EPC STORMWATER REVIEW COMMENTS
IN ORANGE BOXES WITH BLACK TEXT

MVE, INC.
ENGINEERS SURVEYORS
1903 lelaray street, suite 200
colorado springs, co 80909
719.635.5736

Drainage Letter

Meadow Ranch II & III

Project No. 61209

April 17, 2024

PCD File No. CDR243

Drainage Letter

for

Meadow Ranch II & III

Project No. 61209

April 17, 2024

prepared for

Mountain View Ranches, LLC
277 Locust Street, Suite A
Dover, NH 03820

prepared by

MVE, Inc.
1903 Lelaray Street, Suite 200
Colorado Springs, CO 80909
719.635.5736

Statements and Acknowledgments

Engineer's Statement
The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

_____ _____
David R. Gorman, P.E. Colorado No. 31672 Date
For and on Behalf of MVE, Inc.

Developer's Statement
I, the owner/developer have read and will comply with all of the requirements specified in this drainage report and plan.

_____ _____
Taher Nabulsi, Owner Date

El Paso County
Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

_____ _____
Joshua Palmer Date
County Engineer/ECM Administrator

Conditions:

Contents

Drainage Letter

The purpose of this Drainage Letter is to address the Four-Step Process in the construction of the Roadways for Meadow Ranch II & III, a proposed rural residential 35 acre land division, El Paso County, Colorado. The report presents the stormwater management issues specific to this site and discusses the aspects of the drainage design that addresses those issues. The report and included maps present results of the final hydrologic analyses. The report recommends that no additional drainage improvements are needed for the site. This report has been prepared and submitted in accordance with the requirements of the El Paso County Drainage Criteria Manual approval process. An **Appendix** is included with this report with pertinent calculations and data used in the drainage analysis.

1 General Location and Description

1.1 Location

The Meadow Ranch II & III site is located within portions of Sections 3, 4, 10, 11 & 14, Township 17 South, Range 61 West, of the 6th Principal Meridian in El Paso County, Colorado. The site is situated along Myers Road and west of Boone Road. The site is made up of several unplatted parcels having El Paso County Tax Assessor's Schedule Numbers: 1700000021, 1700000029, 1700000023, 1700000024, 1700000025, 1700000026 & 1700000027. A Vicinity Map is included in the **Appendix**.

1.2 Description of Property

The Meadow Ranch II & III site encompasses approximately 2,083 ± acres existing as unplatted parcels. The site is to be divided by Land Survey Plat into 55 Tracts as Meadow Ranch II & III.

This parcel is mostly undeveloped grazing land with minor grading around one residence. The storm runoff from the site generally drains from the north to the south.

Access for this developed area is via Myers Road. The owners intend to divide the 2,083 ± acres parcel into 55 Tracts with with at least 35 acres each. Additionally, a private roadway will be added to the north half of the property and three private roadways will be added to the south portion and connect the proposed Tracts.

1.3 Soil Description

According to the National Resource Conservation Service, there are two primary soil types identified at the Meadow Ranch II & III site within the areas of the roadways. Olney sandy loam, 0 to 3 percent slopes (map unit 60) makes up about 56% of the site and which is contained in Hydrologic Soil Group B. This soil is deep and is well drained, permeability is moderate, and the hazard of erosion is moderate.

The secondary soil group is: Olneysandy loam, 3 to 8 percent slopes (map unit 61) which is primarily the southwest portion of the site makes up about 18%. This soil is contained in Hydrologic Soil Group B. This soil is deep and well drained, permeability is moderate, and the hazard of erosion is slight to moderate. A portion of the Soil Map and data tables from the National Cooperative Soil Survey and relevant Official Soil Series Descriptions (OSD) are included in the **Appendix**.[1] [2]

A portion of the Soil Map and data tables from the National Cooperative Soil Survey and relevant Official Soil Series Descriptions (OSD) are included in the **Appendix**.[3] [4]

1 WSS
2 OSD
3 WSS
4 OSD

Add: Discussion of offsite drainage flow patterns and their impact on the development

2 Drainage Basins and Sub-Basins

2.1 Major Basin Descriptions

The Meadow Ranch II & III site is located in the eastern portion of the East Haynes (HAHA0400) and the northern portion of the West Kramer (KRKR0200) Drainage Basins.

Discharge from the western portion of the site flows southwesterly into an unnamed tributary of Haynes Creek in the East Haynes drainage basin. Flows from the eastern portion of the site flow generally southeast into an unnamed tributary of Kramer Creek in the West Kramer drainage basin.

According to the Federal Emergency Management Agency's Flood Insurance Rate Map (FIRM) Community Panel Number(s) 08041C1275G, effective December 7, 2018, for El Paso County, Colorado, a portion of the site is located within a Federal Emergency Management Agency (FEMA) designated Special Flood Hazard Area (SFHA), Zone A[5]. No portion of the area to be disturbed lies in this Floodplain. An excerpt of the current FEMA Flood Insurance Rate Maps with the site delineated is included in the **Appendix**.

3 Drainage Facility Design

3.1 Reseeding and Allowable Ditch Flow Velocities

What species are being proposed that are not covered in Table 10-4? Specify. Are none of the grasses proposed in Table 10-4? The allowable velocities should be conservative and generally the smallest allowable velocity should be assumed.

All disturbed areas that are not roadway surfaces or otherwise protected by riprap shall be reseeded using the native seed mix contained in the appendix of this report and on the Grading and Erosion Control Plan for this project. The said native seed mix is a recommended El Paso County Seed Mix from an NRCS memo dated June 19, 2001. The seed mix contains specific species of native seed selected for erosion control properties, suitability to the local climate, growth potential and hardiness. Each of the seed species provides good soil holding capabilities ground coverage. The characteristics of each seed species are shown on the Plant Guides also included in the **Appendix.** The El Paso County Drainage Criteria Manual Table 10-4 is intended to provide guidance on allowable flow velocities for various types of open channel grass linings. However, Table 10-4 does not address species contained in most native grass seed mixtures and is not useful for determining allowable flow velocities with these types of linings. Therefore, a supplemental data table is also included in the appendix which contains better descriptions along with testing and research references that indicate the native grass types in the reseed mix are able to withstand flow velocities ranging from 4 ft/sec to 6 ft/sec or more. Flow velocities on all reseeded areas remain below 5 ft/sec and the native grasses are adequate to withstand to flows. Maximum ditch velocity calculation is included in the **Appendix.**

See comments on the appendix, consider using other seed mixes that are more current.

3.2 Water Quality Enhancement Best Management Practices

The El Paso County Engineering Criteria Manual (Appendix I, Section I.7.2) requires the consideration of a “Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainage ways, and implementing long term source controls”. The Four Step Process is incorporated in this project and the elements are discussed below.

1) Step 1: Employ Runoff Reduction Practices: Runoff Reduction Practices are employed in this project. Impervious surfaces have been reduced as much as practically possible. There is only minimal concrete or other hard surfaces proposed. Minimized Directly Connected Impervious Areas (MDCIA) is employed on the project because runoff passes through a private roadside ditch and an open space meadow area before leaving the site.

These private roadside ditches are being used as Receiving Pervious Area (RPA) as detailed in the **BMP Area ID** map attached in the **Appendix**. The RPA has established vegetation. The slope at the UIA/RPA interface prevents any accumulation of sediment from interfering with runoff entering the existing private

Verify, the grading does not appear to show a roadside ditch. Specify what RPAs are ditches/grass buffers so it is clear.

5 FIRM

roadway ditch. The runoff generated from the impervious areas of the roadway will be treated for water quality by the RPA's.

Areas being used as RPA constitute vegetated areas down-gradient of impervious areas as specified in Water Quality Control Volume reduction procedure detailed in Chapter 4, Fact Sheet T-00 "Quantifying Runoff Reduction" of the Urban Storm Drainage Criteria Manual, Volume 3. Permanent seeding will follow the proposed construction, and temporary irrigation will establish a grass cover. The volume reduction calculation was made with the aid of the "UD-BMP_v3.07" spreadsheet developed by Mile High Flood District and is attached in the **Appendix** showing a WQCV reduction more than 60%.

2) Step 2: Stabilize Drainageways: There are no drainage paths on the site. that are required to be stabilized as they are well vegetated with no visual erosion. The mild drainage paths have shallow side slopes of >10:1 with 1-3' fescue grass within the channels.

3) Step 3: Provide Water Quality Capture Volume (WQCV): The runoff generated from the impervious areas of the roadway will be treated for water quality by utilizing the runoff reduction standard. Stormwater runoff from the proposed roadway will be collected in the roadside ditches and will infiltrate into the ground, evaporate, or evapotranspire a quantity of water equal to at least 60% of what the calculated WQCV would be if all impervious area for the applicable development site discharged without infiltration. Runoff Reduction calculations are included in the appendix.

4) Step 4: Consider Need for Industrial and Commercial BMPs: This project is the construction of private roadways for large 35 acre plus rural residential Tracts. There is no anticipated industrial or commercial use of these roadways. No site specific or other source control BMPs are required.

4 Drainage Fees

This project is the construction of private roadways for large 35 acre plus rural residential Tracts. No Site Development Plan is required and no Subdivision Plat is being submitted for the roadways. The East Haynes (HAHA0400) and West Kramer (KRKR0200) Drainage Basins are no fee basins. No Drainage or Bridge Fees are due.

Note: Runoff reduction RPAs are considered a PBMP. See comment on the next page for runoff reduction guidelines and requirements

5 Conclusion

This Drainage Letter presents the compliance with the Four-Step Process for the Meadow Ranch II & III project. The development will have negligible and inconsequential effects on the existing site drainage and drainage conditions downstream. With such a negligible increase in stormwater flows from the site, detention will not be necessary for the proposed development and will not be provided. The proposed project will not, with respect to stormwater runoff, negatively impact the adjacent properties and downstream properties.

State what flows are and what the increase is

Please provide existing conditions & the proposed plan drainage maps.

