municipal use, and in much of the state's economic activity. Western Kansas agriculture and industry relies heavily on ground water; in eastern Kansas, growing populations and industry use surface water. The Survey's water research and service includes an annual water-level measurement program (in cooperation with the Kansas Department of Agriculture), studies of mineral intrusion in the Big Bend and Equus Beds areas, nitrates in the Solomon River basin and in central Kansas, and studies of water resources in the Dakota aquifer, the Quivira National Wildlife Refuge, Rattlesnake Creek, the Republican River, and the Arkansas River. The Survey is currently developing a detailed analysis of the High Plains aquifer.

*Energy.*—Kansas energy production generates more than $2 billion worth of income each year. Because much of the state has long been explored for oil and gas, maintaining that production takes research and information. The Survey studies the state's coal resources, its petroleum reservoirs, techniques such as high-frequency ground-penetrating radar, and new methods of providing information, such as a digital petroleum atlas. The Survey has recently begun a multi-year study of the resources of the Hugoton Natural Gas Area.

*Geology.* —Much of the Survey's work is aimed at producing basic information about the state's geology, information that can be applied to a variety of resource and environmental issues. The Survey 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, applies statistical analyses to geologic problems and issues, and studies specific resources, such as road and highway materials.

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

Kansas Geological Survey Staff participating in the 2000 Field Conference:

M. Lee Allison, Director and State Geologist
William Harrison, Deputy Director and Chief Geologist
Rex C. Buchanan, Associate Director, Public Outreach
James R. McCauley, Assistant Scientist, Geologic Investigations Section
Liz Brosius, Research Assistant, Geology Extension/Editing
Robert S. Sawin, Research Associate, Geology Extension
Tim Carr, Chief, Petroleum Research Section
Tom Weis, Research Assistant, Geologic Investigations Section
Scott White, Assistant Scientist, Energy Research Center
Lee C. Gerhard, Principal Geologist

Kansas Geological Survey
1930 Constant Ave.
Lawrence, KS 66047
785-864-3965
785-864-5317 (fax)
**http://www.kgs.ukans.edu**

**Kansas Forest Service**

The Kansas Forest Service is charged with overseeing the state's forest resources. As a state agency within the Department of Horticulture, Forestry, and Recreation Resources at Kansas State University, the Forest Service improves, enhances, and conserves the state's forest resources. The Forest Service has 21 full-time employees. Approximately 55 percent of its budget is from federal sources (primarily the USDA Forest Service), 26 percent from tree sales, and 19 percent from the state of Kansas. The current state forester is Ray Aslin.

Kansas has more than 1.5 million acres of forest land, land that is extremely important in providing wood products, wildlife habitat, soil-erosion control, clean water, recreation, and scenic beauty. Ninety-four percent of the forest land in the state is owned by private individuals.

The Kansas Forest Service offers a range of services to the citizens of Kansas. These include technical assistance to rural landowners, community tree boards and departments, federal excess property to rural fire districts, and conservation tree sales. In addition to the headquarters in Manhattan, the Forest Service maintains seven district offices.

*Forest Management.*—Private landowners receive technical assistance in managing forest land. Assistance includes information about tree planting, thinning existing forests, pruning high-value trees, and timber harvesting. Loggers and mill operators also receive assistance in harvesting techniques, processing logs, and marketing wood products.

*Conservation Tree Planting and Improvement.*—The Conservation Tree Planting Program provides about 750,000 low-cost tree and shrub seedlings annually for use in conservation plantings. Landowners are encouraged to plant trees for windbreaks, woodlots, erosion control, wildlife habitat, and Christmas trees. Technical assistance is available in designing conservation tree plants to meet landowner's objectives. The Forest Service's Tree Improvement Program utilizes orchard plantings of selected trees and shrubs to produce seed to grow seedlings distributed through its Conservation Tree Planting Program.

*Urban and Community Forestry.*—Tree boards, city foresters, and park administrators receive assistance in long-range planning; training in tree planting and care; and technical assistance in managing their city trees. Professional arborists are offered the latest information and training in tree care practices. Individuals and municipalities receive program support in Tree City USA and other conservation programs.

*Forest Pest Management.*—Foresters monitor insect and disease activities on forest land and in conservation tree plantings, and recommend appropriate control measures.

*Rural Fire Protection.*—Assistance is provided to the state's rural fire departments, including wildfire training, fire prevention materials, and the acquisition and distribution of excess military vehicles for conversion to fire fighting units. Matching grants also are provided to rural communities with populations under 10,000 to help purchase new fire-fighting equipment.

*Windbreak Management.*—Planning and technical assistance in planting and maintaining farmstead, livestock, and field windbreaks are available. Plans include proper design, tree species selection, site preparation, planting instructions, weed control, and long-term care.

Kansas Forest Service
2610 Claflin Road
Manhattan, KS 66502-2798
785-532-3300
785-532-3305 (fax)
**http://www.kansasforests.org**

**Kansas Corporation Commission**

The mission of the Kansas Corporation Commission (KCC) is to protect the public interest through impartial and efficient resolution of all jurisdictional issues. The agency regulates rates, service, and safety of public utilities, common carriers, motor carriers, and regulates oil and gas production by protecting correlative rights and environmental resources. The KCC's responsibility is to ensure that the public interest is served by customers receiving adequate, reliable service at fair and reasonable rates that will allow the utilities' investors the opportunity to earn an adequate return.

The KCC consists of three Commissioners appointed by the Governor with the consent of the Senate. By law, no more than two commissioners can be of the same political party. The Chairman of the Commission is elected by the Commission. The current commissioners are John Wine (chair), Brian Moline, and Cynthia Claus. The KCC is made up of an Energy Division, Transportation Division, Oil and Gas Conservation Division, and Utilities Division.

*Conservation Division.*—The Kansas Legislature gave the KCC responsibility for oil and gas regulatory activities in 1931. In 1986, the KCC's Conservation Division was given sole authority for the regulation of oil and gas, including responsibility for water and environmental protection. The Division's rules and regulations are geared toward protection of fresh and usable water and soil; protection of correlative rights; and prevention of waste of oil and gas resources. The goal of the Division is to set practical and effective standards that protect the environment without unduly restricting drilling and production of oil and gas. The Division operates from Wichita and has district offices in Dodge City, Wichita, Chanute, and Hays.

*Utilities Division.*—The KCC is responsible for regulation of utilities in the state, including electricity, pipelines, telecommunications, and other activities.

Kansas Corporation Commission
1500 SW Arrowhead
Topeka, KS 66604-4027
785-271-3100
785-271-3354 (fax)

Utilities Division
1500 SW Arrowhead
Topeka, KS 66604-4027
785-271-3165
785-271-3357 (fax)

Conservation Division
130 S. Market, Suite 2078
Wichita, KS 67202-3758
316-337-6200
**http://www.kcc.state.ks.us/**

**State Conservation Commission**

Conservation of natural resources is an important concern for all Kansans. The State Conservation Commission, working with the 105 local conservation districts, the 88 organized watershed districts, and state and federal agencies, administers programs that improve water quality, reduce soil erosion, conserve water, and reduce flood potential.

The State Conservation Commission administers Kansas Laws and Statutes designed to assist local entities and individuals in conserving natural resources. The agency is governed by five elected commissioners; two *ex officio* members representing Kansas State University Research and Cooperative Extension; and two appointed members representing the Kansas Department of Agriculture and the USDA–Natural Resources Conservation Service. The agency is administered by an executive director appointed by the Commission. The current executive director is Tracy Streeter.

The SCC establishes state policy for administration of ten programs. The State Conservation Commission's cost-share programs are aimed at providing financial incentives to landowners to implement enduring conservation practices that reduce soil erosion and improve water quality and water conservation. The cost-share program is administered locally by the 105 conservation districts. All landowners within the state of Kansas are eligible to receive cost-share funds.

*Water Resources Cost-Share Program.*—This program provides state financial assistance to landowners for the establishment of enduring water-conservation practices to protect and improve the quality and quantity of Kansas water resources. These activities reduce soil erosion, improve water quality, and increase water conservation.

*Non-Point Source Pollution Control Fund.*—Provides state financial assistance for non-point source pollution-control practices for the protection or restoration of surface- and ground-water quality.

*Riparian and Wetland Protection Program.*—Addresses the conservation and management of riparian areas (banks of streams or rivers and wetlands). Funded projects include alternative livestock water supplies, wetland enhancement, riparian fencing, tree plantings, and soil bio-engineering for streambank stabilization. The program reduces flood damage, filters pollutants, reduces soil erosion, and supplies wildlife habitat.

*State Aid to Conservation Districts.*—Provides state funds to match county funds appropriated by county commissions for the operation of county conservation districts in Kansas.

*Multipurpose Small Lakes Program.*—Provides state financial assistance to governmental and other entities for the construction or renovation of a dam for flood control, water supply, or recreation.

*State Assistance to Watershed Dam Construction.*—Provides state financial assistance to watershed districts and other special purpose districts for the implementation of structural and non-structural practices.

*Water Rights Purchase Program.*—Provides financial assistance to local entities to purchase a water right to restore base flows in designated streams or slow or reverse the decline of ground-water levels in specific aquifers.

*Watershed Planning Assistance Program.*—Provides state financial assistance for obtaining engineering services and environmental assessments for developing general plans and other flood control and rehabilitation projects in watershed districts.

*Land Reclamation Program.*—Addresses the Surface Mining Land Conservation and Reclamation Act, which requires that entities mining industrial materials or minerals of commercial value (such as gypsum, clay, sandstone, sand, shale, silt, gravel or volcanic ash) be licensed to operate a mine and reclaim mine sites upon completion of mining.

*Stream Rehabilitation Program.*—Provides financial assistance for planning and implementing approved stream rehabilitation projects. This program addresses streams that have been adversely altered by channel modification.

*Benefit Area Assistance Program.*—Provides a method for public corporations, namely watershed districts, to be reimbursed for specific expenses when more than 20 percent of the benefits for a flood control project are outside the taxing entity's boundary.

Kansas State Conservation Commission
109 SW 9th Street, Suite 500
Mills Bldg.
Topeka, KS 66612l
785-296-3600
785-296-6172 (fax)
**http://www.ink.org/public/kscc/**

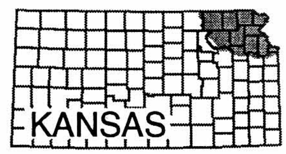
# SCHEDULE & ITINERARY

## Wednesday June 7, 2000

| | |
|---|---|
| 7:00 am | Breakfast |
| 7:30 am | Conference Overview<br>*Lee Allison*, Director, Kansas Geological Survey |
| 8:15 am | **Bus Leaves Holiday Inn for Site 1** |
| 8:30 am | **SITE 1**—Tuttle Creek Lake Spillway<br>*Don Steeples*, University of Kansas<br>*Greg Wurst*, Corps of Engineers |
| 9:15 am | Bus to Site 2 |
| 10:20 am | **SITE 2**—Kansas Hardwoods Sawmill<br>*Steve Floersch*, Kansas Hardwoods Inc.<br>*Ray Aslin*, Kansas Forest Service<br>*Bob Atchison*, Kansas Forest Service |
| 11:20 am | Bus to Site 3 |
| 11:40 am | **SITE 3**—Jeffrey Energy Center<br>*Brad Loveless*, Western Resources Inc. |
| 12:00 pm | Lunch at Jeffrey |
| 12:45 pm | $CO_2$ in Kansas<br>*Scott White*, Energy Research Center<br>*Tim Carr*, Kansas Geological Survey<br>*Dave Williams*, Kansas Corporation Commission |
| 2:00 pm | Tour Coal-Fired Power Plant |
| 4:00 pm | Tour Wind Turbines |
| 5:00 pm | Tour Wetlands and Environmental Areas |
| 5:45 pm | Oregon Trail Nature Park - Dinner at Park |
| 7:30 pm | Bus to motel |
| 8:15 pm | Arrive Holiday Inn, Manhattan |

# Glaciated Region

As the name suggests, the Glaciated Region is the part of Kansas that was glaciated—that is, it was covered by at least two of the eight or nine glaciers that encroached upon much of the northern United States during the Pleistocene Epoch, between 1.6 million and 10,000 years ago. The first of these covered just the northeastern corner of Kansas. The second, which encroached on Kansas about 600,000 years ago, extended almost to Manhattan and beyond Topeka and Lawrence in a line roughly parallel to the present-day Kansas River. In some places, this ice sheet was 500 feet thick.




The underlying bedrock in the Glaciated Region, Pennsylvanian and Permian limestones and shales, was deposited about 320 to 250 million years ago. These rocks, however, have been covered by thick glacial deposits—silt, pebbles, and boulders—that were left behind when the ice melted. In some places, the thick deposits, which geologists call glacial drift, have formed deep soils.

Except for the glacial drift, erosion has erased most of the evidence of glaciation from the Kansas landscape. In other parts of North America, such as Wisconsin, the glaciation was more recent and the landscape still bears the marks of the advancing and retreating ice sheet.

During the Kansan glaciation, the force of the advancing ice was strong enough to break large boulders off outcrops in South Dakota, Iowa, and Minnesota and carry them into Kansas. Rocks that have been transported into an area from far away are called erratics. Among the glacial erratics in northeastern Kansas, quartzite is one of the most common. Quartzite, a metamorphic rock, is quartz sandstone that is so thoroughly cemented with silica ($SiO_2$) that the rock breaks through the grains as easily as around them. It is harder than sandstone and can not be scratched by a knife. The quartzite boulders in the Glaciated Region are known as Sioux quartzite because they come from the area where Sioux quartzite crops out around Sioux Falls, South Dakota.

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# Tuttle Creek Lake

The second largest reservoir in Kansas, Tuttle Creek Lake covers 13,350 acres (at normal pool size) and has 104 miles of shoreline. It is a vital unit in the system of flood control projects within the Kansas River Basin.

Construction began in 1952 by the U.S. Army Corps of Engineers (COE) and was completed in 1962, at a total cost of $80 million. Operation began on July 1 of that year. The COE is responsible for conducting dam safety inspections and maintaining the dam and outlet works. COE employees release water through Tuttle Creek Dam to the Big Blue River in coordination with the Kansas City District's Water Control Section.

Since its completion, flood control has been an important function of the lake. It's estimated that the reservoir has prevented over three billion dollars worth of flood damage. During the record rains of 1993, the reservoir swelled from 13,000 acres to 56,000 acres. The pool crested at 1,137.77 feet on July 23, 1993, almost 63 feet above normal. The 1993 flood resulted in the first spillway release in the history of the lake. During the flood's peak, a record 60,000 cubic feet per second was released. The roar of the water was heard a half mile away. Following three weeks of releases, the gates were closed, revealing the transformation of the spillway channel into a canyonland.

At the other extreme, the reservoir can release water when streamflows decline. During times of extreme drought, water from Tuttle Creek Lake can be released to maintain streamflow to aid navigation on the lower Missouri River and to improve water quality in the Kansas River.

Tuttle Creek Lake also supports recreational activities, such as fishing, boating, swimming, hunting, and camping. Nine public use areas provide facilities such as boat launching ramps, restrooms, water supply, picnic tables, grills, and overnight camping pads. The Kansas Department of Wildlife and Parks (KDWP), which leases the northern half of the lake, operates four state park units at the lake.

### Spillway Fault

Good exposures of faults in Kansas are rare. The slightly curved, almost east-west-trending trace of the Spillway Fault at Tuttle Creek Lake can be followed for about 11 miles. Along the fault's trace, the vertical displacement, or throw, varies from about 5.6 to 28.4 feet. The fault trace is just north of the dam, but does not lie beneath any part of the dam or control gates of the spillway. It crosses Kansas Highway 13 about 375 feet northeast of the east end of the spillway gates. The fault can be seen in the exposure on the east side of the spillway (fig. 3-1).

