Ecological site HX074XY107
Clay Hills

Last updated: 10/04/2019
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General information

Approved. An approved ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model, enough information to identify the ecological site, and full documentation for all ecosystem states contained in the state and transition model.

MLRA notes

Major Land Resource Area (MLRA): 074X–Central Kansas Sandstone Hills

Major Land Resource Area (MLRA) 74, Central Kansas Sandstone Hills, is entirely located in Kansas. It makes up about 8,365 square miles (21,675 square kilometers). The city of Salina and the towns of Concordia, Junction City, McPherson, and Newton are in this MLRA. Interstate Highways 70 and 135 meet in Salina, and Interstate 35 crosses the southern part of this area. Wilson and Kanopolis State Parks are in this area. McConnell Air Force Base is in the southern part of the area.

Following are the various kinds of land use in this MLRA: Cropland--private, 52 percent; Grassland--private, 38 percent, Federal 2 percent; Forest--private, 3 percent; Urban development--private, 3 percent; Water--private, 1 percent; Other--private, 1 percent.

Most of MLRA 74 is in farms. More than one-half of the area is cropland. Winter wheat is the principal crop. Other small grains, grain sorghum, hay, and corn also are important crops. Some areas along the large rivers are irrigated. The crops grown in nonirrigated areas also are grown in irrigated areas, but more corn and less wheat are grown in the irrigated areas. More than one-third of the area supports native grasses grazed by cattle.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and tilth of the soils, and soil moisture management. The resource concerns on pasture and rangeland are the productivity, health, and vigor of plants and the spread of noxious and invasive species.

Conservation practices on cropland generally include high-residue crops in the cropping system; systems of crop residue management, such as no-till and mulch-till; a combination of terraces and grassed waterways; contour farming; contour stripcropping; conservation crop rotations; and nutrient management. Conservation practices on rangeland generally include prescribed grazing, brush management, management of upland wildlife habitat, proper distribution of watering facilities, and control of noxious and invasive plant species.

Classification relationships

Major Land Resource Area (MLRA): 074X–Central Kansas Sandstone Hills

Ecological site concept

The Clay Hills ecological site was formerly known as Clay Upland R074XY007KS. This site is made up of very deep to moderately deep, moderately well to well drained upland soils. This site has a loamy to silty surface (7 to 14 inches) over clayey subsoils and is non-calcareous to the surface. The clay content in the soil is approximately greater than 45 percent at depths less than 14 inches. Generally, the Clay Hills ecological site is located on uplands with a slope range of 0 to 40 percent.

Associated sites

HX074XY130	**Shallow Sandstone** The Shallow Sandstone sites sits adjacent to and in conjunction with the Clay Hills ecological site. This site is characterized by the Hedville soil, which is shallow to very shallow. Many areas of exposed sandstone rock are evident on the higher elevations. This soil formed in residuum weathered from noncalcareous sandstone. This site is found on uplands that are moderately to strongly sloping with a loamy surface layer that may be cobbly.
HX074XY115	**Loamy Hills** The Loamy Hills ecological site sits adjacent to and in conjunction with the Clay Hills ecological site. This site is made up of moderately deep to deep, moderately well to well drained upland soils. This site has fine-silty and loamy surface textures and is non-calcareous to the surface. Generally, the Loamy Hills ecological site is located on uplands with a slope range of 0 to 16 percent.

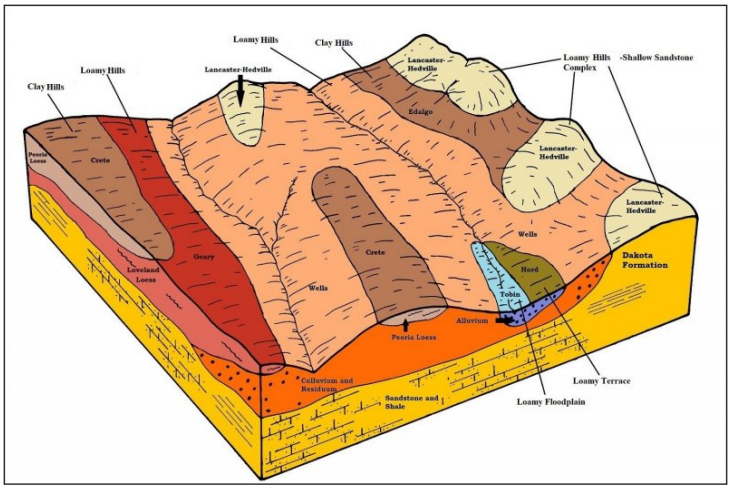


Figure 1. MLRA 74 ESD block diagram.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Andropogon gerardii* (2) *Schizachyrium scoparium*

Legacy ID

R074XY107KS

Physiographic features

The northwest half of MLRA 74 is in the Plains border section of the Great Plains Province of the Interior Plains. The northeast corner is in the Dissected Till Plains section of the Central Lowland Province of the Interior Plains, and the rest of the area is in the Osage Plains section of the same province and division. This area is an undulating to hilly, dissected plain. Wide flood plains and terraces are along the larger rivers, and narrow bottom land is along the small streams.
Elevation is generally 1,310 to 1,640 feet (400 to 500 meters), increasing from east to west. Local relief is typically 65 to 130 feet (20 to 40 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Smoky Hill (1026), 47 percent; Middle Arkansas (1103), 22 percent; Kansas (1027), 11 percent; Republican (1025), 10 percent; and Neosho-Verdigris (1107), 10 percent. The Little Arkansas River forms the southwestern border of this area. From north to south, other rivers that cross the area include the Little Blue, Big Blue, Republican, Solomon, Salt, Saline, Cottonwood, Walnut, and Arkansas Rivers. The Solomon and Saline Rivers join the Smoky Hill River just south of Salina.

The Clay Hills ecological site is situated on nearly level to steep uplands. The soils that make up this site are very deep to moderately deep, and located on uplands. Runoff is low or medium.

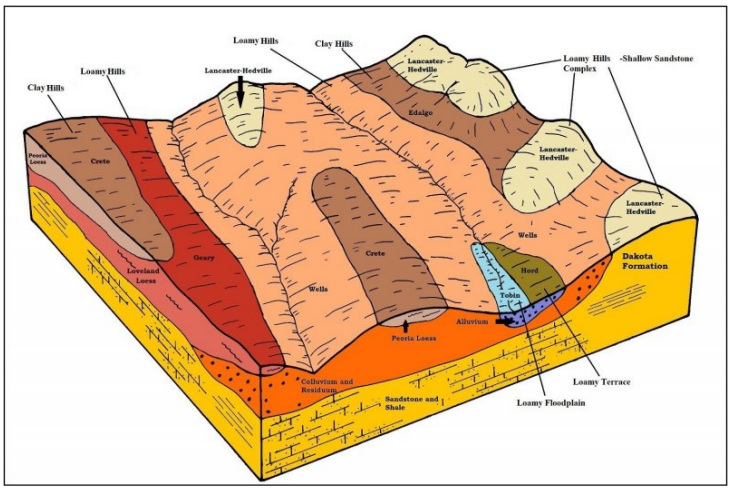


Figure 2. MLRA 74 ESD block diagram.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Shoulder (3) Backslope
Landforms	(1) Upland
Runoff class	Low to high
Elevation	1,300–1,640 ft
Slope	0–40%
Aspect	Aspect is not a significant factor

Climatic features

The average annual precipitation in MLRA 74 is 27 to 34 inches (680 to 860 millimeters). Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The maximum precipitation occurs from the middle of spring to early in autumn. The annual snowfall averages 20 inches (50 centimeters). The average annual temperature is 54 to 57 degrees F (12 to 14 degrees C). The freeze-free period averages 185 days. Precipitation is usually evenly distributed throughout the year with the exception of November through February as the driest months and May and June as the wettest months. Summer precipitation occurs during intense summer thunderstorms. The following weather data originated from weather stations chosen across the geographical extent of the ecological site, and will likely vary from the data for the entire MLRA. The climate data from this narrative and from the tables below derives from the Natural Resources Conservation Service (NRCS) National Water and Climate Center. The dataset is from 1981-2010. The climate data
from the geographical extent of the ecological site could be different from the MLRA 74 data. The following climate stations listed are used to calculate the data for this ecological site.