Drainage Plan: Map(s) of the proposed development at a scale of 1"=20' to 1"=200' shall be included to identify existing and proposed conditions on or adjacent to the site in question. It shall include a minimum of:
Existing and proposed contours at 2 feet maximum intervals. For subdivisions involving rural lots greater than 1.0 acre, the maximum interval may be 5 feet where approved. In terrain greater than 10% the intervals should be 10 foot intervals.
Property lines and existing or proposed easements with purposes noted.
All Streets
Existing drainage facilities and structures, including irrigation ditches roadside ditches, drainageways, gutters and culverts, all indicating flow direction. All pertinent information such as material, size, shape, slope and locations shall also be included.
Overall drainage area boundary and drainage sub-area boundaries relating to the subdivision.
Proposed type of street sections (i.e., vertical or ramp curb and gutters, roadside ditch, gutter flow and/or cross pans).
Proposed storm sewers and open drainageways, including inlets, manholes, culverts, and other appurtenances.
Proposed outfall point for runoff from the developed area and facilities to convey flows to the final outfall point without damage to downstream properties.
Routing and summary of initial and major flow rates at various design points for all storm runoff associated with the property.
Path (s) chosen for computation of time of concentration.
Details of and design computations for detention storage facilities including outlet.
Location and elevations of all defined 100-year floodplains affecting the property.
Location of all existing and proposed utilities affected by or affecting the drainage design

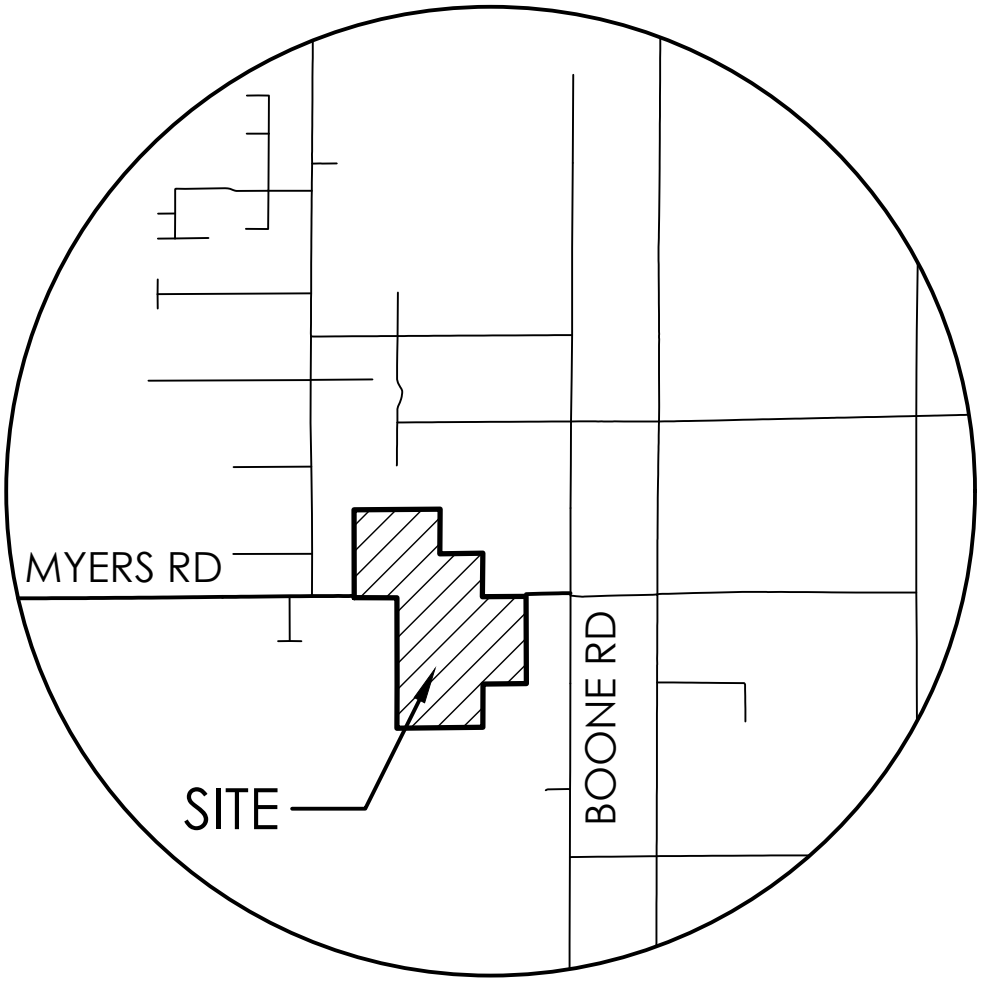
Insurance Program (Washington D.C.: , March 17, 1997).

If the runoff reduction standard is selected to partially or entirely meet the County's water quality treatment requirements, the following requirements apply for the design, construction, and maintenance of runoff reduction PCMs:
•All RPAs and SPAs are considered PCMs and therefore require a signed PCM Maintenance Agreement and an O&M Manual.
•RPA and SPA cannot be located in County ROW.
•RPA areas cannot be located in wetlands.
•Provide a detail in the plans that shows the UIA to RPA interface with the vertical drop of 4". (Note that MHFD Detail T-1 for Grass Buffers actually allows a drop of 1-3" where appropriate. This smaller drop is appropriate for sites with rural roads where there isn't curb that would safely allow for a 4" drop. Potentially no drop would be acceptable if the shoulder and connecting swale have a decent slope to allow drainage. There should be a gravel shoulder between the edge of pavement and the grass buffer.)
•Vegetation in RPAs and SPAs should have a uniform density of at least 80%.
•Irrigation (temporary or permanent) may be required to provide sufficient vegetation.
•Topsoil suitability shall be demonstrated and steps for proper preparation of topsoil per recommendations in MHFD Detail T-0 Table RR-3 shall be incorporated into design.
•In the GEC Plans, the RPA and SPA limits shall be delineated.
•For swales providing runoff reduction:
-V swales – the portion of the ditch from the edge of the impervious surface (UIA) to the flowline of the RPA shall be used for runoff reduction. The backslope for v swales cannot be considered for runoff reduction.
-Trapezoidal swales – The bottom of the ditch width shall be used for runoff reduction. The side slopes of trapezoidal swales cannot be considered for runoff reduction.
•Signage shall be posted in RPAs, so maintenance personnel and owners know that the area is a PCM. The signage should provide text that identifies the RPA as a water quality treatment area and states that the area is to remain vegetated and maintained per the site's O&M Manual.

Appendices

1 General Maps and Supporting Data

Vicinity Map
Portion of Flood Insurance Rate Map
Soil Type map and Tables
Official Soil Series Descriptions
Hydrologic Soil Group Map and Tables



VICINITY MAP

NOT TO SCALE

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

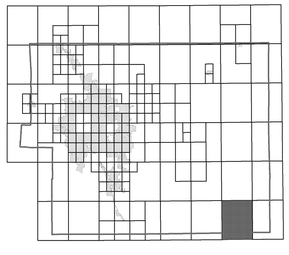
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

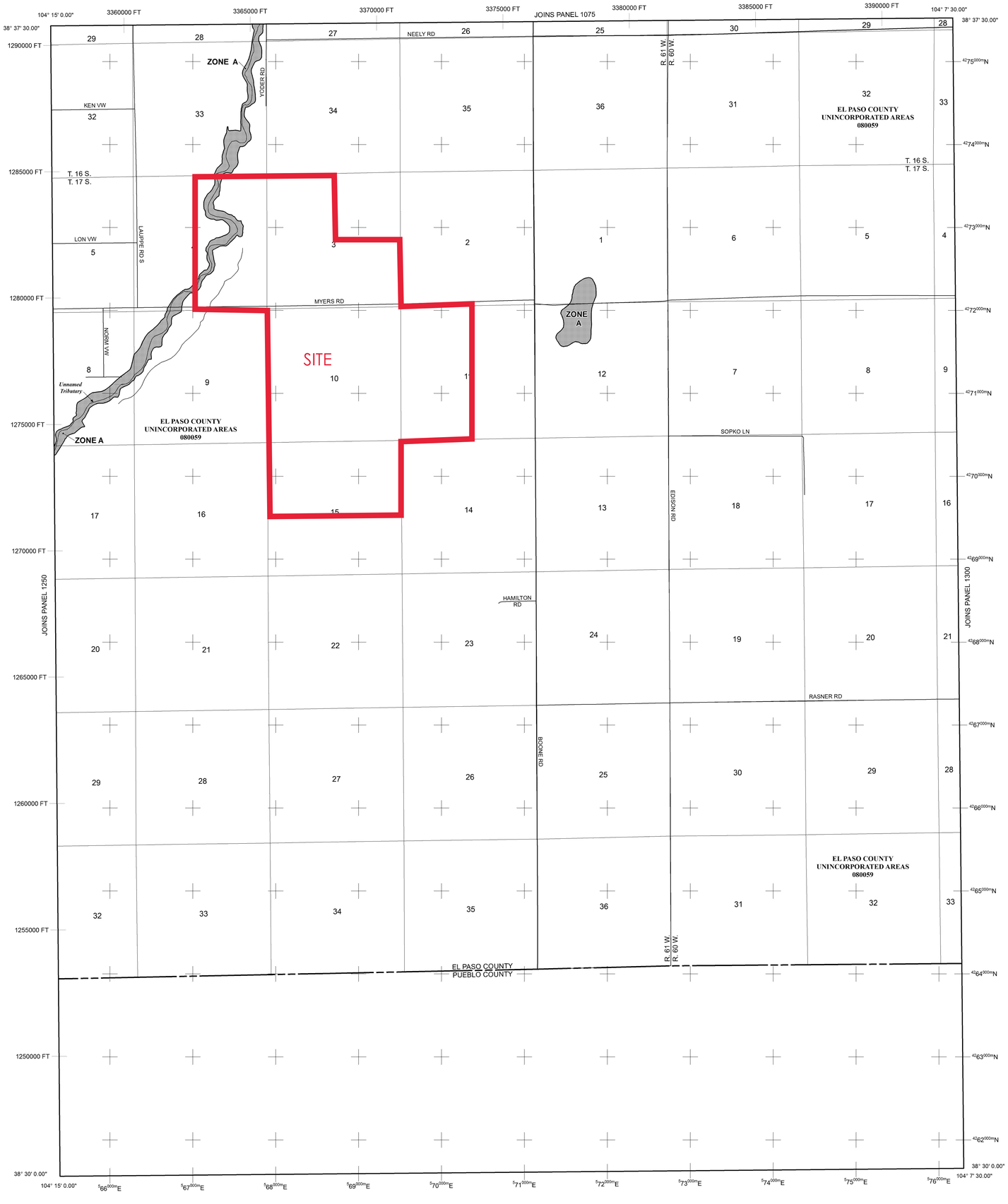
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.
ZONE AE Base Flood Elevations determined.
ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A Cross section line
23 — 23 Transect line
97° 07' 30.00" / 32° 22' 30.00" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN 1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5 • River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'
1000 0 2000 4000 FEET
600 0 600 1200 METERS

NFIP

PANEL 1275G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 1275 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	1275	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C1275G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

