United States Department of Agriculture

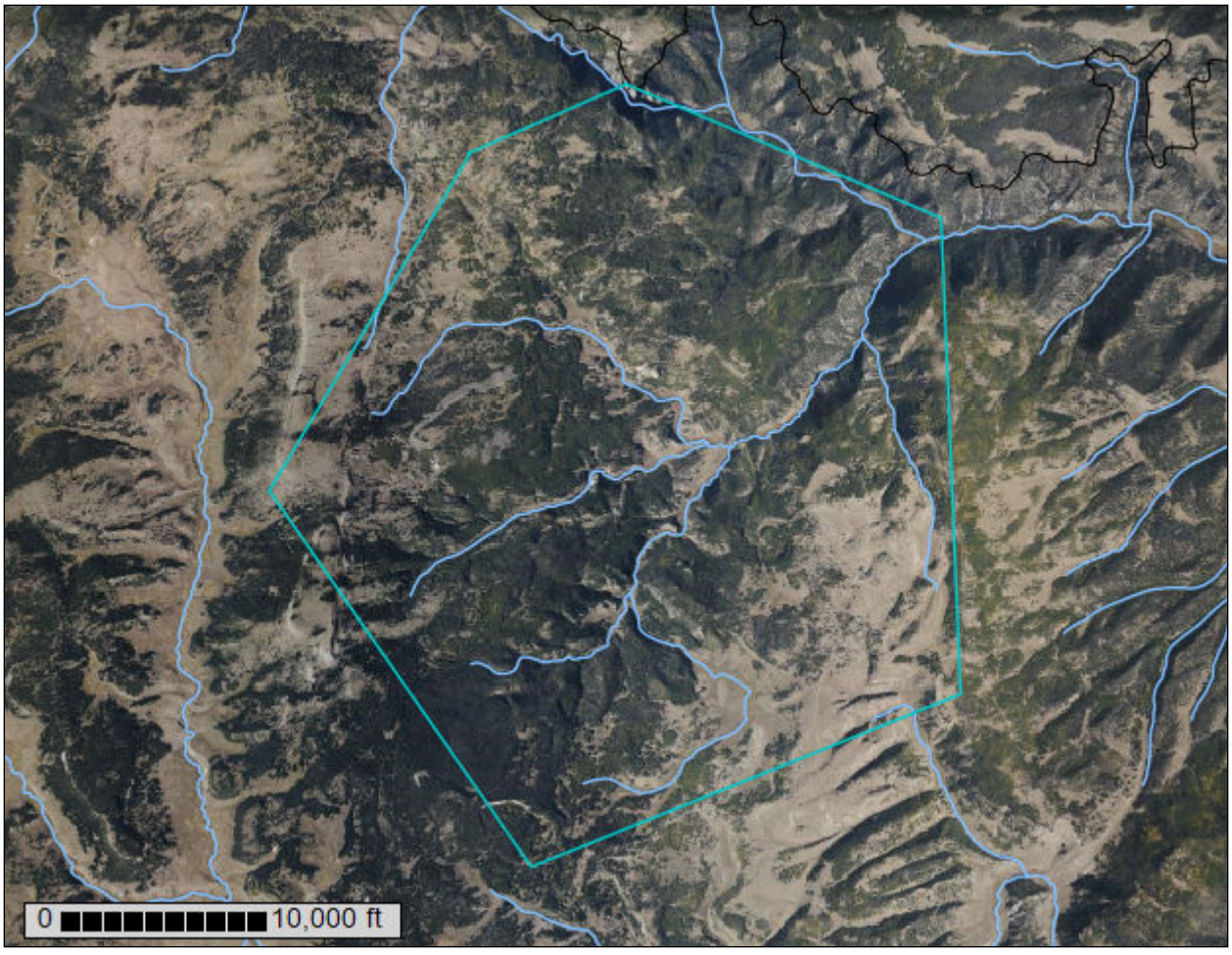
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Carson National Forest, New Mexico, Part of Rio Arriba County

APPENDIX A



February 13, 2024

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

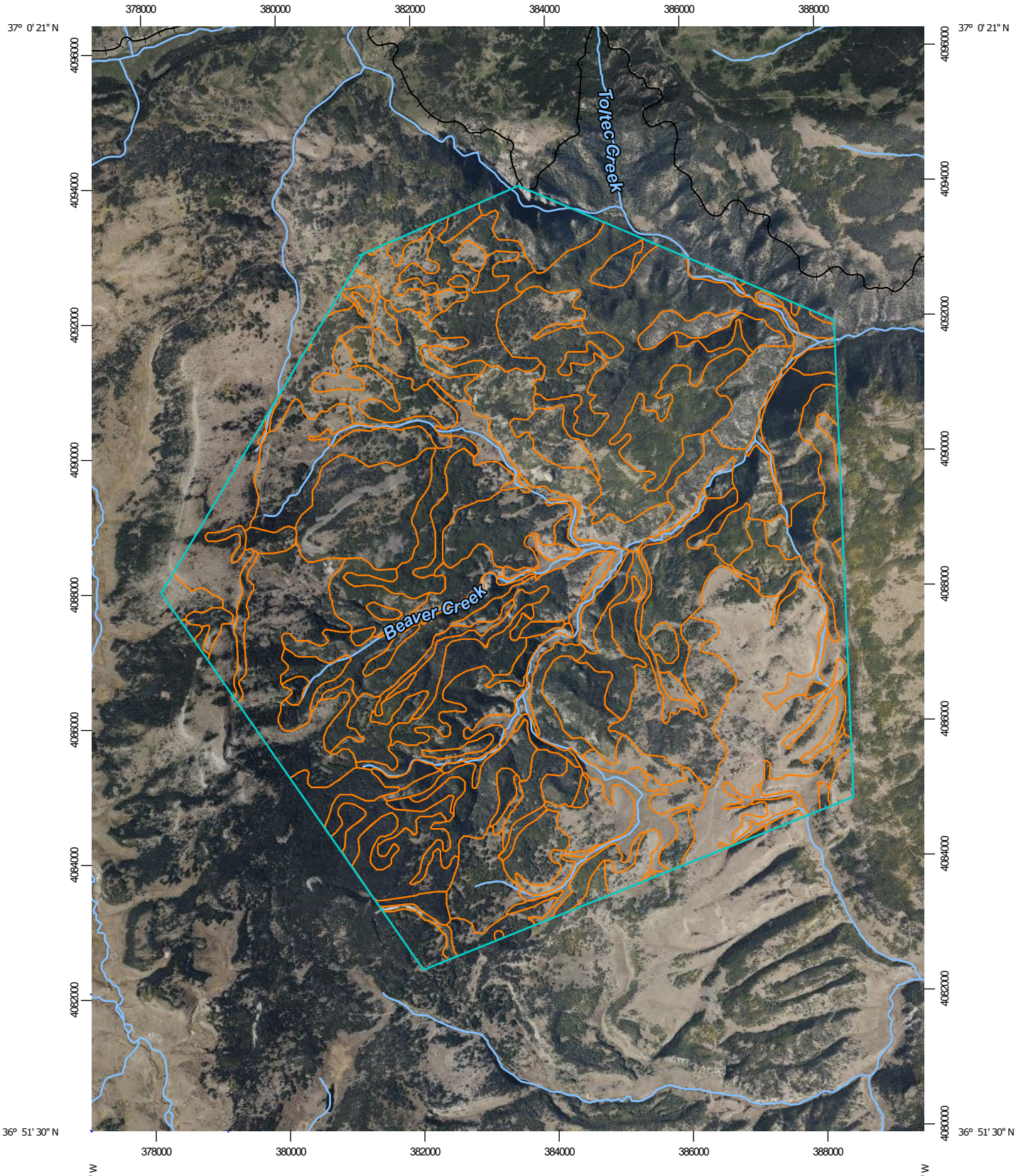
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.



Map Scale: 1:79,800 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 1000 2000 4000 6000

Feet
0 3500 7000 14000 21000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Carson National Forest, New Mexico, Part of Rio Arriba County
Survey Area Data: Version 10, Sep 7, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 16, 2021—Oct 4, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend (Cruces Basin Wilderness Soil Map 1)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
67	Typic Haplocryolls, Cumulic Haplocryolls, and Cumulic Cryaquolls, frequently ponded, soils, 0 to 15 percent slopes	987.7	4.8%
68	Aquic Haplocryolls-Typic Cryaquolls, occasionally ponded, association, 0 to 10 percent slopes	202.2	1.0%
126	Owlcreek family loam, 0 to 15 percent slopes	537.3	2.6%
127	Owlcreek-Presa families complex, 15 to 40 percent slopes	283.4	1.4%
128	Typic Dystrocryepts, 40 to 80 percent slopes, stony	546.0	2.7%
131	Owlcreek-Presa families complex, eroded, 0 to 15 percent slopes	1,534.1	7.5%
132	Typic Haplocryepts, eroded, 15 to 40 percent slopes	112.7	0.6%
135	Owlcreek family loam, eroded, 0 to 15 percent slopes	725.9	3.5%
136	Owlcreek family gravelly loam, eroded, 15 to 40 percent slopes	199.7	1.0%
175	Elbuck-Laventana families complex, 15 to 40 percent slopes	65.6	0.3%
178	Lake Janee family-Leighcan family, dry complex, 15 to 40 percent slopes	5.9	0.0%
179	Typic Haplocryalfs and Typic Dystrocryepts, dry soils, 40 to 80 percent slopes	973.0	4.8%
181	Typic Argicryolls, 0 to 15 percent slopes	112.7	0.6%
182	Sawpit family gravely loam, 15 to 40 percent slopes	286.4	1.4%
187	Calaveras family gravelly sandy loam, 15 to 40 percent slopes	52.2	0.3%
188	Typic Dystrustepts-Udic Haplustalfs complex, frigid, dry, 40 to 80 percent slopes	343.2	1.7%
320	Owlcreek family loam, dry, 0 to 15 percent slopes	2,548.2	12.4%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
321	Owlcreek-Presa families complex, dry, 15 to 40 percent slopes	3,154.2	15.4%
350	Lobat family loam, 0 to 15 percent slopes	11.0	0.1%
351	Abreu-Lobat families complex, 15 to 40 percent slopes	64.3	0.3%
454	Nimerick family loam, 0 to 40 percent slopes	2,114.9	10.3%
456	Leighcan family stony loam, 0 to 40 percent slopes	816.1	4.0%
460	Nimerick family loam, 0 to 15 percent slopes	1,418.4	6.9%
461	Nimerick-Leighcan families complex, 15 to 40 percent slopes	1,846.8	9.0%
471	Presa-Leighcan families complex, dry, 0 to 15 percent slopes	121.5	0.6%
475	Cryorthents, Udorthents, frigid, and Rock outcrop soils, 40 to 120 percent slopes, stony	1,291.1	6.3%
CvF	Calaveras loam, 5 to 35 percent slopes	14.3	0.1%
EmE	Empedrado-Curecanti complex, 2 to 25 percent slopes	12.8	0.1%
HeC	Hesperus-Dula, frequently flooded-Pastorius complex, 0 to 15 percent slopes	93.1	0.5%
Totals for Area of Interest		**20,475.6**	**100.0%**

Map Unit Descriptions (Cruces Basin Wilderness Soil Map 1)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made

up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Carson National Forest, New Mexico, Part of Rio Arriba County

67—Typic Haplocryolls, Cumulic Haplocryolls, and Cumulic Cryaquolls, frequently ponded, soils, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2sdl7
Elevation: 9,180 to 10,170 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 50 to 75 days
Farmland classification: Not prime farmland

Map Unit Composition

Typic haplocryolls and similar soils: 35 percent
Cumulic haplocryolls and similar soils: 30 percent
Cumulic cryaquolls, freq ponded, and similar soils: 25 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Typic Haplocryolls

Setting

Landform: Valley floors
Landform position (three-dimensional): Tread, talf
Down-slope shape: Concave
Across-slope shape: Concave, linear
Parent material: Alluvium derived from igneous, metamorphic and sedimentary rock

Typical profile

A - 0 to 7 inches: loam
Bw1 - 7 to 15 inches: sandy clay loam
Bw2 - 15 to 29 inches: sandy clay loam
C - 29 to 48 inches: sandy clay loam

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.71 to 2.13 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Maximum salinity: Nonsaline (0.0 to 1.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Other vegetative classification: FETH/DAIN/FEAR2 Thurber's fescue/Timber oatrgrass/Arizona fescue (10)

Hydric soil rating: No

Description of Cumulic Haplocryolls

Setting

Landform: Valley floors
Landform position (three-dimensional): Tread, talf
Down-slope shape: Concave
Across-slope shape: Concave, linear
Parent material: Alluvium derived from igneous, metamorphic and sedimentary rock

Typical profile

A - 0 to 17 inches: loam
Bw - 17 to 25 inches: clay loam
BC - 25 to 43 inches: silty clay loam

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.21 to 0.71 in/hr)
Depth to water table: About 39 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 3 percent
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Other vegetative classification: POPR/DECA5/DAIN Kentucky bluegrass/Tufted hairgrass/Timber oatgrass (11)
Hydric soil rating: No

Description of Cumulic Cryaquolls, Freq Ponded

Setting

Landform: Valley floors
Landform position (three-dimensional): Tread, talf
Down-slope shape: Concave
Across-slope shape: Concave, linear
Parent material: Alluvium derived from igneous and metamorphic rock

Typical profile

Oa - 0 to 2 inches: muck
A - 2 to 3 inches: loam
Bw - 3 to 10 inches: clay loam
C - 10 to 43 inches: silty clay loam

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.21 to 0.71 in/hr)

Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 2 percent
Available water supply, 0 to 60 inches: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: C/D
Other vegetative classification: CAAQ/JUDR/POPR Water sedge/Drummond's rush/Kentucky bluegrass (12)
Hydric soil rating: Yes

Minor Components

Pachic haplocryolls

Percent of map unit: 5 percent
Landform: Valley floors
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Concave
Other vegetative classification: FETH/DAIN/FEAR2 Thurber's fescue/Timber oatrgrass/Arizona fescue (10)
Hydric soil rating: No

Typic cryofluvents

Percent of map unit: 5 percent
Landform: Valley floors
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear
Across-slope shape: Concave
Other vegetative classification: ALTE2/PIPU Thinleaf alder/Blue spruce (74)
Hydric soil rating: No

68—Aquic Haplocryolls-Typic Cryaquolls, occasionally ponded, association, 0 to 10 percent slopes

Map Unit Setting

National map unit symbol: 2sdl8
Elevation: 9,510 to 10,170 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 40 to 70 days
Farmland classification: Not prime farmland

Map Unit Composition

Aquic haplocryolls and similar soils: 45 percent

Typic cryaquolls, occas ponding, and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Aquic Haplocryolls

Setting

Landform: Valley floors
Landform position (three-dimensional): Tread, talf
Down-slope shape: Concave
Across-slope shape: Concave, linear
Parent material: Alluvium derived from igneous, metamorphic and sedimentary rock

Typical profile

A - 0 to 10 inches: loam
Bw - 10 to 26 inches: loam
C - 26 to 60 inches: clay

Properties and qualities

Slope: 0 to 10 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.07 to 0.21 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 3 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Other vegetative classification: POFR4/POPR/DECA5/FEOV Shrubby cinquefoil/Kentucky bluegrass/Tufted hairgrass/Sheep fescue (13)
Hydric soil rating: No

Description of Typic Cryaquolls, Occas Ponding

Setting

Landform: Valley floors
Landform position (three-dimensional): Tread, talf
Down-slope shape: Concave
Across-slope shape: Concave, linear
Parent material: Alluvium derived from igneous, metamorphic and sedimentary rock

Typical profile

A - 0 to 10 inches: loam
Bw1 - 10 to 16 inches: silty clay loam
Bw2 - 16 to 29 inches: clay loam
2C - 29 to 60 inches: very cobbly clay loam

Properties and qualities

Slope: 0 to 10 percent

Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.07 to 0.21 in/hr)
Depth to water table: About 0 to 36 inches
Frequency of flooding: Occasional
Frequency of ponding: Occasional
Calcium carbonate, maximum content: 1 percent
Maximum salinity: Nonsaline (0.0 to 1.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 7.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: C/D
Other vegetative classification: CAVE6/DECA5/POPR Blister sedge/Tufted hairgrass/Kentucky bluegrass (14)
Hydric soil rating: Yes

Minor Components

Typic haplocryolls

Percent of map unit: 10 percent
Landform: Valley floors
Landform position (three-dimensional): Tread, talf
Down-slope shape: Concave
Across-slope shape: Concave
Other vegetative classification: FETH/DAIN/FEOV Thurber's fescue/Timber oatgrass/Sheep fescue (34)
Hydric soil rating: No

Typic cryohemists

Percent of map unit: 5 percent
Landform: Valley floors
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Other vegetative classification: SAPL/CAAQ/CALE Diamondleaf willow/Water sedge/White marsh marigold (70)
Hydric soil rating: Yes

126—Owlcreek family loam, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2sdlf
Elevation: 10,000 to 10,820 feet
Mean annual precipitation: 30 to 33 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 45 to 65 days

Farmland classification: Not prime farmland

Map Unit Composition

Owlcreek family and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Owlcreek Family

Setting

Landform: Plains, hills
Landform position (three-dimensional): Mountaintop, interfluve
Down-slope shape: Convex, linear
Across-slope shape: Linear
Parent material: Residuum weathered from volcanic and sedimentary rock

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 6 inches: loam
Bt1 - 6 to 24 inches: gravelly sandy clay loam
Bt2 - 24 to 60 inches: gravelly clay loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Other vegetative classification: PIEN/ABLAA Engelmann spruce/Corkbark fir (32)
Hydric soil rating: No

Minor Components

Presa family

Percent of map unit: 10 percent
Landform: Plains, hills
Landform position (three-dimensional): Mountaintop, interfluve
Down-slope shape: Convex, linear
Across-slope shape: Linear
Other vegetative classification: PIEN/ABLAA Engelmann spruce/Corkbark fir (32)
Hydric soil rating: No

Leighcan family

Percent of map unit: 5 percent
Landform: Plains, hills
Landform position (two-dimensional): Summit

Landform position (three-dimensional): Mountaintop, interfluve
Down-slope shape: Convex, linear
Across-slope shape: Linear
Other vegetative classification: PIEN/ABLAA Engelmann spruce/Corkbark fir (32)
Hydric soil rating: No

127—Owlcreek-Presa families complex, 15 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2sdlg
Elevation: 10,170 to 11,480 feet
Mean annual precipitation: 30 to 33 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 45 to 60 days
Farmland classification: Not prime farmland

Map Unit Composition

Owlcreek family and similar soils: 55 percent
Presa family and similar soils: 30 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Owlcreek Family

Setting

Landform: Scarps, hills
Landform position (three-dimensional): Mountainflank, head slope, nose slope, side slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, concave
Parent material: Colluvium derived from volcanic and sedimentary rock and/or residuum weathered from volcanic and sedimentary rock

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 6 inches: gravelly loam
Bt1 - 6 to 24 inches: gravelly sandy clay loam
Bt2 - 24 to 60 inches: gravelly clay loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent

Available water supply, 0 to 60 inches: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Other vegetative classification: PIEN/ABLAA Engelmann spruce/Corkbark fir (32)
Hydric soil rating: No

Description of Presa Family

Setting

Landform: Scarps, hills
Landform position (three-dimensional): Mountainflank, head slope, nose slope, side slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, concave
Parent material: Colluvium derived from volcanic and sedimentary rock and/or residuum weathered from volcanic and sedimentary rock

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
AB - 2 to 5 inches: gravelly loam
B - 5 to 8 inches: gravelly loam
Bt - 8 to 26 inches: very gravelly sandy clay loam
BC - 26 to 37 inches: very gravelly sandy loam
C - 37 to 60 inches: extremely gravelly sandy loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Low (about 5.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Other vegetative classification: PIEN/ABLAA Engelmann spruce/Corkbark fir (32)
Hydric soil rating: No

Minor Components

Typic dystrocryepts

Percent of map unit: 15 percent
Landform: Scarps, hills
Landform position (three-dimensional): Mountainflank, head slope, nose slope, side slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, concave

Other vegetative classification: PIEN/ABLAA Engelmann spruce/Corkbark fir (32)
Hydric soil rating: No

128—Typic Dystrocryepts, 40 to 80 percent slopes, stony

Map Unit Setting

National map unit symbol: 2sdlh
Elevation: 9,680 to 10,500 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 40 to 60 days
Farmland classification: Not prime farmland

Map Unit Composition

Typic dystrocryepts, stony, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Typic Dystrocryepts, Stony

Setting

Landform: Hills, scarps
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank, side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Colluvium derived from volcanic and sedimentary rock and/or residuum weathered from volcanic and sedimentary rock

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 4 inches: stony loam
Bw - 4 to 18 inches: gravelly loam
C1 - 18 to 30 inches: very gravelly sandy loam
C2 - 30 to 60 inches: very gravelly sandy loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 40 to 80 percent
Surface area covered with cobbles, stones or boulders: 0.1 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8e
Hydrologic Soil Group: B
Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

Minor Components

Typic cryorthents, stony

Percent of map unit: 10 percent
Landform: Scarps, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank, side slope
Down-slope shape: Linear
Across-slope shape: Convex
Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

Rock outcrop

Percent of map unit: 5 percent
Hydric soil rating: Unranked

131—Owlcreek-Presa families complex, eroded, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2sdlj
Elevation: 9,510 to 10,170 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 45 to 75 days
Farmland classification: Not prime farmland

Map Unit Composition

Owlcreek family, eroded, and similar soils: 55 percent
Presa family, eroded, and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Owlcreek Family, Eroded

Setting

Landform: Plains
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Concave
Parent material: Residuum weathered from volcanic and sedimentary rock

Typical profile

A - 0 to 6 inches: loam
Bt1 - 6 to 24 inches: gravelly sandy clay loam
Bt2 - 24 to 60 inches: gravelly clay loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Other vegetative classification: FETH/DAIN/FEAR2 Thurber's fescue/Timber oatrgrass/Arizona fescue (10)
Hydric soil rating: No

Description of Presa Family, Eroded

Setting

Landform: Plains
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Concave
Parent material: Residuum weathered from volcanic and sedimentary rock

Typical profile

A1 - 0 to 3 inches: loam
A2 - 3 to 7 inches: loam
Bt - 7 to 25 inches: very gravelly sandy clay loam
BC - 25 to 35 inches: very gravelly sandy loam
C - 35 to 60 inches: extremely gravelly sandy loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Other vegetative classification: FETH/DAIN/FEAR2 Thurber's fescue/Timber oatrgrass/Arizona fescue (10)
Hydric soil rating: No

Minor Components

Typic dystrocryepts

Percent of map unit: 5 percent
Landform: Plains
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Concave
Other vegetative classification: FETH/DAIN/FEAR2 Thurber's fescue/Timber oatrgrass/Arizona fescue (10)
Hydric soil rating: No

Lamy family #

Percent of map unit: 5 percent
Landform: Plains
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Concave
Other vegetative classification: FETH/DAIN/FEAR2 Thurber's fescue/Timber oatrgrass/Arizona fescue (10)
Hydric soil rating: No

132—Typic Haplocryepts, eroded, 15 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2sdlk
Elevation: 9,180 to 9,840 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 45 to 75 days
Farmland classification: Not prime farmland

Map Unit Composition

Typic haplocryepts, eroded, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Typic Haplocryepts, Eroded

Setting

Landform: Hills, scarps
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Mountainflank, interfluve, side slope
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Colluvium derived from volcanic and sedimentary rock and/or residuum weathered from conglomerate and/or residuum weathered from volcanic sandstone

Typical profile

A - 0 to 3 inches: gravelly sandy loam
Bw - 3 to 13 inches: cobbly sandy loam
C1 - 13 to 30 inches: cobbly sandy clay loam
C2 - 30 to 38 inches: fine sandy loam
R - 38 to 60 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Other vegetative classification: FETH/DAIN/FEAR2 Thurber's fescue/Timber oatrgrass/Arizona fescue (10)
Hydric soil rating: No

Minor Components

Typic haplocryalfs, eroded

Percent of map unit: 10 percent
Landform: Scarps, hills
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Mountainflank, side slope, interfluve
Down-slope shape: Linear, convex
Across-slope shape: Convex, concave
Other vegetative classification: FETH/DAIN/FEAR2 Thurber's fescue/Timber oatrgrass/Arizona fescue (10)
Hydric soil rating: No

Typic cryorthents, eroded

Percent of map unit: 5 percent
Landform: Scarps, hills
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Mountainflank, side slope, interfluve

Down-slope shape: Linear, convex
Across-slope shape: Convex, concave
Other vegetative classification: FETH/DAIN/FEAR2 Thurber's fescue/Timber oatrgrass/Arizona fescue (10)
Hydric soil rating: No

135—Owlcreek family loam, eroded, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2sdlm
Elevation: 10,000 to 10,820 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 45 to 65 days
Farmland classification: Not prime farmland

Map Unit Composition

Owlcreek family, eroded, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Owlcreek Family, Eroded

Setting

Landform: Plains, hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountaintop, interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from volcanic and sedimentary rock

Typical profile

A - 0 to 6 inches: loam
Bt1 - 6 to 24 inches: gravelly sandy clay loam
Bt2 - 24 to 60 inches: gravelly clay loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Other vegetative classification: FETH/DAIN/FEOV Thurber's fescue/Timber oatgrass/Sheep fescue (34)
Hydric soil rating: No

Minor Components

Nimerick family, eroded
Percent of map unit: 10 percent
Landform: Plains, hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountaintop, interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: FETH/DAIN/FEOV Thurber's fescue/Timber oatgrass/Sheep fescue (34)
Hydric soil rating: No

Leighcan family, eroded
Percent of map unit: 5 percent
Landform: Plains, hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountaintop, interfluve
Down-slope shape: Linear, convex
Across-slope shape: Linear
Other vegetative classification: FETH/DAIN/FEOV Thurber's fescue/Timber oatgrass/Sheep fescue (34)
Hydric soil rating: No

136—Owlcreek family gravelly loam, eroded, 15 to 40 percent slopes

Map Unit Setting
National map unit symbol: 2sdln
Elevation: 10,170 to 10,820 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 45 to 65 days
Farmland classification: Not prime farmland

Map Unit Composition
Owlcreek family, eroded, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Owlcreek Family, Eroded

Setting
Landform: Scarps, hills

Landform position (three-dimensional): Mountainflank, head slope, nose slope, side slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, concave
Parent material: Colluvium derived from volcanic and sedimentary rock and/or residuum weathered from volcanic and sedimentary rock

Typical profile

A - 0 to 6 inches: gravelly loam
Bt1 - 6 to 24 inches: gravelly sandy clay loam
Bt2 - 24 to 60 inches: gravelly clay loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Other vegetative classification: FETH/DAIN/FEOV Thurber's fescue/Timber oatgrass/Sheep fescue (34)
Hydric soil rating: No

Minor Components

Leighcan family, eroded

Percent of map unit: 8 percent
Landform: Scarps, hills
Landform position (three-dimensional): Mountainflank, head slope, nose slope, side slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, concave
Other vegetative classification: FETH/DAIN/FEOV Thurber's fescue/Timber oatgrass/Sheep fescue (34)
Hydric soil rating: No

Nimerick family, eroded

Percent of map unit: 7 percent
Landform: Scarps, hills
Landform position (three-dimensional): Mountainflank, head slope, nose slope, side slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, concave
Other vegetative classification: FETH/DAIN/FEOV Thurber's fescue/Timber oatgrass/Sheep fescue (34)
Hydric soil rating: No

175—Elbuck-Laventana families complex, 15 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2sdm7
Elevation: 7,540 to 8,360 feet
Mean annual precipitation: 20 to 24 inches
Mean annual air temperature: 41 to 43 degrees F
Frost-free period: 90 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition

Elbuck family and similar soils: 45 percent
Laventana family and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Elbuck Family

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from metamorphic and sedimentary rock and/or residuum weathered from metamorphic and sedimentary rock and/or slope alluvium derived from metamorphic and sedimentary rock

Typical profile

A - 0 to 2 inches: cobbly sandy loam
Bt1 - 2 to 9 inches: clay loam
Bt2 - 9 to 23 inches: clay loam
Bt3 - 23 to 37 inches: clay loam
BCk - 37 to 43 inches: clay loam
R - 43 to 80 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 17 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 3.0
Available water supply, 0 to 60 inches: Moderate (about 7.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Other vegetative classification: PIPO/QUGA Ponderosa pine/Gambel oak (41)
Hydric soil rating: No

Description of Laventana Family

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from metamorphic and sedimentary rock and/or residuum weathered from metamorphic and sedimentary rock and/or slope alluvium derived from metamorphic and sedimentary rock

Typical profile

Oe - 0 to 0 inches: moderately decomposed plant material
A - 0 to 4 inches: cobbly sandy loam
Bt1 - 4 to 11 inches: very cobbly sandy clay loam
Bt2 - 11 to 19 inches: very cobbly sandy clay loam
Bt3 - 19 to 32 inches: very cobbly sandy clay
R - 32 to 80 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Other vegetative classification: PIPO/QUGA Ponderosa pine/Gambel oak (41)
Hydric soil rating: No

Minor Components

Jemco family

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: PIPO/QUGA Ponderosa pine/Gambel oak (41)
Hydric soil rating: No

Udic haplustepts, frigid, dry

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Convex
Other vegetative classification: PIPO/QUGA Ponderosa pine/Gambel oak (41)
Hydric soil rating: No

178—Lake Janee family-Leighcan family, dry complex, 15 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2sdmb
Elevation: 9,180 to 9,840 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 60 to 75 days
Farmland classification: Not prime farmland

Map Unit Composition

Lake janee family and similar soils: 45 percent
Leighcan family, dry, and similar soils: 35 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lake Janee Family

Setting

Landform: Hillslopes, scarps
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oe - 1 to 1 inches: moderately decomposed plant material
A - 1 to 3 inches: sandy loam
BA - 3 to 9 inches: sandy loam
Bw - 9 to 26 inches: sandy loam
C - 26 to 60 inches: sandy loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

Description of Leighcan Family, Dry

Setting

Landform: Scarps, hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 4 inches: loam
Bw1 - 4 to 12 inches: very cobbly loam
Bw2 - 12 to 25 inches: very cobbly sandy loam
C - 25 to 80 inches: extremely cobbly sandy loam
R - 80 to 87 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B

Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

Minor Components

Owlcreek family, dry
Percent of map unit: 10 percent
Landform: Scarps, hillslopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Linear, convex
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

Nimerick family, dry
Percent of map unit: 10 percent
Landform: Scarps, hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear, convex
Across-slope shape: Linear
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

179—Typic Haplocryalfs and Typic Dystrocryepts, dry soils, 40 to 80 percent slopes

Map Unit Setting
National map unit symbol: 2sdmc
Elevation: 9,180 to 9,840 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 60 to 75 days
Farmland classification: Not prime farmland

Map Unit Composition
Typic haplocryalfs and similar soils: 45 percent
Typic dystrocryepts, dry, and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Typic Haplocryalfs

Setting
Landform: Mountain slopes, scarps
Landform position (three-dimensional): Mountainflank

Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

A1 - 0 to 3 inches: very cobbly sandy loam
A2 - 3 to 7 inches: very cobbly loam
E - 7 to 9 inches: extremely cobbly sandy loam
Bt1 - 9 to 23 inches: extremely gravelly loam
Bt2 - 23 to 30 inches: extremely gravelly sandy clay loam
R - 30 to 60 inches: bedrock

Properties and qualities

Slope: 40 to 80 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 1.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

Description of Typic Dystrocryepts, Dry

Setting

Landform: Mountain slopes, scarps
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

Oi - 0 to 0 inches: slightly decomposed plant material
A - 0 to 5 inches: very cobbly sandy loam
Bw - 5 to 15 inches: very cobbly fine sandy loam
C - 15 to 24 inches: very cobbly fine sandy loam
R - 24 to 60 inches: bedrock

Properties and qualities

Slope: 40 to 80 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 1.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

Minor Components

Lithic cryorthents

Percent of map unit: 10 percent
Landform: Mountain slopes, scarps
Down-slope shape: Convex, linear
Across-slope shape: Convex
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

Rock outcrop

Percent of map unit: 5 percent
Hydric soil rating: Unranked

181—Typic Argicryolls, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2sdmd
Elevation: 9,510 to 10,170 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 60 to 75 days
Farmland classification: Not prime farmland

Map Unit Composition

Typic argicryolls and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Typic Argicryolls

Setting

Landform: Plains, hills
Landform position (three-dimensional): Interfluve

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from volcanic and sedimentary rock

Typical profile

A - 0 to 2 inches: loam
AB - 2 to 8 inches: loam
Bt - 8 to 14 inches: clay loam
C1 - 14 to 19 inches: sandy clay loam
C2 - 19 to 26 inches: sandy loam
R - 26 to 60 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline (0.0 to 1.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Other vegetative classification: FETH Thurber's fescue (22)
Hydric soil rating: No

Minor Components

Typic haplocryalfs

Percent of map unit: 5 percent
Landform: Plains, hills
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: FETH Thurber's fescue (22)
Hydric soil rating: No

182—Sawpit family gravely loam, 15 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2sdmf
Elevation: 9,180 to 10,170 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 60 to 75 days

Farmland classification: Not prime farmland

Map Unit Composition

Sawpit family and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sawpit Family

Setting

Landform: Mountain slopes, scarps
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Concave, convex, linear
Parent material: Colluvium derived from volcanic and sedimentary rock and/or residuum weathered from volcanic and sedimentary rock

Typical profile

A1 - 0 to 3 inches: gravelly loam
A2 - 3 to 7 inches: very cobbly loam
Bw1 - 7 to 11 inches: very cobbly loam
Bw2 - 11 to 22 inches: very cobbly sandy loam
C - 22 to 51 inches: extremely cobbly sandy loam
R - 51 to 61 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 22 to 61 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Available water supply, 0 to 60 inches: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Other vegetative classification: FETH/DAIN/FEAR2 Thurber's fescue/Timber oatrgrass/Arizona fescue (10)
Hydric soil rating: No

Minor Components

Pachic haplocryolls

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Other vegetative classification: FETH/DAIN/FEAR2 Thurber's fescue/Timber oatrgrass/Arizona fescue (10)

Hydric soil rating: No

Typic argicryolls

Percent of map unit: 5 percent
Landform: Hillslopes, scarps
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave, linear
Across-slope shape: Convex, linear
Other vegetative classification: FETH/DAIN/FEAR2 Thurber's fescue/Timber oatrgrass/Arizona fescue (10)
Hydric soil rating: No

187—Calaveras family gravelly sandy loam, 15 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2sdmj
Elevation: 8,200 to 9,510 feet
Mean annual precipitation: 24 to 30 inches
Mean annual air temperature: 36 to 41 degrees F
Frost-free period: 80 to 100 days
Farmland classification: Not prime farmland

Map Unit Composition

Calaveras family and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Calaveras Family

Setting

Landform: Mountain slopes, scarps
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex, linear
Across-slope shape: Concave, linear
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oe - 1 to 1 inches: moderately decomposed plant material
A - 1 to 6 inches: gravelly sandy loam
Bw1 - 6 to 24 inches: very gravelly fine sandy loam
Bw2 - 24 to 36 inches: very gravelly loam
C - 36 to 60 inches: very gravelly sandy clay loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock

Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Other vegetative classification: ABCO/PSMEG/PIPO/QUGA White fir/Rocky mtn. douglas fir/Ponderosa pine/Gambel oak (47)
Hydric soil rating: No

Minor Components

Tusas family #

Percent of map unit: 10 percent
Landform: Mountain slopes, scarps
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank
Down-slope shape: Concave, linear
Across-slope shape: Convex, linear
Other vegetative classification: ABCO/PSMEG/PIPO/QUGA White fir/Rocky mtn. douglas fir/Ponderosa pine/Gambel oak (47)
Hydric soil rating: No

Lobat family

Percent of map unit: 5 percent
Landform: Mountain slopes, scarps
Landform position (three-dimensional): Mountainflank
Down-slope shape: Concave, linear
Across-slope shape: Convex, linear
Other vegetative classification: ABCO/PSMEG/PIPO/QUGA White fir/Rocky mtn. douglas fir/Ponderosa pine/Gambel oak (47)
Hydric soil rating: No

188—Typic Dystrustepts-Udic Haplustalfs complex, frigid, dry, 40 to 80 percent slopes

Map Unit Setting

National map unit symbol: 2sdmk
Elevation: 8,200 to 9,510 feet
Mean annual precipitation: 25 to 28 inches
Mean annual air temperature: 36 to 41 degrees F
Frost-free period: 80 to 100 days
Farmland classification: Not prime farmland

Map Unit Composition

Typic dystrustepts, frigid, dry, and similar soils: 60 percent
Udic haplustalfs, frigid, dry, and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Typic Dystrustepts, Frigid, Dry

Setting

Landform: Mountain slopes, scarps
Landform position (three-dimensional): Mountainflank
Down-slope shape: Concave, linear
Across-slope shape: Convex, linear
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 6 inches: very cobbly sandy loam
Bw - 6 to 24 inches: very gravelly sandy loam
C - 24 to 61 inches: very cobbly loamy sand
R - 61 to 80 inches: bedrock

Properties and qualities

Slope: 40 to 80 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Other vegetative classification: ABCO/PSMEG/PIPO/QUGA White fir/Rocky mtn. douglas fir/Ponderosa pine/Gambel oak (47)
Hydric soil rating: No

Description of Udic Haplustalfs, Frigid, Dry

Setting

Landform: Mountain slopes, scarps
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex, linear
Across-slope shape: Concave, linear
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

A1 - 0 to 3 inches: very cobbly sandy loam

A2 - 3 to 8 inches: loam
Bt1 - 8 to 20 inches: cobbly loam
Bt2 - 20 to 27 inches: cobbly clay loam
C1 - 27 to 30 inches: gravelly sandy clay loam
C2 - 30 to 60 inches: very gravelly sandy clay loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 40 to 80 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Other vegetative classification: ABCO/PSMEG/PIPO/QUGA White fir/Rocky mtn. douglas fir/Ponderosa pine/Gambel oak (47)
Hydric soil rating: No

320—Owlcreek family loam, dry, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2sdn0
Elevation: 9,180 to 9,840 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 60 to 75 days
Farmland classification: Not prime farmland

Map Unit Composition

Owlcreek family, dry, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Owlcreek Family, Dry

Setting

Landform: Plains
Landform position (three-dimensional): Mountaintop, interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from volcanic sandstone

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 6 inches: loam
Bt1 - 6 to 24 inches: gravelly sandy clay loam
Bt2 - 24 to 60 inches: gravelly clay loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

Minor Components

Typic dystrocryepts, dry

Percent of map unit: 10 percent
Landform: Plains
Landform position (three-dimensional): Mountaintop, interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

Presa family, dry

Percent of map unit: 10 percent
Landform: Plains
Landform position (three-dimensional): Mountaintop, interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

321—Owlcreek-Presa families complex, dry, 15 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2sdn1
Elevation: 9,180 to 9,840 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 60 to 75 days
Farmland classification: Not prime farmland

Map Unit Composition

Owlcreek family, dry, and similar soils: 60 percent
Presa family, dry, and similar soils: 30 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Owlcreek Family, Dry

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Colluvium derived from metamorphic and sedimentary rock and/or residuum weathered from metamorphic and sedimentary rock

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 6 inches: sandy loam
Bt1 - 6 to 24 inches: gravelly sandy clay loam
Bt2 - 24 to 60 inches: gravelly clay loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C

Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

Description of Presa Family, Dry

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Colluvium derived from metamorphic and sedimentary rock and/or residuum weathered from metamorphic and sedimentary rock

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
AB - 2 to 5 inches: loam
B - 5 to 8 inches: gravelly loam
Bt - 8 to 26 inches: very gravelly sandy clay loam
BC - 26 to 37 inches: very gravelly sandy loam
C - 37 to 60 inches: extremely gravelly sandy loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

Minor Components

Typic dystrocryepts, dry

Percent of map unit: 10 percent
Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Convex
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

350—Lobat family loam, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2sw52
Elevation: 8,200 to 9,510 feet
Mean annual precipitation: 24 to 30 inches
Mean annual air temperature: 36 to 41 degrees F
Frost-free period: 80 to 100 days
Farmland classification: Not prime farmland

Map Unit Composition

Lobat family and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lobat Family

Setting

Landform: Plains
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from sedimentary rock and/or residuum weathered from sedimentary rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 5 inches: loam
E - 5 to 14 inches: sandy clay loam
Bt1 - 14 to 21 inches: sandy clay loam
Bt2 - 21 to 34 inches: clay loam
Bt3 - 34 to 60 inches: clay loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Other vegetative classification: ABCO/PSMEG/PIPO/QUGA White fir/Rocky mtn. douglas fir/Ponderosa pine/Gambel oak (47)
Hydric soil rating: No

Minor Components

Rocio family
Percent of map unit: 10 percent
Landform: Plains
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: ABCO/PSMEG/PIPO/QUGA White fir/Rocky mtn. douglas fir/Ponderosa pine/Gambel oak (47)
Hydric soil rating: No

Abreu family
Percent of map unit: 5 percent
Landform: Plains
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: ABCO/PSMEG/PIPO/QUGA White fir/Rocky mtn. douglas fir/Ponderosa pine/Gambel oak (47)
Hydric soil rating: No

351—Abreu-Lobat families complex, 15 to 40 percent slopes

Map Unit Setting
National map unit symbol: 2sw53
Elevation: 8,530 to 9,510 feet
Mean annual precipitation: 24 to 28 inches
Mean annual air temperature: 36 to 41 degrees F
Frost-free period: 80 to 100 days
Farmland classification: Not prime farmland

Map Unit Composition
Abreu family and similar soils: 50 percent
Lobat family and similar soils: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Abreu Family

Setting
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Nose slope, side slope, crest

Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 4 inches: loam
BA - 4 to 11 inches: very gravelly sandy clay loam
Bt1 - 11 to 24 inches: very gravelly sandy clay loam
Bt2 - 24 to 37 inches: very gravelly sandy clay loam
BC - 37 to 41 inches: very gravelly sandy clay loam
R - 41 to 60 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.01 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 4.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Other vegetative classification: ABCO/PSMEG/PIPO/QUGA White fir/Rocky mtn. douglas fir/Ponderosa pine/Gambel oak (47)
Hydric soil rating: No

Description of Lobat Family

Setting

Landform: Hillslopes
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Convex
Across-slope shape: Concave
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 5 inches: sandy clay loam
E - 5 to 14 inches: sandy clay loam
Bt1 - 14 to 21 inches: sandy clay loam
Bt2 - 21 to 34 inches: clay loam
Bt3 - 34 to 60 inches: clay loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Other vegetative classification: ABCO/PSMEG/PIPO/QUGA White fir/Rocky mtn. douglas fir/Ponderosa pine/Gambel oak (47)
Hydric soil rating: No

Minor Components

Calaveras family

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Concave
Across-slope shape: Convex
Other vegetative classification: ABCO/PSMEG/PIPO/QUGA White fir/Rocky mtn. douglas fir/Ponderosa pine/Gambel oak (47)
Hydric soil rating: No

454—Nimerick family loam, 0 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2sw59
Elevation: 9,510 to 10,820 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 50 to 70 days
Farmland classification: Not prime farmland

Map Unit Composition

Nimerick family and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nimerick Family

Setting

Landform: Plains, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex, concave
Across-slope shape: Concave, convex
Parent material: Landslide slope alluvium derived from igneous, metamorphic and sedimentary rock

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 7 inches: loam
Bw - 7 to 15 inches: cobbly loam
C - 15 to 43 inches: cobbly loam
R - 43 to 60 inches: bedrock

Properties and qualities

Slope: 0 to 40 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

Minor Components

Typic cryaquolls

Percent of map unit: 10 percent
Landform: Plains
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Other vegetative classification: FETH/DAIN/FEOV Thurber's fescue/Timber oatgrass/Sheep fescue (34)
Hydric soil rating: Yes

