U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Tallgrass Prairie National Preserve

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Tallgrass Prairie National Preserve

tapr_geology.pdf

Version: 1/25/2022

Geologic Resources Inventory Map Document for Tallgrass Prairie National Preserve

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Geologic Resources Inventory Map Document

Tallgrass Prairie National Preserve, Kansas

Document to Accompany Digital Geologic-GIS Data

tapr_geology.pdf

Version: 1/25/2022

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Tallgrass Prairie National Preserve, Kansas (TAPR).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

This document contains the following information:

1) **About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2) **GRI Digital Map and Source Citations** – A listing of the GRI digital geologic-GIS map produced for this project along with sources used in its completion. In addition, a brief explanation of how each source map was used is provided.

3) **Map Unit List** – A listing of all geologic map units present on the map for this project, generally listed from youngest to oldest.

4) **Map Unit Descriptions** – Descriptions for all geologic map units.

5) **Geologic Cross Sections** – Geologic cross section graphics with source geologic cross section abbreviations.

6) **Ancillary Source Map Information** – Additional source map information presented by source map. For each source map this may include a stratigraphic column, index map, map legend and/or map notes.

7) **GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document production credits.

For information about using GRI digital geologic-GIS data contact:

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About the NPS Geologic Resources Inventory Program

Background

The Geologic Resources Inventory (GRI) provides geologic map data and pertinent geologic information to support resource management and science-informed decision making in more than 270 natural resource parks throughout the National Park System. Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The GRI is one of 12 inventories funded by the National Park Service (NPS) Inventory and Monitoring Program. The Geologic Resources Division of the NPS Natural Resource Stewardship and Science Directorate administers the GRI. The NPS Geologic Resources Division partners with the Colorado State University Department of Geosciences to produce GRI products. Many additional partners participate in the GRI process by contributing source maps or reviewing products.

The GRI team undertakes three tasks for each park in the Inventory and Monitoring program: (1) conduct a scoping meeting and provide a summary document, (2) provide digital geologic map data in a geographic information system (GIS) format, and (3) provide a GRI report. These products are designed and written for nongeoscientists.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: https://www.nps.gov/articles/gri-geodatabase-model.htm

Geologic Reports: GRI reports synthesize discussions from the original scoping meeting, follow up conference call(s), and subsequent research. Chapters of each report discuss the geologic setting of the park, distinctive geologic features and processes within the park, highlight geologic issues facing resource managers, and describe the geologic history leading to the present-day landscape. Each report also includes a poster illustrating these GRI digital geologic-GIS data.

For a complete listing of GRI products visit the GRI publications webpage: https://go.nps.gov/gripubs. GRI digital geologic-GIS data is also available online at the NPS Data Store: https://irma.nps.gov/DataStore/Search/Quick. To find GRI data for a specific park or parks select the appropriate park(s), enter “GRI” as a Search Text term, and then select the Search button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: https://

www.nps.gov/subjects/geology/gri.htm. At the bottom of that webpage is a “Contact Us” link if you need additional information. You may also directly contact the program coordinator:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division. Learn more about I&M and the 12 baseline inventories at the I&M webpage: https://www.nps.gov/im/inventories.htm.

GRI Digital Map and Source Map Citations

The GRI digital geologic-GIS map for Tallgrass Prairie National Preserve, Kansas (TAPR):

Digital Geologic-GIS Map of the Tallgrass Prarie National Preserve, Kansas (*GRI MapCode TAPR*)

The digital geologic-GIS map was produced from the following source maps.

> Sawin, Robert S., 2008, Surficial Geology of the Tallgrass Prairie National Preserve, Chase County, Kansas: Kansas Geological Survey, Map Series 119(A), scale 1:12,000 (Surficial Geology of the Tallgrass Prairie National Preserve). (*GRI Source Map ID 74912*).

The GRI used the full extent of the source digital GIS data and incorporated prominent components of the provided source map (e.g., unit colors and unit descriptions) into the GRI digital geologic-GIS dataset and product.

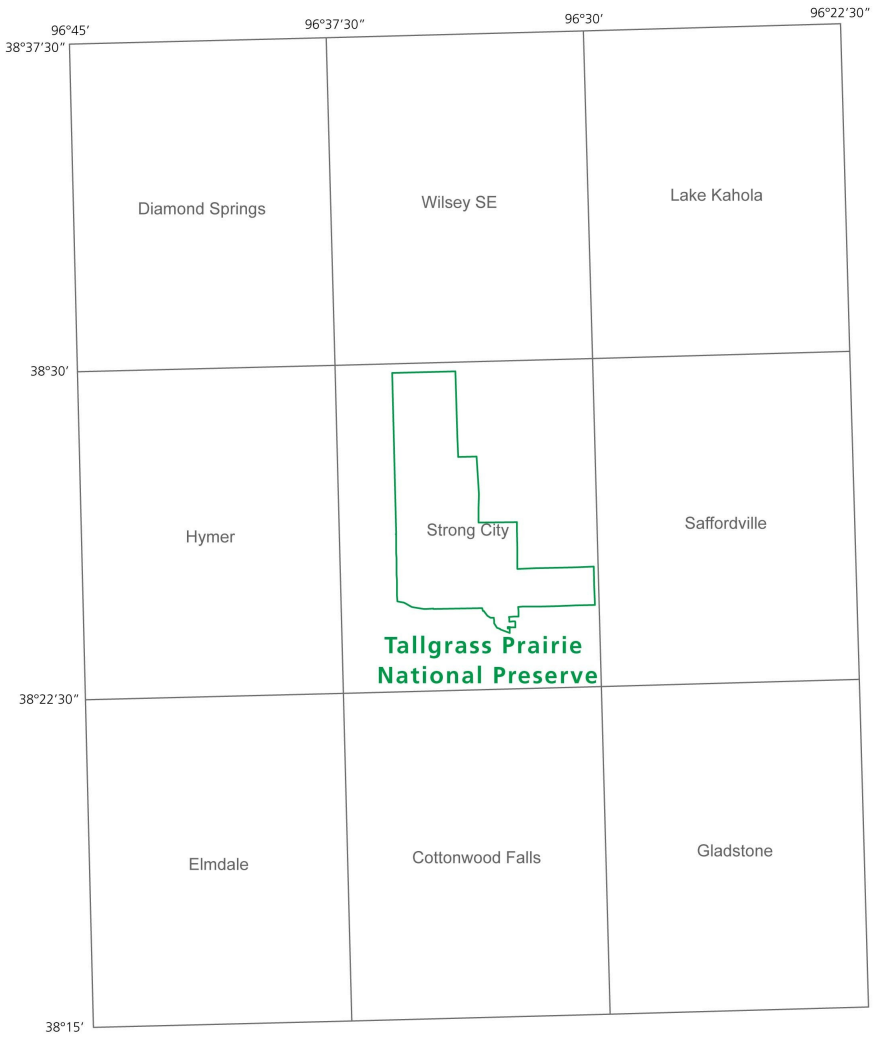
> Sawin, R.S., and Buchanan, R.C. 2008, Water-Bearing Units of the Tallgrass Prairie National Preserve, Chase County, Kansas: Kansas Geological Survey, Map Series 119(B), scale 1:12,000 (Water-Bearing Units of the Tallgrass Prairie National Preserve). (*GRI Source Map ID 74913*).

The GRI used the full extent of the source digital GIS data but only incorporated springs into the GRI digital geologic-GIS dataset and product.

Additional information pertaining to each source map is also presented in the GRI Source Map Information (TAPRMAP) table included with the GRI digital geologic-GIS data.

Index Map

The following index map displays the extent of the GRI digital geologic-GIS map produced for Tallgrass Prairie National Preserve (TAPR) which shares a boundary with the National Preserve boundary (as of January 2022) outlined in green. Also shown are the surrounding 7.5 minute-quadrangles.



Index map by James Winter (Colorado State University).

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Tallgrass Prairie National Preserve, Kansas (TAPR) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qal - Alluvium). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (TAPRUNIT) table included with the GRI digital geologic-GIS data. Some source unit symbols, names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done if a unit was considered to be the same unit as one or more units on other source maps used for this project, and these unit symbols, names and/or ages differed. In this case a single unit symbol and name, and the unit's now recognized age, was adopted. Unit symbols, names and/or ages in a unit descriptions, or on a correlation of map units or other source map figure were not edited. If a unit symbol, name or age was changed by the GRI the unit's source map symbol, name and/or age appears with the unit's source map description.

Cenozoic Era

Quaternary Period

Qal - Alluvium
Qc - Colluvium and alluvium

Paleozoic Era

Permian Period

Pb - Barneston Limestone, Florence Limestone Member
Pm - Matfield Shale
Pkin - Matfield Shale, Kinney Limestone Member
Pw - Wreford Limestone
Psp - Speiser Shale
Pf - Funston Limestone
Pbr - Blue Rapids Shale
Pc - Crouse Limestone
Pec - Easly Creek Shale
Pba - Bader Limestone
Ptei - Bader Limestone, Eiss Limestone Member
Ps - Stearns Shale
Pbe - Beattie Limestone
Pe - Eskridge Shale

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. All descriptions from source map: Surficial Geology of the Tallgrass Prairie National Preserve

Qal - Alluvium (Holocene)

Qal - Alluvium Deposits (Holocene)
The valley floor of Fox Creek and many of the narrow, upland tributaries contain floodplain and terrace deposits of gravelly silt loam and silty clay. The alluvium in Fox Creek valley is up to 35 feet thick.

Qc - Colluvium and alluvium (Pleistocene)

Qc - Collvium/Alluvium Deposits
Colluvium/alluvium fans contain fine- to coarse-grained (angular chert and limestone fragments) material derived from the uplands. These deposits are up to 15 feet thick.

Pb - Barneston Limestone, Florence Limestone Member (Permian)

The Florence limestone caps the highest hills along the northwest edge of the preserve. Up to about 15 feet of lower Florence limestone is present. The Florence is a light-gray to yellow-gray limestone containing several nodular layers of light- to dark-gray chert. Fossils are common. As the Florence weathers, the more resistant chert accumulates on the slopes, and the hilltops become characteristically rounded.

Pm - Matfield Shale (Permian)

The Matfield Shale is about 65 feet thick and is composed of three members, from top to bottom, the Blue Springs shale, the Kinney limestone, and the Wymore shale.

Blue Springs Shale Member. The Blue Springs shale is about 22 feet thick and poorly exposed. The upper part is a gray, yellow, or yellowish-green mudstone that may contain thin, discontinuous layers of limestone. Near the middle, a 1-foot bed of limestone can occur. The lower part of the Blue Springs is a varicolored (yellowish-green, green, red, and purple) mudstone.

