Ecological site EX044B01A131
Shallow Clay (SwC)
10-14" PZ Frigid

Last updated: 2/11/2025
Accessed: 06/21/2026

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): 044B–Central Rocky Mountain Valleys

Major Land Resource Area (MLRA) 44B, Central Rocky Mountain Valleys, is nearly 3.7 million acres of southwest Montana and borders two MLRAs: 43B Central Rocky Mountains and Foothills and 46 Northern and Central Rocky Mountain Foothills. The major watersheds of this MLRA are those of the Missouri and Yellowstone Rivers and their associated headwaters such as the Beaverhead, Big Hole, Jefferson, Ruby, Madison, Gallatin, and Shields Rivers. These waters allow for extensive irrigation for crop production in an area that would generally only be compatible with rangeland and grazing. The Missouri River and its headwaters are behind several reservoirs that supply irrigation water, hydroelectric power, and municipal water. Limited portions of the MLRA are west of the Continental Divide along the Clark Fork River. The primary land use of this MLRA is production agriculture (grazing, small grain production, and hay), but there is some limited mining. Urban development is high with large expanses of rangeland converted to subdivisions for a rapidly growing population. The MLRA consists of one Land Resource Unit (LRU) and seven climate based LRU subsets. These subsets are based on a combination of Relative Effective Annual Precipitation (REAP) and frost free days. Each subset expresses a distinct set of plants that differentiate it from other LRU subsets. Annual precipitation ranges from a low of 9 inches to a high near 24 inches. The driest areas tend to be in the valley bottoms of southwest Montana in the rain shadow of the mountains. The wettest portions tend to be near the edge of the MLRA at the border with MLRA 43B. Frost free days also vary widely from less than 30 days in the Big Hole Valley to around 110 days in the warm valleys along the Yellowstone and Missouri Rivers. The plant communities of the MRLA are highly variable, but the dominant community is a cool-season grass and shrub-steppe community. Warm-season grasses have an extremely limited extent in this MLRA. Most subspecies of big sagebrush are present, to some degree, across the MLRA.

LRU notes

MLRA 44B has one LRU that covers the entire MLRA. The LRU has been broken into seven climate subsets based on a combination of Relative Effective Annual Precipitation (REAP) and frost free days. Each combination of REAP and frost free days results in a common plant community that is shared across the subset. Each subset is giving a letter designation of A through F for sites that do not receive additional water and Y for sites that receive additional water. LRU 01 Subset A has a REAP of nine to 14 inches (228.6-355.6mm) with a frost free days range of 70 to 110 days. This combination of REAP and frost free days results in a nearly treeless sagebrush steppe landscape. The soil moisture regime is Ustic, dry that borders on Aridic and has a Frigid soil temperature regime.

Classification relationships

Mueggler and Stewart. 1980. Grassland and Shrubland habitat types of Western Montana 1. Stipa comata/Bouteloua gracilis h.t. 2. Agropyron spicatum/Bouteloua gracilis h.t. Montana Natural Heritage Program Vegetation Classification 1. Stipa comata - Bouteloua gracilis Herbaceous Vegetation (STICOM – BOUGRA) Needle and thread/Blue grama Natural Heritage Conservation Rank-G5 / S5 Edition / Author- 99-11-16 / S.V. Cooper, EPA Ecoregions of Montana, Second Edition: Level I: Northwestern Forested Mountains Level II: Western Cordillera Level III: Middle Rockies & Northern Great Plains Level IV: Paradise Valley Townsend Basin Dry Intermontane Sagebrush Valleys Shield-Smith Valleys National Hierarchical Framework of Ecological Units: Domain: Dry Division: M330 – Temperate Steppe Division – Mountain Provinces Province: M332 –Middle Rocky Mountain Steppe – Coniferous Forest – Alpine Meadow Section: M332D – Belt Mountains Section M332E – Beaverhead Mountains Section Subsection: M332Ej – Southwest Montana Intermontane Basins and Valleys M332Dk – Central Montana Broad Valleys

Ecological site concept

The Shallow Clay ecological site is an upland site formed from residuum or slope alluvium and is on slopes less than 15 percent. The site does not receive additional moisture from a water table or flooding. It has clay content greater than 35 percent in the upper four (4) inches of the mineral surface. It is shallow and has a root-restrictive layers within 10 to 20 inches (25-50cm). The surface of the site has less than five percent stone cover and is not skeletal, with less than 35 percent rock fragments in the 10 to 20-inch depth. The site does not have a saline or saline-sodic influence and is not strongly or violently effervescent within four inches of the mineral surface. Calcium carbonates may increase with depth.