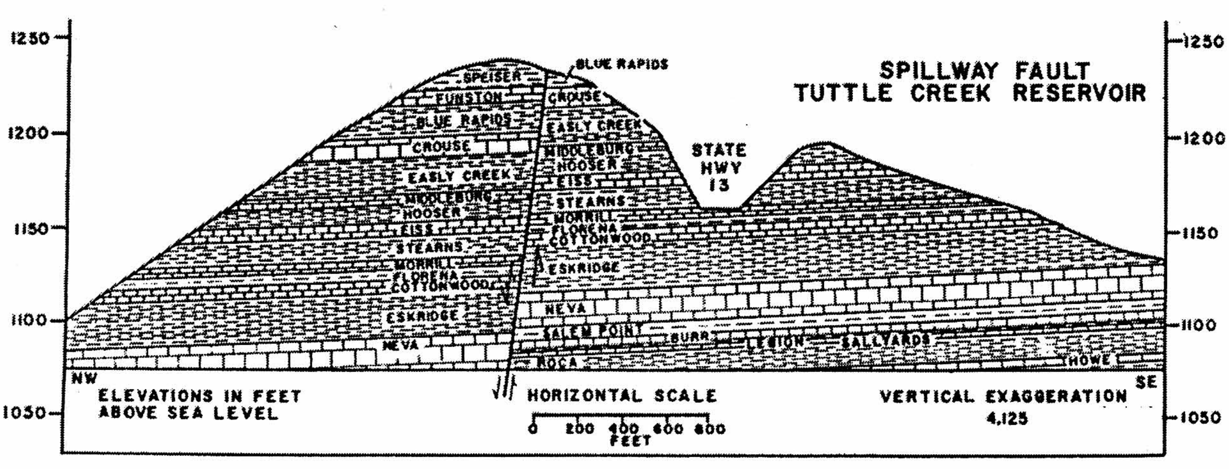


Fig. 3-1—The Spillway Fault on the east side of the spillway (Chelikowsky, 1972).

The Corps of Engineers was aware of the fault during planning and design of the Tuttle Creek project. They mapped the fault, studied drill cores taken along it, and concluded that the fault had not been active in geologically recent time and posed no significant danger to the dam and spillway. There is no evidence that suggests the Spillway Fault has been active in geologically recent time. No disruption of surficial deposits or stream terraces has been observed along the fault, and cores along the fault zone showed it to be well sealed with mudstone. The Spillway Fault is probably related to reactivation of ancient faults associated with deep subsurface tectonic features.

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**Resource Contacts**


Greg Wurst, Park Manager
Corps of Engineers
Tuttle Creek Lake
5020 Tuttle Creek Blvd.
Manhattan, KS 66502
785-539-8511

Don Steeples, Professor
Department of Geology
University of Kansas
Lawrence, KS 66045
785-864-2730
steeples@kuhub.cc.ukans.edu

# Kansas Forest Industry

The forest industry in Kansas employs over 3,215 people and generates an annual income of over $64.5 million. About four percent of manufacturing workers in Kansas work for companies that make paper or other wood products.

Of the more than 50 sawmills in Kansas, well over 30 are portable bandsaw mills. As the name suggests, portable mills can easily be transported to the site where trees are logged.

Each year Kansas forest land grows enough wood to construct 27,395 homes; however only about a third of this is harvested annually. Trees that are large enough to be harvested for wood products are called sawtimber. The majority of sawtimber harvested is processed into high-quality lumber. Over a 13-year-period, sawtimber volume in Kansas has increased by 43 percent, but from a timber-products perspective, forest land is still underutilized.

Small businesses within the Kansas forest industry (like Kansas Hardwoods Inc.) have difficulty finding markets for their products. Many Kansas manufacturers who use wood to make their products often purchase the materials from outside the state or country. Value-added products made from trees like black walnut, oak, cottonwood, hackberry, and eastern red cedar could bring a significant amount of income that is currently being spent elsewhere into the state. Though 85 percent of all the timber harvested in Kansas is milled within the state, 95 percent of the best-quality veneer logs are exported overseas, with the remaining 5 percent sent to Missouri.

**Kansas Hardwoods Inc.**

When Kansas Hardwoods Inc. went into business eight years ago, the company did its own logging. They now rely on loggers to bring the logs to the sawmill in Belvue. Kansas Hardwoods produces custom lumber that is made into cabinets, trim, furniture, and other finish-type products. They also produce pallets and crates. Kansas Hardwoods employs two people and charges $60 per hour to custom cut logs into lumber.

The sawmill at Kansas Hardwoods is a Wood Mizer Superhydrolic 40 E. It can cut over 2,000

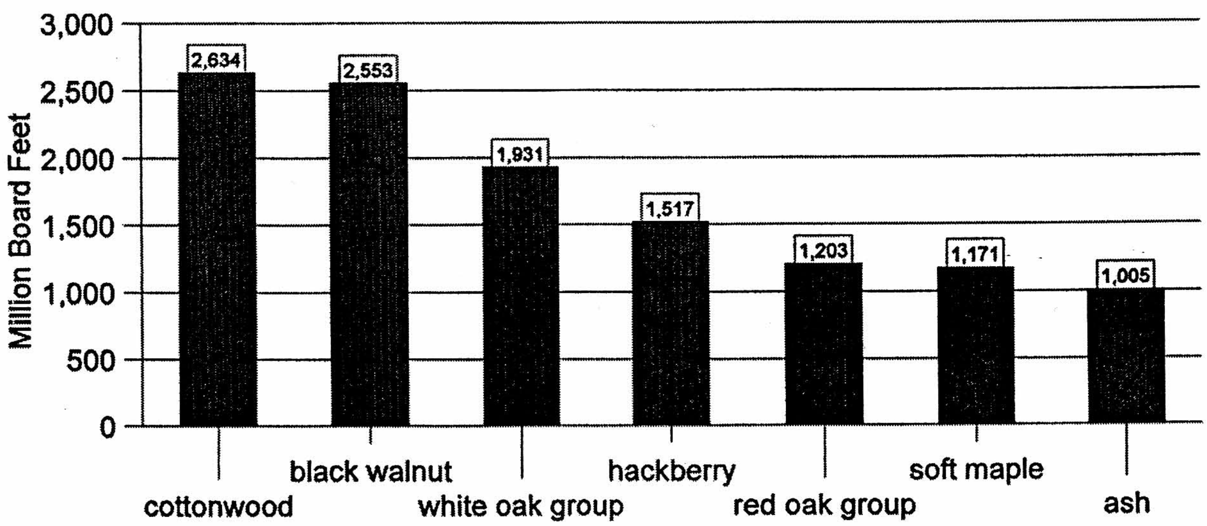


Fig. 3-2—Major timber species harvested in Kansas (Kansas Forest Service).

board feet of lumber per day (a board foot is a piece of wood one inch thick, twelve inches wide, and one foot long).

About 60 percent of the wood used is red oak, which is kiln dried in two electric dehumidifier kilns that together hold 6,900 board feet. For custom-drying hardwoods like black walnut, bur oak, and sycamore, two solar kilns are used. Kansas Hardwoods also sells some lumber without drying it, such as bur oak and cottonwood. This wet or "green lumber" is used to make pallets and crates.

**Resource Contacts**

Ray Aslin, State Forester
Kansas Forest Service
2610 Claflin Road
Manhattan, KS 66502-2798
785-532-3305
raslin@oz.oznet.ksu.edu

Robert Atchison
Rural Forestry Coordinator
Kansas Forest Service
2610 Claflin Road
Manhattan, KS 66502-2798
785-532-3310
ratchiso@oz.oznet.ksu.edu

Erin Zook, District Forester
Kansas Forest Service
1125 Westport Dr
Manhattan, KS 66502-2860
785-776-5182
785-539-7983
Ezook@oznet.ksu.edu

Steve Floersch
Kansas Hardwoods Inc.
22855 Highway 24
Belvue, KS 66407
785-456-8141

# Jeffrey Energy Center

The Jeffrey Energy Center, located five miles north and three miles west of St. Marys, is the largest power plant in Kansas. Construction began in 1974, and the first unit began operation in 1978. Unit 2 was completed in 1980, with Unit 3 following in 1983. The plant was originally designed for four identical 700-megawatt units, but Unit 4 has been postponed until need for additional energy is identified.

To generate electricity, each unit burns pulverized coal to create the heat required to boil water and further heat the steam that is produced. The boiler for each of Jeffrey's three units is capable of producing more than 5,000,000 pounds of steam per hour (which requires boiling more than 10,000 gallons of water per minute). To create this much steam, each boiler consumes up to 470 tons of coal per minute. The steam is then used to turn big turbines, which drive the generators that produce the electricity.

The three coal-fueled units have a total generating capacity of 2,227 megawatts, consuming more than 20,000 tons of coal daily. Low-sulfur coal is delivered by train from mines in northeastern Wyoming in 118-car trains. The plant receives and unloads an average of 11 train units per week, each delivering more than 14,000 tons of coal.

Approximately 20 percent of Jeffrey's total construction costs was spent on pollution-control equipment. Electrostatic precipitators remove 99 percent of the particulate matter in exhaust gases. The flue gases are passed through a large compartment containing electrically charged plates and wire grids. The ash is attracted to the collecting plates, much as lint is attracted by static cling in clothing. The collected ash is sold as a substitute for cement in concrete and for soil stabilization purposes.

The plant is also equipped with flue gas scrubbers, which remove nearly two-thirds of the sulfur from the exhaust gases. Local limestone is ground and mixed with water to form a slurry that is sprayed into the flue gas in the scrubber spray modules. The calcium in the limestone reacts with the sulfur dioxide gas to form calcium sulfate. This precipitate is transported as a slurry to the bottom ash lake for disposal.

**Wind Turbines**

As part of a pilot project to determine the feasibility of using wind power, Kansas Power & Light (KPL) and Kansas Gas & Electric (KGE) have built two 750-kW, variable-speed wind turbines at the Jeffrey Energy Center. Based on historical wind profiles for the area, the turbines are projected to produce approximately 3.6 million kilowatt hours (kWh) of electricity annually. This is enough electricity to meet the annual power needs of approximately 400 households.

During the pilot program, blocks of renewable electric power generated from these new wind turbines and other resources will be available for KPL/KGE customers to purchase. KPL/KGE will begin selling wind-generated electricity in July 2000.

The turbines, built by Zond Development Corporation, are mounted on tubular towers that stand more than 170 feet high. Each turbine has a three-blade rotor mounted on top that turns the turbine generator. Automatic sensors determine wind direction and speed, allowing the turbines to turn automatically to face into the wind and vary blade pitch based on the wind's speed. If the wind speed is too high, the systems' computer will set the rotors at a neutral pitch so they will stop turning. This is done to protect the system.

The turbine will start producing power when the wind speed is 9 mph and will shut off when the wind reaches a speed in excess of 65 mph. Kansas is ranked as the state with the third best wind potential in the United States. North Dakota and Texas are ranked first and second, respectively.

**Wildlife Management and Recreation Areas**

Four wildlife management areas are located at Jeffrey Energy Center:

- Area 1: Public hunting (1,385 acres).
- Area 2: Hunting and fishing by written permission only (5,600 acres)
- Area 3: Wildlife Refuge, no public access (3,476 acres).
- Area 4: Oregon Trail Nature Park and public education area.

The Oregon Trail Nature Park borders the historic Oregon Trail on the southern edge of Jeffrey. Between 1843 and 1866, 300,000 emigrants traveled westward on the 2,000-mile-long trail. The park showcases the natural ecosystems of Kansas and includes two ponds, three nature trails, a shelter house, picturesque silo, amphitheater, and picnic areas.

The trails were constructed of ash produced from burning coal at Jeffrey Energy Center. Cindy Martin, an artist from Onaga, painted three scenes on the silo: "Oregon Bound" on the south side, "Fall Hunt" on the east side, and "Kansas Wildlife" on the west side.

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**Resource Contacts**

Brad Loveless
Manager, Biology & Conservation Programs
Western Resources, Inc.
P.O. Box 889
Topeka, KS 66601-0889
785-575-8115
brad_loveless@wstnres.com

# $CO_2$ in Kansas

Every day we discharge tons of carbon dioxide ($CO_2$), a greenhouse gas, into the atmosphere. Researchers at the Kansas Geological Survey (KGS) and the Tertiary Oil Recovery Project (TORP) at the University of Kansas want to pump $CO_2$ underground and use it to produce more oil. With funding from the Department of Energy, they have begun work on a pilot project to determine the technical and economic feasibility of a technique known as $CO_2$ miscible flooding. Also involved in this six-year project are MV Energy LLC, Kinder Morgan $CO_2$ Co. LP, and the Kansas Department of Commerce.

In $CO_2$ miscible flooding, liquid $CO_2$ is pumped under high pressure into a reservoir through injection wells, creating a $CO_2$ flood bank (fig. 3-3). The front of this $CO_2$ bank mixes with the trapped oil, causing it to become more mobile. As more oil is encountered, an oil bank forms and is pushed ahead of the $CO_2$ flood bank toward producing wells. The producing wells pump the oil to the surface where the $CO_2$ is separated from the oil and reinjected back underground.

The site for the pilot project is located approximately six miles southeast of Russell, at the Hall-Gurney field. The project will target the Lansing-Kansas City reservoir and involve one $CO_2$ injector well and five production wells.

The economic potential of $CO_2$-enhanced oil recovery is significant. Researchers estimate that it could double the current daily oil production, ultimately producing hundreds of millions of barrels of additional oil and generating thousands of additional jobs. Oil price and the cost of $CO_2$ will determine the economic feasibility of this technique.

Currently, Kansas has no $CO_2$ wells, nor is there a pipeline carrying $CO_2$ into the state. This makes the $CO_2$ an expensive part of the oil recovery process.

In addition, there is growing concern about the relationship between increasing atmostpheric $CO_2$ concentrations and global climate change. Sequestering $CO_2$ in geological reservoirs may be one way to safely manage $CO_2$ over long periods of time. KGS researchers, in conjunction with four other state geological surveys, are studying the geological feasibility and costs associated with $CO_2$ sequestration. They are also looking at the feasibility of collecting $CO_2$ from the flue gases discharged at electrical generating facilities. If this $CO_2$ can be captured, it will not only lower costs of the oil recovery but it will serve to reduce the amount of greenhouse gas released into the atmosphere.

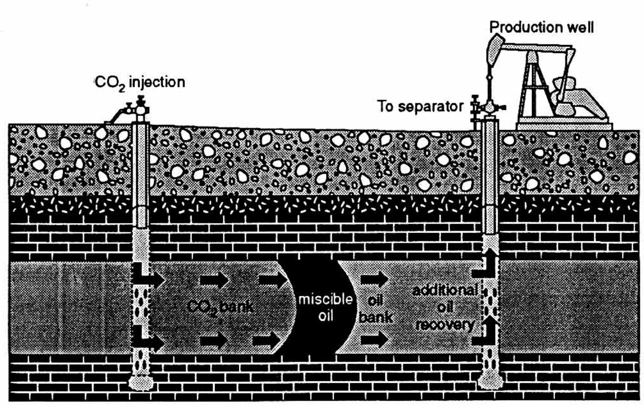


Fig. 3-3—Carbon dioxide miscible flooding.

In the future, $CO_2$ emissions may be restricted. Electric utilities and other large $CO_2$ producers may be required to recover $CO_2$ from their flue gas and remove it from the atmosphere.