Kinney Limestone Member. The thickness of the Kinney limestone can vary in a short distance, ranging from 9 to 22 feet. The average thickness is about 16 feet. Three zones, an upper and lower limestone with a middle mudstone, are common. The *upper limestone* is gray and up to 2 feet thick. Fossil fragments (ostracodes are characteristic) often make up almost the entire rock, giving it a grainy texture. The *middle mudstone* is gray to green and may contain one or more calcareous zones or thin limestones. Fossils are more common in the middle and upper parts. The *lower limestone* ranges from less than a foot to over 9 feet thick. This thickening can occur within a very short distance. Where it is thicker, the light-gray to gray limestone is fossiliferous and weathers to large, elongated blocks that accumulate on the slope below the outcrop.

Wymore Shale Member. The Wymore shale is about 27 feet thick. The upper part is a light-yellowish-brown, gray, and green mudstone that contains a thin limestone; the middle is varicolored (red, purple, and green) mudstone and may contain a boxwork limestone; and the lower mudstone is gray, light yellowish brown, and yellowish green.

Pkin - Matfield Shale, Kinney Limestone Member (Permian)

kin - Matfield Shale, Kinney Limestone Member (Permian)
The thickness of the Kinney limestone can vary in a short distance, ranging from 9 to 22 feet. The average thickness is about 16 feet. Three zones, an upper and lower limestone with a middle mudstone, are common. The *upper limestone* is gray and up to 2 feet thick. Fossil fragments (ostracodes are characteristic) often make up almost the entire rock, giving it a grainy texture. The *middle mudstone* is gray to green and may contain one or more calcareous zones or thin limestones. Fossils are more common in the middle and upper parts. The *lower limestone* ranges from less than a foot to over 9 feet thick. This thickening can occur within a very short distance. Where it is thicker, the light-gray to gray limestone is fossiliferous and weathers to large, elongated blocks that accumulate on the slope below the outcrop.

Pw - Wreford Limestone (Permian)

The Wreford Limestone is composed of three members, from top to bottom, the Schroyer limestone, the Havensville shale, and the Threemile limestone. The combined thickness is about 40 feet.

Schroyer Limestone Member. The thickness of the Schroyer limestone is about 13 feet. The upper part is a massive, gray limestone with layers of chert up to 0.5 feet thick. Weathered blocks can have large vugs, and small fossils are common. The middle part is a soft, orange-brown limestone that has a porous, clayey appearance. The lower third is a gray limestone containing layers of chert. Springs sometimes occur at the base of the Schroyer.

Havensville Shale Member. The Havensville shale is about 9 feet thick. It is a light-yellowish-brown, green, and yellowish-green mudstone with interbedded (up to 2 feet) clayey, light-gray, and light-yellowish-brown limestones that are fossiliferous.

Threemile Limestone Member. The Threemile limestone is prominent at the preserve, forming a bench or “rimrock” of gray limestone that caps most of the flat-topped hills. The average thickness of the Threemile is 18 feet. Nodular and banded chert (chert layers can be up to 1 foot thick) is more abundant in the upper and lower parts of the unit. Chert is usually absent in the middle to upper part, and the limestone weathers to large blocks, which are sometimes vuggy. It is this part of the Threemile that forms the prominent rimrock. Thin mudstone layers may occur within the limestone, and fossils are common throughout the unit. Springs are commonly associated with the Threemile.

Psp - Speiser Shale (Permian)

The Speiser Shale is about 17 feet thick. The upper part is a gray to green, calcareous, fossiliferous mudstone that may contain thin limestone layers. The middle and lower part of the Speiser is a varicolored (red, purple, and green) mudstone.

Pf - Funston Limestone (Permian)

The Funston Limestone averages about 20 feet in thickness, but varies from 15 to 24 feet and can generally be divided into an upper and lower limestone separated by a mudstone. The *upper limestone* contains several mudstone layers, but in general, the upper part is a light-yellowish-brown to light-gray, thin, platy limestone (rarely exposed), and the lower part is a gray, fossiliferous, massive limestone that commonly crops out on the hillsides, often forming a prominent bench. The *middle mudstone* is black to dark gray. The *lower limestone* is very light gray to light yellow gray (sometimes

nearly white), very fine grained, and weathers into thin plates and blocks with sharp, angular edges. Fossils occur at some localities. Springs from the upper and lower limestones are abundant.

Pbr - Blue Rapids Shale (Permian)

The Blue Rapids Shale varies in thickness from 14 to 24 feet, but averages about 17 feet. The gray, green, and light-yellowish-brown, calcareous mudstone may contain a thin limestone layer or boxwork limestone in the lower part of the unit.

Pc - Crouse Limestone (Permian)

The Crouse Limestone is about 11 feet thick, but ranges from 7 to 15 feet. The upper part is a yellow-gray, clayey limestone that weathers into thin plates, a characteristic of this part of the Crouse. The lower part is a gray or light-yellowish-brown, massive limestone containing siliceous nodules and geodes, iron deposits (limonite), and fossils (mostly bivalves and snails). The lower limestone is only 2 to 4 feet thick, but forms a prominent bench with large, detached blocks of limestone scattered along the outcrop. Springs occur at the base of the lower limestone.

Pec - Easly Creek Shale (Permian)

The thickness of the Easly Creek Shale is about 23 feet. The Easly Creek consists of an upper light-green, calcareous mudstone, a prominent limestone near the middle, and a lower varicolored (green, red, and purple), calcareous mudstone that contains a boxwork limestone near its base. The limestone, locally termed the “Easly Creek limestone” is gray, silty, and fossiliferous (algal-coated bivalves and brachiopods are characteristic), and can be over 2 feet thick. It weathers rubbly, but at some localities it is blocky and can resemble the lower limestone in the Crouse. Springs are sometimes associated with the “Easly Creek limestone.”

Pba - Bader Limestone (Permian)

The Bader Limestone is about 26 feet thick and is composed of three members, from top to bottom, the Middleburg limestone, the Hooser shale, and the Eiss limestone.

Middleburg Limestone Member. The Middleburg limestone is about 6 feet thick. It is composed of an upper limestone, middle mudstone and shale, and lower limestone. The upper limestone is gray to light gray or light yellowish brown, fossiliferous, and weathers rubbly, platy, or blocky. Below the upper limestone is a green mudstone, and below it, a black, fissile shale. The lower limestone is light gray, massive, fossiliferous, and is usually about 3 to 4 feet thick. Springs sometimes occur from the Middleburg.

Hooser Shale Member. The thickness of the Hooser shale is about 5 feet. This calcareous mudstone is gray to gray green; near the base it is red.

Eiss Limestone Member. The Eiss limestone varies from 13 to 18 feet thick, but averages about 15 feet. It can be divided into an upper and lower limestone, and middle mudstone. The *upper limestone* is a massive, gray limestone that forms a prominent bench and outcrop. It is about 2 feet thick, becomes characteristically vuggy when weathered, and may contain fossils and siliceous nodules. Gypsum nodules are common in the subsurface. The *middle mudstone* is gray to gray green and fossiliferous. The *lower limestone* is light gray, clayey, fossiliferous, and weathers rubbly. Outcrops of the lower limestone are rare. Springs from the upper limestone are common.

Ptei - Bader Limestone, Eiss Limestone Member (Permian)

tei - Bader Limestone, Eiss Limestone Member (Permian)
The Eiss limestone varies from 13 to 18 feet thick, but averages about 15 feet. It can be divided into an upper and lower limestone, and middle mudstone. The *upper limestone* is a massive, gray limestone that forms a prominent bench and outcrop. It is about 2 feet thick, becomes characteristically vuggy when weathered, and may contain fossils and siliceous nodules. Gypsum nodules are common in the subsurface. The *middle mudstone* is gray to gray green and fossiliferous. The *lower limestone* is light gray, clayey, fossiliferous, and weathers rubbly. Outcrops of the lower limestone are rare. Springs from the upper limestone are common.

Ps - Stearns Shale (Permian)

The Stearns Shale is about 12 feet thick, but ranges from 8 to 14 feet. It is a varicolored (green, red, purple, and gray), calcareous mudstone that may contain thin limestones or boxwork limestone.

Pbe - Beattie Limestone (Permian)

The Beattie Limestone is composed of three members, from top to bottom, the Morrill limestone, the Florena shale, and the Cottonwood limestone. The total thickness is about 21 feet.

Morrill Limestone Member. The Morrill limestone is about 5 feet thick. It is a light-gray to yellow-brown limestone that contains thin mudstone partings. The Morrill weathers irregularly to blocky. In some areas it is massive and forms a prominent outcrop, while in other places it is inconspicuous.

Florena Shale Member. The thickness of the Florena shale is about 11 feet. The Florena is a light-gray-green mudstone. The lower part is very fossiliferous (chonetid brachiopods are characteristic).

Cottonwood Limestone Member. The Cottonwood limestone is about 5 feet thick. The fossiliferous, massive, light-gray to yellow-white limestone has a blocky appearance. Abundant wheat-grain-shaped fusulinids in the upper part are characteristic of the Cottonwood. Scattered chert nodules and thin mudstone partings may be present.

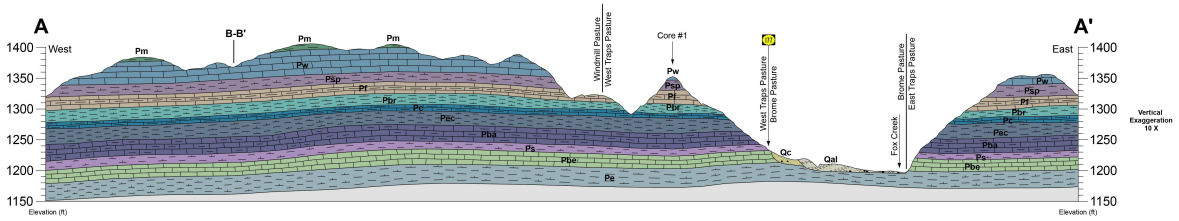
Pe - Eskridge Shale (Permian)

The Eskridge Shale is the lowermost bedrock unit exposed at the preserve, where it crops out along Fox Creek at a few localities. Maximum exposed thickness is 14 feet of light-gray-green mudstone.

