USDA Natural Resources Conservation Service

Ecological site R052XN086MT
Claypan (Cp) 10-14" p.z.

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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

Major Land Resource Area (MLRA): 052X–Brown Glaciated Plains

The Brown Glaciated Plains, MLRA 52, is an expansive, agriculturally and ecologically significant area. It consists of approximately 14.5 million acres and stretches across 350 miles from east to west, encompassing portions of 15 counties in north-central Montana. This region represents the southwestern limit of the Laurentide Ice Sheet and is considered to be the driest and westernmost area within the vast network of glacially derived prairie pothole landforms of the northern Great Plains. Elevation ranges from 2,000 feet (610 meters) to 4,600 feet (1,400 meters).

Soils are primarily Mollisols, but Entisols, Inceptisols, Alfisols, and Vertisols are also common. Till from continental glaciation is the predominant parent material, but alluvium and bedrock are also common. Till deposits are typically less than 50 feet thick, and in some areas glacially deformed bedrock occurs at or near the soil surface (Soller, 2001). Underlying sedimentary bedrock largely consisting of Cretaceous shale, sandstone, and mudstone (Vuke et al., 2007) is commonly exposed on hillslopes, particularly along drainageways. Significant alluvial deposits occur along glacial outwash channels and major drainages, including portions of the Missouri, Teton, Marias, Milk, and Frenchman Rivers. Large glacial lakes, particularly in the western half of the MLRA, deposited clayey and silty lacustrine sediments (Fullerton et al., 2013).

Much of the western portion of this MLRA was glaciated towards the end of the Wisconsin age, with the maximum glacial extent occurring approximately 20,000 years ago (Fullerton et al., 2004). The result is a geologically young landscape that is predominantly a level till plain interspersed with lake plains and dominated by soils in the Mollisol and Vertisol orders. These soils are very productive and generally are well suited to dryland farming. Much of this area is aridic-ustic. Crop-fallow dryland wheat farming is the predominant land use. Areas of rangeland typically are on steep hillslopes along drainages.

The rangeland, much of which is native mixedgrass prairie, increases in abundance in the eastern half of the MLRA. The Wisconsin-age till in the north-central part of this area typically formed large disintegration moraines with steep slopes and numerous poorly drained potholes. A large portion of Wisconsin-age till occurring on the type of the level terrain that would typically be optimal for farming has large amounts of less-suitable sodium-affected Natrustalfs. Significant portions of Blaine, Phillips, and Valley Counties were glaciated approximately 150,000 years ago during the Illinoisan age. Due to erosion and dissection of the landscape, many of these areas have steeper slopes and more exposed bedrock than areas glaciated during the Wisconsin age (Fullerton and Colton, 1986).

While much of the rangeland in the aridic-ustic portion of MLRA 52 is classified as belonging to the “dry grassland” climatic zone, sites in portions of southern MLRA 52 may belong to the “dry shrubland” climatic zone. The dry shrubland zone represents the northernmost extent of the big sagebrush (Artemisia tridentata) steppe on the Great Plains. Because similar soils occur in both southern and northern portions of the MLRA, it is currently hypothesized that climate is the primary driving factor affecting big sagebrush distribution in this area. However, the precise factors are not yet fully understood.

Sizeable tracts of largely unbroken rangeland in the eastern half of the MLRA and adjacent southern Saskatchewan

are home to the Northern Montana population of greater sage-grouse (Centrocercus urophasianus), and large portions of this area are considered to be a Priority Area for Conservation (PAC) by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service, 2013). This population is unique among sage grouse populations in the fact that many individuals overwinter in the big sagebrush steppe (dry shrubland) in the southern portion of the MLRA and then migrate to the northern portion of the MLRA, which lacks big sagebrush (dry grassland), to live the rest of the year (Smith, 2013).

Areas of the till plain near the Bearpaw and Highwood Mountains as well as the Sweetgrass Hills and Rocky Mountain foothills are at higher elevations, receive higher amounts of precipitation, and have a typic-ustic moisture regime. These areas have significantly more rangeland production than the drier aridic-ustic portions of the MLRA and have enough moisture to produce crops annually rather than just bi-annually, as in the drier areas. Ecological sites in this higher precipitation area are classified as the moist grassland climatic zone.

Classification relationships

NRCS Soil Geography Hierarchy
• Land Resource Region: Northern Great Plains
• Major Land Resource Area (MLRA): 052 Brown Glaciated Plains
• Climate Zone: Dry Shrubland

National Hierarchical Framework of Ecological Units (Cleland et al., 1997; McNab et al., 2007)
• Domain: Dry
• Division: Temperate Steppe
• Province: Great Plains-Palouse Dry Steppe Province 331
• Section: Northwestern Glaciated Plains 331D
• Subsection: Montana Glaciated Plains 331Dh
• Landtype Association/Landtype Phase: N/A

National Vegetation Classification Standard (Federal Geographic Data Committee, 2008)
• Class: Xeromorphic Woodland, Scrub and Herb Vegetation Class (3)
• Subclass: Cool Semi-Desert Scrub and Grassland Subclass (3.B)
• Formation: Cool Semi-Desert Scrub and Grassland Formation (3.B.1)
• Division: Cool Semi-Desert Scrub and Grassland Division (3.B.1.Ne)
• Macrogroup: Artemisia tridentata - Artemisia tripartita ssp. tripartita - Purshia tridentata Steppe and Shrubland Macrogroup (3.B.1.Ne.3)
• Group: Artemisia tridentata - Artemisia tripartita - Purshia tridentata Big Sagebrush Steppe and Shrubland Group (3.B.1.Ne.3.b)
• Alliance: Artemisia tridentata ssp. wyomingensis Mesic Steppe and Shrubland Alliance
• Association: Artemisia tridentata ssp. wyomingensis / Pascopyrum smithii Shrub Grassland

EPA Ecoregions
• Level 1: Great Plains (9)
• Level 2: West-Central Semi-Arid Prairies (9.3)
• Level 3: Northwestern Glaciated Plains (42)
• Level 4: North-Central Brown Glaciated Plains (42o) and Glaciated Northern Grasslands (42j)

Ecological site concept

The distinguishing characteristic of this site is the presence of a dense, sodium-affected (natric) horizon between depths of 5 to 10 inches from the surface. The natric horizon exhibits columnar structure, is very hard, and severely limits both root penetration and infiltration. Soil surface horizons (0 to 4 inches) are very fine sandy loam to loam, and the natric horizon is clay or clay loam. The root-restrictive natric horizon favors shallower-rooted rhizomatous species, such as western wheatgrass (Pascopyrum smithii), over deep-rooted bunchgrasses. Other common grasses include blue grama (Bouteloua gracilis), needle and thread (Hesperostipa comata), and Sandberg bluegrass (Poa secunda). The principal shrub on this site is Wyoming big sagebrush (Artemisia tridentata subsp. wyomingensis).