Doct family

Percent of map unit: 10 percent
Landform: Plains, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear, concave

Across-slope shape: Linear, convex
Other vegetative classification: FETH/DAIN/FEOV Thurber's fescue/Timber oatgrass/Sheep fescue (34)
Hydric soil rating: No

456—Leighcan family stony loam, 0 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2sw5b
Elevation: 9,840 to 10,820 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 50 to 70 days
Farmland classification: Not prime farmland

Map Unit Composition

Leighcan family and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leighcan Family

Setting

Landform: Plains, hills
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Linear
Across-slope shape: Concave, linear
Parent material: Residuum weathered from volcanic and metamorphic rock and/or slope alluvium derived from volcanic and metamorphic rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 4 inches: stony loam
Bw1 - 4 to 12 inches: very cobbly loam
Bw2 - 12 to 25 inches: very cobbly sandy loam
C - 25 to 80 inches: extremely cobbly sandy loam
R - 80 to 87 inches: bedrock

Properties and qualities

Slope: 0 to 40 percent
Surface area covered with cobbles, stones or boulders: 0.1 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

Minor Components

Typic haplocryalfs

Percent of map unit: 10 percent
Landform: Plains, hills
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

Nimerick family

Percent of map unit: 5 percent
Landform: Plains, hills
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Concave, linear
Across-slope shape: Linear
Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

460—Nimerick family loam, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2sw5c
Elevation: 9,510 to 10,820 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 50 to 70 days
Farmland classification: Not prime farmland

Map Unit Composition

Nimerick family and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nimerick Family

Setting

Landform: Hills, plains
Landform position (three-dimensional): Interfluve

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from volcanic and metamorphic rock

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 7 inches: loam
Bw - 7 to 15 inches: cobbly loam
C - 15 to 26 inches: cobbly loam
R - 26 to 60 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 22 to 60 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

Minor Components

Owlcreek family

Percent of map unit: 5 percent
Landform: Hills, plains
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

Leighcan family

Percent of map unit: 5 percent
Landform: Hills, plains
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

461—Nimerick-Leighcan families complex, 15 to 40 percent slopes

Map Unit Setting

National map unit symbol: 2sw5d
Elevation: 9,840 to 10,500 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 50 to 70 days
Farmland classification: Not prime farmland

Map Unit Composition

Nimerick family and similar soils: 70 percent
Leighcan family and similar soils: 20 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nimerick Family

Setting

Landform: Hillslopes
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 7 inches: loam
Bw - 7 to 15 inches: cobbly loam
C - 15 to 43 inches: cobbly loam
R - 43 to 60 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B

Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

Description of Leighcan Family

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 4 inches: loam
Bw1 - 4 to 12 inches: very cobbly loam
Bw2 - 12 to 25 inches: very cobbly sandy loam
C - 25 to 80 inches: extremely cobbly sandy loam
R - 80 to 87 inches: bedrock

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

Minor Components

Lake janee family

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Convex
Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

Typic haplocryalfs

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Convex
Other vegetative classification: PIEN/ABLAA/POTR5 Engelmann spruce/Corkbark fir/Quaking aspen (33)
Hydric soil rating: No

471—Presa-Leighcan families complex, dry, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2sw5h
Elevation: 9,180 to 10,170 feet
Mean annual precipitation: 28 to 31 inches
Mean annual air temperature: 32 to 36 degrees F
Frost-free period: 60 to 75 days
Farmland classification: Not prime farmland

Map Unit Composition

Presa family, dry, and similar soils: 60 percent
Leighcan family, dry, and similar soils: 35 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Presa Family, Dry

Setting

Landform: Plains, hills
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear, convex
Across-slope shape: Linear
Parent material: Residuum weathered from volcanic and metamorphic rock

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
AB - 2 to 5 inches: loam
B - 5 to 8 inches: gravelly loam
Bt - 8 to 26 inches: very gravelly sandy clay loam
BC - 26 to 37 inches: very gravelly sandy loam
C - 37 to 60 inches: extremely gravelly sandy loam
R - 60 to 80 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

Description of Leighcan Family, Dry

Setting

Landform: Plains, hills
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear, convex
Parent material: Residuum weathered from volcanic and metamorphic rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 4 inches: loam
Bw1 - 4 to 12 inches: very cobbly loam
Bw2 - 12 to 25 inches: very cobbly sandy loam
C - 25 to 80 inches: extremely cobbly sandy loam
R - 80 to 87 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

Minor Components

Jaroso family

Percent of map unit: 5 percent

Landform: Hills, plains
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Other vegetative classification: PIEN/ABLAA/ABCO/PSMEG Engelmann spruce/ Corkbark fir/White fir/Rocky mtn. douglas fir (46)
Hydric soil rating: No

475—Cryorthents, Udorthents, frigid, and Rock outcrop soils, 40 to 120 percent slopes, stony

Map Unit Setting

National map unit symbol: 2sw5j
Elevation: 8,860 to 10,500 feet
Mean annual precipitation: 26 to 31 inches
Mean annual air temperature: 32 to 43 degrees F
Frost-free period: 50 to 95 days
Farmland classification: Not prime farmland

Map Unit Composition

Cryorthents, stony, and similar soils: 45 percent
Udorthents, frigid, stony, and similar soils: 40 percent
Rock outcrop: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cryorthents, Stony

Setting

Landform: Mountain slopes, scarps
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: stony sandy loam
AC - 3 to 9 inches: very gravelly loam
C1 - 9 to 34 inches: very gravelly sandy loam
C2 - 34 to 40 inches: extremely gravelly sandy loam
R - 40 to 60 inches: bedrock

Properties and qualities

Slope: 40 to 120 percent
Surface area covered with cobbles, stones or boulders: 0.1 percent
Depth to restrictive feature: 10 to 80 inches to lithic bedrock
Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 2.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Other vegetative classification: PIEN Engelmann spruce (59)
Hydric soil rating: No

Description of Udorthents, Frigid, Stony

Setting

Landform: Scarps
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from igneous, metamorphic and sedimentary rock and/or residuum weathered from igneous, metamorphic and sedimentary rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: stony sandy loam
AC - 3 to 9 inches: very gravelly loam
C1 - 9 to 34 inches: very gravelly sandy loam
C2 - 34 to 61 inches: extremely gravelly sandy loam
R - 61 to 80 inches: bedrock

Properties and qualities

Slope: 40 to 120 percent
Surface area covered with cobbles, stones or boulders: 0.1 percent
Depth to restrictive feature: 20 to 80 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Other vegetative classification: PSMEG Rocky mtn. douglas fir (60)
Hydric soil rating: No

Description of Rock Outcrop

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: Unranked

CvF—Calaveras loam, 5 to 35 percent slopes

Map Unit Setting

National map unit symbol: 2tdhz
Elevation: 7,000 to 11,000 feet
Mean annual precipitation: 16 to 30 inches
Mean annual air temperature: 37 to 45 degrees F
Frost-free period: 45 to 100 days
Farmland classification: Not prime farmland

Map Unit Composition

Calaveras and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Calaveras

Setting

Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from tuff over colluvium derived from dacite

Typical profile

A - 0 to 2 inches: loam
AE - 2 to 6 inches: sandy loam
2Bt - 6 to 40 inches: very cobbly sandy loam
3Bt - 40 to 60 inches: extremely cobbly coarse sandy loam

Properties and qualities

Slope: 5 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.71 to 2.13 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: B
Ecological site: F048AY908CO - Mixed Conifer
Hydric soil rating: No

Minor Components

Lobat

Percent of map unit: 6 percent
Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: F048AY908CO - Mixed Conifer
Hydric soil rating: No

Cajete

Percent of map unit: 3 percent
Landform: Hills
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F048AY925CO - Ponderosa Pine Forest
Hydric soil rating: No

Redondo

Percent of map unit: 3 percent
Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F048AY908CO - Mixed Conifer
Hydric soil rating: No

Cosey

Percent of map unit: 3 percent
Landform: Mountain slopes
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R048AY012NM - Mountain Loam Dry
Hydric soil rating: No

EmE—Empedrado-Curecanti complex, 2 to 25 percent slopes

Map Unit Setting

National map unit symbol: 2tdjf
Elevation: 7,500 to 9,500 feet

Mean annual precipitation: 10 to 25 inches
Mean annual air temperature: 39 to 47 degrees F
Frost-free period: 60 to 100 days
Farmland classification: Not prime farmland

Map Unit Composition

Empedrado and similar soils: 55 percent
Curecanti and similar soils: 30 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Empedrado

Setting

Landform: Alluvial fans
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from volcanic rock

Typical profile

A - 0 to 5 inches: loam
Bt1 - 5 to 13 inches: clay loam
Bt2 - 13 to 21 inches: clay loam
Bk - 21 to 60 inches: loam

Properties and qualities

Slope: 2 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.21 to 0.71 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 8 percent
Available water supply, 0 to 60 inches: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: R051XY317CO - Foothill Loam
Other vegetative classification: Blue grama - western wheatgrass (BOGR2-PASM) (G0701)
Hydric soil rating: No

Description of Curecanti

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Alluvium derived from volcanic rock and/or colluvium derived from volcanic rock

Typical profile

A1 - 0 to 6 inches: loam
A2 - 6 to 15 inches: loam
Bt1 - 15 to 26 inches: very gravelly clay loam
Bt2 - 26 to 36 inches: very gravelly clay loam
2BC - 36 to 48 inches: very gravelly coarse sandy loam
2BCk - 48 to 60 inches: extremely gravelly sandy loam

Properties and qualities

Slope: 2 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.21 to 0.71 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 8 percent
Available water supply, 0 to 60 inches: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: R051XY317CO - Foothill Loam
Other vegetative classification: Blue grama - western wheatgrass (BOGR2-PASM) (G0701)
Hydric soil rating: No

Minor Components

Tolman, stony

Percent of map unit: 4 percent
Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R051XY286CO - Rocky Foothills
Other vegetative classification: Twoneedle pinyon/blue grama (PIED/BOGR2) (W0402)
Hydric soil rating: No

Comodore, stony

Percent of map unit: 4 percent
Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R051XY286CO - Rocky Foothills
Other vegetative classification: Twoneedle pinyon/blue grama (PIED/BOGR2) (W0402)
Hydric soil rating: No

Moreno

Percent of map unit: 3 percent
Landform: Mountain valleys

Landform position (three-dimensional): Mountainbase
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R048AY002NM - Mountain Grassland
Hydric soil rating: No

Hesperus

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R048AY004NM - Mountain Loam
Hydric soil rating: No

Jodero, gullied

Percent of map unit: 1 percent
Landform: Drainageways, flood plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R051XY317CO - Foothill Loam
Other vegetative classification: Western wheatgrass - blue grama (PASM-BOGR2) (G0101)
Hydric soil rating: No

HeC—Hesperus-Dula, frequently flooded-Pastorius complex, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2sdk8
Elevation: 7,000 to 9,000 feet
Mean annual precipitation: 16 to 25 inches
Mean annual air temperature: 40 to 45 degrees F
Frost-free period: 75 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition

Hesperus and similar soils: 40 percent
Dula, freq flooded, and similar soils: 25 percent
Pastorius and similar soils: 20 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hesperus

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stream alluvium derived from igneous and sedimentary rock

Typical profile

A - 0 to 4 inches: loam
BA - 4 to 17 inches: loam
Bt - 17 to 38 inches: loam
C - 38 to 60 inches: loam

Properties and qualities

Slope: 1 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.71 to 2.13 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.8 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R048AY004NM - Mountain Loam
Hydric soil rating: No

Description of Dula, Freq Flooded

Setting

Landform: Flood plains
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Alluvium derived from igneous, metamorphic and sedimentary rock

Typical profile

A - 0 to 11 inches: loam
Bg - 11 to 28 inches: loam
2C - 28 to 80 inches: extremely gravelly coarse sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 24 to 40 inches to strongly contrasting textural stratification
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.71 to 2.13 in/hr)
Depth to water table: About 12 to 42 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): 4w
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C
Ecological site: R048AY006NM - Mountain Meadow
Hydric soil rating: Yes

Description of Pastorius

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stream alluvium derived from igneous and sedimentary rock

Typical profile

A - 0 to 12 inches: silt loam
Bt1 - 12 to 20 inches: cobbly loam
Bt2 - 20 to 60 inches: very cobbly loam

Properties and qualities

Slope: 1 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.71 to 2.13 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: R048AY004NM - Mountain Loam
Hydric soil rating: No

Minor Components

Shawa, moist

Percent of map unit: 10 percent
Landform: Hills, valleys
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Convex, linear
Across-slope shape: Linear
Ecological site: R051XY317CO - Foothill Loam
Hydric soil rating: No

Chamita, freq flooded

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear

Across-slope shape: Linear
Ecological site: R048AY006NM - Mountain Meadow
Hydric soil rating: Yes

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Glossary

Many of the terms relating to landforms, geology, and geomorphology are defined in more detail in the following National Soil Survey Handbook link: “National Soil Survey Handbook.”

ABC soil

A soil having an A, a B, and a C horizon.

Ablation till

Loose, relatively permeable earthy material deposited during the downwasting of nearly static glacial ice, either contained within or accumulated on the surface of the glacier.

AC soil

A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

Aeration, soil

The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil

Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil

A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvial cone

A semiconical type of alluvial fan having very steep slopes. It is higher, narrower, and steeper than a fan and is composed of coarser and thicker layers of material deposited by a combination of alluvial episodes and (to a much lesser degree) landslides (debris flow). The coarsest materials tend to be concentrated at the apex of the cone.

Alluvial fan

A low, outspread mass of loose materials and/or rock material, commonly with gentle slopes. It is shaped like an open fan or a segment of a cone. The material was deposited by a stream at the place where it issues from a narrow mountain valley or upland valley or where a tributary stream is near or at its junction with the main stream. The fan is steepest near its apex, which points upstream, and slopes gently and convexly outward (downstream) with a gradual decrease in gradient.

Alluvium

Unconsolidated material, such as gravel, sand, silt, clay, and various mixtures of these, deposited on land by running water.

Alpha,alpha-dipyridyl

A compound that when dissolved in ammonium acetate is used to detect the presence of reduced iron (Fe II) in the soil. A positive reaction implies reducing conditions and the likely presence of redoximorphic features.

Animal unit month (AUM)

The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

Aquic conditions

Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Argillic horizon

A subsoil horizon characterized by an accumulation of illuvial clay.

Arroyo

The flat-floored channel of an ephemeral stream, commonly with very steep to vertical banks cut in unconsolidated material. It is usually dry but can be transformed into a temporary watercourse or short-lived torrent after heavy rain within the watershed.

Aspect

The direction toward which a slope faces. Also called slope aspect.

Association, soil

A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity)

The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low: 0 to 3
Low: 3 to 6
Moderate: 6 to 9
High: 9 to 12
Very high: More than 12

Backslope

The position that forms the steepest and generally linear, middle portion of a hillslope. In profile, backslopes are commonly bounded by a convex shoulder above and a concave footslope below.

Backswamp

A flood-plain landform. Extensive, marshy or swampy, depressed areas of flood plains between natural levees and valley sides or terraces.

Badland

A landscape that is intricately dissected and characterized by a very fine drainage network with high drainage densities and short, steep slopes and narrow interfluves. Badlands develop on surfaces that have little or no vegetative cover overlying unconsolidated or poorly cemented materials (clays, silts, or sandstones) with, in some cases, soluble minerals, such as gypsum or halite.

Bajada

A broad, gently inclined alluvial piedmont slope extending from the base of a mountain range out into a basin and formed by the lateral coalescence of a series of alluvial fans. Typically, it has a broadly undulating transverse profile, parallel to the mountain front, resulting from the convexities of component fans. The term is generally restricted to constructional slopes of intermontane basins.

Basal area

The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

Base saturation

The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Base slope (geomorphology)

A geomorphic component of hills consisting of the concave to linear (perpendicular to the contour) slope that, regardless of the lateral shape, forms an apron or wedge at the bottom of a hillside dominated by colluvium and slope-wash sediments (for example, slope alluvium).

Bedding plane

A planar or nearly planar bedding surface that visibly separates each successive layer of stratified sediment or rock (of the same or different lithology)

from the preceding or following layer; a plane of deposition. It commonly marks a change in the circumstances of deposition and may show a parting, a color difference, a change in particle size, or various combinations of these. The term is commonly applied to any bedding surface, even one that is conspicuously bent or deformed by folding.

Bedding system

A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock

The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography

A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Bench terrace

A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum

Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout (map symbol)

A saucer-, cup-, or trough-shaped depression formed by wind erosion on a preexisting dune or other sand deposit, especially in an area of shifting sand or loose soil or where protective vegetation is disturbed or destroyed. The adjoining accumulation of sand derived from the depression, where recognizable, is commonly included. Blowouts are commonly small.

Borrow pit (map symbol)

An open excavation from which soil and underlying material have been removed, usually for construction purposes.

Bottom land

An informal term loosely applied to various portions of a flood plain.

Boulders

Rock fragments larger than 2 feet (60 centimeters) in diameter.

Breaks

A landscape or tract of steep, rough or broken land dissected by ravines and gullies and marking a sudden change in topography.

Breast height

An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Brush management

Use of mechanical, chemical, or biological methods to make conditions favorable for reseeding or to reduce or eliminate competition from woody vegetation and thus allow understory grasses and forbs to recover. Brush management increases forage production and thus reduces the hazard of erosion. It can improve the habitat for some species of wildlife.

Butte

An isolated, generally flat-topped hill or mountain with relatively steep slopes and talus or precipitous cliffs and characterized by summit width that is less than the height of bounding escarpments; commonly topped by a caprock of resistant material and representing an erosion remnant carved from flat-lying rocks.

Cable yarding

A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees generally are reeled in while one end is lifted or the entire log is suspended.

Calcareous soil

A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche

A general term for a prominent zone of secondary carbonate accumulation in surficial materials in warm, subhumid to arid areas. Caliche is formed by both geologic and pedologic processes. Finely crystalline calcium carbonate forms a nearly continuous surface-coating and void-filling medium in geologic (parent) materials. Cementation ranges from weak in nonindurated forms to very strong in indurated forms. Other minerals (e.g., carbonates, silicate, and sulfate) may occur as accessory cements. Most petrocalcic horizons and some calcic horizons are caliche.

California bearing ratio (CBR)

The load-supporting capacity of a soil as compared to that of standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Canopy

The leafy crown of trees or shrubs. (See Crown.)

Canyon

A long, deep, narrow valley with high, precipitous walls in an area of high local relief.

Capillary water

Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena

A sequence, or “chain,” of soils on a landscape that formed in similar kinds of parent material and under similar climatic conditions but that have different characteristics as a result of differences in relief and drainage.

Cation

An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity

The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Catsteps

See Terracettes.

Cement rock

Shaly limestone used in the manufacture of cement.

Channery soil material

Soil material that has, by volume, 15 to 35 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches (15 centimeters) along the longest axis. A single piece is called a channer.

Chemical treatment

Control of unwanted vegetation through the use of chemicals.

Chiseling

Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compacted layers to a depth below normal plow depth.

Cirque

A steep-walled, semicircular or crescent-shaped, half-bowl-like recess or hollow, commonly situated at the head of a glaciated mountain valley or high on the side of a mountain. It was produced by the erosive activity of a mountain glacier. It commonly contains a small round lake (tarn).

Clay

As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay depletions

See Redoximorphic features.

Clay film

A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Clay spot (map symbol)

A spot where the surface texture is silty clay or clay in areas where the surface layer of the soils in the surrounding map unit is sandy loam, loam, silt loam, or coarser.

Claypan

A dense, compact subsoil layer that contains much more clay than the overlying materials, from which it is separated by a sharply defined boundary. The layer restricts the downward movement of water through the soil. A claypan is commonly hard when dry and plastic and sticky when wet.

Climax plant community

The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil

Sand or loamy sand.

Cobble (or cobblestone)

A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material

Material that has 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

COLE (coefficient of linear extensibility)

See Linear extensibility.

Colluvium

Unconsolidated, unsorted earth material being transported or deposited on side slopes and/or at the base of slopes by mass movement (e.g., direct gravitational action) and by local, unconcentrated runoff.

Complex slope

Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil

A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Concretions

See Redoximorphic features.

Conglomerate

A coarse grained, clastic sedimentary rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

Conservation cropping system

Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the effects of the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage

A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil

Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when subject to compression. Terms describing consistence are defined in the “Soil Survey Manual.”

Contour stripcropping

Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section

The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat)

A type of limnic layer composed predominantly of fecal material derived from aquatic animals.

Corrosion (geomorphology)

A process of erosion whereby rocks and soil are removed or worn away by natural chemical processes, especially by the solvent action of running water, but also by other reactions, such as hydrolysis, hydration, carbonation, and oxidation.

Corrosion (soil survey interpretations)

Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Cover crop

A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Crop residue management

Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cropping system

Growing crops according to a planned system of rotation and management practices.

Cross-slope farming

Deliberately conducting farming operations on sloping farmland in such a way that tillage is across the general slope.

Crown

The upper part of a tree or shrub, including the living branches and their foliage.

Cryoturbate

A mass of soil or other unconsolidated earthy material moved or disturbed by frost action. It is typically coarser than the underlying material.

Cuesta

An asymmetric ridge capped by resistant rock layers of slight or moderate dip (commonly less than 15 percent slopes); a type of homocline produced by differential erosion of interbedded resistant and weak rocks. A cuesta has a long, gentle slope on one side (dip slope) that roughly parallels the inclined beds; on the other side, it has a relatively short and steep or clifflike slope (scarp) that cuts through the tilted rocks.

Culmination of the mean annual increment (CMAI)

The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Cutbanks cave

The walls of excavations tend to cave in or slough.

Decreasers

The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing

Postponing grazing or resting grazing land for a prescribed period.

Delta

A body of alluvium having a surface that is fan shaped and nearly flat; deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

Dense layer

A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depression, closed (map symbol)

A shallow, saucer-shaped area that is slightly lower on the landscape than the surrounding area and that does not have a natural outlet for surface drainage.

Depth, soil

Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Desert pavement

A natural, residual concentration or layer of wind-polished, closely packed gravel, boulders, and other rock fragments mantling a desert surface. It forms where wind action and sheetwash have removed all smaller particles or where rock fragments have migrated upward through sediments to the surface. It typically protects the finer grained underlying material from further erosion.

Diatomaceous earth

A geologic deposit of fine, grayish siliceous material composed chiefly or entirely of the remains of diatoms.

Dip slope

A slope of the land surface, roughly determined by and approximately conforming to the dip of the underlying bedrock.

Diversion (or diversion terrace)

A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Divided-slope farming

A form of field stripcropping in which crops are grown in a systematic arrangement of two strips, or bands, across the slope to reduce the hazard of water erosion. One strip is in a close-growing crop that provides protection from erosion, and the other strip is in a crop that provides less protection from erosion. This practice is used where slopes are not long enough to permit a full stripcropping pattern to be used.

Drainage class (natural)

Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained*. These classes are defined in the “Soil Survey Manual.”

Drainage, surface

Runoff, or surface flow of water, from an area.

Drainageway

A general term for a course or channel along which water moves in draining an area. A term restricted to relatively small, linear depressions that at some time move concentrated water and either do not have a defined channel or have only a small defined channel.

Draw

A small stream valley that generally is shallower and more open than a ravine or gulch and that has a broader bottom. The present stream channel may appear inadequate to have cut the drainageway that it occupies.

Drift

A general term applied to all mineral material (clay, silt, sand, gravel, and boulders) transported by a glacier and deposited directly by or from the ice or transported by running water emanating from a glacier. Drift includes unstratified material (till) that forms moraines and stratified deposits that form outwash plains, eskers, kames, varves, and glaciofluvial sediments. The term is generally applied to Pleistocene glacial deposits in areas that no longer contain glaciers.

Drumlin

A low, smooth, elongated oval hill, mound, or ridge of compact till that has a core of bedrock or drift. It commonly has a blunt nose facing the direction from which the ice approached and a gentler slope tapering in the other direction. The longer axis is parallel to the general direction of glacier flow. Drumlins are products of streamline (laminar) flow of glaciers, which molded the subglacial floor through a combination of erosion and deposition.

Duff

A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Dune

A low mound, ridge, bank, or hill of loose, windblown granular material (generally sand), either barren and capable of movement from place to place or covered and stabilized with vegetation but retaining its characteristic shape.

Earthy fill

See Mine spoil.

Ecological site

An area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. An ecological site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other ecological sites in kind and/or proportion of species or in total production.

Eluviation

The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Endosaturation

A type of saturation of the soil in which all horizons between the upper boundary of saturation and a depth of 2 meters are saturated.

Eolian deposit

Sand-, silt-, or clay-sized clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sheet of sand or loess.

Ephemeral stream

A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

Episaturation

A type of saturation indicating a perched water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 2 meters of the surface.

Erosion

The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (accelerated)

Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Erosion (geologic)

Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion pavement

A surficial lag concentration or layer of gravel and other rock fragments that remains on the soil surface after sheet or rill erosion or wind has removed the finer soil particles and that tends to protect the underlying soil from further erosion.

Erosion surface

A land surface shaped by the action of erosion, especially by running water.

Escarpment

A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Most commonly applied to cliffs produced by differential erosion. Synonym: scarp.

Escarpment, bedrock (map symbol)

A relatively continuous and steep slope or cliff, produced by erosion or faulting, that breaks the general continuity of more gently sloping land surfaces. Exposed material is hard or soft bedrock.

Escarpment, nonbedrock (map symbol)

A relatively continuous and steep slope or cliff, generally produced by erosion but in some places produced by faulting, that breaks the continuity of more gently sloping land surfaces. Exposed earthy material is nonsoil or very shallow soil.

Esker

A long, narrow, sinuous, steep-sided ridge of stratified sand and gravel deposited as the bed of a stream flowing in an ice tunnel within or below the ice (subglacial) or between ice walls on top of the ice of a wasting glacier and left

behind as high ground when the ice melted. Eskers range in length from less than a kilometer to more than 160 kilometers and in height from 3 to 30 meters.

Extrusive rock

Igneous rock derived from deep-seated molten matter (magma) deposited and cooled on the earth's surface.

Fallow

Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grain is grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fan remnant

A general term for landforms that are the remaining parts of older fan landforms, such as alluvial fans, that have been either dissected or partially buried.

Fertility, soil

The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat)

The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity

The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fill slope

A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil

Sandy clay, silty clay, or clay.

Firebreak

An area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of firefighters and equipment. Designated roads also serve as firebreaks.

First bottom

An obsolete, informal term loosely applied to the lowest flood-plain steps that are subject to regular flooding.

Flaggy soil material

Material that has, by volume, 15 to 35 percent flagstones. Very flaggy soil material has 35 to 60 percent flagstones, and extremely flaggy soil material has more than 60 percent flagstones.

Flagstone

A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

Flood plain

The nearly level plain that borders a stream and is subject to flooding unless protected artificially.

Flood-plain landforms

A variety of constructional and erosional features produced by stream channel migration and flooding. Examples include backswamps, flood-plain splays, meanders, meander belts, meander scrolls, oxbow lakes, and natural levees.

Flood-plain splay

A fan-shaped deposit or other outspread deposit formed where an overloaded stream breaks through a levee (natural or artificial) and deposits its material (commonly coarse grained) on the flood plain.

Flood-plain step

An essentially flat, terrace-like alluvial surface within a valley that is frequently covered by floodwater from the present stream; any approximately horizontal surface still actively modified by fluvial scour and/or deposition. May occur individually or as a series of steps.

Fluvial

Of or pertaining to rivers or streams; produced by stream or river action.

Foothills

A region of steeply sloping hills that fringes a mountain range or high-plateau escarpment. The hills have relief of as much as 1,000 feet (300 meters).

Footslope

The concave surface at the base of a hillslope. A footslope is a transition zone between upslope sites of erosion and transport (shoulders and backslopes) and downslope sites of deposition (toeslopes).

Forb

Any herbaceous plant not a grass or a sedge.

Forest cover

All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type

A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Fragipan

A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Genesis, soil

The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gilgai

Commonly, a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of clayey soils that shrink and swell considerably with changes in moisture content.

Glaciofluvial deposits

Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur in the form of outwash plains, valley trains, deltas, kames, eskers, and kame terraces.

Glaciolacustrine deposits

Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are bedded or laminated.

Gleyed soil

Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

Graded stripcropping

Growing crops in strips that grade toward a protected waterway.

Grassed waterway

A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel

Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravel pit (map symbol)

An open excavation from which soil and underlying material have been removed and used, without crushing, as a source of sand or gravel.

Gravelly soil material

Material that has 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Gravelly spot (map symbol)

A spot where the surface layer has more than 35 percent, by volume, rock fragments that are mostly less than 3 inches in diameter in an area that has less than 15 percent rock fragments.

Green manure crop (agronomy)

A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water

Water filling all the unblocked pores of the material below the water table.

Gully (map symbol)

A small, steep-sided channel caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage whereas a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard bedrock

Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hard to reclaim

Reclamation is difficult after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Hardpan

A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Head slope (geomorphology)

A geomorphic component of hills consisting of a laterally concave area of a hillside, especially at the head of a drainageway. The overland waterflow is converging.

Hemic soil material (mucky peat)

Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

High-residue crops

Such crops as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

Hill

A generic term for an elevated area of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline. Slopes are generally more than 15 percent. The distinction between a hill and a mountain is arbitrary and may depend on local usage.

Hillslope

A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of a hill.

Horizon, soil

A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the “Soil Survey Manual.” The major horizons of mineral soil are as follows:

O horizon: An organic layer of fresh and decaying plant residue.

L horizon: A layer of organic and mineral limnic materials, including coprogenous earth (sedimentary peat), diatomaceous earth, and marl.

A horizon: The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon: The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon: The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon: The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon: Soft, consolidated bedrock beneath the soil.

R layer: Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

M layer: A root-limiting subsoil layer consisting of nearly continuous, horizontally oriented, human-manufactured materials.

W layer: A layer of water within or beneath the soil.

Humus

The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups

Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties include depth to a seasonal high water table, the infiltration rate, and depth to a layer that significantly restricts the downward movement of water. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Igneous rock

Rock that was formed by cooling and solidification of magma and that has not been changed appreciably by weathering since its formation. Major varieties include plutonic and volcanic rock (e.g., andesite, basalt, and granite).

Illuviation

The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil

A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers

Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration

The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity

The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate

The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate

The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Very low: Less than 0.2
Low: 0.2 to 0.4
Moderately low: 0.4 to 0.75
Moderate: 0.75 to 1.25
Moderately high: 1.25 to 1.75
High: 1.75 to 2.5
Very high: More than 2.5

Interfluve

A landform composed of the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction. An elevated area between two drainageways that sheds water to those drainageways.

Interfluve (geomorphology)

A geomorphic component of hills consisting of the uppermost, comparatively level or gently sloping area of a hill; shoulders of backwearing hillslopes can narrow the upland or can merge, resulting in a strongly convex shape.

Intermittent stream

A stream, or reach of a stream, that does not flow year-round but that is commonly dry for 3 or more months out of 12 and whose channel is generally below the local water table. It flows only during wet periods or when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders

On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, plants invade following disturbance of the surface.

Iron depletions

See Redoximorphic features.

Irrigation

Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin: Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border: Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding: Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation: Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle): Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow: Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler: Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation: Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding: Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame

A low mound, knob, hummock, or short irregular ridge composed of stratified sand and gravel deposited by a subglacial stream as a fan or delta at the margin of a melting glacier; by a supraglacial stream in a low place or hole on the surface of the glacier; or as a ponded deposit on the surface or at the margin of stagnant ice.

Karst (topography)

A kind of topography that formed in limestone, gypsum, or other soluble rocks by dissolution and that is characterized by closed depressions, sinkholes, caves, and underground drainage.

Knoll

A small, low, rounded hill rising above adjacent landforms.

Ksat

See Saturated hydraulic conductivity.

Lacustrine deposit

Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Lake plain

A nearly level surface marking the floor of an extinct lake filled by well sorted, generally fine textured, stratified deposits, commonly containing varves.

Lake terrace

A narrow shelf, partly cut and partly built, produced along a lakeshore in front of a scarp line of low cliffs and later exposed when the water level falls.

Landfill (map symbol)

An area of accumulated waste products of human habitation, either above or below natural ground level.

Landslide

A general, encompassing term for most types of mass movement landforms and processes involving the downslope transport and outward deposition of soil and rock materials caused by gravitational forces; the movement may or may not involve saturated materials. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones

Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Lava flow (map symbol)

A solidified, commonly lobate body of rock formed through lateral, surface outpouring of molten lava from a vent or fissure.

Leaching

The removal of soluble material from soil or other material by percolating water.

Levee (map symbol)

An embankment that confines or controls water, especially one built along the banks of a river to prevent overflow onto lowlands.

Linear extensibility

Refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. Linear extensibility is used to determine the shrink-swell potential of soils. It is an expression of the volume change between the water content of the clod at $^{1}/_{3}$- or $^{1}/_{10}$-bar tension (33kPa or 10kPa tension) and oven dryness. Volume change is influenced by the amount and type of clay minerals in the soil. The volume change is the percent change for the whole soil. If it is expressed as a fraction, the resulting value is COLE, coefficient of linear extensibility.

Liquid limit

The moisture content at which the soil passes from a plastic to a liquid state.

Loam

Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess

Material transported and deposited by wind and consisting dominantly of silt-sized particles.

Low strength

The soil is not strong enough to support loads.

Low-residue crops

Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

Marl

An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal proportions; formed primarily under freshwater lacustrine conditions but also formed in more saline environments.

Marsh or swamp (map symbol)

A water-saturated, very poorly drained area that is intermittently or permanently covered by water. Sedges, cattails, and rushes are the dominant vegetation in marshes, and trees or shrubs are the dominant vegetation in swamps. Not used in map units where the named soils are poorly drained or very poorly drained.

Mass movement

A generic term for the dislodgment and downslope transport of soil and rock material as a unit under direct gravitational stress.

Masses

See Redoximorphic features.

Meander belt

The zone within which migration of a meandering channel occurs; the flood-plain area included between two imaginary lines drawn tangential to the outer bends of active channel loops.

Meander scar

A crescent-shaped, concave or linear mark on the face of a bluff or valley wall, produced by the lateral erosion of a meandering stream that impinged upon and undercut the bluff.

Meander scroll

One of a series of long, parallel, close-fitting, crescent-shaped ridges and troughs formed along the inner bank of a stream meander as the channel migrated laterally down-valley and toward the outer bank.

Mechanical treatment

Use of mechanical equipment for seeding, brush management, and other management practices.

Medium textured soil

Very fine sandy loam, loam, silt loam, or silt.

Mesa

A broad, nearly flat topped and commonly isolated landmass bounded by steep slopes or precipitous cliffs and capped by layers of resistant, nearly horizontal rocky material. The summit width is characteristically greater than the height of the bounding escarpments.

Metamorphic rock

Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement at depth in the earth’s crust. Nearly all such rocks are crystalline.

Mine or quarry (map symbol)

An open excavation from which soil and underlying material have been removed and in which bedrock is exposed. Also denotes surface openings to underground mines.

Mine spoil

An accumulation of displaced earthy material, rock, or other waste material removed during mining or excavation. Also called earthy fill.

Mineral soil

Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage

Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area

A kind of map unit that has little or no natural soil and supports little or no vegetation.

Miscellaneous water (map symbol)

Small, constructed bodies of water that are used for industrial, sanitary, or mining applications and that contain water most of the year.

Moderately coarse textured soil

Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil

Clay loam, sandy clay loam, or silty clay loam.

Mollic epipedon

A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Moraine

In terms of glacial geology, a mound, ridge, or other topographically distinct accumulation of unsorted, unstratified drift, predominantly till, deposited primarily by the direct action of glacial ice in a variety of landforms. Also, a general term for a landform composed mainly of till (except for kame moraines, which are composed mainly of stratified outwash) that has been deposited by a glacier. Some types of moraines are disintegration, end, ground, kame, lateral, recessional, and terminal.

Morphology, soil

The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil

Irregular spots of different colors that vary in number and size. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Mountain

A generic term for an elevated area of the land surface, rising more than 1,000 feet (300 meters) above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides. A mountain can

occur as a single, isolated mass or in a group forming a chain or range. Mountains are formed primarily by tectonic activity and/or volcanic action but can also be formed by differential erosion.

Muck

Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Mucky peat

See Hemic soil material.

Mudstone

A blocky or massive, fine grained sedimentary rock in which the proportions of clay and silt are approximately equal. Also, a general term for such material as clay, silt, claystone, siltstone, shale, and argillite and that should be used only when the amounts of clay and silt are not known or cannot be precisely identified.

Munsell notation

A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Natric horizon

A special kind of argillic horizon that contains enough exchangeable sodium to have an adverse effect on the physical condition of the subsoil.

Neutral soil

A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

Nodules

See Redoximorphic features.

Nose slope (geomorphology)

A geomorphic component of hills consisting of the projecting end (laterally convex area) of a hillside. The overland waterflow is predominantly divergent. Nose slopes consist dominantly of colluvium and slope-wash sediments (for example, slope alluvium).

Nutrient, plant

Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter

Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low: Less than 0.5 percent
Low: 0.5 to 1.0 percent
Moderately low: 1.0 to 2.0 percent
Moderate: 2.0 to 4.0 percent
High: 4.0 to 8.0 percent
Very high: More than 8.0 percent

Outwash

Stratified and sorted sediments (chiefly sand and gravel) removed or “washed out” from a glacier by meltwater streams and deposited in front of or beyond the end moraine or the margin of a glacier. The coarser material is deposited nearer to the ice.

Outwash plain

An extensive lowland area of coarse textured glaciofluvial material. An outwash plain is commonly smooth; where pitted, it generally is low in relief.

Paleoterrace

An erosional remnant of a terrace that retains the surface form and alluvial deposits of its origin but was not emplaced by, and commonly does not grade to, a present-day stream or drainage network.

Pan

A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material

The unconsolidated organic and mineral material in which soil forms.

Peat

Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped

An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedisediment

A layer of sediment, eroded from the shoulder and backslope of an erosional slope, that lies on and is being (or was) transported across a gently sloping erosional surface at the foot of a receding hill or mountain slope.

Pedon

The smallest volume that can be called “a soil.” A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation

The movement of water through the soil.

Perennial water (map symbol)

Small, natural or constructed lakes, ponds, or pits that contain water most of the year.

Permafrost

Ground, soil, or rock that remains at or below 0 degrees C for at least 2 years. It is defined on the basis of temperature and is not necessarily frozen.

pH value

A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Phase, soil

A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

Piping

Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting

Pits caused by melting around ice. They form on the soil after plant cover is removed.

Plastic limit

The moisture content at which a soil changes from semisolid to plastic.

Plasticity index

The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plateau (geomorphology)

A comparatively flat area of great extent and elevation; specifically, an extensive land region that is considerably elevated (more than 100 meters) above the adjacent lower lying terrain, is commonly limited on at least one side by an abrupt descent, and has a flat or nearly level surface. A comparatively large part of a plateau surface is near summit level.

Playa

The generally dry and nearly level lake plain that occupies the lowest parts of closed depressions, such as those on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation and runoff. Playa deposits are fine grained and may or may not have a high water table and saline conditions.

Plinthite

The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Plowpan

A compacted layer formed in the soil directly below the plowed layer.

Ponding

Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded

Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Pore linings

See Redoximorphic features.

Potential native plant community

See Climax plant community.

Potential rooting depth (effective rooting depth)

Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Prescribed burning

Deliberately burning an area for specific management purposes, under the appropriate conditions of weather and soil moisture and at the proper time of day.

Productivity, soil

The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil

A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use

Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This practice increases the vigor and reproduction capacity of the key plants and

promotes the accumulation of litter and mulch necessary to conserve soil and water.

Rangeland

Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil

A measure of acidity or alkalinity of a soil, expressed as pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid: Less than 3.5
Extremely acid: 3.5 to 4.4
Very strongly acid: 4.5 to 5.0
Strongly acid: 5.1 to 5.5
Moderately acid: 5.6 to 6.0
Slightly acid: 6.1 to 6.5
Neutral: 6.6 to 7.3
Slightly alkaline: 7.4 to 7.8
Moderately alkaline: 7.9 to 8.4
Strongly alkaline: 8.5 to 9.0
Very strongly alkaline: 9.1 and higher

Red beds

Sedimentary strata that are mainly red and are made up largely of sandstone and shale.

Redoximorphic concentrations

See Redoximorphic features.

Redoximorphic depletions

See Redoximorphic features.

Redoximorphic features

Redoximorphic features are associated with wetness and result from alternating periods of reduction and oxidation of iron and manganese compounds in the soil. Reduction occurs during saturation with water, and oxidation occurs when the soil is not saturated. Characteristic color patterns are created by these processes. The reduced iron and manganese ions may be removed from a soil if vertical or lateral fluxes of water occur, in which case there is no iron or manganese precipitation in that soil. Wherever the iron and manganese are oxidized and precipitated, they form either soft masses or hard concretions or nodules. Movement of iron and manganese as a result of redoximorphic processes in a soil may result in redoximorphic features that are defined as follows:

1. Redoximorphic concentrations.—These are zones of apparent accumulation of iron-manganese oxides, including:
   A. Nodules and concretions, which are cemented bodies that can be removed from the soil intact. Concretions are distinguished from nodules on the basis of internal organization. A concretion typically has concentric layers that are visible to the naked eye. Nodules do not have visible organized internal structure; *and*
   B. Masses, which are noncemented concentrations of substances within the soil matrix; *and*
   C. Pore linings, i.e., zones of accumulation along pores that may be either coatings on pore surfaces or impregnations from the matrix adjacent to the pores.
2. Redoximorphic depletions.—These are zones of low chroma (chromas less than those in the matrix) where either iron-manganese oxides alone or both iron-manganese oxides and clay have been stripped out, including:
   A. Iron depletions, i.e., zones that contain low amounts of iron and manganese oxides but have a clay content similar to that of the adjacent matrix; *and*
   B. Clay depletions, i.e., zones that contain low amounts of iron, manganese, and clay (often referred to as silt coatings or skeletans).
3. Reduced matrix.—This is a soil matrix that has low chroma *in situ* but undergoes a change in hue or chroma within 30 minutes after the soil material has been exposed to air.

Reduced matrix

See Redoximorphic features.

Regolith

All unconsolidated earth materials above the solid bedrock. It includes material weathered in place from all kinds of bedrock and alluvial, glacial, eolian, lacustrine, and pyroclastic deposits.

Relief

The relative difference in elevation between the upland summits and the lowlands or valleys of a given region.

Residuum (residual soil material)

Unconsolidated, weathered or partly weathered mineral material that accumulated as bedrock disintegrated in place.

Rill

A very small, steep-sided channel resulting from erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. A rill generally is not an obstacle to wheeled vehicles and is shallow enough to be smoothed over by ordinary tillage.

Riser

The vertical or steep side slope (e.g., escarpment) of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural, steplike landforms, such as successive stream terraces.

Road cut

A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments

Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rock outcrop (map symbol)

An exposure of bedrock at the surface of the earth. Not used where the named soils of the surrounding map unit are shallow over bedrock or where “Rock outcrop” is a named component of the map unit.

Root zone

The part of the soil that can be penetrated by plant roots.

Runoff

The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil

A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Saline spot (map symbol)

An area where the surface layer has an electrical conductivity of 8 mmhos/cm more than the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has an electrical conductivity of 2 mmhos/cm or less.

Sand

As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone

Sedimentary rock containing dominantly sand-sized particles.

Sandy spot (map symbol)

A spot where the surface layer is loamy fine sand or coarser in areas where the surface layer of the named soils in the surrounding map unit is very fine sandy loam or finer.

Sapric soil material (muck)

The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saturated hydraulic conductivity (Ksat)

The ease with which pores of a saturated soil transmit water. Formally, the proportionality coefficient that expresses the relationship of the rate of water movement to hydraulic gradient in Darcy's Law, a law that describes the rate of water movement through porous media. Commonly abbreviated as "Ksat." Terms describing saturated hydraulic conductivity are:

Very high: 100 or more micrometers per second (14.17 or more inches per hour)

High: 10 to 100 micrometers per second (1.417 to 14.17 inches per hour)

Moderately high: 1 to 10 micrometers per second (0.1417 inch to 1.417 inches per hour)

Moderately low: 0.1 to 1 micrometer per second (0.01417 to 0.1417 inch per hour)

Low: 0.01 to 0.1 micrometer per second (0.001417 to 0.01417 inch per hour)

Very low: Less than 0.01 micrometer per second (less than 0.001417 inch per hour).