Geologic Cross Sections

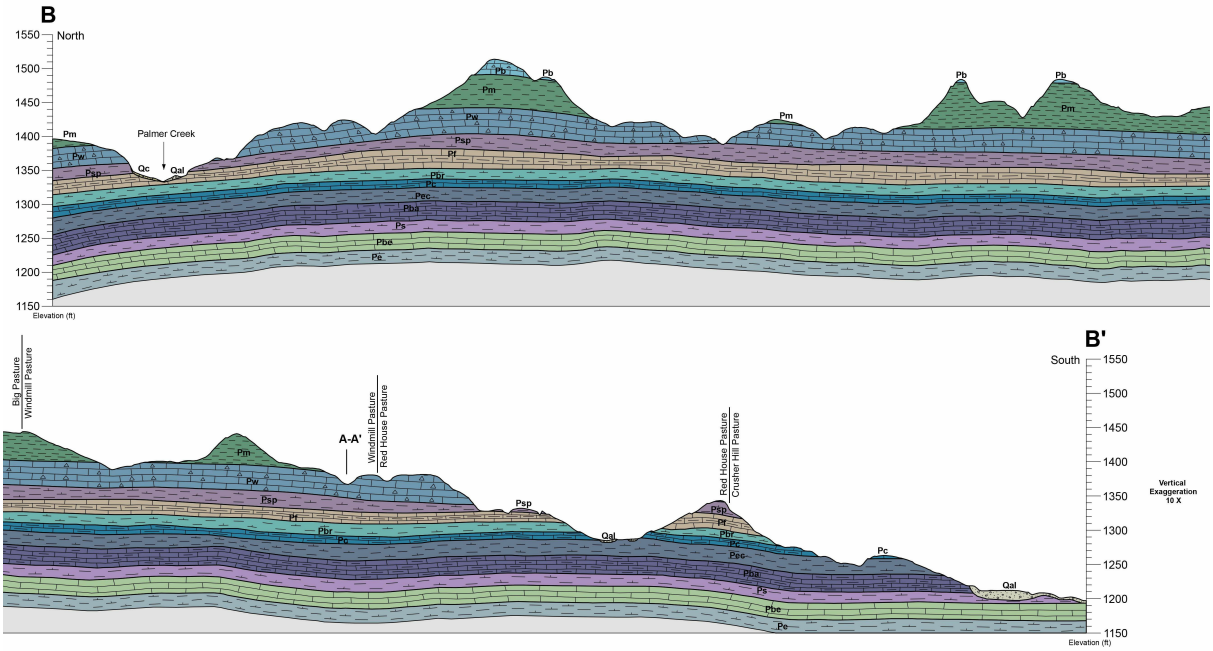
The geologic cross sections present in the GRI digital geologic-GIS data produced for Tallgrass Prairie National Preserve, Kansas (TAPR) are presented below. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A'



Graphic from source map: Surficial Geology of the Tallgrass Prairie National Preserve

Cross Section B-B'



Note that the cross section graphic was split by the GRI so it can be better viewed.

Graphic from source map: Surficial Geology of the Tallgrass Prairie National Preserve

Ancillary Source Map Information

The following sections present ancillary source map information associated with sources used for this project.

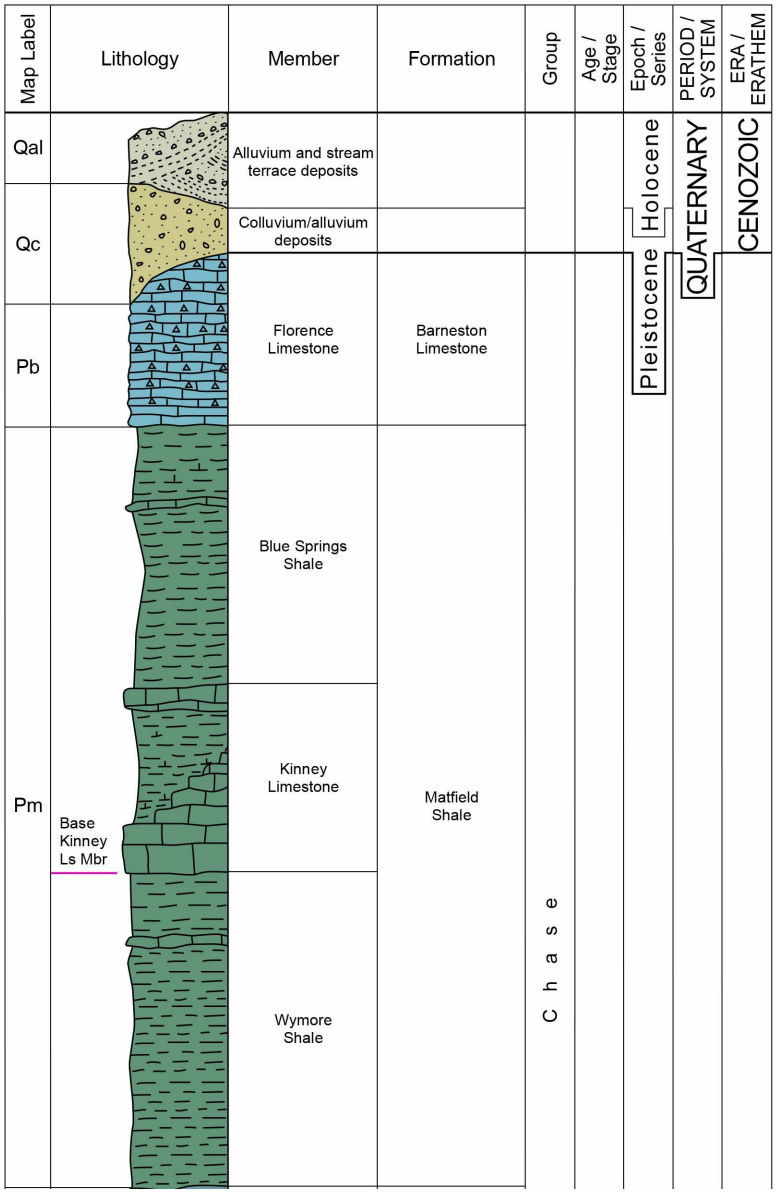
Surficial Geology of the Tallgrass Prairie National Preserve

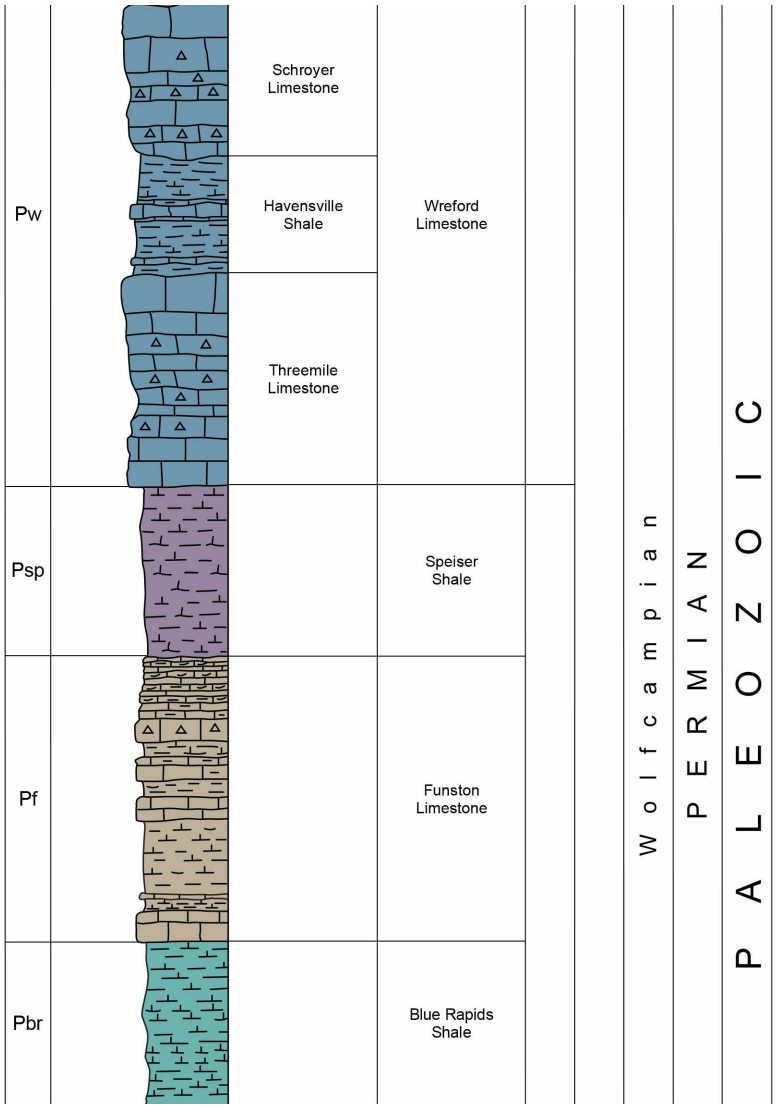
The formal citation for this source.

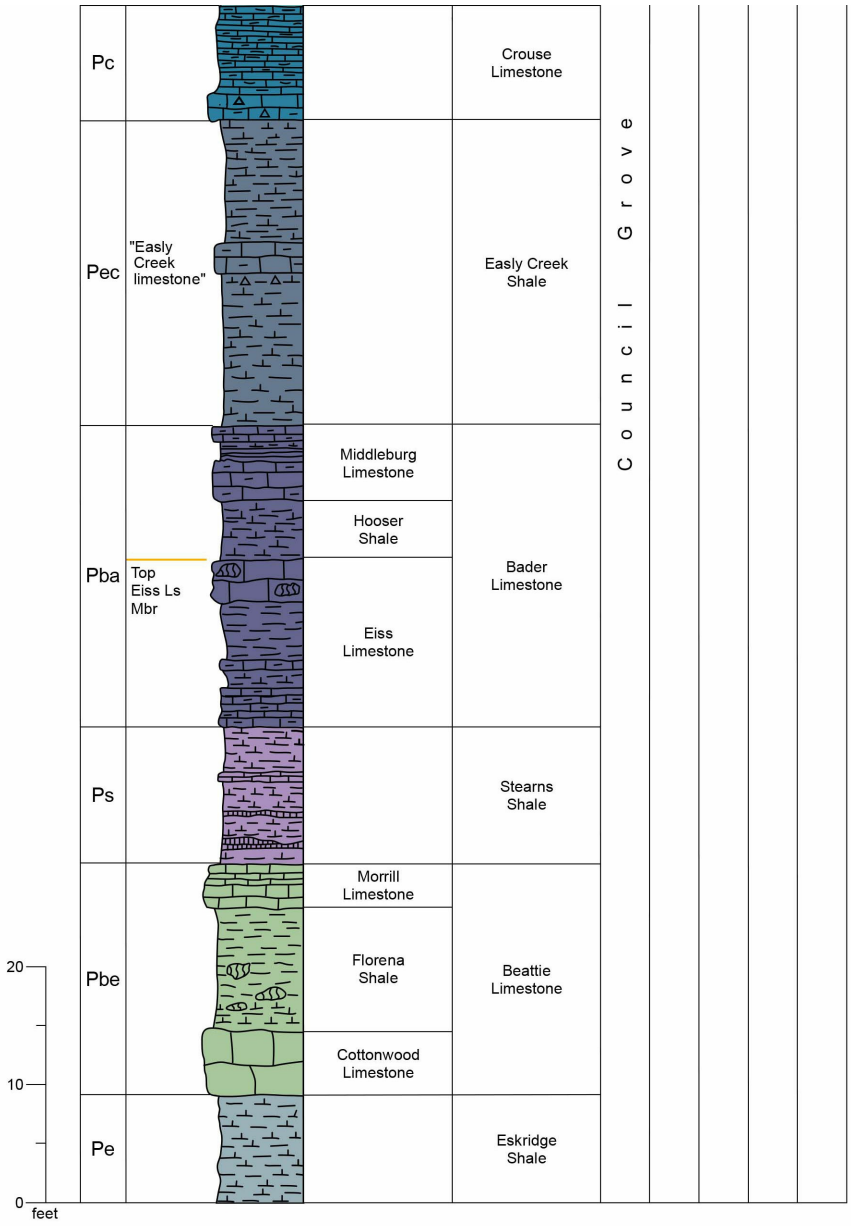
> Sawin, Robert S., 2008, Surficial Geology of the Tallgrass Prairie National Preserve, Chase County, Kansas: Kansas Geological Survey, Map Series 119(A), scale 1:12,000 (*GRI Source Map ID 74912*).