Associated sites

EX044B01A001	**Clayey (Cy) 10-14" PZ Frigid** The Clayey ecological site resides on the neighboring toe slope or hillslope position. Production will be higher on the Clayey site but may express similar plant species.

Similar sites

EX044B01A001	**Clayey (Cy) 10-14" PZ Frigid** The Clayey site shares similar Reference Plant community, however produces higher amounts of biomass
EX044B01A136	**Shallow Loamy (SwLo) 10-14" PZ Frigid** The Shallow Loamy has a similar state and transition model and response to management, but tends to produce a slightly different plant community

Table 1. Dominant plant species

Tree	(1) *Juniperus scopulorum* (2) *Pinus ponderosa*
Shrub	(1) *Artemisia tridentata*
Herbaceous	(1) *Pseudoroegneria spicata* (2) *Hesperostipa comata*

Legacy ID

R044BA131MT

Physiographic features

This ecological site can be found on nearly flat to steep uplands. It often occurs in complexes with other ecological sites, particularly in rougher terrain. This site occurs on all slopes and exposures. Aspect can cause minor changes in the composition and production of plant communities. The amount of exposed rock outcrop tends to increase as slopes increase. Runoff and the potential for water erosion can be significant features of this site.

Table 2. Representative physiographic features

Landforms	(1) Intermontane basin > Hill (2) Intermontane basin > Knoll (3) Intermontane basin > Ridge (4) Intermontane basin > Escarpment

Runoff class	Medium to high
Elevation	1,220 – 1,520 m
Slope	0 – 50 %
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The Central Rocky Mountain Valleys MLRA has a continental climate. Fifty to sixty percent of the annual long-term average total precipitation falls between May and August. Snow on frozen ground makes up the majority of winter precipitation. Average precipitation for LRU 01 Subset A is 12 inches (305 mm), and the frost-free period averages 78 days. Precipitation is highest in May and June. Some of Montana's driest areas are located in sheltered mountain valleys because of the rain-shadow effects on the leeside of some ranges.

Table 3 Representative climatic features

Frost-free period (characteristic range)	40-90 days
Freeze-free period (characteristic range)	90-120 days
Precipitation total (characteristic range)	250-330 mm
Frost-free period (actual range)	30-110 days
Freeze-free period (actual range)	70-130 days
Precipitation total (actual range)	250-360 mm
Frost-free period (average)	80 days
Freeze-free period (average)	110 days
Precipitation total (average)	310 mm

- (1) DEER LODGE 3 W [USC00242275], Deer Lodge, MT
- (2) DILLION U OF MONTANA WESTERN [USC00242409], Dillon, MT
- (3) GLEN 2 E [USC00243570], Dillon, MT
- (4) ENNIS [USC00242793], Ennis, MT
- (5) BOULDER [USC00241008], Boulder, MT
- (6) GARDINER [USC00243378], Gardiner, MT
- (7) TOWNSEND [USC00248324], Townsend, MT
- (8) TRIDENT [USC00248363], Three Forks, MT
- (9) TWIN BRIDGES [USC00248430], Sheridan, MT

- (10) WHITE SULPHUR SPRNGS 2 [USC00248930], White Sulphur Springs, MT
- (11) DILLON AP [USW00024138], Dillon, MT
- (12) HELENA RGNL AP [USW00024144], Helena, MT

Influencing water features

This ecological site has slow permeability and is shallow to bedrock, so runoff tends to be high. Rills and water flow patterns will be conspicuous on steep slopes following extreme runoff events associated with heavy storms.

Wetland description

This site is not associated with wetland characteristics

Soil features

These are shallow clayey soils that are 10 to 20 inches deep and have underlying beds of decomposed shale or nearly impervious clays. These soils are formed from slope alluvium and residuum. The site is well drained with slow permeability. The typical soil surface texture is silty clay loam, with clay content in the top 4 inches exceeding 32 percent. The current soil series is almost entirely Shoddy.

