Ecological site FX052X99X060
Overflow (Ov)

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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 and agriculturally and ecologically significant area. It consists of around 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 the till is sedimentary bedrock largely consisting of Cretaceous shale, sandstone, and mudstone (Vuke et al., 2007). It 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, and the maximum glacial extent occurred 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 occuring on the type of 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 fully understood at this time.

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 because 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: N/A

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: Mesomorphic Shrub and Herb Vegetation Class (2)
• Subclass: Temperate and Boreal Grassland and Shrubland Subclass (2.B)
• Formation: Temperate Grassland, Meadow, and Shrubland Formation (2.B.2)
• Division: Great Plains Grassland and Shrubland Division (2.b.2.Nb)
• Macrogroup: *Hesperostipa comata* – Pascopyrum smithii – Festuca hallii Grassland Macrogroup (2.B.2.Nb.2)
• Group: Pascopyrum smithii – *Hesperostipa comata* – Schizachyrium scoparium – Bouteloua spp. Mixedgrass Prairie Group (2.B.2.Nb.2.c)
• Alliance: Pascopyrum smithii – Nassella viridula Northwestern Great Plains Herbaceous Alliance
• Association: Pascopyrum smithii - Nassella viridula Herbaceous Vegetation

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) & Glaciated Northern Grasslands (42j)

Montana Riparian and Wetland Sites (Hansen et. al, 1995)
• Artemisia cana/Agropyron smithii Habitat Type

Ecological site concept

This provisional ecological site occurs in all climatic zones of MLRA 52. Figure 1 illustrates the distribution of this ecological site based on current data. This map is approximate, is not intended to be definitive, and may be subject to change. Overflow is an extensive ecological site occurring throughout MLRA 52. It occurs on flood plains and stream terraces where flooding and surface runoff provide additional moisture for plant growth. Sometimes, but not always, a seasonal water table is present at a depth of more than 40 inches below the soil surface, especially during peak runoff periods.

The distinguishing characteristics of this site are that it is located on flood plains and that it receives additional moisture from surface water. Soils for this ecological site are typically very deep (more than 60 inches) and derived from alluvium. Soil textures in the upper 4 inches are typically loam, silt loam, or silty clay loam. The soils typically have an ochric epipedon and are commonly stratified (USDA-NRCS, 2016) due to deposition of sediment from multiple flood events. Characteristic vegetation is green needlegrass (Nassella viridula), western wheatgrass (Pascopyrum smithii), and silver sagebrush (Artemisia cana). In some cases, snowberry (Symphoricarpos spp.) also may occur on this site.

Associated sites

FX052X99X150	**Subirrigated (Sb)** The Subirrigated site is adjacent to the Overflow site, typically on lower terraces where ground water is closer to the surface and contributes significantly to site production.
FX052X99X084	**Slough (Sl)** The Slough site is adjacent to the Overflow site, typically in oxbows or channels where flooding is very frequent and a water table is shallow and persistant.
FX052X99X091	**Saline Overflow (Sov)** The Saline Overflow site is adjacent to the Overflow site in similar landscape positions but in areas where salts have accumulated due to geology, hydrology, or soil properties.
FX052X99X061	**Riparian Woodland (RW)** The Riparian Woodland site is adjacent to the Overflow site, typically on lower terraces where flooding is more frequent and riparian woody plants are dominant.

Similar sites

FX052X99X091	**Saline Overflow (Sov)** This site differs from the Overflow site in that soils are saline, sodic, or saline-sodic (EC ≥ 4 or SAR ≥ 13). It supports more sodium-tolerant vegetation and is less productive.
FX052X99X061	**Riparian Woodland (RW)** This site differs from the Overflow site in that it occupies lower terraces and is dominated by riparian woody species. Shrubs and trees dominate the site in terms of cover and production.
FX052X01X062	**Swale (Se) Dry Grassland** This site differs from the Overflow site in that it does not receive additional moisture from stream overflow, but gets run-in from above. It is located in upland swales rather than on floodplains, is slightly less productive, and has a higher proportion of mid-statured bunchgrasses than the Overflow site.
FX052X03X062	**Swale (Se) Dry Shrubland** This site differs from the Overflow site in that it does not receive additional moisture from stream overflow, but gets run-in from above. It is located in upland swales rather than on floodplains, is slightly less productive, and has a higher proportion of mid-statured bunchgrasses than the Overflow site.
FX052X02X062	**Swale (Se) Moist Grassland** This site differs from the Overflow site in that it does not receive additional moisture from stream overflow, but gets run-in from above. It is located in upland swales rather than on floodplains, is slightly less productive, and has a higher proportion of mid-statured bunchgrasses than the Overflow site.
FX052X99X150	**Subirrigated (Sb)** This site differs from the Overflow site in that it occupies lower terraces. It receives additional moisture primarily from ground water whereas the Overflow site receives it from surface water. Depth to a water table is 24 to 40 inches.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Legacy ID