Prominent graphics and text associated with this source.

Correlation of Map Units

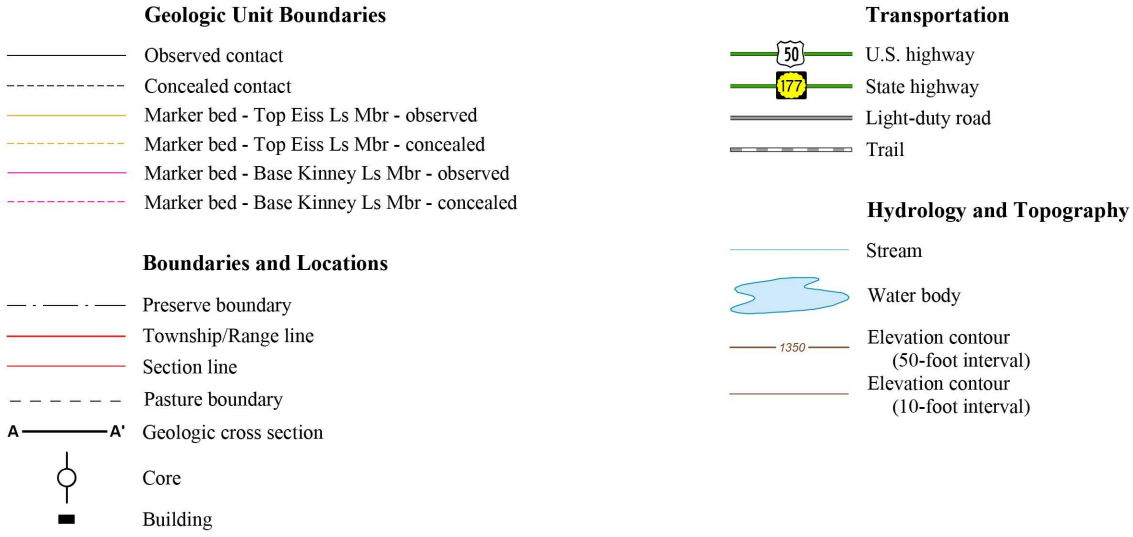



Pw
Schroyer Limestone
Havensville Shale
Threemile Limestone
Wreford Limestone
Psp
Speiser Shale
Pf
Funston Limestone
Pbr
Blue Rapids Shale
Wolfcampian
PERMIAN
PALEOZOIC



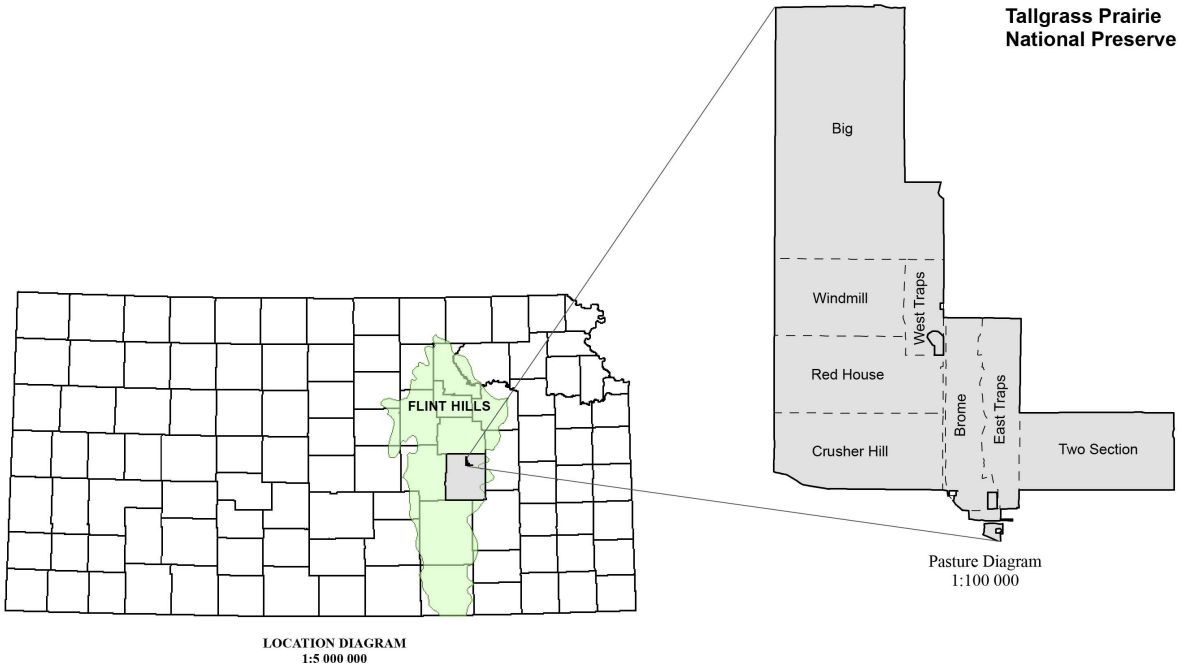
Graphic from source map: [Surficial Geology of the Tallgrass Prairie National Preserve]

Legend



Graphic from source map: Surficial Geology of the Tallgrass Prairie National Preserve

Location and Pasture Diagrams



Graphic from source map: Surficial Geology of the Tallgrass Prairie National Preserve

Report

Surficial Geology of the Tallgrass Prairie National Preserve, Chase County, Kansas

Robert S. Sawin
Kansas Geological Survey

Introduction

A better understanding of the geology and water resources of the Tallgrass Prairie National Preserve is critical to long-term management of the preserve's natural resources. The first phase (springs inventory) of a two-part study designed to characterize the geology and water resources on the preserve was completed by the Kansas Geological Survey in 2001(Sawin and Buchanan, 2001). The second phase—construction of a detailed geologic map and characterization of the hydrogeologic setting—required the gathering of surficial geologic data and mapping from aerial imagery. The geologic map, combined with the springs data, has been used to delineate the preserve's water-bearing rock units.

The geologic map, hydrogeologic map, and supporting data provide the National Park Service and The Nature Conservancy with basic, benchmark information about the nature of the preserve's geology and water resources. Because the preserve's land-use patterns (such as burning regimes, grazing, and human visitation) are changing, and will continue to change in the future, it is important to have these baseline data on the geology and hydrogeologic setting. In addition, geologic and water-resource knowledge gained at the preserve will be useful to resource managers, researchers, and others at the preserve and throughout the Flint Hills region.

Methods

Field work for the geologic map involved systematically locating outcrops by walking each drainage or investigating known outcrops or exposures that were evident on aerial imagery. In most cases, only outcrops where the contact between mappable units could be recognized were recorded. These localities are referred to as control points (hence the CP designation before each number) because they function as "ground truth" for the mapping that was done on the aerial imagery. Each control point was recorded electronically on a WalkAbout Hammerhead XRT Tablet PC with built-in GPS (global positioning system). The tablet PC utilizes ArcGIS 9 ArcMap software by Environmental Systems Research Institute (ESRI) and contains the following data sets:

- National Elevation Dataset (NED) - 1:24,000-scale U.S. Geological Survey topographic map (Strong City, Kansas, quadrangle)
- 2006 Farm Service Agency (FSA) National Agriculture Imagery Program (NAIP) color aerial imagery (1m resolution)
- 2003 Farm Service Agency (FSA) National Agriculture Imagery Program (NAIP) color aerial imagery (2m resolution)
- 2002 Digital Orthophoto Quarter Quadrangles (black and white)
- Natural Resources Conservation Service (NRCS) Soil Survey (SSURGO)

Other attributes (e.g., geologic contact) were also recorded electronically (see Table 1). In addition, the outcrop and other related details were digitally photographed, and if warranted, the section was measured and described.

The electronic data collected in the field were transferred to a desktop PC that was loaded with the same software and layers as on the tablet PC. Using ArcMap, the geologic contacts were digitally drawn on the 2006 NAIP color imagery (other layers were utilized where appropriate) at scales ranging from 1:2,000 to 1:5,000 (most units were mapped at 1:3,000 or 1:3,500), depending on what scale best characterized the contact. Along with the aerial imagery and topographic map, field data, photographs, and measured sections were incorporated into the geologic interpretation.

Surficial Geology Map

The surficial geology map graphically shows the distribution, rock type, and age of bedrock near the earth's surface. It can be used to identify surface and subsurface lithologic units and their stratigraphic relationships, show geologic structures, delineate thick surficial materials such as alluvium, and show the spatial orientation of these features. As planning, development, and renovation continue at the Tallgrass Prairie National Preserve, basic geologic information about the near-surface bedrock geology at specific sites will be important. The geologic map will be useful in construction and engineering projects, in understanding ground-water characteristics, and for environmental assessments. Understanding the near-surface geology and incorporating geologic evaluations into the planning process can help prevent future construction, resource, and environmental problems.

Included with the map is a stratigraphic rock column that depicts the vertical sequence, thickness, and lithologies of the geologic units. A short, generalized description of each geologic unit is also included. East-west and north-south cross sections show the vertical relationship of the rock units.