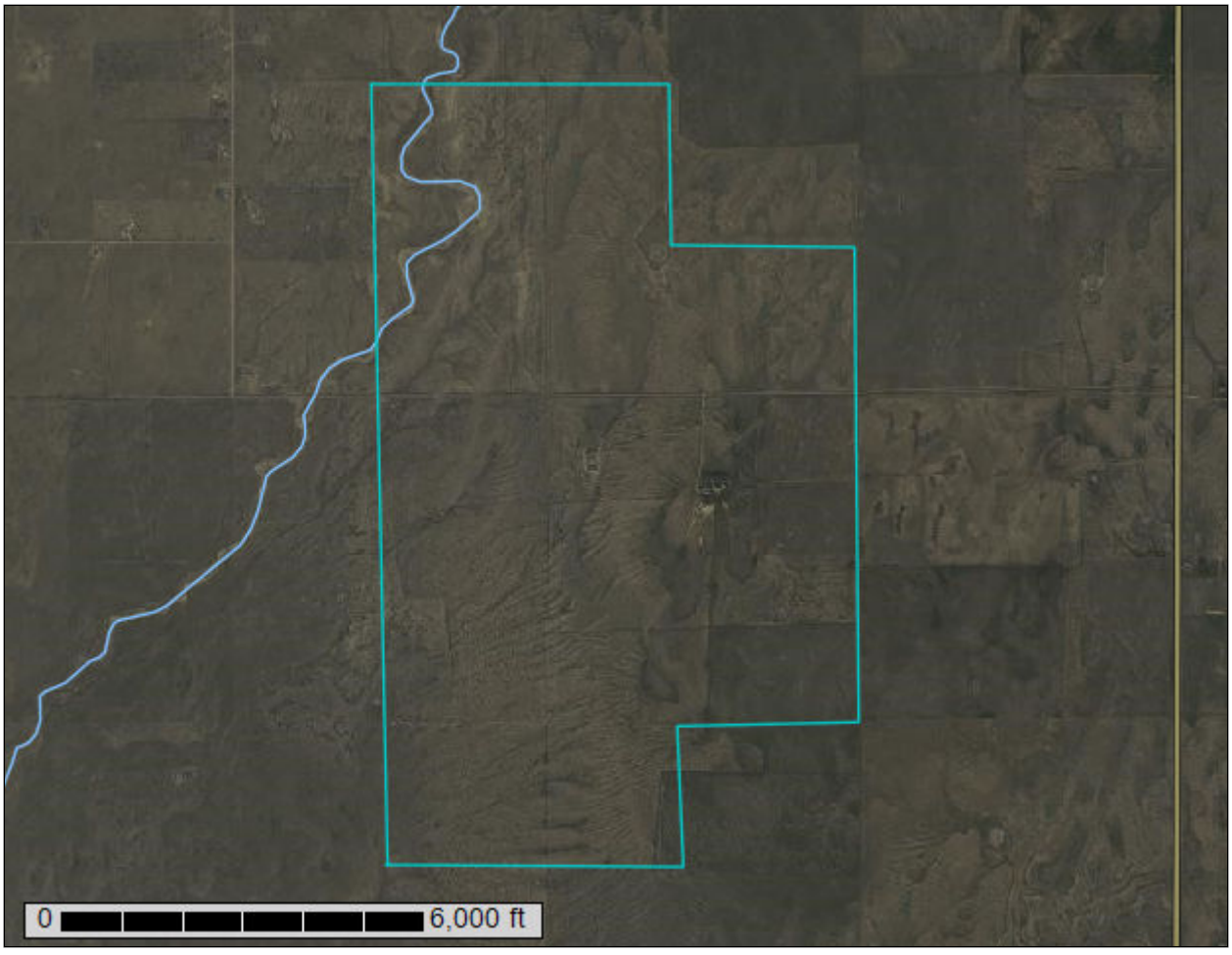
United States Department of Agriculture

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 El Paso County Area, Colorado



April 18, 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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

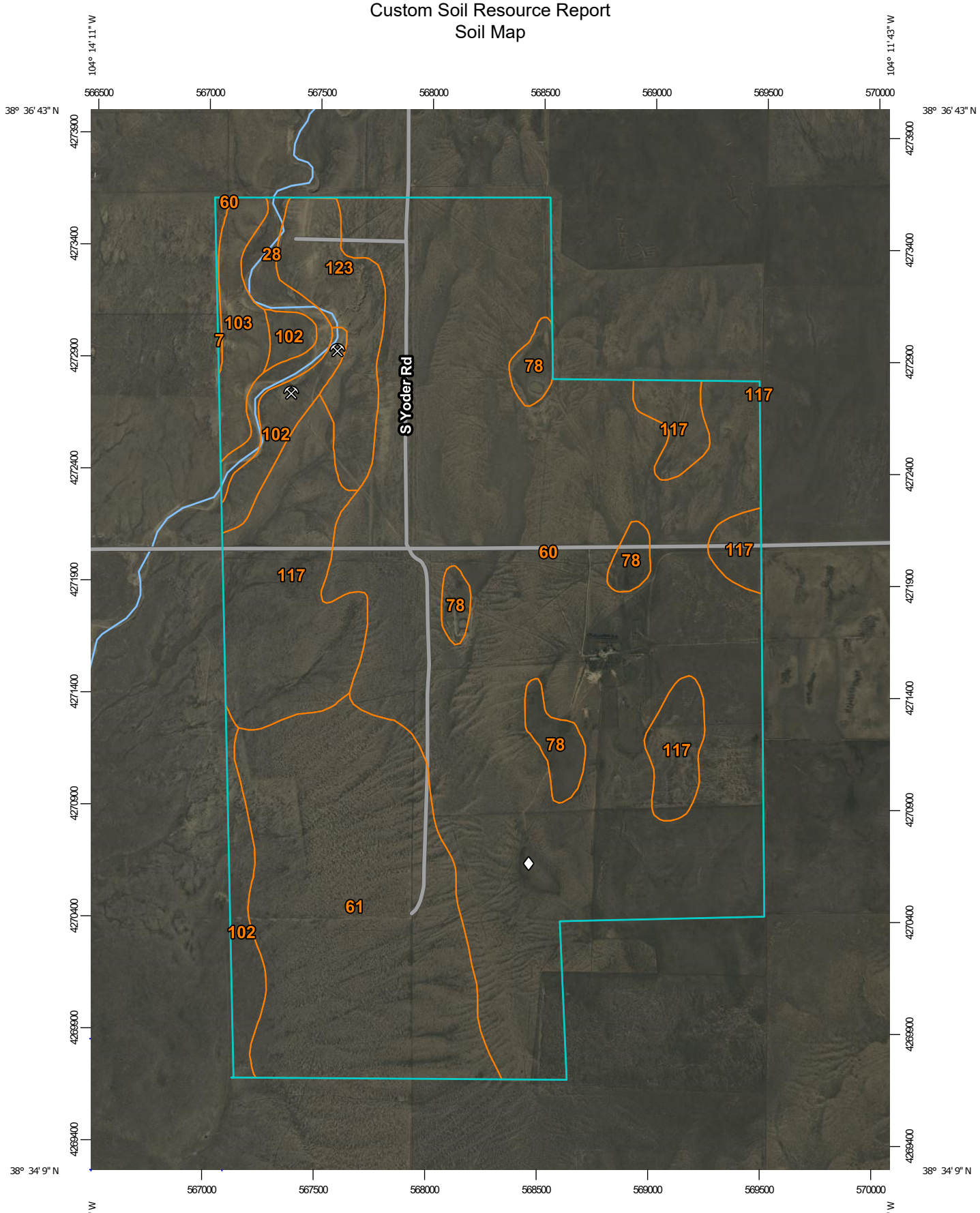
alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

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.

Custom Soil Resource Report
Soil Map



Map Scale: 1:23,100 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 300 600 1200 1800

Feet
0 1000 2000 4000 6000

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: El Paso County Area, Colorado
Survey Area Data: Version 21, Aug 24, 2023

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

Date(s) aerial images were photographed: Sep 11, 2018—Oct 20, 2018

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

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
7	Bijou sandy loam, 3 to 8 percent slopes	3.8	0.2%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	36.3	1.8%
60	Olney sandy loam, 0 to 3 percent slopes	1,116.3	55.7%
61	Olney sandy loam, 3 to 8 percent slopes	367.5	18.3%
78	Sampson loam, 0 to 3 percent slopes	51.1	2.6%
102	Valent sand, 1 to 12 percent slopes, dry	79.8	4.0%
103	Valent sand, 9 to 20 percent slopes, dry	43.4	2.2%
117	Vonid sandy loam, 0 to 5 percent slopes	226.9	11.3%
123	Olney-Vonid soils, 1 to 6 percent slopes, eroded	78.8	3.9%
Totals for Area of Interest		**2,003.9**	**100.0%**

Map Unit Descriptions

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.

El Paso County Area, Colorado

7—Bijou sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2tqxs
Elevation: 5,700 to 6,200 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Bijou

Setting

Landform: Sand sheets
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian sands

Typical profile

A - 0 to 4 inches: sandy loam
Bt1 - 4 to 8 inches: sandy loam
Bt2 - 8 to 21 inches: sandy loam
Bw - 21 to 28 inches: sandy loam
C - 28 to 79 inches: loamy coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.1 to 0.2 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Minor Components

Valent

Percent of map unit: 10 percent
Landform: Sand sheets
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY015CO - Deep Sand
Hydric soil rating: No

Olnest

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

28—Ellicott loamy coarse sand, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 3680
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Ellicott and similar soils: 97 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ellicott

Setting

Landform: Flood plains, stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium

Typical profile

A - 0 to 4 inches: loamy coarse sand
C - 4 to 60 inches: stratified coarse sand to sandy loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: A
Ecological site: R069XY031CO - Sandy Bottomland
Other vegetative classification: SANDY BOTTOMLAND (069AY031CO)
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquoll

Percent of map unit: 1 percent
Landform: Swales
Hydric soil rating: Yes

Other soils

Percent of map unit: 1 percent
Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

60—Olney sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2qnms
Elevation: 3,800 to 6,200 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Olney

Setting

Landform: Sand sheets
Parent material: Eolian sands

Typical profile

A - 0 to 3 inches: sandy loam
BA - 3 to 12 inches: sandy loam
Bt - 12 to 24 inches: sandy clay loam
Btk - 24 to 36 inches: sandy loam
Bk1 - 36 to 46 inches: sandy loam
Bk2 - 46 to 79 inches: fine sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Very slightly saline (2.0 to 3.9 mmhos/cm)
Sodium adsorption ratio, maximum: 2.0
Available water supply, 0 to 60 inches: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: R069XY026CO - Sandy Plains
Forage suitability group: Loamy (G069XW017CO)
Other vegetative classification: Loamy (G069XW017CO)
Hydric soil rating: No

Minor Components

Vonid

Percent of map unit: 9 percent
Landform: Sand sheets
Ecological site: R069XY026CO - Sandy Plains
Other vegetative classification: Loamy, Dry (G069XW019CO), Sandy Plains (069XY026CO_1)
Hydric soil rating: No