R052XY060MT

Physiographic features

Overflow is an extensive ecological site occurring on floodplains, alluvial fans, and stream terraces.

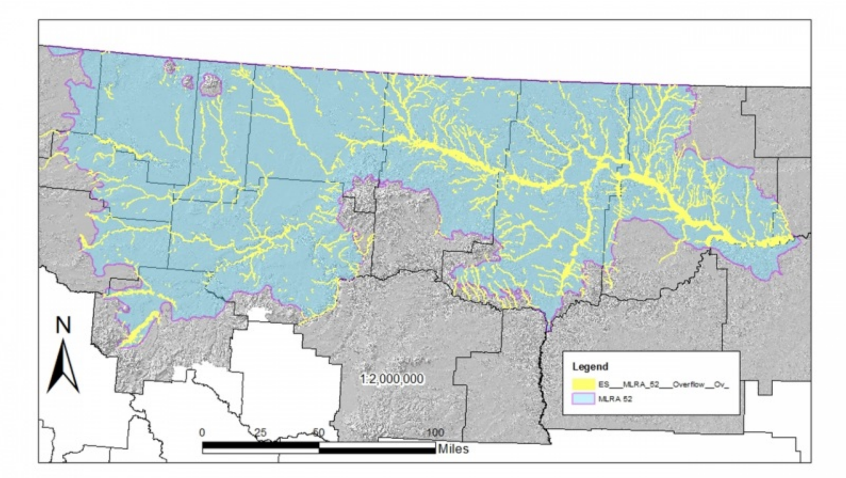

Figure 1. Figure 1. General distribution of the Overflow ecological site by mapunit extent

Table 2. Representative physiographic features

Landforms	(1) River valley > Flood plain (2) River valley > Alluvial fan (3) River valley > Stream terrace
Flooding duration	Brief (2 to 7 days)
Flooding frequency	Rare to occasional
Elevation	610–1,402 m
Slope	0–2%
Water table depth	102–152 cm
Aspect	Aspect is not a significant factor

Climatic features

The Brown Glaciated Plains is a semi-arid region with a temperate continental climate that is characterized by frigid winters and warm to hot summers (Cooper et al., 2001). The average frost-free period for this ecological site is 115 days. The majority of precipitation occurs as steady, soaking, frontal system rains in late spring to early summer. Summer rainfall comes mainly from convection thunderstorms that typically deliver scattered amounts of rain in intense bursts. These storms may be accompanied by damaging winds and large-diameter hail and result in flash flooding along low-order streams. Severe drought occurs on average in 2 out of every 10 years. Annual precipitation ranges from 10 to 17 inches, and 70 to 80 percent of this occurs during the growing season (Cooper et al., 2001). Extreme climatic variations, especially droughts, have the greatest influence on species cover and production (Coupland, 1958, 1961; Biondini et al., 1998).

During the winter months, the western half of MLRA 52 commonly experiences chinook winds, which are strong west to southwest surface winds accompanied by abrupt increases in temperature. The chinook winds are strongest on the western boundary of the MLRA near the Rocky Mountain foothills and decrease eastward. In addition to producing damaging winds, prolonged chinook episodes can result in drought or vegetation kills due to the reaction of plants to a “false spring” (Oard, 1993).