Associated sites

R052XN162MT	**Clayey (Cy) 10-14" p.z.** soils >20 inches in depth, higher production, and no hardpan, different species composition R052XC205MT R053AE061MT
R052XN176MT	**Shallow to Gravel (SwGr) 10-14" p.z.** similar position in landscape, soils with depth restriction that limits available moisture, soils 10-20” deep to sands or loamy sands R052XC216MT
R052XN179MT	**Shallow Clay (SwC) 10-14" p.z.** soils 10-20” deep to bedrock’ soils are clayey over clayey shale R052XC215MT R053AE078MT
R052XN172MT	**Dense Clay (DC) 10-14" p.z.** has less than 2” of soil over the hard argillic layer, more bare ground, and less production R052XC206MT R053AE073MT
R052XN170MT	**Saline Upland (SU) 10-14" p.z.** does not have a very hard layer near surface, plant community contains salt- tolerant species; R052XC210MT R053AE071MT

Similar sites

R052XC204MT	**Claypan (Cp) 10-14" p.z.** May have decrease in total annual production of bluebunch wheatgrass.
R053AE074MT	**Claypan (Cp) (Legacy) RRU 53AE** May have decrease in total annual production of bluebunch wheatgrass, and an increase in other wheatgrasses and/or needlegrass.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Atriplex nuttallii* (2) *Sarcobatus vermiculatus*
Herbaceous	(1) *Pascopyrum smithii* (2) *Sporobolus airoides*

Physiographic features

This ecological site occurs on level to sloping glaciated plains, stream terraces and fans. Slopes vary from 0-15%, but are usually less than 8%. This site occurs on all exposures. Elevations normally vary from 2000 to 4000 feet.

Table 2. Representative physiographic features

Landforms	(1) Terrace (2) Fan (3) Plain
Runoff class	Medium to very high
Flooding frequency	None
Ponding frequency	None
Elevation	2,000–4,000 ft
Slope	1–8%
Aspect	W, NW, N, NE, E, SE, S, SW

Table 3. Representative physiographic features (actual ranges)

Runoff class	Not specified
Flooding frequency	Not specified

Ponding frequency	Not specified
Elevation	1,875–4,800 ft
Slope	1–15%

Climatic features

A semi-arid, temperate climate characterizes the Glaciated Plains. The predominance of cool season species has evolved to take advantage of the precipitation regime that peaks in late spring-early summer (June). Seventy-five percent of the annual precipitation usually falls as steady, soaking, frontal system rains. Summer rains usually come with thunderstorms. Precipitation is the most important factor influencing production (Heitschmidt et al 2005). Severe drought occurs on average in two out of every ten years (Cooper, et al., 2001).

Table 4. Representative climatic features

Frost-free period (characteristic range)	85-123 days
Freeze-free period (characteristic range)	116-142 days
Precipitation total (characteristic range)	10-14 in
Frost-free period (average)	94 days
Freeze-free period (average)	125 days
Precipitation total (average)	12 in