Oterodry

Percent of map unit: 4 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R069XY026CO - Sandy Plains

Other vegetative classification: Loamy, Dry (G069XW019CO), Sandy Plains (069XY026CO_1)
Hydric soil rating: No

Ustertic haplargids, ponded
Percent of map unit: 2 percent
Landform: Closed depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: R069XY011CO - Closed Depression
Other vegetative classification: Clayey (G069XW001CO)
Hydric soil rating: No

61—Olney sandy loam, 3 to 8 percent slopes

Map Unit Setting
National map unit symbol: 2qnmv
Elevation: 3,800 to 6,200 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

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

Description of Olney

Setting
Landform: Sand sheets
Parent material: Eolian sands

Typical profile
A - 0 to 3 inches: sandy loam
BA - 3 to 12 inches: sandy loam
Bt - 12 to 24 inches: sandy clay loam
Btk - 24 to 36 inches: sandy loam
Bk1 - 36 to 46 inches: sandy loam
Bk2 - 46 to 79 inches: fine sandy loam

Properties and qualities
Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Very slightly saline (2.0 to 3.9 mmhos/cm)
Sodium adsorption ratio, maximum: 2.0
Available water supply, 0 to 60 inches: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R069XY026CO - Sandy Plains
Forage suitability group: Loamy (G069XW017CO)
Other vegetative classification: Loamy (G069XW017CO)
Hydric soil rating: No

Minor Components

Vonid

Percent of map unit: 9 percent
Landform: Sand sheets
Ecological site: R069XY026CO - Sandy Plains
Other vegetative classification: Loamy, Dry (G069XW019CO), Sandy Plains (069XY026CO_1)
Hydric soil rating: No

Oterodry

Percent of map unit: 4 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R069XY026CO - Sandy Plains
Other vegetative classification: Loamy, Dry (G069XW019CO), Sandy Plains (069XY026CO_1)
Hydric soil rating: No

Ustertic haplargids, ponded

Percent of map unit: 2 percent
Landform: Closed depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: R069XY011CO - Closed Depression
Other vegetative classification: Clayey (G069XW001CO)
Hydric soil rating: No

78—Sampson loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 369s
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Sampson

Setting

Landform: Depressions, alluvial fans, terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 15 inches: loam
Bt - 15 to 34 inches: clay loam
Bk - 34 to 60 inches: sandy clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: B
Ecological site: R049XB202CO - Loamy Foothill
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 4 percent
Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

102—Valent sand, 1 to 12 percent slopes, dry

Map Unit Setting

National map unit symbol: 2rgs5
Elevation: 4,000 to 6,200 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Valent, Dry

Setting

Landform: Dunes
Parent material: Eolian sands

Typical profile

A - 0 to 6 inches: sand
AC - 6 to 21 inches: sand
C1 - 21 to 36 inches: sand
C2 - 36 to 79 inches: sand

Properties and qualities

Slope: 1 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very high (19.99 to 42.51 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.1 to 0.2 mmhos/cm)
Sodium adsorption ratio, maximum: 0.1
Available water supply, 0 to 60 inches: Very low (about 2.4 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R069XY019CO - Deep Sand
Forage suitability group: Not Suited (G069XW000CO)
Other vegetative classification: Not Suited (G069XW000CO)
Hydric soil rating: No

Minor Components

Vonid

Percent of map unit: 10 percent
Landform: Sand sheets
Ecological site: R069XY026CO - Sandy Plains
Other vegetative classification: Not Suited (G069XW000CO), Sandy Plains (069XY026CO_1)
Hydric soil rating: No

Olney

Percent of map unit: 5 percent
Landform: Sand sheets
Ecological site: R069XY026CO - Sandy Plains
Other vegetative classification: Not Suited (G069XW000CO), Sandy Plains (069XY026CO_1)
Hydric soil rating: No

103—Valent sand, 9 to 20 percent slopes, dry

Map Unit Setting

National map unit symbol: 2rgs7
Elevation: 4,000 to 6,200 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Valent, Dry

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex
Across-slope shape: Convex

Parent material: Eolian sands derived from sedimentary rock

Typical profile

A - 0 to 6 inches: sand
AC - 6 to 21 inches: sand
C1 - 21 to 36 inches: sand
C2 - 36 to 79 inches: sand

Properties and qualities

Slope: 9 to 20 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very high (19.99 to 42.51 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.1 to 0.2 mmhos/cm)
Sodium adsorption ratio, maximum: 0.1
Available water supply, 0 to 60 inches: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R069XY021CO - Choppy Sands
Forage suitability group: Not Suited (G069XW000CO)
Other vegetative classification: Not Suited (G069XW000CO)
Hydric soil rating: No

Minor Components

Vonid

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R069XY026CO - Sandy Plains
Other vegetative classification: Sandy Plains (069XY026CO_1), Not Suited (G069XW000CO)
Hydric soil rating: No

Olney

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Summit, footslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R069XY026CO - Sandy Plains
Other vegetative classification: Not Suited (G069XW000CO), Sandy Plains (069XY026CO_1)
Hydric soil rating: No

117—Vonid sandy loam, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2rgqc
Elevation: 4,000 to 6,200 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Vonid

Setting

Landform: Sand sheets
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian sands

Typical profile

A - 0 to 6 inches: sandy loam
Bt - 6 to 29 inches: sandy loam
Bk - 29 to 52 inches: sandy loam
C - 52 to 79 inches: loamy sand

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 2.0
Available water supply, 0 to 60 inches: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: A
Ecological site: R069XY026CO - Sandy Plains

Forage suitability group: Loamy, Dry (G019XW019CO)
Other vegetative classification: Loamy, Dry (G019XW019CO)
Hydric soil rating: No

Minor Components

Olney
Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R069XY026CO - Sandy Plains
Other vegetative classification: Loamy (G069XW017CO)
Hydric soil rating: No

Valent
Percent of map unit: 4 percent
Landform: Sand sheets
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R067BY015CO - Deep Sand
Other vegetative classification: DEEP SANDS (067XY015CO_2), Loamy, Dry (G069XW019CO)
Hydric soil rating: No

Ustertic haplargids, ponded
Percent of map unit: 1 percent
Landform: Closed depressions
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R067BY010CO - Closed Depression
Other vegetative classification: Clayey (G069XW001CO)
Hydric soil rating: No

123—Olney-Vonid soils, 1 to 6 percent slopes, eroded

Map Unit Setting
National map unit symbol: 2t51d
Elevation: 4,000 to 6,200 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition
Olney, eroded, and similar soils: 50 percent
Vonid, eroded, and similar soils: 40 percent

Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Olney, Eroded

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits

Typical profile

A - 0 to 2 inches: sandy loam
Bt - 2 to 14 inches: sandy clay loam
Bk1 - 14 to 36 inches: sandy loam
Bk2 - 36 to 79 inches: fine sandy loam

Properties and qualities

Slope: 1 to 4 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 (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Nonsaline to very slightly saline (0.5 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 2.0
Available water supply, 0 to 60 inches: Moderate (about 7.8 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R069XY026CO - Sandy Plains
Forage suitability group: Loamy (G069XW017CO)
Other vegetative classification: Loamy (G069XW017CO)
Hydric soil rating: No

Description of Vonid, Eroded

Setting

Landform: Sand sheets
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian sands

Typical profile

A - 0 to 2 inches: sandy loam
Bt - 2 to 29 inches: sandy loam
Bk - 29 to 52 inches: sandy loam
C - 52 to 79 inches: loamy sand

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.5 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 2.0
Available water supply, 0 to 60 inches: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: R069XY026CO - Sandy Plains
Forage suitability group: Loamy, Dry (G019XW019CO)
Other vegetative classification: Loamy, Dry (G019XW019CO)
Hydric soil rating: No

Minor Components

Vonid

Percent of map unit: 5 percent
Landform: Sand sheets
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R069XY026CO - Sandy Plains
Other vegetative classification: Loamy, Dry (G019XW019CO)
Hydric soil rating: No

Olney

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R069XY026CO - Sandy Plains
Other vegetative classification: Loamy (G069XW017CO)
Hydric soil rating: No

tices help to maintain vigor and growth of plants. Fencing and properly locating livestock watering facilities also help to control grazing.

Windbreaks and environmental plantings generally are well suited to these soils. Summer fallow a year prior to planting and continued cultivation for weed control are needed to insure establishment and survival. Trees that are best suited to these soils are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited to these soils are skunkbush sumac, lilac, Siberian peashrub, and American plum.

These soils are best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. Rangeland widlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

The main limitations of the Neville soil for urban use are its limited ability to support a load, moderate shrink-swell potential, and frost action potential. The main limitations of the Rednun soil are slow permeability, shrink-swell potential, and frost action potential. Special designs for buildings and roads are needed to overcome these limitations. Community sewage systems may be required because septic tank absorption fields do not function properly where permeability is slow. Capability subclass IVe.

59—Nunn clay loam, 0 to 3 percent slopes. This deep, well drained soil is on terraces, fans, and uplands. It formed in mixed alluvium. Elevation ranges from about 5,400 to 6,500 feet. The average annual precipitation is about 14 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is grayish brown clay loam about 12 inches thick. The subsoil is grayish brown heavy clay loam about 18 inches thick. The substratum to a depth of 72 inches is light olive brown sandy clay loam in the upper part and light brownish gray clay in the lower part. Visible lime occurs as soft masses and streaks throughout the substratum.

Included with this soil in mapping are small areas of Manzanola clay loam, 0 to 1 percent slopes; Manzanola clay loam, 1 to 3 percent slopes; Sampson loam, 0 to 3 percent slopes; and Ustic Torrifluvents, loamy.

Permeability of this Nunn soil is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow to medium, and the hazard of erosion is slight.

About 70 percent of the acreage of this soil is in dryland and irrigated crops. Wheat is the main dryland crop, and corn and alfalfa are the main irrigated crops. The remaining acreage is used as rangeland.

This soil is suited to the production of native vegetation suitable for grazing. The native vegetation is mainly western wheatgrass, blue grama, alkali sacaton, needleandthread, and side-oats grama. Galleta and fourwing saltbush are also present where this soil occurs in the southern part of the survey area. The presence of princesplume, two-groove milkvetch, and Fremont goldenweed indicates that selenium-bearing plants are in the stand.

Good grazing management is essential to maintain the desirable grasses. Deferment of grazing early in spring helps to maintain the vigor of cool-season grasses. Properly locating livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings generally are well suited to this soil. Summer fallow a year prior to planting and continued cultivation for weed control are needed to insure the establishment and survival of plantings. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, Siberian peashrub, and American plum.