Hydrogeologic Map

The preserve is underlain by alternating layers of limestone and mudstone. Precipitation infiltrates the subsurface and gravity moves the water downward. Fractures in the limestones, which have been widened by flowing water, are conduits for the subsurface movement of water. The mudstones are less permeable and separate the water-bearing limestones; however, the mudstones are fractured enough to allow very slow downward movement of water from one limestone to the next. Where the water-bearing limestones intersect the land surface, the water in the limestones can discharge onto the land surface as springs or seeps. These springs are classified as contact springs, the most common type of spring at the preserve and in the Flint Hills (Buchanan, Sawin, and Lebsack, 1998; Sawin, Buchanan, and Lebsack, 1999).

Delineation of water-bearing limestones associated with springs at the preserve can be generally determined by combining information from topographic and geologic maps. By superimposing the rock unit onto a topographic map, the areal boundaries (defined by the intersection of the rock outcrop with the land surface) of the water-bearing units have been determined. The distribution and occurrence of springs at the preserve were used to identify the water-bearing limestones (Sawin and Buchanan, 2001; Table 2).

Interactive Map

The geologic and hydrogeologic information that was generated in this study has been displayed as an interactive map of the geologic and water-bearing units within the preserve. The interactive map will be served over the Internet using ESRI’s ArcIMS software.

A user-friendly interface has been developed to allow the user to click on a geologic unit and retrieve the name, lithology, description, and hydrogeologic characteristics of that unit. By clicking on a geologic control point or spring location, information about the outcrop (photos, measured sections, etc.) or spring (flow, chemical analysis, etc.) will be displayed.

The interactive map is a server-side application and thus will not require the user to have a high-

speed Internet connection, a robust computer, or to acquire special software to make use of the application. Both the tabular and geospatial databases will be made available for download from the interactive-map web site.

The interactive-map web site is available at http://geoportal.kgs.ku.edu/tallgrass.

Digital Maps and Data

Digital versions of the hard-copy cartographic maps have been produced using ESRI's ArcGIS software. A CD has been created that contains the geologic maps and supporting geospatial databases. ArcReader, which can be thought of as the *Adobe Acrobat Reader* for maps, allows the user to navigate through the map (pan, zoom-in, zoom-out), identify map features, toggle on/off the display of geospatial data layers, and print selected maps.

Report from source map: Surficial Geology of the Tallgrass Prairie National Preserve

Ancillary Map Text

Elevation contours are presented for general reference. They are taken from U.S. Geological Survey Tagged Vector Contour (TVC) files compiled from base maps at a scale of 1:24.00. In some places the contours from the TVCs may be more generalized than the base data used for compilation of geologic outcrop patterns. Outcrop patterns on the map will typically reflect topographic variation more accurately than the associated contour lines. Repeated fluctuation of an outcrop line across a contour line should be interpreted as an indication that the mapped rock unit is maintaining a relatively constant elevation along a generalized contour.

Roads and highways shown on the base map as represented by data from the Kansas Department of Transportation (KDOT) and other sources. U.S. Department of Agriculture – Farm Services Agency (USDA-FSA) National Agriculture Imagery Program (NAIP) imagery also was used to check road location.

Shaded relief is based on U.S. Geological Survey digital elevation models (DEMs) with (1/3 arc-second resolution. The 1/3 arc-second data, in ESRI GRID format, were converted to a hillshade, a multidirectional shaded-relief image using angles of illumination from 0°, 225°, 270°, and 315° azimuths, each 45° above the horizon, with a 4x vertical exaggeration.

This map was produced using the ArcGIS system developed by ESRI (Environmental Systems Research Institute, Inc.)

The Kansas Geological Survey does not guarantee this map to be free from errors or inaccuracies and disclaims any responsibility or liability for interpretations made from the map or decisions based thereon.

Suggested reference to this map:
Sawin, R. S. 2008, Surficial geology of the Tallgrass Prairie National Preserve, Chase County, Kansas Geological Survey, Map M-119A, scale 1:12,000.

Supplemental References

Sawin, R. S., 2008, Methodology and data used to construct the surficial geology (M-119A) and water-bearing units (M-119B) maps of the Tallgrass Prairie National Preserve, Chase County, Kansas: Kansas Geological Survey, Open-file Report 2008-09, 15 p.

Sawin, R. S., and West, R. R., 2008 Lithology and Paleontology of the stratigraphic units cropping out at the Tallgrass Prairie National Preserve, Chase County, Kansas: Kansas Geological Survey, Open-file Report 2008-15, 7 p.

References from source map: Surficial Geology of the Tallgrass Prairie National Preserve

Table 1. Geologic Control Points

Control Pt.	. (GPS)	. (GPS)			& Dip
Core 1	.43577	.56198	(surface)	/Logs	
Core 2	.43271	.55838	Ck (surface)	/Logs	
CP 1	.43294	.56021	/Easly Ck ls	Sect	
CP 2	.43329	.56061	/Crouse	Sect	
CP 3	.43342	.55826	/Easly Ck ls		
CP 4	.43365	.55865	/Crouse		
CP 5	.43364	.55797	/Easly Ck ls		
CP 6	.43372	.55821	/Crouse		
CP 7	.43373	.55838	/Crouse		
CP 8	.43422	.55794	/Crouse		
CP 9	.43435	.55843	/Funston	Sect	
CP 10	.43461	.55870			
CP 11	.43465	.55709	/Eiss		
CP 12	.43634	.55716	/Morrill		
CP 13	.43729	.55737	/Cottonwood	Sect	
CP 14	.43840	.55722	/Morrill	Sect	
CP 15	.43897	.56205	/Eiss		
CP 16	.43913	.55841	/Morrill	Sect	
CP 17	.43947	.55709	/Eiss	Sect	
CP 18	.43954	.55922	/Morrill	Sect	
CP 19	.44071	.56222	/Morrill		
CP 20	.44084	.55956	/Eiss		
CP 21	.44092	.55715	/Middleburg	Sect	
CP 22	.44113	.55745	/Easly Ck ls	Sect	
CP 23	.42629	.55671	/Morrill	Sect	^{o}E
CP 24	.42913	.56052	/Eiss		
CP 25	.42961	.56504	/Easly Ck ls	Sect	^{o}E
CP 26	.42986	.56762	/Crouse	Sect	^{o}E
CP 26a	.43028	.56708	/Easly Ck ls	Sect	
CP 26b	.42938	.56856	Crouse	Sect	
CP 27	.43159	.56899	/Crouse		
CP 28	.41710	.56155	/Eiss		
CP 29	.41117	.55759	/Easly Ck ls		
CP 30	.41234	.55777	/Eiss		
CP 31	.41256	.55883	/Middleburg		
CP 32	.41297	.56050	/Easly Ck ls	Sect	^{o}E
CP 33	.40871	.55999	Quarry		
CP 34	.41080	.55936	Quarry		
CP 35	.41051	.55937	Quarry		
CP 36	.40786	.55748	/Easly Ck ls	Sect	

CP 37	.40770	.57683	/Easly Ck ls			
					ºE	
CP 38	.40908	.57342	/Crouse	Sect		
CP 39	.41661	.58282	/Easly Ck ls			
					ºE	
CP 40	.41477	.58506	/Easly Ck ls			
CP 41	.41700	.58883	/Funston	Sect		
					ºE	
CP 42	.41859	.59528	/Threemile			
Control Pt.	**. (GPS)**	**. (GPS)**				**& Dip**
CP 43	.41490	.59734	/Threemile	Sect		
CP 44	.40789	.58720	/Eiss			
CP 45	.41091	.58608	/Eiss	Sect		
CP 46	.41176	.58311	/Easly Ck ls			
CP 47	.41072	.59177	/Easly Ck ls	Sect		
CP 47a	.41192	.59277	/Crouse	Sect		
CP 48	.41257	.59334	/Funston	Sect		
CP 49	.41393	.58976	/Funston			
CP 50	.42320	.58564	/Crouse	Sect		
CP 51	.42583	.58554	/Crouse			
					ºE	
CP 52	.42733	.59739				
					ºE	
CP 53a	.42768	.58653	/Funston	Sect		
					ºE	
CP 53b	.42815	.58846		Sect		
CP 54	.42632	.58840	/Funston			
					ºE	
CP 55	.42206	.57872				
CP 56	.43424	.58985				
CP 57	.44715	.59450	/Threemile			
CP 58	.44359	.59387	/Threemile			
CP 59	.44213	.59444	/Threemile			
CP 60	.44162	.59568				
CP 61	.43697	.59722	/Threemile			
CP 62	.44757	.56392	/Crouse			
CP 63	.44508	.56447	/Middleburg			
CP 64	.44505	.56826	/Middleburg			
CP 65	.44624	.56870	/Crouse			
CP 66	.45031	.56850				
CP 67a	.44873	.57514	/Crouse	Sect		
CP 67b	.44931	.57571	/Funston	Sect		
CP 67c	.44994	.57653	/Funston	Sect		
CP 68	.44636	.57390	/Crouse			
CP 69	.44351	.57479	/Crouse	Sect		ºE, 5ºE
					ºE	
CP 70	.44356	.56797	/Eiss	Sect		
CP 71	.44092	.56674	/Eiss	Sect		
CP 72	.43933	.58075				
CP 73	.45257	.59357	/Threemile			
CP 74	.45353	.59356	/Schroyer			
CP 75	.45530	.59522				ºW,11ºN
CP 76	.45600	.59360	/Schroyer			
CP 77	.45850	.59138	/Kinney			
CP 78	.45568	.59137				
CP 79	.44991	.58645	/Kinney			