To convert inches per hour to micrometers per second, multiply inches per hour by 7.0572. To convert micrometers per second to inches per hour, multiply micrometers per second by 0.1417.

Saturation

Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Scarification

The act of abrading, scratching, loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.

Sedimentary rock

A consolidated deposit of clastic particles, chemical precipitates, or organic remains accumulated at or near the surface of the earth under normal low temperature and pressure conditions. Sedimentary rocks include consolidated equivalents of alluvium, colluvium, drift, and eolian, lacustrine, and marine deposits. Examples are sandstone, siltstone, mudstone, claystone, shale, conglomerate, limestone, dolomite, and coal.

Sequum

A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil

A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Severely eroded spot (map symbol)

An area where, on the average, 75 percent or more of the original surface layer has been lost because of accelerated erosion. Not used in map units in which “severely eroded,” “very severely eroded,” or “gullied” is part of the map unit name.

Shale

Sedimentary rock that formed by the hardening of a deposit of clay, silty clay, or silty clay loam and that has a tendency to split into thin layers.

Sheet erosion

The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Short, steep slope (map symbol)

A narrow area of soil having slopes that are at least two slope classes steeper than the slope class of the surrounding map unit.

Shoulder

The convex, erosional surface near the top of a hillslope. A shoulder is a transition from summit to backslope.

Shrink-swell

The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Shrub-coppice dune

A small, streamlined dune that forms around brush and clump vegetation.

Side slope (geomorphology)

A geomorphic component of hills consisting of a laterally planar area of a hillside. The overland waterflow is predominantly parallel. Side slopes are dominantly colluvium and slope-wash sediments.

Silica

A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio

The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt

As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone

An indurated silt having the texture and composition of shale but lacking its fine lamination or fissility; a massive mudstone in which silt predominates over clay.

Similar soils

Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Sinkhole (map symbol)

A closed, circular or elliptical depression, commonly funnel shaped, characterized by subsurface drainage and formed either by dissolution of the surface of underlying bedrock (e.g., limestone, gypsum, or salt) or by collapse of underlying caves within bedrock. Complexes of sinkholes in carbonate-rock terrain are the main components of karst topography.

Site index

A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slickensides (pedogenic)

Grooved, striated, and/or glossy (shiny) slip faces on structural peds, such as wedges; produced by shrink-swell processes, most commonly in soils that have a high content of expansive clays.

Slide or slip (map symbol)

A prominent landform scar or ridge caused by fairly recent mass movement or descent of earthy material resulting from failure of earth or rock under shear stress along one or several surfaces.

Slope

The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope alluvium

Sediment gradually transported down the slopes of mountains or hills primarily by nonchannel alluvial processes (i.e., slope-wash processes) and characterized by particle sorting. Lateral particle sorting is evident on long slopes. In a profile sequence, sediments may be distinguished by differences in size and/or specific gravity of rock fragments and may be separated by stone lines. Burnished peds and sorting of rounded or subrounded pebbles or cobbles distinguish these materials from unsorted colluvial deposits.

Slow refill

The slow filling of ponds, resulting from restricted water transmission in the soil.

Slow water movement

Restricted downward movement of water through the soil. See Saturated hydraulic conductivity.

Sodic (alkali) soil

A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodic spot (map symbol)

An area where the surface layer has a sodium adsorption ratio that is at least 10 more than that of the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has a sodium adsorption ratio of 5 or less.

Sodicity

The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to $Ca^{++} + Mg^{++}$. The degrees of sodicity and their respective ratios are:

Slight: Less than 13:1
Moderate: 13-30:1
Strong: More than 30:1

Sodium adsorption ratio (SAR)

A measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Soft bedrock

Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil

A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief and by the passage of time.

Soil separates

Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand: 2.0 to 1.0
Coarse sand: 1.0 to 0.5
Medium sand: 0.5 to 0.25
Fine sand: 0.25 to 0.10
Very fine sand: 0.10 to 0.05
Silt: 0.05 to 0.002
Clay: Less than 0.002

Solum

The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Spoil area (map symbol)

A pile of earthy materials, either smoothed or uneven, resulting from human activity.

Stone line

In a vertical cross section, a line formed by scattered fragments or a discrete layer of angular and subangular rock fragments (commonly a gravel- or cobble-sized lag concentration) that formerly was draped across a topographic surface and was later buried by additional sediments. A stone line generally caps material that was subject to weathering, soil formation, and erosion before burial. Many stone lines seem to be buried erosion pavements, originally formed by sheet and rill erosion across the land surface.

Stones

Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony

Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stony spot (map symbol)

A spot where 0.01 to 0.1 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surrounding soil has no surface stones.

Strath terrace

A type of stream terrace; formed as an erosional surface cut on bedrock and thinly mantled with stream deposits (alluvium).

Stream terrace

One of a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream; represents the remnants of an abandoned flood plain, stream bed, or valley floor produced during a former state of fluvial erosion or deposition.

Stripcropping

Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind erosion and water erosion.

Structure, soil

The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are:

Platy: Flat and laminated

Prismatic: Vertically elongated and having flat tops

Columnar: Vertically elongated and having rounded tops

Angular blocky: Having faces that intersect at sharp angles (planes)

Subangular blocky: Having subrounded and planar faces (no sharp angles)

Granular: Small structural units with curved or very irregular faces

Structureless soil horizons are defined as follows:

Single grained: Entirely noncoherent (each grain by itself), as in loose sand

Massive: Occurring as a coherent mass

Stubble mulch

Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind erosion and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil

Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling

Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum

The part of the soil below the solum.

Subsurface layer

Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow

The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Summit

The topographically highest position of a hillslope. It has a nearly level (planar or only slightly convex) surface.

Surface layer

The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the “plow layer,” or the “Ap horizon.”

Surface soil

The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

Talus

Rock fragments of any size or shape (commonly coarse and angular) derived from and lying at the base of a cliff or very steep rock slope. The accumulated mass of such loose broken rock formed chiefly by falling, rolling, or sliding.

Taxadjuncts

Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior. Soils are recognized as taxadjuncts only when one or more of their characteristics are slightly outside the range defined for the family of the series for which the soils are named.

Terminal moraine

An end moraine that marks the farthest advance of a glacier. It typically has the form of a massive arcuate or concentric ridge, or complex of ridges, and is underlain by till and other types of drift.

Terrace (conservation)

An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field

generally is built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geomorphology)

A steplike surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, lake, or seashore. The term is usually applied both to the relatively flat summit surface (tread) that was cut or built by stream or wave action and to the steeper descending slope (scarp or riser) that has graded to a lower base level of erosion.

Terracettes

Small, irregular steplike forms on steep hillslopes, especially in pasture, formed by creep or erosion of surficial materials that may be induced or enhanced by trampling of livestock, such as sheep or cattle.

Texture, soil

The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.”

Thin layer

Otherwise suitable soil material that is too thin for the specified use.

Till

Dominantly unsorted and nonstratified drift, generally unconsolidated and deposited directly by a glacier without subsequent reworking by meltwater, and consisting of a heterogeneous mixture of clay, silt, sand, gravel, stones, and boulders; rock fragments of various lithologies are embedded within a finer matrix that can range from clay to sandy loam.

Till plain

An extensive area of level to gently undulating soils underlain predominantly by till and bounded at the distal end by subordinate recessional or end moraines.

Tilth, soil

The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toeslope

The gently inclined surface at the base of a hillslope. Toeslopes in profile are commonly gentle and linear and are constructional surfaces forming the lower part of a hillslope continuum that grades to valley or closed-depression floors.

Topsoil

The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements

Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Tread

The flat to gently sloping, topmost, laterally extensive slope of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural steplike landforms, such as successive stream terraces.

Tuff

A generic term for any consolidated or cemented deposit that is 50 percent or more volcanic ash.

Upland

An informal, general term for the higher ground of a region, in contrast with a low-lying adjacent area, such as a valley or plain, or for land at a higher elevation than the flood plain or low stream terrace; land above the footslope zone of the hillslope continuum.

Valley fill

The unconsolidated sediment deposited by any agent (water, wind, ice, or mass wasting) so as to fill or partly fill a valley.

Variegation

Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve

A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Very stony spot (map symbol)

A spot where 0.1 to 3.0 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surface of the surrounding soil is covered by less than 0.01 percent stones.

Water bars

Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Weathering

All physical disintegration, chemical decomposition, and biologically induced changes in rocks or other deposits at or near the earth’s surface by atmospheric or biologic agents or by circulating surface waters but involving essentially no transport of the altered material.

Well graded

Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wet spot (map symbol)

A somewhat poorly drained to very poorly drained area that is at least two drainage classes wetter than the named soils in the surrounding map unit.

Wilting point (or permanent wilting point)

The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow

The uprooting and tipping over of trees by the wind.

APPENDIX B

PROJECT INFORMATION

Project Title: Cruces Basin Wetland Action Plan
Project Type: WETLANDS, SPRINGS, CIENEGAS
Latitude/Longitude (DMS): 36.925576 / -106.305519
County(s): RIO ARRIBA
Project Description: The Cruses Basin was identified as a Wetland Jewel by the Carson National Forest Wetland Jewels project. Amigos Bravos agreed to develop a Wetlands Action Plan (WAP) that provides a roadmap for restoring the Cruces Basin Wilderness wetlands. As part of this project a section of the plan will summarize the challenges, opportunities, and steps for conducting restoration in Wilderness Areas that could be used for future wetland restoration in other Wilderness Areas. The wetlands that are the focus of this WAP are located in the watersheds of Diablo Creek and Beaver Creek in the Cruces Basin Wilderness.

REQUESTOR INFORMATION

Project Organization:
Contact Name: Jack Marchetti
Email Address: jack.marchetti@dgf.nm.gov
Organization: New Mexico Department of Game and Fish
Address: 1 Wildlife Way, Santa Fe NM 87507
Phone: 5054791269

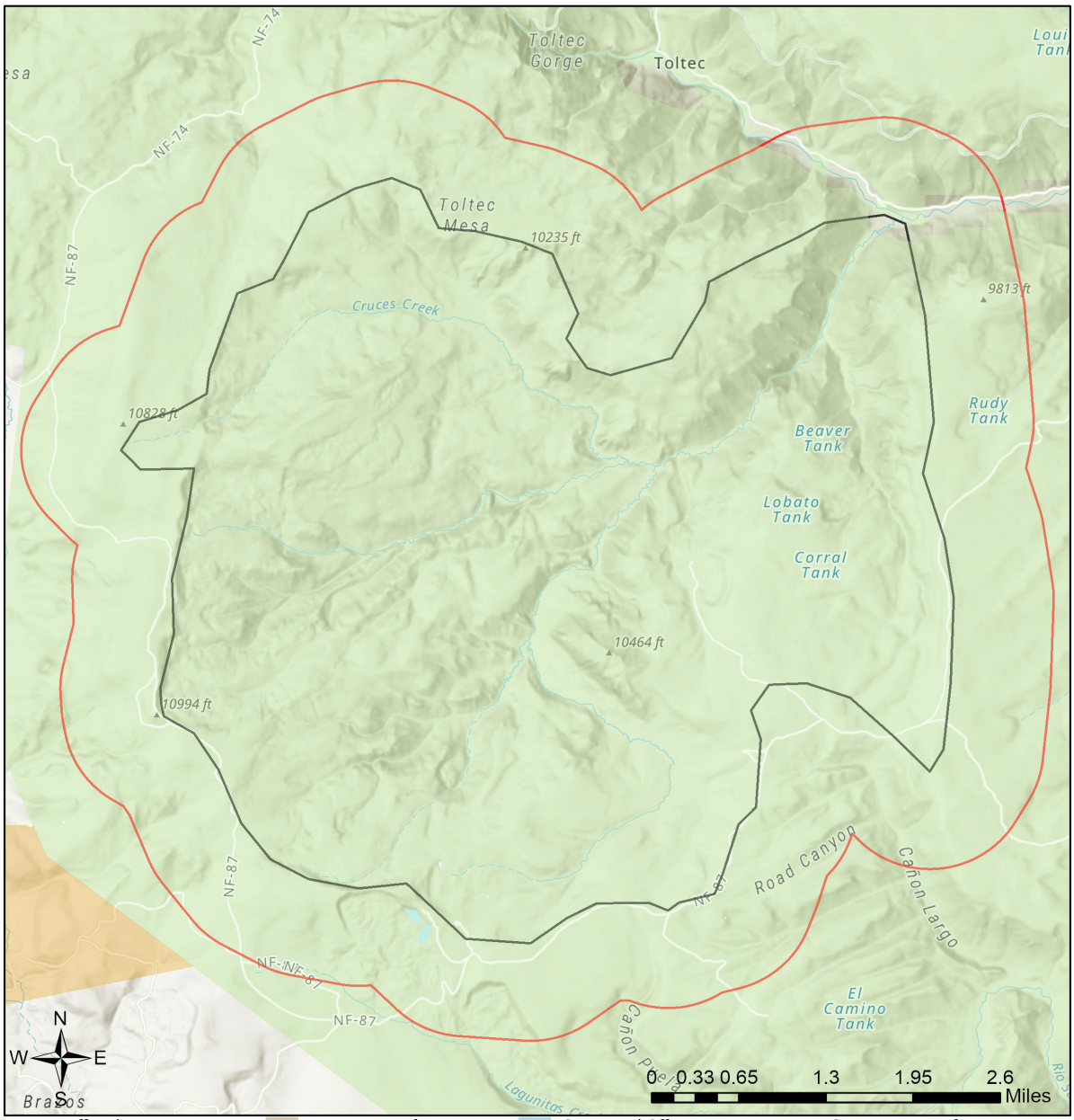
OVERALL STATUS

This report contains an initial list of recommendations regarding potential impacts to wildlife or wildlife habitats from the proposed project; see the Project Recommendations section below for further details. Your project proposal is being forwarded to a New Mexico Department of Game and Fish (Department) biologist for review to determine whether there are any additional recommendations regarding the proposed actions. A Department biologist will be in touch within 30 days if there are further recommendations regarding this project proposal.

About this report:

- This environmental review is based on the project description and location that was entered. The report must be updated if the project type, area, or operational components are modified.
- This is a preliminary environmental screening assessment and report. It is not a substitute for the potential wildlife knowledge gained by having a biologist conduct a field survey of the project area. Federal status and plant data are provided as a courtesy to users. The review is also not intended to replace consultation required under the federal Endangered Species Act (ESA), including impact analyses for federal resources from the U.S. Fish and Wildlife Service (USFWS) using their Information for Planning and Consultation tool.
- This report contains information on wildlife species protected under the ESA and the Wildlife Conservation Act (WCA), Species of Greatest Conservation Need (SGCN), and Species of Economic and Recreational Importance (SERI). Species listed under the ESA are protected from take at the federal level and under the WCA are protected from take at the state level. SGCN are identified in the State Wildlife Action Plan (SWAP) for New Mexico; all of these species are considered to be of conservation concern but not all of them are protected from take at the state or federal level. The harvest of all SERI is regulated at the state level. The Department has no authority to designate critical habitat for species listed under the WCA; only the USFWS can designate critical habitat for species listed under the ESA.
- The New Mexico Environmental Review Tool (ERT) utilizes species observation locations and species habitat suitability models, both of which are subject to ongoing change and refinement. Inclusion or omission of a species within a report cannot guarantee species presence or absence within your project area. To determine occurrence of any species listed in this report, or other wildlife that may be present within your project area, onsite surveys conducted by a qualified biologist during appropriate, species-specific survey timelines may be necessary.
- The Department encourages use of the ERT to modify proposed projects for avoidance, minimization, or mitigation of wildlife impacts. However, the ERT is not intended to be used in a repeatedly iterative fashion to adjust project attributes until a previously determined recommendation is generated. The ERT serves to assess impacts once project details are developed. The New Mexico Crucial Habitat Assessment Tool, the data layers from which are included in the ERT, is the appropriate system for advising early-stage project planning and design to avoid areas of anticipated wildlife concerns and associated regulatory requirements.

Cruces Basin Wetland Action Plan



- Buffered Project Boundary
- Project Boundary
- Bureau of Land Management
- City Land
- County Land
- Department of Defense
- Department of Energy
- NM Department of Game & Fish
- NM State Forestry Division
- NM State Parks
- National Park Service
- Private
- State Land Office
- State of New Mexico
- Tribal Land
- U.S. Army Corps of Engineers
- U.S. Bureau of Reclamation
- U.S. Department of Agriculture
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. Natural Resources Conservation Service

USGS, New Mexico Department of Game and Fish (NMDGF), Natural Heritage New Mexico (NHNM), and USDA Forest Service,

Compiled by Richard Norwood of NHNM over the period 2020 to 2021.
Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community

Special Status Animal Species Potentially within 1200 Meters of Project Area

Common Name	Scientific Name	USFWS (ESA)	NMDGF (WCA)	NMDGF SGCN/SERI
Western Toad	Anaxyrus boreas	PS	E	SGCN
Boreal Chorus Frog	Pseudacris maculata			SGCN
Northern Leopard Frog	Lithobates pipiens			SGCN
Eared Grebe	Podiceps nigricollis			SGCN
Clark's Grebe	Aechmophorus clarkii			SGCN
American Bittern	Botaurus lentiginosus			SGCN
Peregrine Falcon	Falco peregrinus		T	SGCN
Mountain Plover	Charadrius montanus			SGCN
Flammulated Owl	Otus flammeolus			SGCN
Western Burrowing Owl	Athene cunicularia hypugaea			SGCN
Boreal Owl	Aegolius funereus		T	SGCN
Common Nighthawk	Chordeiles minor			SGCN
Black Swift	Cypseloides niger			SGCN
Lewis's Woodpecker	Melanerpes lewis			SGCN
Williamson's Sapsucker	Sphyrapicus thyroideus			SGCN
Olive-Sided Flycatcher	Contopus cooperi			SGCN
Bank Swallow	Riparia riparia			SGCN
Pinyon Jay	Gymnorhinus cyanocephalus			SGCN
Clark's Nutcracker	Nucifraga columbiana			SGCN
Pygmy Nuthatch	Sitta pygmaea			SGCN
Western Bluebird	Sialia mexicana			SGCN
Mountain Bluebird	Sialia currucoides			SGCN
Loggerhead Shrike	Lanius ludovicianus			SGCN
Gray Vireo	Vireo vicinior		T	SGCN
Virginia's Warbler	Leiothlypis virginiae			SGCN
Grace's Warbler	Setophaga graciae			SGCN
Vesper Sparrow	Pooecetes gramineus			SGCN
Brown-Capped Rosy-Finch	Leucosticte australis			SGCN
Cassin's Finch	Haemorhous cassinii			SGCN
Evening Grosbeak	Coccothraustes vespertinus			SGCN
Rainbow Trout	Oncorhynchus mykiss			SERI
Brown Trout	Salmo trutta			SERI
Brook Trout	Salvelinus fontinalis			SERI
Spotted Bat	Euderma maculatum		T	SGCN
American Pika	Ochotona princeps			SGCN
Gunnison's Prairie Dog	Cynomys gunnisoni			SGCN
Black Bear	Ursus americanus			SERI
Pacific Marten	Martes caurina		T	SGCN

Special Status Animal Species Potentially within 1200 Meters of Project Area

Common Name	Scientific Name	USFWS (ESA)	NMDGF (WCA)	NMDGF SGCN/SERI
Mountain Lion	Puma concolor			SERI
Elk	Cervus canadensis			SERI
Mule Deer	Odocoileus hemionus			SERI
Pronghorn	Antilocapra americana			SERI

ESA = Endangered Species Act, C = Candidate, LE = Listed Endangered, LT = Listed Threatened, XN = Non-essential Experimental Population, for other ESA codes see this website: https://nhnm.unm.edu/node/1378928; WCA = Wildlife Conservation Act, E = Endangered, T = Threatened; SERI = Species of Economic and Recreational Importance; SGCN = Species of Greatest Conservation Need.

Special Status Plant Species Potentially within 1200 Meters of Project Area

Common Name	Scientific Name	USFWS (ESA)	NMAC	NMRPCS
Ripley Milkvetch	Astragalus ripleyi			SS

NMAC = New Mexico Administrative Code, NMRPCS = New Mexico Rare Plant Conservation Strategy, SS = NM Rare Plant Conservation Strategy Species, E = Endangered

Project Recommendations

Your proposed project activities may require a custom review for assessment of potential effects to wildlife. See the "OVERALL STATUS" section above to determine the likelihood that your project will be reviewed further based on its location. A Department biologist will confirm whether any additional conservation measures are needed. You should expect to receive any additional project recommendations within 30 days of your project submission. If the "OVERALL STATUS" section indicates that no further consultation with the Department is required based on its location, then you will only receive additional project feedback from the Department if a biologist deems it necessary.

Your project could affect important components of wildlife habitat, including fawning/calving or wintering areas for species such as deer and elk, or general high wildlife movement and activity areas for large mammals. Mitigation measures should focus on high use sites and movement areas based on collar data and expert knowledge of Department and land management agency personnel. Management recommendations within these areas may include the following.

- Restrictions on noise-generating activities during wintering and calving/fawning seasons, specific timing of which may vary throughout the state. These activities would include oil and gas well pad development and operations that expose wildlife to loud noises from drilling, compressors, and pumping stations within 400 feet of the source.
- Modifying fences along high use areas to make them wildlife friendly and facilitate large animal movement.

Burrowing owl (*Athene cunicularia*) may occur within your project area. Burrowing owls are protected from take by the Migratory Bird Treaty Act and under New Mexico state statute. Before any ground disturbing activities occur, the Department recommends that a preliminary burrowing owl survey be conducted by a qualified biologist using the Department's burrowing owl survey protocol. Should burrowing owls be documented in the project area, please contact the Department or USFWS for further recommendations regarding relocation or avoidance of impacts.

Prairie dog colonies may occur within the vicinity of your project area. Both black-tailed prairie dogs (*Cynomys ludovicianus*) and Gunnison's prairie dogs (*Cynomys gunnisoni*) are designated as New Mexico SGCN, and their colonies provide important habitat for other grassland wildlife. Wherever possible, occupied prairie dog colonies should be left undisturbed, and all project activities should be directed off the colony. Any burrows that are located on the project site should be surveyed by a qualified biologist to determine whether burrows are active or inactive and whether burrowing owls may be utilizing the site. Colonies within the range of the black-tailed prairie dog can be surveyed by a qualified biologist diurnally, year-round using binoculars. Colonies within the range of the Gunnison's prairie dog can be surveyed by a qualified biologist diurnally, using binoculars during the warmer months from April through October and by searching for fairly fresh scat and lack of cobwebs or debris at the mouths of burrows during the cold months (November through March). If ground-disturbing activities cannot be relocated off the prairie dog colony, or if project activities involve control of prairie dogs, the Department recommends live-trapping and relocation of prairie dogs. The Department can provide recommendations regarding suitability of potential translocation areas and procedures.

The proposed project occurs within or near a riparian area. Because riparian areas are important wildlife habitats, the project footprint should avoid removing any riparian vegetation or creating ground disturbance either directly within or affecting the riparian area, unless the project is intended to restore riparian habitat through non-native plant removal and replanting with native species. If your project involves removal of non-native riparian trees or planting of native riparian vegetation, please refer to the Department's habitat handbook guideline for Restoration and Management of Native and Non-native Trees in Southwestern Riparian Ecosystems. The New Mexico Riparian Habitat Map (NMRipMap) may also provide useful information on local riparian habitat composition and structure.

Your proposed project occurs within an area where springs or other important natural water features occur. This may result in the presence of a high use area for wildlife relative to the surrounding landscape. To ensure continued function of these important wildlife habitats, your project should consider measures to avoid the following.

- Altering surface or groundwater flow or hydrology,
- Disturbance to soil that modifies geomorphic properties or facilitates invasion of non-native vegetation.
- Affecting local surface or groundwater quality.
- Creating disturbance to wildlife utilizing these water features. Disturbance to wildlife can be reduced through practices including clustering infrastructure and activity wherever possible, avoiding large visual obstructions around water features, and limiting nighttime project operations or activities.

Department biologists are available for site-specific consultation regarding measures to assist with management and conservation of these habitat resources.

Your project could affect important components of wildlife habitat, including fawning/calving or wintering areas for species such as deer and elk, or general high wildlife movement and activity areas for large mammals. Mitigation measures should focus on high use sites and movement areas based on collar data and expert knowledge of Department and land management agency personnel. Management recommendations within these areas may include the following.

- Restrictions on noise-generating activities during wintering and calving/fawning seasons, specific timing of which may vary throughout the state. These activities would include oil and gas well pad development and operations that expose wildlife to loud noises from drilling, compressors, and pumping stations within 400 feet of the source.
- Modifying fences along high use areas to make them wildlife friendly and facilitate large animal movement.

Disclaimers regarding recommendations:

- The Department provides technical guidance to support the persistence of all protected species of native fish and wildlife, including game and nongame wildlife species. Species listed within this report include those that have been documented to occur within the project area, and others that may not have been documented but are projected to occur within the project vicinity.
- Recommendations are provided by the Department under the authority of § 17-1-5.1 New Mexico Statutes Annotated 1978, to provide "communication and consultation with federal and other state agencies, local governments and communities, private organizations and affected interests responsible for habitat, wilderness, recreation, water quality and environmental protection to ensure comprehensive conservation services for hunters, anglers and nonconsumptive wildlife users".
- The Department has no authority for management of plants or Important Plant Areas. The New Mexico Endangered Plant Program, under the Energy, Minerals, and Natural Resources Department's Forestry Division, identifies and develops conservation measures necessary to ensure the survival of plant species within New Mexico. Plant status information is provided within this report as a courtesy to users. Recommendations provided within the ERT may not be sufficient to preclude impacts to rare or sensitive plants, unless conservation measures are identified in coordination with the Endangered Plant Program.
- Additional coordination and/or consultation may also be necessary under the federal ESA or National Environmental Policy Act (NEPA). Further site-specific mitigation recommendations may be proposed during ESA consultation and/or NEPA analyses or through coordination with affected federal agencies.

APPENDIX C

RIO GRANDE RETURN

Wetland Restoration Assessment

Cruces Basin Wilderness

August 2024

Peter Watson, Karen Menetrey, Reid Whittlesey

Beaver Pond in Beaver Creek, Cruces Basin Wilderness

Table of Contents

Table of Figures

Introduction

Cruces Basin Wilderness, consisting of 18,876 acres, is in the Carson National Forest in Northern New Mexico. Elevations in the Wilderness range from 8,500-10,700 feet. The vegetation is a mosaic of spruce/ fir forest, aspen glades, subalpine meadow, and riparian woodlands. Water resources in the basin include headwater slope wetlands and riverine wetlands along four creeks: Beaver, Cruces, Diablo and Escondido. Cruces Basin Wilderness is a roadless protected area under the federal 1964 Wilderness Act, and all wetlands therein are designated by the State of New Mexico as Outstanding National Resources Waters (ONRW), which provides further protection against development and water quality degradation. The area is used for recreation (hiking, hunting, camping, and fishing) and cattle grazing, and is also subject to browsing by wildlife (elk and deer). When improperly managed, these can become factors in watershed degradation. According to the US Forest Service's Watershed Condition Framework system, Beaver Creek Watershed is identified as “Functioning at Risk,” with Aquatic Biota Condition listed as “Poor” and Riparian Wetland Condition listed as “Fair.” Beaver Creek is identified as impaired for temperature by the New Mexico Environment Department Surface Water Quality Bureau.

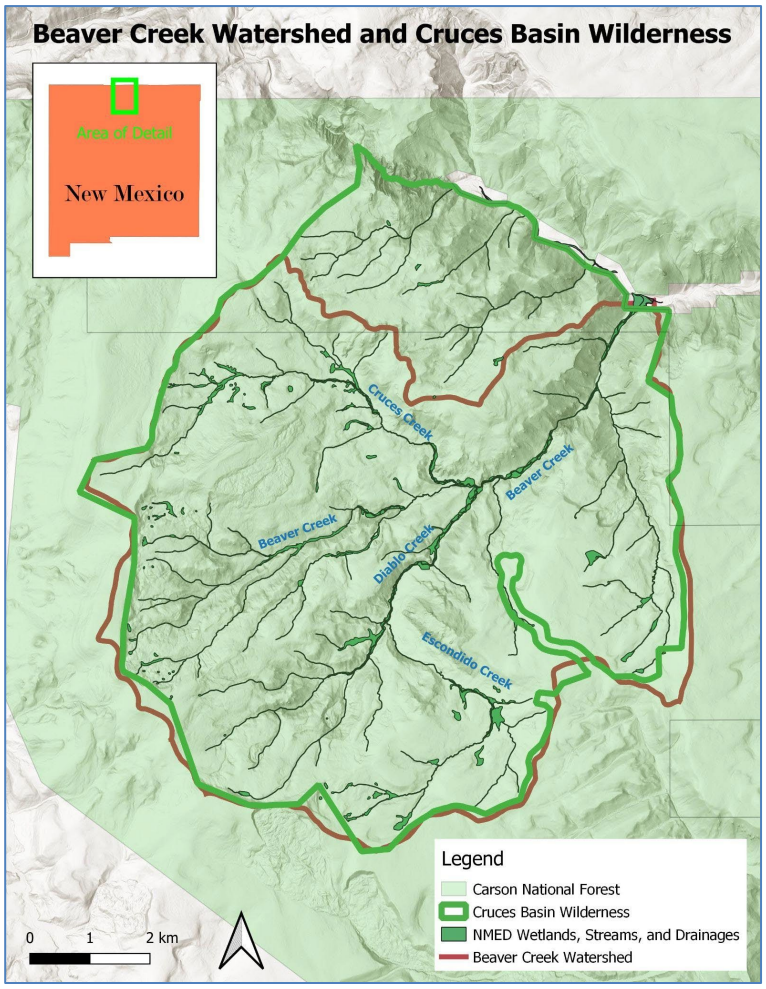


Figure 1. Overview map of Cruces Basin Wilderness and the Beaver Creek Watershed

2024 Draft National Wetlands Inventory Update

Wetlands in the Cruces Basin Wilderness were mapped for the National Wetlands Inventory (NWI) in approximately 2010. The 2010 mapping was the basis for the ONRW wilderness wetlands, and for the Amigos Bravos Wetland Jewels. The New Mexico Environment Department Wetlands Program is currently updating wetland mapping for wilderness areas with Saint Mary's University GeoSpatial Services. Draft NWI mapping shared by GeoSpatial Services in July 2024 indicates that the primary revisions to the 2010 mapping include an increase in wetland acreage, and recoding (per Cowardin, 1979) the majority of PEM1A (palustrine emergent persistent temporarily flooded) wetlands as PEM1B (palustrine emergent persistent saturated) to reflect the understanding that they are saturated wetlands deriving moisture from snowmelt and groundwater rather than overbank flooding from creeks. PEM1B is the most abundant wetland type throughout the basin. Small sections are coded as PEM1A or PEM1C (palustrine emergent persistent seasonally flooded) where the creeks provide overbank flooding during spring runoff. Lower Beaver Creek is dominated by PSS (palustrine scrub shrub) and PFO (palustrine forested) where there are beaver dams that inundate the floodplain and support the growth of riparian shrubs and trees. Beaver ponds along lower Beaver Creek are coded as PUBFb (palustrine unconsolidated bottom semipermanently flooded beaver). There are also five small stock ponds in the Wilderness coded PUBFh (palustrine unconsolidated bottom semipermanently flooded diked/impounded)

According to the Landscape Position, Landform, Water Flow Path, Water Body Type (LLWW) classification system (Tiner, 2011), most of the wetlands in Cruces Basin Wilderness are TESLOU (terrene slope outflow) with various modifiers, most commonly ds (discharge stream) and hw (headwater) or ST2TI (stream middle gradient throughflow intermittent). The beaver ponds PD4TI (pond beaver throughflow intermittent). The stock ponds are PD2aTHhi (pond dammed/impounded agricultural severely human-induced).

As described by the Hydrogeomorphic classification system (Brinson, 1993), most wetlands in the Cruces Basin are in the Slope Class. The second most abundant are in the Riverine class. The beaver dams and stock ponds are in the Depressional Class. HGM classes are inferred because the draft updated data was not coded yet for HGM.

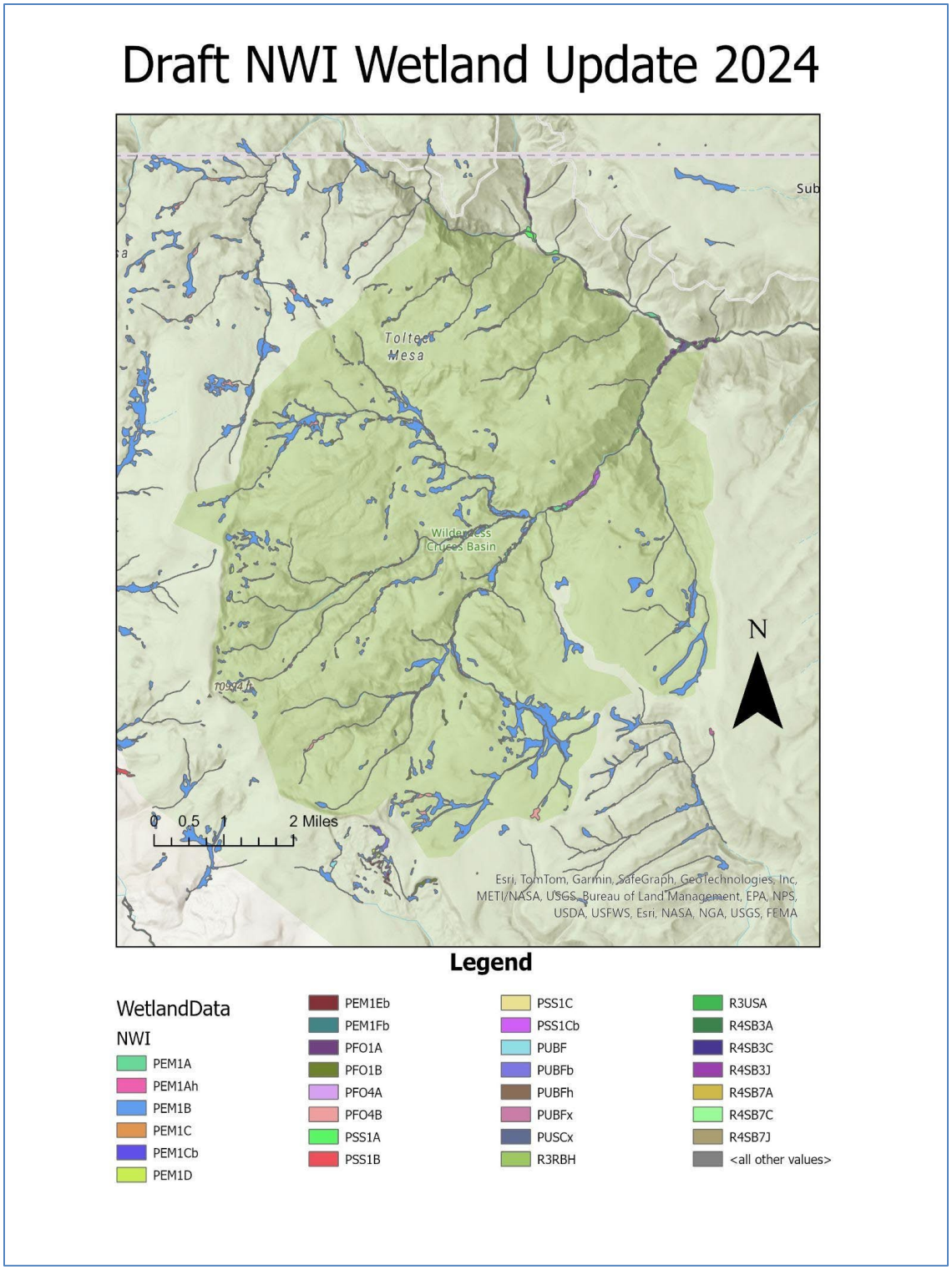


Figure 2. Map showing draft updated National Wetlands Inventory data for Cruces Basin Wilderness. Data by Saint Mary's University GeoSpatial Services, 2024.

Survey Methodology

Rio Grande Return assessed wetlands in the Cruces Basin Wilderness to evaluate existing conditions. Staff members Reid Whittlesey, Karen Menetrey and Peter Watson developed the assessment protocol in ArcGIS Survey123 in October 2023. The survey consisted of collecting georeferenced points which identified water resource impairments, describing them by location (upland, riverine, wetland, etc), impairment type (headcut, channel incision, browse/ graze, etc), and identifying whether restoration materials (e.g. rocks, trees) are available nearby. The survey also collected georeferenced points of reference reaches, or places where the water resource condition has not been significantly altered by human activity or through anthropogenic disturbance regimes. These include beaver-dominated stream reaches and intact slope wetlands. Reference conditions are rare within the project area. Rio Grande Return staff spent a week in October 2023, and half a week in August 2024, hiking throughout the wilderness to conduct the survey. Points were mainly collected inside Wilderness boundaries, but some points were collected outside where poor road drainage was causing water resource degradation within the Wilderness. Lower Beaver Creek was only surveyed using geospatial analysis on satellite imagery due to its steep topography restricting both human surveyors, livestock, and native ungulates. Results of the initial survey are also documented in a Cruces Basin Wilderness Wetland Assessment ArcGIS StoryMap: https://arcg.is/1qzHmu.

Survey Results

The three most common impairments identified by the survey were channel incision, headcuts/ active erosion, and severe grazing/ browse. These were ubiquitous throughout the wilderness. Also common were bank erosion, hoof shear, and road/ trail drainage issues. The "other" category was used when the impairment did not fit any of the existing categories, such as damage caused to a stream by a trail crossing.

The watershed was categorized into survey reaches based on valley morphology and level of impacts. Each of these reaches is shown on Figure 4 and discussed in detail to create a high-level view of the impairments facing water resources in Cruces Basin Wilderness.

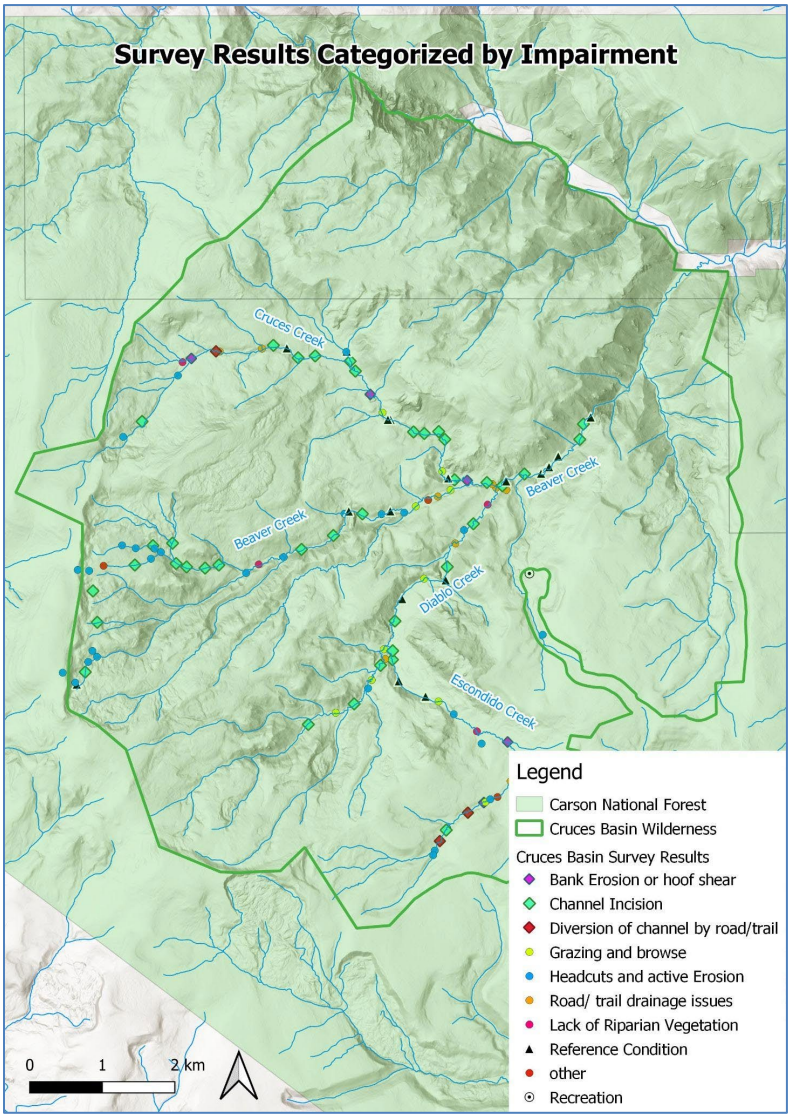


Figure 3. Map showing watershed survey results categorized by impairment.

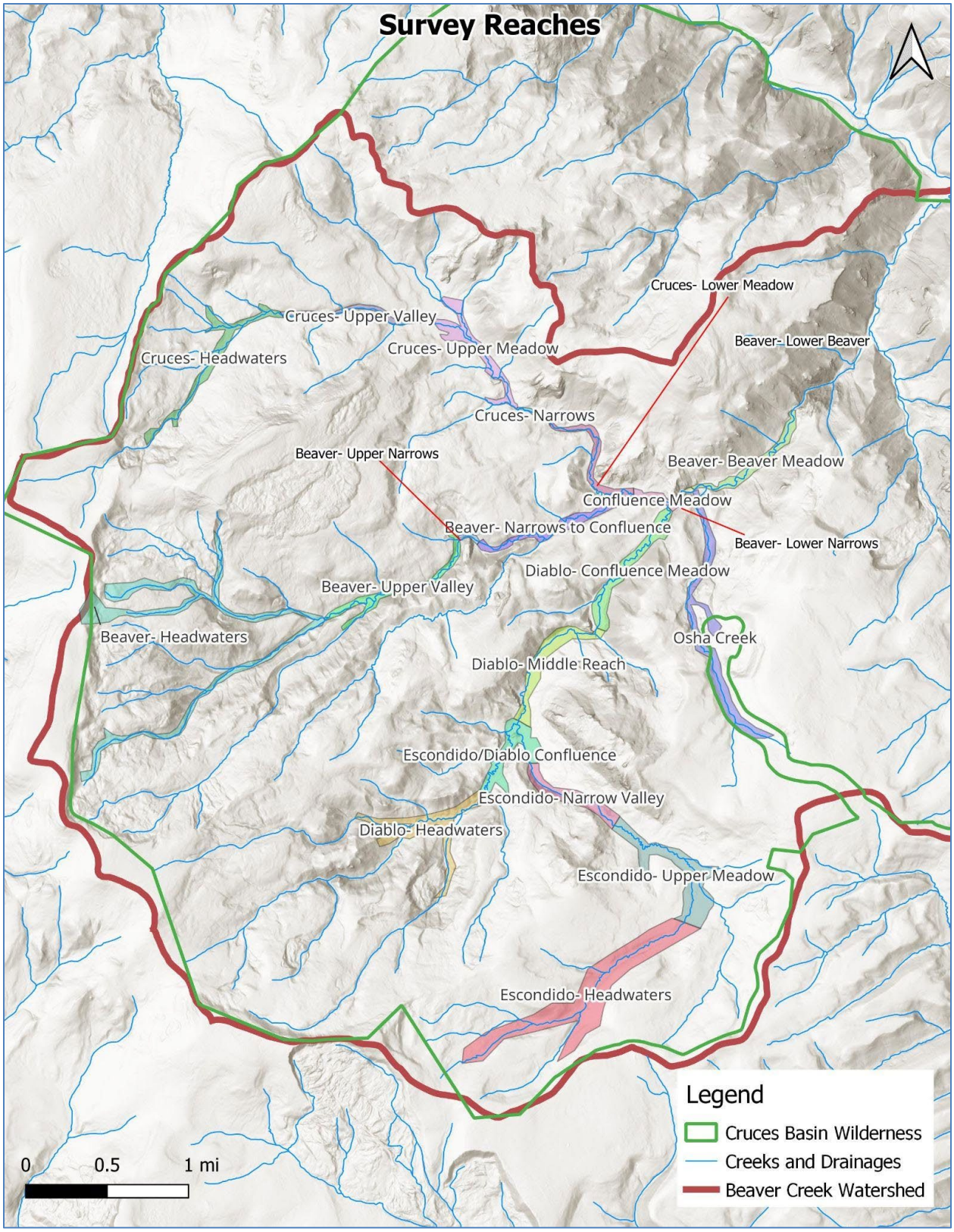


Figure 4. Map showing survey reached referenced in this document, which were delineated in the field based on valley morphology and condition.