Table 3. Representative climatic features

Frost-free period (average)	115 days
Freeze-free period (average)	140 days

Precipitation total (average)	330 mm

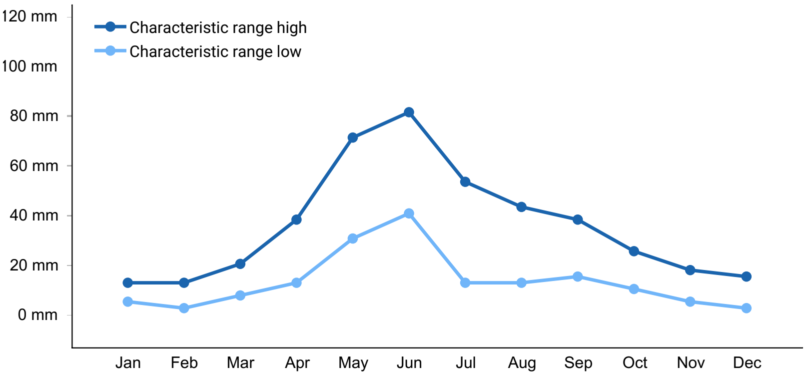

Figure 2. Monthly precipitation range

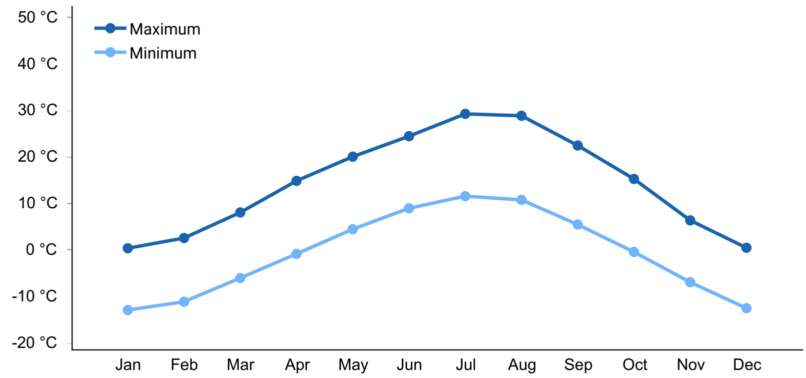

Figure 3. Monthly average minimum and maximum temperature

Climate stations used

- (1) GERALDINE [USC00243445], Geraldine, MT
- (2) CONRAD [USC00241974], Conrad, MT
- (3) TURNER 11N [USC00248415], Turner, MT
- (4) CONTENT 3 SSE [USC00241984], Zortman, MT
- (5) GOLDBUTTE 7 N [USC00243617], Sunburst, MT
- (6) SACO 1 NNW [USC00247265], Saco, MT
- (7) CARTER 14 W [USC00241525], Floweree, MT
- (8) CHESTER [USC00241692], Chester, MT
- (9) HARLEM [USC00243929], Harlem, MT
- (10) LOMA 1 WNW [USC00245153], Loma, MT

Influencing water features

This is a riparian site that receives additional moisture via surface runoff and from stream overflow. Hydrology is typical of upper stream terraces in that the site contributes recharge to the stream reach during peak precipitation cycles (May-June). The site receives additional moisture from surrounding uplands that saturates the soil profile and enters the stream as either surface flow or subsurface flow. During major flood events, the site may be flooded for brief durations. Outside of peak precipitation cycles, the stream system typically exhibits a losing hydrology pattern. Sometimes, a seasonal groundwater table deeper than 40 inches below the soil surface is present, particularly during spring runoff.

Soil features

The Overflow concept covers over 500,000 acres in MLRA 52. Soil series that best represent the central concept for this ecological site are Havre and Harlem soils that receive brief flooding. Both of these soils are in the Fluvents suborder. The Havre series is in the fine-loamy family, meaning it contains 18 to 35 percent clay in the particle-size control section, and has mixed mineralogy. The Harlem series is in the fine family, meaning it contains between 35 and 60 percent clay in the particle-size control section, and has smectitic mineralogy. The typical parent material for these soils is alluvium deposits. These and all other soils in this site concept receive additional moisture from surface runoff and/or brief flooding. The surface horizon lacks enough organic matter to have a mollic epipedon. The soil moisture regime for this ecological site concept is ustic, which means that the soils are moist in some or all parts for either 180 cumulative days or 90 consecutive days during the growing season but are dry in some or all parts for over 90 cumulative days. These soils have a frigid soil temperature regime (Soil Survey Staff, 2014).

Surface textures found on this site are typically loam, silt loam, or silty clay loam. The underlying horizons are typically comprised of stratified alluvial deposits. They are characterized by many thin layers of sediment deposited by past flood events. Textures are highly variable and may range from sandy loam to clay loam. In the upper 20 inches, electrical conductivity is less than 4 and the sodium absorption ratio is less than 13. The surface horizon typically contains 1 to 3 percent organic matter, and moist colors vary from brown (10YR 5/3) to dark grayish brown (10YR 4/2). Calcium carbonate equivalent is typically less than 15 percent throughout the soil profile. Soil pH classes are slightly acid to strongly alkaline in the surface horizon and slightly alkaline to strongly alkaline in the subsurface horizons. The soil depth class for this is site is typically very deep (more than 60 inches). Content of coarse fragments is less than 35 percent in the upper 20 inches of soil.