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**Resource Contacts**


Scott White
Kansas Geological Survey
1930 Constant Avenue
The University of Kansas
Lawrence, Kansas 66047-3726
785-864-2073

Tim Carr
Kansas Geological Survey
1930 Constant Avenue
The University of Kansas
Lawrence, Kansas 66047-3726
785-864-2135
tcarr@kgs.ukans.edu

Dave Williams
Kansas Corporation Commission
Conservation Division
130 S. Market, Rm 2078
Wichita, Kansas 67202
316-337-6218
dwilliams@kcc.state.ks.us

# SCHEDULE & ITINERARY

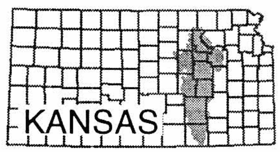
## Thursday June 8, 2000

| | |
|---|---|
| 7:00 am | Breakfast |
| 7:45 am | **Bus Leaves Holiday Inn for Site 4** |
| 8:15 am | **SITE 4**—Siltation at Tuttle Creek Lake - Randolph Bridge<br>*Earl Lewis*, Kansas Water Office |
| 8:15 am | Bus to Site 5 |
| 9:15 am | **SITE 5**<br>Horseshoe Creek Watershed District<br>*Tracy Streeter*, State Conservation Commission<br>*Phil Balch*, State Conservation Commission<br>Riparian Forests<br>*Ray Aslin*, Kansas Forest Service<br>*Bob Atchison*, Kansas Forest Service<br>*Erin Zook*, Kansas Forest Service |
| 10:15 am | Bus to Site 6 |
| 11:15 am | **SITE 6**—Governor's Water Quality Initiative/TMDL's-Buessing Dairy<br>*Joe Harner*, Kansas State University<br>*Tracy Streeter*, State Conservation Commission<br>*Al LeDoux*, Kansas Water Office<br>*Margaret Fast*, Kansas Water Office |
| 12:00 pm | Lunch in Axtell, Kansas |
| 1:00 pm | Bus to Site 7 |
| 1:10 pm | **SITE 7**—Governor's Water Quality Buffer Initiative - Keiser-Woolsoncroft Riparian Filter Strip<br>*Tom Badger*, State Conservation Commission/NRCS<br>*Eldon Schwant*, Natural Resources Conservation Service |
| 1:50 pm | Bus to Site 8 |
| 2:10 pm | **SITE 8**—Centralia Lake - Multipurpose Small Lakes Program<br>*Tracy Streeter*, State Conservation Commission<br>*Al LeDoux*, Kansas Water Office |
| 2:10 pm | Bus to Site 9 |

| | |
|---|---|
| 2:30 pm | **SITE 9**—Black Vermillion Watershed Project/Siltation in Streams and Reservoirs<br>*Earl Lewis*, Kansas Water Office<br>*Anna Wolfe*, Corps of Engineers<br>*Phil Snell*, Corps of Engineers |
| 3:20 pm | Bus to Site 10 |
| 4:30 pm | **SITE 10**—Konza Prairie Research Natural Area<br>*David Hartnett*, Konza Prairie Research Natural Area<br>*Valerie Wright*, Konza Prairie Research Natural Area |
| 5:30 pm | Refreshments and Dinner at Konza |
| 7:00 pm | Ranching and Cowboys in the Flint Hills<br>*Jim Hoy*, Emporia State University |
| 7:30 pm | Konza Prairie Sunset Bison Tour |
| 8:45 pm | Bus to motel |
| 9:00 pm | Arrive Holiday Inn, Manhattan |

# The Flint Hills

The Flint Hills are familiar to many travelers because this part of the state is traversed by both I-70 and the Kansas Turnpike. Despite disagreement about the exact boundaries of the Flint Hills, most geologists agree that the hills extend from Marshall County, in the north, to Cowley County, in the south. (Of course, the hills don't end abruptly at the state line; they continue into Oklahoma, where they are known as the Osage Hills.)




The Flint Hills were formed by the erosion of limestones and shales deposited about 290 million years ago during the early part of the Permian Period. At this time, shallow seas covered much of the state, as they did during the Pennsylvanian Period (323 to 290 million years ago). Unlike the Pennsylvanian limestones to the east, however, the limestones in the Flint Hills contain numerous bands of chert, or flint. Because chert is much less soluble than the limestone around it, the weathering of the limestone has left behind a clayey soil full of cherty gravel. This gravel-filled soil covers the rocky uplands and slows the process of erosion. Most of the hilltops in this region are capped with this cherty gravel.

The cherty soil makes the land better for ranching than farming. Because of this, the Flint Hills is still largely native prairie grassland, one of the last great preserves of tallgrass prairie in the country. The tall grasses in this region are mostly big and little bluestem, switch grass, and Indian grass. Except along stream and river bottoms, trees are rare. The streams in the Flint Hills have cut deep, precipitous channels. Streams cut in chert-bearing strata are narrow, boxlike channels, whereas those cut in weaker shales are wider, more gently sloping valleys.

One of the prominent limestones in the Flint Hills is the Fort Riley Limestone Member (the lowest member of the Barneston Limestone). Known in southern Kansas as Silverdale limestone, the Fort Riley is 30 to 45 feet thick and is riddled with caves and solution cavities. At Silverdale, where it is quarried in southern Cowley County, the Fort Riley is nearly 60 feet thick. The Cowley County courthouse in Winfield, Kansas, is built out of this limestone.

Another characteristic limestone in the Flint Hills is the Florence Limestone Member (of the Barneston Limestone). Ranging from 12 to 45 feet in thickness, this limestone often contains a variety of fossils, including brachiopods, pelecypods, bryozoans, and fusulinids.

**References**

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# Kansas Watershed Districts

The Kansas Watershed District Act was passed in 1953 in response to the flood of 1951. The Act provides a process for local citizens to organize and vote to establish a district. Once a district is formed, a board of directors is appointed and begins to develop a general plan. Each year, an annual meeting is held to revisit the plan and elect board members. Eligible voters include all persons owning land or residing within the district.

Watershed districts have the power of taxing authority and eminent domain. Districts no longer have statutory mill levy limitations.

Currently, Kansas has 88 organized watershed districts (fig. 4-1). Some completed their general plans years ago; others, like Horseshoe Creek Watershed District, are just starting; and the rest are somewhere in between. With a few exceptions, most districts are located east of U.S. Highway 81.

**Horseshoe Creek Watershed District**

The Horseshoe Creek Watershed Joint District No. 110 (fig. 4-2) was organized under the auspices of the Kansas Watershed District Act (K.S.A. 24-1201 et seq.) in October 1995. The District was formed to organize community action regarding flooding. In April 1996, the District made requests to state and federal agencies for assistance in developing the general plan for the watershed.

The Horseshoe Creek Watershed covers 67,500 acres. It includes land in Marshall (38,170 acres) and Washington counties (15,280 acres) in northeast Kansas and Gage (13,650 acres) and Jefferson counties (400 acres) in southeast Nebraska.

Horseshoe Creek joins the Big Blue River three miles upstream from Marysville. The Big Blue River is the most significant contributor into Tuttle Creek Lake and the Kansas River. This water resource is a direct and indirect source to municipal and industrial water supplies in northeast Kansas.

The Horseshoe Creek Watershed is located in the Blue River priority sub-basin of the Governor's Water Quality Initiative. Because of the priority location within the Governor's Water Quality Initiative, the watershed district received planning

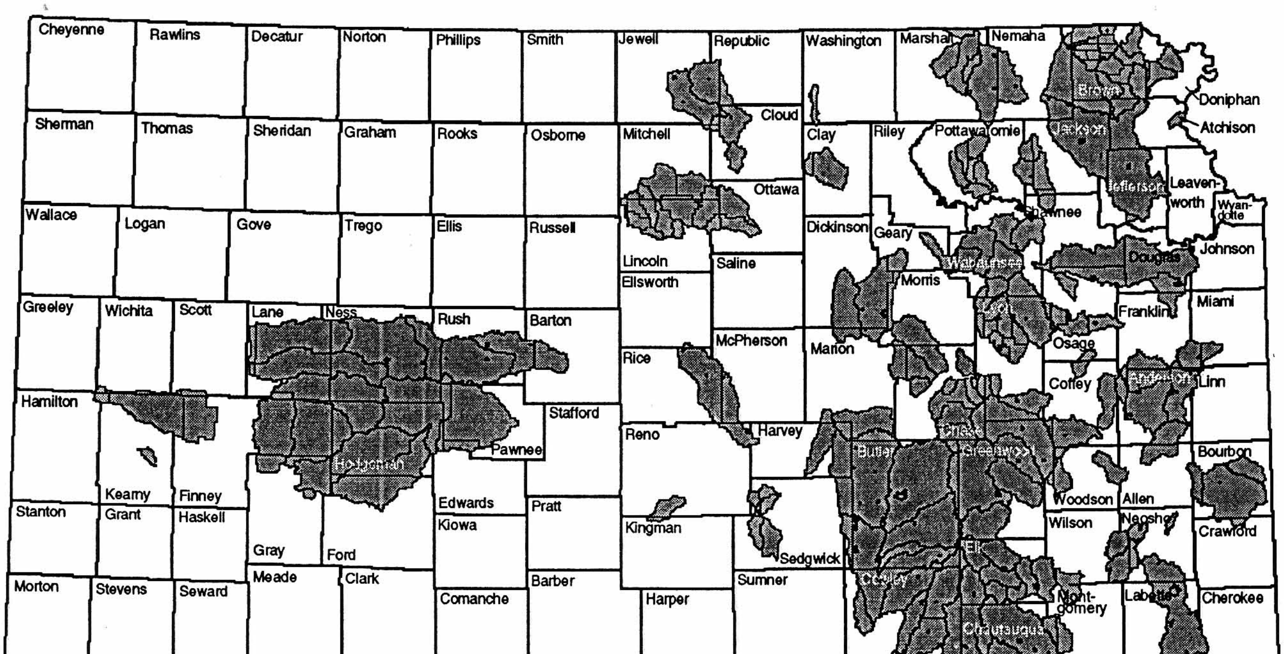
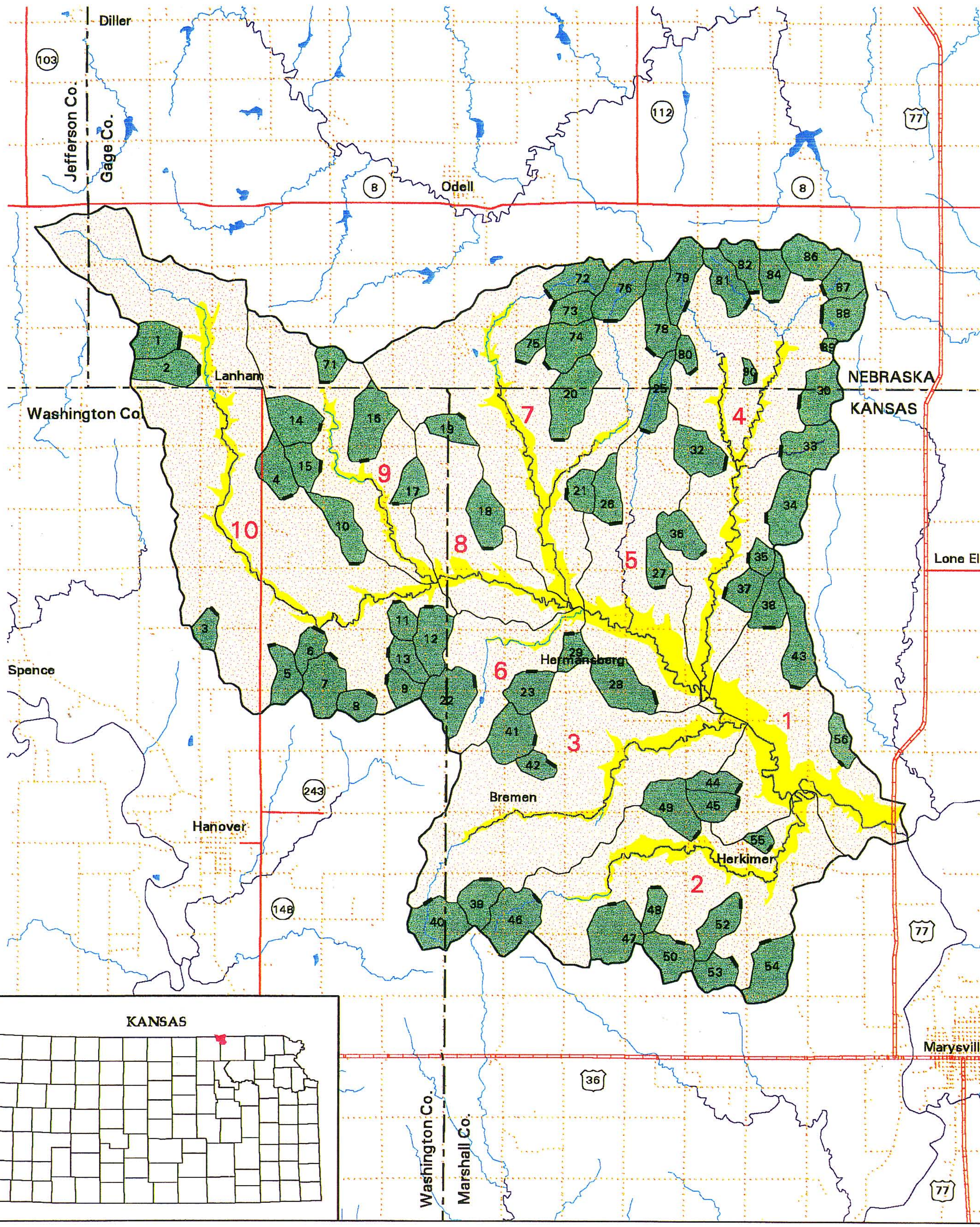



Fig. 4-1—Locations of the 88 watershed districts in Kansas.

# Fig. 4-2— HORSESHOE CREEK WATERSHED

## WASHINGTON & MARSHALL COUNTIES, KANSAS
## GAGE & JEFFERSON COUNTIES, NEBRASKA




AREA BENEFITED

DRAINAGE CONTROLLED BY SMALL DETENTION DAMS

Map Scale 1:144000
Roads and Rivers: Census 1995 TIGER Line
14-Digit HUC Boundaries: USDA-NRCS and USGS

USDA-NRCS DMT
March 01, 1999

assistance guarantees from several state and federal agencies. The Kansas Water Office, Kansas Department of Health and Environment, State Conservation Commission, Kansas Department of Wildlife and Parks, Kansas Forest Service, and the U.S.D.A. Natural Resources Conservation Service have been the principal agencies providing technical assistance to the watershed during resource plan development.

State and federal agencies encourage watershed districts to consider plan alternatives that address the proper management of all natural resources—soil, water, air, plants, and animals—while weighing the effects of project activity on the human element. The Horseshoe Creek Watershed Board has endorsed the total resource planning concept in the development of the resource plan for the watershed.

Under state law, the watershed district's jurisdiction is limited to that portion located in Kansas. However, when dealing with issues of surface-water quantity and quality, the problems cannot be addressed fully without consideration of the entire hydrologic unit. Although it may be simpler to develop and apply resource management systems within one jurisdictional unit, the result will be piecemeal. Consequently, the Board has agreed to consider the entire hydrologic unit during the resource planning. During implementation of the resource plan, the Board will work with agencies and jurisdictions in Kansas and Nebraska to access programs that will assist in the effort.

The Horseshoe Creek Watershed District Board has selected a resource management alternative that, upon implementation, will: (1) reduce flooding, (2) reduce all forms of soil erosion, (3) improve water quality, (4) maintain air quality, (5) improve the condition of grasslands and woodlands, and (6) improve the habitat for terrestrial and aquatic wildlife. This plan takes into account impacts on the environment, as well as social and economic impacts.

**Resource Contacts**

Horseshoe Creek Watershed District No. 110
599 5th Road
Bremen, KS 66412-9999
785-744-3386

Tracy D. Streeter, Executive Director
State Conservation Commission
109 SW 9th Street, Ste. 500
Mills Building
Topeka, KS 66612-1299
785-296-3600
tstreeter@scc.state.ks.us

# Riparian Forests of Kansas

For many people, Kansas forestry is an oxymoron. Only three percent of the state's land area is forested, but it is the very scarcity of the resource that makes trees in Kansas so ecologically significant. Most naturally occurring forest land is found in the eastern third of the state, with 83 percent adjacent to streams and rivers, that is, riparian areas. Prior to European settlement, Kansas forest land covered about 8.5 percent of the state's land area. As settlement occurred, many forested bottomlands were converted to cropland where the ground was especially productive and supplemental irrigation was unnecessary. Today riparian areas continue to be some of the most productive land for agricultural crops and timber products.

Riparian areas are also ecologically sensitive. Loss of native vegetation in riparian areas reduces the ecosystem's ability to provide clean water and many other benefits. Significant portions of Kansas's riparian areas do not have enough vegetation to function properly.

It is the goal of the Kansas Forest Service to encourage landowners to protect and manage their riparian forests and re-establish trees when riparian ecosystems are not functioning properly.

## Riparian Forest Buffers

The area needed for a riparian forest buffer to function properly depends on many factors, including slope, soil type, farming practices, size of crop fields, and the landowner's objectives. Research at Iowa State University (ISU) suggests that when the objective is to remove agricultural chemicals and sediment from surface and subsurface runoff, at least a 66-feet-wide buffer is necessary. A narrower buffer does not hold water in the root zone long enough for chemicals to be removed. If the only objective is removing sediment from surface runoff, a 50-feet-wide forest buffer may be adequate, provided slopes are less than five percent. A Kansas State University (KSU) study of the Kansas River following the 1993 flood indicated that trees did a better job stabilizing the river bank than any other type of vegetation. The research found that when trees were present, an average of 10.5 feet of soil was deposited, as opposed to an average bank loss of 78 feet with grass, and 150 feet when agricultural crops were the only vegetation.