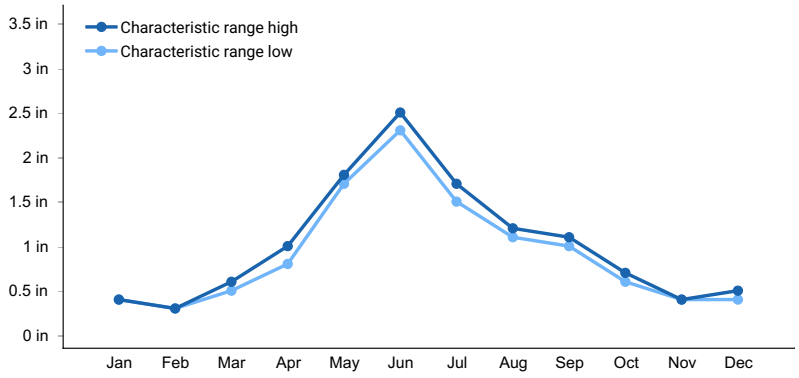


Figure 1. Monthly precipitation range

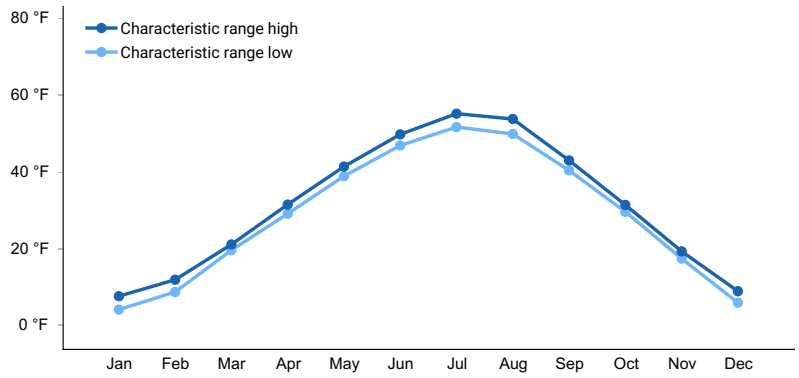


Figure 2. Monthly minimum temperature range

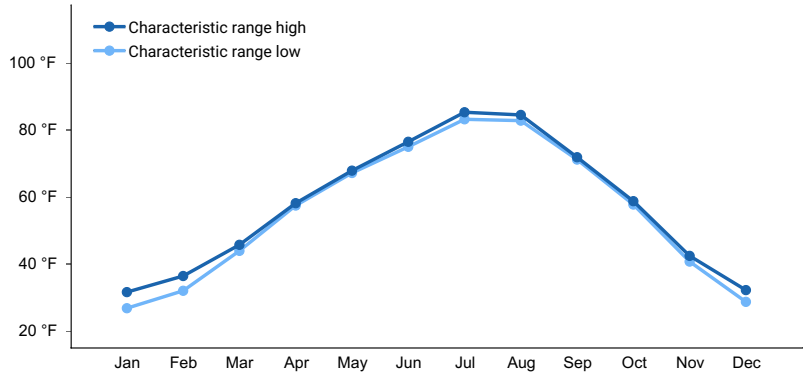


Figure 3. Monthly maximum temperature range

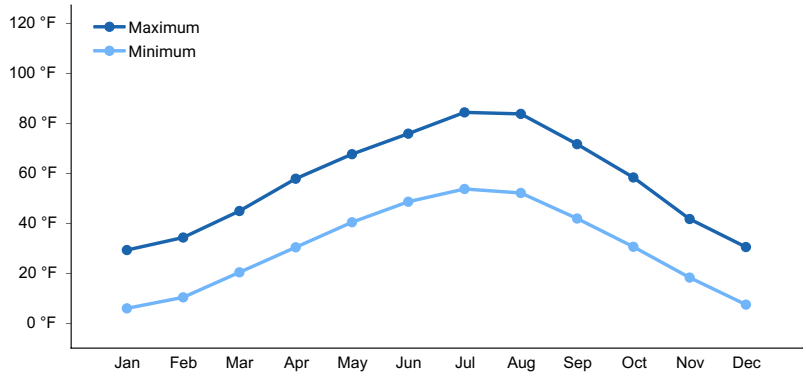


Figure 4. Monthly average minimum and maximum temperature

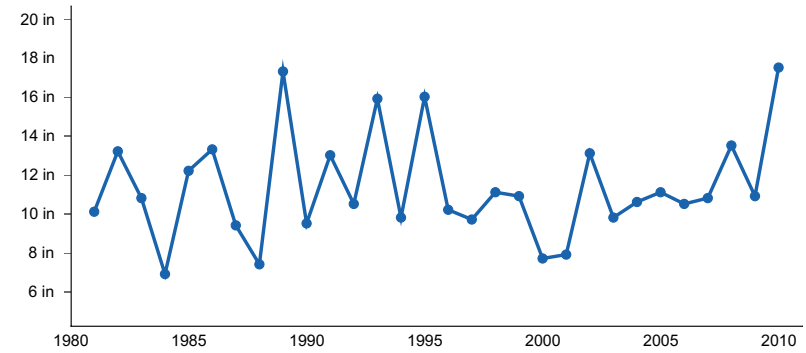


Figure 5. Annual precipitation pattern

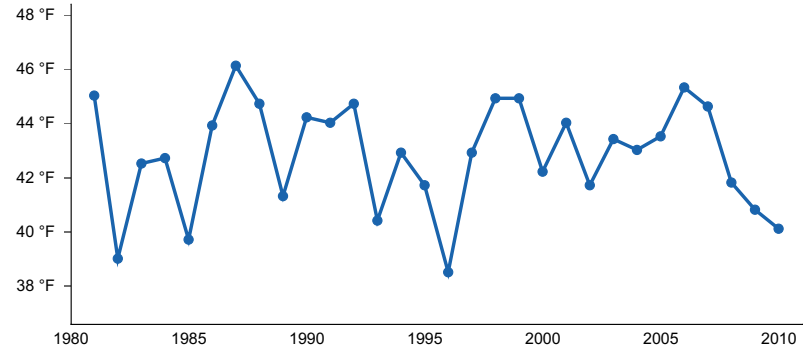


Figure 6. Annual average temperature pattern

Climate stations used

- (1) CHESTER [USC00241692], Chester, MT
- (2) HAVRE CITY CO AP [USW00094012], Havre, MT
- (3) SHELBY [USC00247500], Shelby, MT

- (4) GLASGOW [USW00094008], Glasgow, MT

Influencing water features

This site is not influenced by water from streams.

Wetland description

This site is not influenced by water from wetlands.

Soil features

These deep and very deep, well drained soils formed in glacial till. Soils occupy glacial uplands. The surface layer varies from 2-8” in depth, and has a clay loam to fine sandy loam texture. The B horizon is characterized by a hard argillic horizon (6-10’’ thick), which restricts root penetration. The argillic layer has strong columnar structure. Salt accumulations are often visible in the lower part of the B horizon. These soils are usually very hard when dry and very sticky when wet.
Permeability is very slow. Soil ph varies from 6.6 – 9.0. This site is characterized by the following soil components: Gerdrum, Archin, Elloam and Thoeny.