Table 3. Representative climatic features

Frost-free period (characteristic range)	149-154 days
Freeze-free period (characteristic range)	178-191 days
Precipitation total (characteristic range)	29-32 in
Frost-free period (actual range)	145-157 days
Freeze-free period (actual range)	175-193 days
Precipitation total (actual range)	28-33 in

Frost-free period (average)	152 days
Freeze-free period (average)	185 days
Precipitation total (average)	31 in

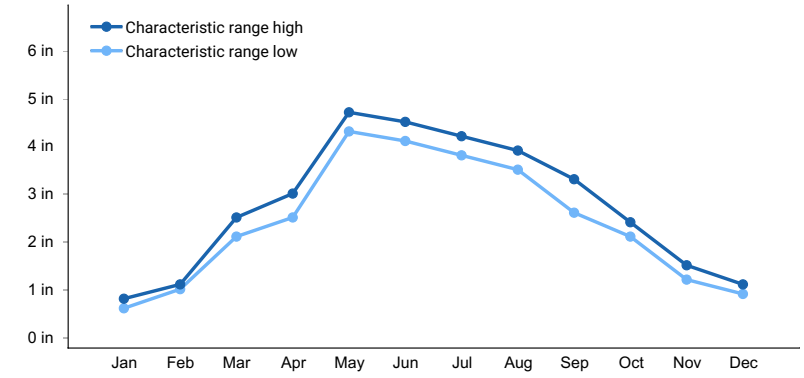


Figure 3. Monthly precipitation range

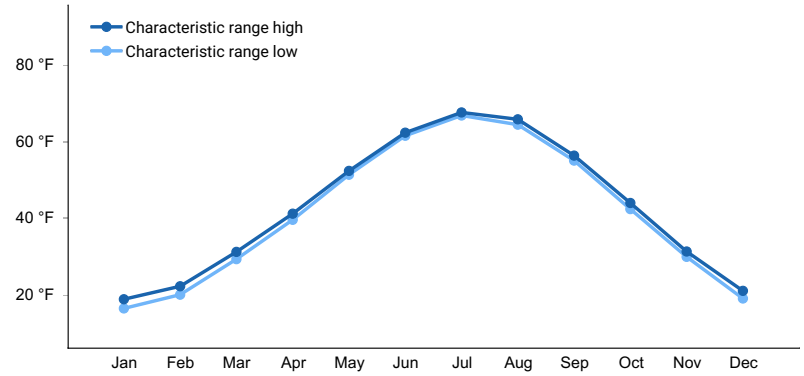


Figure 4. Monthly minimum temperature range

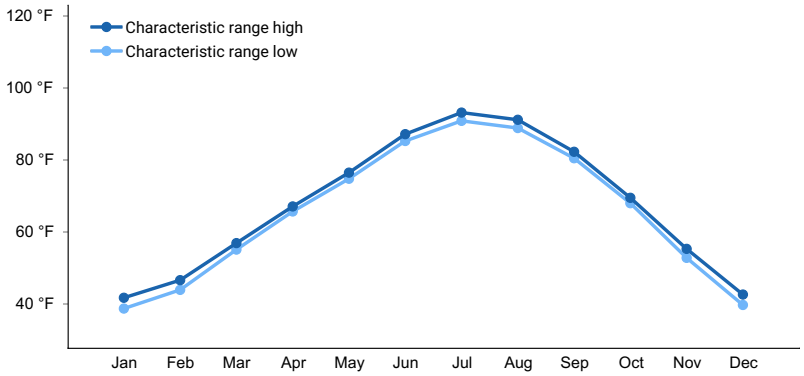


Figure 5. Monthly maximum temperature range

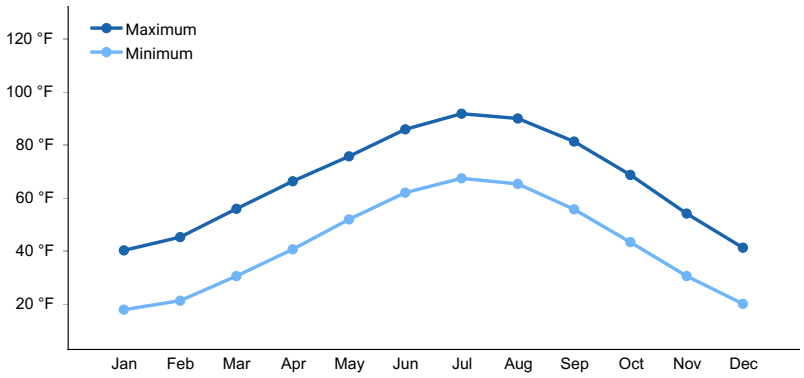


Figure 6. Monthly average minimum and maximum temperature

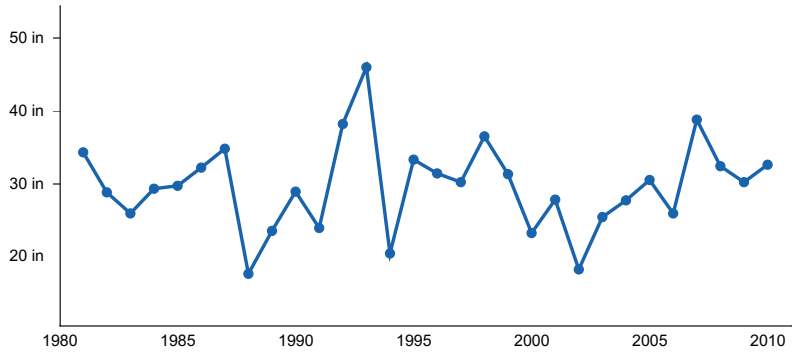


Figure 7. Annual precipitation pattern

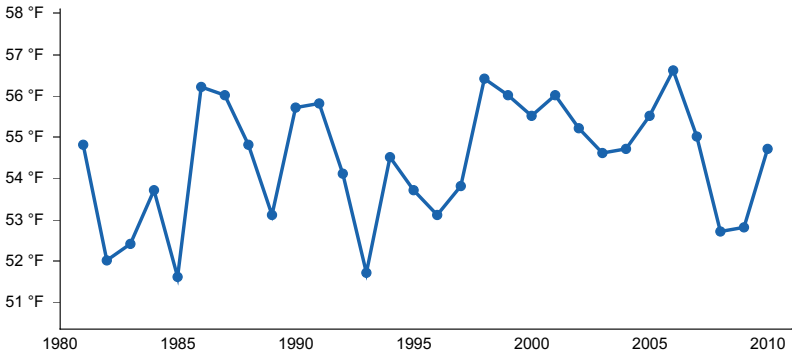


Figure 8. Annual average temperature pattern

Climate stations used

- (1) WASHINGTON [USC00148578], Washington, KS
- (2) CONCORDIA MUNI AP [USW00013984], Concordia, KS
- (3) CONCORDIA 1 W [USC00141761], Concordia, KS
- (4) CLAY CTR [USC00141559], Clay Center, KS
- (5) MINNEAPOLIS [USC00145363], Minneapolis, KS
- (6) SALINA MUNI AP [USW00003919], Salina, KS
- (7) SMOLAN 1NE [USC00147551], Lindsborg, KS
- (8) KANOPOLIS LAKE [USC00144178], Ellsworth, KS
- (9) MCPHERSON [USC00145152], McPherson, KS

Influencing water features

Soils on the Clay Hills ecological site range from moderately well to well drained, have very slow to slow permeability, and a high available water capacity. Erosion on this site by wind and water is a hazard if the vegetation is severely overgrazed or mismanaged. This site can retain large amounts of water which is tightly held by clay particles. Consequently, water is not available during dry cycles for plant growth, adding stress to the plants. These dry cycles decrease total annual forage production.