Table 4. Representative soil features

Parent material	(1) Alluvium
Surface texture	(1) Loam (2) Silt loam (3) Silty clay loam
Drainage class	Well drained
Soil depth	152–183 cm
Available water capacity (0-101.6cm)	11.18–17.02 cm
Calcium carbonate equivalent (0-12.7cm)	0–14%
Electrical conductivity (0-50.8cm)	0–3 mmhos/cm
Sodium adsorption ratio (0-50.8cm)	0–12
Soil reaction (1:1 water) (0-101.6cm)	6.1–9
Subsurface fragment volume <=3" (0-50.8cm)	0–34%
Subsurface fragment volume >3" (0-50.8cm)	0–34%

Ecological dynamics

The information in this ecological site description, including the state-and-transition model (STM), was developed based on historical data, current field data, professional experience, and a review of the scientific literature. As a result, all possible scenarios or plant species may not be included. Key indicator plant species, disturbances, and ecological processes are described to inform land management decisions.

The Overflow provisional ecological site in MLRA 52 Dry Grassland consists of four states: The Reference State (1.0), the Invaded State (2.0), the Cropland State (3.0), and the Post-Cropland State (4.0). Plant communities associated with this ecological site evolved under the combined influences of climate, grazing, hydrology, and fire. Extreme climatic variability results in frequent droughts, which have the greatest influence on the relative contribution of species cover and production (Coupland, 1958, 1961; Biondini et al., 1998). Due to the dominance of cool-season graminoids, annual production is highly dependent upon mid- to late-spring precipitation (Heitschmidt and Vermeire, 2005; Anderson, 2006).

Native grazers also shaped these plant communities. Bison (Bison bison) were the dominant historic grazer, but pronghorn (Antilocapra americana), elk (Cervus canadensis), and deer (Odocoileus spp.) were also common. Small mammals such as prairie dogs (Cynomys spp.) and ground squirrels (Urocitellus spp.) also influenced this plant community (Salo et al., 2004). Grasshoppers and periodic outbreaks of Rocky Mountain locusts (Melanoplus spretus; Lockwood, 2004) also played an important role in the ecology of these communities.

The historic ecosystem also experienced relatively frequent lightning-caused fires, with estimated fire return intervals of 6 to 25 years (Bragg, 1995). Historically, Native Americans also set periodic fires. The majority of lightning-caused fires occurred in July and August, whereas Native Americans typically set fires during spring and fall to correspond with the movement of bison (Higgins, 1986). Generally, the mixedgrass ecosystem is resilient to fire and the historic fire return interval had neutral or slightly positive effects on the plant community (Vermeire et al., 2011, 2014). However, studies have shown that shorter fire return intervals can have a negative effect, shifting species composition toward warm-season short-statured grasses (Shay et. al., 2001; Smith and McDermid, 2014). Conversely, long-term fire suppression in the 20th century removed periodic fire from the ecosystem altogether. Lack of periodic fires can result in an increase in litter accumulation, providing ideal conditions for seed germination and seedling establishment of non-native species.

Hydrology, particularly flooding, is another major ecological driver for this site. The amount of moisture received from runoff and/or flooding has a significant effect on species composition and production. If the hydrology is altered, or if downcutting or incisment of the stream channel occurs, production will decrease and the site may transition into a drier upland site. Excessive ponding or flooding of the site may, in some cases, cause salinization. On a large portion of this site, the hydrology has been significantly altered by irrigation, major dams, and diversions. The implications of this alteration have not been fully studied and require further investigation.