Escondido Creek

Headwaters: Cattle trailing and scarcity of upland vegetation cover is causing channel incision, upland erosion, and, in some places, stream capture from the natural channel into the livestock trail**.** The meandering, historic channel and its floodplain are visible in some places contrasting with the incised, straightened active channel. In this reach, there are an estimated 10 significant (1-3ft) headcuts per mile of stream. The uplands have sparse vegetation cover that is heavily grazed (more than 40% utilization), leading to sheet erosion, rills, and gullies across the whole headwaters reach. There are frequent slope wetlands and seeps, all of which are incised to some degree. There is good access to material for restoration work.

Upper Meadow: Cattle trailing and scarcity of upland vegetation cover is causing channel incision, upland erosion, and, in some places, stream capture**.** There is no riparian woody vegetation in this reach, although one single old willow stump was observed. There is dense *Elodea* growth in places, indicating high solar loading on the stream. Material is far, up to ½ mile or more away. There are frequent slope wetlands and seeps, all of which are incised to some degree. There is unambiguous evidence of recent and historic OHV incursion in this reach, and the tracks lead to a junction of pasture fences that appears to be used as a salt lick location due to the high level of cattle traffic.

Narrow valley: The grade here steepens significantly and appears to be controlled by boulders. There are a few sections where it flattens briefly which appear to correspond with historic beaver dams. There are several historic beaver-chewed stumps in this reach. There are healthy willows and cottonwoods and lots of large woody debris (LWD) in the channel.

Escondido Creek/ Diablo Creek confluence area: Like Escondido Headwaters, the historic channel and its floodplain are visible in what is now the uplands of the current incised, straightened channel. There are some alders and browsed willows growing here,

and historic beaver-chewed sticks scattered across the historic floodplain. This reach is a suitable candidate for process-based restoration work because material is close and there is a high potential to reconnect the historic floodplain. There are one or two significant headcuts in this reach. The uplands have sparse vegetation cover that is heavily grazed (more than 40% utilization), leading to sheet erosion, rills, and gullies across the whole reach.

Diablo Creek

Headwaters: The headwaters of Diablo are a handful of small valleys with perennial streams. These streams are all incised. There are lots of alder and willow growing in the more confined valleys, but the willows are heavily browsed. These tributaries have abundant large woody debris (LWD) and occasionally become braided or otherwise more complex, despite being incised. There are several incised slope wetlands in this reach. There is great material availability and high potential to reconnect former floodplain, making this a suitable candidate for process-based restoration work. The uplands have sparse vegetation cover that is heavily grazed (more than 40% utilization), leading to sheet erosion, rills, and gullies across the whole headwaters reach.

Middle Reach: The channel is incised and straightened with the historic channel and floodplain visible above it. There are a lot of browsed willows and alders. There are three enormous old beaver dams in this reach. There is good material close at hand, and process-based restoration work has high potential. Beaver Dam Analogs (BDAs) could reconnect the old floodplain and Assisted Log Structure (ALS) installation could add channel complexity and reduce its straightness.

Confluence Meadow: The valley broadens significantly and riparian woody vegetation is lacking or severely browsed. The channel is incised and straightened with the historic channel visible above it. It regains some meanders and begins to develop an inset floodplain towards the confluence with Beaver Creek but remains incised. The uplands have sparse vegetation cover that is heavily grazed (more than 40% utilization),

leading to sheet erosion, rills, and gullies across the whole reach. There is sufficient material available except for the last ¼ mile right above the confluence with Beaver Creek.

Cruces Creek

Headwaters: Numerous incised slope wetlands form the headwaters and there is heavy cattle trailing causing incision, widening, and capture of the channel as its tributaries converge and develop significant flow. Most slope wetlands in this reach are threatened by active headcuts. The uplands have sparse vegetation cover that is heavily grazed (more than 40% utilization), leading to sheet erosion, rills, and gullies across the whole headwaters reach. Riparian woody vegetation is sparse and heavily browsed.

Upper Valley: The upper valley is of medium gradient and alternates between forest and meadow. Trailing and slope wetland incision continue down the valley, and there is very little willow. The channel is deeply incised (4ft+) in some spots. Good material is available nearby. There is at least one old beaver dam in this reach.

Upper Meadow: The valley opens into a large meadow and the grade lessens. There are many slope wetlands and one major spring in this reach, all incised and cutting headward. The channel is incised and straightened. The uplands have sparse vegetation cover that is heavily grazed (more than 40% utilization), leading to sheet erosion, rills, and gullies across the whole reach. Material availability varies but is generally within 200 yards of the stream. There are a few landscape features that may have been old beaver dams. Process-based restoration work has high potential to reconnect the floodplain and arrest wetland erosion.

Narrows: This reach has limited ungulate access and therefore has healthy woody riparian vegetation. The grade steepens and the channel is slightly incised. There is more recent (10–15-year-old) beaver chew in this reach.

Lower meadow: This reach is straightened and moderately incised with woody riparian vegetation absent or severely browsed at the upper end, but abundant at the downstream end. There are many slope wetlands and springs; some are in decent shape but others are incised. The uplands have sparse vegetation cover that is heavily grazed (more than 40% utilization), leading to sheet erosion, rills, and gullies across the whole reach. Good material is available nearby. Process-based restoration work has high potential to add complexity and reconnect floodplain in this reach. The abundant willows, alders, and cottonwoods at the bottom of the reach appear to begin at the pasture fence (which is currently in disrepair). There is ample evidence that this was once a large beaver complex, including one massive, breached dam about 180 ft long.

Beaver Creek

Headwaters: The headwaters begin at the steep Brazos Ridge that is part of the continental divide. There is very poor ground cover here with an abundance of Pussytoes (*Antennaria*), indicating historic and current overgrazing. Rills and sheet erosion are widespread and there are several large gullies from concentrated drainage from Forest Road 87, which follows the ridge for 2-3 miles. All the tributary drainages forming Beaver Creek's headwaters are deeply incised (3-4ft increasing to 8-10ft) with massive headcuts. The northernmost tributaries show the most recent signs of erosion, whereas the more southern tributaries have begun to stabilize, vegetate, and develop inset floodplains. There are numerous head cuts in the slope wetlands. This whole drainage is unzipping. It was difficult to determine a sole source of the gullying but it appears to be a combination of the pervasive sheet erosion and the several road drainage gullies. Near the top of the main stem of Beaver Ck., there is a large old beaver pond that has been converted into an extensive wet meadow (highlighted in green in the photo below, blue arrows indicate flow path). There is an active headcut about 20 ft below this that is approximately 5ft deep, threatening the entire wet meadow (indicated by the red arrow). The incision continues downstream, becoming deeper. It appears to be recent as the streambanks are completely unvegetated and there are multiple trees that have recently collapsed into the channel, suggesting that the channel is in a Stage 3 Degrading condition of evolution, per

The Stream Evolution Model developed by Cluer and Thorne (2014). It appears to end where Beaver Creek gains its main headwater tributary and there is a broad zone of deposition.

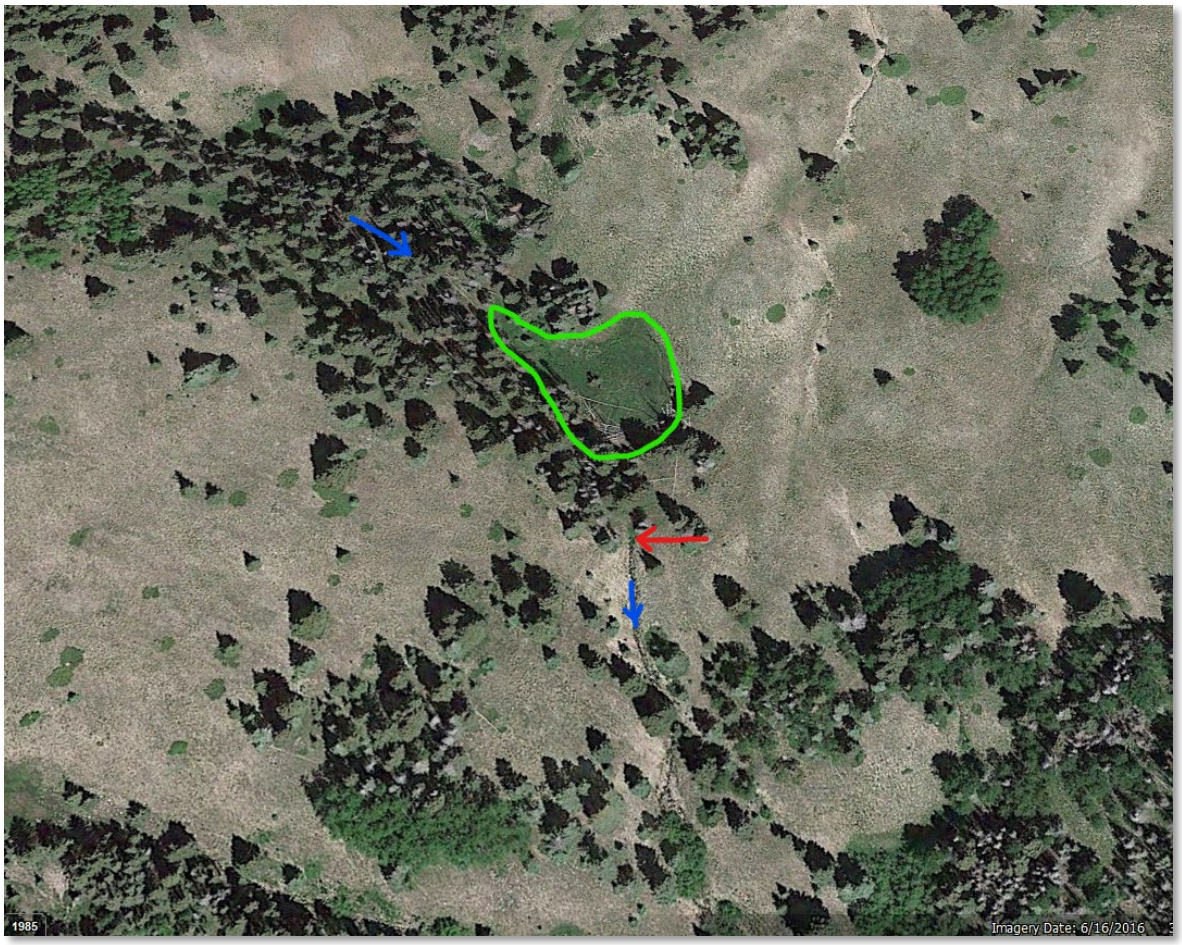


Figure 5. Beaver-created wetland threatened by headcut (red arrow). Blue arrow shows direction of flow.

Upper Valley: The grade lessens, and the channel is moderately incised, with several slope wetlands downcutting to meet the stream grade. Woody riparian vegetation is sparse or severely browsed. An inset floodplain is developing in some spots. Material is good and available nearby. This reach would be a suitable candidate for process-based restoration work to raise the channel elevation and arrest downcutting.

Upper Narrows: The narrows are steep, bouldery, and confined. There is healthy woody riparian vegetation and lots of large woody debris (LWD).

Narrows to Cruces Creek confluence: The valley broadens into a meadow and the grade lessens. There are several incised sections and headcuts, but in some places the channel has floodplain connectivity and complexity. Woody vegetation is generally present but disappearing in places and all is heavily browsed. Woody vegetation becomes more abundant near the historic dam complex at the Cruces Creek confluence. There is abundant suitable material available and process-based restoration work has high potential to reconnect the floodplain. Fencing could protect the dense willow stands near the confluence area. The uplands have sparse vegetation cover that is heavily grazed (more than 40% utilization), leading to sheet erosion, rills, and gullies across the whole reach.

Confluence Meadow: Riparian woody vegetation is present on Beaver and Cruces Creeks, but not Diablo. The channel is incised but has some complexity. Multiple trails cross the creeks in this reach, contributing fine sediment and leading to widening. Material is present but not as abundant or accessible as other reaches. Process-based restoration work has high potential to reconnect the floodplain. Some trail work (either simple bridges or armoring the crossings) would be helpful because these trails appear to be used by humans and livestock.

Lower Narrows: This reach is confined, steep, and bouldery, with abundant woody riparian vegetation and large woody debris (LWD).

Beaver Meadow: This is a large, gentle meadow with abundant willow, cottonwood, and alder. A valley-wide beaver complex lies in the middle of it with multiple tiers of dams, canals, and 3 lodges. Water is spread across the entire valley above the dams. There is vigorous willow recruitment. The upper and lower end of this meadow have no active beavers and would be good candidates for Assisted Log Structure or BDA

installations to support the beavers and reconnect the floodplain. The meadow ends at a steep gorge which descends to the Rio de Los Pinos.

Lower Beaver: This reach is a broad meadow that is protected from cattle grazing by a steep, impassable gorge upstream and private land boundaries downstream. Geospatial analysis shows that it is beaver-dominated with a healthy riparian shrubland growing in the floodplain. Without collaboration with private landowners, this reach is inaccessible for restoration work but provides a suitable reference reach for the rest of the watershed.

Watershed Concept Design and Site Prioritization

Summary of Restoration Approach

The Carson National Forest (CNF) Land Management Plan (2022) states, “Focusing restoration on headwater wetlands and first order streams has benefits that cascade throughout the watershed and can facilitate future restoration downstream. Fixing watershed problems at their source assists natural recovery and increases the potential for future restoration lower in the watershed. Due to the many first order streams located on the Carson National Forest there are opportunities for important headwater wetland restoration that are rare in the arid Southwest.” With a watershed-scale restoration plan, priority sites for restoration must be identified based on scale of impact, ease of access, material availability, and other factors. Stakeholder input and management goals are also crucial factors, which can be identified collaboratively in stakeholder meetings.

Streams in the Cruces Basin have been altered from historical conditions due to the extirpation of beaver and land uses including timber removal, road building, and livestock grazing. These activities removed the structural elements such as beaver dams and woody debris that are critical for creating functioning aquatic habitats.

The restoration goal for stream systems in the Cruces Basin is to restore the hydro-geomorphic processes that maintain complex aquatic and riparian habitat, channel-floodplain connectivity, and high groundwater tables and water storage. This will be

accomplished through an iterative process of adding structural elements such as beaver dams and woody debris to streams to force the development of a multi-threaded channel network across the entire available floodplain. Because process-based perennial stream restoration relies on periods of high streamflow such as large spring runoff or summer monsoon events to do the hydrogeomorphic work of restoration rather than large earth-moving equipment, this will occur over a period of years and may involve multiple restoration treatments.

In some sections of the watershed where there is little to no channel incision, the restoration goal may be achieved in a single process-based restoration treatment, while in other areas where the channel is more deeply incised, multiple treatments may be needed. Where the stream channel is significantly incised, the objective of the first treatment phase is to widen and aggrade the channel so that over time it will fully reconnect to its historic floodplain. Aggradation in this first phase of treatment will likely be limited to the current channel width. Objectives for subsequent treatments could include increasing lateral connectivity and the development of a multi-threaded channel to increase the proportion of the valley bottom engaged.

Ephemeral and intermittent channel restoration focusing on arresting headcuts does not require the same degree of phased implementation, but allowing for adaptive management and retreatments in projects (i.e. multi-year project funding that can support evaluating structure efficacy and maintenance) increases project resiliency and impact. Similarly, project funding can also be phased in and is scalable. While achieving a large enough scale of a project to be ecologically significant is highly recommended, portions of the defined projects may be funded so long as there is a commitment to achieving the restoration goals long term.

Project costs or implementation reflect the tentative total amount for completion of each project. A watershed-scale assessment and design report is the recommended first step and can determine actual structure numbers, volumetric fill, locations, and lead to a more accurate total cost. Each project is best framed as a two-year project, with a significant intervention occurring in year one and re-treatments/adaptive management occurring in year two. In entrenched or highly degraded reaches a 5-10 year timeframe may be required for recovery.

The estimated cost of a watershed-scale assessment and design report is $40,000. Preparation of the report would include additional geospatial and field analysis that results in a 90% design using a phased timeline approach. The design could be used to obtain Clean Water Act 401 permit coverage. The assessment and design report would not include the archaeological survey or biological opinion needed for National Environmental Policy Act (NEPA) compliance.

Watershed-Scale Priorities

Based on the data collected during two field surveys, stakeholder meetings, and geospatial analysis, Rio Grande Return staff identified several watershed-scale priority tasks for the Wilderness. These are recommended across all reaches in the watershed.

1. Address headcuts and halt incision of wetlands.
2. Develop and implement a regenerative grazing management plan.
3. Expand riparian wetlands using low tech, process-based restoration.

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1. **Address headcuts and halt incision of wetlands.**

To address the numerous headcuts in the Wilderness, it will first be necessary to fund and perform a headcut identification and assessment effort with feasibility and design considerations. Many sites in the watershed have multiple headcuts and gullies over 3 feet deep, which is considered the maximum depth treatable by hand crews (Zeedyk et. al. 2014). In these instances, the best course of action may be to stabilize the channel at its new grade and promote inset floodplain development, or to use water-spreading techniques to reroute water around the headcuts. However, sites that have gullies and headcuts less than 3 feet deep and have potential to protect a large area of wetland from cutting headward, should be prioritized for stabilization.

2. **Develop and implement a grazing management plan.**

The second priority is to develop and implement a grazing management plan. Research and restoration projects have demonstrated that re-establishing healthy

vegetation cover and implementing long term grazing management is a necessary foundation to watershed-scale restoration (Small et. al. 2016). Woody and non-woody wetland vegetation across the Wilderness was heavily utilized (over 40%) during both survey trips.

The CNF's 2022 Land Management Plan addresses managing grazing in ways that are compatible with ecosystem health, but currently has no specific, actionable plan to draw upon for management of the Cruces Basin. The two allotments that contain Cruces Basin are the Apache Complex and Lagunitas.

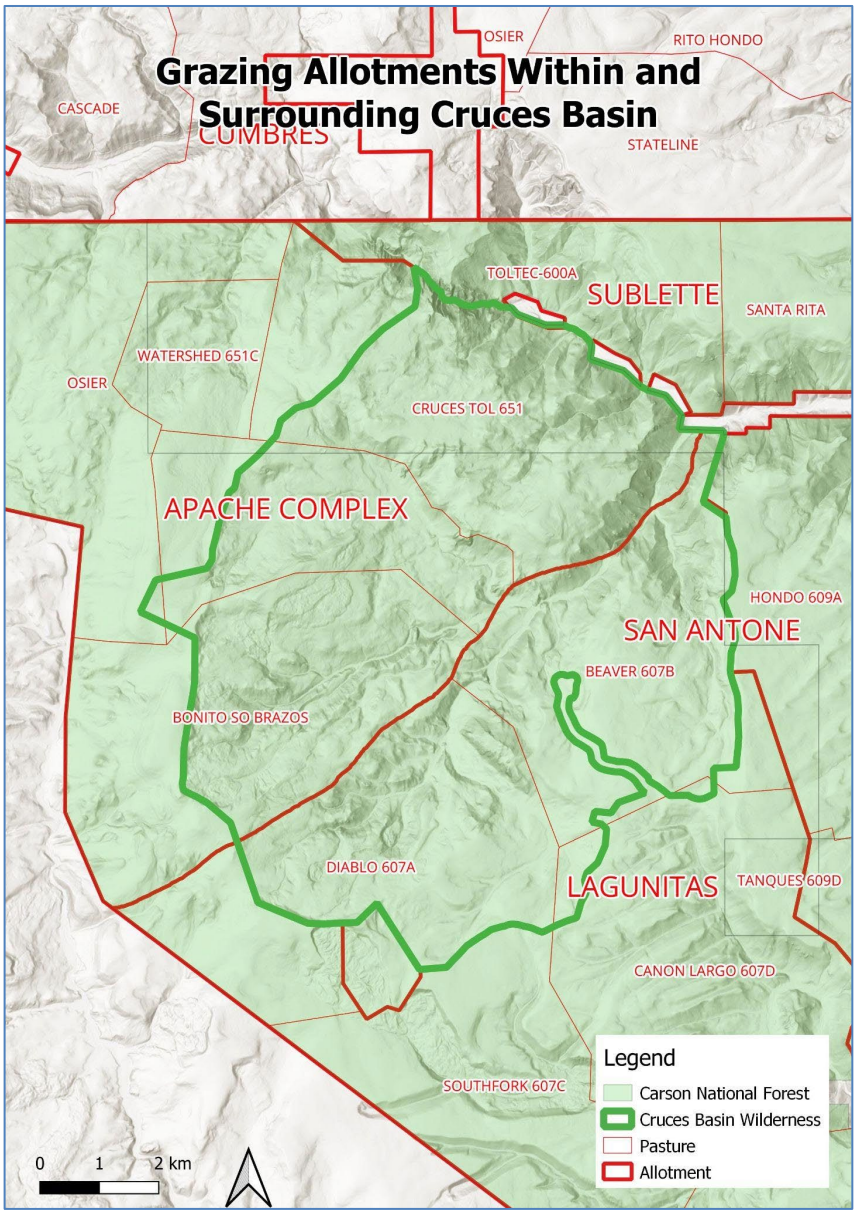


Figure 6. Map showing grazing allotments within and surrounding Cruces Basin.

3. Expand riparian wetlands using low tech, process-based restoration.

Historically, Beaver Creek Watershed was occupied by beavers across most of its extent (descriptions of historic beaver complexes are provided in "Survey Results"). The riparian wetlands created by these beavers are now largely gone. There are several priority stream reaches in the Wilderness where beaver mimicry and low tech, process-based

restoration has high potential to expand riparian wetlands, raise the water table, reconnect the historic inset floodplain, and improve fish and beaver habitat. *Projects for these reaches should be implemented using a phased approach over multiple years to most effectively impact the ecosystem and incorporate an adaptive management regime into the implementation plan*. These reaches are discussed in detail below.

Evaluating Priority Reaches

To determine priority reaches for restoration, several factors determining potential project success were weighed against the potential ecological impact of a successful project. These factors included availability of material, presence of beaver, site geomorphology, level of degradation, and presence or absence of current degrading factors such as unregulated grazing or OHV trespass.

During the field survey, material availability was evaluated throughout the watershed. Having material nearby is crucial for efficient implementation of process-based restoration, especially in a wilderness setting where mechanized transport is not possible. Materials for process-based restoration consist of logs,

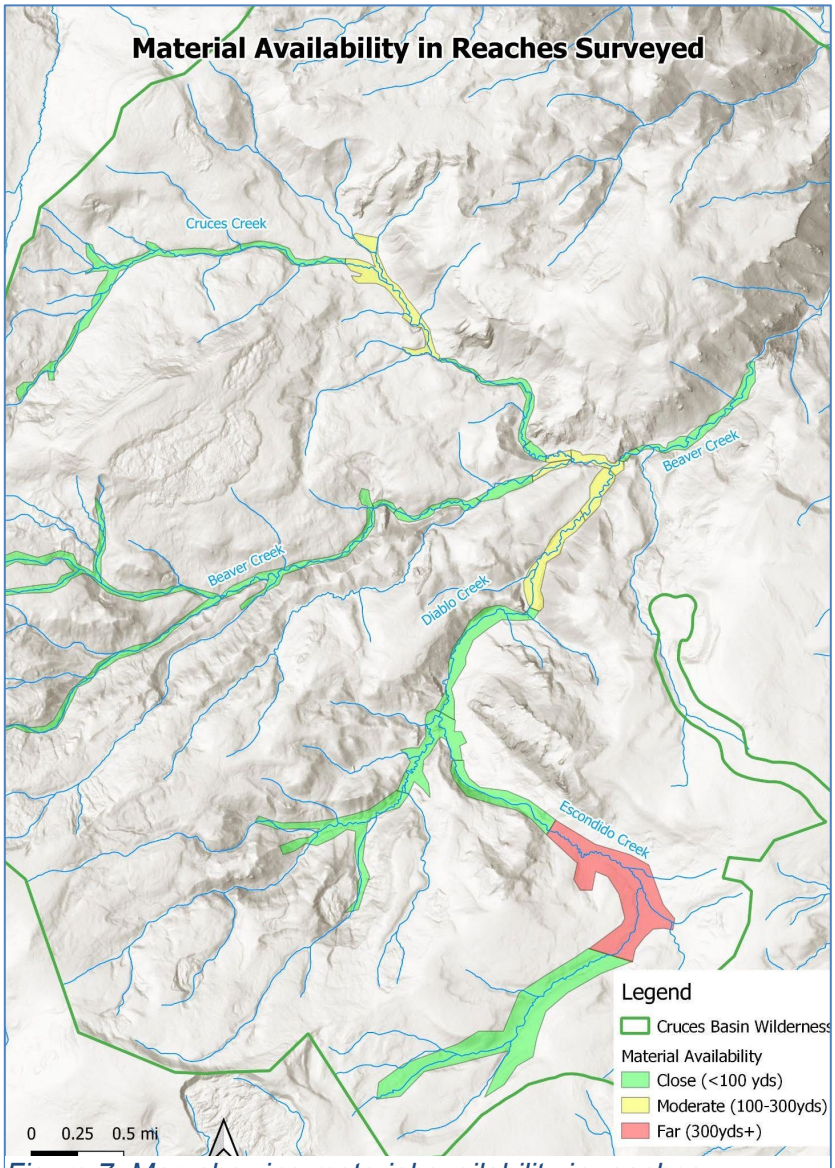


Figure 7. Map showing material availability in reaches surveyed. Material availability is a crucial factor when prioritizing reaches for treatment in a wilderness setting.

small diameter conifers, rocks, sod, willows, dirt, and gravel.

Another consideration when employing process-based restoration techniques to increase riparian wetland extent that involve beaver mimicry (BDAs and Assisted Log Structures) is proximity to active beaver colonies that can colonize project sites. Beavers are active in the Beaver Meadow reach of Beaver Creek, as well as in Lower Beaver. Beaver sign (e.g. beaver dam or chew) from the last 10-15 years was seen as far upstream as the Narrows reach of Cruces Creek. This demonstrates that the beavers in this watershed may be comfortable moving up to 1.5 miles in search of new habitat. This is a conservative estimate based on observation. Beavers are known to migrate much farther to find suitable habitat (McNew et al. 2005). Sites beyond 1.5 miles of the active beaver colony on Beaver Creek should be considered for beaver relocation to bolster the watershed's population and expedite beaver recolonization. Additionally, the presence of intact willow stands is a key factor when prioritizing areas for beaver mimicry work because colonizing beavers will need a sufficient initial food source to establish a self-sustaining colony. This is typically

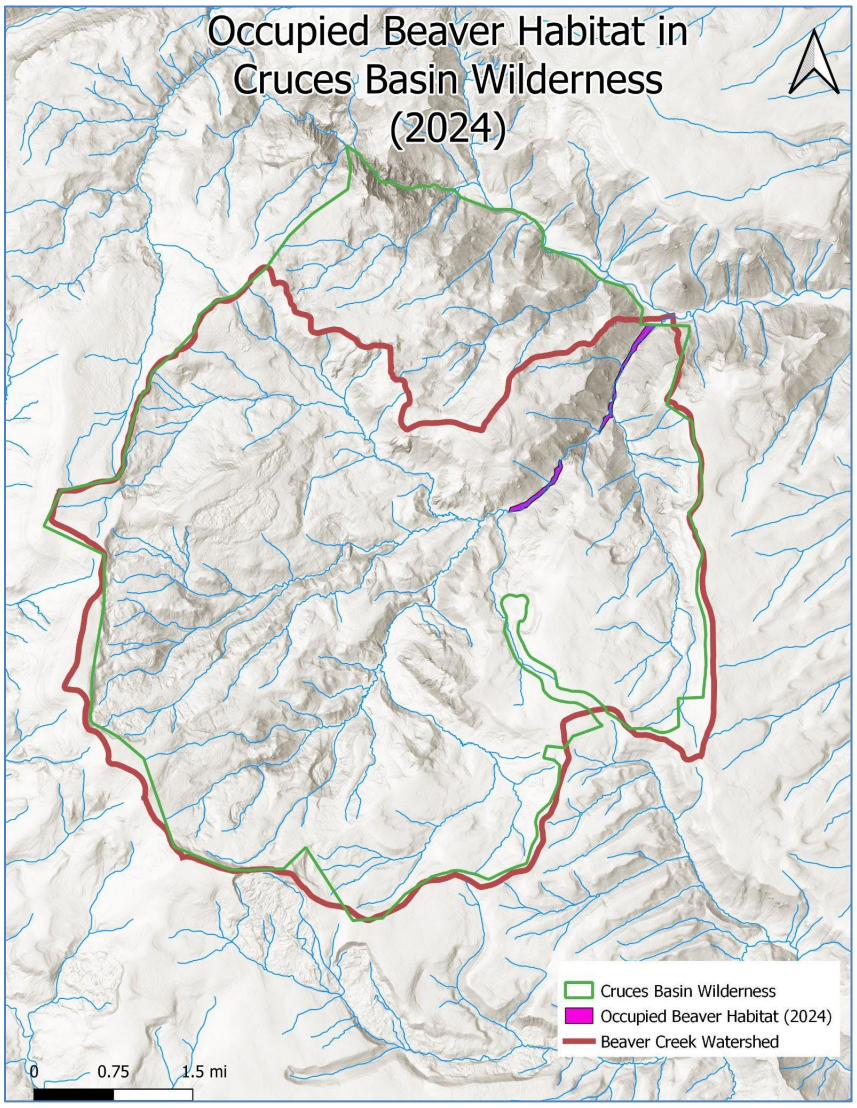


Figure 8. Map showing occupied beaver habitat in Cruces Basin as of 2024, determined by field and geospatial survey results.

accomplished through riparian planting and exclosures. Finally, beaver mimicry projects are best carried out in unconfined valley segments where there would have historically been large, beaver created wetlands (Wohl 2019).

Areas that had heavy unregulated grazing and severe loss of riparian woody vegetation were not prioritized for riparian wetland expansion because potential for success in these reaches is low. Instead, these reaches were prioritized for headcut stabilization and grazing management as an initial step towards ecosystem recovery.

To identify priority reaches for arresting headcuts and slowing gully formation, wetland acreage threatened by the headcut was weighed against difficulty to arrest the headcut. The headwaters reaches of all the streams in Cruces Basin present opportunities to preserve wetland acreage by arresting numerous headcuts under 3ft deep.

Based on these considerations, Rio Grande Return staff identified nine high priority reaches for treatment to expand riparian wetlands and halt incision of existing wetlands. These reaches are Beaver: Confluence Meadow, Beaver: Narrows to Confluence, Beaver: Headwaters, Diablo: Confluence Meadow, Escondido/ Diablo Confluence, Diablo, Headwaters, Cruces: Lower Meadow, Cruces: Upper Meadow, and Cruces: Headwaters. See Figure 9 for map. Our recommendation is to fund and implement a high resolution, watershed scale project design focusing on these reaches. The table below lists reaches by name, recommended actions and whether they are a high, medium, or low priority for riparian wetland expansion. The table is organized alphabetically by name rather than by priority.

Table 1. Table outlining the priority for treatment of each reach in the watershed.

Reach Name	Recommended Action	Priority
Beaver: Lower Beaver	No Treatment	L
Beaver: Beaver Meadow	No Treatment	L
Beaver: Lower Narrows	No Treatment	L

Reach Name	Recommended Action	Priority
Beaver- Confluence Meadow	Extend riparian wetland, beaver habitat expansion	H
Beaver: Narrows to Confluence	Extend riparian wetland, beaver habitat expansion	H
Beaver: Upper Narrows	No Treatment	L
Beaver: Upper Valley	Stabilize incision and headcuts in existing wetlands, extend riparian wetland, beaver habitat expansion	M
Beaver: Headwaters	Stabilize incision and headcuts in existing wetlands	H
Cruces: Lower Meadow	Stabilize incision and headcuts in existing wetlands, extend riparian wetland, beaver habitat expansion, address trailing damage to wetlands	H
Cruces: Narrows	No Treatment	L
Cruces: Upper Meadow	Stabilize incision and headcuts in existing wetlands, extend riparian wetland, beaver habitat expansion	H
Cruces: Upper Valley	Stabilize incision and headcuts in existing wetlands, address trailing damage to wetlands	M
Cruces: Headwaters	Stabilize incision and headcuts in existing wetlands	H
Diablo: Confluence Meadow	Extend riparian wetland, beaver habitat expansion	H
Diablo: Middle Reach	Extend riparian wetland, beaver habitat expansion	M
Diablo: Escondido/Diablo Confluence	Stabilize incision and headcuts in existing wetlands, extend riparian wetland, beaver habitat expansion	H
Diablo: Headwaters	Stabilize incision and headcuts in existing wetlands, extend riparian wetland where applicable	H

Reach Name	Recommended Action	Priority
Escondido: Narrow Valley	Stabilize incision and headcuts in existing wetlands	M
Escondido: Upper Meadow	Stabilize incision and headcuts in existing wetlands	M
Escondido: Headwaters	Stabilize incision and headcuts in existing wetlands	H
Osha Creek	No Treatment	L

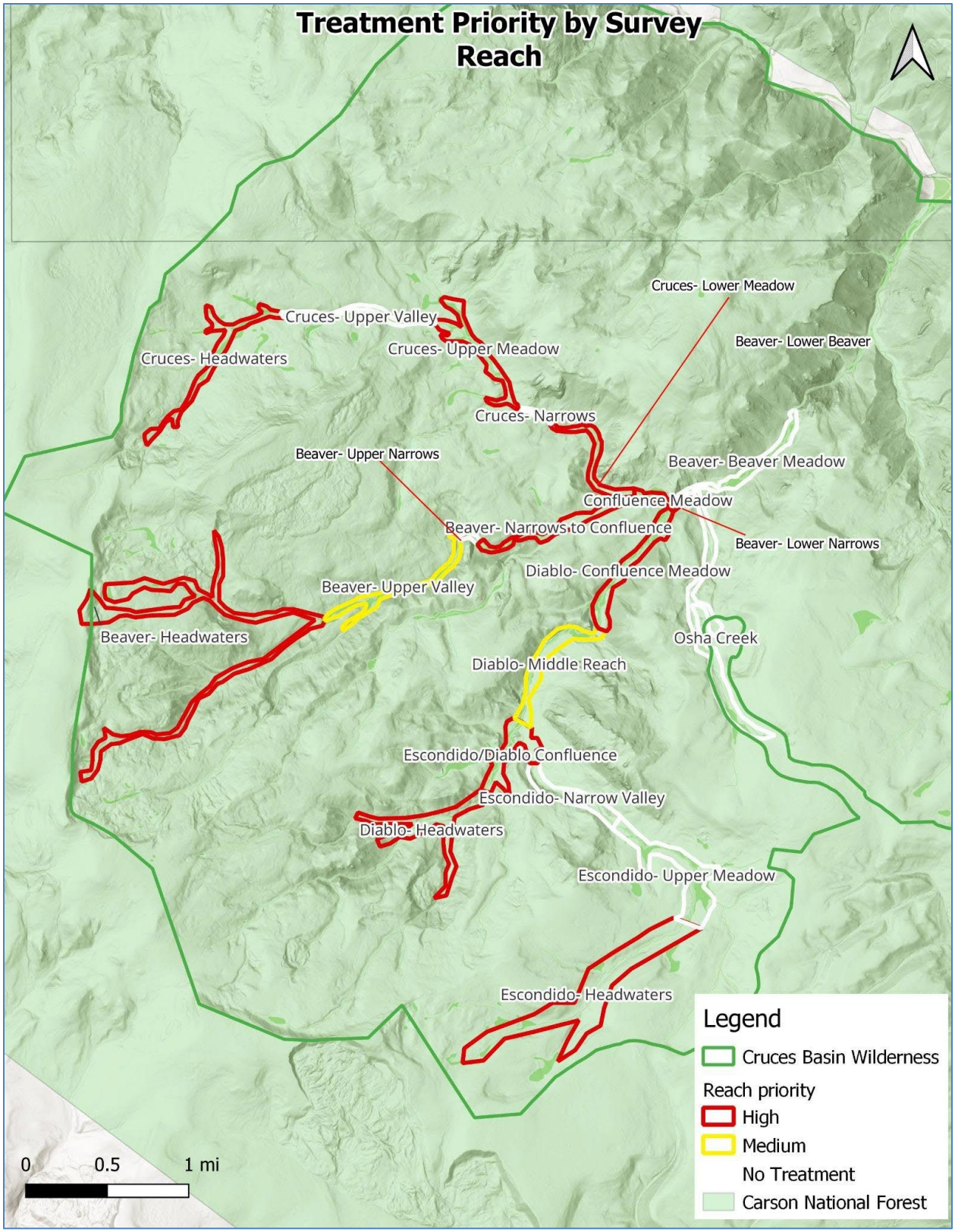


Figure 9. Map showing priority reaches for treatment.

Concept Design for High Priority Reaches for Riparian Wetland Expansion

For reaches identified as high priority, concept designs are detailed below.

Beaver: Confluence Meadow

Goal: Expand riparian wetland and encourage beaver habitat expansion.

Recommended Techniques: Using a phased approach over multiple years, construct targeted beaver dam analog (BDA) and Assisted Log Structure (ALS) complexes with high structure density where material is locally available, hardened stream crossings.

Types of Materials: Logs, branches, rocks, gravel, sod, harvested on-site.

Figure 10. View showing the confluence of Diablo Creek (left) and Beaver Creek (right). Note the presence of willow along Beaver Creek and the absence of willow along Diablo Creek.

Approximate Volumetric Measurements: Up to 20 BDAs at approximately 30-45 cubic feet each, up to 20 ALS structures at 30-70 cubic feet each, 2 hardened stream crossings at 12 cubic feet each.

Cost Estimate: Up to $28,000.00 for implementation.

Note that costs for implementation include all costs for construction: personnel, travel, per diem, materials harvesting, mobilization/de-mobilization, administrative costs, monitoring and overhead. Implementation does not include costs for planning, detailed design, and compliance/permitting. It is recommended that prioritized actions (project reaches) are bundled to increase the economy of scale.

Beaver: Narrows to Confluence

Goal: Expand riparian wetland and encourage beaver habitat expansion.

Recommended Techniques: Using a phased approach over multiple years, construct targeted beaver dam analog (BDA) and Assisted Log Structure (ALS) complexes with high structure density where material is locally available, hardened stream crossings, construct Log Flow Splitters, Worm Ditches, Log Step Falls, Zuni Bowls, One-Rock Dams (ORD), Rock Rundowns, and/or Log Mattresses (LM) to halt incision of slope wetlands.

Figure 11. Beaver Creek as it flows through the Narrows to Confluence Reach is incised and straightened.

Figure 12. There are several large headcuts in the Narrows to Confluence Reach.

Types of Materials: Logs, branches, rocks, gravel, sod, harvested on-site.

Approximate Volumetric Measurements: Up to 66 BDAs at approximately 30-45 cubic feet each, around 60 ALS structures at 30-70 cubic feet each, 4 hardened stream crossings at 12 cubic feet each, 10 Log Step Falls at 12 cubic feet each.

Cost Estimate: Up to $94,000.00 for implementation.

Beaver: Headwaters

Goal: Protect existing wetlands from further incision and support baseflow elevation. *Note: There are several high-gradient, destabilized, confined reaches of the Beaver Headwaters where no treatment is recommended. Priorities in this reach are to treat headcuts threatening wetlands at the top of the watershed.*

Recommended Techniques: Using a phased approach over multiple years, construct Log Flow Splitters, Worm Ditches, Log Step Falls, Zuni Bowls, One-Rock Dams (ORD), Rock Rundowns, and/or Log Mattresses (LM) to halt incision of slope wetlands.

Figure 13. There are numerous headcuts of varying sizes threatening wetlands in the Headwaters Reach.

Types of Materials: Logs, branches, rocks, gravel, sod, harvested on-site.

Approximate Volumetric Measurements: Up to 30 Log Step Falls at 12 cubic feet each, 20-30 Rock Rundowns at 6 cubic feet each, 80-100 ORDs/ LMs at 3 cubic feet each.

Cost Estimate: Up to $21,700.00 for implementation.

Figure 14. Headcuts near forested areas are good candidates for Log Step Fall treatments because logs are nearby.

Diablo: Confluence Meadow

Goal: Expand riparian wetland and encourage beaver habitat expansion.

Recommended Techniques: Using a phased approach over multiple years, construct targeted beaver dam analog (BDA) and Assisted Log Structure (ALS) complexes with high structure density where material is locally available, hardened stream crossings, targeted leadout construction to reconnect old channels, and assist willow propagation by harvesting from local populations and planting at low densities around initial BDA complexes.

Figure 15. Diablo is straightened and incised in the Confluence Meadow Reach, a great candidate for riparian wetland expansion.

Types of Materials: Logs, branches, rocks, gravel, sod, willow poles, harvested on-site.

Approximate Volumetric Measurements: Around 60 BDAs at approximately 30-45 cubic feet each, 60-70 ALS structures at 30-70 cubic feet each, 2 hardened stream crossings at 12 cubic feet each.

Cost Estimate: Up to $89,300.00 for implementation.

Diablo: Escondido/ Diablo Confluence

Figure 16. Both streams are incised in this reach and are good candidates for riparian wetlands expansion.

Goal: Protect existing wetlands from further incision and support baseflow elevation; expand riparian wetland and encourage beaver habitat expansion.

Recommended Techniques: Using a phased approach over multiple years, construct targeted beaver dam analog (BDA) and Assisted Log Structure (ALS) complexes with high structure density where material is locally available, hardened stream crossings, targeted leadout construction to reconnect old channels, Log Step Falls, Zuni Bowls, One-Rock Dams (ORD), and/or Log Mattresses (LM) to halt incision of slope wetlands, and assist willow propagation by harvesting from local populations and planting at low densities around initial BDA complexes.

Types of Materials: Logs, branches, rocks, gravel, sod, willow poles, harvested on-site.

Approximate Volumetric Measurements: Over 50 BDAs at 30-45 cubic feet each, and around 60 ALS structures at 30-70 cubic feet each, 1 hardened stream crossing at 12 cubic feet, 5-10 Log Step Falls at 12 cubic feet each, 15-20 ORDs/ LMs at 3 cubic feet each.

Cost Estimate: Up to $89,800.00 for implementation.

Diablo: Headwaters

Figure 17. Diablo's headwaters contain numerous incised slope wetlands.

Goal: Protect existing wetlands from further incision and support baseflow elevation.

Recommended Techniques: Using a phased approach over multiple years, construct Log Flow Splitters, Worm Ditches, Log Step Falls, Zuni Bowls, One-Rock Dams (ORD), Rock Rundowns, and/or Log Mattresses (LM) to halt incision of slope wetlands.

Types of Materials: Logs, branches, rocks, gravel, sod, harvested on-site.

Approximate Volumetric Measurements: 10-15 Log Step Falls at 12 cubic feet each, 10-15 Rock Rundowns at 6 cubic feet each, 20-30 ORDs/ LMs at 3 cubic feet each.

Cost Estimate: Up to $9,750.00 for implementation.

Cruces: Lower Meadow

Goal: Protect existing wetlands from further incision and support baseflow elevation; expand riparian wetland and encourage beaver habitat expansion.