CP 80	.44998	.58377	/Threemile			
CP 81	.45005	.58168	/Threemile			
CP 82	.45087	.57954				
CP 83	.45845	.58587	/Threemile	Sect		
CP 84	.45928	.58808				
CP 85	.45907	.58177	/Threemile			
CP 86	.45941	.57958				
Control Pt.	**. (GPS)**	**. (GPS)**				**& Dip**
CP 87	.46037	.57655		Sect		
CP 88	.46021	.57531	/Crouse	Sect		
CP 89	.45876	.57835	/Threemile			
CP 90	.45833	.57761				
CP 91	.46202	.57345	/Crouse	Sect		
CP 92	.46217	.57107	/Middleburg	Sect		
CP 93	.46220	.56365	/Morrill	Sect		
CP 94	.46087	.55955	/Morrill			
CP 95	.45593	.56486				
CP 96	.45582	.56692				
CP 97	.46085	.56655	/Eiss			
CP 98	.46597	.58935	/Threemile			
CP 99	.46526	.58518	/Threemile			
CP 100	.46250	.57647	/Crouse	Sect		
					ºE	
CP 101	.46437	.57060	/Eiss			
CP 102	.46427	.57189	/Eiss	Sect		ºW, 2ºS
CP 103	.46756	.57363	/Easly Ck ls			
CP 104	.46728	.57686	/Easly Ck ls			
					ºE	
CP 105	.46904	.57743	/Crouse			
CP 106	.46842	.57971	/Crouse			
CP 107	.46910	.58152	/Funston			
CP 108	.46985	.58815	/Threemile			
CP 109	.47076	.59196	/Kinney			
CP 110	.47087	.58650	/Threemile	Sect		
CP 111	.47279	.58826	/Threemile	Sect		
CP 112	.47379	.58896		Sect		
CP 113	.47446	.58958				
CP 114	.47671	.59047	/Kinney	Sect		
CP 115	.47745	.59024	/Kinney	Sect		
CP 116	.46791	.59438	/Kinney	Sect		
CP 117	.46099	.59694				
					ºE	
CP 118	.46158	.59303	/Kinney			
CP 119	.47102	.57842	/Crouse			
CP 120	.47340	.57905	/Funston			
CP 121	.47752	.58331	/Threemile			
CP 122	.47841	.58479	/Threemile			
CP 123	.47635	.57985	/Threemile			
CP 124	.47469	.57203	/Funston	Sect		
CP 125	.47371	.57148	/Crouse			
CP 126	.47281	.56988	/Easly Ck ls	Sect		
CP 127	.47234	.56861	/Middleburg			
CP 128	.47218	.56755	/Eiss			
CP 129	.47714	.56927	/Crouse			
CP 130	.48300	.57237	/Crouse			
CP 131	.48190	.57224	/Crouse			

CP 132	.47996	.57334	/Funston	Sect	
CP 133	.48184	.57749	/Funston		
CP 134	.48169	.57979	/Threemile		
Control Pt.	**. (GPS)**	**. (GPS)**			**& Dip**
CP 135	.48881	.56846	/Crouse		
CP 136	.48903	.57870	/Crouse		
CP 137	.48736	.58450	/Funston		
CP 138	.49126	.58336	/Funston		
CP 139	.49046	.59136	/Threemile		
CP 140	.48797	.59130	/Threemile		
CP 141	.48599	.59159	/Threemile		
CP 142	.48433	.59105	/Threemile		
CP 143	.48292	.58928	/Threemile		
CP 144	.48135	.58851	/Schroyer		
CP 145	.48001	.58815	/Kinney		
CP 146	.47964	.59095	Sp		
CP 147	.49587	.56833	/Funston		
CP 148	.48997	.57379	/Funston		
CP 149	.49157	.56805	/Crouse	Sect	
CP 150	.49159	.57814	/Funston		
CP 151	.49267	.58042			
CP 152	.49236	.58480			
CP 153	.49193	.59519	/Threemile		
CP 154	.49293	.59431	/Threemile		
CP 155	.49187	.59746	/Threemile		
CP 156	.49432	.58355	/Threemile		
CP 157	.43694	.54820	/Morrill		
CP 158	.43603	.54839	/Cottonwood		
CP 159	.43586	.55503	/Cottonwood		
CP 160	.43735	.55419	/Cottonwood	Sect	
CP 161	.41787	.55603	/Morrill		
CP 162	.41641	.55148			
CP 163	.41349	.55638	/Eiss		
CP 164	.40684	.55616	/Eiss		
CP 165	.40678	.55416	/Eiss		
CP 166a	.40848	.55385	/Cottonwood	Sect	
CP 166b	.40763	.55467	/Morrill	Sect	
CP 167	.40222	.55194	/Cottonwood		
CP 168	.40226	.55282			
CP 169	.40307	.55423	/Eiss		
CP 170	.40033	.55973	/Cottonwood		
CP 171	.39879	.55124	/Morrill	Sect	
CP 172	.40065	.54092	/Cottonwood		
CP 173	.40257	.54366	/Cottonwood		
CP 174	.40255	.54266	/Morrill		
CP 175	.41132	.54260	/Morrill		
				^{o}E	
CP 176	.41550	.54708	/Eiss	Sect	
CP 177	.41534	.54811	/Morrill	Sect	
CP 178	.41450	.54351	/Easly Ck ls		
CP 179	.41289	.54248	/Eiss		
CP 180	.40245	.53922	/Morrill		
CP 181	.40955	.54116	/Eiss		
Control Pt.	**. (GPS)**	**. (GPS)**			**& Dip**
CP 182	.41667	.53872	/Crouse		

CP 183	.42310	.53915	/Crouse			
CP 184	.42185	.54180	/Middleburg	Sect		
CP 185	.41976	.53913	/Threemile			
CP 186	.42203	.54424	/Eiss			
CP 187	.42098	.54481	/Morrill			
CP 188	.41953	.54435	/Middleburg			
CP 189	.41969	.54601	/Morrill			
CP 190	.41971	.54637	/Cottonwood			
CP 191	.41914	.54715	/Cottonwood			
CP 192	.40466	.53924	/Eiss			
CP 193	.40375	.53925	/Eiss			
CP 194	.43711	.54720	/Eiss			
CP 195	.43892	.53935 (est)	/Threemile			
CP 196	.43837	.54431	/Crouse (est)			
CP 197	.43871	.54566	/Middleburg			
CP 198	.42400	.54832	/Cottonwood			
CP 199	.42667	.54846	/Eiss			
CP 200	.42780	.54789	/Morrill	Sect		
CP 201	.42824	.54791	/Cottonwood	Sect		
CP 202	.42846	.54649	/Morrill			
CP 203	.42728	.54487	/Eiss			
CP 204	.42703	.54330	/Crouse			
CP 205	.42880	.53985	/Crouse			
CP 206	.42953	.53941	/Middleburg			
CP 207	.43290	.53922	/Eiss			
CP 208	.43128	.54367	/Morrill			
CP 209	.42994	.54766	/Cottonwood			
CP 210	.43174	.54920	/Cottonwood			
CP 211	.40735	.53919	/Easly Ck ls			
CP 212	.40658	.53387	Ck ls			
CP 213	.40807	.53407	/Crouse			
CP 214	.40857	.53426	/Crouse	Sect		
CP 215	.41021	.53373	Funston			
CP 216	.41082	.53320	/Threemile			
CP 217	.40799	.53124	/Crouse			
CP 218	.40705	.53119	/Crouse			
CP 219	.40665	.53165	Ck ls		ºW	
CP 220	.40624	.52914	/Crouse			
CP 221	.40581	.52651	Funston			
CP 222	.40762	.52753	/Funston			
CP 223	.41001	.52370	/Schroyer			
CP 224	.41313	.52984	/Funston			
CP 225	.41391	.53071	/Crouse			
CP 226	.41333	.53440	/Crouse			
CP 227	.41328	.53648	/Eiss			
CP 228	.41440	.53525	/Middleburg			
CP 229	.41571	.53321	/Easly Ck ls	Sect		
Control Pt.	**. (GPS)**	**. (GPS)**				**& Dip**
CP 230	.41674	.53165	Ck ls			
CP 231	.41739	.53127	/Crouse			
CP 232	.41860	.52988	/Crouse			
CP 233	.41963	.53005	/Funston			
CP 234	.41653	.53548	/Crouse			
CP 235	.41514	.53464	/Middleburg			
CP 236	.41417	.52461	/Threemile			

			(est)		
CP 237	.41479	.52435		/Threemile	
			(est)		
CP 238	.41519	.52429		/Schroyer	
			(est)		
CP 239	.41531	.52341		/Schroyer	
CP 240	.41376	.52620		/Funston	
			(est)		
CP 241	.41481	.52987		/Funston	
CP 242	.41759	.52688		/Threemile	
			(est)		
CP 243	.42067	.51054		/Crouse	
CP 244	.42052	.50865		/Middleburg	Sect
CP 245	.41798	.50576		/Eiss	
CP 246	.41777	.50643		/Middleburg	
CP 247	.41197	.50606		/Middleburg	
CP 248	.41430	.50892		/Crouse	
CP 249	.41552	.51073		/Funston	
CP 250	.41190	.50898		Ck ls	Sect
CP 251	.41160	.51058		/Crouse	Sect
CP 252	.41112	.51103		/Crouse	Sect
CP 253	.41020	.51134		/Funston	
CP 254	.41198	.51385		/Funston	Sect
CP 255	.41442	.51414		/Funston	
CP 256	.41520	.51424		T/ Funston	
CP 257	.41548	.51723		T/Funston	
CP 258	.41667	.51927		/Threemile	
CP 259	.41165	.51802		T/Funston	
CP 260	.41220	.52012		/Threemile	
CP 261	.41035	.50687		/Crouse	
CP 262	.40951	.50592		. Funston	
CP 263	.40683	.52199		T/Funston	
CP 264	.40768	.51758		/Funston	
CP 265	.40886	.51878		/Threemile	
CP 266	.40888	.51656		/Funston	
CP 267	.40803	.51540		/Funston	
CP 268a	.39977	.52364		/Funston	Sect
CP 268b	.39939	.52503		/Funston	Sect
CP 269	.40712	.50310		/Crouse	
CP 270	.40744	.50476		/Funston	
CP 271	.42017	.50225		/Crouse	
CP 272	.41900	.50224		/Middleburg	
CP 273	.41835	.50228		/Eiss	
CP 274	.41175	.50226		/Crouse	Sect
CP 275	.41032	.55746		/Crouse	
USGS BM	.43731	.55707		culvert	

Table from source map: Surficial Geology of the Tallgrass Prairie National Preserve

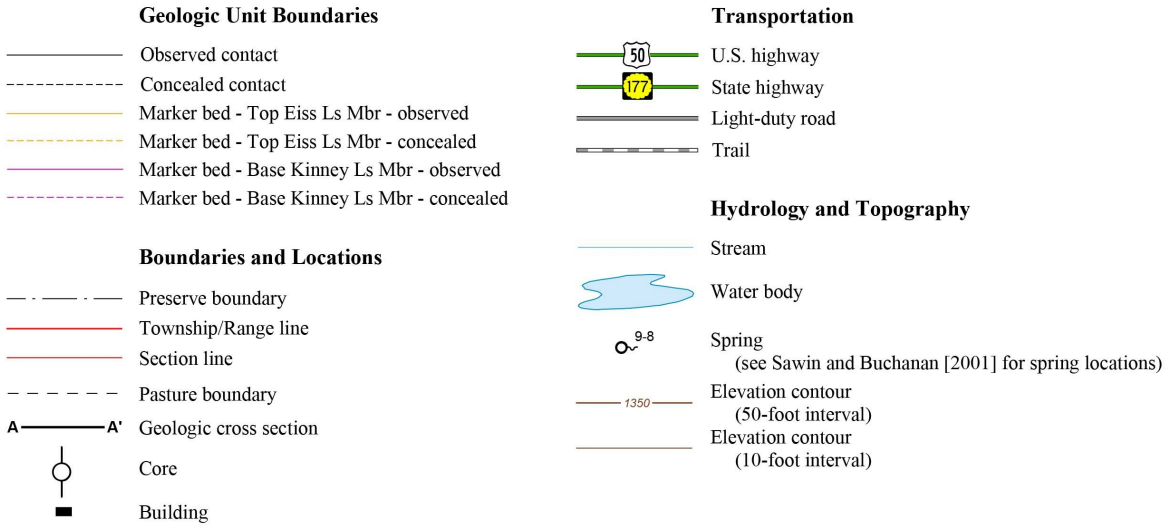
Water-Bearing Units of the Tallgrass Prairie National Preserve

The formal citation for this source.