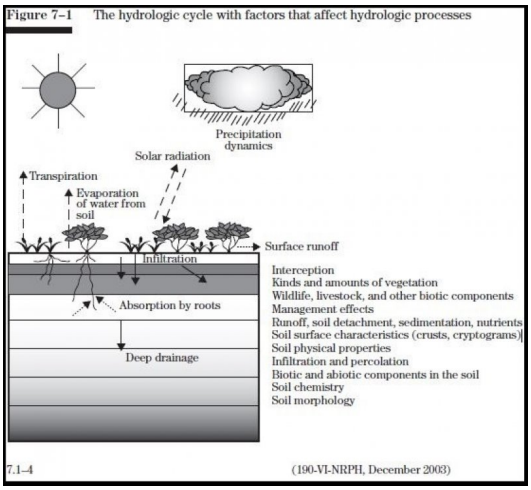
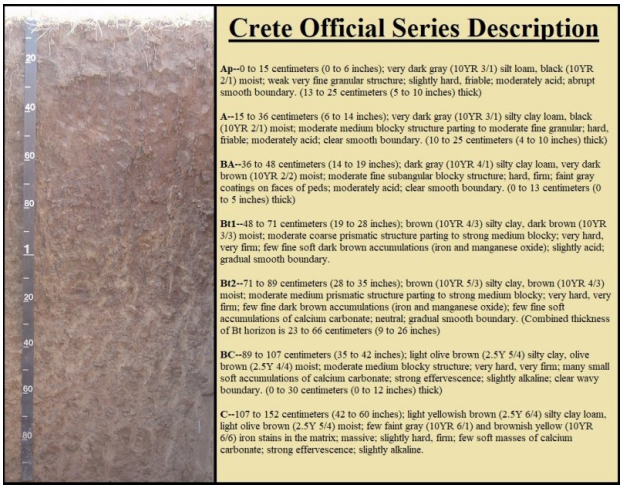


Figure 9. Fig. 7-1 from the National Range and Pasture Handbook.

Soil features

The soils representing Clay Hills ecological site are Crete and Edalgo. These are moderately deep to very deep upland soils with loamy to silty surfaces (7 to 14 inches) over clayey subsoils. These soils are moderately well to well drained and are usually noncalcareous in the surface layer. Some soils may be calcareous in the subsoil and substratum. Soil moisture is tightly held and generally unavailable for plant growth during dry stress periods.



Crete Official Series Description

Ap--0 to 15 centimeters (0 to 6 inches); very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; weak very fine granular structure; slightly hard, friable; moderately acid; abrupt smooth boundary. (13 to 25 centimeters (5 to 10 inches) thick)

A--15 to 36 centimeters (6 to 14 inches); very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate medium blocky structure parting to moderate fine granular; hard, friable; moderately acid; clear smooth boundary. (10 to 25 centimeters (4 to 10 inches) thick)

BA--36 to 48 centimeters (14 to 19 inches); dark gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) moist; moderate fine subangular blocky structure; hard, firm; faint gray coatings on faces of peds; moderately acid; clear smooth boundary. (0 to 13 centimeters (0 to 5 inches) thick)

Bt1--48 to 71 centimeters (19 to 28 inches); brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; moderate coarse prismatic structure parting to strong medium blocky; very hard, very firm; few fine soft dark brown accumulations (iron and manganese oxide); slightly acid; gradual smooth boundary.

Bt2--71 to 89 centimeters (28 to 35 inches); brown (10YR 5/3) silty clay, brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong medium blocky; very hard, very firm; few fine dark brown accumulations (iron and manganese oxide); few fine soft accumulations of calcium carbonate; neutral; gradual smooth boundary. (Combined thickness of Bt horizon is 23 to 66 centimeters (9 to 26 inches)

BC--89 to 107 centimeters (35 to 42 inches); light olive brown (2.5Y 5/4) silty clay, olive brown (2.5Y 4/4) moist; moderate medium blocky structure; very hard, very firm; many small soft accumulations of calcium carbonate; strong effervescence; slightly alkaline; clear wavy boundary. (0 to 30 centimeters (0 to 12 inches) thick)

C--107 to 152 centimeters (42 to 60 inches); light yellowish brown (2.5Y 6/4) silty clay loam, light olive brown (2.5Y 5/4) moist; few faint gray (10YR 6/1) and brownish yellow (10YR 6/6) iron stains in the matrix; massive; slightly hard, firm; few soft masses of calcium carbonate; strong effervescence; slightly alkaline.

Figure 10. Crete soil series profile and description located in MLRA 74.

Table 4. Representative soil features

Parent material	(1) Loess (2) Residuum–shale
Surface texture	(1) Silt loam (2) Silty clay loam (3) Loam
Family particle size	(1) Fine
Drainage class	Well drained to moderately well drained
Permeability class	Slow to very slow
Soil depth	20–80 in
Surface fragment cover <=3"	0–8%
Available water capacity (0-40in)	3.8–11.5 in

Calcium carbonate equivalent (0-40in)	0–5%
Clay content (Depth not specified)	35–59%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	5.1–8.4

Ecological dynamics

The Clay Hills ecological site in MLRA 74 consists of dynamic plant communities resulting from the complex interaction of many ecological factors and processes. The vegetation evolved on moderately deep to very deep, moderately well drained to somewhat excessively drained, loamy or clayey soils under a diverse, fluctuating climate. Plants were historically grazed by herds of large herbivores and periodically subjected to intense wildfires.

The original plant community developed with fires of various intensities and frequencies during different seasons of the year playing an important part in ecological processes. Historically, wildfires started by lightning often occurred in spring and early summer months when thunderstorms were prevalent, but also in late summer and fall during dry weather periods. It is also recognized that early Native Americans often used fire to attract herds of migratory herbivores, especially bison.

The dominant tall grasses were rhizomatous, enabling them to survive the ravages of even intense wildfires and thus gain a competitive advantage in the plant community. In contrast, most trees and shrubs were suppressed by fire and occurred only sparsely on protected areas. Growth of perennial forbs, and especially legumes, were usually enhanced following a fire event. After an intense fire there was usually a substantial, but short-term, increase in the abundance of annual forbs as well.

Grazing history had a major impact on the dynamics of the site. The vegetative community developed under a grazing regime that consisted primarily of periodic grazing by large herds of bison. As the herds moved through an area, grazing was probably intense. When herds moved to adjacent areas, grazed vegetation was afforded an extended period of rest and recovery during the growing season. Other grazing and feeding animals such as elk, pronghorns, deer, rabbits, insects, and numerous burrowing rodents had secondary influences on plant community development.

Variations in climate, especially a pattern of annual late summer drought and long-term drought cycles spanning several years, also had a major impact upon plant community development. Species composition fluctuated according to the duration and severity of long-term droughts. During prolonged dry cycles, many of the weaker, shallow-rooted plants died and production of deeper-rooted plants significantly decreased. When sufficient rainfall occurred following an extended dry period, annual forbs and grasses would temporarily occur in abundance. When precipitation returned to normal or above-normal, the deeper-rooted grasses and forbs responded and returned to their production potentials.

Typically, growth of warm-season grasses in MLRA 74 begins during the period of May 1 to May 15 and continues until mid-September. Generally, 70 percent of total production is completed by mid-July. This varies only slightly from year to year, depending upon temperature and precipitation patterns. Cool-season grasses generally have two short growing periods, one in the fall (September and October) and again in the spring (April, May, and June).

As European settlers began utilizing the area for production of domestic livestock within fenced pastures in place of roaming bison herds, the ecological dynamics and physical aspects were altered, and the plant community shifted from its original composition. These changes were usually in proportion to the season and intensity of the use by livestock and were accelerated by a combination of drought and overgrazing. Taller grasses and forbs more palatable to bison were similarly selected and consumed by cattle and horses. Those palatable species were repeatedly grazed throughout the growing season, thus weakening them. Over time, they were gradually replaced

by the increase and spread of less palatable species. Where the history of overuse by domestic livestock was more intense, even the plants that initially increased were often replaced by less desirable and lower-producing plants. In some instances, production and plant diversity was reduced to a mixture of mid- and shortgrasses, annual grasses, and unpalatable forbs.