Research results show that a properly functioning riparian forest has the ability to remove 80 to 90 percent of nitrate-nitrogen and atrazine, 50 to 80 percent of the phosphates, 50 percent of the sediment, and 60 percent of certain pathogens. These forests also provide timber products while storing carbon, offsetting carbon dioxide emissions.

In spite of all the research that supports the environmental benefits, the financial incentives (e.g., Governor's Water Quality Initiative) that encourage re-establishing riparian forests, and the potential marketing of timber products, riparian forests continue to be converted to other land uses. This a concern for the Kansas Forest Service, which is working to re-establish riparian forests.

## Education

Education will always be important in promoting the protection and re-establishment of riparian forests. However, some studies at KSU indicate that the majority of farmers and ranchers already understand the benefits associated with conserving and re-establishing riparian forests.

## Incentives to Protect and Establish Riparian Forest Buffers

Costs associated with the protection and re-establishment of riparian areas can be high, especially when it requires the loss of highly productive farm ground. However, many U.S. Department of Agriculture (USDA) programs provide significant financial incentives to re-establish riparian forest buffers, such as Continuous CRP (Conservation Reserve Program) combined with the Governor's Buffer Initiative. Kansas may also pursue additional financial incentives through CREP, the Conservation Reserve Enhancement Program. CREP would give Kansas some flexibility in CRP rules while providing even more financial incentives than Continuous CRP. Although financial incentives are available (or will be in the near future) to re-establish riparian forests, landowners are not rewarded for protecting and managing the riparian forests they already have. There is no financial award for being good stewards of existing riparian forests.

### Getting the Job Done

The Kansas Forest Service has eight District Foresters who provide one-on-one technical assistance to Kansas landowners throughout the state. Some District Foresters are responsible for forestry programs in over 20 counties and can not adequately promote the protection and re-establishment of riparian forests to meet water-quality needs.

The Kansas Forest Service is considering the establishment of a Kansas Forest Trust that can address the many issues that face the forest resources of our state. The Kansas Forest Trust could provide landowners a "turn-key" operation for the re-establishment, management, and protection of their riparian forests to improve water quality. The Kansas Forest Trust could also help landowners who are interested in planting trees to sequester carbon from the atmosphere to reduce the threat of global warming. In a state where forests are thought to be nonexistent, where landowners rarely consider the beneficial role trees play in conservation, the Kansas Forest Trust could help to establish and protect trees in riparian areas that would enhance conservation and improve overall agricultural production practices.

### Koppes Farm—Horseshoe Creek

The riparian forest on the Koppes farm is fairly typical for eastern Kansas. The primary timber species are bur oak, hackberry, and black walnut. The area shows little evidence of management practices even though the Kansas Forest Service prepared a Forest Stewardship Management Plan for the previous owners in 1991. At that time, 31 black walnut trees were identified and marked for harvest (3,694 board feet); however, the trees were never harvested. Evidence of the marking (blue painted numbers) can still be seen on a few walnut trees.

Harvesting trees in riparian forests is a sound management tool that improves the health and productivity of the forest. The Koppes riparian forest is in need of a selective harvest to remove over-mature trees and allow younger pole-sized trees to grow. There is also need for greater species diversity. Hackberry makes up too much of this forest. Harvesting some of the hackberry will promote the establishment and growth of other trees such as black walnut, bur oak, and green ash.

The small area of cropland east of the road and south of Horseshoe Creek (where the State Conservation Commission is conducting an erosion study) is a prime example of Kansas riparian areas that are devoid of any vegetation. This riparian ecosystem can not function properly without trees.

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**Resource Contacts**

Ray Aslin, State Forester
Kansas Forest Service
2610 Claflin Road
Manhattan, KS 66502-2798
785-532-3305
raslin@oz.oznet.ksu.edu

Robert Atchison
Rural Forestry Coordinator
Kansas Forest Service
2610 Claflin Road
Manhattan, KS 66502-2798
785-532-3310
ratchiso@oz.oznet.ksu.edu

Erin Zook, District Forester
Kansas Forest Service
1125 Westport Dr.
Manhattan, KS 66502-2860
785-776-5182
785-539-7983
Ezook@oznet.ksu.edu

## Governor's Water Quality Initiative

In October 1995, Governor Bill Graves announced a multi-agency initiative to protect and restore the quality of Kansas surface waters. The Governor's Water Quality Initiative is an incentive-based program, in which local participants work with state government on a voluntary basis to implement water-quality protection and restoration strategies.

State agencies cooperating in the initiative are the State Conservation Commission, Kansas Water Office, Kansas Department of Agriculture, Kansas Department of Health and Environment, and Kansas Department of Wildlife and Parks. Kansas State University and the USDA-Natural Resources Conservation Service are also involved.

Because water-quality data indicated that the Delaware River, Big Blue River, and Kansas River mainstem corridor (Junction City to Kansas City) had the highest levels of contamination in the state, the Kansas-Lower Republican River basin (fig. 4-3) was chosen as the pilot basin. The Kansas-Lower Republican River basin cuts through 23 Kansas counties, from the Nebraska line in Republic County to Johnson County on the Missouri border. The Kansas River valley provides water to about 30 percent of the people of Kansas.

Within the Kansas-Lower Republican River basin, the Black Vermillion watershed in the Big and Little Blue River sub-basins (Tuttle Creek Lake drainage) and Grasshopper Creek watershed in the Delaware River sub-basin (Perry Lake drainage) were specifically targeted for efforts to reduce pollutants in surface water. Three major pollutants were identified: sediments from erosion, the crop herbicide atrazine, and fecal coliform bacteria found in human and animal waste.

One of the distinguishing features of the Governor's Water Quality Initiative is voluntary participation. Voluntary adoption of pollution control or best management practices (BMP's) by property owners and managers is encouraged through information, education, and incentive-based programs. BMP's include nutrient and pesticide management plans, pasture and rangeland management practices, confined livestock waste management systems, failing wastewater/septic systems repairs, plugging of abandoned wells, remediation of illegal dump sites, terraces, waterways, streambank stabilization, riparian restoration, and wetland development or restoration.

The State Conservation Commission, working through county conservation districts, is primarily responsible for providing incentives and cost-sharing opportunities to landowners for adoption or installation of BMP's. The technical assistance necessary to properly adopt or install BMP's is available from a host of state and federal agencies as well as the private sector. Local delivery of technical service is provided to landowners through the USDA-Natural Resources Conservation Service and Kansas State University Research and Extension.

Federal and state funding to evaluate, promote, and implement BMP's in the Kansas-Lower Republican River basin has exceeded $15 million. As a result of a variety of educational, technical assistance, and financial assistance programs, water quality in the targeted areas appears to be improving. In three targeted areas of the Kansas-Lower Republican River basin —Mission Lake (water supply for Horton, KS), Delaware River, and Blue River—atrazine levels have decreased over the past three years. Although these results are preliminary, state officials are encouraged by the trend.

### Buessing Dairy

Operated by Richard, Roy, and Rodger Buessing, the Buessing Dairy is a 120-cow operation. Several years ago the dairy's cooperators voluntarily adopted best management practices (BMP's) to address the problem of waste runoff.

Working with K-State's Department of Biological & Agricultural Engineering, the owners installed a system in 1997 to keep livestock waste products from draining into nearby streams. The cows are housed in a concrete-floored confinement area. Waste moves into a concrete storage basin, which is designed for 120-day storage. This allows the owners to store the manure until fields are open

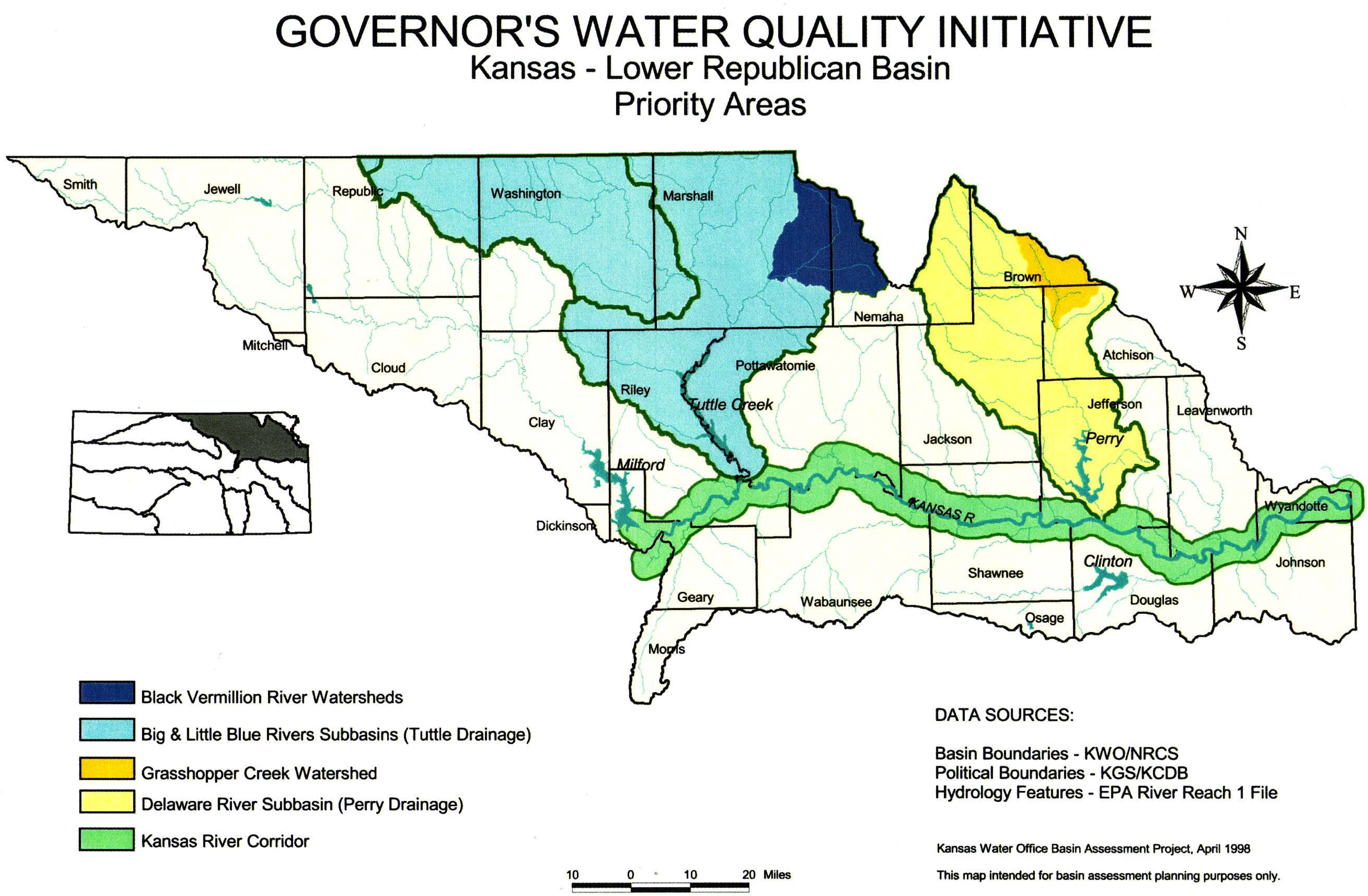


Fig. 4-3—Locations of priority areas within the Kansas-Lower Republican River Basin.

and tillable. The storage basin is designed to contain runoff from a 25-year, 24-hour storm. Storm runoff is discharged in a controlled fashion to four wetland cells. These cells are arranged in a stairstep manner below the storage basin. The total area of the wetland cells is approximately one and a half acres at the bottom.

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## Resource Contacts

Tracy D. Streeter, Executive Director
State Conservation Commission
109 SW 9th Street, Ste. 500
Mills Building
Topeka, KS 66612-1299
785-296-3600
tstreeter@scc.state.ks.us

Ray Aslin, State Forester
Kansas Forest Service
2610 Claflin Road
Manhattan, KS 66502-2798
785-532-3309
raslin@oz.oznet.ksu.edu

Al LeDoux, Director
Kansas Water Office
901 South Kansas Ave.
Topeka, KS 66612-1249
785-296-3185

Margaret Fast
Kansas Water Office
901 South Kansas Ave.
Topeka, KS 66612-1249
785-296-0865

Joe Harner, Extension Engineer
Dept. of Biological & Agricultural Engineering
Seaton Hall Room 233
Kansas State University
Manhattan, KS 66502
785-532-2930
jharner@ksu.edu

## TMDL's (Total Maximum Daily Loads)

The multiagency, voluntary, private-public partnership approach established by the Governor's Water Quality Initiative has been adopted into the Kansas Water Plan as the way to approach water-quality issues in the state. The establishment of Total Maximum Daily Loads (TMDL's) will serve as the primary targeting mechanism to continue this approach to restoration of water quality in Kansas.

A TMDL is the maximum amount of pollutant that may enter a stream, lake, or wetland without causing a violation of the water-quality standards, that is, an impairment of the designated uses of that water body. A list of waters that have consistently violated standards is prepared every two years. The current list was developed in 1998 and cites a number of pollutants that impair water uses: sediment, bacteria, chloride, sulfate, eutrophication (excessive nutrient loading), pesticides, and herbicides (for example, atrazine). In addition, dissolved oxygen levels and biological data indicate occasional impairments to aquatic life in certain streams and lakes.

Like many other states, Kansas is under a Court Decree to establish TMDL's for the impaired streams, lakes, and wetlands of the state. Since 1972, states have been required by the U.S. Environmental Protection Agency (EPA) to list the water bodies that are impaired by pollutants and establish TMDL's on those bodies. Listing began in 1992, but it took litigation on the part of environmental groups to bring about TMDL establishment.

Kansas uses its existing data base to examine water quality and further define the impairment issues relative to seasonal trends and flow conditions. The basic goal of the Kansas TMDL process is to reduce, over the long run, the frequency of violations of water-quality standards. This goal is achieved by assigning responsibility for corrective actions and management practices to the point and non-point sources within a given watershed. Kansas TMDL's rely on watershed management as the pathway for water-quality improvement.

Using the State Water Planning Process, the Kansas TMDL program establishes a hierarchy of priority among the TMDL's, which allows the state to target pollutants and geographic areas of the highest concern. The Basin Advisory Committee in each basin (Kansas has 12 major river basins—see fig. 4-4) helps the Kansas Department of Health and Environment (KDHE) set priorities, which become incorporated into the 12 Basin Plans for the Kansas Water Plan.

Between 1999 and 2003, the state intends to establish TMDL's in each of the 12 basins. On June 30, 1999, KDHE submitted 90 TMDL's for the Kansas-Lower Republican basin. These TMDL's are now in the implementation phase which will span the next ten years. Currently, KDHE is developing 120 TMDL's for the Lower Arkansas, Upper Arkansas, and Cimarron basins; these will be submitted to EPA on June 30, 2000. Next year, the Missouri and Marais des Cygnes basins will be the focus of attention. In 2002-2003, TMDL's will be established for the Neosho, Verdigris, and Walnut basins in southeast Kansas and the Upper Republican, Solomon, and Smoky Hill-Saline basins in the northwest.