Table 4. Representative soil features

Parent material	(1) Residuum – sedimentary rock (2) Slope alluvium – sedimentary rock
Surface texture	(1) Clay loam (2) Silty clay loam (3) Sandy clay loam
Family particle size	(1) Clayey
Drainage class	Moderately well drained to well drained
Permeability class	Moderately slow to slow
Depth to restrictive layer	30 – 50 cm
Soil depth	30 – 50 cm
Available water capacity (0-50.8cm)	6.6 – 7.87 cm
Calcium carbonate equivalent (0-50.8cm)	10 %

Clay content (0-10.2cm)	30 %
Soil reaction (1:1 water) (0-50.8cm)	7.4 – 10

Ecological dynamics

Shallow Clay ecological site occurs across a relatively small landscape; slight variations within the plant community may occur due to aspect, elevation, and relative effective annual precipitation; however, this is quite limited.

The reference plant community is dominated by bluebunch wheatgrass (Pseudoroegneria spicata) and western wheatgrass (Pascopyrum smithii). Subdominant species may include green needlegrass (Nassella viridula), needle and thread (Hesperostipa comata), Wyoming big sage (Artemisia tridentata ssp. wyomingensis), winterfat (Krascheninnikovia lanata), and Indian ricegrass (Achnatherum hymenoides).

Large scale coniferous expansion has occurred on this and neighboring ecological sites. Up to two coniferous trees per acre may exist on this ecological site though tree canopy should be localized to small patches. The common tree species may include Rocky Mountain juniper (Juniperus scopulorum), ponderosa pine (Pinus ponderosa var scopulorum), or Douglas fir (Pseudotsuga menziesii).

Wyoming big sagebrush steppe communities historically had low fuel loadings and were characterized by 10- to 70-year interval, fires that produced a mosaic of burned and unburned lands (Bunting et al., 1987). A shift to the dominance of shrubs may occur in response to improper grazing management, drought, or due to a lack of fire. Shrub encroachment by a variety of species, including broom snakeweed (Gutierrezia sarothrae), fringed sagewort (Artemisia frigida), Wyoming big sagebrush (Artemisia tridentata ssp. wyomingensis), rubber rabbitbrush (Ericameria nauseosa), yellow rabbitbrush (Chrysothamnus viscidiflorus), and plains prickly pear (Opuntia polyacantha) occurs within this site as the mid-stature bunchgrasses decrease. Shrub dominance and grass loss can be associated with soil erosion and, ultimately, thinning of the native soil surface. Subsequent loss of soil could lead to a Degraded State. All states could also lead to the Invaded State when there is a lack of weed prevention and control measures.

Historical records indicate that, prior to the introduction of livestock (cattle and sheep) during the late 1800s, elk and bison grazed this ecological site. Due to bison's nomadic nature and herd structure, grazed areas received periodic high intensity, short duration grazing pressure. Forage for livestock was noted as minimal in areas recently grazed by bison (Lesica and Cooper 1997). Meriwether Lewis documented that he was met by 60 Shoshone warriors on horseback in August 1805, and the Corps of Discovery was later supplied with horses by the same band of Shoshone. This suggests that the areas near the modern-day Montana towns of Twin Bridges, Dillon, Grant, and Dell were grazed by an untold number of horses prior to the large introduction of cattle and sheep. Livestock grazing has occurred on most of this ecological site in southwestern Montana for more than 150 years. The gold boom in the 1860s brought the first herds of livestock overland from Texas, and homesteaders began settling the area. During this time, cattle were the primary domestic grazers in the area. In the 1890s, Montana sheep production began to increase and dominated the livestock industry until the 1930s. Since the 1930s, cattle production has dominated the livestock industry in the region (Wyckoff and Hansen 2001).

Natural and prescribed fire, both used by indigenous peoples, were major ecological drivers of not only this ecological site but the entire MLRA. Indigenous peoples have utilized fire on this ecological site for thousands of years prior to European settlement as a means to move wildlife populations for harvest (Roos, Christopher I., et al. 2018). Fire tended to restrict tree and shrub growth to small patches and promote an herbaceous plant community. The natural fire return interval was highly variable, but it was likely shorter than 30 years. With the historically recent (since 1910) suppression of fire, shrubs and coniferous trees have increased significantly.