This soil is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by providing nesting areas and escape cover. For pheasant, undisturbed nesting cover is vital and should be provided for in plans for habitat development; this is especially true for intensively farmed areas. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

The main limitations of this soil for urban use are slow permeability, low strength, and shrink-swell potential. Buildings and roads must be designed to overcome the limitations of low bearing strength and shrink-swell potential. Septic tank absorption fields do not function properly because of the slow permeability. Capability subclasses IIIc, nonirrigated, and IIe, irrigated.

60—Olney sandy loam, 0 to 3 percent slopes. This deep, well drained soil formed in calcareous sandy sediment on uplands. Elevation ranges from 5,200 to 6,000 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is grayish brown sandy loam about 6 inches thick. The subsoil, about 21 inches thick, is brown sandy clay loam in the upper 7 inches and pale brown sandy clay loam grading to sandy loam in the lower 14 inches. The substratum to a depth of 60 inches is very pale brown sandy loam that grades to loamy sand. The lower part of the subsoil and the substratum have visible lime in the form of soft masses and seams.

Included with this soil in mapping are small areas of Olney and Vona soils, eroded; Vona sandy loam, 1 to 3 percent slopes; and soils that are similar to this Olney soil in the upper 40 inches but that are very dark brown and loamy below a depth of 40 inches. Also included are

several wet-weather lakes, usually less than 2 acres in size.

Permeability of this Olney soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow. The hazard of erosion generally is moderate, but it is high where this soil is under dryland cultivation.

This soil is used for nonirrigated crops and for range.

Sorghum, sudangrass, and millet grown for forage and hay are the main crops. Pinto beans and grain sorghums are also grown. All of these crops except pinto beans respond to nitrogen fertilizer. This soil is very susceptible to soil blowing. Use of crop residue, stripcropping, and emergency tillage helps to control soil blowing.

This soil is suited to the production of native vegetation suitable for grazing. The native vegetation is mainly blue grama, which has a typical bunchgrass growth form and makes up one-third to one-half of the cover. Other species are sand dropseed, needleandthread, side-oats grama, and buckwheat.

Seeding is a suitable practice if the range has deteriorated. Seeding of native grasses is a good practice. If the range is severely eroded and blowouts have developed, fertilizing the new seeding is a good practice. Brush control may be needed, and grazing management may help to improve the depleted range. Grazing should be managed so that enough forage is left standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow.

Windbreaks and environmental plantings generally are suited to this soil. Soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by providing nesting areas and escape cover. For pheasant, undisturbed nesting cover is vital and should be provided for in plans for habitat development, especially in areas of intensive farming. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

The main limitations for urban development on this soil are the frost-action potential, the shrink-swell potential of the subsoil, and the hazard of soil blowing. Roads, streets, and buildings need to be designed to minimize the effects of the shrink-swell potential and frost-heave damage. Erosion control practices are needed to reduce soil blowing when the soil surface is bare during construction. Capability subclass IVe.

61—Olney sandy loam, 3 to 5 percent slopes. This deep, well drained, sandy soil formed in calcareous sandy sediment on uplands. Elevation ranges from 5,200 to 6,000 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is grayish brown sandy loam about 6 inches thick. The subsoil, about 21 inches thick, is brown sandy clay loam in the upper 7 inches and pale brown sandy clay loam that grades to sandy loam in the lower 14 inches. The substratum to a depth of 60 inches is very pale brown sandy loam that grades to loamy sand. The lower part of the subsoil and the substratum have visible lime in the form of soft masses and seams.

Included with this soil in mapping are small areas of Olney and Vona soils, eroded; Vona sandy loam, 3 to 9 percent slopes; and soils that are similar to this Olney soil but are very dark brown loam below a depth of 40 inches. Also included are a few wet-weather lakes, usually less than 2 acres in size.

Permeability of this Olney soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium. The hazard of erosion generally is moderate, but it is high where this soil is dryfarmed. The soil is very susceptible to soil blowing.

Most of the acreage is used as rangeland. Some of the acreage is dryfarmed, and a small acreage is farmed under sprinkler irrigation.

This soil is suited to the production of native vegetation suitable for grazing. The native vegetation is mainly blue grama, which has a typical bunchgrass growth form and makes up one-third to one-half of the cover. Other species are sand dropseed, needleandthread, side-oats grama, and buckwheat.

Seeding is advisable if the range has deteriorated. Seeding the native grasses is a good practice. If the range is severely eroded and blowouts have developed, fertilizing the new seeding is a good practice. Brush control may be needed, and grazing management may help to improve the depleted range. Grazing should be managed so that enough forage is left standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow.

Windbreaks and environmental plantings generally are suited to this soil. Soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for

ring-necked pheasant, mourning dove, and many nongame species can be developed by providing nesting areas and escape cover. For pheasant, undisturbed nesting cover is vital and should be provided for in plans for habitat development. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

The main limitations for urban development are the shrink-swell potential of the subsoil, frost-action potential, and the hazard of soil blowing. Roads and streets and buildings need to be designed to minimize the effects of the shrink-swell potential and frost-heave damage. Practices that reduce the hazard of soil blowing are needed when the soil surface is bare during construction. Capability subclass IVe.

62—Olney and Vona soils, eroded. This undifferentiated group is on uplands. Slopes range from 0 to 9 percent but average about 3 percent. Elevation ranges from 5,200 to 6,000 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the frost-free period is about 145 days.

Both the Olney soil and the Vona soil may occur in each delineated area, or each soil may occur separately.

Included with these soils in mapping are small areas of Olney sandy loam, 0 to 3 percent slopes; Olney sandy loam, 3 to 5 percent slopes; Vona sandy loam, 1 to 3 percent slopes; and Vona sandy loam, 3 to 9 percent slopes.

The Olney soil is deep and well drained. It formed in calcareous sandy sediment. The sandy loam surface layer in most areas has been lost, primarily as a result of soil blowing, exposing the subsoil and in some places the substratum. In some places the surface has a choppy, or dunelike, appearance because of the accumulation of wind-deposited soil material. The subsoil, where present, is about 21 inches thick. It is brown sandy clay loam in the upper 7 inches and pale brown sandy clay loam that grades to sandy loam in the lower 14 inches. The substratum extends to a depth of 60 inches or more. It is very pale brown sandy loam that grades to loamy sand. The lower part of the subsoil and the substratum have visible lime in the form of soft masses and seams.

Permeability of the Olney soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow to medium, and the hazard of erosion is high. Erosion is mainly a result of soil blowing (fig. 4), but in places rills and gullies have been produced by water erosion.

The Vona soil is deep and well drained. It formed in sandy, calcareous, eolian material. The sandy loam surface layer in most areas of this soil has been lost mainly as a result of soil blowing, exposing the subsoil and in some places the substratum. In some places the surface has a choppy, or dunelike, appearance because of the accumulation of wind-deposited soil material. The subsoil is brown sandy loam about 8 inches thick where it has not been eroded. The substratum extends to a depth of 60 inches or more. It is pale brown to very pale brown sandy loam in the upper part and grades to light yellowish brown fine sandy loam in the lower part.

Permeability of the Vona soil is moderately rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is slow, and the hazard of erosion is high. Erosion is mainly a result of soil blowing, but in places some rills and gullies have been produced by water erosion.

These soils are used mostly as rangeland.

These soils are not suited to dryland farming. Most of the acreage was previously cultivated, but the major part of this has been seeded to grass or abandoned.

These soils are suited to the production of native vegetation suitable for grazing. The native vegetation is mainly blue grama, which has a typical bunchgrass growth form and makes up one-third to one-half of the cover. Other species are sand dropseed, needleandthread, side-oats grama, and buckwheat.

Seeding is advisable if the range has deteriorated. Seeding the native grasses is a good practice. If the range is severely eroded and blowouts have developed, fertilizing the new seeding is a good practice. Brush control may be needed, and grazing management may improve the depleted range. Grazing should be managed so that enough forage is left standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow.

These soils are generally suited to windbreaks and environmental plantings. Soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

These soils are best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

The main limitations of these soils for urban development are frost-action potential and the hazard of soil blowing. Roads and streets need to be designed to minimize frost-heave damage. Practices are needed to reduce soil blowing when the soil surface is bare during construction. Capability subclass VIe.

63—Paunsaugunt-Rock outcrop complex, 15 to 65 percent slopes. This moderately steep to very steep complex is on mountains. Elevation ranges from 7,200 to 8,000 feet. The average annual precipitation is about 15 inches, and the average annual air temperature is about 43 degrees F.

The Paunsaugunt soil makes up about 50 percent of the complex and Rock outcrop about 40 percent. About 10

2 Hydrologic Calculations

Runoff Reduction Worksheets & Maps

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Designer:	TJW
Company:	MVE, INC.
Date:	April 18, 2024
Project:	MOUNTAIN RANCHES
Location:	North Road 1

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth: 0.60 inches

Depth of Average Runoff Producing Storm, d_6 = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA								
Area ID	N1-W1	N1-W2	N1-E1	N1-E2								
Downstream Design Point ID	None	None	None	None								
Downstream BMP Type	None	None	None	None								
DCIA (ft^2)	--	--	--	--								
UIA (ft^2)	26,217	26,217	26,217	26,217								
RPA (ft^2)	43,658	42,993	43,658	23,219								
SPA (ft^2)	--	--	--	--								
HSG A (%)	0%	0%	0%	0%								
HSG B (%)	100%	100%	100%	100%								
HSG C/D (%)	0%	0%	0%	0%								
Average Slope of RPA (ft/ft)	0.010	0.010	0.010	0.010								
UIA:RPA Interface Width (ft)	2298.00	2298.00	2298.00	2298.00								

CALCULATED RUNOFF RESULTS

Area ID	N1-W1	N1-W2	N1-E1	N1-E2								
UIA:RPA Area (ft^2)	69,875	69,210	69,875	49,436								
L / W Ratio	0.06	0.06	0.06	0.06								
UIA / Area	0.3752	0.3788	0.3752	0.5303								
Runoff (in)	0.00	0.00	0.00	0.00								
Runoff (ft^3)	0	0	0	0								
Runoff Reduction (ft^3)	1092	1092	1092	1092								

CALCULATED WQCV RESULTS

Area ID	N1-W1	N1-W2	N1-E1	N1-E2								
WQCV (ft^3)	1092	1092	1092	1092								
WQCV Reduction (ft^3)	1092	1092	1092	1092								
WQCV Reduction (%)	100%	100%	100%	100%								
Untreated WQCV (ft^3)	0	0	0	0								

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	None											
DCIA (ft^2)	0											
UIA (ft^2)	104,868											
RPA (ft^2)	153,528											
SPA (ft^2)	0											
Total Area (ft^2)	258,396											
Total Impervious Area (ft^2)	104,868											
WQCV (ft^3)	4,370											
WQCV Reduction (ft^3)	4,370											
WQCV Reduction (%)	100%											
Untreated WQCV (ft^3)	0											

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	258,396
Total Impervious Area (ft^2)	104,868
WQCV (ft^3)	4,370
WQCV Reduction (ft^3)	4,370
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0

This error needs to be corrected, the ratio is too low and the spreadsheet will not calculate values correctly. Try breaking out the RPAs further the UIA:RPA widths are not quite so long. Typical comment for all runoff reduction calculations.