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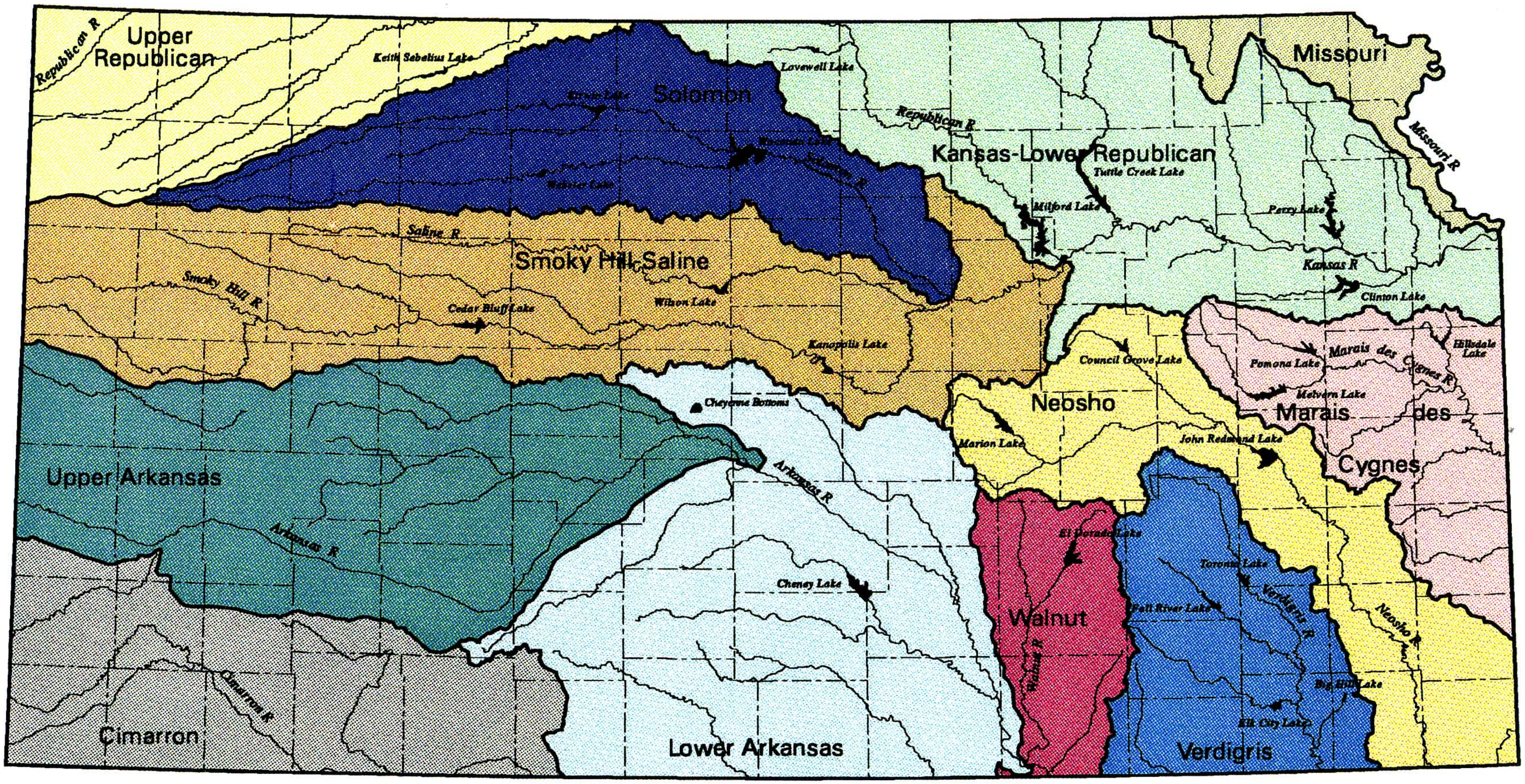
# Kansas River Basins and Federal Lakes




Kansas Water Office

May 1996

Fig. 4-4—Twelve major river basins in Kansas.

**Resource Contacts**

Tom Stiles
Kansas Department of Health and Environment
Forbes Building 283
Topeka, KS 66620-0001
785-296-6170
tstiles@kdhe.state.ks.us

Tracy D. Streeter, Executive Director
State Conservation Commission
109 SW 9th Street, Ste. 500
Mills Building
Topeka, KS 66612-1299
785-296-3600
tstreeter@scc.state.ks.us

Al LeDoux, Director
Kansas Water Office
901 South Kansas Ave.
Topeka, KS 66612-1249
785-296-3185

Margaret Fast
Kansas Water Office
901 South Kansas Ave.
Topeka, KS 66612-1249
785-296-0865

# Governor's Water Quality Buffer Initiative

The Kansas Water Quality Buffer Initiative, proposed by Governor Bill Graves and enacted by the 1998 Legislature, amended K.S.A. 2-1915 to provide state financial and tax incentives to landowners establishing grass filter strips or riparian forest buffers through the federal Conservation Reserve Program (CRP). Currently, the financial incentives are provided in the form of bonus rental payments to Kansas-Lower Republican River basin landowners enrolling in CRP's continuous sign-up for grass filter strip or riparian forest buffer practices. The tax incentive allows land enrolled in CRP within 150 feet of perennial and intermittent streams to be appraised and taxed as grassland or wasteland, rather than as cropland as required on all other CRP lands. The tax incentive is available to landowners statewide.

The primary goal of the Kansas Water Quality Buffer Initiative is to reduce non-point source pollution runoff in high-priority targeted areas. Research at various universities, including Kansas State University, has concluded that riparian buffers and grass filter strips are capable of reducing the runoff of sediments, nitrogen, phosphorous, and herbicides by 50 to 85 percent. Preliminary results of a KSU evaluation of filter strips indicate that properly constructed and maintained strips are also effective in reducing the runoff of fecal coliform bacteria.

In fiscal years 1999 and 2000, $80,000 was appropriated to the State Conservation Commission (SCC) to administer the Buffer Initiative with the same amount recommended for fiscal year 2001. These funds are provided to landowners through annual rental payments equal to either 30 percent (for grass filter strips) or 50 percent (for riparian forest buffers) of the annual federal rental payment. Together, the annual state and federal rental payments cannot exceed $150 per acre. State contracts are written to provide these payments for 10 or 15 years, subject to annual appropriations.

Part of the appropriation has also been used to provide the educational and technical assistance needed to develop and implement the Buffer Initiative. To that end, the SCC has entered into a partnership agreement with the U.S. Department of Agriculture–Natural Resources Conservation Service (NRCS), with NRCS assigning an employee to the SCC to serve as the Buffer Initiative Coordinator.

The Buffer Initiative was designed to complement the Governor's Water Quality Initiative, established in 1995 by Governor Graves for the Kansas-Lower Republican River basin. As a result, funding was initially targeted to the Upper Black Vermillion and Little Delaware-Mission Creek watersheds, located in Marshall, Nemaha, Brown, and Atchison counties. Subsequent expansions have incorporated the Horseshoe Creek, Upper Delaware River, and the Big and Little Blue River drainages. These expansions encompass additional parts of the counties listed above and also incorporate parts of Clay, Jackson, Pottawatomie, Republic, Riley, and Washington counties.

As of March 2000, the SCC has entered into 130 Buffer Initiative contracts, enrolling approximately 1,300 acres. Five of the contracts have been for riparian forest buffers, the rest for grass filter strips. These enrolled acres will protect an estimated 150 stream miles.

Future plans for the Buffer Initiative will likely be connected to the issue of Total Maximum Daily Loads (TMDL's). On June 30, 1999, TMDL's were established for the Kansas-Lower Republican River basin for certain non-point source pollutants. TMDL's are required by federal law to limit the amount of pollutants existing in streams, lakes, and wetlands. The entire area currently eligible for the Buffer Initiative is also considered a high-priority area for TMDL's. The SCC will propose expansion of the Buffer Initiative to remaining high-priority TMDL areas in the Kansas-Lower Republican River basin.

The Kansas Water Plan draft for fiscal year 2002 has identified the Governor's Water Quality Buffer Initiative as an applicable program for TMDL areas currently being established in the Cimarron, Lower Arkansas, and Upper Arkansas River basins. Future expansions of the Buffer Initiative into other river basins will likely be proposed.

### Keiser-Woolsoncroft Riparian Filter Strip

Jim and Janet Keiser-Woolsoncroft enrolled 116 acres in Marshall and Nemaha counties into the federal CRP and the Kansas Water Quality Buffer Initiative. The Kansas Forest Service and the USDA Natural Resources Conservation Service, through the Marshall and Nemaha County Conservation Districts, provided technical assistance, with financial assistance being provided by the CRP program and the State Conservation Commission.

### References


Streeter, T., 2000, Governor's Buffer Initiative: Water and the Future of Kansas Conference Proceedings, March 1, 2000, p. 14.


### Resource Contacts

Tracy D. Streeter, Executive Director
State Conservation Commission
109 SW 9th Street, Ste. 500
Mills Building
Topeka, KS 66612-1299
785-296-3600
tstreeter@scc.state.ks.us

Ray Aslin, State Forester
Kansas Forest Service
2610 Claflin Road
Manhattan, KS 66502-2798
785-532-3309
raslin@oz.oznet.ksu.edu

Tom Badger
Buffer Initiative Coordinator
State Conservation Commission/NRCS
109 SW 9th Street, Ste. 500
Mills Building
Topeka, KS 66612-1299
785-296-3600

Eldon Schwant
District Conservationist
Natural Resources Conservation Service
411 North Street
Seneca, KS 66538
785-336-2186

# Multipurpose Small Lakes Program

The State of Kansas owns storage space in 12 federal lakes from which water is sold under contract. For medium and large users located in proximity to the lakes or the streams below the lakes, this program provides an excellent, long-term dependable source of water for many municipal and industrial purposes. But for most small towns and rural water districts, the program was not flexible enough. Initial costs were usually prohibitive. Many communities could not afford a long pipeline and other hardware involved in moving water from the lake or river to where it could be treated and distributed. These smaller towns needed an affordable water supply closer to their customers.

Cooperatively, the Kansas Water Office and the State Conservation Commission developed the Multipurpose Small Lakes (MPSL) Program in 1985 (K.S.A. 82a-1601). Several sites had been identified for flood control dams, and it was determined that these lakes could also be used to provide water supply for small towns and rural water districts, at an affordable price. Objectives of the program are to: (1) reduce flood damages; (2) develop dependable water supply sources near the communities that need them; (3) initiate a process that, over time, matches water supply needs with development; (4) enable the development of projects that are cost- and resource-efficient and that can be operated and maintained at the local level; and (5) ensure that adequate measures are installed to protect the lake from pollution and siltation.

A guiding principle behind the MPSL Program was the State's commitment to pay for future water-supply storage in the lake if the water supply would be needed within the next 20 years. The Kansas Water Office (KWO) agreed to obtain necessary water rights for the added water supply storage space. Future users of that water would, through a contract with the KWO, repay the State's costs. The water right, upon repayment of those costs, would transfer to the user.

The MPSL Program thus provides the mechanism necessary to develop proposed flood-control lakes into multipurpose lakes that can control flooding and serve as much-needed sources of water for small towns. If the costs are reasonable, they can be designed with recreation features for boating and fishing. The MPSL Program is also flexible enough to allow existing single-purpose lakes to be renovated to include multipurpose benefits.

### Centralia Lake

Centralia Lake was the first lake built under MPSL Program. It was constructed in 1987 to provide flood protection, recreation, and a public water supply. The lake, sponsored by the Upper Black Vermillion Watershed District and City of Centralia, provides 450 surface acres for recreation, controls runoff from an 8,139-acre watershed that enters the South Fork of the Black Vermillion River, and contains 824 acre-feet of storage for public water supply.

This lake received federal assistance for flood control through the Natural Resources Conservation Service and the Small Watershed Program. The MPSL Program provided $108,000 for public water-supply storage and $240,000 for non-point source pollution control measures in the drainage area. The water-supply storage is currently contained in a water right assigned to the Kansas Water Office. Any future user would be required to pay the state for the portion of the water right it wishes to utilize.

Total cost for the project was $2.3 million. Listed below is a summary of funding sources:

| | |
|---|---|
| Federal | $1,186,000 |
| State MPSL Program | $348,000 |
| State Community Development Block Grant | $365,000 |
| Kansas Dept. of Wildlife and Parks | $120,000 |
| Local (City, Watershed District, Rural Water District) | $289,000 |

## References

Kansas Water Office, 2000, Multi-Purpose Small Lakes: www.kwo.org/kwo/smlakes.html

## Resource Contacts

Tracy D. Streeter, Executive Director
State Conservation Commission
109 SW 9th Street, Ste. 500
Mills Building
Topeka, KS 66612-1299
785-296-3600
tstreeter@scc.state.ks.us

Al LeDoux, Director
Kansas Water Office
901 South Kansas Ave.
Topeka, KS 66612-1249
785-296-3185

# Black Vermillion Watershed Project

The Black Vermillion River and its tributaries are located almost entirely in Marshall and Nemaha counties in northeast Kansas. A small portion of the watershed extends into Nebraska. The Black Vermillion River empties into the Big Blue River about 30 miles above Tuttle Creek Lake Dam.

Changes in the channels (channelization) of the Black Vermillion and North Fork Black Vermillion rivers have affected stream bank stability and the frequency and magnitude of flooding. The worst flooding occurs from the confluence of the Black Vermillion and North Fork Black Vermillion rivers near Vliets downstream to Frankfort. Streambank instability is a problem throughout the basin.

Channelization—cutting a new channel across a meander to straighten the channel—shortens the length of the stream, increases the velocity of the water, and results in more erosion of the bed and banks of the stream, which makes the stream wider and deeper. Channelization usually results in flooding problems somewhere downstream because of the increased volume and velocity of water in the stream. Channelization has shortened the Black Vermillion and North Fork Black Vermillion channel lengths from 71.3 to 55.5 miles, a total of 15.8 miles.

In 1997, the Kansas Water Office contracted with the U.S. Army Corps of Engineers (COE) to investigate flooding conditions, streambank erosion, and channel degradation issues prevalent in the Black Vermillion River basin. Under this contract, the COE developed hydrologic and hydraulic computer models to analyze and compare historical and current conditions of the watershed. These models were used to evaluate the impact of changes in streambank stability, water surface profiles, and flood frequency and magnitude.

A 1999 report by the COE outlined five possible alternatives for reducing flooding, streambank erosion, and channel degradation. The report discusses the advantages and disadvantages of each alternative, provides a rough cost estimate, and lists several potential funding sources. Each alternative could be implemented alone or in combination with other alternatives; however, to address the erosion and flooding problems in the basin, a holistic watershed approach that incorporates a combination of alternatives is important. Potential alternatives are listed below.

1) Stabilizing Streambeds and Streambanks—Currently, the stream is unstable because of channelization. If erosion in the upstream reaches of the watershed is not prevented, aggradation and degradation problems will remain, and downstream flooding will continue and probably increase. Streambed stabilization is a prerequisite for bank stabilization.

2) Building a New Reservoir—A new reservoir would reduce flooding in the downstream reaches of the watershed. The closer the reservoir is to the lower portion of the basin, the more beneficial it would be for reducing flooding. The amount of land required for a reservoir is large and continued maintenance would be required.

3) Easements—Purchasing easements for buffer zones along the river would do little to prevent flooding, but would help reduce the amount of sediment added to the stream and improve conditions in the riparian zone. Purchasing easements for the entire floodplain in the lower portion of the basin would provide the most benefits. This would provide economic compensation for land that is frequently inundated with water and hard to farm, but finding willing landowners may be difficult.

4) Wetland Complex—Creating a 100-acre wetland complex downstream from the confluence of the Black Vermillion and North Fork Black Vermillion rivers would provide economic benefits to the landowner for land that is frequently inundated with water. It would also capture sediment, help retain flood waters, and create wildlife habitat. A wetland complex would require maintenance and take land out of production.

The Black Vermillion Watershed has serious flooding and erosion problems that will be difficult to totally eliminate. However, if nothing is done, the problems will escalate. Flooding will likely become more frequent with higher flood stages, and the stream will further degrade and carry more sediment.

Several agencies have programs that might be used to partially fund some of the alternatives outlined above.

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Kansas Water Office, 2000, A Few Words About Our Rivers and Streams: HydroGRAM, Spring 2000, p. 14-15.

U.S. Army Corps of Engineers, Kansas City District, 1998, Black Vermillion Watershed Study: Report for the Kansas Water Office, October 21, 1998.

U.S. Army Corps of Engineers, Kansas City District, 1999, Alternatives for the Black Vermillion Watershed: Report for the Kansas Water Office, November 2, 1999, 16 p.

## Resource Contacts

Earl Lewis
Kansas Water Office
901 S. Kansas Ave.
Topeka, KS 66612-1249
785-296-3185

Anna Wolfe
Hydraulic Engineer
U.S. Army Corps of Engineers
601 E. 12th Street, Rm. 843
Kansas City, MO 64106
816-983-3122
Anna.M.Wolfe@usace.army.mil

## Siltation in Kansas Streams and Reservoirs

Sediment deposition in reservoirs, streams, and public water-supply impoundments impacts water-storage capacity, flood control, water quality, aquatic habitat, and recreation.

Erosion problems, like those in the Black Vermillion basin, increase the sediment load that is transported downstream. When a stream reaches the lower portion of its basin, the slope of the channel decreases, and the water velocity slows down. The stream is no longer able to transport the large sediment load and deposition occurs. As sediment is deposited, the stream is likely to braid—that is, migrate laterally. This partially explains why flooding occurs in the lower part of the basin.