Table 5. Representative soil features

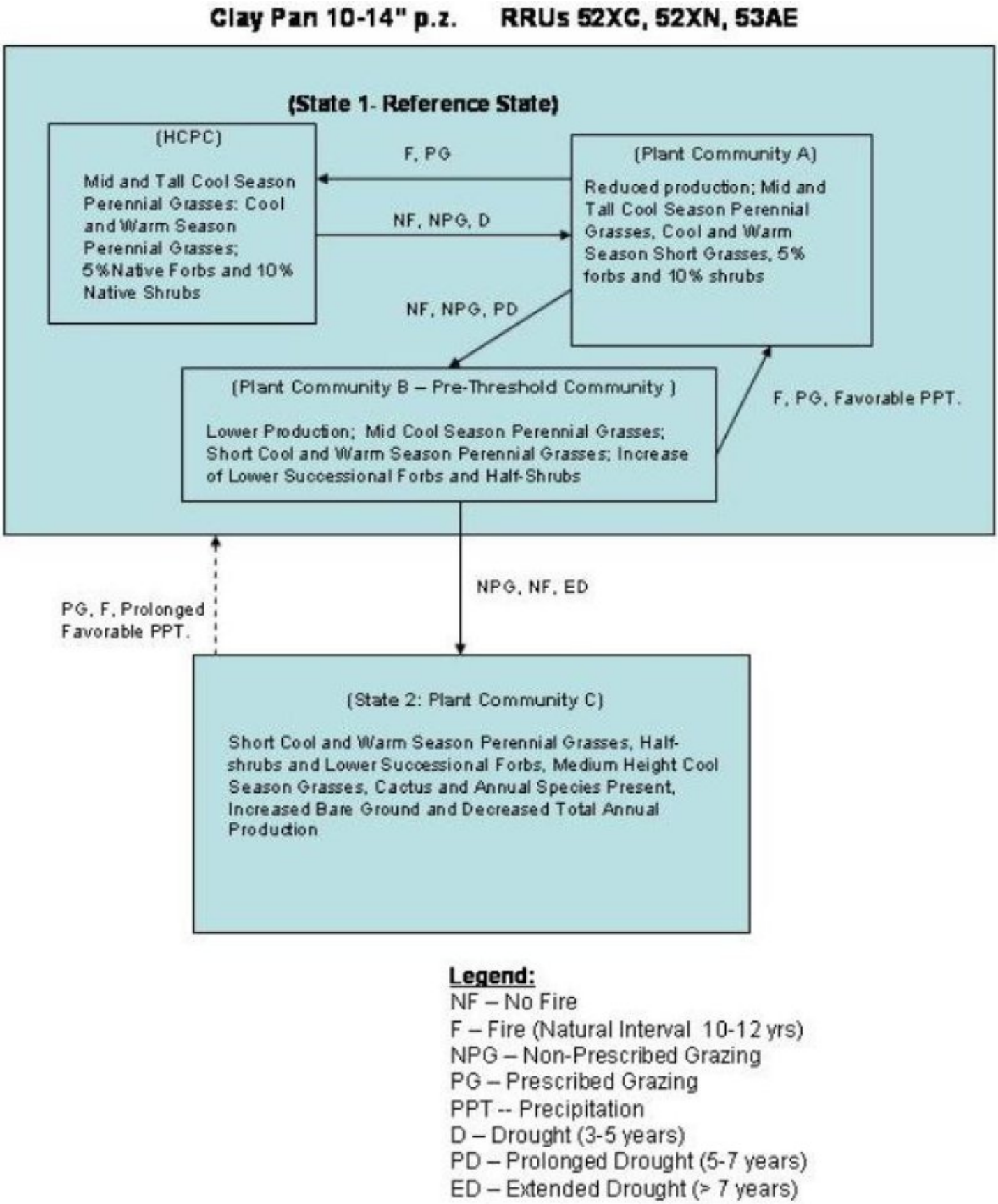
Parent material	(1) Till–sedimentary rock (2) Glaciofluvial deposits
Surface texture	(1) Loam (2) Fine sandy loam (3) Clay loam
Family particle size	(1) Clayey (2) Fine
Drainage class	Well drained
Permeability class	Very slow
Depth to restrictive layer	20–78 in
Soil depth	20–78 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (Depth not specified)	4–5 in
Calcium carbonate equivalent (Depth not specified)	0–10%
Electrical conductivity (Depth not specified)	0–16 mmhos/cm
Sodium adsorption ratio (Depth not specified)	5–25
Soil reaction (1:1 water) (Depth not specified)	6.6–9
Subsurface fragment volume <=3" (Depth not specified)	5–15%
Subsurface fragment volume >3" (Depth not specified)	0–2%

Ecological dynamics

This site developed through time under the influence of climate, geological materials, fire, plants and animals. Research consistently shows that precipitation is the principal factor altering productivity on ecological sites in the

Northern Great Plains (Heitschmidt et al. 2005). The same authors concluded that grazing reduces herbage standing crop, whereas its effects on above ground net primary production varies with timing of grazing and precipitation events, along with the functional and structural composition of the plant community.
It is theorized that these lands burned on a natural interval of 10-12 years (Frost 1998). However, environmental characteristics of this site limit herbage production and subsequent fuel accumulation. Therefore, in comparison to other upland ecological sites, the role of natural fire is probably less significant in the development of this site.
The resultant historic climax plant community (HCPC) is the basis for plant community interpretations. The HCPC has been determined by evaluating rangeland relic areas, and other areas protected from excessive disturbance. The HCPC is comprised of a mixture of cool and warm season grasses and shrubs. About 85% of the annual production is from grasses and sedges, most of which is produced during the cool season. Forbs and shrubs contribute 5 and 10%, respectively, to total annual production. Total vegetative production averages 900 lbs/ac in normal years, 500 lbs/ac in “unfavorable” years, and 1200 lbs/ac in “favorable” years.
This site is moderately resilient to disturbance because soil characteristics limit plant growth. Departures from the HCPC generally result from management actions, drought, and/or a change in the natural fire regime. The site is considered fragile in the sense that vegetative vigor and composition will rapidly decline in the absence of prescribed grazing and during prolonged drought. With favorable precipitation and/or prescribed grazing treatments, the plant community can return to the HCPC. However, succession may be slow. Trends in plant community dynamics, states, transitional pathways, and thresholds have been evaluated and determined through experience and research.
Successional pathways of the Clay Pan 10-14” p.z. ecological site cannot be satisfactorily described using traditional theories of plant succession leading to a single climax community (Briske et al. 2005). As the HCPC regresses to an early seral state, it is theorized that a threshold is crossed somewhere within the mid-seral state. Plant communities occurring below this threshold are in a steady state. Succession back to the HCPC does not occur within a reasonable length of time, and/or without a large input of energy.
Three plant communities and the successional pathways that commonly occur within the Reference State (State 1) are shown in the following diagram. In addition, the transition from State 1 to State 2 and a representative plant community in the latter state are also illustrated. Ecological processes are discussed in the plant community descriptions following the diagram.
State and Transition Model Diagram:

State and transition model



State 1
Reference State

Community 1.1
Historic Climax Plant Community (HCPC) Mid and tall cool-season perennial grasses, cool

and warm-season perennial grasses, 5 percent native forbs, and 10 percent native shrubs.