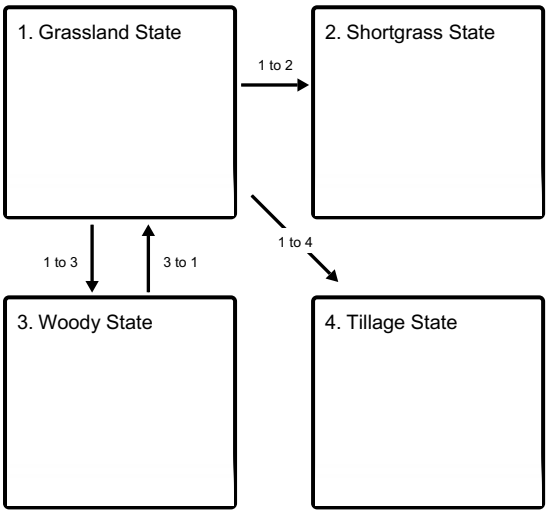
The frequency and role that fires played in maintaining the plant community was reduced with the advent of roads, cultivated fields, and fire suppression techniques developed by European settlers. Use of prescribed fire as a management tool has also diminished in some localities, especially surrounding population centers. In the absence of periodic, intense fire, there has often been a gradual increase in woody species. In some areas, shrubs and trees have encroached to the point of being the dominant influence in the plant community.

The gently rolling topography of this ecological site was attractive to European settlers who sought to create agrarian lifestyles. Some areas of this site were brought under cultivation and used to grow wheat, corn, sorghum, and other crops. Tillage and crop production caused the destruction of the original native plant community and often major degradation of the inherent structure and fertility of the surface soil layer. Many acres that were formerly used for cultivated crops have been reseeded or allowed to re-vegetate through natural succession.

The following diagram illustrates some of the pathways that the vegetation on this site may take from the Reference Plant Community as influencing ecological factors change. There may be other states or plant communities not shown on the diagram, as well as noticeable variations within those illustrated.

State and transition model

Ecosystem states



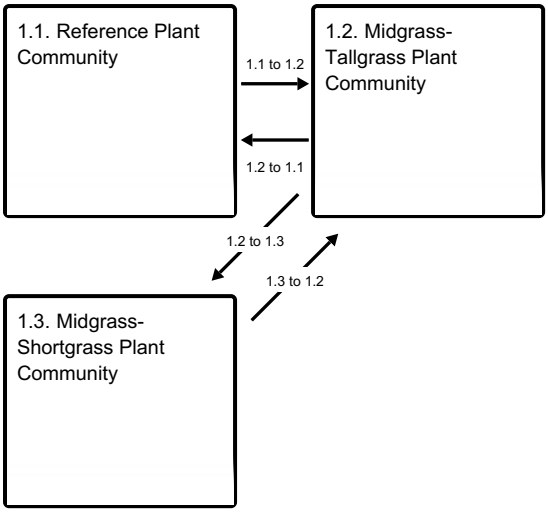
1 to 2 - Long-term, heavy, continuous overgrazing, no rest and recovery

1 to 3 - Lack of fire and brush control

1 to 4 - Tillage by machinery

3 to 1 - Prescribed grazing, brush management, and prescribed burning

State 1 submodel, plant communities



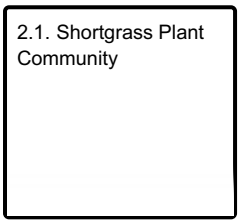
1.1 to 1.2 - Heavy, continuous grazing without adequate rest and recovery

1.2 to 1.1 - Prescribed grazing that incorporates periods of deferment during the growing season

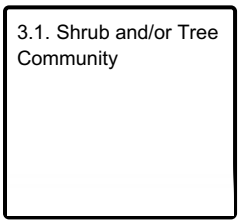
1.2 to 1.3 - Long-term (greater than 20 years) continuous grazing with no rest and no recovery

1.3 to 1.2 - Prescribed grazing with adequate rest and recovery period during the growing season

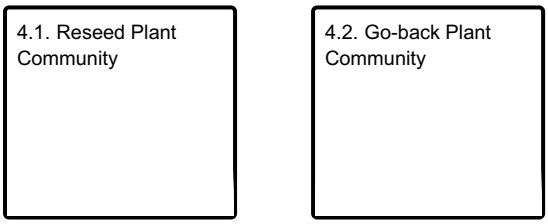
State 2 submodel, plant communities



State 3 submodel, plant communities



State 4 submodel, plant communities



State 1
Grassland State

The Grassland State defines the ecological potential and natural range of variability resulting from the natural disturbance regime of the Clay Hills ecological site. This state is supported by empirical data, historical data, local expertise, and photographs. It is defined by a suite of native plant communities that are a result of periodic fire, drought, and grazing. These events are part of the natural disturbance regime and climatic process. The Reference Plant Community consists of warm-season tall- and midgrasses, cool-season, and sod-forming grasses, forbs, and shrubs. The Midgrass/Tallgrass Plant Community is made up primarily of warm-season midgrasses, with an interspersed cool-season component and decreasing amounts of forbs and tallgrasses. The Midgrass-Shortgrass Plant Community is dominated by midgrasses, shortgrasses, and cool-season midgrasses.

Characteristics and indicators. Tallgrasses and Midgrasses are dominant in the Grassland State.

Resilience management. Management strategies that will sustain this State include monitoring key forage species and providing a forage and animal balance.

Community 1.1
Reference Plant Community

Figure 11. MLRA 74 Reference Plant Community.

The interpretive plant community for this site is the Reference Plant Community, and represents the original community that existed prior to European settlement. The site is characterized as a grassland essentially free of trees and large shrubs. It is dominated by tall, warm-season grasses including big bluestem, switchgrass, and Indiangrass. The major midgrass is little bluestem. Combined, these grasses will account for 65 to 75 percent of vegetation produced annually. Other prevalent midgrasses are sideoats grama, western wheatgrass, Canada wildrye, and composite dropseed. Scattered throughout are minor amounts of shortgrasses consisting of blue grama and buffalograss. The Reference Plant Community supports a wide variety of legume species, which are interspersed throughout the grass sward. The most abundant are groundplum milkvetch, violet prairie clover, slimflower scurfpea, and prairie bundleflower. Slimflower scurfpea may dominate the aspect of this site in late spring and early summer before it matures and breaks off at ground level to be rolled away by the wind. Other important forbs include Maximilian sunflower, dotted blazing star, upright prairie coneflower, Missouri goldenrod, and pitcher sage. Leadplant and Jersey tea are low-growing shrubs that occur over the site. Unlike most shrubs, these plants are both quite tolerant to fire. Occasional clumps of smooth and fragrant sumac may be found on exposures with steeper-sloped exposures where they partially escape the effects of intense fires. Growth of warm-season grasses on this site typically begins during the period of May 1 to May 15 and continues until mid September. As a general rule, 75 percent of total production is completed by mid-July. This varies only slightly from year to year depending upon temperature and precipitation patterns. There are exceptions as big bluestem will occasionally initiate spring growth in early April following mild winter temperatures. Also, it is not unusual for other warm-season grasses such as Indiangrass and little bluestem to have some new leaf growth arising from basal buds in late October following moderate fall temperatures. Cool-season grasses, sedges and rushes generally have two primary growth periods, one in the spring (March through early June) and again in the fall (September and October). Some growth may occur in winter months during periods of unseasonably mild temperatures.

Resilience management. This is a stable plant community when grazing and fire are adequately managed. A prescribed grazing program that incorporates periods of deferment during the growing season benefits the tallgrasses and even the more palatable forb species. Excessive grazing and livestock trailing can quickly impact soil stability and lead to sheet and gully erosion. Because this site often occurs on ridgetops and other high elevations on the landscape, it is preferred by grazing animals during the hot days of late summer to gain relief from heat and insects. Concentrated livestock use, such as winter feeding areas, can cause compaction of the wet, clay soils and stress the dominant tallgrasses.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- switchgrass (*Panicum virgatum*), grass

- Indiangrass (*Sorghastrum nutans*), grass
- composite dropseed (*Sporobolus compositus var. compositus*), grass

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	2200	3080	4400
Forb	250	350	500
Shrub/Vine	50	70	100
Total	**2500**	**3500**	**5000**

Community 1.2
Midgrass-Tallgrass Plant Community

Figure 13. Midgrass/Tallgrass Plant Community in MLRA 74.