Recommended Techniques: Using a phased approach over multiple years, construct targeted beaver dam analog (BDA) and Assisted Log Structure (ALS) complexes with high structure density where material is locally available, hardened stream crossings, One-Rock Dams (ORD), and/or Log Mattresses (LM) to halt incision of slope wetlands, French Drains to harden trail crossings of slope wetlands, and assist willow propagation by harvesting from local populations and planting at low densities around initial BDA complexes.

Types of Materials: Logs, branches, rocks, gravel, sod, willow poles, harvested on-site.

Figure 18. Cruces Creek is incised and straightened in the Lower Meadow Reach, making it a good candidate for riparian wetlands expansion.

Figure 19. Livestock, elk, and recreational trailing is damaging slope wetlands in the Lower Meadow Reach.

Approximate Volumetric Measurements: Up to 60 BDAs at 30-45 cubic feet each, 40-60 ALS structures at 30-70 cubic feet each, 5-6 French Drains at 4 cubic feet each, 15-20 ORDs/ LMs at 3 cubic feet each. **Cost Estimate:** Up to $91,000.00 for implementation.

Cruces: Upper Meadow

Figure 20. Cruces Creek is incised in the Upper Meadow Reach, making it a suitable candidate for riparian wetland expansion.

Figure 21. The Upper Meadow Reach contains numerous wetlands threatened by headcuts.

Goal: Protect existing wetlands from further incision and support baseflow elevation; expand riparian wetland and encourage beaver habitat expansion.

Recommended Techniques: Using a phased approach over multiple years, construct targeted beaver dam analog (BDA) and Assisted Log Structure (ALS) complexes with high structure density where material is locally available, hardened stream crossings, One-Rock Dams (ORD), and/or Log Mattresses (LM) to halt incision of slope wetlands, and assist willow propagation by harvesting from local populations and planting at low densities around initial BDA complexes.

Types of Materials: Logs, branches, rocks, gravel, sod, willow poles, harvested on-site.

Approximate Volumetric Measurements: Up to 73 BDAs at 30-45 cubic feet each, 50-70 ALS structures at 30-70 cubic feet each, 1 hardened stream crossing at 12 cubic feet, 10-15 Log Step Falls at 12 cubic feet each, 20-30 ORDs/ LMs at 3 cubic feet each.

Cost Estimate: Up to $113,000.00 for implementation.

Cruces: Headwaters

Goal: Protect existing wetlands from further incision and support baseflow elevation.

Recommended Techniques: Using a phased approach over multiple years, construct Log Flow Splitters, Worm Ditches, Log Step Falls, Zuni Bowls, One-Rock Dams (ORD), Rock Rundowns, and/or Log Mattresses (LM) to halt incision of slope wetlands.

Types of Materials: Logs, branches, rocks, gravel, sod, harvested on-site.

Figure 22. Wetlands in the Cruces Headwaters Reach are incised. Note the change in vegetation upstream versus downstream. Upland vegetation is becoming dominant downstream of the headcut because of reduced water availability.

Approximate Volumetric Measurements: 15-20 Log Step Falls at 12 cubic feet each, 25-35 Rock Rundowns at 6 cubic feet each, 3 hardened stream crossings at 12 cubic feet each, 60-80 ORDs/ LMs at 3 cubic feet each.

Cost Estimate: Up to $18,600.00 for implementation.

Additional Restoration Considerations

Trail drainage and water crossing improvements would be appropriate and impactful throughout the watershed. These should be implemented wherever trail drainage is causing gullying or poor stream crossings are leading to widening and sedimentation. For example, the user/ livestock trails in the Beaver and Cruces valleys cross the creek multiple times, and these crossings should be addressed to reduce fine sediment from entering the creeks and mitigate widening.

Road drainage work would be impactful in multiple areas surrounding the Wilderness, but ease of access for machinery is a consideration. For example, drainage work on Forest Road 87, while desirable due to its high potential to improve gullying in the Beaver Creek Headwaters, may not be practical due to the difficulty of transporting a machine on many miles of rough road. Road work on Forest Road 527 may be more feasible and would reduce runoff velocity onto the wet meadows forming the headwaters of Osha Creek.

Process-Based Restoration Toolbox for Wilderness Applications

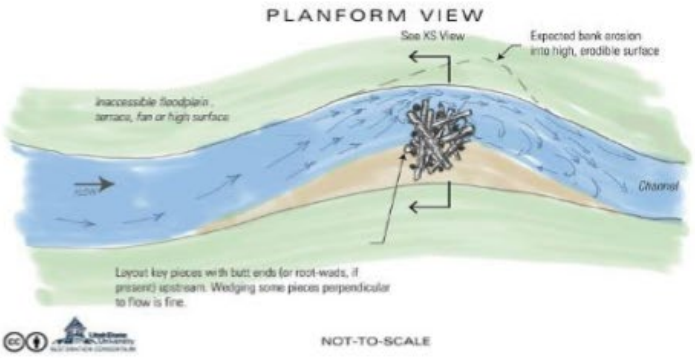
Process-Based Restoration for Wilderness Applications

Restoration Tool Fact Sheet: (p.1/3)

Assisted Log Structure (ALS)

Restoration Tool Name and Purpose:

Assisted Log Structures or Post-Assisted Log Structures (ALS/PALS): Low-tech process-based restoration to enhance floodplain connectivity.



Planform view of a Bank-Attached ALS (Wheaton et. al. 2019)

Application & Function:

These structures are used to address lack of complexity, lack of large woody debris, incision, and straightened channels in wadeable streams. They mimic the accumulation of large woody debris which induces anabranching and meandering, increases channel complexity, and promotes floodplain connectivity.

Technical Description:

ALS/PALS consist of large woody material such as tree crowns, saplings, and root wads that are tangled together and placed in the channel. The structure can be anchored to the bed by use of untreated wooden posts (PALS) or wedged into the stream channel, boulders, or streamside trees and roots (ALS) They can be built in a variety of sizes and channel locations. These include mid-channel and bank-attached.

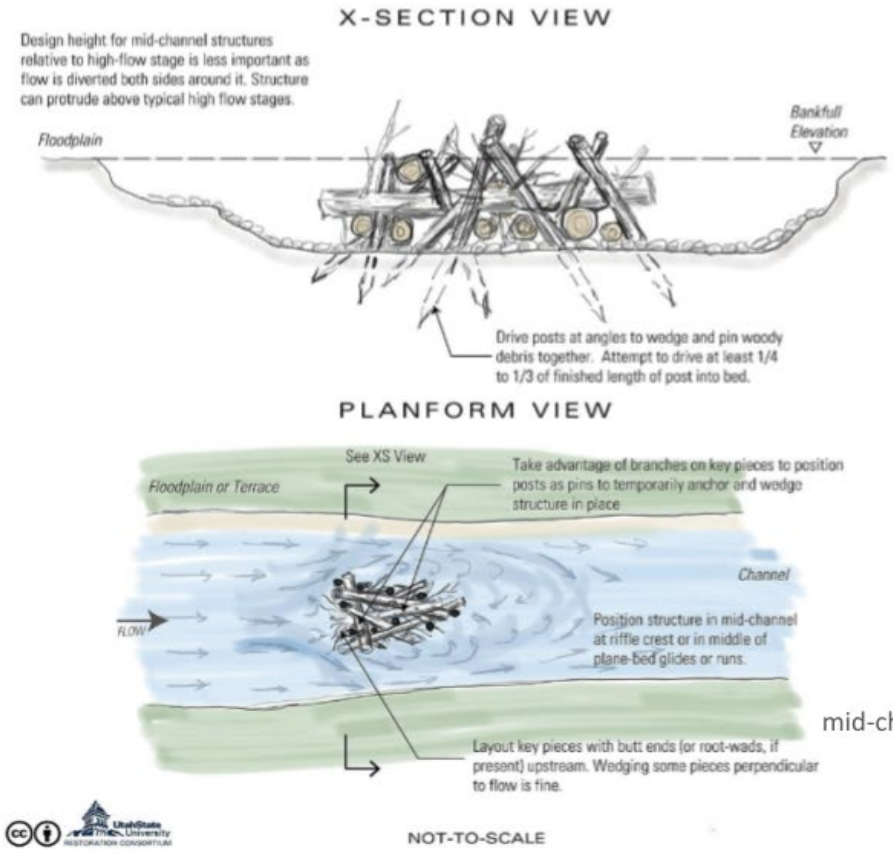
PALS that has accumulated woody debris after several years. Note sandbar development and side channel pool habitat forming downstream (P. Watson 2023)

Assisted Log Structure (ALS)

Mid-channel ALS promote anabranching, bar development, and plunge pool formation. Bank-attached ALS increase meander radius and form scour pools. Bank-attached ALS are constructed on developing point bars at a width of 80-95% of low-flow channel width, to constrict water and create hydraulic pressure against the opposite bank. They do not exceed bankfull height. Mid-channel ALS are constructed at or above bankfull height and direct water around either side to encourage bar formation and anabranching. If posts are used to create a PALS, they should be driven into the bed up to ⅓ their length, and at an angle to pin down the woody material. These structures may naturally float away over time and rack up on a downstream log jam, which is within design parameters to increase woody debris accumulation.

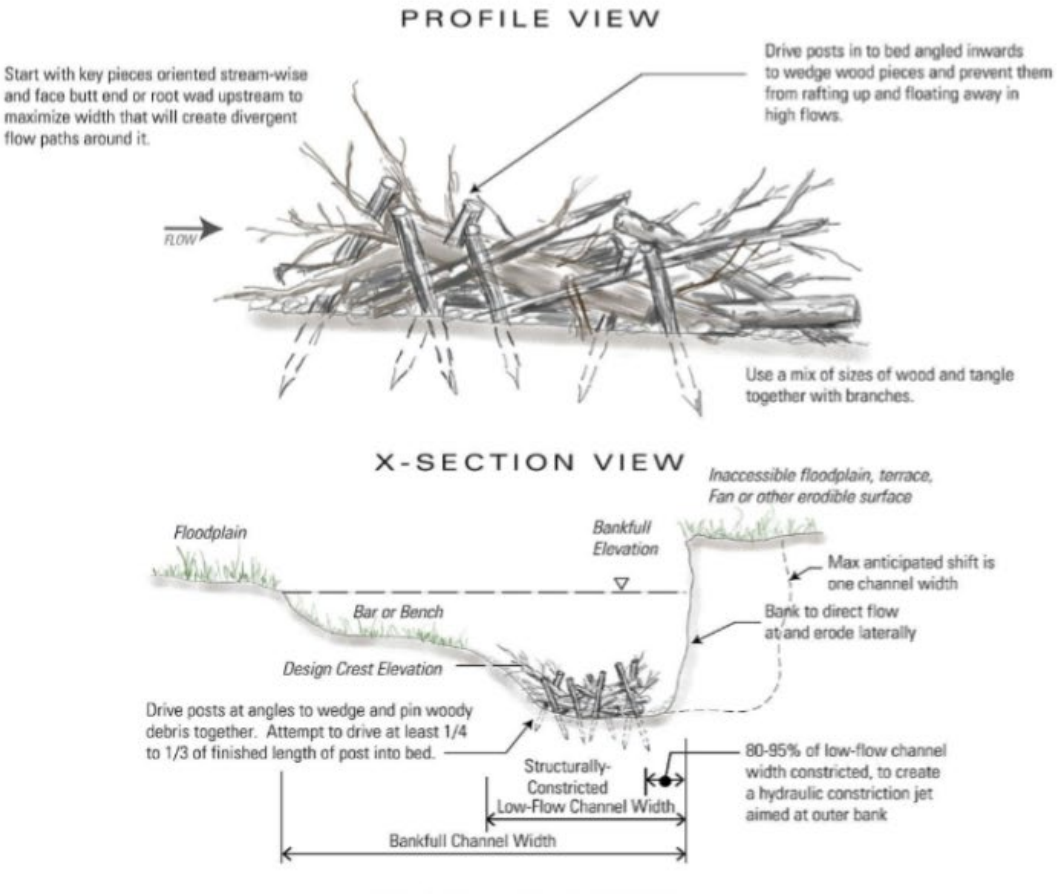
Installation and Staging:

Materials are sourced on-site. Installation will be performed as specified by Wheaton et. al. 2019: Low-Tech, Process-Based Restoration of Riverscapes.



Schematic of a mid-channel ALS (Wheatc et. al. 2019)

Assisted Log Structure (ALS)



Schematic of a bank attached ALS
(Wheaton et. al. 2019)

References:

NRCS. 2023. Conservation Enhancement Activity E643D. United States Department of Agriculture. https://www.nrcs.usda.gov/sites/default/files/2023-10/E643D-Apri-_2023-fy24-new.pdf

Wheaton J.M., Bennett S.N., Bouwes, N., Maestas J.D. and Shahverdian S.M. (Editors). 2019. Low-Tech Process-Based Restoration of Riverscapes: Design Manual. Version 1.0. Utah State University Restoration Consortium. Logan, UT. 286 pp. DOI: 10.13140/RG.2.2.19590.63049/2.

Process-Based Restoration for Wilderness Applications

Restoration Tool Fact Sheet: (p. 1/3)

Beaver Dam Analogue (BDA)

Restoration Tool Name and Purpose:

Beaver Dam Analogue: Low-tech process-based restoration to enhance floodplain connectivity.

Application & Function:

These structures are used to mimic, promote, and sustain the natural processes of beaver dam activity and wood accumulation that lead to more fully connected floodplains. They raise the water table, attenuate flooding, provide pool habitat, settle out sediment, and promote beaver immigration to the project site. They are constructed in wadeable streams. They are located to maximize ponding and/or floodplain connectivity.

Technical Description:

BDAs are built to mimic natural beaver dams. They consist of an even-crested, channel-spanning dam built of woody material, rocks, and sediment. The crest is typically bankfull height or higher. The dams can be straight or convex downstream. The base of the dam is roughly as broad as the crest height, and the width decreases towards the top. The profile of the dam is mound shaped, with plenty of woody material on the downstream face to reduce scour from flows spilling over the top of the dam. The upstream face of the dam will be reinforced with rocks and sediment sourced from the upstream pool to reduce leakage and strengthen the base of the dam.

Postless BDA incorporating boulders and woody material (P. Watson 2023)

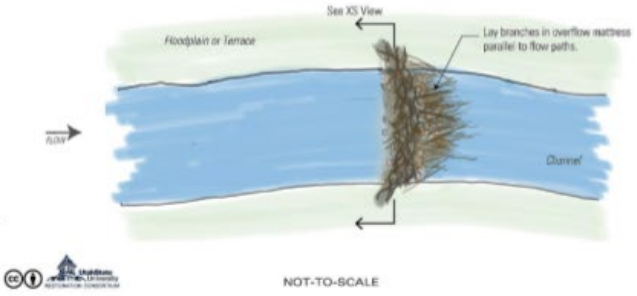
Post-assisted BDA that has been taken over by a beaver colony (P. Watson 2023)

Beaver Dam Analogue (BDA)

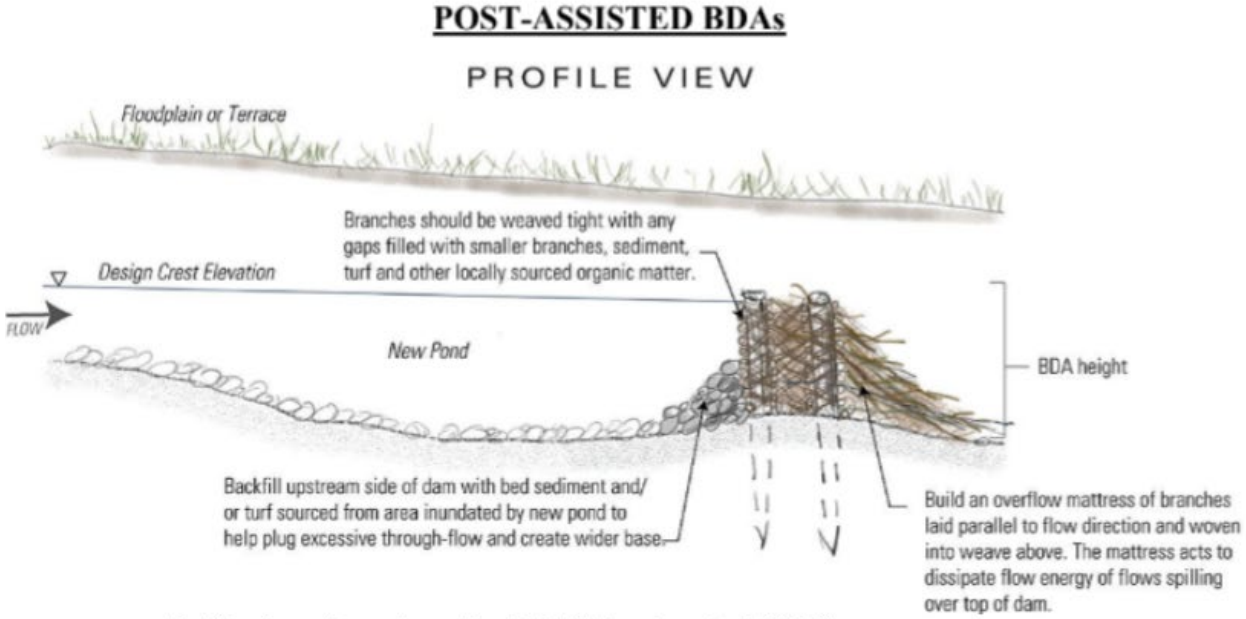
BDAs can be built as post-assisted or postless. Postless BDAs are built in the manner described above, and derive their structure from bulk and from woody material being integrated into the bank and streambed. Post-assisted BDAs are built in the same manner, but, when construction is complete, sharpened, untreated wooden posts are driven through the dam into the streambed up to ⅓ their length to reinforce the dam against high flows.

Installation and Staging:

All material for BDAs is collected on-site. Installation will be performed as specified by Wheaton et. al. 2019: Low-Tech, Process-Based Restoration of Riverscapes.

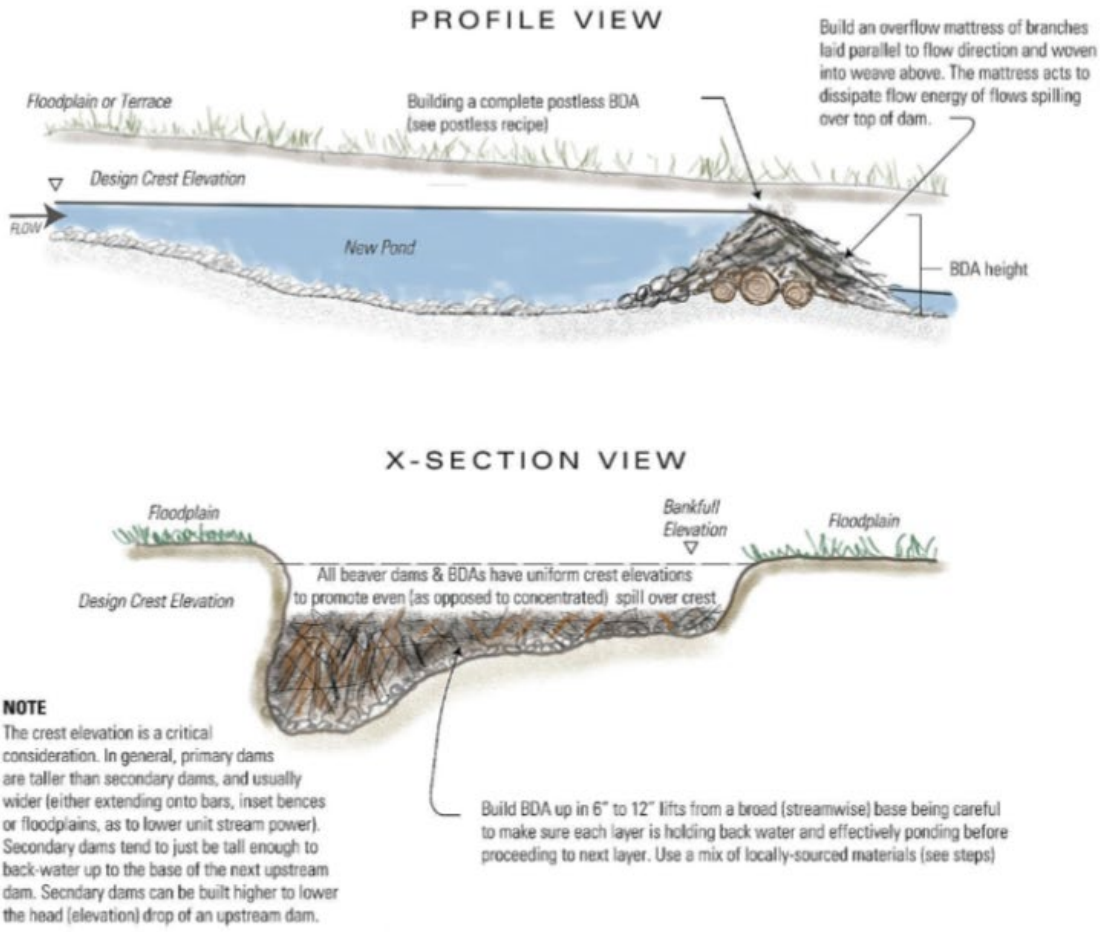


Planform view of a postless BDA (Wheaton et. al. 2019)



Profile view of a post-assisted BDA (Wheaton et. al. 2019)

Beaver Dam Analogue (BDA)



Schematic of a postless BDA (Wheaton et. al. 2019)

References:

NRCS. 2023. Conservation Enhancement Activity E643D. United States Department of Agriculture. https://www.nrcs.usda.gov/sites/default/files/2023-10/E643D-Apri-_2023-fy24-new.pdf

Wheaton J.M., Bennett S.N., Bouwes, N., Maestas J.D. and Shahverdian S.M. (Editors). 2019. Low-Tech Process-Based Restoration of Riverscapes: Design Manual. Version 1.0. Utah State University Restoration Consortium. Logan, UT. 286 pp. DOI: 10.13140/RG.2.2.19590.63049/2.

Process-Based Restoration for Wilderness Applications

Restoration Tool Fact Sheet: (p. 1/2)

Willow & Cottonwood Planting

Restoration Tool Name and Purpose:

Willow and Cottonwood planting is fundamental to ecosystem recover in headwater streams that have lost woody vegetation due to heavy browse pressure.

Application & Function:

Willow and Cottonwood planting (planting) is performed where woody riparian vegetation has been diminished or removed by chronic heavy browse. Planting serves to re-establish willow and cottonwood woodlands historically present alongside beaver-dominated, headwater streams. Planting improves streamside and instream habitat, and is foundational to process-based restoration of former beaver-dominated streams.

Willow poles staged at the beginning of the planting season. Planted willows visible in background, about 12 years old (P. Watson 2023)

Technical Description:

Narrowleaf Cottonwood and various willow species (*Populus angustifolia* and *Salix spp.*) are planted in a wilderness setting using the wattle method. Poles, 6-8 feet long, of the species are harvested from a site at a similar elevation to the restoration site during the late winter. These are stored in a creek to keep them wet and alive. Before the poles begin to leaf out, usually in April and early May, it is time to plant. Bundles of 2-4 willow stems are made using natural string like hemp or jute, and laid into a 12-14" deep trench dug at an angle to the stream, with their ends in the water. The trench is filled in, and the willows can be pinned down with handmade stakes or nearby rocks. The tips are trimmed to 4-5" of exposure to promote root development. Wattles will develop strong roots their first year, and begin to grow aboveground woody material either the first or second year.

Willow & Cottonwood Planting

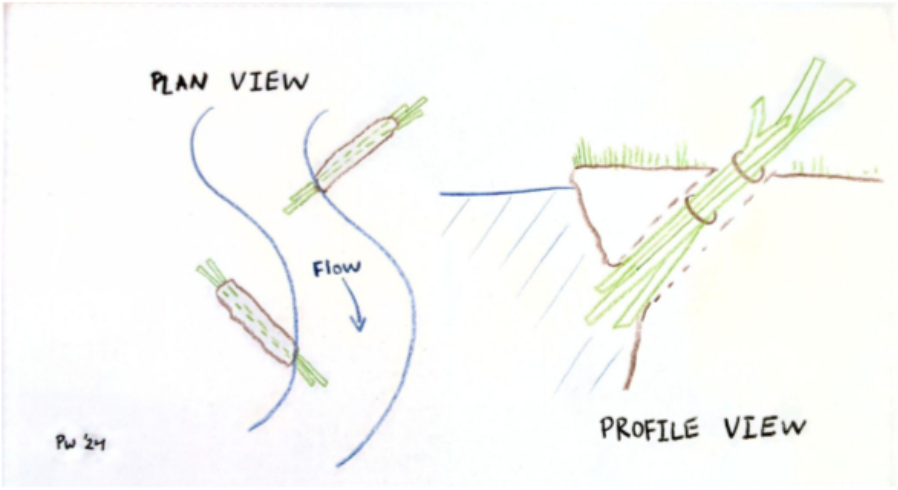


Diagram showing initial wattle planting of *Salix* and *Populus* species. Stems will grow vertically upwards from planted wattles (P. Watson 2024).

Installation and Staging:

Poles can be harvested onsite or nearby, if there are ample stands that can support harvesting. Otherwise, willow must be packed in from the nearest donor stand. Poles should be staged with the butt ends in a creek (½-⅓ submerged) until ready to plant.

References:

NRCS. 2019. Conservation Practice Standard 612: Tree- Shrub Establishment. United States Department of Agriculture. https://www.nrcs.usda.gov/sites/default/files/2022-12/612-NHCP-CPS-Tree-Shrub-Establishment-2022.pdf

Process-Based Restoration for Wilderness Applications

Restoration Tool Fact Sheet: (p. 1/2)

OHV (Off-Highway Vehicle) Barriers

Restoration Tool Name and Purpose:

Vehicle barrier, OHV barrier. Used to control undesired OHV incursion into wilderness.

Application & Function:

OHV barriers are used to block undesired vehicle access into wilderness areas that contain former, decommissioned roads.

Technical Description:

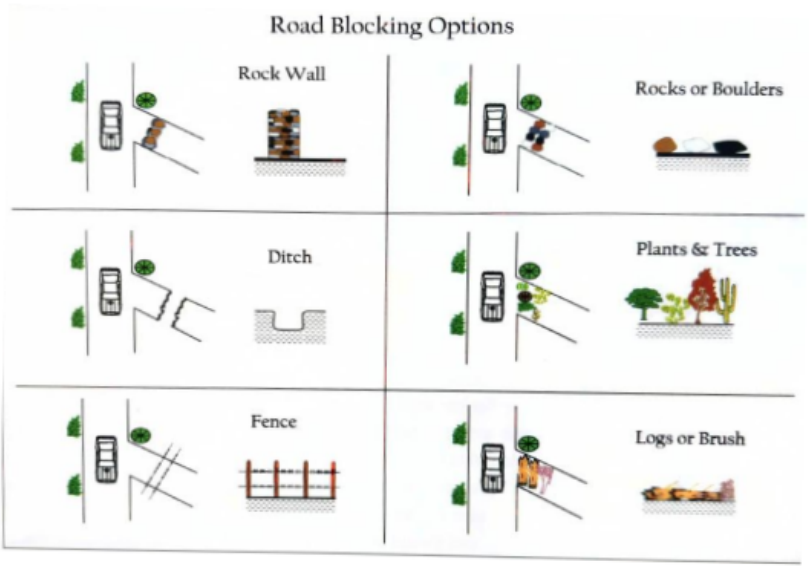
OHV barriers are typically buck-and-rail fences or treated wooden stakes (bollards) driven into the ground with a hydraulic post pounder, or set into hand-dug holes. Buck-and-rail fences have the advantage that no digging is required, they are self supporting, and can often be built with locally felled small-diameter trees. Bollard style OHV barriers are advantageous because they can be installed quickly if stakes and a post pounder are available. A third style of OHV barrier, using large boulders to block a road, is most effective but requires a source of boulders and heavy equipment on-site. Welded pipe fences are also an effective barrier, requiring welding equipment on site.

Buck-and-Rail style OHV barrier (P. Watson 2020)

Bollard OHV barrier at the Cruces Basin Wilderness trailhead (USFS 2023)

Restoration Tool Fact Sheet: (p. 2/2)

OHV (Off-Highway Vehicle) Barriers



OHV barrier options (Zeedyk 2012)

Installation and Staging:

Installation will depend on the style of OHV barrier chosen, detailed in the "Technical Description" section. Some styles will require outside materials and specialized equipment (pipe rail, bollard) where others may only require materials available on-site (buck-and-rail).

References:

Eubanks, E. 2006. Vehicle Barriers: Their Use and Planning Considerations. USDA Forest Service San Dimas Technology and Development Center, California. https://www.fs.usda.gov/t-d/programs/eng/projects/MVAC/pdfPubs/VehicleBarriers.pdf

Zeedyk, B. 2012. Water Harvesting from Low-Standard Rural Roads. Joint publication of The Quivira Coalition, Zeedyk Ecological Consulting, Rio Puerco Management Committee, and NMED.

Restoration Tool Fact Sheet: (p. 1/2)

Road Drainage Improvement

Restoration Tool Name and Purpose:

Road drainage improvement prevents poor road drainage from creating gullies in wetland features.

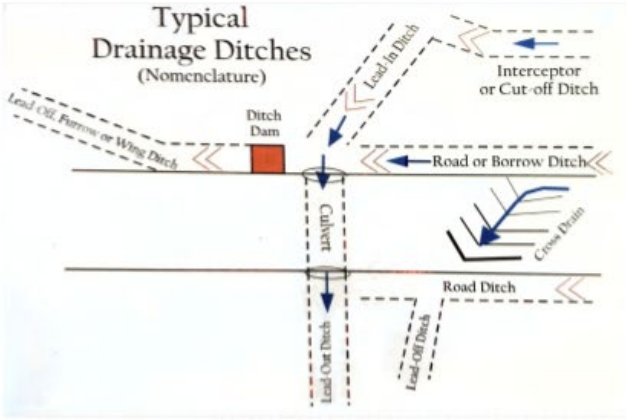
Application & Function:

Although wilderness areas do not have roads within them, road drainage issues along wilderness borders can cause significant damage to wetland resources within the wilderness. Road drainage improvements are necessary when road runoff is being concentrated by infrequent or lacking drains, causing erosion, gullying, and headcuts. Draining roads correctly and more frequently ensures that runoff cannot be concentrated into flows with erosive force.

Gully caused by concentrated road drainage (P. Watson 2023)

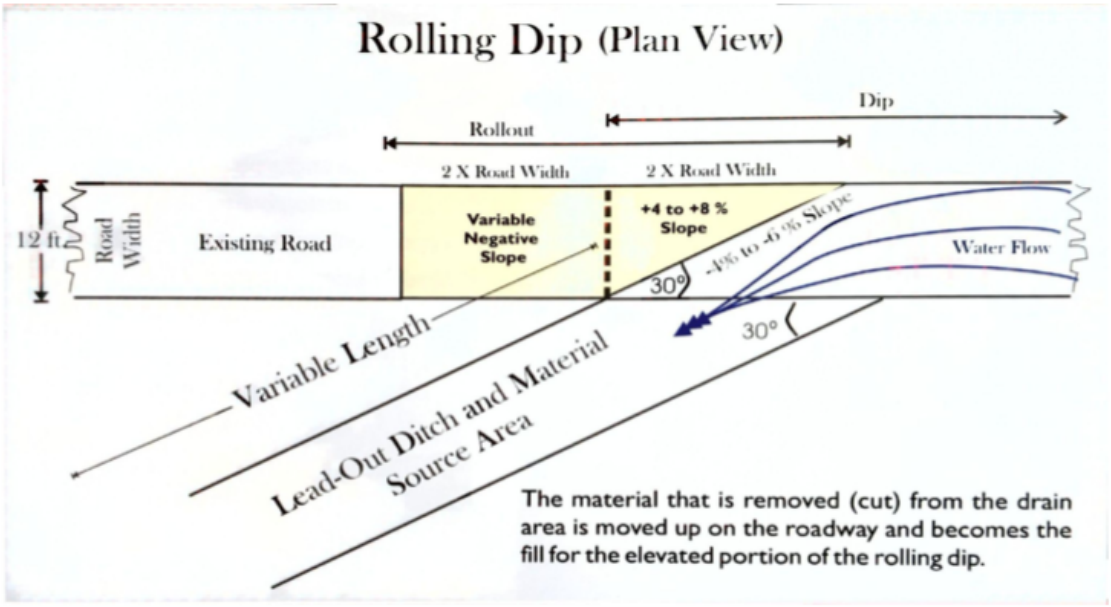
Technical Description:

The two main problems with road drainage are inadequate drain size and infrequent drain location. Both of these cause water to accelerate to erosive flows as it careens down a road surface with no outlet. Road drains are installed with heavy equipment such as a bulldozer or mini-excavator. Each road presents different drainage problems, and will have to be assessed by a skilled equipment operator to determine the frequency, type, and location of drains necessary.



Several types of road drains (Zeedyk 2012)

Road Drainage Improvement



Rolling dips are a simple type of drainage to install on a dirt road, allowing water to be shunted off frequently and with little velocity (Zeedyk 2012).

Installation and Staging:

Depending on the severity of drainage issues present, fill material may need to be sourced from outside the site, but generally material is soured on-site. Road drainage will be done in accordance with Zeedyk (2012), *Water Harvesting from Low-Standard Rural Roads* and Rocky Mountain Research Station (2002), Management and Techniques for Riparian Restorations: Roads Field Guide, Volumes I and II.

References:

Rocky Mountain Research Station. 2002. Management and Techniques for Riparian Restorations: Roads Field Guide Volumes I and II. USDA Forest Service, Gen.Tech.RepRMR5-CTR-102 Volumes I and II.

Water/Road Interaction Core Team. 2000. Water/Road Interaction Field Guide. USDA Forest Service, San Dimas Technology and Development Center. San Dimas, CA.

Zeedyk, B. 2012. Water Harvesting from Low-Standard Rural Roads. Joint publication of The Quivira Coalition, Zeedyk Ecological Consulting, Rio Puerco Management Committee, and NMED.

Process-Based Restoration for Wilderness Applications

Restoration Tool Fact Sheet: (p. 1/2)

Exclosure Fencing

Restoration Tool Name and Purpose:

Exclosure fencing is a method for preventing ungulate damage to wetlands.

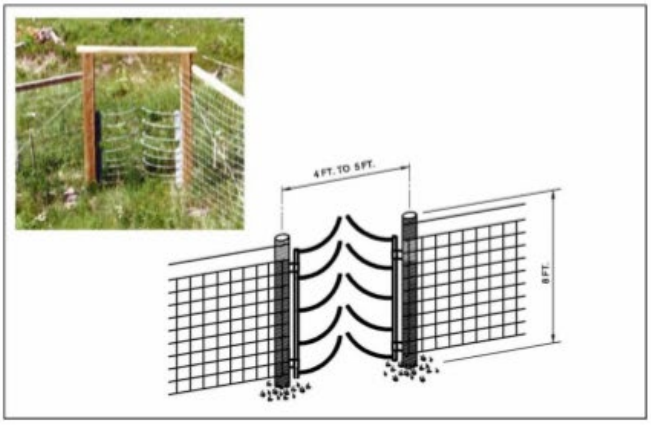
Application & Function:

Exclosure fencing is used where grazing, browsing, and trampling are damaging a wetland. This supports ecosystem recovery that is enabled by process-based restoration structures such as Beaver Dam Analogues.

Technical Description:

Exclosure fencing can be built to exclude just cattle, or both cattle and elk. Cattle exclosures consist of a standard, 5-wire fence. Elk exclosures are built with woven wire panels, to a height of at least 8 feet. Both types of exclosures should include an upstream and downstream human gate to provide access to the stream, and ideally also include a one-way exit for animals accidentally trapped inside.

Valley bottom elk exclosure (P. Watson 2021)



One-way wildlife gate (Munckhof Manufacturing 2011)

RIO GRANDE RETURN

Installation and Staging:

Materials for exclosure fencing must be brought into the worksite. In a wilderness setting, this could entail mule packing or an approved helicopter drop of materials. Instillation can be performed without the use of power tools by using hand pounders, post-hole diggers, and saws.

References:

Munckhof Manufacturing. 2011. Animal Control. https://www.munckhof.com/animal-control/

Zeedyk, B., Walton, M., Gadzia, T. 2014. Characterization and Restoration of Slope Wetlands in New Mexico. Quivira Coalition: Santa Fe

Drift Fences

Restoration Tool Name and Purpose:

Drift fences are a method of preventing ungulate damage to wetlands.

Application & Function:

Drift fences are used where cattle trailing is causing incision, compaction, and/or channelization of wetland features. These fences discourage trailing and encourage diffuse movement.

Technical Description:

The primary objective of a drift fence is to be an obstacle to livestock movement to discourage trailing through a wetland feature. Zeedyk et. al (2014) describe a 3-wire fence built with stays at 4 foot intervals for high visibility, spanning the valley bottom and terminating at a flat bench where cattle can easily trail. They emphasize the importance of visibility and not placing drift fences in narrow terrain where they would cause cattle to bunch up and mill around. Drift fences are an effective tool to reduce grazing pressure on valley bottom wetlands without construction of exclosure fencing. In a wilderness setting, drift fences can also be constructed as buck-and rail fences, which would require less material to be packed in.

Installation and Staging:

A buck-and-rail drift fence could be constructed from onsite materials, gathered by felling medium-diameter trees. Materials for wire drift fencing must be brought into the worksite. In a wilderness setting, this could entail mule packing or an approved helicopter drop of materials. Installation can be performed without the use of power tools by using hand pounders, post-hole diggers, and saws.

References:

Zeedyk, B., Walton, M., Gadzia, T. 2014. Characterization and Restoration of Slope Wetlands in New Mexico. Quivira Coalition: Santa Fe

Jack Fall

Restoration Tool Name and Purpose:

Jack fall is a method of preventing ungulate damage to wetlands.

Application & Function:

Jack fall is used where grazing, browsing, and trampling are damaging a wetland. This technique discourages ungulates from grazing in wetlands and can reduce browse and graze pressure.

A small jack fall structure (P. Watson 2023)

Technical Description:

Jack fall structures are simply trees and brush that are directionally felled or dragged to cover a degrading wetland feature and hinder livestock and elk access. These have a limited lifespan, since their effectiveness decreases as they decay. They are generally most effective as an initial treatment, followed by intensive grazing management.

Installation and Staging:

Jack fall structures are constructed by felling trees available onsite. No offsite material is required.

References:

Zeedyk, B., Walton, M., Gadzia, T. 2014. Characterization and Restoration of Slope Wetlands in New Mexico. Quivira Coalition: Santa Fe

Restoration Tool Fact Sheet: (p. 1/2)

Hardened Stream Crossing

Restoration Tool Name and Purpose:

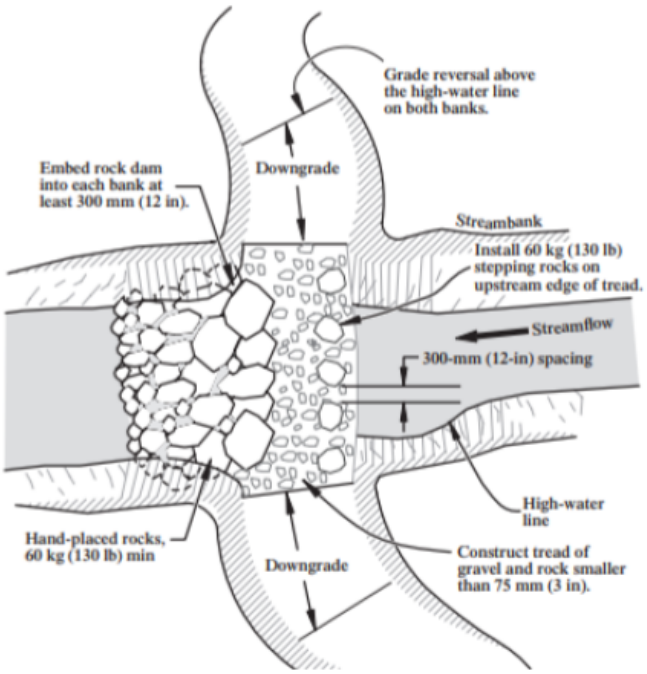
Hardened Stream Crossing, Rock Ford, Armoured Swale, French Drain. Allows stock or user trail to cross stream without widening and sedimentation of stream channel.

Application & Function:

These structures are used at any location where a high-traffic trail crosses a river or wetland feature and trailing is causing downcutting and widening. They work by hardening the crossing with stone to resist further bank erosion. In the case of the French Drain, they allow water to seep underneath the trail.

Technical Description

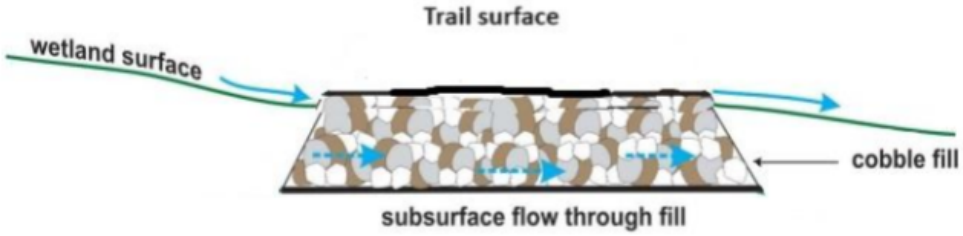
Armoured stream crossings, otherwise known as rock fords or armoured swales, are a type of stream crossing where large rocks are firmly set in the channel at the crossing location to resist erosion by hoof or foot. It must be ensured that the channel crossing is lower than the trail surface to prevent trail capture at high flow. The trail must also cross the stream at or close to 90 degrees to prevent trail capture. The banks of the stream where they dip down to allow the trail to cross must have rocks laid into them to prevent shearing.



Example schematic of an armoured stream crossing (PCTA 2011)

Hardened Stream Crossing

French Drains are another type of armoured crossing where porous fill such as gravel or cobble is laid in the channel at the crossing location. This allows water to seep underneath the trail without trail traffic damaging the channel. French drains are typically used where a trail crosses a wetland feature and has created a rut.



Profile view of a french drain (Adapted from Zeedyk et. al. 2014)

Installation and Staging:

All material is sourced on site. Installation will be done according to Zeedyk et. al. (2014) and Birkby (2005), *Lightly on the Land*. In accordance with Wilderness regulations, no geotextile fabric will be used.

References:

Birkby, R. 2005. *Lightly on the Land: The SCA Trail Building and Maintenance Manual*. Student Conservation Association, Seattle, WA.

NRCS. 2022. CONSERVATION PRACTICE STANDARD:STREAM CROSSING, CODE 578. https://www.nrcs.usda.gov/sites/default/files/2022-10/Stream_Crossing_578_NHCP_CPS_2022_0.pdf

PCTA. 2011. Course 302: Drainage Crossings. https://www.pcta.org/wp-content/uploads/2012/11/302_Drainage_Crossings_v0311.pdf?x20165

Zeedyk, B., Walton, M., Gadzia, T. 2014. Characterization and Restoration of Slope Wetlands in New Mexico. Quivira Coalition: Santa Fe

Restoration Tool Fact Sheet: (p. 1/2)

Log Flow Splitter

Restoration Tool Name and Purpose:

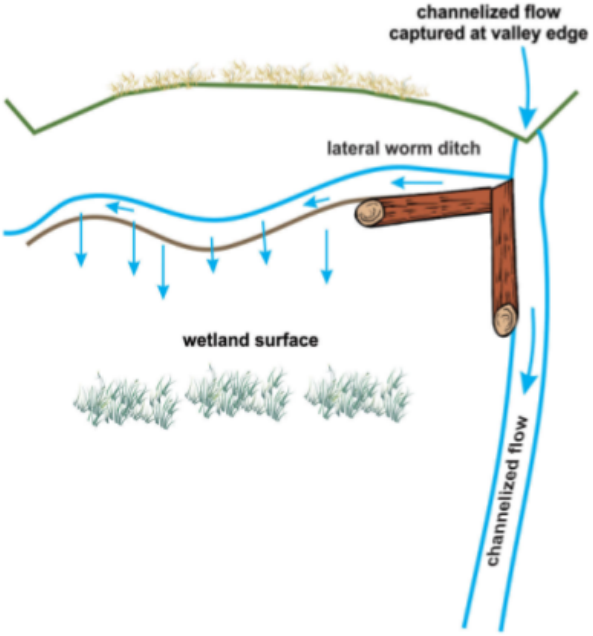
Where the channel is not deeply incised, log flow splitters spread water across the landscape instead of flowing only in the channel.