Improper grazing of this site can result in a reduction in the cover of the cool-season midgrasses and an increase in blue grama (Hansen et al., 1995; Smoliak et al., 1972). Improper grazing practices include any practices that do not allow sufficient opportunity for plants to physiologically recover from a grazing event or multiple grazing events within a given year and/or that do not provide adequate cover to prevent soil erosion over time. These practices may include, but are not limited to, overstocking, continuous grazing, and/or inadequate seasonal rotation moves over multiple years. Bunchgrasses are generally affected first. While western wheatgrass appears to be relatively resistant to grazing on this site, presumably due to the increased moisture availability and its rhizomatous nature, it can eventually be significantly reduced by improper grazing. Periods of drought can also reduce mid-statured, cool-season grasses (Coupland, 1958, 1961). Further degradation of the site due to improper grazing can result in reduced vigor of rhizomatous wheatgrasses and dominance of unpalatable forbs (Hansen et al., 1995). Cover of mid-statured bunchgrasses is severely reduced or absent. This site is quite resilient and has not been documented as crossing a threshold into an altered native state. However, it is highly susceptible to invasion by non-native species. Introduced perennial grasses such as bluegrasses (Poa spp.) and smooth brome (*Bromus inermis*) are the most common invasive species. These species appear to be able to invade any phase of the Reference State and, once established, will displace native species and dominate the ecological functions of the site. Noxious weeds are also a major concern on this site. Leafy spurge (*Euphorbia esula*), Canada thistle (*Cirsium arvense*), and Russian knapweed (*Acroptilon repens*), also known as hardheads, are common on this site and capable of displacing native species.

The Overflow ecological site is often considered prime farmland. The vast majority of this site has been converted to cropland, mostly for irrigated hay. Common crop species include alfalfa, orchardgrass, and a grass/alfalfa mix. Annual crops such as wheat, corn, and barley are occasionally planted as part of a rotation or when renovating hay fields. Flood irrigation is common. Water is typically diverted from nearby streams and delivered to fields via canals. Extensive irrigation systems are in place on many parts of the Milk and Missouri River drainages. When this site is taken out of production, the site is either allowed to revert back to native vegetation or is managed as perennial pasture. Sites left to undergo natural plant succession after cultivation can, over several decades, support cool-season midgrasses, although hydrology is typically drastically altered from the Reference State and invasion of non-native species is highly probable. Those sites seeded with non-native species may persist with this cover type indefinitely. Even when reseeded to native species, the site is unlikely to return to the Reference State due to altered hydrology and soil properties.

The STM diagram suggests possible pathways that plant communities on this site may follow as a result of a given set of ecological processes and management. The site may also support states not displayed in the STM diagram. Landowners and land managers should seek guidance from local professionals before prescribing a particular management or treatment scenario. Plant community responses vary across this MLRA due to variability in weather, soils, and aspect. The reference community phase may not necessarily be the management goal. The lists of plant species and species composition values are provisional and are not intended to cover the full range of conditions, species, and responses for the site. Species composition by dry weight is provided when available and is considered provisional based on the sources identified in the narratives associated with each community phase.

State 1: Reference State
The Reference State contains three community phases. This state evolved under the combined influences of climate, grazing, flooding, and fire, with climatic variation having the greatest influence on cover and production. In general, this phase was resilient to grazing and fire, although these factors could influence species composition in localized areas. Vegetation is characterized by silver sagebrush, rhizomatous wheatgrasses, and mid-statured cool-season bunchgrasses. Following disturbance, this state will exhibit an increase in blue grama and unpalatable forbs. Rhizomatous wheatgrasses and mid-statured bunchgrasses will decrease significantly (Hansen et al., 1995).

Community Phase 1.1: Reference Community Phase
The Reference Community Phase is dominated by silver sagebrush and rhizomatous wheatgrasses. Western wheatgrass is the principle species, but thickspike wheatgrass (*Elymus lanceolatus*) may be present as well. Mid-statured, cool-season bunchgrasses are common with green needlegrass by far the most abundant species. Other grass species that may be present at low cover are bearded slender wheatgrass (*Elymus trachycaulus* ssp. subsecundus), blue grama (*Bouteloua gracilis*), and needle and thread (*Hesperostipa comata*). Common forbs include American vetch (*Vicia americana*), scarlet globemallow, and common yarrow (*Achillea millefolium*). Silver sagebrush is abundant and may comprise up to 30 percent canopy cover. Other woody species that may be present are snowberry and plains cottonwood (*Populus deltoides*). When present, plains cottonwood generally makes up a widely spaced decadent stand that has an understory of silver sagebrush/rhizomatous wheatgrass (Hansen et al., 1995). The approximate species composition of the reference plant community is as follows:

Percent composition by weight*
Rhizomatous Wheatgrass 40%
Green Needlegrass 20%
Other Native Grasses 5%
Perennial Forbs 15%
Shrubs/Subshrubs 20%
Plains Cottonwood 0-1%