Some of the major invasive species that can occur on this site include (but are not limited to) spotted knapweed (Centaurea stoebe), leafy spurge (Euphorbia esula), cheatgrass (Bromus tectorum), field brome (Bromus arevensis), yellow toadflax (Linaria vulgaris), and dandelion (Taraxicum spp.). Invasive weeds are beginning to have a high impact on this ecological site.

Plant Communities and Transitions
A state and transition model for this ecological site is depicted below. Thorough descriptions of each state, transition, plant community, and pathway follow the model. This model is based on available experimental research, field data, field observations, and interpretations by experts. It is likely to change as knowledge increases.

The plant communities within the same ecological site will differ across the MLRA due to the naturally occurring variability in weather, soils, and aspect. The biological processes on this site are complex; therefore, representative values are presented in a land management context. The species lists are representative and are not botanical descriptions of all species occurring, or potentially occurring, on this site. They are intended to cover the core species and the known range of conditions and responses.

Although there is considerable qualitative experience supporting the pathways and transitions within the state and transition model (STM), no quantitative information exists that specifically identifies threshold parameters between grassland types and invaded types in this ecological site. For information on STMs, see the following citations: Bestelmeyer et al. (2003), Bestelmeyer et al. (2004), Bestelmeyer and Brown (2005), and Stringham et al. (2003).

State and transition model

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
Grass/Grasslike					
1	**Mid-Statured Cool Season bunchgrass**			504-673	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	381-628	35-55
	green needlegrass	NAVI4	*Nassella viridula*	48-95	5-10
	needle and thread	HECO26	*Hesperostipa comata*	0-67	0-7
2	**Rhizomatous grasses**			224-280	
	western wheatgrass	PASM	*Pascopyrum smithii*	191-280	7-12
	thickspike wheatgrass	ELLA3	*Elymus lanceolatus*	0-56	0-3
3	**Shortgrasses/Grasslikes**			22-45	
	blue grama	BOGR2	*Bouteloua gracilis*	11-47	1-5
	prairie Junegrass	KOMA	*Koeleria macrantha*	17-28	1-3
	Sandberg bluegrass	POSE	*Poa secunda*	17-28	1-3
	plains reedgrass	CAMO	*Calamagrostis montanensis*	0-28	0-3
	threadleaf sedge	CAFI	*Carex filifolia*	0-17	0-1
Forb					
4	**Forbs**			34-50	
	dotted blazing star	LIPU	*Liatris punctata*	11-56	0-4
	American vetch	VIAM	*Vicia americana*	11-56	0-4
	purple prairie clover	DAPU5	*Dalea purpurea*	0-34	0-2
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0-28	0-1
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0-22	0-1
	spiny phlox	PHHO	*Phlox hoodii*	0-11	0-1
	bastard toadflax	COUM	*Comandra umbellata*	0-11	0-1
	desertparsley	LOMAT	*Lomatium*	0-11	0-1
	common yarrow	ACMI2	*Achillea millefolium*	0-11	0-1
	locoweed	OXYTR	*Oxytropis*	0-6	0-1
Shrub/Vine					
5	**Shrubs**			84-101	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	47-112	0-15
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0-67	0-3
	winterfat	KRLA2	*Krascheninnikovia lanata*	17-56	1-3
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0-17	0-1
	prairie sagewort	ARFR4	*Artemisia frigida*	0-11	0-2
	plains pricklypear	OPPO	*Opuntia polyacantha*	0-11	0-1
	spineless horsebrush	TECA2	*Tetradymia canescens*	0-11	0-1
	currant	RIBES	*Ribes*	0-6	0-1
	Woods' rose	ROWO	*Rosa woodsii*	0-6	0-1
Tree					

6	**Coniferous Trees and Tall Shrubs**			0-11	
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	0-11	0-1
	ponderosa pine	PIPOS	*Pinus ponderosa var. scopulorum*	0-11	0-1
	Douglas-fir	PSME	*Pseudotsuga menziesii*	0-11	0-1

Table 6. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 7. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 8. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 9. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 10. Community 5.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Animal community