This plant community developed as a result of many years of repeated, heavy grazing. Midgrasses dominate the site and comprise 40 to 50 percent of the annual production. Most abundant midgrasses include little bluestem, sideoats grama, western wheatgrass, composite dropseed, and purple lovegrass. Although tallgrasses have been reduced to a secondary component, they still contribute 20 to 35 percent of the total herbage production and maintain a visible presence in the community aspect. Shortgrasses such as blue grama, bufflograss, tumble windmillgrass, fall witchgrass, and prairie threeawn produce 10 to 15 percent of the vegetation. Forb production is quite variable and may range from 5 to 25 percent of the total vegetation depending upon frequency of fire and amounts and timing of rainfall events. Perennial forbs include white sagebrush, slimflower scrurfpea, Missouri goldenrod, Baldwin ironweed, white heath aster, and Cuman ragweed. In some locations shrubs and trees such as smooth sumac, fragrant sumac, coralberry, and eastern red cedar comprise up to 10 percent of the vegetation.

Resilience management. Although little bluestem is the predominant species, big bluestem, Indiangrass, and switchgrass plants with reduced vigor and stature are commonly found throughout the site. This plant community is relatively stable under long-term grazing unless negatively impacted by additional stresses like extended drought and extreme grazing pressure. While switchgrass may initially increase with heavy grazing on this site, it will eventually decrease along with big bluestem and Indiangrass. Unprotected plants are usually grazed repeatedly and remain in a low state of vigor. Of these remnants, big bluestem is generally the most abundant, having rhizomes that can persist for many years in a weakened condition. In this stage, new growth will emerge as three to five prostrate leaves, which provide partial relief from grazing. These tallgrass remnants respond favorably to periods of rest from grazing and may regain enough vigor to produce viable seed heads with two to three years of careful grazing management. Prescribed grazing with adequate rest and recovery periods during the growing season will shift this plant community to include more productive tallgrasses. With continued management the taller grasses will gradually increase in vigor and abundance to dominate the landscape.

Dominant plant species

- little bluestem (*Schizachyrium scoparium*), grass

- sideoats grama (*Bouteloua curtipendula*), grass
- western wheatgrass (*Pascopyrum smithii*), grass
- composite dropseed (*Sporobolus compositus var. compositus*), grass
- purple lovegrass (*Eragrostis spectabilis*), grass

Community 1.3
Midgrass-Shortgrass Plant Community

This plant community developed as a result of long-term, heavy, continuous overgrazing. Midgrasses dominate the site and comprise 40 to 55 percent of the annual production. Most abundant midgrasses include little bluestem, sideoats grama, western wheatgrass, and composite dropseed. Shortgrasses such as blue grama, hairy grama, buffalograss, tumble windmillgrass, fall witchgrass, and purple threeawn produce 20 to 30 percent of the vegetation. Forb production is quite variable and may range from 10 to 30 percent of the total vegetation depending upon amounts and timing of rainfall events. Perennial forbs include white sagebrush, slimflower scurfpea, Missouri goldenrod, Baldwin ironweed, white heath aster, and Cuman ragweed. In some locations shrubs and trees such as fragrant sumac, eastern red cedar, and coralberry comprise up to 15 percent of the vegetation.

Resilience management. Remnant plants of big bluestem, Indiangrass, and switchgrass are only found in protected locations. These plants are usually grazed repeatedly and remain in a low state of health and vigor. Of these remnants, big bluestem is generally the most abundant. It has rhizomes that can persist for many years in a weakened condition. When in this state of vigor, new growth consisting of three to five leaves will emerge in a prostrate position rather than upright. This allows the plants to partially escape grazing. These remnant plants respond favorably to periods of rest from grazing and may regain vigor in two to three years. However, their numbers or percentage of composition is greatly reduced and it may take many years to regain a large role in the plant community. Prescribed grazing with adequate rest and recovery periods during the growing season will shift this plant community to include more productive tallgrasses. With continued management the taller grasses will gradually increase in vigor and abundance to dominate the landscape.

Dominant plant species

- little bluestem (*Schizachyrium scoparium*), grass
- sideoats grama (*Bouteloua curtipendula*), grass
- western wheatgrass (*Pascopyrum smithii*), grass
- composite dropseed (*Sporobolus compositus var. compositus*), grass
- blue grama (*Bouteloua gracilis*), grass
- buffalograss (*Bouteloua dactyloides*), grass

Pathway 1.1 to 1.2
Community 1.1 to 1.2

Reference Plant Community

Midgrass-Tallgrass Plant Community

These mechanisms include management controlled by repetitive heavy use, no rest or recovery of the key forage species, and no forage and animal balance for many extended grazing seasons. This type of management lasting for periods greater than 10 years will shift functional and structural plant group dominance toward a Midgrass Plant Community.

Context dependence. Plant community composition shifts from tallgrass- to midgrass-dominant.

Pathway 1.2 to 1.1
Community 1.2 to 1.1

Midgrass-Tallgrass Plant Community

Reference Plant Community

Causes of plant community shift include management (10-15 years) with adequate rest and recovery of the key forage species (big bluestem, switchgrass, Indiangrass, and little bluestem) within the Reference Plant Community . If woody species are present, prescription fires every 6-8 years will be necessary for their removal and maintenance.

Conservation practices

Prescribed Burning
Prescribed Grazing

Pathway 1.2 to 1.3
Community 1.2 to 1.3

These mechanisms include management controlled by repetitive heavy use, no rest or recovery of the key forage species and no forage and animal balance for many extended grazing seasons. This type of management lasting for periods greater than 20 years will shift functional and structural plant group dominance toward a Midgrass-Shortgrass Plant Community.

Pathway 1.3 to 1.2
Community 1.3 to 1.2

Causes of plant community shift include management (10-15 years) with adequate rest and recovery of the key forage species (little bluestem, sideoats grama, big bluestem, switchgrass, and Indiangrass) within the Midgrass/Tallgrass Plant Community . If woody species are present, prescription fires every 6-8 years will be necessary for their removal and maintenance.

Conservation practices

Prescribed Burning
Prescribed Grazing

State 2
Shortgrass State

With heavy, continuous grazing, blue grama and buffalograss will become the dominant species and have a sod-bound appearance. Unable to withstand the grazing pressure, only a remnant population of western wheatgrass remains.

Characteristics and indicators. The Shortgrass State is characterized with specific dynamic soil property changes. Changes between the Grassland State and the Shortgrass State have been documented. As plant community cover decreases from bunchgrasses to more of the sod grasses there is a decrease in infiltration and interception and an increase in surface runoff (Thurow T., 2003).

Resilience management. This is a resistant and resilient state. Grazing management practice should include a forage and animal balance.

Dominant plant species

- blue grama (*Bouteloua gracilis*), grass
- buffalograss (*Bouteloua dactyloides*), grass

Community 2.1
Shortgrass Plant Community

Figure 14. MLRA 74 Shortgrass Plant Community.

This plant community presents a distinctive shortgrass aspect on the landscape. It is dominated by blue grama and buffalograss with notable amounts of western wheatgrass and sideoats grama present in a state of low vigor and productivity. Other grasses include Japanese brome, cheatgrass, composite dropseed, silver beardgrass, Kentucky bluegrass, prairie threeawn, fall witchgrass, and tumble windmillgrass. These species commonly account for 70 to 80 percent of the annual forage production. Like the desirable grasses, palatable legumes and other forbs have been reduced by continuous heavy grazing and competition over many years. Prevalent broadleaf species in this situation include annual ragweed, white sagebrush, Cuman ragweed, Baldwin ironweed, wavyleaf thistle, and curlycup gumweed. Forbs may comprise 20 to 30 percent of the total vegetation.

Resilience management. Recovery of the tallgrasses, midgrasses, and associated forb characteristics of the Reference Plant Community will require many years of careful management that includes prescribed grazing and extended periods of rest during the growing season. If remnant stands of the desired species are not present or located nearby as seed sources for reestablishment, interseeding measures may be necessary to create pioneer colonies for seed dispersal throughout the community. Prescribed burning can be a useful tool if used strategically to benefit the desired species, especially in the later stages of the recovery process.