Estimated Total Annual Production*
Low - 1000
Representative Value - 1500
High - 2000
*Estimate based on current observation – subject to revision

Community Phase 1.2: Silver Sagebrush/Rhizomatous Wheatgrass/Forb Phase
The Silver Sagebrush/Rhizomatous Wheatgrass/Forb Phase is characterized by declining abundance of desirable grasses and an increase in unpalatable forbs and blue grama (Hansen et al., 1995). Rhizomatous wheatgrass are still the dominant grass species, but their abundance and production are beginning to decline. Green needlegrass is reduced to scattered plants and has low vigor. Blue grama increases but does not appear to dominate the site. Unpalatable forbs such as common yarrow (*Achillea millefolium*) and white sagebrush (*Artemisia ludoviciana*), also known as cudweed sagewort, are increasing in this phase. Cover of silver sagebrush remains around 30 percent.

Community Phase Pathway 1.1a
Drought, improper grazing management, or a combination of these factors can shift the Reference Community Phase (1.1) to the Silver Sagebrush/Rhizomatous Wheatgrass/Forb Phase (1.2). These factors favor a decrease in cool-season midgrasses and an increase in unpalatable forbs (Coupland, 1961; Hansen et al., 1995).

Community Phase Pathway 1.2a
Normal or above-average precipitation and proper grazing management can shift the Silver Sagebrush/Rhizomatous Wheatgrass/Forb Phase (1.2) to the Reference Community Phase (1.1). These factors favor a decrease in unpalatable forbs and an increase in cool-season midgrasses.

Community Phase Pathway 1.2b
Prolonged drought (approximately 3 years or more), continued improper grazing practices, or a combination of these factors can shift the Silver Sagebrush/Rhizomatous Wheatgrass/Forb Phase (1.2) to the At-Risk Phase (1.3). The Silver Sagebrush/Rhizomatous Wheatgrass/Forb Phase transitions to the At-Risk Phase when the understory becomes dominated by forbs.

Community Phase 1.3: At-Risk Phase
In the At-Risk Phase; the understory has become dominated by forbs. Green needlegrass has been eliminated or nearly so. Rhizomatous wheatgrasses have been significantly reduced and have poor vigor. Unpalatable forbs such as common yarrow and cudweed sagewort are the dominant herbaceous species. The decreased vigor of native grasses may make this phase more susceptible to invasion by non-native species such as Kentucky bluegrass (*Poa pratensis*), smooth brome, and noxious weeds.

Community Phase Pathway 1.3a
The At-Risk Community Phase (1.3) can return to the Silver Sagebrush/Rhizomatous Wheatgrass/Forb Phase (1.2) with normal or above-normal spring precipitation and proper grazing management.

Transition T1A
The Reference State (1) transitions to the Invaded State (2) when aggressive perennial grasses or noxious weeds invade. Kentucky bluegrass and smooth brome are widespread invasive species in the northern Great Plains (Toledo et al., 2014; Dekeyser et al., 2013). Close proximity to a seed source combined with favorable growing conditions are thought to be the major contributing factors to invasion on this site. Decreased vigor of native species may also increase susceptibility to invasion.

Transition T1B
Tillage or application of herbicide followed by seeding of cultivated crops, such as wheat, barley, or introduced hay, transitions the Reference State (1) to the Cropland State (4).

State 2: Invaded State
The Invaded State (2) occurs when invasive plant species invade adjacent native grassland communities. The Overflow ecological site is highly susceptible to invasion, and the Invaded State is very common. Flooding not only creates favorable growing conditions but also readily transports seed onto the site from upstream. It thereby creates ideal conditions for invasion by non-native species. A large portion of the uncultivated acres of this ecological site exhibit some degree of invasion by non-native species. In general, the Overflow ecological site is more susceptible to degradation by invasive species than by any other mechanism. Even slight disturbances can be sufficient for invasive species to establish.

Introduced perennial grasses, such as Kentucky bluegrass and smooth brome, are the most common concerns. These species are widespread throughout the Northern Great Plains (Toledo et al., 2014). They are very competitive and displace native species by forming dense root mats, altering nitrogen cycling, and having allelopathic effects on germination (DeKeyser et al., 2013). Plant communities dominated by Kentucky bluegrass and smooth brome have significantly less cover of native grass and forb species (Toledo et al., 2014; Dekeyser et al., 2009). They appear to be capable of invading any phase of the Reference State, regardless of grazing management practices, and have been found to substantially increase under long-term grazing exclusion (DeKeyser et al., 2009, 2013; Grant et al., 2009). Effects on soil quality are still unknown at the time of this writing, but possible concerns are alteration of surface hydrology and modification of soil surface structure (Toledo et al., 2014). Reduced plant species diversity, simplified structural complexity, and altered biologic processes result in a state that is substantially departed from the Reference State (1).