RPAs should be broken down at a minimum per lot lines - and all RPAs should be identified as you have for the larger sections.

N1-W1 RPA (43,658 SF)

N1-W1 UIA (26,217 SF)

N1-E1 RPA (43,658 SF)

N1-E1 UIA (26,217 SF)

This grading does not appear to be a ditch.

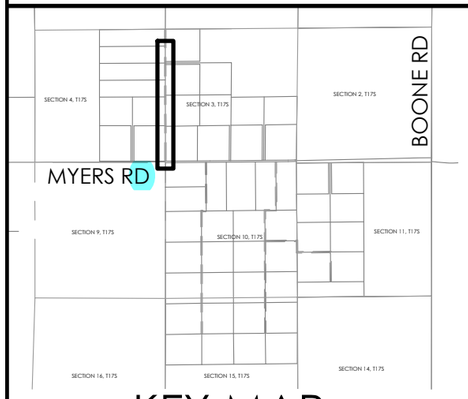
MYERS RD

N1-W2 RPA (42,993 SF)

N1-W2 UIA (26,217 SF)

N1-E2 RPA (23,219 SF)

N1-E2 UIA (26,217 SF)



KEY MAP

NOT TO SCALE

LEGEND

- PROPERTY LINE
- EASEMENT LINE

EXISTING

- 5985 INDEX CONTOUR
- 84 INTERMEDIATE CONTOUR

PROPOSED

- 5985 INDEX CONTOUR
- 84 INTERMEDIATE CONTOUR
- AREA BOUNDARY

SURFACE TYPES		
UNCONNECTED IMPERVIOUS AREA (UIA)	104,868 SF. TOTAL	
RECEIVING PERVIOUS AREA (RPA)	153,528 SF. TOTAL	

MVE, INC.
ENGINEERS SURVEYORS
1903 lelaray street suite 200
colorado springs co 80909
719.635.5736 www.mvecivil.com

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Designer: TJW
Company: MVE, INC.
Date: April 18, 2024
Project: MOUNTAIN RANCHES
Location: South Road 1

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth: 0.60 inches
Depth of Average Runoff Producing Storm, d_6 = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA								
Area ID	S1-W1	S1-E1	S1-W2	S1-E2								
Downstream Design Point ID	None	None	None	None								
Downstream BMP Type	None	None	None	None								
DCIA (ft^2)	--	--	--	--								
UIA (ft^2)	36,282	36,282	42,450	42,450								
RPA (ft^2)	33,732	43,718	34,108	37,550								
SPA (ft^2)	--	--	--	--								
HSG A (%)	0%	0%	0%	0%								
HSG B (%)	100%	100%	100%	100%								
HSG C/D (%)	0%	0%	0%	0%								
Average Slope of RPA (ft/ft)	0.010	0.010	0.010	0.010								
UIA:RPA Interface Width (ft)	3298.00	3298.00	2298.00	2298.00								

CALCULATED RUNOFF RESULTS

Area ID	S1-W1	S1-E1	S1-W2	S1-E2								
UIA:RPA Area (ft^2)	70,014	80,000	76,558	80,000								
L / W Ratio	0.06	0.06	0.06	0.06								
UIA / Area	0.5182	0.4535	0.5545	0.5306								
Runoff (in)	0.00	0.00	0.00	0.00								
Runoff (ft^3)	0	0	0	0								
Runoff Reduction (ft^3)	1512	1512	1769	1769								

CALCULATED WQCV RESULTS

Area ID	S1-W1	S1-E1	S1-W2	S1-E2								
WQCV (ft^3)	1512	1512	1769	1769								
WQCV Reduction (ft^3)	1512	1512	1769	1769								
WQCV Reduction (%)	100%	100%	100%	100%								
Untreated WQCV (ft^3)	0	0	0	0								

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	None											
DCIA (ft^2)	0											
UIA (ft^2)	157,464											
RPA (ft^2)	149,108											
SPA (ft^2)	0											
Total Area (ft^2)	306,572											
Total Impervious Area (ft^2)	157,464											
WQCV (ft^3)	6,561											
WQCV Reduction (ft^3)	6,561											
WQCV Reduction (%)	100%											
Untreated WQCV (ft^3)	0											

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	306,572
Total Impervious Area (ft^2)	157,464
WQCV (ft^3)	6,561
WQCV Reduction (ft^3)	6,561
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0

MYERS RD

S1-E1 RPA
(43,718 SF)

S1-W1 RPA
(33,732 SF)

S1-E1 UIA
(36,282 SF)

S1-W1 UIA
(36,282 SF)

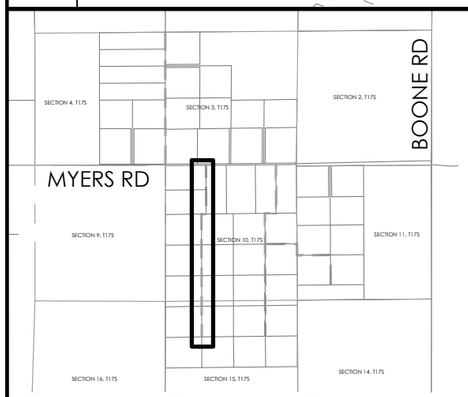
S1-E2 RPA
(37,550 SF)

S1-E2 UIA
(42,450 SF)

S1-W2 RPA
(34,108 SF)

S1-W2 UIA
(42,450 SF)

N



KEY MAP

NOT TO SCALE

LEGEND

PROPERTY LINE

EASEMENT LINE

EXISTING

5985 INDEX CONTOUR

84 INTERMEDIATE CONTOUR

PROPOSED

5985 INDEX CONTOUR

84 INTERMEDIATE CONTOUR

AREA BOUNDARY

SURFACE TYPES		
UNCONNECTED IMPERVIOUS AREA (UIA)	157,464 SF. TOTAL	
RECEIVING PERVIOUS AREA (RPA)	149,108 SF. TOTAL	

MVE, INC.
ENGINEERS SURVEYORS
1903 lelaray street suite 200
colorado springs co 80909
719.635.5736 www.mvecivil.com

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Designer: TJW
Company: MVE, INC.
Date: April 18, 2024
Project: MOUNTAIN RANCHES
Location: South Road 2

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth: 0.60 inches
Depth of Average Runoff Producing Storm, d_6 = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA								
Area ID	S2-W1	S2-E1	S2-W2	S2-E2								
Downstream Design Point ID	None	None	None	None								
Downstream BMP Type	None	None	None	None								
DCIA (ft^2)	--	--	--	--								
UIA (ft^2)	39,038	39,038	42,474	42,474								
RPA (ft^2)	40,962	36,103	28,782	37,526								
SPA (ft^2)	--	--	--	--								
HSG A (%)	0%	0%	0%	0%								
HSG B (%)	100%	100%	100%	100%								
HSG C/D (%)	0%	0%	0%	0%								
Average Slope of RPA (ft/ft)	0.010	0.010	0.010	0.010								
UIA:RPA Interface Width (ft)	3298.00	3298.00	2298.00	2298.00								

CALCULATED RUNOFF RESULTS

Area ID	S2-W1	S2-E1	S2-W2	S2-E2								
UIA:RPA Area (ft^2)	80,000	75,141	71,256	80,000								
L / W Ratio	0.06	0.06	0.06	0.06								
UIA / Area	0.4880	0.5195	0.5961	0.5309								
Runoff (in)	0.00	0.00	0.00	0.00								
Runoff (ft^3)	0	0	0	0								
Runoff Reduction (ft^3)	1627	1627	1770	1770								

CALCULATED WQCV RESULTS

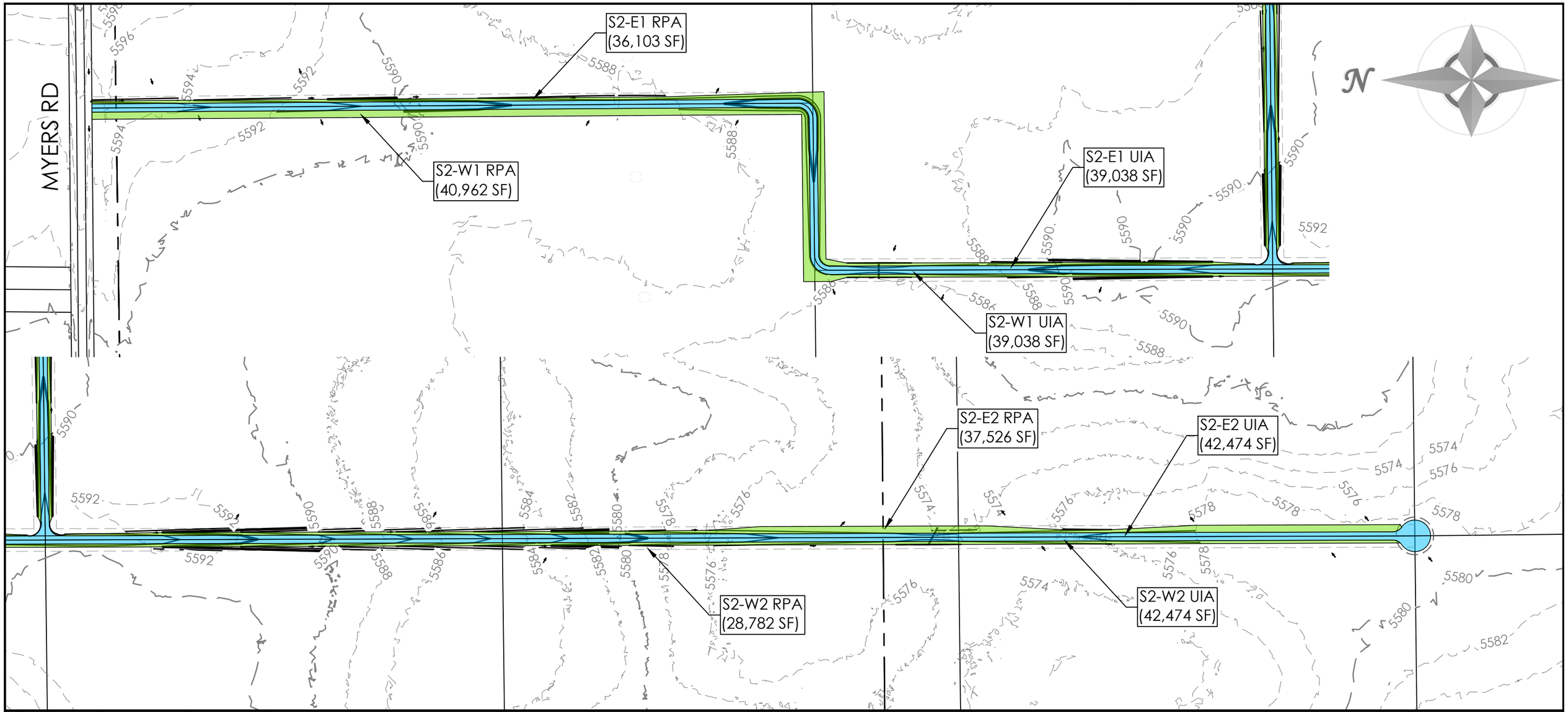
Area ID	S2-W1	S2-E1	S2-W2	S2-E2								
WQCV (ft^3)	1627	1627	1770	1770								
WQCV Reduction (ft^3)	1627	1627	1770	1770								
WQCV Reduction (%)	100%	100%	100%	100%								
Untreated WQCV (ft^3)	0	0	0	0								