Dominant plant species

- blue grama (*Bouteloua gracilis*), grass
- buffalograss (*Bouteloua dactyloides*), grass

State 3
Woody State

This state is dominated by a shrub and/or tree plant community. The increase and spread of shrubs and trees results from an absence of fire. Woody plants can increase up to 34 percent from a lack of fire according to a study from 1937 to 1969, in contrast to a 1 percent increase on burned areas (Bragg and Hulbert, 1976). Periodic burning will hinder the establishment of most woody species and favor forbs and grasses. However, it should be pointed out that not all unburned areas have a woody plant invasion. Birds, small mammals, and livestock are instrumental in the distribution of seed and accelerating the spread of most trees and shrubs common to this site. The speed of encroachment varies considerably and can occur on both grazed and non-grazed pastures. Many species of wildlife, especially bobwhite quail, turkey, and white-tailed deer benefit from the growth of trees and shrubs for both food and cover. When management for specific wildlife populations is desirable, these options should be considered in any brush management plan.

Characteristics and indicators. Hydrologic function is affected by the amount of vegetative cover. Canopy interception loss can vary from 25.4 percent to 36.7 percent (Thurow and Hester, 1997). A small rainfall event is usually retained in the foliage and does not reach the litter layer at the base of the tree. Only when canopy storage is reached and exceeded does precipitation fall to the soil surface. Interception losses associated with the accumulation of leaves, twigs, and branches at the bases of trees are considerably higher than losses associated

with the canopy. The decomposed material retains approximately 40 percent of the water that is not retained in the canopy (Thurow and Hester, 1997). Soil properties affected include biological activity, infiltration rates, and soil fertility.

Resilience management. Special planning will be necessary to assure that sufficient amounts of fine fuel are available to carry fires with enough intensity to control woody species. In some locations the use of chemicals as a brush management tool may be desirable to initiate and accelerate this transition.

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- honeylocust (*Gleditsia triacanthos*), tree
- Osage-orange (*Maclura pomifera*), tree
- coralberry (*Symphoricarpos orbiculatus*), shrub
- fragrant sumac (*Rhus aromatica var. serotina*), shrub
- smooth sumac (*Rhus glabra*), shrub

Community 3.1
Shrub and/or Tree Community

This plant community is dominated by shrubs consisting primarily of coralberry, fragrant sumac, and smooth sumac. Trees including osage orange, honeylocust, and eastern redcedar are common invaders that become established in some areas. Coralberry is generally the most abundant shrub and often forms low, dense thickets throughout the site. Shrubs and trees may produce 40 to 60 percent of the total vegetation. The spread of shrubs and trees results from the absence of fire. Periodic burning tends to hinder the establishment of most of these woody species and favor grass and forb species. However, not all unburned areas have a woody plant problem. The speed of woody encroachment varies considerably, depending on seed availability in surrounding areas. Numerous birds are instrumental in the distribution of seed and accelerating the spread of shrub and tree species over the site. Woody encroachment may also occur on areas subjected to longtime continuous overgrazing. In these situations the associated grasses will usually consist of composite dropseed, purple lovegrass, Kentucky bluegrass, smooth bromegrass, and Scribner's rosette grass. Shrubs and trees will also invade areas where both grazing and fire have been excluded for many years. Heavy accumulation of plant mulch and litter retards herbage growth and provides a favorable habitat for seed germination and establishment of many woody species. The associated grasses in this situation are usually big bluestem, little bluestem, Indiangrass, switchgrass, sedges, and Canada wildrye. Grass production is significantly reduced by competition from forbs and woody species. Grass yields vary from 40 to 50 percent of the total vegetative production. Forbs often produce 5 to 20 percent of the total. Major forbs include white sagebrush, Cuman ragweed, Baldwin ironweed, and common yarrow. In this plant community, the amount of available forage is heavily dependent upon the predominant woody species and the kind(s) of livestock and/or wildlife utilizing the site. Usually a prescribed burning program accompanied with prescribed grazing will gradually return the plant community to one dominated by grasses and forbs. Longer periods will be needed where the tall and midgrasses have been greatly reduced or eliminated. Special planning will be necessary to assure that sufficient amounts of fine fuel are available for carrying the intensive fires necessary to control woody species. Use of labeled herbicides as a brush management tool will usually be necessary to reduce populations of fire resistant species like osage orange and honeylocust and accelerate the recovery of desired vegetative cover. Many species of wildlife, especially bobwhite quail and whitetail deer, benefit from the growth of shrubs for both food and as cover. When wildlife populations are a desirable component, this should be considered in any brush management plans.

Resilience management. The shrub and tree plant community is sustained by the absence of fire and brush control.

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- honeylocust (*Gleditsia triacanthos*), tree
- Osage-orange (*Maclura pomifera*), tree
- smooth sumac (*Rhus glabra*), shrub
- fragrant sumac (*Rhus aromatica*), shrub
- coralberry (*Symphoricarpos orbiculatus*), shrub

State 4
Tillage State

Extensive areas of the historic Clay Hills plant communities were plowed and converted to production of cultivated crops by the early European settlers and subsequent generations. In addition to destroying the original plant community, repeated tillage commonly resulted in major changes in soil conditions. Reductions in organic matter, mineral levels, soil structure, oxygen levels, and water holding capacity, along with increased runoff/erosion and shifts in the populations of soil-dwelling organisms, were common on these sites. The extent of these changes depended upon duration of cropping as well as crops grown and other management practices. The Tillage State consists of abandoned cropland that has been naturally revegetated (go-back) or planted/seeded to grassland. Many reseeded plant communities were planted with a local seeding mix under the Conservation Reserve Program (CRP) or were planted to a monoculture of sideoats grama. Go-back communities are difficult to define due to the variability of plant communities that can exist. Many of these communities are represented by the genus Aristida (threeawns).

Characteristics and indicators. This is an alternative state since the energy, hydrologic, and nutrient cycles are altered to that of the Reference State in its natural disturbance regime. Bulk density, aggregate stability, soil structure, and plant functional and structural groups are not fully restored to that of the Reference State. Mechanical tillage can destroy soil aggregation. Soil aggregates are an example of dynamic soil property change. Aggregate stability is critical for infiltration, root growth, and resistance to water and wind erosion (Brady and Weil, 2008).

Resilience management. This state is a result of a land use management decision.

Community 4.1
Reseed Plant Community

This plant community occurs on areas that were formerly farmed and reseeded with a mixture of native species common in the Reference Plant Community. Most seeding mixtures consisted of a blend of grasses that include sand bluestem, Indiangrass, switchgrass, little bluestem, sideoats grama, blue grama, and western wheatgrass. In some locations, seed of legumes and forbs such as prairie bundleflower and Maximilian sunflower were included in the mixture. Once these areas become fully established, production is comparable to that of the Reference Plant Community. Total annual production ranges varies according to the species planted, established plants, and years of establishment. When reseeded areas and areas supporting native rangeland exist in the same pasture, they seldom are utilized at the same intensity because domestic livestock usually prefer plants growing on the native rangeland areas. When feasible, reseeded plant communities should be managed as separate pastures or units. Some seeded areas are invaded by trees and shrubs during the establishment period of the desired plants. These invader species commonly include elm, common hackberry, eastern redcedar, and eastern cottonwood. Occasional burning is effective in controlling establishment of these woody plants.

Resilience management. Following termination of cultivation, total annual production is quite variable and full recovery of the original plant community, including forbs and legumes, may take many decades. Additions of organic matter and minerals, deferred grazing, prescribed burning, and related management practices described earlier for this ecological site can be beneficial to the rehabilitation.