Application & Function:

Log flow splitters are used to divert flow around an active headcut, re-wet a drying slope wetland, or to spread flow across the landscape in the context of keyline design. Zeedyk et. al. (2014) identifies them as good structures to use in conjunction with worm ditches.

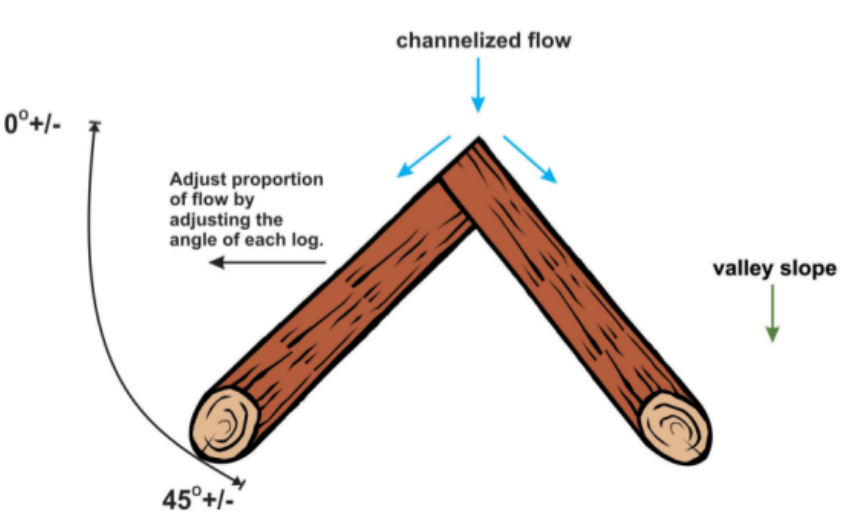
Technical Description:

The logs used to construct the flow splitter are set into a trench dug in the desired orientation. They are reinforced with rocks or sod that was dug up when constructing the trench. An important consideration is creating a gently sloped lead out from the flow splitter that does not cause new channelization.



A log flow splitter being used in conjunction with a worm ditch to re-wet a wetland surface (Zeedyk et al. 2014)

Log Flow Splitter



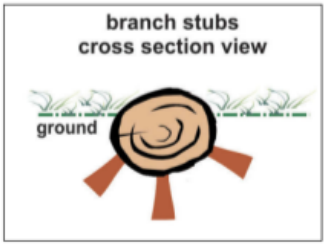


Diagram of the construction of a log flow splitter (Zeedyk et. al 2014)

Installation and Staging:

Onsite materials are used for these structures. Logs can be harvested near the site with proper permission and clearances.

References:

Zeedyk, B., Walton, M., Gadzia, T. 2014. Characterization and Restoration of Slope Wetlands in New Mexico. Quivira Coalition: Santa Fe

Restoration Tool Fact Sheet: (p. 1/3)

Induced Meandering

Restoration Tool Name and Purpose:

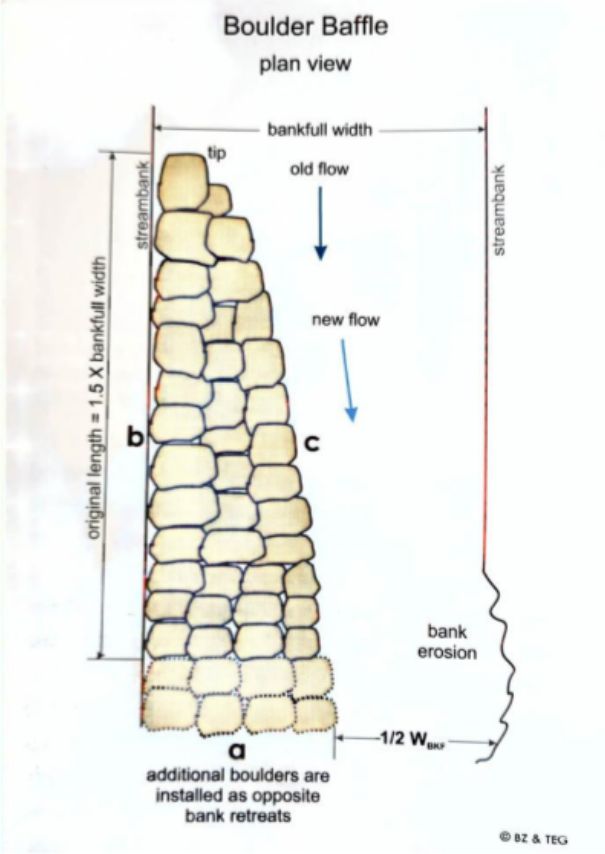
Induced Meandering structures promote channel aggradation and inset floodplain development of incised channels.

Application & Function:

Induced Meandering techniques have been successfully used across the Southwest for years to stabilize eroding channels. Induced Meandering structures can be used to promote point bar development, channel aggradation and inset floodplain development of incised channels, leading to the formation of a stable stream channel.

Technical Description:

Rock baffles, log baffles, log mattresses, and one-rock dams (ORDs) are the Induced Meandering structures most applicable in a wilderness setting. Rock baffles and log baffles are designed to force water to flow into and collect sediment from the opposite bank (see diagram, p 3). Rock and log baffles are constructed of rocks and logs large enough to withstand the expected flood level of the channel.



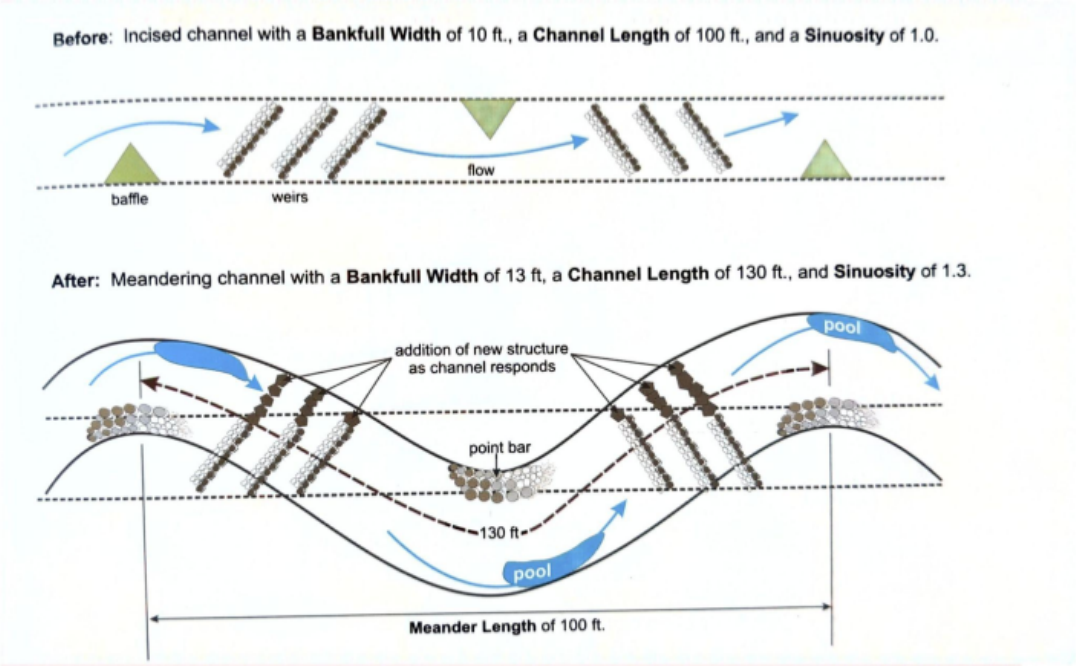
Rock baffle schematic (Zeedyk & Clothier 2009)

This sediment generated by the redirected flow is collected downstream by a log mattress or an ORD, which are both low grade control structure spanning the bankfull width of the channel. These grade control structures slow the water's erosive force and promotes channel aggradation, while the baffles promote meandering and point bar development.

Induced Meandering

Installation and Staging:

Design and installation of induced meandering structures is detailed extensively in Zeedyk & Clothier (2009). The log and rock material can be sourced on-site, making these techniques highly applicable in a wilderness setting.



The Induced Meandering Process (Zeedyk & Clothier 2009)

References:

Stream Dynamics, Santa Clara Forestry Department, WildEarth Guardians, Sustainable Ecosystems, New Mexico Environmental Department. 2016. Santa Clara Pueblo Canyon Upper Santa Clara Creek Watershed Restoration Project 2016.

Zeedyk, B. & Clothier, V. 2009. *Let the Water do the Work*. Quivira Coalition, Santa Fe, New Mexico.

Induced Meandering

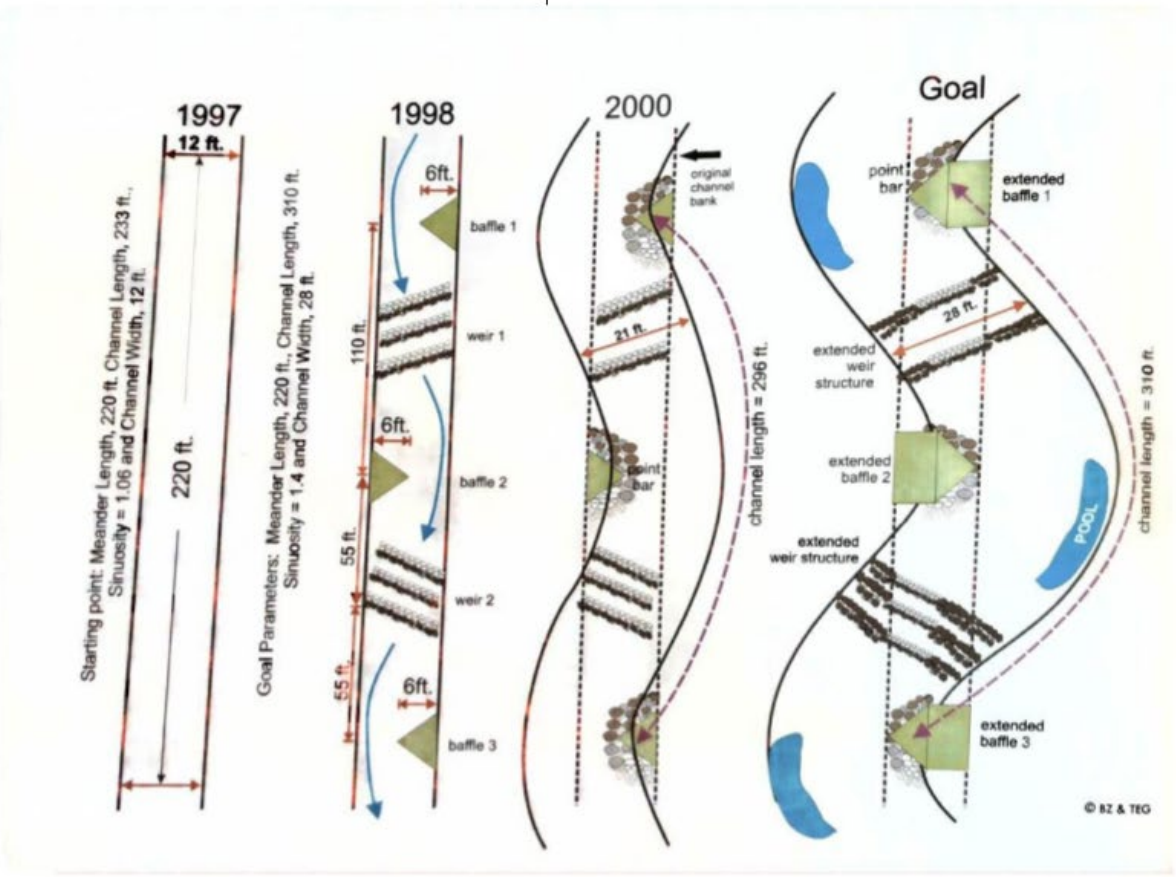


Diagram showing expected channel evolution following induced meander treatment (Zeedyk & Clothier 2009)

Restoration Tool Fact Sheet: (p. 1/2)

Worm Ditch

Restoration Tool Name and Purpose:

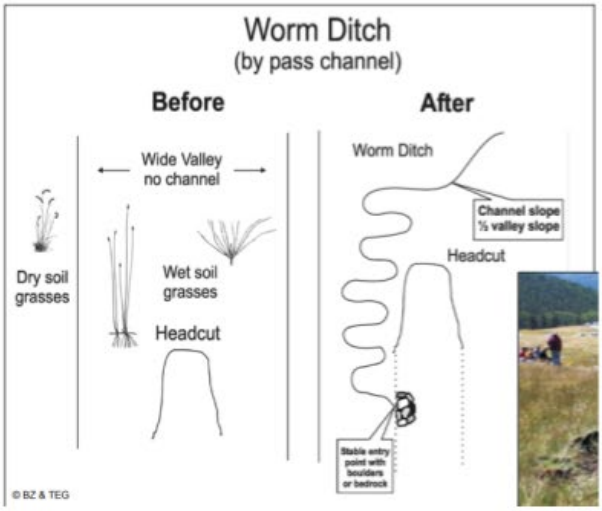
Worm ditches move water out of incised channels and promote water-spreading on historic wetlands.

Application & Function:

The goal of the worm ditch is to spread water by creating and redirecting water to a new channel that has a gentler slope than the original flow channel. Worm ditches can be dug by hand or machine.

Technical Description:

A worm ditch is a type of flow splitter used to encourage sheet flow rather than concentrated flow in a channel. Dug as a sinuous bypass channel, it can be used to move water out of an incised channel onto historic wetlands. Dug as a straighter channel across slope, it can also be used to divert water around a headcut to reduce the potential for continuing erosion.



Schematic of a worm ditch used to bypass a headcut (Zeedyk and Jansens, 2009)

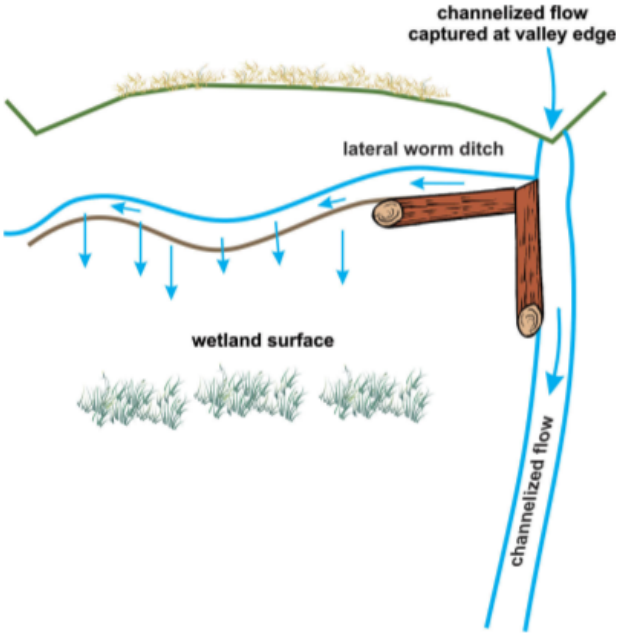
Hand-dug worm ditch (K. Menetrey 2015)

Restoration Tool Fact Sheet: (p. 2/2)

Worm Ditch

Installation and Staging:

Worm ditches can be dug with shovels, making them appropriate for wilderness setting. Wetland sod and soil removed from the ditch can be incorporated into chinking for other structures. Design of worm ditches is detailed in Zeedyk and Jansens (2009), Zeedy et al. (2014) and Zeedyk and Vrooman (2017)



Schematic of a worm ditch to move water laterally and re-wet a historic wetland (Zeedyk et al., 2014)

References:

Zeedyk, B. and J. W. Jansens. 2009. An introduction to erosion control. 3rd edition. Joint publication from Earth Works Institute, The Quivira Coalition, and Zeedyk Ecological Consulting.

Zeedyk, B., Walton, M., Gadzia, T. 2014. Characterization and Restoration of Slope Wetlands in New Mexico. Quivira Coalition: Santa Fe

Zeedyk, W.D. and S. Vrooman. 2017. The Plug and Pond Treatment: Restoring Sheetflow to High Elevation Slope Wetlands in New Mexico. New Mexico Environment Department, Surface Water Quality Bureau Wetlands Program (NMED-SWQB).

Restoration Tool Fact Sheet: (p. 1/2)

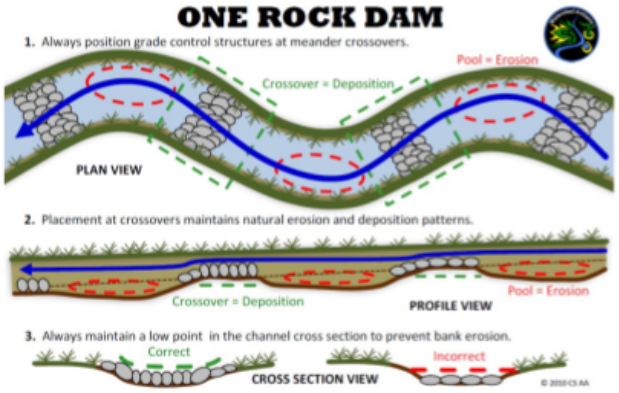
One Rock Dam

Restoration Tool Name and Purpose:

A One Rock Dam is a grade control structure used to prevent a gully from becoming eroding deeper.

Application & Function:

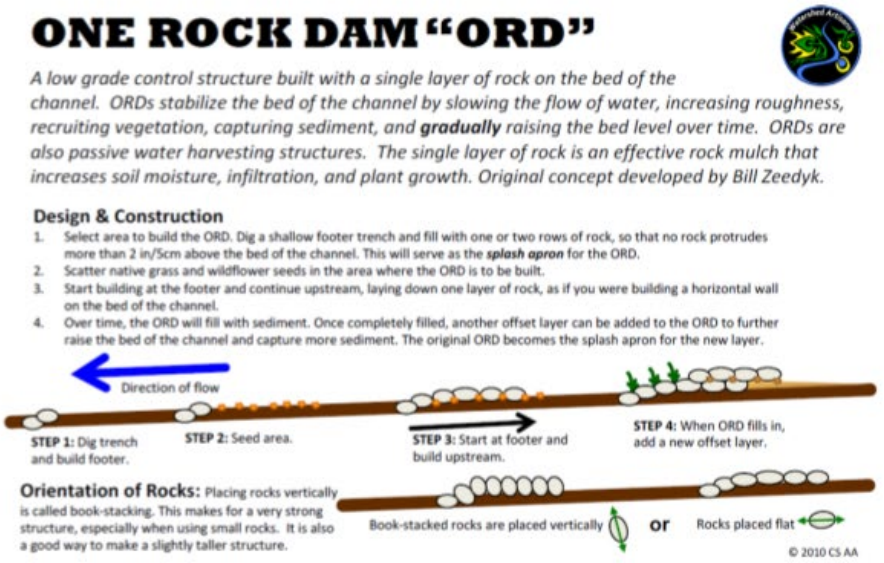
One rock dams are typically used in ephemeral channels to stabilize the grade. By armoring and raising the channel by a height of one rock, they harvest water and sediment, providing substrate for vegetation that further stabilizes the channel.



One Rock Dam Schematic. Figure from Sponholtz and Anderson (2013)

Technical Description

A One Rock Dam is constructed of many rocks but is only one-rock high. Rocks are not not stacked. Rocks are placed in several, parallel rows across a gully floor or channel and packed tightly together. A row of rocks should be of equal height and appear relatively flat or level from bank to bank. Rocks should be selected, sized, and placed so that the completed structure ends up relatively level from bank to bank and flat from the upstream edge to the downstream edge. This can be accomplished by placing larger rocks in the deepest part of the channel, and smaller ones to either side.



One Rock Dam Guidelines for Construction. Figure from Sponholtz and Anderson (2013)

Installation and Staging:

All material is sourced on site and can be transported and placed by hand. Installation will be done according to Sponholtz and Anderson (2013).

References:

Zeedyk, B. and J. W. Jansens. 2009. An introduction to erosion control. 3rd edition. Joint publication from Earth Works Institute, The Quivira Coalition, and Zeedyk Ecological Consulting.

Zeedyk, B. & Clothier, V. 2009. *Let the Water do the Work*. Quivira Coalition, Santa Fe, New Mexico.

Sponholtz, C. and A.C. Anderson. 2013. Erosion Control Field Guide. Quivira Coalition and Watershed Artisans

Restoration Tool Fact Sheet: (p. 1/2)

Zuni Bowl

Restoration Tool Name and Purpose:

Zuni Bowls address erosion by stabilizing active head cuts.

Application & Function:

Zuni Bowls are headcut control structures constructed with rock lined stepfalls and plunge pools that prevent headcuts from continuing to migrate upstream. Zuni Bowls stabilize actively eroding headcuts by dissipating the energy of falling water at the headcut pour over and the bed of the channel. The structure converts the single cascade of an eroding headcut into a series of smaller step falls. Zuni Bowls also serve to maintain soil moisture on the face of the headcut, encouraging the establishment of protective vegetation.

Technical Description

A Zuni Bowl is created by lining a headcut with rocks. First a splash apron is created, then a lower pour over. Rocks are then stacked up the walls of the headcut from bottom and chinked with rock (and sod if in a wetland setting) until the headcut is fully armored.

Zuni Bowl Schematic. Figure from Sponholtz, C. and A.C. Anderson (2013)

Zuni Bowl constructed in a slope wetland (K. Menetrey 2014)

Zuni Bowl

ZUNI BOWL

An in-channel headcut control structure composed of rock-lined step falls and plunge pools that prevents headcuts from continuing to migrate upstream. Zuni Bowls stabilize actively eroding headcuts by dissipating the energy of falling water at the headcut pour-over and the bed of the channel. The structure converts the single cascade at an eroding headcut into a series of smaller step falls. Zuni Bowls also serve to maintain soil moisture on the face of the headcut, encouraging the establishment of protective vegetation. Original concept developed by the people of Zuni Pueblo and Bill Zeedyk.

Design & Construction

1. Select a headcut for treatment. Shape and layback the face of the headcut to create a uniform surface on which to build.
2. Determine the height of the headcut. Next measure and mark the location downstream from the face of the headcut that is three to four times (3-4x) the height of the headcut. At this location dig a shallow trench and fill with one to two rows of rock, so that no rock protrudes more than 2 in/5cm above the bed of the channel. This will serve as the ***splash apron*** for the Zuni Bowl.
3. Scatter native grass and wildflower seeds in the area where the Zuni Bowl is to be built.
4. Gather the largest rocks available, and place them in a row just upstream from, and in contact with, the splash apron. These rocks should sit at an elevation approximately ⅓ the total height of the headcut. This will serve as the ***lower pour-over*** of the Zuni Bowl. Use keystones on the pour-over whenever possible.
5. Armor the bottom of the ***plunge pool*** with a single layer of rocks. Place these rocks at a uniform height to create a stable foundation for the rest of the Zuni Bowl. Smaller rocks may be used for this part of the Zuni Bowl.
6. Starting just upstream from the lower pour-over, lay courses of rock around the face of the headcut. This will form the walls of the bowl. Maintain contact with the shaped surface. The structure will have more integrity if built with layers of off-set rocks that form a sloping wall inside of the headcut, as opposed to merely lining the face with rocks. Improve the durability of the structure by avoiding gaps in the rock work. As an extra precaution, you can use biodegradable geotextile fabric to line the face of the headcut prior to laying down rocks.
7. Continue to lay courses of rock on the face of the headcut until you reach the height of the ***original headcut pour-over***. No rocks in the ***Zuni Bowl pour-over*** should protrude above this level to allow water to flow freely over the structure. Use keystones whenever possible.
8. Construct a ***ORD*** downstream from the Zuni Bowl. Place the upstream edge of the ORD approximately six to eight times (6-8x) the height of the headcut away from the Zuni Bowl pour-over.

Zuni Bowl Guidelines for Construction. Figure from Sponholtz and Anderson (2013).

Installation and Staging:

All material is sourced on site. Rocks can be carried and placed by hand. Installation will be done according to Sponholtz and Anderson (2013).

References:

Zeedyk, B. and J. W. Jansens. 2009. An introduction to erosion control. 3rd edition. Joint publication from Earth Works Institute, The Quivira Coalition, and Zeedyk Ecological Consulting.

Zeedyk, B. & Clothier, V. 2009. *Let the Water do the Work*. Quivira Coalition, Santa Fe, New Mexico.

Sponholtz, C. and A.C. Anderson. 2013. Erosion Control Field Guide. Quivira Coalition and Watershed Artisans

Process-Based Restoration for Wilderness Applications

Restoration Tool Fact Sheet: (p.1/2)

Media Luna

Restoration Tool Name and Purpose:

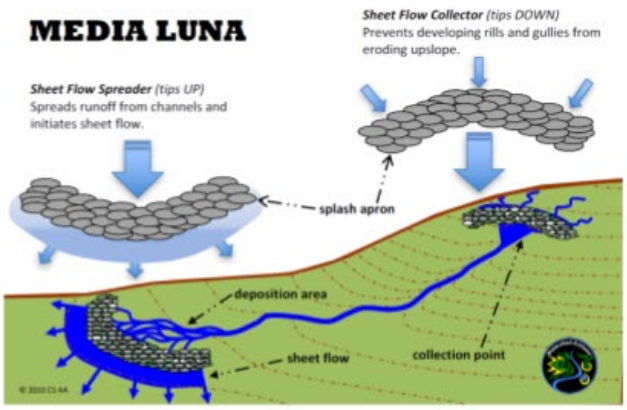
Media Lunas spread or concentrate flow.

Application & Function:

Media Lunas are used to direct sheet flow and control erosion on a landscape.

Technical Description

Media Lunas are constructed of a single layer of rocks placed in a semi-arc either convex or concave. A layer of rock is embedded on the downstream edge to anchor the structure and serve as a splash pad for pour over of surface runoff. Rocks are placed in successive rows upstream of the anchor. The porous space between the rocks is backfilled with sediment.



Media Luna Schematic. Figure from Sponholtz and Anderson (2013)

Media Luna, flow direction from left to right (K. Menetrey 2017)

MEDIA LUNA

There are two types of Media Luna structures – both used to manage sheet flow and prevent erosion. "Sheet flow collectors" (tips DOWN) prevent erosion (small headcuts) at the head of rills and gullies by creating a stable transition from sheet flow to channel flow at the collection point. "Sheet flow spreaders" (tips UP) are used to create a depositional area on relatively flat ground by dispersing erosive channelized flow and reestablishing sheet flow where it once occurred. Original concept developed by Van Clothier.

Design & Construction

1. Identify which type of Media Luna ("tips UP" or "tips DOWN") is appropriate for the treatment site.
2. If the treatment site is at the collection point of a network of rills (< 6 in/15cm deep) or small channels (< 1 ft/30cm deep) then use a ***sheet flow collector*** (tips DOWN). First lay out the down-slope edge of the structure by selecting two points on the banks of the main channel immediately down slope from where the rills enter. Using a leveling tool, lay out a level arc from bank to bank so that the tips point down slope, and the arc spans all of the rills that you aim to treat.
3. If the treatment site is located where runoff from rills or a shallow channel can easily be spread across relatively flat ground, then use a ***sheet flow spreader*** (tips UP). First lay out the down-slope edge of the structure by creating a level arc across the flat area with the tips on a slightly higher contour. The tips should be far enough up slope that they prevent water from running around the ends of the structure.
4. Layout the up-slope edge of both types of Media Lunas by tracing a level arc parallel to the down-slope edge to create a band that is at least 3 ft/1m wide. Media Lunas composed of wider bands of rock mulch offer more protection from erosion, improved infiltration and increased plant recruitment.
5. Scatter native grass and wildflower seeds in the area where the Media Luna is to be built.
6. To construct the ***splash apron***, start by digging a shallow trench from tip to tip along the down-slope edge. Fill the trench with one to two rows of rock, so that no rock protrudes more than 2 in/5cm above ground level.
7. For both types of Media Lunas, continue construction on the down-slope edge (by the splash apron) and work up slope covering the ground with a single layer of rock mulch to form a band at least 3 ft/1m wide. The tops of the rocks need to be level to ensure proper function of the structure.

Media Luna Guidelines for Construction. Figure from Sponholtz and Anderson (2013)

Installation and Staging:

All material is sourced on site and can be placed by hand. Installation will be done according to Sponholtz and Anderson (2013).

References:

Zeedyk, B. and J. W. Jansens. 2009. An introduction to erosion control. 3rd edition. Joint publication from Earth Works Institute, The Quivira Coalition, and Zeedyk Ecological Consulting.

Zeedyk, B. & Clothier, V. 2009. *Let the Water do the Work*. Quivira Coalition, Santa Fe, New Mexico.

Sponholtz, C. and A.C. Anderson. 2013. Erosion Control Field Guide. Quivira Coalition and Watershed Artisans

Restoration Tool Fact Sheet: (p. 1/3)

Log and Fabric Step Falls

Restoration Tool Name and Purpose:

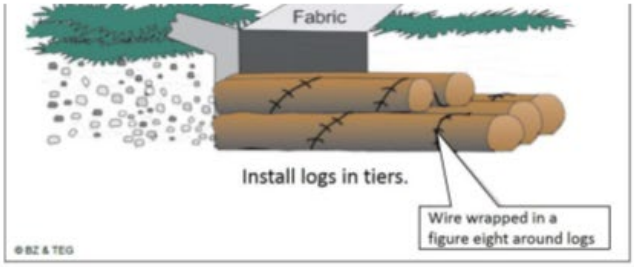
Log and Fabric Step Falls (Headcut Control Structure For Moist Soils). This structure is used to control headcuts advancing through wet soil areas such as wet meadows, springs, and seeps.

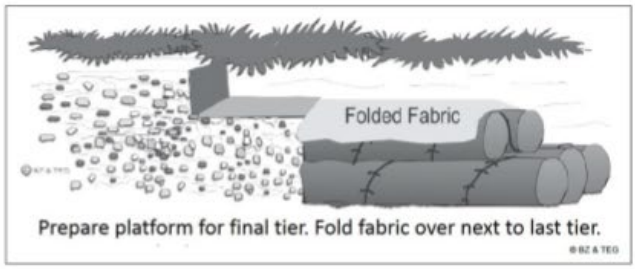
Application & Function:

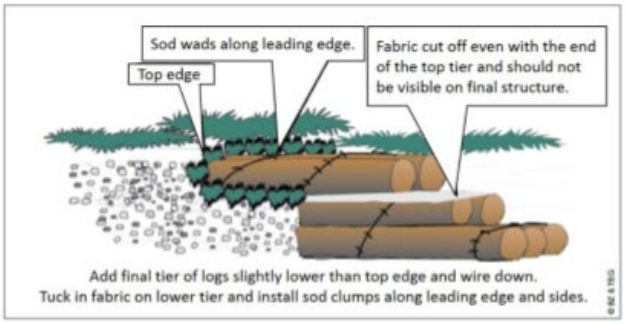
The erosive action of headcuts can be stopped if a healthy mat of wet soil plants can become established to hold the headwall in place. Text and figures from Zeedyk, W.D. and J. Jansens (2009).

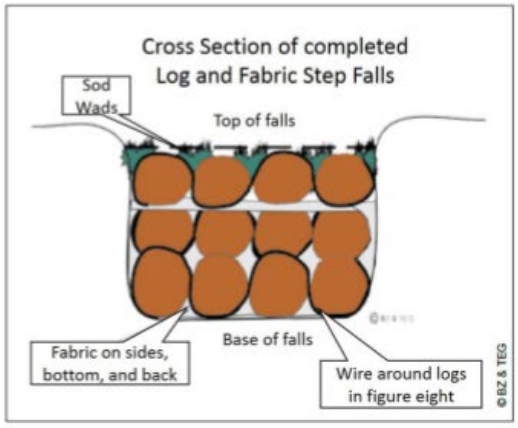
Technical Description:

Log and Fabric Step Falls are much like Zuni Bowls but constructed with logs instead of rocks. They fill headcuts with logs and reduce the erosive force of water from the pour over, because the water trickles from log to log instead of following the longer drop of a waterfall over the headcut. Log and Fabric Step Falls also capture sediment that recruits vegetation, and soil stays moist under and behind the logs.









Log and Fabric Step Falls

Installation and Staging:

Logs can be harvested near the restoration site. Although the structure typically calls for filter fabric, it may be omitted in a wilderness setting.

Structures will be constructed in accordance with Sponholtz and Anderson (2013):
Materials Needed
1. Geotextile Fabric (silt fencing fabric in 3 foot widths works well
and is convenient to use).
2. Logs: Logs 6 to 10 inches in diameter and varying lengths from
4 to 8 feet long. (For example, bottom tier, 8 feet long, second tier,
6 feet, third tier, 4 feet.) Logs should be straight, trimmed and
green, or seasoned, but not rotten. Any protruding knots, limbs, or
knobs make stacking very difficult and should be trimmed.

Log and Fabric Step Fall (K. Menetrey 2014)

A crew constructs a Log Step Fall at a large headcut (P. Watson 2023)

Log and Fabric Step Falls

Construction Steps:

1. Prepare the site by "squaring up" the headwall, sidewalls, and bottom of the channel. Eliminate the scour pool and any irregularities (rocks, roots, or indentations) in the channel bottom, sidewalls, or headwall. Use a shovel, spade, pick, or crowbar to shape the site. Save and stockpile sod clumps of wet soil grasses and sedges for use in the final step.
2. When preparation is finished, cut and drape geotextile fabric across the headwall, sidewalls, and channel bottom. Three pieces work better than one. The first should start about 2 feet above the lip of the headwall, extend down the headwall, and cover the channel bottom for 6-8 feet (the length of the bottom tier of logs). The second should be draped over one side wall and part way across the channel bottom. The third should be draped over the opposite sidewall in a like manner. Temporarily anchor the fabric in place by weighting the ends with rock or sod clumps. Once logs are placed, the extra flap of material will be folded back over the logs.
3. Install logs in the prepared site using as many tiers as necessary to stack them even with the lip of the headwall. (See Figures below). Logs within each tier should be of the same diameter; between tiers, they can be of different diameters. Logs in the bottom tier should be the longest; the top tier, the shortest. For example, if three tiers are needed, make the bottom tier 8 feet long, the middle tier 6 feet, and the top tier 4 feet long. It is important to wedge logs tightly against the face of the headwall and sidewalls. When all tiers are in place, fold the extra flap of fabric back over the top logs. Using smooth wire and fencing staples, wire each tier of logs together as you go. (Wire tier one logs before installing tier two, etc.) Tamp soil into any open spaces between fabric, headwall, and sidewalls.

References:

Sponholtz, C. and A.C. Anderson. 2013. Erosion Control Field Guide. Quivira Coalition and Watershed Artisans

Zeedyk, B., Walton, M., Gadzia, T. 2014. Characterization and Restoration of Slope Wetlands in New Mexico. Quivira Coalition: Santa Fe

Process-Based Restoration for Wilderness Applications

Restoration Tool Fact Sheet: (p. 1/2)

Rock Mulch Rundown

Restoration Tool Name and Purpose:

Rock Mulch Rundown can be used for smaller headcuts in lieu of a Zuni Bowl or Log and Fabric Step Fall.

Application & Function:

The Rock Mulch Rundown structure is used in low energy headcuts (< 1.5 ft tall) in small catchments and off channel return sites to stabilize them and prevent upstream erosion.

A volunteer crew with Albuquerque Wildlife Federation constructs a Rock Mulch Rundown (K. Menetrey 2019)

Technical Description:

Typically, the headcut is first laid back by shaping it to a stable angle (3:1 slope), and then the slope is armored with rock. The pore space between the rocks is chinked with smaller rock or sediment. In some small headcuts, shaping is not required.

ROCK MULCH RUNDOWN

A headcut control structure where the face of the headcut has been laid back to a stable angle of repose (minimum of a 3:1 slope), and then covered with a single layer of rock mulch. The mulch serves to slow runoff, increase soil moisture, recruit vegetation, and ultimately prevent the headcut from migrating further up slope. Rock Mulch Rundowns are ONLY to be used on low energy headcuts, like those found in upland rills and gullies with small catchment areas, and where sheetflow collects and enters a channel. Original concept by Craig Sponholtz.

Design & Construction

1. Select a low energy headcut for treatment.
2. Determine the extent of the 3:1 slope. Take care to balance the cutting required to achieve a 3:1 slope vs. the potential disturbance to existing vegetation.
3. Layback the headcut by cutting away soil from the top of the face, and then use the cut material to fill the base of the headcut. Where possible, the Rundown should be the entire width of the channel below the headcut. Narrow headcuts may need to be widened to accommodate the rock work. Adjacent headcuts, separated by uneroded fingers of earth, but leading to the same channel, can be combined into a single Rundown structure. Knock down the uneroded earth between the headcuts, and use it as fill.
4. Compact the fill.
5. Scatter native grass and wildflower seed and rake the surface of the Rundown.
6. Dig a shallow trench on the down slope side of the Rundown and fill with one to two rows of rock, so that no rock protrudes more than 2 in/5cm above the bed of the channel. This will serve as the ***splash apron*** for the Rundown.
7. Cover the entire surface of the Rundown with a single layer of rock mulch. The center of the Rundown should be the lowest point in the structure so that water will not run around the edges.
8. Continue to lay rock on the surface of the Rundown until you reach the height of the ***headcut pour-over***. No rocks should protrude above this level to allow water to flow freely over the structure. It is very important to avoid gaps in the rock work because gaps cause weak points in the structure. Fill gaps with small gravel if needed. To improve durability, you can use a biodegradable geotextile mesh to line the surface of the Rundown prior to laying down rocks.

Figure from Sponholtz and Anderson (2013)

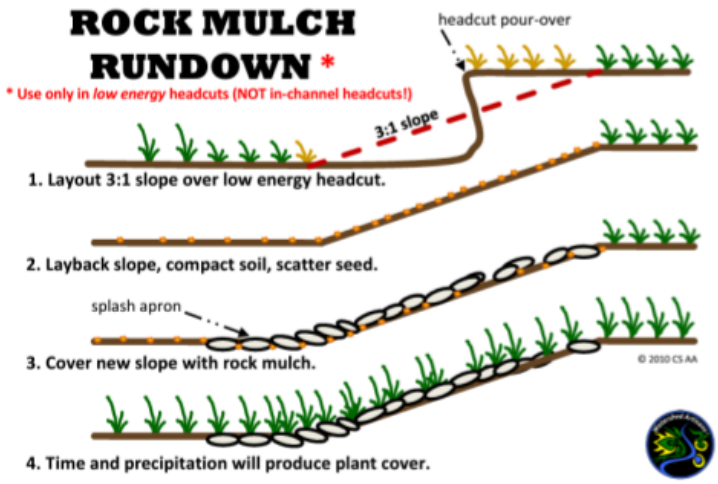


Figure from Sponholtz and Anderson (2013)

Installation and Staging:

All material is sourced on site and can be transported and placed by hand. Installation will be done according to Sponholtz and Anderson (2013).

References:

Sponholtz, C. and A.C. Anderson. 2013. Erosion Control Field Guide. Quivira Coalition and Watershed Artisans

Species list

Note: This species list is intended only to characterize the overall vegetation community of the Wilderness and is therefore not comprehensive.

Engelman Spruce (*Picea engelmanii)*

Blue Spruce (*Picea pungens)*

Subalpine Fir (*Abies lasiocarpa*)

Limber Pine *(Pinus flexilis*)

Quaking Aspen (*Populus tremuloides*)

Narrowleaf Cottonwood (*Populus angustifolia*)

Willow species (*Salix spps*)

Silverbark Alder (*Alnus incanum*)

Wild Rose (*Rosa* sp)

Shrubby Cinquefoil (*Dasiphora fruticosa*)

Common Juniper (*Juniperus communis)*

Currant (*Ribes sp)*

Timothy grass (*Phleum pratense)*

Poa sp (Probably Kentucky Blue Grass, *Poa pratensis*)

Sedge species (*Carex spps)*

Juncus balticus

Other *Juncus spps*

Cattail (*Typha sp)*

Elodea sp

Purple Gentian sp (*Gentiania sp)*

Corn Lilly (*Veratrum californicum*)

Green Gentian (*Frasera speciosa)*

Wooly Cinquefoil (*Potentilla hippiana*)

Pussytoes (*Antennaria sp*)

References

Birkby, R. 2005. Lightly on the Land: The SCA Trail Building and Maintenance Manual. Student Conservation Association, Seattle, WA.

Brinson, M. M. 1993. A Hydrogeomorphic Classification for Wetlands. Technical Report WRPDE-4. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

Carson National Forest. 2022. Carson National Forest Land Management Plan. US Forest Service, Southwest Region.

Cluer, B. and C. Thorne. 2014. A Stream Evolution Model Integrating Habitat and Ecosystem Benefits. River Research and Applications, 30(2), p. 135-154.

Cowardin, L.M., V. Carter, F.C. Golet, E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. FWS/OBS-79/31. U.S. Fish and Wildlife Service: Washington, D.C.

Eubanks, E. 2006. Vehicle Barriers: Their Use and Planning Considerations. USDA Forest Service San Dimas Technology and Development Center, California. https://www.fs.usda.gov/td/programs/eng/projects/MVAC/pdfPubs/VehicleBarriers.pdf

McNew, L.B Jr., and A. Woolf. 2005. Dispersal and Survival of Juvenile Beavers (*Castor canadensis*) in Southern Illinois. The American Naturalist, 154(1), p. 217-228.

PCTA. 2011. Course 302: Drainage Crossings. https://www.pcta.org/wp-content/uploads/2012/11/302_Drainage_Crossings_v0311.pdf?x20165

Rocky Mountain Research Station. 2002. Management and Techniques for Riparian Restorations: Roads Field Guide Volumes I and II. USDA Forest Service, Gen.Tech.RepRMR5-CTR-102 Volumes I and II.

Stream Dynamics, Santa Clara Forestry Department, WildEarth Guardians, Sustainable Ecosystems, New Mexico Environmental Department. 2016. Santa Clara Pueblo Canyon Upper Santa Clara Creek Watershed Restoration Project 2016.

Tiner, R. W. 2011. Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Waterbody Type Descriptors: Version 2.0. U.S. Fish and Wildlife Service, National Wetlands Inventory Program, Northeast Region, Hadley, Massachusetts.

Small, B. A., J. K. Frey, and C. C. Gard. 2016. Livestock grazing limits beaver restoration in northern New Mexico. Restoration Ecology 24(5):646-655.

Water/Road Interaction Core Team. 2000. Water/Road Interaction Field Guide. USDA Forest Service, San Dimas Technology and Development Center. San Dimas, CA.

Wheaton J.M., Bennett S.N., Bouwes, N., Maestas J.D. and Shahverdian S.M. (Editors). 2019. Low-Tech Process-Based Restoration of Riverscapes: Design Manual. Version 1.0. Utah State University Restoration Consortium. Logan, UT. 286 pp. DOI: 10.13140/RG.2.2.19590.63049/2.

Wohl, E. 2019. *Saving the Dammed.* Oxford University Press.

Zeedyk, B., M. Walton, and T. Gadzia. 2014. Characterization and Restoration of Slope Wetlands in New Mexico. Quivira Coalition: Santa Fe.

Zeedyk, B. 2012. Water Harvesting from Low-Standard Rural Roads. Joint publication of The Quivira Coalition, Zeedyk Ecological Consulting, Rio Puerco Management Committee, and NMED.

Zeedyk, B. and V. Clothier. 2009. Let the Water do the Work. Quivira Coalition, Santa Fe, New Mexico. 1 July 2005Dispersal and Survival of Juvenile Beavers (*Castor canadensis*) in Southern Illinois.

APPENDIX D

MINIMUM REQUIREMENTS ANALYSIS FRAMEWORK Instructions

"… except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act..."

— Section 4(c), Wilderness Act of 1964

Introduction

The Minimum Requirements Analysis Framework (MRAF) promotes wilderness stewardship by providing a consistent, interagency format for conducting a Minimum Requirements Analysis (MRA) for an action proposed in a wilderness area that involves a use otherwise prohibited by the Wilderness Act.