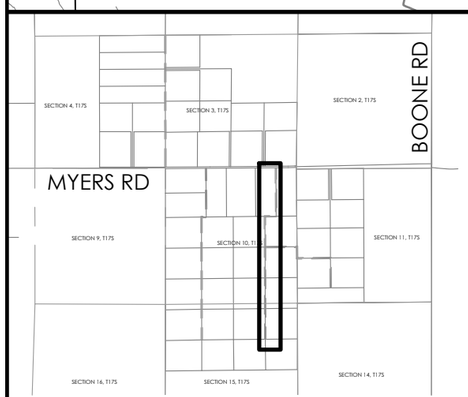
CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	None											
DCIA (ft^2)	0											
UIA (ft^2)	163,024											
RPA (ft^2)	143,373											
SPA (ft^2)	0											
Total Area (ft^2)	306,397											
Total Impervious Area (ft^2)	163,024											
WQCV (ft^3)	6,793											
WQCV Reduction (ft^3)	6,793											
WQCV Reduction (%)	100%											
Untreated WQCV (ft^3)	0											

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	306,397
Total Impervious Area (ft^2)	163,024
WQCV (ft^3)	6,793
WQCV Reduction (ft^3)	6,793
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0





KEY MAP

NOT TO SCALE

LEGEND

PROPERTY LINE

EASEMENT LINE

EXISTING

5985 INDEX CONTOUR

84 INTERMEDIATE CONTOUR

PROPOSED

5985 INDEX CONTOUR

84 INTERMEDIATE CONTOUR

AREA BOUNDARY

SURFACE TYPES		
UNCONNECTED IMPERVIOUS AREA (UIA)	163,024 SF. TOTAL	
RECEIVING PERVIOUS AREA (RPA)	143,373 SF. TOTAL	

MVE, INC.
ENGINEERS SURVEYORS
1903 lelaray street suite 200
colorado springs co 80909
719.635.5736 www.mvecivil.com

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Designer: TJW
Company: MVE, INC.
Date: April 17, 2024
Project: MOUNTAIN RANCHES
Location: South Road 2A

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth: 0.60 inches
Depth of Average Runoff Producing Storm, d_6 = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA								
Area ID	S2A-N1	S2A-S1	S2A-N2	S2A-S2								
Downstream Design Point ID	None	None	None	None								
Downstream BMP Type	None	None	None	None								
DCIA (ft^2)	--	--	--	--								
UIA (ft^2)	32,736	32,729	15,743	15,553								
RPA (ft^2)	31,092	26,200	15,958	10,191								
SPA (ft^2)	--	--	--	--								
HSG A (%)	0%	0%	0%	0%								
HSG B (%)	100%	100%	100%	100%								
HSG C/D (%)	0%	0%	0%	0%								
Average Slope of RPA (ft/ft)	0.010	0.010	0.010	0.010								
UIA:RPA Interface Width (ft)	2928.00	2928.00	1301.00	1266.00								

CALCULATED RUNOFF RESULTS

Area ID	S2A-N1	S2A-S1	S2A-N2	S2A-S2								
UIA:RPA Area (ft^2)	63,828	58,929	31,701	25,744								
L / W Ratio	0.06	0.06	0.06	0.06								
UIA / Area	0.5129	0.5554	0.4966	0.6041								
Runoff (in)	0.00	0.00	0.00	0.00								
Runoff (ft^3)	0	0	0	0								
Runoff Reduction (ft^3)	1364	1364	656	648								

CALCULATED WQCV RESULTS

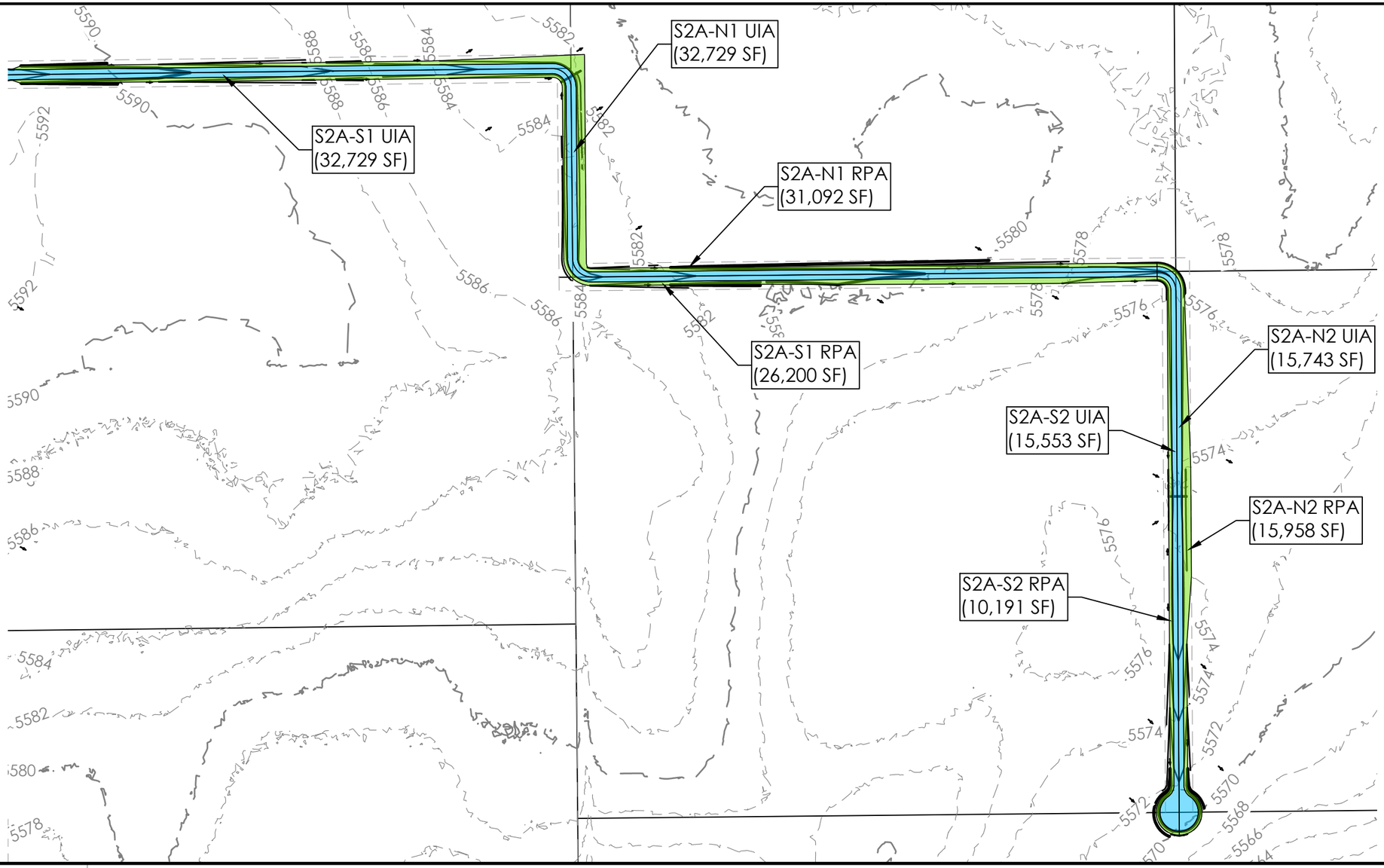
Area ID	S2A-N1	S2A-S1	S2A-N2	S2A-S2								
WQCV (ft^3)	1364	1364	656	648								
WQCV Reduction (ft^3)	1364	1364	656	648								
WQCV Reduction (%)	100%	100%	100%	100%								
Untreated WQCV (ft^3)	0	0	0	0								

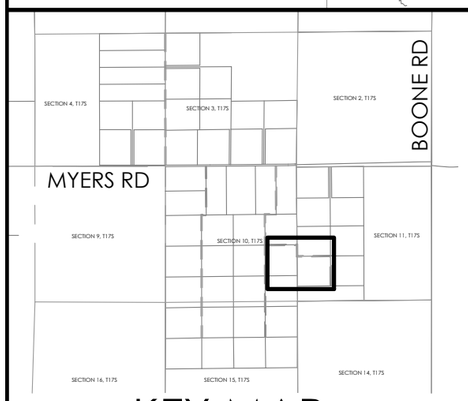
CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	None											
DCIA (ft^2)	0											
UIA (ft^2)	96,761											
RPA (ft^2)	83,441											
SPA (ft^2)	0											
Total Area (ft^2)	180,202											
Total Impervious Area (ft^2)	96,761											
WQCV (ft^3)	4,032											
WQCV Reduction (ft^3)	4,032											
WQCV Reduction (%)	100%											
Untreated WQCV (ft^3)	0											

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	180,202
Total Impervious Area (ft^2)	96,761
WQCV (ft^3)	4,032
WQCV Reduction (ft^3)	4,032
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0





KEY MAP

NOT TO SCALE

LEGEND

PROPERTY LINE

EASEMENT LINE

EXISTING

5985 INDEX CONTOUR

84 INTERMEDIATE CONTOUR

PROPOSED

5985 INDEX CONTOUR

84 INTERMEDIATE CONTOUR

AREA BOUNDARY

SURFACE TYPES		
UNCONNECTED IMPERVIOUS AREA (UIA)	96,761 SF. TOTAL	
RECEIVING PERVIOUS AREA (RPA)	83,441 SF. TOTAL	

MVE, INC.
ENGINEERS SURVEYORS
1903 lelaray street suite 200
colorado springs co 80909
719.635.5736 www.mvecivil.com

3 Hydraulic Calculations

Typical Roadside Ditch Velocity Calculation
Reseeding Mix, Grass Characteristics and Allowable Velocities