Mid and tall cool-season perennial grasses, cool and warm-season perennial grasses, 5 percent native forbs, and 10 percent native shrubs. Western/thickspike wheatgrass, bluebunch wheatgrass and green needlegrass are common cool season mid grasses on this ecological site. Alkali sacaton, a tall warm season grass occurs on this site in the eastern glaciated plains. These high-successional grasses account for about 75% of total plant production in the HCPC. Needle and thread, another cool season mid grass is common and tends to replace the green needlegrass when it is stressed by lack of moisture, grazing or etc. About 10% of the total production is comprised of a mix of warm and cool season short grasses and grasslike plants. These species include: blue grama, sandberg bluegrass, plains reedgrass, prairie junegrass, needleleaf sedge, and threadleaf sedge. American vetch, a cool season, nitrogen-fixing legume is one of the most important members of the forb community. White and purple prairie clover are important warm season legumes. Additional nitrogen is fixed by lower successional legumes (milkvetches, scurfpeas, and prairie thermopsis). Onion, hoods phlox, scarlet globemallow, wooly plantain, and biscuitroot often occur in the HCPC. The latter group contains a mix of warm and cool season species whose relative occurrence on the site is largely influenced by the timing and amount of precipitation. Forbs contribute about 5% of the total annual production. Nuttall saltbush, greasewood and silver sagebrush are the most important browse species occurring on this site. While the former two species make their major growth and flower during the cool season, silver sagebrush is a warm season species. Shrubs such as big sagebrush and pricklypear cactus may occur in some areas. Fringed sagebrush, a half-shrub may also be found in the HCPC. Shrubs normally make up about 10% of the total annual production. Broom snakeweed, annual bromes, and annual forbs are not a part of the HCPC. Their presence indicates possible ecological deterioration, or downward trend. Trend is difficult to interpret because large areas of bare ground between plants are fairly common. Total annual production within the HCPC averages 900 lbs/ac during normal years. Thus production is 300 lbs/ac higher than it is on the Dense Clay 10-14” p.z. ecological site, and 400 lbs/ac less than on the Clayey 10-14” p.z. ecological site. Production declines as the HCPC regresses from the HCPC to lower successional communities. Regression may result from grazing management strategies that do not allow adequate recovery periods between grazing events, drought, and/or the disruption of the normal fire sequence. The above disturbances favor the replacement of green needlegrass, bluebunch wheatgrass, and western/thickspike wheatgrass by needle and thread, blue grama, sandberg bluegrass, prairie junegrass, hairy goldenaster, and hoods phlox. Nuttall saltbush may also be replaced by broom snakeweed, fringed sagewort, etc. Cheatgrass and Japanese brome may invade the site. As the result of these vegetative changes, there is less litter to protect the soil and less infiltration. Hydrologic cycles are impaired when plant communities are unable to effectively use precipitation. Plant basal cover varies from 7-20%. Litter varies from 40-50%, and bare ground ranges from 25-45%. Thus, surface runoff and erosion are potential concerns on the Clay Pan 10-14” p.z. ecological site. Runoff and soil erosion increase as the HCPC regresses to earlier seral states. The major plant species composition and production by dry weight are shown for the HCPC in the following table. Total annual production has been derived from several sources, and has been adjusted to represent a typical annual moisture cycle.

Table 6. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	425	765	1020
Shrub/Vine	50	90	120
Forb	25	45	60
Tree	–	–	–
Total	**500**	**900**	**1200**

Table 7. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	0%
Grass/grasslike foliar cover	0%
Forb foliar cover	0%
Non-vascular plants	0-1%
Biological crusts	0-1%

Litter	15-40%
Surface fragments >0.25" and <=3"	0-1%
Surface fragments >3"	0-1%
Bedrock	0%
Water	0%
Bare ground	10-20%

Table 8. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	1-5%
Grass/grasslike basal cover	10-15%
Forb basal cover	1-2%
Non-vascular plants	0%
Biological crusts	0%
Litter	0%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	0%

Table 9. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	0-1%	0-20%	0-25%
>0.5 <= 1	–	0-40%	0-40%	0-50%
>1 <= 2	–	0-50%	0-25%	0-25%
>2 <= 4.5	–	0-10%	0-15%	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 1.2
Plant Community A Reduced production, mid and tall cool-season perennial grasses, cool- and warm-season short grasses, 5 percent forbs and 10 percent shrubs.

Reduced production, mid and tall cool-season perennial grasses, cool- and warm-season short grasses, 5 percent forbs and 10 percent shrubs. Total annual production is about 80% of the HCPC. Western and thickspike wheatgrasses, and green needlegrass still contribute approximately 60% of the annual production. However, they are less vigorous and individual plant growth is reduced from what it is in the HCPC. The short grass production increases in comparison to the HCPC. Plant height and plant litter are reduced while bare ground increases. Surface runoff and soil temperature increases, infiltration decreases, and shallow-rooted short grasses and sedges gain a competitive advantage over medium height, deep-rooted cool season perennial grasses. They are able to compete more successfully with the mid-grasses because of the ability of relatively shallow root systems to utilize

shallowly penetrating moisture, characteristic of this site. Total shrub production continues to represent about 5% of total annual production. However, vigor of the prairie clovers and American vetch has decreased relative to the vigor of hoods phlox and other low-successional forbs. Total shrub production remains at about 10% of the total annual production.

Community 1.3
Plant Community B - Pre-threshold Community Lower production, mid cool-season perennial grasses, short cool and warm-season perennial grasses, increase of lower successional forbs and half-shrubs.