Sawin, R.S., and Buchanan, R.C. 2008, Water-Bearing Units of the Tallgrass Prairie National Preserve, Chase County, Kansas: Kansas Geological Survey, Map Series 119(B), scale 1:12,000 (*GRI Source Map ID 74913*).

Prominent graphics and text associated with this source.

Legend



Note that the GRI only captured springs from this source publication.

Graphic from source map: Water-Bearing Units of the Tallgrass Prairie National Preserve

Table 2. Spring Data

Table 2. Spring Data (revised from Sawin and Buchanan, 2001). Spring numbers in ( ) are from Sawin and Buchanan, 2000. Data was collected in April 2001.

Control Pt.	Lat. (GPS)	Long. (GPS)	Contact	Graphic	Joints	Strike & Dip
Core 1	38.43577	-96.56198	Threemile (surface)	Core/Logs		
Core 2	38.43271	-96.55838	Easly Ck (surface)	Core/Logs		
CP 1	38.43294	-96.56021	B/Easly Ck ls	Meas Sect		
CP 2	38.43329	-96.56061	B/Crouse	Meas Sect		
CP 3	38.43342	-96.55826	T/Easly Ck ls			
CP 4	38.43365	-96.55865	B/Crouse			
CP 5	38.43364	-96.55797	B/Easly Ck ls			
CP 6	38.43372	-96.55821	B/Crouse			
CP 7	38.43373	-96.55838	B/Crouse			
CP 8	38.43422	-96.55794	B/Crouse			
CP 9	38.43435	-96.55843	B/Funston	Meas Sect		
CP 10	38.43461	-96.55870	Funston			
CP 11	38.43465	-96.55709	T/Eiss			
CP 12	38.43634	-96.55716	T/Morrill			
CP 13	38.43729	-96.55737	T/Cottonwood	Meas Sect		
CP 14	38.43840	-96.55722	T/Morrill	Meas Sect		
CP 15	38.43897	-96.56205	T/Eiss			
CP 16	38.43913	-96.55841	T/Morrill	Meas Sect		
CP 17	38.43947	-96.55709	T/Eiss	Meas Sect		
CP 18	38.43954	-96.55922	T/Morrill	Meas Sect		
CP 19	38.44071	-96.56222	T/Morrill			
CP 20	38.44084	-96.55956	T/Eiss			
CP 21	38.44092	-96.55715	T/Middleburg	Meas Sect		
CP 22	38.44113	-96.55745	B/Easly Ck ls	Meas Sect		
CP 23	38.42629	-96.55671	T/Morrill	Meas Sect	N50ºE	
CP 24	38.42913	-96.56052	T/Eiss			
CP 25	38.42961	-96.56504	B/Easly Ck ls	Meas Sect	N77ºE	
CP 26	38.42986	-96.56762	B/Crouse	Meas Sect	N40ºE	
CP 26a	38.43028	-96.56708	T/Easly Ck ls	Meas Sect		
CP 26b	38.42938	-96.56856	Upper Crouse	Meas Sect		
CP 27	38.43159	-96.56899	T/Crouse			
CP 28	38.41710	-96.56155	T/Eiss			

CP 29	38.41117	-96.55759	B/Easly Ck ls			
CP 30	38.41234	-96.55777	T/Eiss			
CP 31	38.41256	-96.55883	T/Middleburg			
CP 32	38.41297	-96.56050	B/Easly Ck ls	Meas Sect	N53ºE	
CP 33	38.40871	-96.55999	Funston Quarry			
CP 34	38.41080	-96.55936	Funston Quarry			
CP 35	38.41051	-96.55937	Funston Quarry			
CP 36	38.40786	-96.55748	B/Easly Ck ls	Meas Sect		
CP 37	38.40770	-96.57683	B/Easly Ck ls		N50ºE	
CP 38	38.40908	-96.57342	B/Crouse	Meas Sect		
CP 39	38.41661	-96.58282	B/Easly Ck ls		N85ºE	
CP 40	38.41477	-96.58506	B/Easly Ck ls			
CP 41	38.41700	-96.58883	B/Funston	Meas Sect	N33ºE	
CP 42	38.41859	-96.59528	B/Threemile			

Control Pt.	Lat. (GPS)	Long. (GPS)	Contact	Graphic	Joints	Strike & Dip
CP 43	38.41490	-96.59734	B/Threemile	Meas Sect		
CP 44	38.40789	-96.58720	T/Eiss			
CP 45	38.41091	-96.58608	T/Eiss	Meas Sect		
CP 46	38.41176	-96.58311	B/Easly Ck ls			
CP 47	38.41072	-96.59177	B/Easly Ck ls	Meas Sect		
CP 47a	38.41192	-96.59277	T/Crouse	Meas Sect		
CP 48	38.41257	-96.59334	B/Funston	Meas Sect		
CP 49	38.41393	-96.58976	B/Funston			
CP 50	38.42320	-96.58564	B/Crouse	Meas Sect		
CP 51	38.42583	-96.58554	B/Crouse		N50ºE	
CP 52	38.42733	-96.59739	Threemile		N52ºE	
CP 53a	38.42768	-96.58653	B/Funston	Meas Sect	N40ºE	
CP 53b	38.42815	-96.58846	Funston	Meas Sect		
CP 54	38.42632	-96.58840	B/Funston		N50ºE	
CP 55	38.42206	-96.57872	Crouse			
CP 56	38.43424	-96.58985	Threemile			
CP 57	38.44715	-96.59450	B/Threemile			
CP 58	38.44359	-96.59387	B/Threemile			
CP 59	38.44213	-96.59444	B/Threemile			
CP 60	38.44162	-96.59568	Funston			
CP 61	38.43697	-96.59722	B/Threemile			

CP 62	38.44757	-96.56392	B/Crouse			
CP 63	38.44508	-96.56447	T/Middleburg			
CP 64	38.44505	-96.56826	T/Middleburg			
CP 65	38.44624	-96.56870	B/Crouse			
CP 66	38.45031	-96.56850	Funston			
CP 67a	38.44873	-96.57514	T/Crouse	Meas Sect		
CP 67b	38.44931	-96.57571	B/Funston	Meas Sect		
CP 67c	38.44994	-96.57653	B/Funston	Meas Sect		
CP 68	38.44636	-96.57390	B/Crouse			
CP 69	38.44351	-96.57479	B/Crouse	Meas Sect	N53ºE	N18ºE, 5ºE
CP 70	38.44356	-96.56797	T/Eiss	Meas Sect		
CP 71	38.44092	-96.56674	T/Eiss	Meas Sect		
CP 72	38.43933	-96.58075	Schroyer			
CP 73	38.45257	-96.59357	T/Threemile			
CP 74	38.45353	-96.59356	B/Schroyer			
CP 75	38.45530	-96.59522	Kinney			N82ºW,11ºN
CP 76	38.45600	-96.59360	T/Schroyer			
CP 77	38.45850	-96.59138	T/Kinney			
CP 78	38.45568	-96.59137	Kinney			
CP 79	38.44991	-96.58645	T/Kinney			
CP 80	38.44998	-96.58377	T/Threemile			
CP 81	38.45005	-96.58168	B/Threemile			
CP 82	38.45087	-96.57954	Funston			
CP 83	38.45845	-96.58587	T/Threemile	Meas Sect		
CP 84	38.45928	-96.58808	Kinney			
CP 85	38.45907	-96.58177	B/Threemile			
CP 86	38.45941	-96.57958	Funston			

Control Pt.	Lat. (GPS)	Long. (GPS)	Contact	Graphic	Joints	Strike & Dip
CP 87	38.46037	-96.57655	Funston	Meas Sect		
CP 88	38.46021	-96.57531	T/Crouse	Meas Sect		
CP 89	38.45876	-96.57835	B/Threemile			
CP 90	38.45833	-96.57761	Funston			
CP 91	38.46202	-96.57345	B/Crouse	Meas Sect		
CP 92	38.46217	-96.57107	B/Middleburg	Meas Sect		
CP 93	38.46220	-96.56365	T/Morrill	Meas Sect		
CP 94	38.46087	-96.55955	B/Morrill			

CP 95	38.45593	-96.56486	Middleburg			
CP 96	38.45582	-96.56692	Crouse			
CP 97	38.46085	-96.56655	T/Eiss			
CP 98	38.46597	-96.58935	T/Threemile			
CP 99	38.46526	-96.58518	B/Threemile			
CP 100	38.46250	-96.57647	B/Crouse	Meas Sect	N55ºE	
CP 101	38.46437	-96.57060	B/Eiss			
CP 102	38.46427	-96.57189	T/Eiss	Meas Sect		N35ºW, 2ºS
CP 103	38.46756	-96.57363	B/Easly Ck ls			
CP 104	38.46728	-96.57686	B/Easly Ck ls		N34ºE	
CP 105	38.46904	-96.57743	B/Crouse			
CP 106	38.46842	-96.57971	T/Crouse			
CP 107	38.46910	-96.58152	B/Funston			
CP 108	38.46985	-96.58815	B/Threemile			
CP 109	38.47076	-96.59196	B/Kinney			
CP 110	38.47087	-96.58650	B/Threemile	Meas Sect		
CP 111	38.47279	-96.58826	T/Threemile	Meas Sect		
CP 112	38.47379	-96.58896	Schroyer	Meas Sect		
CP 113	38.47446	-96.58958	Schroyer			
CP 114	38.47671	-96.59047	B/Kinney	Meas Sect		
CP 115	38.47745	-96.59024	T/Kinney	Meas Sect		
CP 116	38.46791	-96.59438	T/Kinney	Meas Sect		
CP 117	38.46099	-96.59694	Kinney		N55ºE	
CP 118	38.46158	-96.59303	B/Kinney			
CP 119	38.47102	-96.57842	T/Crouse			
CP 120	38.47340	-96.57905	B/Funston			
CP 121	38.47752	-96.58331	B/Threemile			
CP 122	38.47841	-96.58479	T/Threemile			
CP 123	38.47635	-96.57985	B/Threemile			
CP 124	38.47469	-96.57203	B/Funston	Meas Sect		
CP 125	38.47371	-96.57148	T/Crouse			
CP 126	38.47281	-96.56988	T/Easly Ck ls	Meas Sect		
CP 127	38.47234	-96.56861	T/Middleburg			
CP 128	38.47218	-96.56755	T/Eiss			
CP 129	38.47714	-96.56927	B/Crouse			
CP 130	38.48300	-96.57237	B/Crouse			