When a stream empties into a reservoir, such as Tuttle Creek Lake, the sudden reduction in slope and water velocity causes sediment to be deposited in the same way. This deposition of sediment, or siltation, begins in the upper reaches of the reservoir and gradually fills toward the dam. This affects a reservoir's usefulness for flood control. If the designed flood control pool becomes smaller because of siltation, the flood-control abilities of the reservoir are also reduced.

Sediment affects water quality. Pollutants can enter the stream with the sediment and either settle to the bottom or be dissolved into the water. Siltation can also be detrimental to aquatic habitat. Sediment can clog fish gills, destroy bottom habitat where eggs are laid, and reduce water clarity.

Siltation also affects recreation. Recreational facilities may become impaired or unusable because of sediment deposition. Fancy Creek State Park, located on the upper end of Tuttle Creek Lake near the Randolph bridge, is an excellent example of a recreational area that has been severely impacted by siltation. This area once housed a marina and provided abundant access to the lake. Now, because this part of the reservoir has silted in, access to the lake is very limited, and many recreational areas are under-used or have been abandoned.

The State of Kansas currently owns water-supply storage space in 12 federal reservoirs in Kansas. Water storage space has been purchased under contracts with the U.S. Army Corps of Engineers (COE). The planned life of these reservoirs is 50 or 100 years. Just like water storage, flood control, and recreation, sediment storage is a planned use for these reservoirs (table 4-1). The COE-estimated sedimentation rates for Kansas reservoirs have been relatively accurate, except for Council Grove, Marion, and John Redmond lakes (which are not included in the table). Reservoir yield analysis—a measure of the ability of a reservoir and upstream watershed to provide water consistently throughout a drought—is used to predict the water supply for the next 40 years. Because sediment occupies space in a reservoir that would otherwise be available for storage, it has a direct effect on reservoir yield.

Information on siltation in small public water-supply lakes does not exist in most cases, or is extremely outdated. The Kansas Water Office is working with the COE to conduct sediment surveys on actively used city lakes and analyze the impact of sediment in these lakes on the future water supply.

### References


Fast, M., 2000, House substitute for Senate Bill 287: HydroGRAM, Winter Issue, p. 9–11.

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### Resource Contacts


Earl Lewis
Kansas Water Office
901 S. Kansas Ave.
Topeka, KS 66612-1249
785-296-3185

Philip Snell
U.S. Army Corps of Engineers
601 E. 12th Street, Rm. 843
Kansas City, MO 64106
816-983-3123

Table 4-1. Storage loss from sedimentation in Kansas lakes.

| Lake | Date of closure | Original capacity at top flood control pool (acre-feet) | Sediment allocation (acre-feet) | Current loss rate of storage due to sediment (acre-feet per year) | Projected loss of storage due to sediment in 2010 (acre-feet) |
|---|---|---|---|---|---|
| Clinton | 1977 | 397,538 | 20,000 | 167 | 5,511 |
| Hillsdale | 1981 | 159,840 | 10,200 | 160 | 4,640 |
| Kanopolis | 1946 | 447,091 | 53,000 | 609 | 38,976 |
| Melvern | 1972 | 362,814 | 26,000 | 406 | 15,428 |
| Milford | 1967 | 1,173,098 | 160,000 | 1,792 | 77,056 |
| Perry | 1969 | 765,100 | 123,000 | 1,989 | 81,549 |
| Pomona | 1962 | 247,376 | 14,000 | 263 | 12,624 |
| Tuttle Creek | 1962 | 2,367,017 | 228,000 | 4,861 | 233,328 |
| Wilson | 1964 | 778,517 | 40,000 | 459 | 21,114 |

# McDowell Creek Road Landslide

Fig. 4-5—Kansas landslides have damaged or destroyed houses and other structures, closed roads, and disrupted transportation systems. In May 1995, a landslide just south of Manhattan closed McDowell Creek Road and subsequently cost Riley County $880,000 to stabilize the slope and repair the road. The landslide, which occurred following several weeks of heavy spring rains, damaged over one-quarter mile of the road. The road was displaced about 20 feet vertically and 40 feet horizontally by the slide. The asphalt was pushed together in some places and pulled apart and twisted in others. Power poles moved laterally and were sitting at angles, the lines stretched taut. Many trees slid sideways but remained upright.

# Kansas Geological Survey

**Public Information Circular 13** March 1999


*The growth of the Kansas City metropolitan area and other cities in the state creates the potential for more property damage as a result of landslides*

# Landslides in Kansas


**Gregory C. Ohlmacher**

Geologic Investigations, Kansas Geological Survey


## Introduction

In May of 1995, a Kansas landslide made news when a local TV station filmed the collapse of a $400,000 home in Overland Park, Kansas (fig. 1). This Johnson County landslide also destroyed one other home and affected four vacant lots. That same month, a landslide near Manhattan closed McDowell Creek Road and subsequently cost Riley County $880,000 to stabilize the slope and repair the road.

Kansas landslides have damaged or destroyed houses and other structures, closed roads, and disrupted transportation systems. Every year, structures must be repaired and landslide debris removed from highways and railroad tracks. Nationally, landslides cause an estimated $1.5 billion in property losses.

Many areas of Kansas have all the required conditions for landslides. The growth of the Kansas City metropolitan area and other cities in the state creates the potential for more property damage as a result of landslides. This circular provides property owners, government officials, and developers an introduction to landslides in Kansas and outlines common approaches for their remediation. Terms shown in **boldface type** are defined in the glossary.

## Landslide Features

A **landslide** is the downhill movement of masses of soil and rock by gravity. **Soil**, as defined by civil engineers, is the loose material between the ground surface and the underlying **bedrock**. Landslides come in many forms. **Rock falls** occur along cliffs and outcrops where blocks of rock break off and fall down the slope. **Block slides** and **slumps** occur where blocks or masses of intact soil or rock move downslope along a **failure surface.** Block slides have straight failure surfaces, and the motion is analogous to a box (the landslide mass) sliding down a ramp (the failure surface). Slumps, on the other hand, have concave failure surfaces. As the landslide mass moves along this curved surface, it rotates and tilts trees and other objects so that they point uphill. **Earth flows** (fig. 2) are landslides in soil in which the landslide mass breaks apart instead of remaining relatively intact as in a slump or block slide. The motion in an

Figure 1—*A 1995 landslide in Overland Park, Kansas, that destroyed two homes and damaged four lots (Beverly Bynum/The Kansas City Star. Reprinted with permission.)*

*Landslides are natural phenomena that occurred in Kansas long before human occupation*

earth flow is analogous to a thick mixture of soil and water oozing down the slope. **Creep** is the slow, imperceptible downslope movement of soil and rock. Because creep rarely fractures the ground surface, other evidence such as tilted trees, telephone poles, or walls must be used to identify affected areas. Creep is widespread on hillsides throughout Kansas.

Scarps, tension gashes, and lobes are features that identify active or recently active landslides (fig. 2). A **scarp** is a steep (nearly vertical) region of exposed soil and rock at the **head** of the landslide where the failure surface ruptures the ground surface. **Tension gashes** are breaks in the ground surface that are oriented parallel to the scarp and are found throughout the landslide mass. **Lobes** are bulges in the ground surface where the landslide mass mounds up at the **toe** of the landslide. With time, tension gashes fill with soil, the scarp erodes back, and vegetation covers the surface muting the features of the landslide. Old landslides can be recognized by the irregular, bulging ground surface that remains long after other features have vanished.

Damage to human-made structures can be another indicator of landslide activity. Sidewalks and roads out of alignment, retaining walls that lean downslope, broken utility lines, cracked foundations and walls, and doors and windows out of plumb are examples of such structural damage. However, this damage is not necessarily due to landslides. Other geologic hazards, including **subsidence** and **expansive soil**, can cause similar structural damage.

## Causes of Landslides

Landslides are natural phenomena that occurred in Kansas long before human occupation. The basic ingredients for landslides are gravity, susceptible soil or rock, sloping ground, and water.

The most common rocks found in Kansas are shales, limestones, and sandstones. Shales—rocks composed of **clay**- and silt-sized grains—are most often associated with landslides. When shale is near the ground surface where the **water content** fluctuates, it **weathers** into a clayey soil that could be landslide prone. Block slides, slumps, and earth flows commonly occur in shales and the soils developed on shales. Limestones are usually hard sedimentary rocks composed of calcium carbonate and can provide strength to slopes. Sandstones, rocks composed of sand-sized grains, can be either loosely cemented and soft or hard and resistant. Hard rock layers that resist weathering are termed **competent rocks**. Sandstones and limestones exposed in cliffs or roadcuts can pose a risk for rock fall, especially when they overlie shales.

Landslides require hilly terrain. In general, as the slope angle increases, the potential for landslides also increases. Anything that increases the slope angle can trigger a landslide. For example, a stream that is actively eroding a hill increases the slope angle at the base. Construction practices that increase slope angle can also cause landslides. The maximum safe slope angle for any hillside is a function of the type, thickness, and water content of soil and rock. Water acts as a lubricant in soil and rock. As water content increases, the strength of the soil and rock decreases. This can lead to landslides.

*Construction and maintenance practices can affect the stability of a hillside*

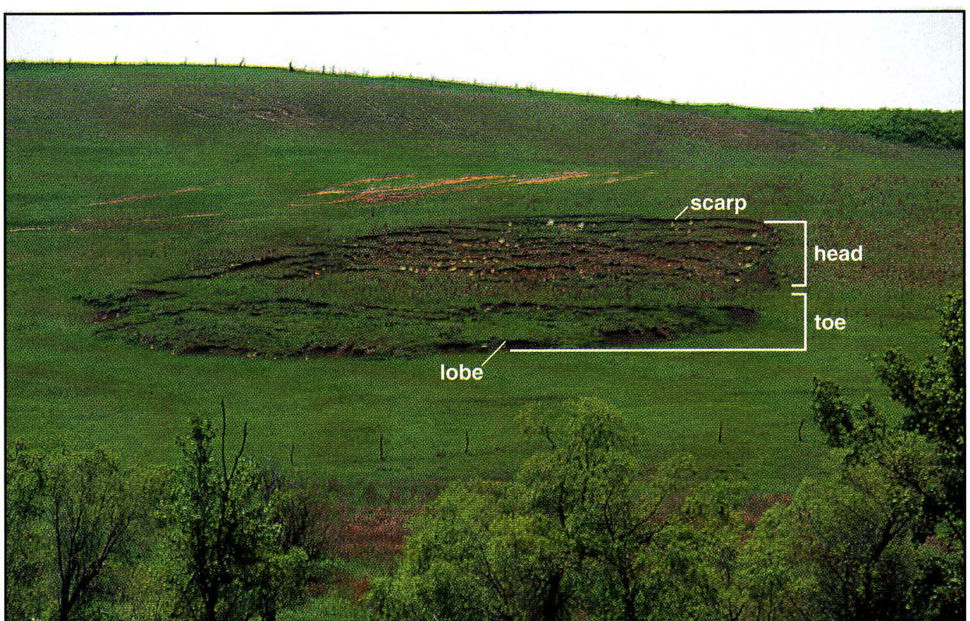


Figure 2—*An earth flow near Interstate Highway 70, Ellsworth County. The head is the upslope portion of the landslide. The scarp, the steeply inclined failure surface with exposed soil and rock, marks the top of a landslide. The toe is the downslope portion of the landslide. A mound of soil called a lobe marks the toe of the landslide.*

## Landslide-prone Areas of Kansas

The U.S. Geological Survey (Radbruch-Hall et al., 1982) identified several regions of Kansas as landslide prone, including the Missouri River Corridor in northeastern Kansas, the Smoky Hills in northern and central Kansas, and a small area in northwestern Hamilton County (fig. 3). The Missouri River Corridor includes the Kansas City Metropolitan Area (Johnson, Leavenworth, and Wyandotte counties). Though not shown on the U.S. Geological Survey map, the region along the Kansas River and its tributaries from Kansas City to Junction City should also be considered landslide prone. This includes the cities of Lawrence, Manhattan, and Topeka. Although landslides are more likely in these regions, they can occur anywhere in the state.

## Landslide Warning Signs

One or more of the following features may be early signs of a potential landslide: (1) saturated soil, seeps, or springs in areas that were dry in the past, (2) growth of reeds and wetlands vegetation on the lower portions of the slope, (3) fresh breaks and cracks in the ground surface, (4) ground-surface bulges in the lower portion of the slope, (5) new structural defects including out-of-alignment roads and sidewalks, cracked foundations, out-of-plumb doors and windows, and cracked walls, (6) tilted retaining walls, trees, and telephone poles, and (7) leaking water and sewer lines.

## Construction Practices and Landslides

Construction and maintenance practices can affect the stability of a hillside. The risk of initiating a landslide on a landslide-prone slope is increased by (1) excavating into the base or side of the slope, (2) placing fill and constructing buildings at the top or side of the slope, (3) changing surface-water drainage patterns, (4) adding water to the soil or rock, (5) removing layers of competent rock, and (6) removing vegetation.

Figure 4 illustrates how construction practices can increase the risk of landslide for a house built on a landslide-prone hillside. In this example, vegetation was removed to prepare the lot for construction and to improve the view. Soil and rock were excavated upslope of the site and placed downslope to create a flat area, or pad, for the house. A competent layer of rock might be removed to construct the pad or add a basement. The horizontal pad collects more rainwater, which infiltrates the soil. An automatic sprinkler system adds more water to the soil. Any or all of these factors increases the potential for landslides that could damage or destroy the house.

## Prevention and Remediation of Landslides

Many methods are used to remedy landslide problems. The best solution, of course, is to avoid landslide-prone areas altogether. Before purchasing land or an existing structure or building a new structure, the buyer should consult an engineering geologist (see p. 5) or a geotechnical engineer to evaluate the potential for landslides and other geology-related problems.

Listed below are some common remedial methods used when landslide-prone slopes cannot be avoided. There is no guarantee

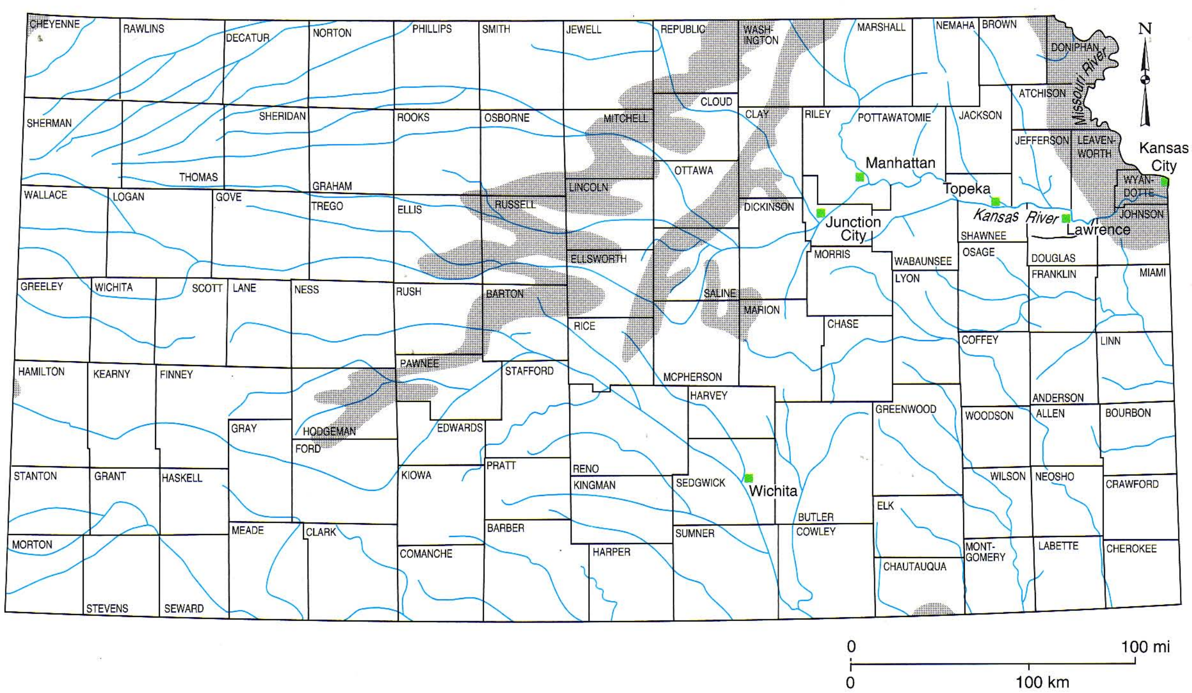


Figure 3—*Landslide-prone areas in Kansas as identified on the 1982 U.S. Geological Survey landslide map of the conterminous United States (Radbruch-Hall et al., 1982). Landslide risk is moderate in the shaded areas (1.5% to 15% of the area is landslide prone). Other areas in Kansas have a low landslide risk (less than 1.5% of area). Though not shown on this map, the region along the Kansas River and its tributaries from Kansas City to Junction City may also have a moderate landslide risk.*

that any one method or combination thereof will completely stabilize a moving hillside.