Lower production, mid cool-season perennial grasses, short cool and warm-season perennial grasses, increase of lower successional forbs and half-shrubs. This Community is dominated by a mix of medium and short grasses. Blue grama, threadleaf sedge, needle and thread and sandberg bluegrass increased in the community by replacing some of the mid grasses. However, western and thickspike wheatgrass and green needlegrass continue to contribute nearly 50% of the total annual production. In comparison to Community A, the short grasses contain more blue grama, a warm season species. Sand dropseed and tumblegrass may also begin to appear in the community. Warm season forbs increase and replace American vetch and other high-successional forbs. The warm season half-shrub, fringed sagewort, increases in production. Pricklypear cactus and broom snakeweed are conspicuous in this community. Annual production is 40-60% of potential for the site. Plant species in this community tend to exhibit more salt tolerant characteristics than the species found in the HCPC or Community A. Infiltration is moderately reduced due to adverse changes in plant community composition and/or distribution. The amount of bare ground is moderately higher than expected for this site (bare ground = 45-60%). In comparison to the HCPC, total plant cover varies from 30-40%. Litter is reduced to 10-15%, which is moderately less, relative to site potential and weather. Active rill formation is slight at infrequent intervals, mostly in exposed areas. Water flow patterns match what is expected for the site, erosion is minor with some instability and deposition (USDI and USDA 2000). Plant community B is called the “pre-threshold community”. It is critical that this community be recognized and strategies implemented to prevent further regression. Although this community can improve to either Community A or HCPC through successional processes, further disturbance will result in regression to a lower state. Once Community B regresses to a lower state, normal successional processes are restricted.

Pathway 1.1A
Community 1.1 to 1.2

No fire, non-prescribed grazing, drought (3 to 5 years) Non-prescribed grazing, drought and/or a cessation of the natural fire regime will cause regression from HCPC to Community A.

Pathway 1.2A
Community 1.2 to 1.1

Fire (natural interval 10 to 12 years), prescribed grazing Favorable growing conditions, the implementation of prescribed grazing, or periodic fire will move Plant Community A to the HCPC. This succession can occur within a couple of years.

Pathway 1.2B
Community 1.2 to 1.3

No fire, non-prescribed grazing, prolonged drought (5 to 7 years) Community A will regress to Community B under non-prescribed grazing, prolonged drought, or an extended period without fire. The rate of regression varies with the kind, intensity, frequency, and duration of the disturbances. Severe drought may cause retrogression within a couple years.

Pathway 1.3A
Community 1.3 to 1.2

Fire, prescribed grazing, favorable precipitation The Clay Pan 10-14” p.z. ecological site is resilient within the Reference State. Prescribed grazing and/or a period of favorable precipitation will induce succession from Community B to Community A within a reasonable time frame.

State 2
Degraded State

Community 2.1
Plant Community C Short cool- and warm-season perennial grasses, half-shrubs and lower successional forbs, medium-height cool-season grasses, cactus and annual species present, increased bare ground, and decreased total annual production

Short cool- and warm-season perennial grasses, half-shrubs and lower successional forbs, medium-height cool-season grasses, cactus and annual species present, increased bare ground, and decreased total annual production Plant Community C is characterized by a significant reduction in species composition by weight of medium-height, cool season grasses. Wheatgrasses contribute about 25% of total annual growth. Plants produce few seed heads and are low in vigor. This community is dominated by low-successional grasses and sedges. Blue grama, prairie junegrass, other short grasses, sedges and clubmoss contribute about 50% of the total annual production. Clubmoss cover is usually most severe on soils with loamy A and E horizons. Broom snakeweed, fringed sagewort and pricklypear cactus are conspicuous in the community. Japanese brome, cheatgrass, annual forbs (fanweed and pepperweed), and curlycup gumweed will be present. Total annual production is reduced about 75% from levels in the HCPC. Percent composition of forbs and shrubs are highly variable from place to place and from year to year in this community. Variability is apparent in productivity and occurrence of individual species. Litter cover averages about 10%, which is a large reduction relative to site potential. Water flow patterns are numerous and there is moderate active pedestalling. In communities that are not characterized with clubmoss, bare ground is moderately to much higher than expected. There is moderate soil loss or degradation in interspaces with some degradation beneath plant canopies. Compared to the HCPC, there has been a structural shift from medium height to short grasses, and a functional shift from cool to warm season plants. Reproductive capability of cool season plants is greatly reduced relative to recent climatic conditions.

Transition T1A
State 1 to 2

Non-prescribed grazing, no fire, extended drought (greater than 7 years) However, Community B is much less resistant to perturbations than Community A. Lower production, lower vegetative cover, less litter, and increased bare ground contribute to increase Community B’s susceptibility to disturbance. Extended drought and non-prescribed grazing can lead to further retrogression (State 2). The threshold separating Communities B and C appears to be the functional threshold, below which the type, amount, and pattern of vegetation is often inadequate to prevent accelerated soil erosion.

Restoration pathway R2A
State 2 to 1

Prescribed grazing, fire (natural interval 10 to 12 years), prolonged favorable precipitation. Plant community C is a steady state. It is resistant to significant succession. Blue grama, other short grasses, sedges and clubmoss form a competitive community. The adverse soil conditions and a theorized inadequate seed bank of species found in State #1 greatly restrict potential for succession to State #1. When clubmoss cover is more than 20-25%, succession is not expected to occur within a reasonable length of time. However, significant succession may occur with the combination of prescribed grazing, implementation of the natural fire regime, and an extended period of favorable moisture. This potential is depicted with the dashed line in the state and transition diagram. In comparison to more common ecological sites with moderately deep to deep soils (ie, Silty 10-14” p.z., Clayey 10-14” p.z., and Sandy 10-14” p.z.), annual production on a Clay Pan 10-14” p.z. ecological site is about 30% less. Therefore, vegetation response to mechanical treatments and range seeding will be less than the response expected on the higher producing sites (NRCS Conservation Practice Standard 548-1).