Although noxious weeds are not widespread in most of MLRA 52, they are a common concern on the Overflow ecological site. Leafy spurge, Russian knapweed, and Canada thistle are the most common noxious weeds. These species are very aggressive perennials that typically displace native species and dominate ecological function when they invade a site. Sometimes, these species can be suppressed through intensive management (herbicide application, biological control, or intensive grazing management). Control efforts are unlikely to eliminate noxious weeds, but their density can be sufficiently suppressed so that species composition and structural complexity are similar to that of the Reference State (1). However, cessation of control methods will most likely result in recolonization of the site by the noxious species.

Transition T2A
Tillage or application of herbicide followed by seeding of cultivated crops, such as wheat, barley, or introduced hay, transitions the Invaded State (2) to the Cropland State (3).

State 3: Cropland State
The Cropland State (3) occurs when land is put into cultivation. Deep, fertile soils and favorable moisture conditions make the Overflow ecological site prime farmland. Additionally, its proximity to perennial streams make it ideal for irrigation. Because of this, the vast majority of the Overflow ecological site has been converted to farmland. It is most commonly planted to non-native perennial species and irrigated for production of hay. Common species include alfalfa, orchardgrass, and grass/alfalfa mixes. Annual crops such as wheat and barley are commonly planted in rotation with perennial species at 5- to 15-year intervals. Silage corn is grown is some areas, but this crop is of limited extent. Flood irrigation is most common but center pivot sprinklers are used in some areas. Several major storage reservoirs and large networks of irrigation canals are present in much of the Milk and Missouri River valleys. Cropping and irrigation projects have vastly altered vegetation and hydrology on much of the Overflow ecological site.

Transition T3A
The transition from the Cropland State (3) to the Post-Cropland State (4) occurs with the cessation of cultivation. The site may be simply abandoned, seeded to introduced perennial forage species, or seeded to a mix of native species.

State 4: Post-Cropland State
The Post-Cropland State (5) occurs when cultivated cropland is abandoned and allowed to either re-vegetate naturally or is seeded to perennial species for grazing or wildlife use. This state can transition back to the Cropland State (3) if the site is put back into cultivation.

Phase 4.1: Abandoned Cropland Phase
In the absence of active management, the site can re-vegetate naturally and, over time, potentially return to a perennial grassland community. Shortly after cropland is abandoned, annual forbs invade the site (Samuel and Hart, 1994). At this phase, the site is highly susceptible to erosion due to the absence of perennial species. Eventually, these pioneering annual species are replaced by perennial species. This phase is highly susceptible to invasion by exotic species, such as smooth brome and Kentucky bluegrass, and noxious weeds.

Phase 4.2: Perennial Grass Phase
When the site is actively managed as perennial forage for grazing or wildlife, this community phase can persist indefinitely. This phase is not common but, when present, is typically managed as introduced perennial grasses for grazing. Sometimes irrigation and fertilization is used to boost production. Fine-textured soils may be subject to ponding and salinization if irrigation is not carefully managed. A mixture of native species may also be seeded to provide species composition and structural complexity similar to that of the Reference State (1). However, soil quality and hydrology have been substantially altered and are unlikely to return to pre-cultivation conditions.

Transition T4A
Tillage or application of herbicide followed by seeding of cultivated crops, such as wheat, barley, or introduced hay, transitions the Post-Cropland State (4) to the Cropland State (3).