*Improving surface and subsurface drainage:* Because water is a main factor in landslides, improving surface and subsurface drainage at the site can increase the stability of a landslide-prone slope. Surface water should be diverted away from the landslide-prone region by channeling water in a lined drainage ditch or sewer pipe to the base of the slope. The water should be diverted in such a way as to avoid triggering a landslide adjacent to the site. Surface water should not be allowed to pond on the landslide-prone slope.

Ground water can be drained from the soil using trenches filled with gravel and perforated pipes or pumped water wells. Swimming pools, water lines, and sewers should be maintained to prevent leakage, and the watering of lawns and vegetation should be kept to a minimum. Clayey soils and shales have low **hydraulic conductivity** and can be difficult to drain.

*Excavating the head:* Removing the soil and rock at the head of the landslide decreases the driving pressure and can slow or stop a landslide. Additional soil and rock above the landslide will need to be removed to prevent a new landslide from forming upslope. Flattening the slope angle at the top of the hill can help stabilize landslide-prone slopes.

*Buttressing the toe:* If the toe of the landslide is at the base of the slope, fill can be placed over the toe and along the base of the slope. The fill increases the resisting forces along the failure surface in the toe area. This, in turn, blocks the material in the head from moving toward the toe. However, if the toe is higher on the slope, adding fill would overload the soil and rock below the toe, thus causing a landslide to form downslope of the fill.

*Constructing piles and retaining walls:* Piles are metal beams that are either driven into the soil or placed in drill holes. Properly placed piles should extend into a competent rock layer below the landslide. Wooden beams and telephone poles are not recommended for use as piles because they lack strength and can rot.

Because landslides can ooze through the gaps between the piles, retaining walls are often constructed. Retaining walls can be constructed by adding lagging (metal, concrete, or wooden beams) horizontally between the piles. Such walls can be further strengthened by adding tiebacks and buttressing beams (fig. 5). Tiebacks are long rods that attach to the piles and to a competent rock layer below the ground surface. Buttressing beams are placed at an angle downslope of the piles to prevent the piles from toppling or tilting. Retaining walls also are constructed of concrete, cinder blocks, rock, railroad ties, or logs, but these may not be strong enough to resist landslide movement and could topple.

*Removal and replacement:* Landslide-prone soil and rock can be removed and replaced with stronger materials, such as silty or sandy soils. Because weathering of shales can form landslide-prone soils, the removal and replacement procedure must include measures to prevent continued weathering of the remaining rock. Landslide material should never be pushed back up the slope. This will simply lead to continued motion of the landslide.

*Preserving vegetation:* Trees, grasses, and vegetation can minimize the amount of water infiltrating into the soil, slow the erosion caused by surface-water flow, and remove water from the soil. Although vegetation alone cannot prevent or stop a landslide, removal of vegetation from a landslide-prone slope may initiate a landslide.

*Rock fall protection:* Rock falls are contained by (1) ditches at the base of the rock exposure, (2) heavy-duty fences, and (3) concrete catch walls that

***Before purchasing land or an existing structure or building a new structure, the buyer should consult an engineering geologist***

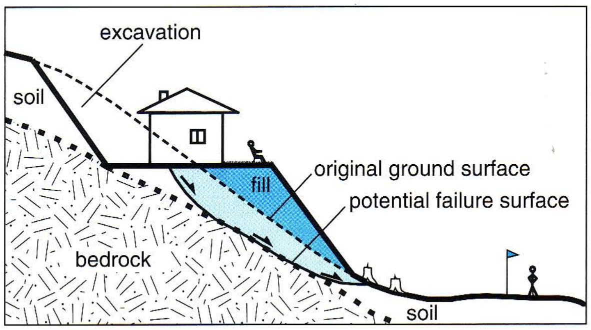


Figure 4—*Diagram of a house built on a landslide-prone hillside, constructed with questionable practices. The soil upslope from the house was excavated leaving a steep soil face. This soil was placed as fill on top of existing soil to create a building lot (pad). Vegetation was removed from the slope, and surface water might pond on the lot. A potential failure surface is shown below the house.*

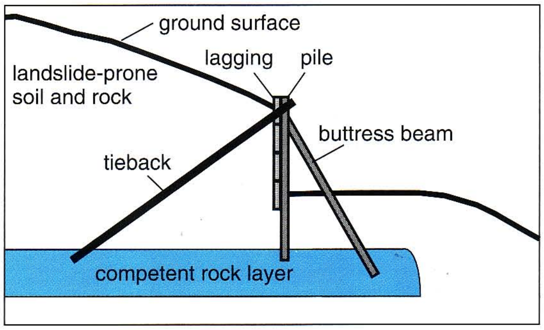


Figure 5—*Diagram of a retaining wall with tiebacks and buttress beams. Tiebacks are metal rods that extend from the piles to a competent rock layer below the ground surface. Buttress beams are metal beams that are inclined downslope from the piles that prevent the piles from toppling. Lagging consists of wooden, metal, or concrete beams placed upslope and between the piles to fill in the gaps.*

*Lack of maintenance can cause renewed landslide movement*

slow errant boulders that have broken free from the rock outcrop. In some cases, loose blocks of rock are attached to bedrock with rock bolts, long metal rods that are anchored in competent bedrock and are threaded on the outside for large nuts. A metal plate with a center hole, like a very large washer, is placed over the end of the rod where it extends from the loose block, and the nut is then added and tightened.

Once constructed, remedial measures must be inspected and maintained. Lack of maintenance can cause renewed landslide movement.

***What is an engineering geologist?*** An engineering geologist is an individual with a degree in geology who has taken specialized courses and has work experience in evaluating the effects of geology and geologic processes on structures (buildings, roads, dams, etc.).

***What should I expect from an engineering geologist?*** Engineering geologists begin by collecting background data on the site and surrounding area, including published reports of geologic problems in the vicinity, geologic maps, geologic hazard maps, and soils maps. They will then inspect the site and surrounding area. Based on the background search and the site inspection, they may want to drill or trench the site to better define the problem and to collect soil and rock samples for testing. Additionally, they may suggest placement of instruments to monitor ground-water flow and movement of soil and rock. Finally, engineering geologists will provide a written report on the extent of geologic problems and may make recommendations on suitable remedial methods.

***Where can you find an engineering geologist?*** Generally, engineering geologists work for civil, geotechnical, and environmental engineering firms. Some own their own companies or work independently. Check the Yellow Pages under geologists or engineers for local companies. You can also use Internet yellow pages or search engines (such as Yahoo or Excite) to find geologists and engineering firms. Local governments should also be a good source of information.

## Glossary

**Bedrock:** General term for the solid rock that underlies the soil.

**Block slide:** A mass of soil and rock that moves along a straight failure surface without rotation or internal deformation in the landslide mass.

**Clay:** A group of submicroscopic silicate minerals related to mica. Clay-sized particles are less than 0.0039 mm in diameter.

**Competent rock:** Hard rock layers that resist weathering.

**Creep:** Slow, imperceptible movement of soil and rock downslope.

**Earth flow:** A mass of soil that moves downslope and undergoes internal deformation. During an earth flow, the landslide mass breaks apart.

**Expansive soil:** Soil containing clay minerals that increase in volume when wet and decrease when dry.

**Failure surface:** A planar surface at the base of the landslide along which motion has occurred; it separates the material that has moved from the stationary material.

**Head:** The upslope portion of a landslide.

**Hydraulic conductivity:** Capability of water to move through soil or rock.

**Landslide:** A mass of soil and rock that moved downslope by gravity.

**Lobe:** A bulge in the ground surface where soil and rock mounds at the toe of a landslide.

**Rock fall:** Free-fall of rock blocks from a cliff or rock outcrop.

**Scarp:** Steeply dipping region of exposed soil and rock that marks the upslope end of a landslide.

**Slump:** A mass of soil and rock that moves along a curved failure surface with rotation but without internal deformation of the landslide material.

**Soil (engineering usage):** All loose (unconsolidated) material between the ground surface and the underlying bedrock, including stream, river, and glacial sediments.

**Subsidence:** Sinking or settling of the ground surface caused when soil or rock collapses into a void. Subsidence can be natural (a sinkhole) or human induced (due to underground mining or pumping of petroleum or water).

**Tension gashes:** Cracks in the ground surface caused by stretching or buckling of the landslide mass during failure.

**Toe:** The downslope portion of a landslide.

**Water content:** The amount of water by weight in the soil. Water content is found by dividing the weight of water in the soil by the weight of dry soil.

**Weather, Weathering:** Physical and chemical processes that disintegrate bedrock and form soil.

# Internet Sites

The following internet sites contain additional information on landslides. Although accurate at the time of publication, URL's and the information on Internet sites are subject to change.

**Landslide information from the U.S. Geological Survey:**

- Geologic hazards—landslides: http://landslides.usgs.gov/landslides.html
- National Landslide Information Center: http://gldage.cr.usgs.gov/html_files/nlicsun.html

**Landslide information from the Federal Emergency Management Agency:**

- Fact sheet on landslides: http://www.fema.gov/library/landslif.htm

**Landslide information from other states:**

- Landslides in Nebraska: http://csd.unl.edu/csd/illustrations/landslides/slides/slides.html
- Inventory of landslides along Nebraska highways: http://nesen.unl.edu/csd/illustrations/landslides/landslide.html
- Hazards from California mudslides: http://www.consrv.ca.gov/dmg/pubs/notes/33/index.htm
- Landslides in forested terrain in California: http://www.consrv.ca.gov/dmg/pubs/notes/50/index.htm

**Landslide information from the Geological Survey of Canada:**

- Landslides and snow avalanches: http://sts.gsc.nrcan.gc.ca/page1/geoh/slide.htm

# Additional Reading


Creath, W. B., 1996, Home Buyer's Guide to Geologic Hazards: The American Institute of Professional Geologists, Arvada, Colorado, 30 p.

Nuhfer, E. B., Proctor, R. J., and Moser, P. H., 1993, The Citizen's Guide to Geologic Hazards: The American Institute of Professional Geologists, Arvada, Colorado, 134 p.

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Sidle, R. C., Pearce, A. J., and O'Loughlin, C. L., 1985, Hillslope Stability and Land Use: American Geophysical Union, Water Resources Monograph 11, 140 p.

Turner, A. K., and Schuster, R. L., 1996, Landslides—Investigation and Mitigation: National Research Council, Transportation Research Board, Special Report 247, 673 p.


The mission of the Kansas Geological Survey, operated by The University of Kansas in connection with its research and service program, is to conduct geological studies and research and to collect, correlate, preserve, and disseminate information leading to a better understanding of the geology of Kansas, with special emphasis on natural resources of economic value, water quality and quantity, and geologic hazards.

The Geology Extension program furthers the mission of the KGS by developing materials, projects, and services that communicate information about the geology of Kansas, the state's earth resources, and the products of the Kansas Geological Survey to the people of the state.


**Public Information Circular 13**
***March 1999***



**Kansas Geological Survey**
**Geology Extension**
**1930 Constant Avenue**
**The University of Kansas**
**Lawrence, Kansas**
**66047–3726**
**(785) 864–3965**
**http://www.kgs.ukans.edu**



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# Konza Prairie Research Natural Area

Konza Prairie Research Natural Area, containing 8,616 acres, is a tallgrass prairie preserve owned by The Nature Conservancy and managed by the Kansas State University Division of Biology. As a protected research site, it is a unique outdoor laboratory that provides an opportunity for the study and preservation of the native tallgrass prairie ecosystem. Konza is divided into watershed-sized management units with various burning and grazing treatments designed to study the role of fire and grazing in the tallgrass prairie ecosystem. It serves as a benchmark for comparisons with managed habitats, and as an educational facility for students and the public.

Konza is located in the midst of the Flints Hills physiographic region. Alternating layers of cherty limestone and shale form steep-sloped hills that are capped by the harder limestones. As the limestones are broken down by erosion, the chert (or flint) accumulates at the surface. The combination of thin, rocky soils and steep slopes has precluded cultivation and promoted grazing and preservation of the native vegetation.

The underlying rocks were deposited in an ancient sea during the Permian Period, about 280 million years ago. Rainwater readily penetrates the fractured limestone layers, but because the underlying shale is relatively impervious, the water moves laterally, creating seeps and springs along slopes beneath the limestone ledges that are delineated by shrub thickets.

The tallgrass prairie, in addition to the dominant grasses, includes many different plant forms. About 450 plant species occur at Konza, but only about 60 of these are grasses. The prairie contains an abundance of broad-leafed wildflowers (forbs), woody plants, mosses, algae, and lichens. The prairie supports a variety of animal life, ranging from bison, prairie chickens, rodents and shrews, to microscopic invertebrates, fungi, and microbes beneath the soil surface. The lower reaches of Kings Creek and Shane Creek, the two major streams on Konza, are forested in a narrow strip, called a gallery forest. This forest contains oak, elm, hackberry, walnut, and hickory trees. About six percent of Konza is wooded.

Operation of the site, building upkeep, salaries, and costs of maintaining the management plan (e.g., burning treatments) are funded by the State through the Kansas Agricultural Experiment Station, and the KSU's Bureau of General Research. Scientific research is funded by outside granting sources totaling approximately one million dollars per year.

The basic Konza research design offers scientists the unique opportunity to join in an "experiment in progress" which is supported and documented by almost 25 years of accumulated data. Currently there are more that 100 research projects active on Konza, and more than a third of these are conducted by non-KSU scientists.

The Friends of Konza Prairie is a private group dedicated to prairie preservation, education, and public understanding of Konza research results. Membership fees and contributions are used primarily for educational opportunities about the tallgrass prairie, providing information to all ages through the Konza Environmental Education Program (KEEP). Trained docents volunteer their time for numerous tasks, especially as guides for school groups on the nature trail and in the bison area. The goals of the program include promoting environmental awareness in the prairie habitat and offering a true prairie outdoor experience to the public.

Public access at Konza is restricted because disturbance might inadvertently affect research projects. However, almost 3,000 visitors a year participate in tours conducted by volunteer docents, and thousands use the hiking trails on the north edge of the preserve. Three hiking trails are located near the main entrance to Konza on McDowell Creek Road. A scenic overlook is five miles north of Interstate 70 on Kansas Highway 177.

## References

Konza Prairie Research Natural Area Fact Sheet and brochures.

## Resource Contacts

David C. Hartnett, Director
Konza Prairie Research Natural Area
Kansas State University
Division of Biology
209 Bushnell
Manhattan, KS 66506-4901
785-532-5925
dchart@ksu.edu

Valerie Wright
Environmental Educator
Konza Prairie Research Natural Area
Division of Biology, Ackert Hall
Kansas State University
Manhattan, KS 66506-4901
785-587-0381
keepkonza@ksu.edu

# SCHEDULE & ITINERARY

## Friday June 9, 2000

| | |
|---|---|
| 7:00 am | Breakfast |
| 8:00 am | **Bus Leaves Holiday Inn for Site 11** |
| 9:00 am | **SITE 11**—Milford Wetlands Project (Steve Lloyd Wetlands)<br>*Mark Mohler*, Kansas Department of Wildlife and Parks |
| 9:30 am | Bus to Site 12 |
| 10:30 am | **SITE 12**—Republican River Compact and Litigation<br>*Scott Ross*, Div. of Water Resources, Dept. of Agriculture<br>*John Cassidy*, Attorney General's Office<br>*Don Pitts*, Shughart, Thomson & Kilroy |
| 11:15 am | Bus to Site 13 |
| 11:50 am | **SITE 13**—Winkler Kimberlite<br>*Tom Weis*, Kansas Geological Survey |
| 12:25 pm | Bus to Manhattan |
| 1:00 pm | **Arrive Holiday Inn, Manhattan** |

# Milford Wetlands Project

The Milford Wetlands Project is a public-private wetlands restoration project located north of Kansas Highway 82 and Wakefield, Kansas, on the upper reaches of the Republican River arm of Milford Lake. The wetlands will provide habitat for waterfowl and shorebirds, as well as game and non-game wildlife species. The wetlands will also act as a natural filtering system for land-use runoff chemicals such as atrazine, and will slow siltation of the reservoir.