Additional community tables

Table 10. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					

1	**Rhizomatous Wheatgrasses**			180–360	
	western wheatgrass	PASM	*Pascopyrum smithii*	90–180	–
	tufted wheatgrass	ELMA7	*Elymus macrourus*	90–180	–
2	**Cool-season Bunchgrasses**			225–450	
	green needlegrass	NAVI4	*Nassella viridula*	90–180	–
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	90–180	–
	needle and thread	HECO26	*Hesperostipa comata*	45–90	–
3	**Warm-season Bunchgrasses**			45–90	
	alkali sacaton	SPAI	*Sporobolus airoides*	45–90	–
4	**Miscellaneous Grasses**			0–90	
	blue grama	BOGR2	*Bouteloua gracilis*	0–45	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–45	–
	plains reedgrass	CAMO	*Calamagrostis montanensis*	0–45	–
	threadleaf sedge	CAFI	*Carex filifolia*	0–45	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–45	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–45	–
	squirreltail	ELEL5	*Elymus elymoides*	0–45	–
	Grass, native	2GN	*Grass, native*	0–45	–
Forb					
5	**Dominant Forbs**			9–45	
	American vetch	VIAM	*Vicia americana*	9–45	–
2	**Clovers**			18–90	
	purple prairie clover	DAPU5	*Dalea purpurea*	9–45	–
	white prairie clover	DACA7	*Dalea candida*	9–45	–
7	**Miscellaneous Forbs**			0–45	
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–45	–
	aster	ASTER	*Aster*	0–45	–
	scurfpea	PSORA2	*Psoralidium*	0–45	–
	prairie thermopsis	THRH	*Thermopsis rhombifolia*	0–45	–
	pussytoes	ANTEN	*Antennaria*	0–45	–
	bastard toadflax	COUM	*Comandra umbellata*	0–45	–
	milkvetch	ASTRA	*Astragalus*	0–45	–
	spiny phlox	PHHO	*Phlox hoodii*	0–45	–
	Forb, native	2FN	*Forb, native*	0–45	–
Shrub/Vine					
8	**Shrubs**			5–90	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–45	–
	Nuttall's saltbush	ATNU2	*Atriplex nuttallii*	5–45	–
	silver sagebrush	ARCA13	*Artemisia cana*	0–45	–
	greasewood	SAVE4	*Sarcobatus vermiculatus*	0–45	–
	big sagebrush	ARTR2	*Artemisia tridentata*	1–45	–
	prairie sagewort	ARFR4	*Artemisia frigida*	1–15	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–1	–

Animal community

Livestock Management
The Clay Pan 10-14” p.z. ecological site is suited for livestock grazing. However, prescribed grazing management is needed. Forage production is somewhat limited by soil characteristics. Many species occurring in State #1 are palatable to livestock, which makes the communities susceptible to heavy stocking and season long grazing. The cool season medium height grasses are generally selectively grazed, giving the short grasses a competitive advantage. Grazing during early spring may result in soil compaction. Any additional factor reducing infiltration and increasing runoff on this site is a management concern. Shorter grazing periods and adequate periods of rest following grazing are needed to facilitate plant regrowth and accumulate litter.
This ecological site has a component of shortgrass species, as do most other sites in the northern mixed prairie. The shortgrasses usually increase with grazing pressure and decrease with deferment or prescribed grazing. However, succession is not guaranteed in the Northern Great Plains. Sampling four-year old ungrazed exclosures and grazed areas with 35% utilization, Vogel and Van Dyne (1966) found essentially the same basal cover of grasses, sedges, forbs, litter and bare soil on protected and grazed sites. They concluded that four years was too short of a time for cover to change significantly. Hofmann and Ries (1989) observed similar results following a four-year study in North Dakota. Even after 41 years of exclosure, changes in species composition can be relatively small when the site is in the dry, low production portion of northern mixed prairie (Brand and Goetz, 1986). They concluded that site characteristics limited the development of potential vegetation with the exclusion of grazing, but the potential impacts of prescribed grazing on succession were not discussed. The Clay Pan 10-14” p.z. ecological site is not as productive as the sites evaluated by Vogel and Van Dyne, Hofmann and Ries, or by Brand and Goetz. Therefore, range managers should recognize the environmental limitations of this site. Prescribed grazing management is always a good recommendation. Furthermore, chiseling of these soils is common in Phillips County and can be very successful given the right conditions.

Wildlife Interpretations
The HCPC associated with this ecological site provides diverse and valuable wildlife habitat. This site often occurs as a mosaic with other ecological sites, thus creating “ecotones” that serve as a magnet for many species of wildlife. Antelope and mule deer prefer grazing this site because of the Nuttall saltbush and diversity of forage species. However, the landscape does not provide thermal and escape cover. The bare ground limits the potential of the site for upland birds and for ground-nesting birds.
This ecological site becomes less valuable for deer and antelope when plant diversity declines with regression. For example, the disappearance of either the tall cool season grasses or warm season grass would shorten the length of the “green forage” season. The increase of blue grama, clubmoss, hoods phlox, etc. is also associated with the loss of palatable forbs. These changes tend to adversely impact foraging opportunities for deer, antelope, upland birds, etc. Community C has very little value for most wildlife species because of insufficient vegetative structural diversity, residual grass carry-over and litter cover.

Plant Preferences by Animal Kind
Refer to NRCS Field Office Technical Guide, Section IIE, General Information, for tables displaying plant preferences by livestock and wildlife.

Hydrological functions

Water is the main factor limiting vegetative production on this site. Soil components in this ecological site are normally classed into Hydrologic Group D. These soils have a medium to very high runoff potential, with hydrologic runoff curves of 89 to 80. Field investigations are needed to adjust the runoff curves when plant communities deteriorate from the HCPC. Areas where ground cover is less than 50% have the greatest potential to have reduced infiltration and higher runoff.

Recreational uses

This site provides hunting opportunities for upland game species.

Wood products

This site has no significant value for wood products.

Other information

This site ecological site is not highly resistant to disturbances. Species diversity is adversely affected by season long continuous grazing and by heavy stocking. Medium height grasses are replaced by short grasses. The number of structural/functional groups is reduced with regression from the HCPC. The amount of solar energy that is captured and converted to carbohydrates for plant growth is reduced in State 2. A reduction in total vegetative growth results in less potential vegetation that can be transformed into litter. Litter reductions result in less infiltration, and more runoff and soil erosion.