CP 131	38.48190	-96.57224	T/Crouse			
CP 132	38.47996	-96.57334	B/Funston	Meas Sect		
CP 133	38.48184	-96.57749	T/Funston			
CP 134	38.48169	-96.57979	B/Threemile			

Control Pt.	Lat. (GPS)	Long. (GPS)	Contact	Graphic	Joints	Strike & Dip
CP 135	38.48881	-96.56846	T/Crouse			
CP 136	38.48903	-96.57870	B/Crouse			
CP 137	38.48736	-96.58450	T/Funston			
CP 138	38.49126	-96.58336	T/Funston			
CP 139	38.49046	-96.59136	B/Threemile			
CP 140	38.48797	-96.59130	B/Threemile			
CP 141	38.48599	-96.59159	B/Threemile			
CP 142	38.48433	-96.59105	B/Threemile			
CP 143	38.48292	-96.58928	T/Threemile			
CP 144	38.48135	-96.58851	T/Schroyer			
CP 145	38.48001	-96.58815	B/Kinney			
CP 146	38.47964	-96.59095	Blue Sp			
CP 147	38.49587	-96.56833	B/Funston			
CP 148	38.48997	-96.57379	T/Funston			
CP 149	38.49157	-96.56805	B/Crouse	Meas Sect		
CP 150	38.49159	-96.57814	B/Funston			
CP 151	38.49267	-96.58042	Funston			
CP 152	38.49236	-96.58480	Funston			
CP 153	38.49193	-96.59519	B/Threemile			
CP 154	38.49293	-96.59431	B/Threemile			
CP 155	38.49187	-96.59746	B/Threemile			
CP 156	38.49432	-96.58355	B/Threemile			
CP 157	38.43694	-96.54820	T/Morrill			
CP 158	38.43603	-96.54839	B/Cottonwood			
CP 159	38.43586	-96.55503	B/Cottonwood			
CP 160	38.43735	-96.55419	B/Cottonwood	Meas Sect		
CP 161	38.41787	-96.55603	B/Morrill			
CP 162	38.41641	-96.55148	Cottonwood			
CP 163	38.41349	-96.55638	T/Eiss			
CP 164	38.40684	-96.55616	T/Eiss			
CP 165	38.40678	-96.55416	T/Eiss			

CP 166a	38.40848	-96.55385	T/Cottonwood	Meas Sect		
CP 166b	38.40763	-96.55467	T/Morrill	Meas Sect		
CP 167	38.40222	-96.55194	T/Cottonwood			
CP 168	38.40226	-96.55282	Morrill			
CP 169	38.40307	-96.55423	T/Eiss			
CP 170	38.40033	-96.55973	B/Cottonwood			
CP 171	38.39879	-96.55124	T/Morrill	Meas Sect		
CP 172	38.40065	-96.54092	T/Cottonwood			
CP 173	38.40257	-96.54366	T/Cottonwood			
CP 174	38.40255	-96.54266	T/Morrill			
CP 175	38.41132	-96.54260	T/Morrill		N43ºE	
CP 176	38.41550	-96.54708	T/Eiss	Meas Sect		
CP 177	38.41534	-96.54811	T/Morrill	Meas Sect		
CP 178	38.41450	-96.54351	T/Easly Ck ls			
CP 179	38.41289	-96.54248	T/Eiss			
CP 180	38.40245	-96.53922	T/Morrill			
CP 181	38.40955	-96.54116	T/Eiss			

Control Pt.	**Lat. (GPS)**	**Long. (GPS)**	**Contact**	**Graphic**	**Joints**	**Strike & Dip**
CP 182	38.41667	-96.53872	B/Crouse			
CP 183	38.42310	-96.53915	B/Crouse			
CP 184	38.42185	-96.54180	B/Middleburg	Meas Sect		
CP 185	38.41976	-96.53913	B/Threemile			
CP 186	38.42203	-96.54424	T/Eiss			
CP 187	38.42098	-96.54481	T/Morrill			
CP 188	38.41953	-96.54435	T/Middleburg			
CP 189	38.41969	-96.54601	T/Morrill			
CP 190	38.41971	-96.54637	T/Cottonwood			
CP 191	38.41914	-96.54715	T/Cottonwood			
CP 192	38.40466	-96.53924	T/Eiss			
CP 193	38.40375	-96.53925	B/Eiss			
CP 194	38.43711	-96.54720	T/Eiss			
CP 195	38.43892	-96.53935	B/Threemile (est)			
CP 196	38.43837	-96.54431	B/Crouse (est)			
CP 197	38.43871	-96.54566	T/Middleburg			
CP 198	38.42400	-96.54832	T/Cottonwood			
CP 199	38.42667	-96.54846	T/Eiss			

CP 200	38.42780	-96.54789	T/Morrill	Meas Sect		
CP 201	38.42824	-96.54791	T/Cottonwood	Meas Sect		
CP 202	38.42846	-96.54649	T/Morrill			
CP 203	38.42728	-96.54487	T/Eiss			
CP 204	38.42703	-96.54330	B/Crouse			
CP 205	38.42880	-96.53985	B/Crouse			
CP 206	38.42953	-96.53941	T/Middleburg			
CP 207	38.43290	-96.53922	T/Eiss			
CP 208	38.43128	-96.54367	T/Morrill			
CP 209	38.42994	-96.54766	T/Cottonwood			
CP 210	38.43174	-96.54920	B/Cottonwood			
CP 211	38.40735	-96.53919	B/Easly Ck ls			
CP 212	38.40658	-96.53387	Easly Ck ls			
CP 213	38.40807	-96.53407	B/Crouse			
CP 214	38.40857	-96.53426	T/Crouse	Meas Sect		
CP 215	38.41021	-96.53373	Upper Funston			
CP 216	38.41082	-96.53320	B/Threemile			
CP 217	38.40799	-96.53124	T/Crouse			
CP 218	38.40705	-96.53119	B/Crouse			
CP 219	38.40665	-96.53165	Easly Ck ls		N75ºW	
CP 220	38.40624	-96.52914	B/Crouse			
CP 221	38.40581	-96.52651	Upper Funston			
CP 222	38.40762	-96.52753	B/Funston			
CP 223	38.41001	-96.52370	B/Schroyer			
CP 224	38.41313	-96.52984	B/Funston			
CP 225	38.41391	-96.53071	B/Crouse			
CP 226	38.41333	-96.53440	B/Crouse			
CP 227	38.41328	-96.53648	T/Eiss			
CP 228	38.41440	-96.53525	B/Middleburg			
CP 229	38.41571	-96.53321	B/Easly Ck ls	Meas Sect		

Control Pt.	**Lat. (GPS)**	**Long. (GPS)**	**Contact**	**Graphic**	**Joints**	**Strike & Dip**
CP 230	38.41674	-96.53165	Easly Ck ls			
CP 231	38.41739	-96.53127	B/Crouse			
CP 232	38.41860	-96.52988	T/Crouse			
CP 233	38.41963	-96.53005	B/Funston			
CP 234	38.41653	-96.53548	B/Crouse			

CP 235	38.41514	-96.53464	T/Middleburg	
CP 236	38.41417	-96.52461	B/Threemile (est)	
CP 237	38.41479	-96.52435	T/Threemile (est)	
CP 238	38.41519	-96.52429	B/Schroyer (est)	
CP 239	38.41531	-96.52341	T/Schroyer	
CP 240	38.41376	-96.52620	T/Funston (est)	
CP 241	38.41481	-96.52987	B/Funston	
CP 242	38.41759	-96.52688	B/Threemile (est)	
CP 243	38.42067	-96.51054	B/Crouse	
CP 244	38.42052	-96.50865	T/Middleburg	Meas Sect
CP 245	38.41798	-96.50576	T/Eiss	
CP 246	38.41777	-96.50643	T/Middleburg	
CP 247	38.41197	-96.50606	B/Middleburg	
CP 248	38.41430	-96.50892	B/Crouse	
CP 249	38.41552	-96.51073	B/Funston	
CP 250	38.41190	-96.50898	Easly Ck ls	Meas Sect
CP 251	38.41160	-96.51058	B/Crouse	Meas Sect
CP 252	38.41112	-96.51103	T/Crouse	Meas Sect
CP 253	38.41020	-96.51134	B/Funston	
CP 254	38.41198	-96.51385	B/Funston	Meas Sect
CP 255	38.41442	-96.51414	B/Funston	
CP 256	38.41520	-96.51424	Near T/ Funston	
CP 257	38.41548	-96.51723	Near T/Funston	
CP 258	38.41667	-96.51927	B/Threemile	
CP 259	38.41165	-96.51802	Near T/Funston	
CP 260	38.41220	-96.52012	B/Threemile	
CP 261	38.41035	-96.50687	B/Crouse	
CP 262	38.40951	-96.50592	u. Funston	
CP 263	38.40683	-96.52199	Near T/Funston	
CP 264	38.40768	-96.51758	B/Funston	
CP 265	38.40886	-96.51878	B/Threemile	
CP 266	38.40888	-96.51656	T/Funston	
CP 267	38.40803	-96.51540	B/Funston	
CP 268a	38.39977	-96.52364	B/Funston	Meas Sect
CP 268b	38.39939	-96.52503	T/Funston	Meas Sect
CP 269	38.40712	-96.50310	B/Crouse	

CP 270	38.40744	-96.50476	B/Funston	
CP 271	38.42017	-96.50225	B/Crouse	
CP 272	38.41900	-96.50224	T/Middleburg	
CP 273	38.41835	-96.50228	T/Eiss	
CP 274	38.41175	-96.50226	B/Crouse	Meas Sect
CP 275	38.41032	-96.55746	B/Crouse	
USGS BM	38.43731	-96.55707	Box culvert	

Table from source map: Water-Bearing Units of the Tallgrass Prairie National Preserve

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