State and transition model

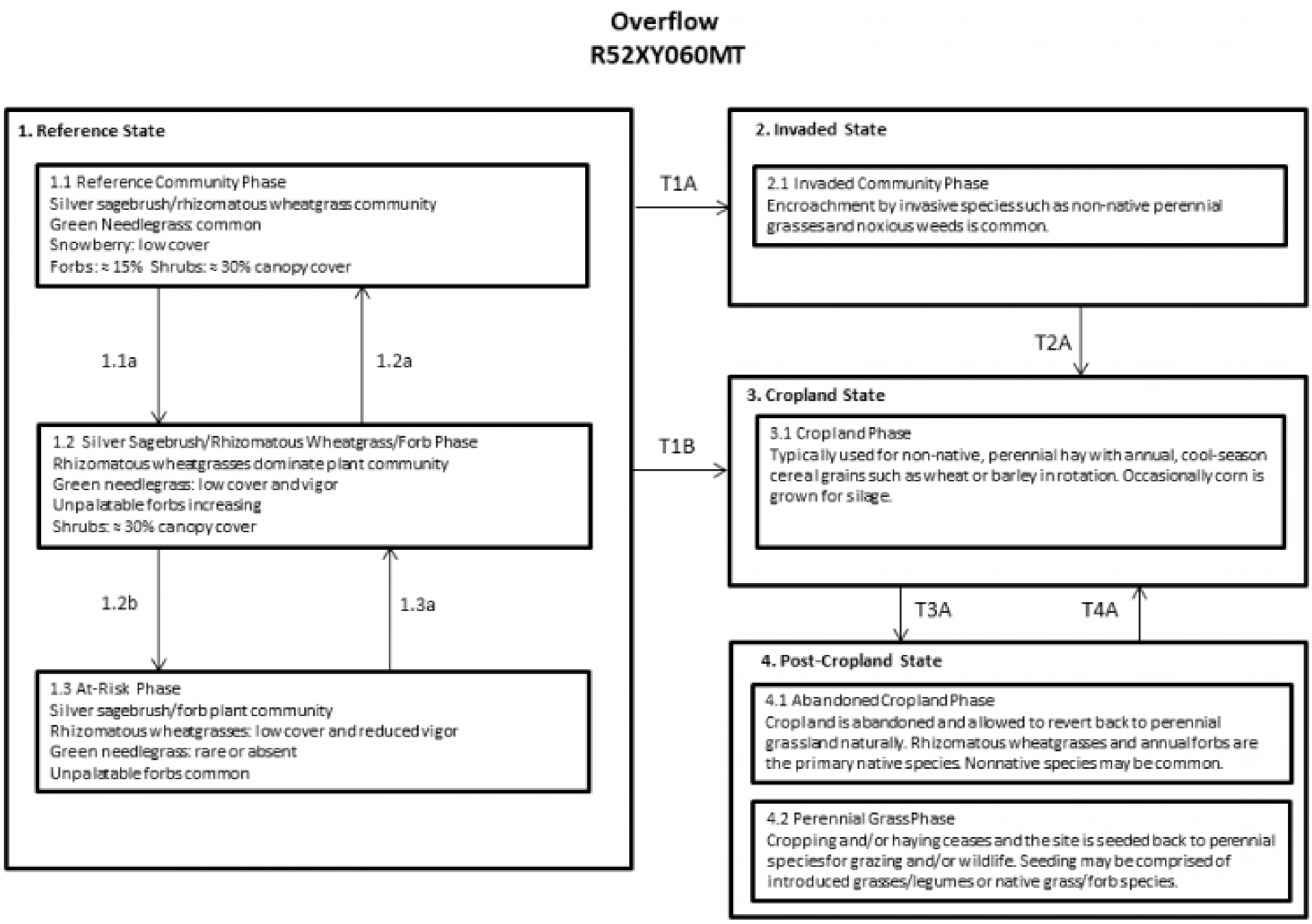

Figure 2. State-and-transition diagram

Overflow
R52XY060MT

Legend

- 1.1a drought, improper grazing management
- 1.2a normal or above-normal spring moisture, proper grazing management
- 1.2b prolonged drought, continued improper grazing, or a combination of these factors
- 1.3a normal or above-normal spring moisture, proper grazing management
- T1A introduction of non-native invasive species (introduced grasses and/or noxious weeds)
- T1B, T2A, T4A tillage or herbicide application and seeding of annual crops or non-native hayland (frequently combined with irrigation practices)
- T3A cessation of annual cropping

Figure 3. State-and-transition legend

Inventory data references

One medium-intensity plot and one low-intensity plot were available for this site. These plots were used in conjunction with a review of the scientific literature and professional experience to approximate the plant communities for this provisional ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional based on these plots and the sources identified in this ecological site description.

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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.

Author(s)/participant(s)	
Contact for lead author	
Date	

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

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

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:

---

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

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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):**

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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:**

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17. **Perennial plant reproductive capability:**