The Shallow Clay (SwC) ecological site provides a variety of wildlife habitats for an array of species. Prior to the settlement of this area, large herds of antelope, elk, and bison roamed. Though the bison have been replaced, mostly with domesticated livestock, elk and antelope still frequently utilize this largely intact landscape for winter habitat in areas adjacent to forests. The relatively high grass component of the Reference Community provides excellent nesting cover for multiple neotropical migratory birds that select for open grasslands, such as the long-billed curlew and McCown's longspur. Managed livestock grazing is suitable on this site due to the potential to produce an abundance of high-quality forage. This is often a preferred site for grazing by livestock, and animals tend to congregate in these areas. To maintain the productivity of the Shallow Clay site, grazing on adjoining sites with less production must be managed carefully to be sure utilization on this site is not excessive. Management objectives should include maintenance or improvement of the native plant community. Careful management of the timing and duration of grazing is important. Shorter grazing periods and adequate deferment during the growing season are recommended for plant maintenance, health, and recovery. According to McLean et al., early-season defoliation of bluebunch wheatgrass can result in high mortality and reduced vigor in plants. They also suggest, based on prior studies, that the opportunity for regrowth is necessary before dormancy to reduce injury bluebunch. Since needle-and-thread normally matures earlier than bluebunch wheatgrass and produces a sharp awn, this species is usually avoided after seed set. Changing the grazing season will help utilize needle and thread more efficiently. Continual non-prescribed grazing of this site will be injurious, will alter the plant composition and production over time, and will result in the transition to the Altered State. The transition to other states will depend on the duration of poorly managed grazing as well as other circumstances such as weather conditions and fire frequency. The Altered State can degrade further to the Degraded Shortgrass State or the Invaded State. Management should focus on grazing management strategies that will prevent further degradation, such as seasonal grazing deferment or winter grazing where feasible. Communities within this state are still stable and healthy under proper management. Forage quantity and quality may be substantially decreased from the Reference State. Grazing is possible in the Invaded State. Invasive species are generally less palatable than native grasses. Forage production is typically greatly reduced in this state. Due to the aggressive nature of invasive species, sites in the Invaded State face an increased risk of further degradation to the Invaded Communities. Grazing must be carefully managed to avoid further soil loss and degradation and possible livestock health issues. Prescriptive grazing can be used to manage invasive species. In some instances, carefully targeted grazing (sometimes in combination with other treatments) can reduce or maintain species composition of invasive species. In the Degraded Shortgrass State, grazing may be possible but is generally not economically and/or environmentally sustainable.

Hydrological functions

The hydrologic cycle functions best in the Bunchgrass State (1) with good infiltration and deep percolation of rainfall; however, the cycle degrades as the vegetation community declines. Rapid rainfall infiltration, high soil organic matter, good soil structure, and good porosity accompany high bunchgrass canopy cover. High ground cover reduces raindrop impact on the soil surface, which keeps erosion and sedimentation transport low. Water leaving the site will have a minimal sediment load, which allows for high water quality in associated streams. High rates of infiltration will allow water to move below the rooting zone during periods of heavy rainfall. The Bluebunch Wheatgrass Community (1.1) should have no rills or gullies present, and drainage ways should be vegetated and stable. Water flow patterns, if present, will be barely observable. Plant pedestals are essentially nonexistent. Plant litter remains in place and is not moved by wind or water. Improper grazing management results in a community shift to the Mixed Bunchgrass Community (1.2). This plant community has a similar canopy cover, but bare ground will have less than 15 percent canopy. Therefore, the hydrologic cycle is functioning at a level similar to the water cycle in the Bluebunch Wheatgrass Community/Needle-and-Thread (1.1). Compared to the Bluebunch Wheatgrass/Needle-and-Thread Community (1.1), infiltration rates are slightly reduced and surface runoff is slightly higher. In the Rhizomatous Community (2.1), the Degraded Shortgrass State (3) and the Invaded State (4) have greatly reduced canopy and ground cover compared to the Bunchgrass State (1), which impedes the hydrologic cycle. Infiltration will decrease and runoff will increase due to reduced ground cover, the presence of shallow-rooted species, rainfall splash, soil capping, reduced organic matter, and poor structure. Sparse ground cover and decreased infiltration can combine to increase the frequency and severity of flooding within a watershed. Soil erosion is accelerated, the quality of surface runoff is poor, and sedimentation increases. The hydrology of the Conifer Encroached State (5) is highly variable, but studies suggest that an increased tree canopy affects the interception of rainfall as well as the amount of available soil moisture for herbaceous vegetation. This can negatively affect infiltration and increase runoff.