More information on the MRAF and its appropriate uses is available at Wilderness Connect. Please refer to your agency's policies and other guidance for more direction on how and when to conduct an MRA.

This document is intended for uses prohibited by Section 4(c) of the Wilderness Act in designated wilderness, but it can be used to analyze all projects in wilderness. Check agency policy to determine if this workbook may be appropriate for other proposals in wilderness.

Use of this document assumes familiarity with the Wilderness Act, other relevant legislation, and agency policy. For training in the Wilderness Act or on conducting an MRA, go to the e-learning course listing for the Arthur Carhart National Wilderness Training Center.

WORKBOOK INSTRUCTIONS

The MRAF derives from Section 4(c) (Prohibition of Certain Uses) of the Wilderness Act and involves two steps: Step 1 determines whether a use that would otherwise be prohibited may be ***necessary*** in wilderness to meet minimum requirements to administer the area for the purposes of the Wilderness Act; if so, Step 2 provides guidance for determining the ***minimum*** amount of a prohibited activity necessary to address the issue.

If you are using this form to analyze a non-prohibited use, consider using a modified version of the first question posed in Step 2 (see below). For example: *"Is there 'special provisions' language in legislation (or other Congressional direction) that explicitly allows consideration of a use otherwise prohibited by Section 4(c)?"* OR *"Is there 'special provisions' language in legislation (or other Congressional direction) that explicitly*

allows consideration of an action that would otherwise degrade wilderness character?"

It may be appropriate to apply the MRA process to a recurring action that has the same purpose, effect, or environmental/social context each time it is undertaken (aka a "Programmatic MRA"). A Programmatic MRA's determination should include sideboards and/or limitations for any non-conforming uses rather than simply allowing a particular non-conforming use for a specific action. Where actions need to be tailored to each site, a Programmatic MRA is generally not sufficient on its own but may be useful to inform a site-specific MRA. Site-specific analysis tiered to the programmatic MRA may be necessary to address individual situations. The determination should also articulate the purpose(s) and context to which the Programmatic MRA applies and mandate that a separate analysis be conducted for any action above and beyond that purpose or context. Identify an expiration date and/or threshold criteria that would trigger a re-evaluation of the analysis. Check agency policy or consult with respective agency wilderness lead to determine when a Programmatic MRA may be appropriate.

Title

Use a title that is descriptive but does not suggest a proposed action. For example, "Bighorn Sheep Population Decline in the Peak Wilderness" is appropriate because the title describes the issue being analyzed but does not assume an outcome. "Bighorn Sheep Collaring in the Peak Wilderness" would be inappropriate because the title assumes collaring will be the final outcome of the analysis.

Step 1: Determine If Administrative Action May Be Necessary

Issue Statement

Describe the issue

The description should explain in general terms the issue that may require some action in wilderness. The issue may be a problem, situation, opportunity, or other circumstance that requires consideration. It is not a proposed action, tool, or solution.

The description should neither assume action will be taken nor identify a specific method. Moreover, the description should not attempt to justify the use of motorized equipment or mechanical transport or the placement of an installation, structure, or temporary road. Instead, the statement of the existing issue should identify what is occurring in the wilderness so that the rest of the analysis in Step 1 can determine whether action may be necessary in wilderness. If Step 1 determines action is needed, use Step 2 to identify and evaluate specific actions, methods, etc.

The table on the following page provides appropriate and inappropriate examples of describing an issue. The brief descriptions provided here are for illustrative purposes only. Actual descriptions should provide all relevant background information.

Appropriate examples of description	Inappropriate examples of description
An administrative cabin is deteriorating, and there is a proposal to reconstruct it. The structure is located six miles inside the wilderness and is currently used by trail crews and wilderness rangers.	Motorized tools will be needed to restore an administrative cabin.
A request is received for access to a valid, existing mining claim. The request includes building a temporary road for 2.3 miles to allow access for an excavator.	The only feasible access to the mining claim would require building a temporary road.
A windstorm has blown down trees across maintained trails. Approximately 47 miles of trail are affected. These trails provide access to 32% of the wilderness.	Chainsaws would be the quickest tool for clearing the downed trees.
There is a lack of information available to biologists about a wildlife species that has the potential for listing under the ESA.	A helicopter should be used to survey the population because all other methods would take too long.
Fire has altered approximately 600 acres of wildlife habitat important for elk winter range. Development outside the wilderness has severely limited the winter range, causing a decline in populations.	Re-seeding of the burned area using a helicopter is needed to maintain wildlife habitat. Seeding using hand crews is not possible due to limited budgets.
A trail bridge has washed out. The bridge serves a trail used by visitors and outfitter-guides to access approximately 20% of the wilderness. Alternate routes to this portion of the wilderness would add 18 miles to the trip.	There is a need to replace a washed-out trail bridge. A helicopter is needed to fly in a replacement bridge and would be the most cost effective and safest tool for the job.
Riverbank erosion is destabilizing a pioneer cabin listed on the National Historic Register. The erosion has accelerated due to a change in river flow caused by fallen beetle-killed trees.	Construction of rock gabions has been proposed to stop erosion.
There is a lack of information on air quality in a wilderness area's Class I airshed. The effects of poor air quality are suspected as a cause for the decline of a threatened plant species.	An air-quality monitoring station is needed for monitoring and must be installed in the wilderness.
Invasive plant species are present in the wilderness along the Clear Creek, Blue Lake, and Windy Pass Trails. These trails are the most popular access routes to the lake basin area of the wilderness and are used by both recreation livestock users and hikers.	A motorized herbicide sprayer is the most efficient tool to treat invasive plants.

Options Outside of Wilderness

Can the issue be resolved or addressed outside of wilderness?

Answer “yes” or “no.” If the issue can be addressed outside of wilderness, check “yes” and stop; action in wilderness is not necessary to meet minimum requirements. If the issue cannot be addressed outside of wilderness, check “no” and continue to the next section. While the answer will usually be “yes” or “no,” some issues will require additional consideration. In such cases, perform whatever additional analysis is needed before proceeding to answer “yes” or “no.”

Examples of administrative actions that can likely be resolved outside of wilderness:

- Installing nest boxes outside wilderness boundaries to benefit a bird species.
- Using remote sensing instead of snow pillows as one component of hydrologic research.

Examples of administrative actions that are unlikely to be resolved outside of wilderness:

- Addressing a pre-existing installation in wilderness.
- Addressing a series of heavily used campsites that are causing excessive sedimentation into an adjacent lake.

Examples where additional analysis of alternatives may be needed before answering “yes” or “no”:

- A research proposal has been received, and alternate non-wilderness sites for conducting the research have not been documented and analyzed.
- There is an existing private right present in wilderness, and analysis has not been conducted to determine the feasibility of altering the right so as to better preserve wilderness.

Consider including the following factors in the explanation box when comparing and analyzing options outside of wilderness:

- List of areas considered (inside and outside wilderness). This should be a broad consideration so as to assure non-wilderness options are not overlooked.
- Identify special considerations related to the issue. List any factors that limit the consideration of sites (e.g., landforms, soils, or other relevant factors).
- If response to the issue involves scientific research, consider if the activity involves trammeling of wilderness or is limited to observational activities. Experimental research is generally more appropriate outside of wilderness and often yields similar results.

The finding that options do not exist outside of wilderness does not mean that action in wilderness is automatically necessary. Complete the rest of Step 1 to determine if action is necessary in wilderness.

Criteria for Determining Necessity

Do any of the criteria below apply?

A. Wilderness Character

Based on the Issue Statement, are any of the qualities of wilderness character degraded, impaired, or threatened to a degree that it is necessary to analyze potential action to address the issue?

The primary mandate of the Wilderness Act is to preserve wilderness character. Section 2(a) directs agencies to manage wilderness areas:

> "…in such manner as will leave them unimpaired for future use as wilderness, and so as to provide for the protection of these areas, ***the preservation of their wilderness character****…"* (emphasis added).

Similar direction is repeated in Section 4(b):

> "Except as otherwise provided in this Act, ***each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area*** and shall so administer such area for such other purposes for which it may have been established as also ***to preserve its wilderness character***" (emphasis added).

The definition of "wilderness," found in Section 2(c) of the Wilderness Act, identifies five qualities of wilderness character. Taken together, these qualities represent the primary tangible aspects of wilderness character that link on-the-ground conditions in wilderness and the outcomes of wilderness stewardship to the statutory definition of wilderness. Wilderness character may be more than these five qualities. In addition to the tangible qualities used to analyze if action may be necessary to preserve wilderness character, there are also important intangible aspects of wilderness character that are difficult or impossible to describe. It is up to the local wilderness manager to determine if a particular MRA needs to consider intangible qualities. Explain whether and how the situation described in the Issue Statement may degrade, impair, or threaten each quality to a degree that action may be necessary. (Positive and negative effects to each quality from each alternative will be considered in Step 2).

Untrammeled

Wilderness ecological systems are unhindered and free from intentional actions of modern human control or manipulation. The Wilderness Act states that a wilderness is "an area where the earth and its community of life are untrammeled by man" and are to be managed "in contrast with those areas where man and his own works dominate the landscape." This quality is important because it is the essence of wilderness: a place where a humble and restrained approach reflects a respect for the autonomy of nature and allows us to learn from the natural world. The Untrammeled quality puts the "wild" in wilderness. It is unlikely that action is necessary to preserve this quality unless the decision is to stop taking action (e.g., removal of a dam managed to perpetually manipulate the movement of water in wilderness).

Undeveloped

Wilderness is essentially without structures, installations, the use of motors, landing of aircraft, or other forms of mechanical transport. The Wilderness Act states that wilderness is “an area of undeveloped Federal land” and is essentially “without permanent improvements or human habitation.” This quality is important because it prevents modification of the land caused by “expanding settlement and growing mechanization.” To preserve the Undeveloped quality, it may be necessary to remove existing structures or installations. This does not extend, however, to “other features of value,” which, if identified, are part of an area’s wilderness character (see below for a description of the Other Features of Value quality). Cultural resources, in the form of structures or installations, frequently qualify as part of the Other Features of Value quality.

Natural

Wilderness ecological systems are substantially free from the effects of modern civilization. The Wilderness Act states that wilderness retains its "primeval character and influence” and is to be “protected and managed so as to preserve its natural conditions.” This quality is important because it preserves indigenous species and ecological processes identifiable to that area. To preserve the Natural quality, it may be necessary to take action to correct human-caused unnatural conditions, including those present at the time of designation. Identifying a need to preserve this quality does not automatically mean that taking action is a given, however. That analysis occurs in Step 2 and is based upon preserving wilderness character as a whole (e.g., consideration of known methods, and the degree of impact the method would have on other qualities of wilderness character). Remember: Step 1 only indicates whether you need to perform that analysis in Step 2.

Outstanding Opportunities for Solitude or a Primitive and Unconfined Recreation

The Wilderness Act states that wilderness has “outstanding opportunities for solitude or a primitive and unconfined type of recreation.” This quality is important because it provides chances to be by oneself and offers opportunities for primitive recreation, personal challenge, and self-discovery while allowing visitors to be removed from the constraints of civilization. To preserve this quality, it may be necessary to reduce visitor encounters, reduce signs of modern civilization inside wilderness, remove agency-provided recreation facilities, reduce management restrictions on visitor behavior, or take action to improve opportunities for solitude or primitive and unconfined recreation.

A diminished condition of one of the elements of this quality (Solitude or Primitive and Unconfined Recreation) may require analyzing potential action that addresses the issue. For example, diminished solitude may require taking regulatory action such as instituting a limit on group size. Identifying a need to preserve this quality does not automatically mean that taking action is a given, however. That analysis occurs in Step 2 and is based upon preserving wilderness character as a whole (i.e., improving one of the elements within this quality may involve tradeoffs with the quality’s other element or with the other qualities of wilderness character).

Other Features of Value

In addition to the four qualities of wilderness character listed above (which all wilderness areas possess), the Wilderness Act states that wilderness "may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value" (emphasis added). This quality is important because it protects features unique and integral to an individual wilderness that might not be identified with one of the other four qualities. Not all wilderness areas possess this quality, but when they do, this quality must be preserved along with the others. The Other Features of Value quality typically consists of important geological formations, cultural resources, or paleontological sites. This quality normally does not include species or ecosystems—those values are addressed in the Natural quality—unless markedly unique to the wilderness.

Other Features of Value may be identified in legislation, through a nationally maintained register (e.g., National Register of Historic Places), or as a locally recognized feature that defines how people value the wilderness. For example, is there symbolism represented by the feature that gives meaning to the wilderness (e.g., spiritual values, traditional practices, or stories associated with the area)? In all cases, such features must be integral to the wilderness. Usually, these features are identified in a Wilderness Management Plan or other planning document. To preserve this quality, it may be necessary to take action to protect these features. However, it is not necessary to preserve all features from natural weathering. Deciding whether and how to protect Other Features of Value occurs in Step 2 and is based upon preserving wilderness character as a whole.

Wilderness Character Trade-offs to Consider

The above description of the primary tangible qualities of wilderness character is not comprehensive. For a detailed discussion of wilderness character, refer to pages 32-59 in Keeping It Wild 2: An Updated Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System, U.S. Forest Service Rocky Mountain Research Station, General Technical Report, RMRS-GTR-340. Additional information is provided at Wilderness Connect in the Wilderness Character Toolbox and in agency-specific policy and guidance.

Taking action often positively affects one or more qualities of wilderness character while negatively affecting others. Positive and negative impacts may even occur within the same quality, moreover. For example, consider an analysis of whether taking action to control an infestation of a non-native invasive weed may be necessary to preserve one or more of the qualities of wilderness character. In the following example, a non-native invasive weed that was not found in the wilderness seven years ago is now present in over 80 percent of the wilderness area. A native endangered plant species has experienced significant decline during the same seven-year period. The endangered plant species is critical to the survival of an endangered species of butterfly.

Untrammeled: With this example, action is not necessary to preserve this quality. The presence of the non-native weed is not an ongoing management decision to trammel, one that the manager has the discretion to stop. *(In fact, if action were to be taken, it*

would degrade the Untrammeled quality because the action, even if necessary, is an intentional human-caused manipulation of "the earth and its community of life." Consider that while analyzing alternatives in Step 2, not here.)

Undeveloped: With this example, action is not necessary to preserve this quality. The non-native weeds are not a development. *(Again, do not confuse necessity to take action (here) with the effects of taking action. There might be some degree of development if you used motorized equipment to control the weeds. If so, address it in each alternative under Step 2.)*

Natural: With this example, action is necessary to preserve this quality. While the presence of the non-native weed is an effect of modern civilization on the ecosystem, Step 1 does not determine what action to take. That decision will occur in Step 2 and could include no action (e.g., if taking action would cause more harm to the Natural or other qualities of wilderness character than taking no action at all).

Outstanding Opportunities for Solitude or a Primitive and Unconfined Recreation: With this example, the circumstances of the non-native weed vary widely. Most visitors would not associate the non-native weed with a human activity affecting solitude. However, a major infestation creating a monoculture plantation that is an obvious indication of human effects, or of a weed that effectively prevents movement in an area, may present a situation where action is required to preserve this quality.

Other Features of Value: The circumstances will vary based on the wilderness area's specific Other Features of Value and will need to be described. For example, it is possible that a monoculture of a non-native weed that creates a condition of poor soil stability could accelerate the weathering of cultural resources identified in the Other Features of Value quality.

B. Valid Existing Rights

Is action necessary to satisfy a valid existing right? If so, cite the specific right, terms and conditions, and source.

Valid Existing Rights (VERs) are created by a legally binding conveyance, lease, deed, contract, or law. In the wilderness context, VERs normally convey a very limited interest in land (e.g., roads, utility lines, communication sites, minerals, or other similar rights).

Where the right is explicitly defined (i.e., "perfected"), the holder may exercise the right to its full extent but not in excess of the right granted. An example is a right-of-way for an existing road held by deed on a property later acquired by the agency.

Where the right is not explicitly defined, determine its extent before fulfilling the right while preserving wilderness character to the greatest extent. An example is the existence of a general right to develop a road that does not currently exist. The VER owner has a right to a road, but that does not mean the VER owner has absolute discretion as to where to build it and what kind of road it should be. The precise location and specifications would need to be analyzed in Step 2 so that the right can be satisfied in a way that minimizes degradation of wilderness character.

C. Special Provisions of Wilderness Legislation

Is action necessary to satisfy a special provision in wilderness legislation (i.e., Section 4(d) of the Wilderness Act of 1964 or subsequent wilderness enabling laws) that requires action? Cite law and section.

Special provisions in either the Wilderness Act of 1964 or subsequent designating legislation sometimes require the managing agency to consider taking action. Legal directives stated in terms of “shall” or “must” require that action be taken or mandate that a particular use be allowed.

Legal directives stated in terms of “may” or similar general terms do not require action; they only *allow* for action in wilderness in compliance with the Wilderness Act. Such directives would not be cited in Step 1 but will be considered in Section 2 to inform the development of alternatives.

However, certain special provisions of wilderness legislation stated in terms of “may” further identify an executive branch official to whom the discretion to invoke the provision is granted under criteria separate from the minimum requirements criteria. If the responsible official has invoked that provision, consider it to be a requirement as if it had been written in terms of “shall” (see Example #1 below).

Examine the special provision and describe whether the law states that a specific action “shall” or simply “may” be taken. Legislative history (e.g., Congressional committee reports) may be useful in interpreting the law, but such documents do not have the force of law unless stated in the statute. Special provisions requiring action may apply nationally or on a geographically limited basis. Examples of wilderness legislation with affirmative special provisions include the following:

Example #1: Wilderness Act Section 4(d)(1)

(This example applies nationwide)

The first part of this special provision states:

“The use of aircraft or motorboats, where these uses have already become established, may be permitted to continue subject to such restrictions as the [Secretary] deems desirable.”

Under this provision, the Secretary *may* permit the use of aircraft. The criteria for permitting aircraft appear in Section 4(d) of the Wilderness Act: 1) where it has already become established and is thus a continuation of that use; and 2) subject to restrictions the Secretary deems desirable. If the authority (i.e., local land management plan) has exercised discretion to retain an existing airstrip that predates wilderness designation, as documented pursuant to Section 4(d)(1) criteria, you should interpret subsequent management of the airstrip as “necessary” because of the special provision, until such time as the Secretary decides otherwise. To preserve wilderness character to the greatest extent under the provision, the agency must, in Step 2, determine the minimum amount of management activity to sufficiently operate the airstrip.

The second part of this special provision states:

“Such measure may be taken as may be necessary in the control of fire, insects, and

diseases, subject to such conditions as the Secretary deems desirable."

This provision is implemented under DOI Secretarial Order (SO) 3372, which states: "Utilize active land, vegetation, and wildfire management techniques that are supported by best practices and best available science." This applies to all DOI lands, including wilderness. Agencies are directed to incorporate into land management plans "vegetation management techniques that are appropriate for the landscape, produce the desired results of reducing fuel loads, and are supported by the best available science." Agency wilderness manuals then describe the techniques that are appropriate for the landscape. (Note: This SO implements Executive Order (EO) 13855 and does not have a counterpart in USDA. EOs and SOs can be modified or rescinded at any time; verify that an Order is still in place before relying on its direction).

Example #2: Clark County Conservation of Public Land and Natural Resources Act, Sec. 210.

(This example applies to all but one wilderness in Clark County, NV) (Special Provisions - Wilderness Connect For Practitioners)

"Subject to such terms and conditions as the Secretary may prescribe, nothing in this title precludes the installation and maintenance of hydrologic, meteorological, or climatological collection devices in the wilderness areas designated by this title if the facilities and access to the facilities are essential to flood warning, flood control, and water reservoir operation activities."

This provision applies to 19 wilderness areas managed by three agencies. This provision uses the term "nothing precludes," which is the converse of a directive stated in terms of "shall" and holds the same non-discretionary meaning. If the placement of hydrologic, meteorological, or climatological collection devices is determined to be essential to flood warning, flood control, and water reservoir operation, it must be allowed. In this case, your analysis must conclude that it is essential to place such a device in the wilderness for those purposes, and that determination should have been made before initiating an MRAF. Once made, cite that determination in Step 1 as having established necessity.

Example #3: John D. Dingell, Jr. Conservation, Management, and Recreation Act, Sec. 604.

(This example applies only to the Death Valley Wilderness in California).

"The designation of the Death Valley National Park Wilderness by section 601(a)(1) shall not preclude the operation and maintenance of the Mormon Peak Microwave Facility."

When special provisions of wilderness legislation necessitate action, determine the minimum action in Step 2.

D. Requirements of Other Federal Laws

Not including special provisions found in wilderness-enabling laws, does another Federal law, by itself or as implemented or interpreted through EO, court order, etc.,

require action? Cite law and section.

There are a limited number of Federal laws, by themselves or as implemented or interpreted through EOs, court orders, etc., that require action and/or allow a particular use within designated wilderness. These are typically stated in terms of “shall” or “must.” Federal laws stated in terms of “may” or other general or broad terms do not *require* action; they only allow for action in wilderness when consistent with the Wilderness Act. Unless another law explicitly overrides the Wilderness Act’s requirements, the agency must carry out its actions consistent with the requirements of the Wilderness Act. Agency policy documents are not legal directives and are not considered in this section. Agency policy will be addressed in Step 2, under the “Other Direction” heading.

Under these criteria, identify and cite specific applicable provisions of other Federal laws that require action. When the applicability of another law is in question, wilderness managers should consult with their respective agency wilderness lead, who may seek legal counsel. If no other laws apply, state that in your analysis. Examples of Federal laws with affirmative directives that necessitate action (that may or may not need to take place in wilderness) include but are not limited to the following:

Example #1: The Endangered Species Act (16 U.S.C. 1531-1544, 87 Stat, 884) as amended

In this example, the law states, “Federal agencies shall…utilize their authorities…by carrying out programs for the conservation of endangered species and threatened species.” Conservation, as defined in the Act, means “the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measure provided pursuant to the [Endangered Species] Act are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management."

The affirmative direction from the Endangered Species Act (ESA) requires the agency to take actions necessary to conserve threatened and endangered species, and so the test for necessity in Step 1 of the MRAF *may* have been met. The ESA does not specify any particular type or location of action, only that action is required. This requirement is often consistent with requirements of the Wilderness Act to preserve wilderness character, specifically the preservation of natural conditions (Section 2(c)). Give careful consideration to the possibility of avoiding impacts to wilderness character by conducting actions outside of wilderness that could benefit the species inside of wilderness. The Recovery Plan for the species may help address this question.

In determining how to carry out a particular method or procedure, consider the timing, frequency, duration, and types of uses necessary to recover the species while preserving wilderness character. Methods or procedures that are the minimum necessary for administration of the area as wilderness and the recovery of the threatened or endangered species are determined in Step 2 of the MRAF.

Example #2: The Disaster Relief Act (42 U.S.C. 5132, as amended)

In this example, the law states, “The President shall insure that all appropriate Federal agencies are prepared to issue warnings of disasters to State and local officials."

The Disaster Relief Act requires the agency to take actions necessary to issue disaster warnings. This law does not specify a particular type of action, nor that the action must take place in wilderness. If the only way to fulfill the requirements of providing warning is to take action in wilderness, however, this statute establishes the necessity to take *some* action. For example, if placing volcanic hazard monitoring devices outside wilderness does not provide sufficiently accurate readings, placing these devices inside wilderness may be required.

If action cannot be taken outside of wilderness, Step 2 of the MRAF will determine the number and type of facilities, access, duration, and frequency of activities required to provide disaster warning while otherwise preserving wilderness character.

Step 1: Determination – Is Administrative Action Necessary in Wilderness?

Based on the responses and detailed explanations in A through D above, is there a need to proceed to Step 2? If at least one criterion in B through D in Step 1 has been met, or at least one quality of wilderness character is threatened, check the "Yes" box and provide a thorough explanation of the rationale described in A through D. It may also be helpful to describe in this determination how action would be consistent with the public purposes of wilderness or satisfy a specific agency obligation. If none of the criteria have been met, action is NOT necessary. Check the "No" box, explain why the proposed project does not meet the criteria, and stop your analysis.

Step 2: Determine the Minimum Activity

Other Direction

Is there "special provisions" language in Federal law that explicitly allows consideration of (but does not require) a prohibited use? (Step 1 has a similar question in Section C, but that question is specific to other legislation requiring action in wilderness; this question is specific to the legislation addressing consideration of prohibited uses).

AND/OR

Has the issue been addressed or prescribed in agency policy, wilderness management plans, other types of management plans, or legal directive (e.g., treaty, EO, court order, or other binding agreement with Federal, state, or local agencies or authorities)?

If a special provision states that an activity "may" be allowed in wilderness, that law does not require action. Cite it in this section to aid in development of alternatives. Such statutes generally call attention to an activity that may be permissible if it satisfies the minimum requirements criteria. Note that some statutes stated in terms of "may" allow a responsible official to invoke the provision under criteria apart from the minimum requirements criteria and so are cited in Step 1 (see instructions for Part C). Consider the methods identified in the special provision in at least one alternative in Step 2. For example, a special provision for the Pine Forest Range Wilderness says the State of Nevada may use aircraft to manage wildlife populations, guided by the principle of doing

only the minimum necessary to manage the area as wilderness (P.L. 113-291, Section 3064(e)). This special provision neither requires an activity nor allows for any method to be used apart from the minimum requirements criteria. Consider the use of aircraft in drafting an alternative(s); you can select such an alternative if you determine it to be the minimum activity to manage wildlife populations.

Frequently, agency policy, wilderness management plans, other types of management plans, or agreements with tribal, state, or local governments or other Federal agencies are integral to the identification of a situation that has prompted an MRA. Consequently, direction identified or prescribed in those plans often should be included in the "Description of the Situation" section in Step 1. Although these documents do not by themselves necessitate action, they often are central in identifying situations that need to be analyzed to determine if action in wilderness is necessary.

In addition, if you have addressed an issue in agency policy, wilderness management plan, other types of management plan, or agreement with tribal, state, and local governments or other Federal agencies, cite the pertinent document and its explicit direction. While the direction contained in these documents is often essential in developing alternatives, those alternatives should not be the only ones considered, nor should they automatically become the Selected Alternative. Unless direction in a plan derives from an MRA, do not use that direction to determine the result of a new analysis.

Uncontrollable Timing Requirements

What, if any, are the considerations that would dictate timing of the action?

These considerations apply equally to each alternative. For example, it may be necessary to avoid a critical bird nesting season or seasonal high-water levels in streams. Time requirements do not include availability of workers, training, materials, agency approvals, or available funding. These can be important factors for project planning and implementation but should not limit your alternatives.

Workflow Components

What are the distinct components or phases of the action?

Identifying workflow components is the first step in developing and describing alternatives that address the situation/Issue Statement identified in Step 1. For simple issues, there may only be one workflow component while a complex project may require many. Breaking out the workflow in this manner will aid in developing, clearly describing, and comparing alternatives and fully analyzing the impact of each alternative on each quality of wilderness character.

There can be vastly different ways to respond to an issue, so it is important not to set up workflow components in a manner that eliminates feasible alternatives, especially those that avoid uses prohibited by section 4(c). The list of components should be broad enough to support a full range of alternatives. In some alternatives, a certain component may not be applicable, and so may be noted as "N/A" in the description of that

alternative.

In the table provided in the workbook, list each distinct workflow component needed to address the Issue Statement. These components will form the basis for comparing the alternatives that follow. Add additional workflow components as needed.

The purpose of this section is to ensure that the agency considers the minimum uses and activities for all steps in the workflow. Without this process, distinct workflow steps could inadvertently be lumped together, resulting in more than the minimum activity occurring (including uses prohibited by Section 4(c)). Identify the distinct components that might differ from one alternative to another. For example:

Transporting personnel and transporting material or equipment may be accomplished by different means. Materials or equipment may be so large that they cannot be transported by foot or stock, so a one-time transport by helicopter may be the minimum necessary. That does not mean that personnel transport to the site requires helicopter landings; personnel could walk in and camp for the duration of the project.

In constructing a fence to protect riparian vegetation from livestock grazing, it may be necessary to use motorized equipment to build corner braces in some terrain. Fence posts, however, could be pounded manually. Identifying one workflow component for building corner braces and another for installing fence posts keeps discrete requirements separate to ensure a minimum number of prohibited uses.

In the example below, assume you have already determined the need to research and monitor wildlife in wilderness. The discrete components are listed as follows:

Component 1	Transportation of personnel to project site
Component 2	Transportation of equipment to project site
Component 3	Tools used at project site
Component 4	Removal of equipment

Feasibility of Alternatives

Only include feasible alternatives in this section. Some alternatives that are not feasible may warrant documentation in the “Alternatives Considered but Dismissed” section to provide a brief description and explanation of why it was dismissed and not considered in detail.

Possible reasons for dismissal include alternatives that are:

- Impossible
    - If research shows an alternative is impossible to accomplish by any means, it should not be analyzed in detail.
- Unacceptable impacts
    - Alternatives that would clearly result in inappropriate adverse impacts to wilderness character should not be analyzed in detail.
- Unsafe

- Most safety issues can be mitigated so that the risk is reduced to an appropriate level. Alternatives that involve risks for workers or the public and that cannot be mitigated should be considered but dismissed.

- Ineffective
  - Alternatives that have been determined to be ineffective in addressing the issue under similar circumstances should not be analyzed in detail.
- Excessive costs
  - Cost is not a factor in determining feasibility unless an alternative is so costly that the funds cannot be obtained, resulting in the issue not being addressed. The amount of funding obtained prior to writing an MRA cannot be used for dismissal.
- Timing
  - Dismiss alternatives that would require time allocations incongruent with urgent situations. This only applies where a gradual or lengthy response would clearly result in unacceptable hazards or significant degradation to wilderness character.

Step 2: Alternatives

Component Methods

How will each of the components of the action be performed under this alternative?

It is important to identify the components of the action first before developing the alternatives. Separating an action into components provides a foundation for building well-thought-out alternatives (and promotes consistency among alternatives).

For each alternative, enter the method that will be used to accomplish each component in the “Component Methods for this Alternative” column. This is an iterative rather than linear process. As you describe activities in this section, you may find it necessary to revisit the “Workflow Components” section to revise them and account for the description of an alternative. In some cases, you will have sketched out methods within an alternative that may not work together as a functional alternative. In this case, modify the Component Methods or move them to other alternatives to form functional alternatives. For some alternatives, an individual workflow component might be marked as “not applicable.”

Here is the wildlife research and monitoring example in an alternative called “Installation of Monitoring Cameras” (again, assume you have already determined in Step 1 that action is necessary).

Workflow Components		Component Methods for this Alternative
#1	Transportation of personnel to project site	Workers walk to work site.
#2	Transportation of equipment to project site	Tools used to set up/clear sites will be non-motorized and non-mechanized. Equipment transported by foot or by stock.
#3	Tools used at project site	Hand saws to clear vegetation, battery-powered monitoring camera, nylon strap to affix camera to tree, hand tools to install an attractant wooden stake near camera.
#4	Removal of equipment and final condition of site	Stations would be dismantled and removed from wilderness after monitoring is completed.

Use the methods identified for each of the workflow components as the basis for preparing a detailed narrative description of the alternative.

Description of Alternatives

What are the details of each alternative? When, where, and how will the action occur? What mitigation measures will be taken? Provide a complete narrative description of the Component Methods identified above.

For each alternative, give it a short name in the first text box (e.g., No Action, Removal by Foot and Stock). In the larger text box, describe in detail the methods and techniques that will be used, when the activity will take place, where the activity will take place, and necessary mitigation measures.

The level of detail required in the description of alternatives and effects varies by the complexity of the activity. For some projects, it may be necessary to reference agency policy, standards, or guidelines for construction of facilities and structures, etc.

Identify and describe a full range of feasible alternatives, including (as applicable) alternatives that use:

- A proposed Section 4(c) prohibited use(s)
- A combination of Section 4(c) prohibited uses (e.g., motor vehicles) and non-prohibited uses (e.g., pack stock)
- No Section 4(c) prohibited uses

For each alternative:

A. Describe in detail if an authorization is proposed for any activities that are prohibited for the general public (e.g., scientific collecting, exceeding group size, etc.).

B. Describe the quantities of all Section 4(c) prohibited uses, including:

- **Temporary road:** Identify duration of use, length of road, approximate location, degree of development, etc.
- **Motor vehicle:** Estimate days and hours of use. State decibel levels, if known.
- **Motorized equipment:** Estimate days and hours of use. State decibel levels, if known.
- **Motorboat:** Estimate days and hours of use. State decibel levels, if known.
- **Landing of aircraft:** Identify number of landings, including delivery of materials via drop-off or pick-up.
- **Other form of mechanical (motorized or non-motorized) transport:** Identify the travel route and estimated days and hours of use.
- **Structures and installations:** State the number and location of each. If temporary, state the date of removal.

C. Describe any other tools or actions that may affect wilderness character. For example, tools such as the use of explosives or the total flight time over a wilderness may each affect wilderness character even though the Wilderness Act prohibits neither. In addition, actions by employees, including the size of their work group or the timing and duration of their stay, are not prohibited by the Wilderness Act but may affect wilderness character.

A No Action alternative is often necessary to facilitate a comprehensive comparison of the effects of taking any action. For example, the No Action alternative can:

- Provide a comparison that identifies if an action alternative would cause greater degradation to wilderness character than doing nothing at all.
- Provide short- and long-term comparisons of effects.

In some situations, the No Action alternative might better preserve the qualities of wilderness character than taking action. This is especially true with more complex issues. Generally, only simple issues do not warrant a No Action alternative.

Action alternatives that are not feasible or are otherwise unacceptable to implement are not analyzed here but should be identified, along with the reasons why they were not fully considered, in the section titled “Alternatives Considered but Dismissed.”

Mitigation measures: Mitigation measures are actions that reduce or eliminate the negative impacts of a given component of the alternative. Include an explanation of how the impacts from the various activities, methods, and tools that could be used might be mitigated: through employee training; location of work areas, campsites, and travel routes; project timing; temporary closures; or other actions. For example, a common mitigation measure for scientific installations is a requirement that they be painted a

matte color that blends with the landscape to reduce visibility. A mitigation measure for helicopter flights might be to avoid bird nesting season.

Criteria for Comparing Alternatives

For each activity specific to this alternative, check whether the activity has a positive, negative, or no effect on each of the following comparison criteria. In the text box provided, describe the type, duration, and magnitude of the effects. Note that it is possible to check both positive and negative boxes if the proposed activity will have both effects.

After discussion of each of the qualities of wilderness character below, a common example follows (the aforementioned proposal to install monitoring cameras in a wilderness). Explanatory notes appear in red, describing why particular activities were "graded" as they were.

Wilderness Character

What is the effect of each Component Method on the qualities of wilderness character? What mitigation measures will be taken?

Untrammeled

Identify how this quality is positively impacted where a trammeling action is reduced or eliminated or is negatively impacted where trammeling increases. Discuss the degree to which the components or processes of ecological systems are intentionally controlled, manipulated, or hindered by the proposed actions.

This quality is degraded by modern human activities or actions that control or manipulate the components or processes of ecological systems inside the wilderness. Examples include suppression of natural fire or managing vegetation and wildlife even if the manipulation would ultimately improve the Natural quality, such as eliminating a non-native species. Any manipulation of the biophysical environment has a negative impact to this quality. The only way a positive effect to this quality could be registered is if the proposal would stop an ongoing manipulation of the biophysical environment.

The negative effect to the Untrammeled quality is greater when:

- There is an increase in the number of ecological components or processes affected.
- The proposed action intends to shape resulting ecological conditions or processes rather than merely remove a human-caused condition.
- The goals of the action are highly prescriptive, requiring more choices made by people rather than nature.
- The proposed action is likely to require multiple interventions.
- The risk of unintended consequences is high.
- The proposed action has not been tested in the same or a similar ecosystem.

For projects where the intent is not to manipulate wilderness ecosystems (e.g.,

removing a structure or preserving solitude), simply state that there is no effect and, if appropriate, describe the impacts to one or more of the other qualities.

For actions that intend to manipulate natural conditions or processes, consider the following questions:

- Describe the number of processes or ecosystem components affected, and complexity, area, and type of the trammeling.
    - What is the scope of the action: Does it affect multiple species or processes?
    - What is the size of the area involved?
    - What is the degree or intensity of the manipulation: Does it shape ecological conditions or remove a condition caused by modern humans (as defined in Section 2(a) of the Wilderness Act)?
    - What is the breadth of the ecological goals of the proposal?
    - What type and duration of trammeling is proposed? Does it involve a single action or long-term control and manipulation (e.g., one-time moving of a species or a permanently installed fish ladder)?
- What is the likelihood of avoiding or needing future trammeling?
    - Will the trammeling result in natural processes resuming or the avoidance of future trammeling?
    - What is the risk of unintended consequences, and what would those consequences be?
- Is this a reliable, tested manipulation of the ecosystem?
    - What is the probability of success?
    - Has the action been tried in this type of ecosystem before?
    - How extensive has the action been used or tested?
    - Was the action shown to be reliable, or is this an experiment?

Cumulative Impacts

Within the area addressed in the Issue Statement in Step 1, identify ongoing trammeling actions occurring concurrently within the issue area and future impacts (planned, in planning, or expected (but not speculative)). Would the evaluation questions be answered differently if this alternative were to be considered together with ongoing or future impacts? Consider unique synergistic and countervailing (mitigating) impacts resulting from interaction of the alternative and ongoing or further impacts in addition to additive impacts.

Component #	For each component number, indicate the impact the **method for this alternative** will have on each of the five qualities of Wilderness: Positive = P, Negative = N, No Effect = 0 *Describe in detail the impacts to each of the five qualities in the narrative section below*	Untrammeled	Undeveloped	Natural	Solitude or Primitive and Unconfined Recreation	Other Features of Value
#1	Workers walk to work site.	0				
#2	Tools used to setup/clear sites will be non-motorized and non-mechanized. Equipment transported by foot or by stock.	0				
#3	Hand saws to clear vegetation, battery-powered monitoring camera, nylon strap to affix camera to tree, hand tools to install an attractant wooden stake near camera.	N				
#4	Stations would be dismantled and removed from wilderness after monitoring is completed. This includes removing the camera, nylon strap, attractant, and wooden stake.	0				

Explain the intensity of the action that would intentionally control, manipulate, or hinder the conditions or processes of ecological systems:

The installation of an attractant to intentionally lure wildlife to the camera location is manipulating the movement of wildlife. No other actions are intentionally controlling, hindering, or manipulating natural processes or conditions. (Note: There are no positive impacts because the activity is not undoing a previous control of the community of life.)

Undeveloped

Describe the positive or negative impacts to this quality in terms of how “the imprint of man’s work [would remain] substantially unnoticeable,” and how wilderness will continue to contrast with other areas of “growing mechanization.” Include the effects of the use of any motorized equipment or mechanical transport, or the continued presence, addition, or removal of any structures or installations on maintaining the Undeveloped quality.

This quality is degraded by the presence of structures, installations, or the use of motor vehicles, motorized equipment, or other forms of mechanical transport that increases people’s ability to occupy or modify the environment. Examples include communication

equipment, monitoring installations, administrative cabins, trail bridges, helicopter landings, and the use of chainsaws, pumps, motor vehicles, motorboats, etc. An alternative that uses none of these prohibitions would have no impact on this quality. An alternative that removes a structure or installation or otherwise stops a prohibited use would have a positive effect on this quality. An alternative that uses a less powerful tool (e.g., using a wheelbarrow instead of a motor vehicle to transport material) may have less of a negative effect on this quality. Note that when a proposal is broken down into phases or components, more than one effect to this quality may occur. For instance, an alternative to remove a bridge by flying it out with a helicopter would both improve (by removing the structure) and degrade (by using an aircraft) this quality.

For actions that involve a structure, motor vehicle, etc., consider the following questions:

- What is the type and degree of development?
- What are the number and duration of structures and installations, and how advanced are materials or technology?
    - What are the number and size of structures and installations, and how long will they be there?
    - To what degree can they transform the landscape?
    - How many structures and installations are currently in the project area, and what is the cumulative effect?
- What motorized tools or motorized or mechanical transport are proposed for use, including number, duration, and power of tool(s)?
    - What are the types, number of uses, and amount of time motorized tools or motorized or mechanical transport will be in use?
    - How large of an area in the wilderness will they affect?
    - To what degree can they transform the ecosystem?

Cumulative Impacts

Within the area addressed in the Issue Statement in Step 1, identify existing developments within the issue area and future developments (planned, in planning, or expected (but not speculative)). Would the evaluation questions be answered differently if this alternative were to be considered together with ongoing or future impacts? Consider unique synergistic and countervailing (mitigating) impacts resulting from interaction of the alternative and ongoing or further impacts in addition to additive impacts.

Component #	For each component number, indicate the impact the **method for this alternative** will have on each of the five qualities of Wilderness: Positive = P, Negative = N, No Effect = 0 *Describe in detail the impacts to each of the five qualities in the narrative section below*	Untrammeled	Undeveloped	Natural	Solitude or Primitive and Unconfined	Other Features of Value
#1	Workers walk to work site.		0			
#2	Tools used to set up/clear sites will be non-motorized. Equipment transported by foot or by stock.		0			
#3	Hand saws to clear vegetation, battery-powered monitoring camera, nylon strap to affix camera to tree, hand tools to install an attractant wooden stake near camera.		N			
#4	Stations would be dismantled and removed from wilderness after monitoring is completed. This includes removing the camera, nylon strap, attractant, and wooden stake.		0			

Explain the effects to this quality in terms of how “the imprint of man’s work [would remain] substantially unnoticeable,” and how wilderness will continue to be in contrast to other areas of “growing mechanization”:

Non-motorized transportation or tools do not affect this quality (Note: Using traditional, non-motorized tools—or no tools at all—does not make the wilderness less developed (and so described as a positive impact); it merely keeps the wilderness from becoming negatively developed (a no-effect impact, in other words).

The presence of a camera, even though not permanent, is an occupation and modification of the environment. Even though the camera will be removed when monitoring is complete, the installation of the camera is a negative effect; removing the camera at the end of the project is merely returning the wilderness to conditions prior to the project, thus no effect.

Natural

Describe the potential positive or negative impacts to this quality in terms of protection, impairment, or restoration of natural conditions (i.e., air, water, soil, wildlife) including endangered, threatened, or rare species, natural biological diversity, and self-regulating

ecosystems.

Where applicable, include a discussion of the effects related to protecting natural conditions within the regional landscape (i.e., insects, disease, non-native species).

This quality is affected by intended or unintended effects of modern civilization on the ecological systems inside the wilderness. There are positive impacts to this quality if the alternative would improve natural conditions, negative impacts if the alternative would degrade natural conditions, and no impact if the alternative would have no effect on natural conditions. Examples of degradation of this quality include the results of allowing non-native invasive species to become established or expanding the suppression of natural fire. Examples of preservation of this quality may include the effects of successfully treating non-native species, restoring native species, or allowing natural fire (if doing so would allow the resulting fuel loading to fall once again within a natural range of variability). Note that in some instances, an alternative might have both positive and negative impacts. For instance, providing artificial water to aid in the recovery of a threatened and endangered species would be a positive impact to this quality (if necessary to maintain the species within a natural range of variability) and a negative impact because of the change to the area's natural hydrology.

For alternatives intended to produce positive effects to the Natural quality, alternatives intended to respond to other issues, and No Action alternatives, describe:

- Magnitude: area, duration, number of ecological components affected
  - Describe the effect, both positive and negative, to the conditions and processes affected.
- Ecological significance of the area, species, or processes affected
  - Describe if the effect would be to a species, community, or process of known ecological importance.
- Risk of increasing or unintended effects
  - Is the condition or threat stable, improving, or getting worse? What is the likely future trend?
  - Is the action proposed in the alternative known to be reliable in this ecosystem, or is it an experiment?
- Understanding of natural conditions or processes at risk
  - Describe the impact of the alternative in mitigating conditions that are a result of modern human activity.
    - What is the certainty that the conditions addressed are a result of human impact?
    - Is the current condition within the range of natural variability?
    - Would the alternative result in an ecosystem that reflects human desires rather than natural processes?
    - Is the alternative limited to the human-caused change to the ecosystem?
  - What is the likelihood of irreversible changes?
  - What is the likelihood of the ecosystem being able to be self-sustaining (without further management input), and how long will it take to be in that condition? What risks are associated with waiting?