Community 4.2
Go-back Plant Community

This plant community also occurs on areas that were formerly farmed. When tillage operations ceased, the areas were allowed to revegetate or “go back” naturally in contrast to artificial reseeding to a selected species or group of species. The go-back process is a slow, gradual transformation that requires many years and many successional changes or stages in the plant community. The speed and extent of revegetation depends on the size of the area, level of grazing management and the proximity of the area to existing seed sources. In the initial stages of revegetation the site is usually dominated by annual forbs such as annual ragweed, slender snakecotton, Canadian horseweed, prairie sunflower, common sunflower, Mexican fireweed, camphorweed, and annual buckwheat. Gradually these are replaced by annual grasses including prairie threeawn, mat sandbur, tumblegrass, little barley, cheatgrass, and witchgrass. As plant succession progresses the plant community gradually becomes dominated by perennials. The major grasses include sand dropseed, composite dropseed, thin paspalum, purple lovegrass, red lovegrass, Scribner’s rosette grass, Carolina crabgrass, silver beardgrass, smooth bomegrass, kentucky bluegrass,

and tumble windmillgrass. Common forbs are Cuman ragweed, white sagebrush, Carruth's sagewort, white heath aster, Missouri goldenrod, and sand milkweed. Combinations of these plants can form a stable community. In time with prescribed grazing management, other perennial grasses and forbs common in the Reference Plant Community return to the site. Blue grama is a shortgrass that is very common to the native plant communities on this site. However, it seldom occurs in go-back communities, even after 40 to 50 years of plant succession. Some go-back areas are invaded by trees and shrubs. The more common include elm, common hackberry, eastern redcedar, eastern cottonwood, osage orange, honeylocust, and roughleaf dogwood. Occasional burning is effective in controlling these woody plants. Total annual production varies by site. This depends on seasonal precipitation and the stage of plant succession in the plant community.

Resilience management. Following termination of cultivation, total annual production is quite variable and full recovery of the original plant community, including forbs and legumes, may take many decades. Additions of organic matter and minerals, deferred grazing, prescribed burning, and related management practices described earlier for this ecological site can be beneficial to the rehabilitation.

Transition 1 to 2
State 1 to 2

Long-term management (approximately 30 years) without a forage and animal balance and heavy, continuous grazing without adequate recovery periods between grazing events will convert the Grassland State to a Shortgrass State made up of blue grama and buffalograss sod. Drought in combination with this type of management will quicken the rate at which this transition occurs.

Constraints to recovery. The ecological processes affected are the hydrologic and nutrient cycles. There is an increase in evaporation rate, runoff, and in bulk density. There is a decrease in infiltration, a change in plant composition, and the functional and structural groups have changed dominance. These are all examples of the soil and vegetation properties that have compromised the resilience of the Grassland State and therefore transitioned to a Shortgrass State.

Transition 1 to 3
State 1 to 3

Changes from a Grassland State to a Woody State lead to changes in hydrologic function, forage production, dominant functional and structural groups, and wildlife habitat. Understory plants may be negatively affected by trees and shrubs by reductions in light, soil moisture, and soil nutrients. Increases in tree and shrub density and size have the effects of reducing understory plant cover and productivity, and desirable forage grasses often are most severely reduced (Eddleman, 1983). As vegetation cover changes from grasses to trees, a greater proportion of precipitation is lost throughout interception and evaporation; therefore, less precipitation is available for producing herbaceous forage or for deep drainage or runoff (Thurow and Hester, 1997).

Constraints to recovery. Recovery is possible through management.

Transition 1 to 4
State 1 to 4

This transition is triggered by a management action as opposed to a natural event. Tillage, or breaking the ground with machinery for crop production, will move the Grassland State to a Tillage State.

Constraints to recovery. The resilience of the Reference State has been compromised by the fracturing and blending of the native virgin sod. The energy, hydrologic, and nutrient cycles are altered and vary from that of the Grassland State.

Restoration pathway 3 to 1
State 3 to 1

Restoration efforts will be costly, labor-intensive, and can take many years, if not decades, to return to a Grassland State. Once canopy levels reach greater than 20 percent, estimated cost to remove trees is very expensive and includes high energy inputs. The technologies needed in order to go from an invaded Woody State to a Grassland

State include but are not limited to: prescribed burning— the use of fire as a tool to achieve a management objective on a predetermined area under conditions where the intensity and extent of the fire are controlled; brush management—manipulating woody plant cover to obtain desired quantities and types of woody cover and/or to reduce competition with herbaceous understory vegetation, in accordance with overall resource management objectives; and prescribed grazing—the controlled harvest of vegetation with grazing or browsing animals managed with the intent to achieve a specified objective. In addition, to grazing at an intensity that will maintain enough cover to protect the soil and maintain or improve the quantity and quality of desirable vegetation. When a juniper tree is cut and removed, the soil structure and the associated high infiltration rate may be maintained for over a decade (Hester, 1996). This explains why the area near the dripline usually has substantially greater forage production for many years after the tree has been cut. It also explains why runoff will not necessarily dramatically increase once juniper is removed. Rather, the water continues to infiltrate at high rates into soils previously ameliorated by junipers, thereby increasing deep drainage potential. In rangeland, deep drainage amounts can be 16 percent of the total rainfall amount per year (Thurow and Hester, 1997).

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Tallgrass dominant 60%**			1000–2100	
	big bluestem	ANGE	*Andropogon gerardii*	800–1225	–
	switchgrass	PAVI2	*Panicum virgatum*	200–525	–
	Indiangrass	SONU2	*Sorghastrum nutans*	150–350	–
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	50–175	–
2	**Midgrasses subdominant 20%**			300–700	
	little bluestem	SCSC	*Schizachyrium scoparium*	250–525	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	150–350	–
	purple lovegrass	ERSP	*Eragrostis spectabilis*	0–30	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	0–30	–
3	**Shortgrasses minor 3%**			25–105	
	blue grama	BOGR2	*Bouteloua gracilis*	50–150	–
	hairy grama	BOHI2	*Bouteloua hirsuta*	0–25	–
	buffalograss	BODA2	*Bouteloua dactyloides*	0–25	–
4	**Cool-season grasses minor 5%**			45–175	
	western wheatgrass	PASM	*Pascopyrum smithii*	25–175	–
	Canada wildrye	ELCA4	*Elymus canadensis*	10–25	–
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	0–25	–
	sedge	CAREX	*Carex*	10–25	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–25	–
Forb					
5	**Forbs minor 10%**			110–350	
	American licorice	GLLE3	*Glycyrrhiza lepidota*	5–25	–

	American licorice	GLLE3	*Glycyrrhiza lepidota*	5–25	
	Nuttall's sensitive-briar	MINU6	*Mimosa nuttallii*	5–25	–
	groundplum milkvetch	ASCR2	*Astragalus crassicarpus*	5–25	–
	Illinois bundleflower	DEIL	*Desmanthus illinoensis*	5–25	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	5–25	–
	pitcher sage	SAAZG	*Salvia azurea var. grandiflora*	5–25	–
	Baldwin's ironweed	VEBA	*Vernonia baldwinii*	5–25	–
	Missouri goldenrod	SOMI2	*Solidago missouriensis*	5–25	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	5–25	–
	compassplant	SILA3	*Silphium laciniatum*	5–25	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–10	–
	hoary verbena	VEST	*Verbena stricta*	0–10	–
	common yarrow	ACMI2	*Achillea millefolium*	0–10	–
	white heath aster	SYER	*Symphyotrichum ericoides*	0–10	–
	Carolina larkspur	DECAV2	*Delphinium carolinianum ssp. virescens*	0–10	–
	prairie groundsel	PAPL12	*Packera plattensis*	0–10	–
	stiff goldenrod	OLRI	*Oligoneuron rigidum*	0–10	–
	blue wild indigo	BAAU	*Baptisia australis*	0–10	–
	dotted blazing star	LIPU	*Liatris punctata*	0–10	–
	green antelopehorn	ASVI2	*Asclepias viridis*	0–10	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–10	–
	slimflower scurfpea	PSTE5	*Psoralidium tenuiflorum*	0–10	–
	aromatic aster	SYOB	*Symphyotrichum oblongifolium*	0–10	–
Shrub/Vine					
6	**Shrubs trace 2%**			30–70	
	leadplant	AMCA6	*Amorpha canescens*	20–60	–
	Jersey tea	CEHE	*Ceanothus herbaceus*	10–30	–

Animal community

Wildlife

This site is good prairie wildlife habitat when maintained in the Grassland State. It provides nesting sites for a number of ground-nesting bird species including eastern and western meadowlarks, and the upland sandpiper. The greater prairie chicken often uses this site for booming grounds or leks, where the males carry out their courtship displays, a truly unique spring prairie ritual.