Recreational uses

This site provides some limited recreational opportunities for hiking, horseback riding, big game hunting, and upland bird hunting. The forbs have flowers that appeal to photographers. This site provides valuable open space.

Inventory data references

Information presented was derived from the site’s Range Site Description (SwCy 9 –14” P.Z., Northern Rocky Mountain Valleys, South, East of Continental Divide), NRCS clipping data, literature, field observations, and personal contacts with range-trained personnel (i.e., used professional opinion of agency specialists, observations of land managers, and outside scientists).

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Approval

Kirt Walstad, 2/11/2025

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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Date	04/25/2019
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** **Rills will not be evident on lesser sloping Reference Communities. Steeper slopes (greater than 30%) may have rills particularly after extreme weather events however they will remain short**

2. **Presence of water flow patterns:** **Water flow patterns will not be evident on lesser sloping Reference Communities however will likely be evident on slopes greater than 30% however they will be short.**

3. **Number and height of erosional pedestals or terracettes:** **Steep slopes (greater than 30%) may contain both pedestals and terracettes as a result of slow infiltration and higher run-off. Height of either will not exceed ¾" tall.**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** **Bare ground in Reference State can be highly variable from 20-30%.**

5. **Number of gullies and erosion associated with gullies:** **Not present.**

6. **Extent of wind scoured, blowouts and/or depositional areas:** **Not Evident**

7. **Amount of litter movement (describe size and distance expected to travel):** **Litter movement varies by slope class of the site as well as size of litter. In Reference, litter typically consists of perennial grass leaves and stems up less than 6-8 inches long and 0.25 inches in diameter. These types of litter tend to be resistant to movement on gentle slopes however may move up to 12 inches on steeper slopes as a result of extreme weather events.**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** **Site tends to remain relatively stable due to clay content. Stability values of 4-6 in interspaces and 5-6 under plant canopies/bases. A horizon is less than 2 inches thick**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Structure is medium to strong fine granular. A Horizon should be 2 inches thick with color, when wet, typically ranging in Value of 5 or less and Chroma of 3 or less. Local geology may affect color in which it is important to reference the Official Series Description (OSD) for characteristic range. https://soilseries.sc.egov.usda.gov/osdname.aspx

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Infiltration is naturally slow to clay content of soil. High proportions of deep rooted bunchgrasses combined with rhizomatous species between bunchgrasses optimized infiltration. Taproots of shrubs and forbs assist with infiltration. Plant spaces in a heterogenous pattern reduce runoff.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** A compaction layer is not present in the reference condition.

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: Mid-statured, perennial bunchgrasses

    Sub-dominant: Rhizomatous grasses = shortgrasses/grasslikes > forbs ? shrubs ? subshrubs

    Other:

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Plant mortality and decadence is rare on grasses and forbs. Some shrubs may express decadence in response to high snow load with slow infiltration on occasion.

14. **Average percent litter cover (%) and depth (in):** Total litter cover ranges from 35 to 45%. Most litter is irregularly distributed on the soil surface and is not at a measurable depth.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Average annual production is 850. Low: 580 High 1030. Production varies based on effective precipitation and natural variability of soil properties for this ecological site.

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:** Potential invasive (including noxious) species (native and non-native). Invasive species on this ecological site include (but not limited to) annual brome spp., spotted

knapweed, yellow toadflax, ventenata, crested wheatgrass, etc. Native species such as rocky mtn Juniper, ponderosa pine, Douglas fir, broom snakeweed, rabbitbrush spp., big sagebrush, blue grama, etc. when their populations are significant enough to affect ecological function, indicate site condition departure.

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17. **Perennial plant reproductive capability: In the reference condition, all plants are vigorous enough for reproduction either by seed or rhizomes in order to balance natural mortality with species recruitment.**