Cumulative Impacts

Within the area addressed in the Issue Statement in Step 1, identify current impacts to the Natural quality within the issue area and foreseeable impacts (expected, but not speculative). Would the evaluation questions be answered differently if this alternative were to be considered together with ongoing or future impacts? Consider unique synergistic and countervailing (mitigating) impacts resulting from interaction of the alternative and ongoing or further impacts in addition to additive impacts.

Component #	For each component number, indicate the impact the **method for this alternative** will have on each of the five qualities of Wilderness: Positive = P, Negative = N, No Effect = 0 *Describe in detail the impacts to each of the five qualities in the narrative section below*	Untrammeled	Undeveloped	Natural	Solitude or Primitive and Unconfined	Other Features of Value
#1	Workers walk to work site.			0		
#2	Tools used to set up/clear sites will be non-motorized. Equipment transported by foot or by stock.			0		
#3	Hand saws to clear vegetation, battery-powered monitoring camera, nylon strap to affix camera to tree, hand tools to install an attractant wooden stake near camera.			P		
#4	Stations would be dismantled and removed from wilderness after monitoring is completed. This includes removing the camera, nylon strap, attractant, and wooden stake.			0		

Explain the effects to this quality in terms of protection, degradation, or restoration of natural conditions:

Walking crews and equipment to the project site, as well as dismantling and removing monitoring equipment, will not affect the Natural quality.

The act of collecting data from cameras will have no effect on the Natural quality.

(Note: Impacts that might be avoided (e.g., clearing vegetation during nesting season for another species) should not be listed here but should be discussed in the narrative; negative impacts that cannot be completely avoided should be accounted for in these tables and discussed—including ways to minimize the impacts—in the narrative).

(Note: In this scenario, be careful about stating that collecting data has a beneficial effect on the Natural quality. Data itself does not change conditions on the ground. Management actions taken because of the data is what could affect the Natural quality, either positively or negatively. If future management actions are identified because of the data, a separate analysis could potentially find that the management action would improve natural conditions on the ground, and thus have a positive effect on the Natural quality).

Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation

Identify how opportunities for visitors to experience solitude or a primitive and unconfined type of recreation will be protected or impaired.

Describe the impacts to this quality that will be noticeable to the visitor and could affect his or her experience in wilderness. Include negative impacts to visitors from the use of motorized equipment, mechanical transport, landing of aircraft, structures, or installations as well as positive impacts from actions that preserve or improve opportunities. If necessary, describe these positive or negative impacts separately for each sub-part of this quality: Outstanding Opportunities for Solitude; Primitive Recreation; and Unconfined Recreation.

Settings that degrade or improve these opportunities will affect this quality. Examples of degradation include: management actions that cause (by action or inaction) loss of opportunities due to crowding or too many visitor encounters (affecting opportunities for solitude); facilities or other signs of modern civilization (affecting opportunities for primitive recreation); or excessive restrictions on visitor behavior (affecting opportunities for unconfined recreation). An alternative that manages visitor use to increase solitude, for example, would have a positive impact on this quality. This same alternative, however, would have a negative impact on this quality by restricting visitors. Some management actions may be necessary to preserve one or more of the other qualities even though doing so would degrade the Outstanding Opportunities quality. For example, fire grates, toilets, trail bridges, and designated campsites degrade this quality as well as the Undeveloped quality but may be necessary to preserve the Natural quality.

If an alternative has both positive and negative impacts to this quality, check both boxes and explain in the space provided.

Any change to:

- Visitor encounters?
    - What is the current use level of the area?

    - Describe change in frequency and timing of encounters.
    - Describe if a visitor's encounters with employees would deviate from standard levels of frequency, timing, or group size for visitor encounters in the wilderness.
    - Describe current sensitivity of visitors based on quality of solitude at time of designation and changes in the timing of encounters (daily or seasonally).
- Number of structures or installations (are they primitive or modern)?
    - Describe size, color, placement, type of materials, and other factors that would make the structures or installations more or less visible and thus a reminder of "expanding settlement" (Section 2(a) of the Wilderness Act).
- Amount of aircraft, vehicle, or motorized tool use?
    - Describe the duration, magnitude, and intensity of the impact.
    - Describe noise level.
    - Describe sensitivity of visitors based on quality of solitude at time of designation and timing of use during periods of or in areas of greater visitor sensitivity.
- Restrictions on visitors?
    - Describe if temporary, permanent, or seasonal restrictions will result.
    - Describe if visitors will be restricted from certain locations, including from camping at will.
    - Describe any invasions of privacy.
- The setting's natural or primitive appearance?
    - How remote is the area that will be affected?
    - How natural does the area currently appear?

Cumulative Impacts

Within the area addressed in the Issue Statement in Step 1, identify loss of solitude, degradation to primitive recreation, and existing confinement of visitors. Also identify expected (but not speculative) impacts. Would the evaluation questions be answered differently if this alternative were to be considered together with ongoing or future impacts? Consider unique synergistic and countervailing (mitigating) impacts resulting from interaction of the alternative and ongoing or further impacts in addition to additive impacts.

Component #	For each component number, indicate the impact the **method for this alternative** will have on each of the five qualities of Wilderness: Positive = P, Negative = N, No Effect = 0 *Describe in detail the impacts to each of the five qualities in the narrative section below*	Untrammeled	Undeveloped	Natural	Solitude or Primitive and Unconfined	Other Features of Value
#1	Workers walk to work site				0	
#2	Tools used to set up/clear sites will be non-motorized. Equipment transported by foot or by stock				0	
#3	Hand saws to clear vegetation, battery powered monitoring camera, nylon strap to affix camera to tree, hand tools to install an attractant wooden stake near camera				N	
#4	Stations would be dismantled and removed from wilderness after monitoring is completed. This includes removing the camera, nylon strap, attractant, and wooden stake.				0	

Explain how opportunities for visitors to experience solitude or a primitive and unconfined type of recreation will be protected or degraded. As appropriate, describe solitude, primitive recreation, and unconfined recreation separately:

Encountering a few employees with hand tools and equipment will have virtually no effect on opportunities for solitude as the group size and frequency of encounters with employees would be similar to expected encounters in this wilderness.

Even though camera stations will be set up away from trails to lessen the noticeability and impact to wilderness visitors, these installations would have a negative impact on visitors who come across them.

Removing the camera at the end of the project is merely returning the wilderness to conditions prior to the project, thus no effect.

This alternative will have no effect on opportunities for primitive recreation.

Other Features of Value

Identify any values or characteristics of this wilderness (e.g., "ecological, geological, or other features of scientific, educational, scenic, or historical value") that are not accounted for in the above qualities and describe the effects the proposal may have on these features. Heritage and cultural resources, including historic sites and paleontological localities, may be included here.

This quality is intended to incorporate features that are truly unique and integral to the designation or management of the area as wilderness. The following questions were provided in Keeping It Wild 2: An Updated Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System to help staff determine whether a feature is unique and integral to wilderness:

- Is the feature specifically identified in the enabling legislation for the wilderness?
- Does the feature define how people think about the wilderness, or how they value the wilderness?
- Is the feature nationally recognized (for example, through an official designation such as the National Register) or considered a priority heritage asset (for example, identified as significant in an agency plan)?

An alternative that degrades any of these features would have a negative impact on this quality while an alternative that improves them would have a positive impact. The alternative may have no impact on this quality, either from simply not degrading the quality, or because the wilderness area lacks other features of value that might be affected by the proposal.

- Will the activity help to realize the scientific, educational, scenic, or historic values of the feature?
  - Is action necessary to prevent the loss of these values?
  - Will these values not be realized unless action is taken?
- Describe the nature of the effect.
  - How will the alternative impact the feature either positively or negatively?
- Are there irreversible impacts?
  - Are irreversible impacts considered to be an acceptable natural process?
  - Are irreversible impacts human caused?
- Why is the effect significant? (include intangible elements)
  - What group or entity would be affected by damage or loss of this feature (including personal, spiritual, cultural impacts, where they have been expressed by the group)?
  - Are natural impacts (weathering) considered to be acceptable for the feature and the values the feature represents?
  - Can impacts be appropriately mitigated to preserve the meanings and values of the features?

Cumulative Impacts

Within the area addressed in the Issue Statement in Step 1, identify ongoing impacts to other features of value occurring concurrently within the issue area and future impacts (planned, in planning, or expected (but not speculative)). Would the evaluation questions be answered differently if this alternative were to be considered together with ongoing or future impacts? Consider unique synergistic and countervailing (mitigating) impacts resulting from interaction of the alternative and ongoing or further impacts in addition to additive impacts.

Component #	For each component number, indicate the impact the **method for this alternative** will have on each of the five qualities of Wilderness: Positive = P, Negative = N, No Effect = 0 *Describe in detail the impacts to each of the five qualities in the narrative section below*	Untrammeled	Undeveloped	Natural	Solitude or Primitive and Unconfined	Other Features of Value
#1	Workers walk to work site				0	
#2	Tools used to set up/clear sites will be non-motorized. Equipment transported by foot or by stock				0	
#3	Hand saws to clear vegetation, battery powered monitoring camera, nylon strap to affix camera to tree, hand tools to install an attractant wooden stake near camera				N	
#4	Stations would be dismantled and removed from wilderness after monitoring is completed. This includes removing the camera, nylon strap, attractant, and wooden stake.				0	

Explain any effects to features of scientific, educational, scenic, or historical value that are integral to the character of the wilderness area and are not accounted for in the above qualities, including cultural and paleontological resources:

There are no other features of value affected by this alternative.

After completing Alternative 1, follow the instructions above to draft additional alternatives.

For each alternative, identify the method that will be used to accomplish each component.

Repeat as necessary for each alternative.

Step 2: Alternatives Considered but Dismissed

What alternatives were considered but dismissed? Why were they dismissed?

Document alternatives considered but dismissed as part of your review, as appropriate. Moreover, briefly describe the dismissed alternatives in the Step 2 Determination rationale to show that the analysis considered a full range of alternatives. Valid reasons for deciding that an alternative is unacceptable or not feasible should be limited to:

1) Actions that are impossible to accomplish by any means.
2) Actions that are possible to accomplish, but implementation would clearly cause unacceptably adverse impacts to wilderness character.
3) Actions that would cause an unacceptable safety risk to workers or the public that cannot be mitigated.
4) Actions that have proven not to be effective.
5) Actions that are not responsive to the issue.
6) Actions that are so costly that they could not be implemented immediately, and wilderness character would be degraded because of failure to respond in a timely manner.
7) Alternatives that are not technically or legally feasible.

Do not eliminate alternatives from full consideration simply because implementation would take more time, money, or personnel, or because the skills or equipment needed are not readily available on the local unit. For example, use of a helicopter may cost more than widening an existing trail to serve as a temporary road, but if both alternatives are feasible, fully evaluate them regardless of cost.

Step 2: Determination – What is the Minimum Activity?

Selected Alternative

List the selected alternative that represents the minimum requirements necessary to administer the area as wilderness. Describe the rationale for selecting that alternative in the text box provided.

Provide a comparison of the alternatives and state why the selected alternative best preserves wilderness character as a whole as compared to the other alternatives considered. Make an affirmative statement that after considering all the impacts and benefits cumulatively for each alternative, the selected alternative preserves wilderness to the greatest degree. Describe the degree of degradation or improvement to wilderness character to support the conclusion for selecting the preferred alternative.

The determination must document a comparative analysis where the variables are considered in relation to one another and the interests at stake are weighed. It must: (1) balance competing qualities of wilderness character, (2) determine which is the most important quality(s) under the given circumstances, and (3) rationalize the method(s) chosen to protect that quality(s). The positive or negative effects to each quality noted in the "Comparison of Alternatives" section serve as a starting point for the discussion.

The determination does not have to recount every effect on every quality of wilderness character for each alternative. Rather, it should focus on those qualities and effects that are driving the determination, and how one quality was considered in relation to the others. The discussions in the explanatory text boxes in this section will provide a way to assess and compare the magnitude of the effects, forming a justification for the determination. The selected alternative should be the one that best preserves wilderness character as a whole.

The rationale should demonstrate that the determination is clearly a result of objective evaluation of the alternatives, not the result of an inappropriate bias or justification of an alternative or method for non-wilderness reasons. When discussing why other alternatives do not meet the minimum requirements, be sure to include a brief reference to the "Alternatives Considered but Dismissed" section.

Articulate the cumulative effects of your determination. This should include both past effects as well as reasonably foreseeable future effects to the same qualities, and from other actions (e.g., pertinent ecological interventions, installations, or structures). In some cases, regional consideration may be appropriate. If monitoring has identified a trend in a specific quality, note it in your selected alternative.

The selected alternative must conform to all applicable laws. When the determination involves a special provision or requirements of other laws, explain how the selected alternative represents the minimum required to realize those provisions while also preserving wilderness character to the degree feasible.

The selected alternative should also be consistent with agency policy. Cite the specific criteria, direction, standard, or guideline that applies and explain how the alternative complies.

There is no need to address each item included in the "Other Direction" section of the

MRAF workbook. However, the rationale should briefly demonstrate consistency and compliance with key provisions of policies and other guidance, some of which may have been listed in the “Other Direction” section.

Goals and objectives of projects, plans, or other guidance are not relevant unless those goals and objectives are tied to wilderness character. A Wilderness Stewardship Plan, for instance, may identify thresholds for particular Wilderness Act Section 4(b) purposes, such as visitor use capacities or limits on scientific installations. If the selected alternative will affect the realization of those purposes, that effect should be noted. Cite any relevant guidance.

The Wilderness Act contains no provision that allows the use of “faster, cheaper, and easier” as a criterion for authorizing any of the prohibited uses. The only criteria are: 1) that such uses are the minimum necessary for wilderness administration, and 2) that wilderness character is preserved. Agency policies may define or even expand upon these criteria.

The discussion should explain how the determination will preserve wilderness character as a whole and explain how the determination reflects the fundamental values of humility and restraint. These can often be the deciding factor when justifying why one value or quality is chosen over another. For example, any *irreversible* impacts (e.g., alteration of bedrock, the release of a non-native bioagent, the preventable loss of a species) inherently conflict with the notions of humility and restraint. The determination should not be based on optimizing wilderness character but preserving wilderness character while minimizing human actions. Select the alternative that collectively minimizes the existing or future degradation to all qualities of wilderness character and thus preserves wilderness character overall.

The determination should also include a list of all:

- Section 4(c) prohibitions allowed by the determination, with all limitations and mitigation measures listed (e.g., the number of helicopter landings, type and number of installations and the required date of their removal, or types of motorized equipment allowed and the amount of their use) but remain prohibited to the general public.
- Other required mitigation measures.
- Monitoring and/or reporting requirements, when applicable, related to the approved action.

For authorizations in wilderness areas administered by the Forest Service, record and report any authorizations of Wilderness Act Section 4(c) prohibited uses in the Natural Resource Manager – Wilderness database, as part of end-of-year reporting.

Approvals

Depending on agency policy, signatures should include that of the administrator who has the authority to approve Section 4(c) prohibited uses or other restricted activities included in the determination.

MINIMUM REQUIREMENTS ANALYSIS FRAMEWORK WORKBOOK

APPENDIX E

"…except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act…"

— Section 4(c), Wilderness Act of 1964

Introduction

The Minimum Requirements Analysis (MRA) is designed to examine whether a project truly needs to occur in wilderness, and if so, how to accomplish it with the least impact to the wilderness resource. The framework below is intended to help managers: 1) evaluate actions proposed in wilderness involving a use otherwise prohibited by the Wilderness Act; and 2) consider appropriate choices about administrative actions they might take. Like the previous version of this document (the Minimum Requirements Decision Guide (MRDG)), the MRA Framework (MRAF) is based on the Wilderness Act and is consistent with agency policy. The MRAF incorporates lessons learned by agency employees as they used the MRDG over the years. The goal of the MRAF is to help provide consistency in the way wilderness-managing agencies consider actions to address threats to wilderness, and to ensure that agencies strive to preserve wilderness character through their on-the-ground decisions.

This document is intended for uses prohibited by Section 4(c) of the Wilderness Act in designated wilderness, but it can be used to analyze all projects in wilderness. Check agency policy to determine if this workbook may be appropriate for other proposals in wilderness.

If applicable, per agency policies, collaborate and coordinate with associated Tribe(s) and/or Tribe(s) with historical, treaty, or related ties to the area.

Note: For each fillable field, click or tap on the arrow that will appear to the left of the Word "HELP" for more instructions. Please read the full instructions before proceeding. Delete this note before finalizing the document.

Title

Click or tap here to enter a descriptive title. The title should not suggest a proposed action or outcome. When appropriate, use wilderness name in the title.

Step 1: Determine If Administrative Action May Be Necessary

Issue Statement

Click or tap here to describe the issue.

HELP - “Issue Statement”

The description should explain the issue that may require some action in a specific wilderness. The issue may be a problem, situation, opportunity, or other circumstance that requires consideration. It is not a proposed action, tool, or solution.

Options Outside of Wilderness

Is this issue wilderness dependent, or can an action occur outside of wilderness to properly resolve the issue now or over time?

HELP – “Options”

Some issues will require analysis of alternate sites before answering “yes” or “no.”

Can the issue be resolved or addressed outside of wilderness?

☐ YES **STOP – EXPLAIN BELOW AND DO NOT TAKE ACTION**

☐ NO **EXPLAIN BELOW AND PROCEED TO THE NEXT SECTION**

Click or tap here to explain the options.

Criteria for Determining Necessity

HELP **-** **“**Determining Necessity”

Based on the legal requirements in Section 4(c) of the Wilderness Act, one or more of the factors A-D below must be met for any action to be considered.

Do any of the criteria below apply?

A. Wilderness Character

Based on the Issue Statement, are any of the qualities of wilderness character degraded, impaired, or threatened to a degree that it is necessary to analyze potential action otherwise prohibited by Section 4(c) to address the issue?

UNTRAMMELED

Select your answer.

☐ YES ☐ NO

Click or tap here to explain your “Untrammeled” response.

HELP - “Untrammeled” Definition

The "earth and its community of life" are essentially unhindered and free from modern human control or manipulation, "in contrast with those areas where man and his own works dominate the landscape."

HELP - “Untrammeled” Explanation

Is there ongoing action that intentionally controls or manipulates the components or processes of ecological systems? An unauthorized water impoundment, for example.

UNDEVELOPED

Select your answer.

☐ YES ☐ NO

Click or tap here to explain your “Undeveloped” response.

HELP - “Undeveloped” Definition

Wilderness retains its "primeval character and influence" and is essentially "without permanent improvements" or modern human occupation.

HELP - “Undeveloped” Explanation

Are there structures or installations within wilderness that have not previously been determined to be the minimum requirement or a part of the area’s wilderness character?

NATURAL

Select your answer.

☐ YES ☐ NO

Click or tap here to explain your “Natural” response.

HELP - “Natural” Definition

A wilderness area is to be "protected and managed so as to preserve its natural conditions." Wilderness ecological systems are substantially free from the effects of modern civilization.

HELP - “Natural” Explanation

Are there unnatural (caused by modern humans) changes to ecological conditions or processes? What is the certainty of human causation and the range of natural conditions?

OUTSTANDING OPPORTUNITIES FOR SOLITUDE or PRIMITIVE and UNCONFINED RECREATION

Select your answer.

☐ YES ☐ NO

Click or tap here to explain your “Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation” response.

HELP - “Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation” Definition

The Wilderness Act defines wilderness as having “outstanding opportunities for solitude or a primitive and unconfined type of recreation.”

HELP - “Solitude or Primitive and Unconfined Recreation” Explanation

Are opportunities for solitude or a primitive and unconfined recreation unacceptably degraded?

OTHER FEATURES OF VALUE

Select your answer.

☐ YES ☐ NO

Click or tap here to explain your “Other Features of Value” response.

HELP - “Other Features of Value” Definition

A wilderness “may also contain ecological, geological, or other features of scientific, educational, scenic, or historical use” that reflect the character of the area as wilderness.

HELP - “Other Features of Value” Explanation

Is there a tangible feature: 1- identified in legislation? 2 - on a national register? 3 - that is integral to the meaning of this wilderness? 4 - identified in a local management plan? Is the feature degraded or threatened?

B. Valid Existing Rights

Select your answer.

Is action necessary to satisfy a valid existing right? If so, cite the specific right, terms and conditions, and source.

☐ YES ☐ NO

Click or tap here to explain your “Valid Existing Rights” response.

HELP - “Valid Existing Rights” Definition

Valid existing rights are created by a legally binding conveyance, lease, deed, contract, or law.

HELP - “Valid Existing Rights” Explanation

Identify the valid existing right and explain how it requires action in wilderness.

C. Special Provisions of Wilderness Legislation

Is action necessary to satisfy a special provision in wilderness legislation (i.e., Section 4(d) of the Wilderness Act of 1964 or subsequent wilderness-enabling laws) that requires action? Cite law and section.

☐ YES ☐ NO

Click or tap here to explain your “Special Provisions of Wilderness Legislation” response.

HELP - “Special Provisions” Explanation

If there is language regarding a special provision, is it stated in terms of "shall" or "must"? If there is special provision language, is it specific about a type of use, tool, location, or time?

D. Requirements of Other Federal Laws

Not including special provisions found in wilderness-enabling laws, does another Federal law, by itself or as implemented or interpreted through EO, court order, etc., ***require*** *action? Cite law and section.*

☐ YES ☐ NO

Click or tap here to explain your "Requirements of Other Federal Laws" response.

HELP - "Requirements of Other Federal Laws" Explanation

Few laws contain affirmative direction that requires action in wilderness areas. If other laws apply, are they in terms of "shall" or "must"? If other laws apply, are they specific about type of use, tool, location, or time?

Step 1: Determination – Is Administrative Action Necessary in Wilderness?

Based on the responses and detailed explanations in A through D above, is there a need to proceed to Step 2? If at least one criterion in B through D in Step 1 has been met, or at least one quality of wilderness character is threatened, check the "Yes" box and provide a thorough explanation of the rationale described in A through D. It may also be helpful to describe in this determination how action would be consistent with the public purposes of wilderness or satisfy a specific agency obligation. If none of the criteria have been met, action is NOT necessary. Check the "No" box, explain why the proposed project does not meet the criteria, and stop your analysis.

☐ YES **EXPLAIN BELOW AND COMPLETE STEP 2 OF THE MRAF**

☐ NO **STOP – EXPLAIN BELOW AND DO NOT TAKE ACTION**

Click or tap here to explain your "Determination" response.

HELP - "Determination" Explanation

Based on the legal requirements in Section 4(c) of the Wilderness Act, were one or more of the factors in A-D above met?

Step 2: Determine the Minimum Activity

Other Direction

Is there "special provisions" language in legislation or other congressional direction that explicitly allows consideration of (but does not require) a prohibited use? (Step 1 has a similar question in Section C, but that question is specific to other legislation requiring action in wilderness; this question is specific to other legislation addressing ***consideration of prohibited uses)****.*

AND/OR

Has the issue been addressed or prescribed in agency policy, management plans, or legal directive (e.g., treaty, EO, court order, or other binding agreement with federal, state, or local agencies or authorities)?

☐ YES **DESCRIBE OTHER DIRECTION**

☐ NO **SKIP TO "UNCONTROLLABLE TIMING REQUIREMENTS" BELOW**

Click or tap here to explain your "Other Direction" response.

HELP **-** "Other Direction" Description

Focus on other direction that constrains or identifies alternatives that can be considered.

Uncontrollable Timing Requirements

What, if any, are the considerations that would dictate timing of the action?

Click or tap here to explain your "Uncontrollable Timing Requirements" response.

HELP – "Uncontrollable Timing Requirements" Description

For example, to avoid a critical bird nesting season. Do not include availability of workers, available funding, or other administrative considerations.

Workflow Components

What are the distinct components or phases of the action?

Example	*Transportation of personnel to the project site*
Component 1	Click or tap here to enter text.
Component 2	Click or tap here to enter text.
Component 3	Click or tap here to enter text.
Component 4	Click or tap here to enter text.
Component 5	Click or tap here to enter text.

HELP - “Workflow Components”

These components are the logical phases of the action. While they may often be the same for each alternative, this is not always true.

Feasibility of Alternatives
Only include feasible alternatives in this section. Some alternatives that are not feasible may warrant documentation in the “Alternatives Considered but Dismissed” section to provide a brief description and explanation of why it was dismissed and not considered in detail.

Possible reasons for dismissal include alternatives that are impossible, have unacceptable impacts, are unsafe, are proven ineffective, have excessive costs, or whose timing would cause degradation to wilderness character.

The alternatives should also be reasonable. For example, there is no need to include helicopters in an alternative for equipment transport when that equipment can be easily carried by people or pack stock along a maintained trail.

Refer to the MRAF instructions regarding alternatives and the effects to each of the comparison criteria.

HELP **-** Certain “Feasibility of Alternatives” Definitions

Impossible
If research shows an alternative is impossible to accomplish by any means, it should not be analyzed in detail.

Unacceptable Impacts
Alternatives that would clearly result in inappropriate adverse impacts to wilderness character should not be analyzed in detail.

Unsafe
Most safety issues can be mitigated so that the risk is reduced to an appropriate level. Those alternatives that involve risks for workers or the public that cannot be mitigated should be considered but dismissed.

Ineffective
Alternatives that have been determined to be ineffective in addressing the issue under similar circumstances should not be analyzed in detail.

Excessive Costs
Cost is not a factor in determining feasibility unless an alternative is so costly that the funds cannot be obtained, resulting in the issue not being addressed. The amount of funding obtained prior to writing an MRA cannot be used for dismissal.

Timing
Dismiss alternatives that would require time allocations incongruent with urgent situations. This only applies where a gradual or lengthy response would clearly result in unacceptable hazards or significant degradation to wilderness character.

Alternatives
In the MRAF, alternatives are a full range of options that best preserve wilderness character, whereas in a NEPA analysis, the alternatives disclose and compare the environmental effects.

Step 2: Alternatives

Alternative 1

Click or tap here to enter the name of Alternative 1.

Component Methods

How will each of the components of the action be performed under this alternative?

Component	Workflow Components	Component Methods for this Alternative
	Example: Transportation of personnel to the project site.	*Example: Workers walk to work site.*
1	Click or tap here to enter text.	Click or tap here to enter text.
2	Click or tap here to enter text.	Click or tap here to enter text.
3	Click or tap here to enter text.	Click or tap here to enter text.
4	Click or tap here to enter text.	Click or tap here to enter text.
5	Click or tap here to enter text.	Click or tap here to enter text.

HELP **-** **“**Component Methods”

Identify the components of the action first, then develop the alternatives. Separating an action into components provides a foundation for building well-thought-out alternatives (and promotes consistency among alternatives).

HELP **-** **“**Workflow Components”

Enter the workflow components from Step 2. These will be the same for every alternative.

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken? Provide a complete narrative description of the Component Methods identified above.

Click or tap here to enter a description of the alternative.

Wilderness Character

Component Number	For each component number, indicate the impact the **method for this alternative** will have on each of the five qualities of Wilderness: Positive = P, Negative = N, No Effect = 0 *Describe in detail the impacts to each of the five qualities in the narrative section below*	Untrammeled	Undeveloped	Natural	Solitude or Primitive and Unconfined	Other Features of Value
	Example: Workers walk to work site.	0	0	0	0	0
1	Click or tap here to enter text.	0	0	0	0	0
2	Click or tap here to enter text.	0	0	0	0	0
3	Click or tap here to enter text.	0	0	0	0	0
4	Click or tap here to enter text.	0	0	0	0	0
5	Click or tap here to enter text.	0	0	0	0	0

What is the effect of each Component Method on the qualities of wilderness character? What mitigation measures will be taken? Include cumulative impacts in the explanation.

UNTRAMMELED: Explain the intensity of the action that would intentionally control, manipulate, or hinder the conditions or processes of ecological systems:

Click or tap here to enter “Untrammeled” explanation.

HELP - Untrammeled

Examples include suppression of natural fire or managing vegetation or wildlife, even if it improves the Natural Quality (e.g., eliminating a non-native species). Any manipulation of the biophysical environment has a negative impact to this quality.

UNDEVELOPED: Explain the effects to this quality in terms of how “the imprint of man’s work [would] remain substantially unnoticeable,” and how wilderness will continue to be in contrast with other areas of “growing mechanization”:

Click or tap here to enter “Undeveloped” explanation.

HELP - Undeveloped

Examples include describing: 1. Type and degree of structures and installations: number, duration, and how advanced are materials and technology. 2. Motorized tools or mechanical transport: number, duration, and the power of the tool to modify the landscape.

NATURAL: Explain the effects to this quality in terms of protection, degradation, or restoration of natural conditions:

Click or tap here to enter “Natural” explanation.

HELP - Natural Help

Examples of negative impacts include allowing establishment of non-native species or suppressing natural fire. Examples of preservation of this quality include the removal of non-native species, restoration of native species, or allowing natural fire.

OUTSTANDING OPPORTUNITIES FOR SOLITUDE OR PRIMITIVE and UNCONFINED RECREATION: Explain how opportunities for visitors to experience solitude or a primitive and unconfined type of recreation will be protected or degraded. As appropriate, describe solitude, primitive recreation, and unconfined recreation separately**:**

Click or tap here to enter “Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation” explanation.

HELP - Outstanding Opportunities

Actions that have a negative impact are those that increase visitor encounters, facilities, or other modern developments or tool use, or restrictions on visitors. Decreasing encounters, reducing development, or repealing regulations have a positive impact.

OTHER FEATURES OF VALUE: Explain any effects to features of scientific, educational, scenic, or historical value that are not accounted for in the above qualities, including cultural and paleontological resources that are integral to wilderness character:

Click or tap here to enter “Other Features of Value” explanation.

HELP – “Other Features of Value”
Examples of negative impacts include degradation of cultural or paleontological features. Actions that preserve of otherwise recognize the Other Features of Value Quality would produce positive impacts.

Mitigation Measures Help

Mitigation can be used to: avoid impacts by not implementing part of an action; minimize impact by limiting the magnitude of the action; rectify impact by rehabilitating the affected environment; or monitor and adapt management to reduce impacts.

Alternative 2:

Click or tap here to enter the name of Alternative 2.

Component Methods
How will each of the components of the action be performed under this alternative?

Component	Workflow Components	Component Methods for this Alternative
	Example: Transportation of personnel to the project site.	*Example: Workers walk to work site.*
1	Click or tap here to enter text.	Click or tap here to enter text.
2	Click or tap here to enter text.	Click or tap here to enter text.
3	Click or tap here to enter text.	Click or tap here to enter text.
4	Click or tap here to enter text.	Click or tap here to enter text.
5	Click or tap here to enter text.	Click or tap here to enter text.

HELP - “Component Methods”

Identify the components of the action first, then develop the alternatives. Separating an action into components provides a foundation for building well-thought-out alternatives (and promotes consistency among alternatives).

HELP - “Workflow Components”

Enter the workflow components from Step 2. These will be the same for every alternative.

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken? Provide a complete narrative description of the Component Methods identified above.

Click or tap here to enter a description of Alternative 2.

Wilderness Character

Component Number	For each component number, indicate the impact the **method for this alternative** will have on each of the five qualities of Wilderness: Positive = P, Negative = N, No Effect = 0 *Describe in detail the impacts to each of the five qualities in the narrative section below*	Untrammeled	Undeveloped	Natural	Solitude or Primitive and Unconfined	Other Features of Value
	Example: Workers walk to work site.	0	0	0	0	0
1	Click or tap here to enter text.	0	0	0	0	0
2	Click or tap here to enter text.	0	0	0	0	0
3	Click or tap here to enter text.	0	0	0	0	0
4	Click or tap here to enter text.	0	0	0	0	0
5	Click or tap here to enter text.	0	0	0	0	0

What is the effect of each Component Method on the qualities of wilderness character? What mitigation measures will be taken? Include cumulative impacts in the explanation.

UNTRAMMELED: Explain the intensity of the action that would intentionally control, manipulate, or hinder the conditions or processes of ecological systems:

Click or tap here to enter “Untrammeled” explanation.

HELP - Untrammeled

Examples include suppression of natural fire or managing vegetation or wildlife, even if it improves the Natural Quality (e.g., eliminating a non-native species). Any manipulation of the biophysical environment has a negative impact to this quality.

UNDEVELOPED: Explain the effects to this quality in terms of how “the imprint of man’s work [would] remain substantially unnoticeable,” and how wilderness will continue to be in contrast with other areas of “growing mechanization”:

Click or tap here to enter “Undeveloped” explanation.

HELP **-** Undeveloped

Examples include describing: 1. Type and degree of structures and installations: number, duration, and how advanced are materials and technology. 2. Motorized tools or mechanical transport: number, duration, and the power of the tool to modify the landscape.

NATURAL: Explain the effects to this quality in terms of protection, degradation, or restoration of natural conditions:

Click or tap here to enter “Natural” explanation.

HELP **-** Natural

Examples of negative impacts include allowing establishment of non-native species or suppressing natural fire. Examples of preservation of this quality include the removal of non-native species, restoration of native species, or allowing natural fire.

OUTSTANDING OPPORTUNITIES FOR SOLITUDE OR PRIMITIVE and UNCONFINED RECREATION: Explain how opportunities for visitors to experience solitude or a primitive and unconfined type of recreation will be protected or degraded. As appropriate, describe solitude, primitive recreation, and unconfined recreation separately**:**

Click or tap here to enter “Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation” explanation.

HELP **-** Outstanding Opportunities

Actions that have a negative impact are those that increase visitor encounters, facilities, or other modern developments or tool use, or restrictions on visitors. Decreasing encounters, reducing development, or repealing regulations have a positive impact.

OTHER FEATURES OF VALUE: Explain any effects to features of scientific, educational, scenic, or historical value that are not accounted for in the above qualities, including cultural and paleontological resources that are integral to wilderness character:

Click or tap here to enter “Other Features of Value” explanation.

HELP - Other Features of Value
Examples of negative impacts include degradation of cultural or paleontological features. Actions that preserve of otherwise recognize the Other Features of Value Quality would produce positive impacts.

Mitigation Measures Help

Mitigation can be used to: avoid impacts by not implementing part of an action; minimize impact by limiting the magnitude of the action; rectify impact by rehabilitating the affected environment; or monitor and adapt management to reduce impacts.

Mitigation Measures

Mitigation can be used to: avoid impacts by not implementing part of an action; minimize impact by limiting the magnitude of the action; rectify impact by rehabilitating the affected environment; or monitor and adapt management to reduce impacts.

Examples of Mitigation Measures re: Untrammeled Quality

Examples include suppression of natural fire or managing vegetation or wildlife, even if it improves the Natural Quality (e.g., eliminating a non-native species). Any manipulation of the biophysical environment has a negative impact to this quality.

Examples of Mitigation Measures re: Undeveloped Quality

Examples include describing 1. Type and degree of structures and installations: number, duration, and how advanced are materials and technology. 2. Motorized tools or mechanical transport: number, duration, and the power of the tool to modify the landscape

Examples of Mitigation Measures re: Natural Quality

Examples of negative impacts include allowing establishment of non-native species or suppressing natural fire. Examples of preservation of this quality include the removal of non-native species, restoration of native species, or allowing natural fire.

Examples of Mitigation Measures re: Outstanding Opportunities for Solitude or Primitive Unconfined Recreation Quality

Actions that have a negative impact are those that increase visitor encounters, facilities, or other modern developments or tool use, or restrictions on visitors. Decreasing encounters, reducing development, or repealing regulations has a positive impact.

Examples of Mitigation Measures re: Other Features of Value Quality

Examples of negative impacts include degradation of cultural or paleontological features. Actions that preserve of otherwise recognize Other Features of Value would produce positive impacts.

Alternative 3:

Click or tap here to enter the name of Alternative 3.

Component Methods
How will each of the components of the action be performed under this alternative?

Component	Workflow Components	Component Methods for this Alternative
	Example: Transportation of personnel to the project site.	*Example: Workers walk to work site.*
1	Click or tap here to enter text.	Click or tap here to enter text.
2	Click or tap here to enter text.	Click or tap here to enter text.
3	Click or tap here to enter text.	Click or tap here to enter text.
4	Click or tap here to enter text.	Click or tap here to enter text.
5	Click or tap here to enter text.	Click or tap here to enter text.

HELP - “Component Methods”

Identify the components of the action first, then develop the alternatives. Separating an action into components provides a foundation for building well-thought-out alternatives (and promotes consistency among alternatives).

HELP - “Workflow Components”

Enter the workflow components from Step 2. These will be the same for every alternative.

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken? Provide a complete narrative description of the Component Methods identified above.

Click or tap here to enter a description of Alternative 3.

Wilderness Character

Component Number	For each component number, indicate the impact the **method for this alternative** will have on each of the five qualities of Wilderness: Positive = P, Negative = N, No Effect = 0 *Describe in detail the impacts to each of the five qualities in the narrative section below*	Untrammeled	Undeveloped	Natural	Solitude or Primitive and Unconfined	Other Features of Value
	Example: Workers walk to work site.	0	0	0	0	0
1	Click or tap here to enter text.	0	0	0	0	0
2	Click or tap here to enter text.	0	0	0	0	0
3	Click or tap here to enter text.	0	0	0	0	0
4	Click or tap here to enter text.	0	0	0	0	0
5	Click or tap here to enter text.	0	0	0	0	0

What is the effect of each Component Method on the qualities of wilderness character? What mitigation measures will be taken? Include cumulative impacts in the explanation.

UNTRAMMELED: Explain the intensity of the action that would intentionally control, manipulate, or hinder the conditions or processes of ecological systems:

Click or tap here to enter "Untrammeled" explanation.

HELP – "Untrammeled"

Examples include suppression of natural fire or managing vegetation or wildlife, even if it improves the Natural Quality (e.g., eliminating a non-native species). Any manipulation of the biophysical environment has a negative impact to this quality.

UNDEVELOPED: Explain the effects to this quality in terms of how “the imprint of man’s work [would] remain substantially unnoticeable,” and how wilderness will continue to be in contrast with other areas of “growing mechanization”:

Click or tap here to enter “Undeveloped” explanation.

HELP **–** **“**Undeveloped”

Examples include describing: 1. Type and degree of structures and installations: number, duration, and how advanced are materials and technology. 2. Motorized tools or mechanical transport: number, duration, and the power of the tool to modify the landscape.

NATURAL: Explain the effects to this quality in terms of protection, degradation, or restoration of natural conditions:

Click or tap here to enter “Natural” explanation.

HELP – “Natural”

Examples of negative impacts include allowing establishment of non-native species or suppressing natural fire. Examples of preservation of this quality include the removal of non-native species, restoration of native species, or allowing natural fire.

OUTSTANDING OPPORTUNITIES FOR SOLITUDE OR PRIMITIVE and UNCONFINED RECREATION: Explain how opportunities for visitors to experience solitude or a primitive and unconfined type of recreation will be protected or degraded. As appropriate, describe solitude, primitive recreation, and unconfined recreation separately**:**

Click or tap here to enter “Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation” explanation.

HELP – “Outstanding Opportunities”

Actions that have a negative impact are those that increase visitor encounters, facilities, or other modern developments or tool use, or restrictions on visitors. Decreasing encounters, reducing development, or repealing regulations have a positive impact.

OTHER FEATURES OF VALUE: Explain any effects to features of scientific, educational, scenic, or historical value that are not accounted for in the above qualities, including cultural and paleontological resources that are integral to wilderness character:

Click or tap here to enter “Other Features of Value” explanation.

HELP – “Other Features of Value”
Examples of negative impacts include degradation of cultural or paleontological features. Actions that preserve of otherwise recognize the Other Features of Value Quality would produce positive impacts.

Mitigation Measures Help

Mitigation can be used to: avoid impacts by not implementing part of an action; minimize impact by limiting the magnitude of the action; rectify impact by rehabilitating the affected environment; or monitor and adapt management to reduce impacts.

Mitigation Measures

Mitigation can be used to: avoid impacts by not implementing part of an action; minimize impact by limiting the magnitude of the action; rectify impact by rehabilitating the affected environment; or monitor and adapt management to reduce impacts.

Examples of Mitigation Measures re: Untrammeled Quality

Examples include suppression of natural fire or managing vegetation or wildlife, even if it improves the Natural Quality (e.g., eliminating a non-native species). Any manipulation of the biophysical environment has a negative impact to this quality.

Examples of Mitigation Measures re: Undeveloped Quality

Examples include describing 1. Type and degree of structures and installations: number, duration, and how advanced are materials and technology. 2. Motorized tools or mechanical transport: number, duration, and the power of the tool to modify the landscape

Examples of Mitigation Measures re: Natural Quality

Examples of negative impacts include allowing establishment of non-native species or suppressing natural fire. Examples of preservation of this quality include the removal of non-native species, restoration of native species, or allowing natural fire.

Examples of Mitigation Measures re: Solitude or Primitive Unconfined Recreation Quality

Actions that have a negative impact are those that increase visitor encounters, facilities, or other modern developments or tool use, or restrictions on visitors. Decreasing encounters, reducing development, or repealing regulations has a positive impact.

Examples of Mitigation Measures re: Other Features of Value Quality

Examples of negative impacts include degradation of cultural or paleontological features. Actions that preserve of otherwise recognize Other Features of Value would produce positive impacts.

Additional Alternatives

To add more alternatives, copy and paste a blank alternative from above. Delete this note before finalizing the document.

Step 2: Alternatives Considered but Dismissed

What alternatives were considered but dismissed? Why were they dismissed?

Explain:

Click or tap here to enter “Considered but Dismissed” explanation.

HELP - “Why Were They Dismissed?”
Reasons for dismissing an alternative include: not responsive to the issue; causes greater harm to wilderness character; so costly that it could not be implemented immediately, and wilderness character would be degraded due to delay; or safety cannot be mitigated.

HELP - “Explain”
Do not eliminate alternatives from full consideration simply because implementation would take more time, money, or personnel, or because the skills or equipment needed are not readily available on the local unit.

Step 2: Determination – What is the Minimum Activity?

Refer to the MRAF instructions before identifying the selected alternative and explaining the rationale for its selection.

Selected Alternative

Click or tap here to enter the name of the selected alternative.

Explain rationale for selection, including a comparison of the selected alternative with other alternatives:

Click or tap here to explain the rationale for the selection.

Approved?	Prohibited Use	Quantity, Timing, Frequency, or Duration
☐	Mechanical Transport:	Click or tap here to enter text.
☐	Motorized Equipment:	Click or tap here to enter text.
☐	Motor Vehicles:	Click or tap here to enter text.
☐	Motorboats:	Click or tap here to enter text.
☐	Landing of Aircraft:	Click or tap here to enter text.
☐	Temporary Roads:	Click or tap here to enter text.
☐	Structures:	Click or tap here to enter text.
☐	Installations:	Click or tap here to enter text.

Describe mitigation measures as well as monitoring and reporting requirements, if appropriate:

Click or tap here to describe mitigation measures.

HELP - “Explain Rationale for Selection”

Which of the prohibited uses found in Section 4(c) of the Wilderness Act are approved in the selected alternative? Describe limits on quantity, timing, frequency, or duration.

Approvals

Project Title (from page 2)**:**

Click or tap here to enter the name of project title.

Refer to agency policies for the following signature authorities:

Prepared by:

Name Click or tap here to enter text. Position Click or tap here to enter text.

Signature _____ Date _____

Reviewed by:

Name Click or tap here to enter text. Position Click or tap here to enter text.

Click or tap here to enter reviewer comments.

Signature _____ Date _____

Reviewed by:

Name Click or tap here to enter text. Position Click or tap here to enter text.

Signature _____ Date _____

Click or tap here to enter reviewer comments.

Approved by:

Name Click or tap here to enter text. Position Click or tap here to enter text.

Signature _____ Date _____