Milford Lake, located on the Republican River in Clay and Geary counties, was created by the U.S. Army Corps of Engineers as a flood control reservoir. It began operating in 1967. It is the largest reservoir in Kansas with a surface area of 15,600 acres and 163 miles of shoreline. The Corps manages 33,000 acres of land resources at Milford. The Kansas Department of Wildlife and Parks operates the state park, the Milford Wildlife Area at the north end of the lake, and the Milford Fish Hatchery and Nature Center, both located below the dam.

When completed, the Milford Wetlands Project will add about 2,300 acres of wetlands around the north end of Milford Lake. The $5 million project is 75 percent ($3.75 million) funded through a Corps of Engineers Wetlands Restoration Grant, which requires a 25 percent ($1.25 million) match from other non-federal public and private sources. In 1998, the Kansas State Legislature approved $361,512 for the project in memory of Representative Steve Lloyd of Clay Center, a strong supporter of the project.

Additional land acquisition is not necessary since the project is totally contained within property already owned by the Corps of Engineers. Construction is scheduled to begin in the spring of 2001, with completion anticipated by the end of 2003. The completed project will be operated and maintained by the Kansas Department of Wildlife and Parks. The Kansas Wildscape Foundation, a non-profit organization, is helping raise the grant match. When completed, Milford Wetlands will be the second largest state managed area in Kansas.

**References**

George, K., 1999, The Milford Wetlands Project: Handout, 4 p.

U.S. Army Corps of Engineers (Kansas City District), 1993, Milford Lake (brochure): U.S. Printing Office.

**Resource Contacts**

John Bond
Public Land Supervisor
Kansas Dept. of Wildlife and Parks
Region #2 Office
3300 SW 29th
Topeka, KS 66614
785-273-6740

# Republican River Compact and Litigation

The Republican River basin begins in the plains of eastern Colorado, flows through northwest Kansas and southwest Nebraska, and, after traversing a good part of southern Nebraska, returns to Kansas in Republic County before emptying into Milford Lake. After leaving Milford, the Republican River joins the Smoky Hill to form the Kansas River (fig. 5-1).

Following Congressional consent and Presidential approval of the Republican River Compact in May 1943, the Bureau of Reclamation and Corps of Engineers began the planning and development of projects in the basin. The federal projects in place today include a system of seven Bureau of Reclamation reservoirs, two Corps of Engineer's projects (Harlan County Reservoir in Nebraska and Milford Lake), and six irrigation districts.

In addition to the federal projects, significant ground-water development has occurred in the Republican River basin. This ground-water development is at the heart of the current controversy between Kansas and Nebraska. Kansas alleges that in many years, Nebraska's ground-water use, when combined with its surface-water use, places it over its allocation under the Compact.

## Significance to Kansas

The Republican River and its tributaries are important resources to the State of Kansas. Kansas interests in the basin include: (1) ground- and surface-water rights in the upper Republican River tributaries of northwest Kansas, including the South Fork Republican River, Sappa Creek, Beaver Creek, and Prairie Dog Creek including the Almena Irrigation District; (2) the Kansas Bostwick Irrigation District; (3) both surface water and ground-water users of the mainstem Republican River in Kansas; and (4) users of Milford Lake including downstream users on the Kansas River.

## The Republican River Compact

The Republican River Compact was negotiated during the early 1940's with participation by the States of Colorado, Kansas, and Nebraska and a representative of the President of the United States. The Compact was formally signed on December 31, 1942.

Its purposes, as stated in Article I, are to (1) provide for equitable division of such waters, (2) remove all causes of controversy, (3) promote interstate comity, (4) promote joint action by the States and the United States in the efficient use of water and the control of destructive floods, and (5) provide for the most efficient use of waters in the Republican River basin.

To accomplish these purposes, the negotiators of the Compact determined the virgin water supply within the basin. The Compact defines virgin water supply as "the water supply within the basin undepleted by the activities of man." Based on the virgin water supply determination, the Compact made specific allocations to each of the three states in fourteen different sub-basins. The Compact includes provisions for adjustment to the virgin water supply and allocations based on future records and/or changing conditions.

The Compact has a number of provisions related to the federal government's actions in developing projects within the basin to the benefit of the various states. Major federal developments anticipated by the Compact were flood control projects (clearly shown as being needed following the 1935 flood) and irrigation development.

The Compact makes it the duty of the three states to administer the Compact through the official in each state who is charged with administering water law. The Compact grants to those officials, in their capacity as Compact Commissioners, the power to adopt by unanimous vote, rules and regulations consistent with the provisions of the Compact. In the late 1950's, following the construction of several of the federal projects, the Compact Commissioners met to establish the administration of the Compact. The meetings resulted in the adoption of rules and regulations by which the Compact is administered on July 15, 1959. During the annual meetings in the early 1960's, methods were adopted to annually estimate, by sub-basin, the virgin water

# Republican River Basin

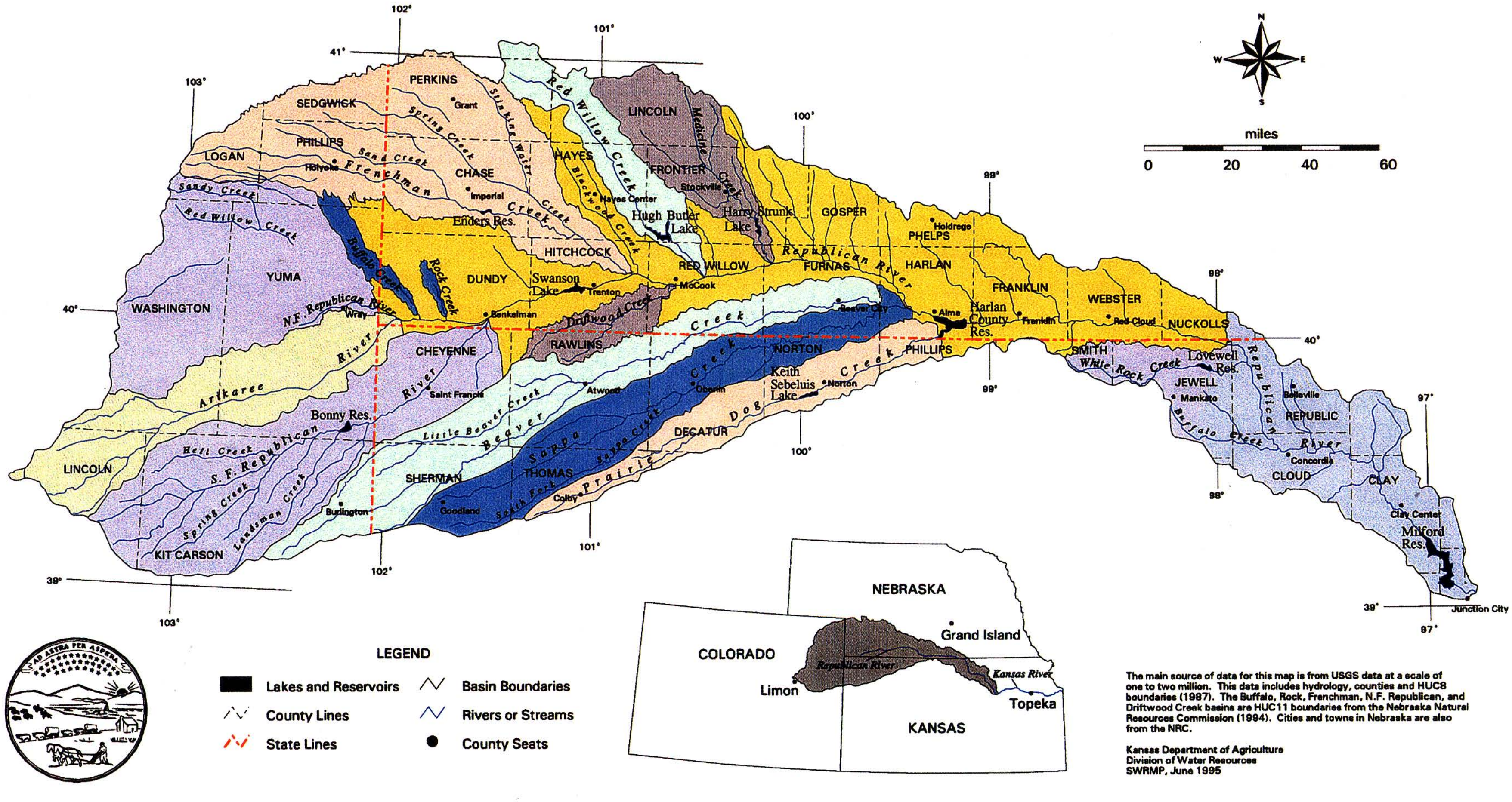


Fig. 5-1—Republican River Basin (Kansas Dept. of Agriculture, Division of Water Resources).

supply and consumptive use of surface water and ground water by each of the states. The Compact Administration meets annually to report on events pertaining to the Compact and to take any necessary action regarding the administration of the Compact. The states can make rules and regulations for administration of the Compact only by unanimous vote. During the 1960's, the Compact Administration developed methods to estimate the basin's water supply and uses of the supply, and each year these estimates are prepared by the Compact Administration. Annual estimates were discontinued in 1995 because the states disagreed on the methods used to make these estimates.

### Litigation

After years of seeking to resolve concerns about Nebraska's overuse of its Republican River Compact allocations through the Compact Administration, in May 1998, Attorney General Stovall, on behalf of Kansas, filed a lawsuit before the U.S. Supreme Court to seek relief. On January 19, 1999, the U.S. Supreme Court issued its order agreeing to hear Kansas' case.

In April 1999, the Court invited Nebraska to file a motion to dismiss Kansas' case based on its contention that ground water is not regulated by the Compact. During the summer of 1999, Nebraska, Kansas, Colorado, and the federal government each filed briefs on the motion to dismiss. The Supreme Court appointed a special master to hear the motion to dismiss. On January 4, 2000, oral arguments on Nebraska's motion to dismiss were heard before Special Master Vincent McKusick. The state of Colorado and the U.S. Department of Justice presented oral arguments at the hearing, arguing, along with Kansas, that ground water is regulated by the Compact and that Nebraska's motion to dismiss should be denied.

On January 28, 2000, the special master submitted his report and recommendations to the Court on Nebraska's motion to dismiss. The master recommended that the Court reject Nebraska's motion, firmly rejecting Nebraska's claim that ground water consumption could not be restricted by the Compact. The master also rebuffed Colorado's argument that the Compact could not restrict non-alluvial (Ogallala) pumping.

Due to the importance of the ground-water issue, on March 8, 2000, the Supreme Court has agreed to allow exceptions to the Special Master's report. Nebraska was required to submit its exceptions by April 7. Responses by the other parties are required by late May. The Supreme Court will likely rule on the exceptions in its fall 2000 session.

### References

Barfield, D., 2000, Republican River Compact, Background and Update: unpublished text for website (May 5, 2000).

### Resource Contacts

Scott Ross, Water Commissioner
Division of Water Resources
Dept. of Agriculture
820 S. Walnut, Box 192
Stockton, KS 67669-0192
785-425-6787
sross@kda.state.ks.us

John Cassidy
Attorney General's Office
120 S.W. 10th Ave., 2nd Floor
Topeka, KS 66612-1597
785-368-8421

Don Pitts, Attorney
Shughart, Thomson & Kilroy
12 Wyandotte Plaza
120 West 12th Street
Kansas City, MO 64105
816-395-0614

# Kansas Kimberlites

With rare exceptions, the rocks we see at the surface in Kansas are sedimentary in origin—that is, they're made up of particles deposited by wind or water. Among the exceptions are the kimberlites of Riley and Marshall counties, igneous rocks formed from the cooling of molten magma that exploded to the surface during the Cretaceous Period, about 90 million years ago.

Kimberlite is a soft, dull-gray rock with thin white veins. It originates deep in the earth, in the upper mantle—the layer that lies about 25 to 250 miles beneath the earth's surface. As kimberlitic magma erupts, it expands, breaking up rock in its path and exploding through the crust (perhaps at speeds of 1,300 feet per second). These eruptions form deep, carrot-shaped pipes that often occur in small clusters (fig. 5-2). The explosion produces small craters at the surface and leaves behind a mixture of igneous and sedimentary rock that often contains garnets, a dark-red, semi-precious stone.

Kimberlites are scientifically important because they provide clues about the deep subsurface: snapshots of an otherwise inaccessible part of the earth. They also generate economic interest because they are the source of most of the world's diamonds. Diamonds form in the upper mantle, generally at depths between 90 and 125 miles. Kimberlites serve as elevators that bring diamonds to the surface. However, of the 4,000 kimberlites known worldwide, 90% do not contain diamonds. So far, diamonds have not been found in Kansas kimberlites.

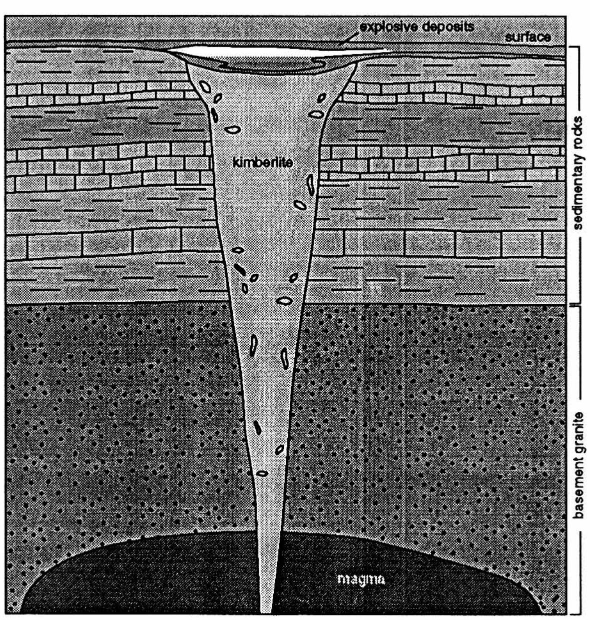


Fig. 5-2—Generalized diagram of a kimberlite pipe.

In Kansas, ten kimberlite pipes, all located in Riley County, have long been known to geologists. During the summer and fall of 1999, researchers at the Kansas Geological Survey located and drilled into three new kimberlites, two in Riley and one in Marshall County. All of the newly discovered kimberlite pipes are covered with soil, 15 to 20 feet below the ground surface. All are on private property.

To find the kimberlites, KGS researchers conducted detailed ground surveys of the earth's magnetic levels. Because kimberlites are composed of igneous rocks, which contain different minerals from the surrounding sedimentary rocks, they produce a distinctive magnetic signature.

The ground surveys were conducted at locations where previous aerial surveys had indicated possible kimberlites. These aerial surveys were conducted in the early 1980's by Cominco American, Inc., a mining company headquartered in Spokane, Washington, that explored for diamonds in the early 1980's. The detailed ground surveys identified three locations with probable kimberlites. Starting in late September 1999, the Survey drilled at these locations and confirmed the presence of three new kimberlites.

At each location, the Survey drilled 300 feet into the kimberlites and obtained continuous core samples of this rock that originated deep within the earth. Researchers then performed tests to measure the amount of magnetite, a mineral inherent in magma, present in the cores from each site. Two of the cores had fairly consistent readings, suggesting a similarity in rock characteristics throughout the 300 feet of sample. The Marshall County core, however, showed a surprising amount of variation in the amount of magnetite present.

Research on the kimberlites is part of a larger Survey study of the geology of the Manhattan quadrangle. That study involves mapping the area's bedrock geology, analyzing the deep subsurface, and looking at geologic hazards such as landslides.

## References

Kansas Geological Survey, 2000, Survey Researchers Find Rare Volcanic Features: Kansas Geological Survey, The Geologic Record, v. 6.1, 4 p.

## Resource Contacts

Tom Weis
Geologic Investigations
Kansas Geological Survey
1930 Constant Ave.
Lawrence, KS 66047
785-864-2186
tvweis@kgs.ukans.edu

Pieter Berendsen
Geologic Investigations
Kansas Geological Survey
1930 Constant Ave.
Lawrence, KS 66047
785-864-2141
pieterb@kgs.ukans.edu