Inventory data references

Data Source Number of Records Sample Period State County
SCS-Range-417 (#503) 1 1991 MT Phillips
ECS-1
Modified Double Sampling 0
USDA-SCS-MT 1981 Technical Range Site Description

Other references

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Frost, C. C. 1998. Presettlement fire frequency regimes of the United States: a first approximation. Pages 70-81. in Teresa L. Pruden and Leonard A. Brennan (eds.). Fire in ecosystem management: shifting paradigm from suppression to prescription. Tall Timbers Fire Ecology Conference Proceedings. No. 20. Tall Timbers Research Station, Tallahassee, FL.
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Vogel, W.G. and G.M. Van Dyne. 1966. Vegetation responses to grazing management on a foothill sheep range. J. Range Manage. 19:80-85.

Contributors

Kirt Walstad

Approval

Kirt Walstad, 1/24/2024

Acknowledgments

Site Description Revisions
The 2005 Clay Pan 10-14” p.z. ecological site description replaces earlier dated versions of Clay Pan 10-14” p.z. descriptions in Rangeland Resource Unit 52XN, located in Section II-E-8 of the NRCS Field Office Technical Guide. This 2005 revision incorporates the State and Transition Model theory, additional data on site productivity, and an improved understanding of many rangeland health indicators.
Site Description Approval
This ecological site description is approved with the understanding that it is no more than another step in our continual effort to update the NRCS technical guide. In order to facilitate the process, NRCS field personnel are encouraged to forward existing information and/or new data that can be used to improve the utility of this site description. Please forward the information and data to the State Rangeland Management Specialist.
Author Date Approval Date
Dr. John Lacey 02/23/2005 Loretta J. Metz 03/19/2005

Maxine Rasmussen, Area RMS, Glasgow, MT
Jon Siddoway, Area RMS, Great Falls, MT
Rick Bandy, Area RSS, Great Falls, MT
Greg Snell, Area RSS, Glasgow, MT

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.

Author(s)/participant(s)	Loretta Metz, Maxine Rasmussen, Jon Siddoway
Contact for lead author	Area Rangeland Management Specialist, Glasgow Area Office, MT Reference site used? No
Date	05/04/2005
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills should not be present in HCPC. If in plant community A on slopes > 15%, careful examination will yield slight evidence of rills that are less than ½ inch deep, linear, but short in length. If in plant community B on slopes > 15%, rills would be visible, ½ inch deep or more, linear, rarely exceeding 1 foot in length. Distance between rills is irregular.

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2. **Presence of water flow patterns:** Water flow patterns should not be observable in HCPC. If in plant community A, careful examination will yield short discontinuous water flow patterns. If in plant community B, water flow patterns would be visible as long (more than 1-foot) and continuous across the landscape.

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3. **Number and height of erosional pedestals or terracettes:** Pedestals or terracettes are nonexistent in HCPC. If in plant community A, careful examination on slopes > 8% yield occasional pedestals approximately ¼ inch above the soil surface. If in plant community B, pedestals are frequent and ½ - ¾ inch above the soil surface.

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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 10-20% of the soil surface should be bare in HCPC. Bare ground should be less than 2” in diameter. If in plant community A, 20-45% of the soil surface can be exposed. If in plant community B, 45-60% of the soil surface can be exposed.

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5. **Number of gullies and erosion associated with gullies:** None.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** None.

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7. **Amount of litter movement (describe size and distance expected to travel):** Litter movement is not expected with HCPC. If in plant community A, careful examination will yield some fine litter movement for a short distance. If in plant community B, litter, both fine and coarse, movement is visible, especially on slopes > 8%, but the distance moved is less than 1 foot.

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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):** Stability class anticipated to be 5 or 6 under plant canopy. Interspaces are between 3-5.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** The light gray to grayish brown clay surface layer is 2 - 8” thick. The surface texture ranges from loam, fine sandy loam and clay loam. Soil organic matter is usually 1-3%.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** In HCPC, 40-50% plant canopy and 40-70% basal cover with small gaps between plants should reduce raindrop impact and slow overland flow, providing increased time for infiltration to occur. Healthy, deep rooted native grasses enhance infiltration and reduce runoff. Infiltration rate is slow. If in plant community A, 15-30% plant canopy and 20-35% basal cover with moderate gaps between plants will intensify raindrop impact and increase overland flow, causing decreased time for infiltration. If in plant community B, 10-20% plant canopy and 10-20% basal cover with sizeable gaps between plants, amplifies raindrop impact and increases overland flow. The site tends to be more xeric as runoff increases.

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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):** No compaction layer or soil surface crusting should be evident in any of the State 1 plant communities. Restrictive, very hard claypan begins at 2 - 8 inches.

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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:

    Sub-dominant:

    Other:

    Additional: HCPC: Tall and mid-stature, cool season bunch grasses = mid-stature, cool season rhizomatous grasses > short cool season bunch grasses > shrubs > forbs. Plant community A: Mid-stature, cool season rhizomatous grasses > tall and mid-stature, cool season bunch grasses >short stature, warm season rhizomatous > shrubs > forbs. Plant community B: Mid-stature, cool season rhizomatous grasses Short warm season perennial grasses > tall and mid-stature, cool season bunch grasses >forbs>shrubs.

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or**

decadence): Plant mortality and decadence very low in HCPC and Plant community A. In periods of drought, shrubs would exhibit decadence in the state 1 reference communities.

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14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 500 - 1200 #/acre from Plant community B to HCPC in the State 1 reference community.

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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:** Blue grama, prairie junegrass, needleleaf sedge, curly cup gumweed, Sandberg bluegrass, fringed sagewort, plains prickly pear, broom snakeweed, dense clubmoss.

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17. **Perennial plant reproductive capability:** All species are capable of reproducing in HCPC and Plant community A. In Plant community B, plant seedlings will be weighed in favor of marginal and undesirable species.