Big-game animals such as white-tailed deer, pronghorn, and the bison historically used this site commonly for grazing. The Clay Hills and associated sites were favored by bison for “wallows” or depressions where they would roll in the dust or mud, as the season dictated, to try and rid themselves of flies and gnats that were a constant nuisance on the prairie. These depressions can still be seen on the prairie landscape.

Many small mammals, reptiles, and amphibians are found on this site as well. Larger predators such as the coyote are attracted by these smaller animals as are avian predators such as hawks and owls.

Some animals are important because of their threatened and endangered status and require special consideration. Please check the Kansas Department of Wildlife and Parks and Tourism (KDWPT) website at www.ksoutdoors.com for the most current listing for your county.

Grazing Interpretations

Calculating Safe Stocking Rates: Proper stocking rates should be incorporated into a grazing management strategy that protects the resource, maintains or improves rangeland health, and is consistent with management objectives. In addition to usable forage, safe stocking rates should consider ecological condition, trend of the site, past grazing use history, season of use, stock density, kind and class of livestock, forage digestibility, forage nutritional value, variation of harvest efficiency based on preference of plant species, and/or grazing system, and site grazeability factors (such as steep slopes, site inaccessibility, or distance to drinking water).

Often the current plant community does not entirely match any particular Community Phase as described in this Ecological Site Description. Because of this, a resource inventory is necessary to document plant composition and production. Proper interpretation of inventory data will permit the establishment of a safe initial stocking rate.

No two years have exactly the same weather conditions. For this reason, year-to-year and season-to-season fluctuations in forage production are to be expected on grazing lands. Livestock producers must make timely adjustments in the numbers of animals or in the length of grazing periods to avoid overuse of forage plants when production is unfavorable, and to make advantageous adjustments when forage supplies are above average.

Initial stocking rates should be improved through the use of vegetation monitoring and actual use records that include number and type of livestock, the timing and duration of grazing, and utilization levels. Actual use records over time will assist in making stocking rate adjustments based on the variability factors.

Average annual production must be measured or estimated to properly assess useable forage production and stocking rates.

Hydrological functions

Following are the estimated withdrawals of freshwater by use in MLRA 74:
Public supply—surface water, 6.6%; ground water, 5.7%; Livestock —surface water, 0.3%; ground water, 4.2%; Irrigation—surface water, 70.8%; ground water, 0.5%; Other—surface water, 12.0%; ground water, 0.0%

The total withdrawals average 210 million gallons per day (795 million liters per day). About 10 percent is from ground water sources, and 90 percent is from surface water sources. If moisture is carefully conserved, the moderate precipitation generally is adequate for crops and pasture. The surface water is generally suitable for most uses with appropriate treatment. Water is stored in reservoirs outside this area for public supply, industry, and irrigation within this area. Some in-stream diversions also are used.

Recreational uses

This site provides opportunities for a variety of outdoor activities which might include bird watching, hiking, outdoor and wildlife photography, and hunting. A wide variety of plants are in bloom throughout the growing season, especially in those years with average and above rainfall, and they provide much aesthetic appeal to the landscape. This site is subject to sheet erosion when mismanaged.

Wood products

This site generally does not produce trees of sufficient size for commercial harvest.

Other products

None.

Other information

Because of its landscape setting, this site is attractive to many for home sites and other developments. However, the high clay content (high shrink-swell potential) of these soils can create foundation problems and severely limit their suitability for septic systems and access roads.

Site Development and Testing Plan

This site went through the approval process.

Inventory data references

Information presented here has been derived from NRCS clipping data, numerous ocular estimates and other inventory data. Field observations from experienced range-trained personnel was used extensively to develop this ecological site description.

NRCS contracted the development of MLRA 79 ESDs in 2005. Extensive review and improvements were made to those foundational ESDs in 2017-2018, which provided an approved product.

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Approval

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

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Contact for lead author	State Rangeland Management Specialist for Kansas.
Date	10/03/2019

Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** No natural rill formation common or part of the Clay Hills ecological site.

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2. **Presence of water flow patterns:** There are no water flow patterns evidenced by litter, soil, or gravel redistribution, or pedestalling of vegetation or stones that break the flow of water as a result of overland flow.

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3. **Number and height of erosional pedestals or terracettes:** There is no evidence of pedestals or terracettes that would indicate the movement of soil by water and/or by wind on this site.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Less than 5% bare ground is found on this site. It is the remaining ground cover after accounting for ground surface covered by vegetation (basal and canopy [foliar] cover), litter, standing dead vegetation, gravel/rock, and visible biological crust (e.g., lichen, mosses, algae).

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5. **Number of gullies and erosion associated with gullies:** No evidence of accelerated water flow resulting in downcutting of the soil.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** No wind-scoured or blowout areas where the finer particles of the topsoil have blown away, sometimes leaving residual gravel, rock, or exposed roots on the soil surface. Also, there are no areas of redeposited soil onto this site from another site due to the wind, i.e., depositional areas.

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7. **Amount of litter movement (describe size and distance expected to travel):** No evidence of litter movement (i.e., dead plant material that is in contact with the soil surface).

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil surfaces may be stabilized by soil organic matter which has been fully incorporated into aggregates at the soil surface, adhesion of decomposing organic matter to the soil surface, and biological crusts. A soil stability kit will score a range from 5-6.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Crete OSD:
   Ap--0 to 15 centimeters (0 to 6 inches); very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; weak very fine granular structure; slightly hard, friable; moderately acid; abrupt smooth boundary. (13 to 25 centimeters (5 to 10 inches) thick)

A--15 to 36 centimeters (6 to 14 inches); very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate medium blocky structure parting to moderate fine granular; hard, friable; moderately acid; clear smooth boundary. (10 to 25 centimeters (4 to 10 inches) thick)

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Functional and structural groups are that of the Reference Plant Community (see functional and structural group worksheet). Note changes to plant communities if different than that of the functional and structural group worksheet.

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** There is no evidence of a compacted soil layer less than 6 inches from the soil surface. Soil structure is similar to that described in Indicator 9. Compacted physical features will include platy, blocky, dense soil structure over less dense soil layers, horizontal root growth, and increased bulk density (measured by weighing a known volume of oven-dry soil).

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12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant: Group 1 Tallgrass dominant 60% 2100 lbs. big bluestem 800-1225, switchgrass 200-525, Indiangrass 150-350, composite dropseed 50-175.

    Sub-dominant: Group 2 Midgrass subdominant 20% 700 lbs. little bluestem 250-525, sideoats grama 150-350, purple lovegrass 0-30, porcupinegrass 0-30.

    Other: Group 3 Shortgrass Minor 3% 105 lbs. blue grama 50-150, hairy grama 0-25, buffalograss 0-25.

    Additional: Group 4 cool-season grasses 5% 175 lbs. western wheatgrass 25-175, sedge 10-25, Canada wildrye 10-25, Scribner's rosette grass 0-25, prairie Junegrass 0-25
    Group 5 forbs minor 10% 350 lbs.
    Group 6 shrub trace 2% 70 lbs.

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Recruitment of plants is occurring and there is a mixture of many age classes of plants. The majority of the plants are alive and vigorous. Some mortality and decadence is expected for the site, due to drought, unexpected wildfire, or a combination of the two events. This would be expected for both dominant and subdominant groups.

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14. **Average percent litter cover (%) and depth (in):** Plant litter is distributed evenly throughout the site. There is no restriction to plant regeneration due to depth of litter. When prescribed burning is practiced, there will be little litter the first half of the growing season.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** All species (e.g., native, seeded, and weeds) alive in the year of the evaluation, are included in the determination of total above ground production. Site potential (total annual production) ranges from 2,500 lbs in a below-average rainfall year and 5,000 lbs in an above-average rainfall year. The representative value for this site is 3,500 lbs production per year.

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:** There are no noxious weeds present. Invasive plants make up a small percentage of plant community, and invasive brush species are < 5% canopy.

17. **Perennial plant reproductive capability:** The number and distribution of tillers or rhizomes is assessed on perennial plants occupying the evaluation area. No reduction in vigor or capability to produce seed or vegetative tillers given the constraints of climate and herbivory.