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Apr 19 2024

Maximum Velocity for Roadway Ditch

Triangular

Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 3.23
N-Value	= 0.040

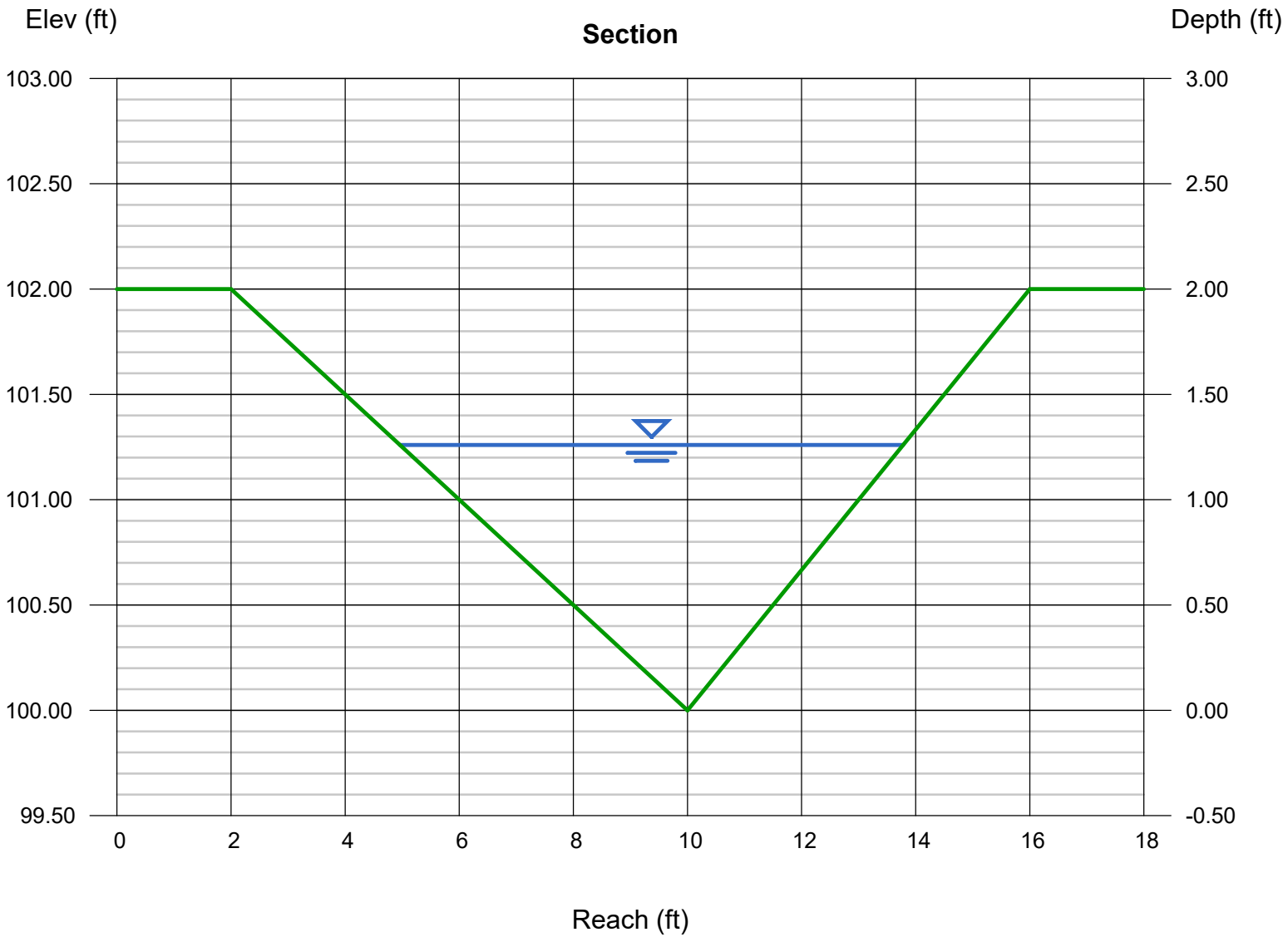
Calculations

Compute by:	Known Q
Known Q (cfs)	= 26.20

Highlighted

Depth (ft)	= 1.26
Q (cfs)	= 26.20
Area (sqft)	= 5.56
Velocity (ft/s)	= 4.72
Wetted Perim (ft)	= 9.18
Crit Depth, Yc (ft)	= 1.29
Top Width (ft)	= 8.82
EGL (ft)	= 1.61

What storm event is this?



Recommended El Paso County Grass Seed Mixes

Grass mix for quick revegetation – all sites:

Grass:	Variety	PLS lbs per acre
Crested Wheat Grass	Ephraim or HyCrest	4.0
Perennial Rye	Linn	2.0
Western Wheatgrass	Barton	3.0
Smooth Brome Grass	Lincoln or Manchar	5.0
Sideoats Grama	El Reno	2.5
		Total: 16.5

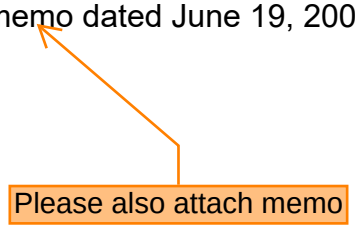
Grass mix for heavier soil areas:

Grass:	Variety	PLS lbs per acre
Crested Wheat Grass	Ephraim	3.0
Slender Wheat Grass	Sodar	2.5
Western Wheatgrass	Barton	5.0
Smooth Brome Grass	Lincoln or Manchar	4.0
Sideoats Grama	El Reno	3.0
		Total: 17.5

Grass mix for sandy soils:

Grass:	Variety	PLS lbs per acre
Sideoats Grama	El Reno	3.0
Western Wheatgrass	Barton	2.5
Slender Wheat Grass	Native	2.0
Little Bluestem	Pastura	2.0
Sand Dropseed	Native	0.5
Switch Grass	Nebraska 28	3.0
Weeping Love Grass	Morpha	1.0
Optional: Perennial Rye		2.0
		Total: 14-16

(From NRCS memo dated June 19, 2001)



Where in this article is it stated that these grasses are appropriate for El Paso County?

Plant Guide

SIDE-OATS GRAMA

Bouteloua curtipendula (Michx.) Torr.

Plant Symbol = BOCU

Contributed by: USDA NRCS Plant Materials Center, Manhattan, Kansas

Alan Shadow, East Texas Plant Materials Center, Nacogdoches, Texas

Uses

Forage: Side-oats grama produces high quality, nutritious forage that is relished by all classes of livestock throughout the summer and fall, and it remains moderately palatable into winter. This makes it one of the most important range grass species.

Erosion Control: Weaver and Albertson (1944) described the role of side-oats grama in the recovery of grasslands following the drought of the 1930's. It was one of the few grasses that covered large areas bared by the loss of other grasses during the drought period. Side-oats grama is recommended in grass mixtures for range and pasture seeding, for earth fill and bank stabilization, for other critical areas and recreational plantings. Successful seeding can be obtained in rocky, stony or shallow soil sites. In fact side-oats is often found in nearly pure stands on caliche outcrops, stony hillsides and breaks (Harlan, 1954).

Wildlife: Side-oats provides some forage for antelope and deer when actively growing. Elk will use this grass as forage throughout the year. Leithead et al. (1971) indicated that the seed of this species was consumed by wild turkeys.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

General: Side-oats grama is a deep rooted, perennial grass. The plants crown will spread very slowly by means of extremely short, stout rhizomes. A mid-grass in height, it has rather wide leaves and a very distinct inflorescence consisting of a zigzag stalk with small compressed spikes dangling from it at even intervals. The short spikes dangle from one side of the stalk, thus providing the plant with its common name. In the vegetative state the grass is easily recognized by the long, evenly spaced hairs attached to the margins of the leaf near its base. Side-oats grama possesses the C-4 photosynthetic pathway common to warm-season grasses (Waller and Lewis, 1979).

Distribution: For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site. One of the most widely distributed of the grama grasses. It has a widespread distribution eastward from the Rocky Mountains to near the east coast except in the southeast.

Habitat: Side-oats grama grows effectively in the dryer mid-grass prairie section of the Great Plains that has an annual rainfall of 12-20 inches. This species occurs naturally in mixed stands with blue grama (*Bouteloua gracilis*) and little bluestem (*Schizachyrium scoparium*). This grass is better adapted to calcareous and moderately alkaline soils than to neutral or acidic soils (Leithead etal., 1971)

Adaptation

Side-oats is adapted to a broad range of sandy to clayey textured soils; it is least tolerant of loose sands and dense clays. The best stands of side-oats are found on medium to fine texture upland soils. This species has shown varying tolerance to soil salinity from weak to moderate. Side-oats is moderately drought tolerant, but less than blue grama. It is moderately tolerant of semi-shaded conditions and can be found in open woodlands. It will sustain damage from wildfires when actively growing and under drought stress conditions, but is fairly tolerant of fire in a dormant state. It is also fairly tolerant of spring flooding. It probably has the widest range of adaptation of any of the warm-season perennial grass plants. It grows in combination with tall warm-season

grasses such as big bluestem (*Andropogon gerardii*) and switchgrass (*Panicum virgatum*) all the way to the short grass plants such as buffalo grass (*Bouteloua dactyloides*) and blue grama (*Bouteloua gracilis*). Thus, it can successfully grow in a variety of climates and habitats in the continental U.S.

Establishment
Seed improved cultivars of this grass no deeper than ¼ inch on fine textured soils and ¾ inch on coarser textured soils. Planting with a grass seed drill on a firm, weed free seedbed at the rate of 2.5 to 5.0 pounds of pure live seed (PLS) is encouraged. Broadcasting at a higher seeding rate (50 to 100 percent increase) can be utilized on a previously prepared seedbed that will be culti-packed after seeding is completed. Increased seeding rate should also be used on bare areas, harsh sites, or on areas that require denser or quicker stand establishment. Seeding is more likely to be successful if moisture conditions are good and if mulch is used to retain moisture on the seeding site. Most seed germinates within 7 days under good field conditions. Seedling vigor is good when compared to other warm season grasses. Field germination, emergence and establishment of this species are better than other grama grasses. Protection from grazing is encouraged while seedlings are in the juvenile stage of growth.

Management
As a mid-grass, side-oats grama is intermediate in many respects between the tall and short grass species. Side-oats grama is not as resistant to grazing pressure as is blue grama due to its taller growth habit. Side-oats seedlings are vigorous and stands tend to establish quickly and can often be utilized for forage production the second year after planting. Side-oats grama is usually included in range mixes and should be managed as native rangeland. Management should include proper livestock stocking rates and correct season of use.

Pests and Potential Problems
Grasshoppers can be destructive of seedling stands. Some stem and leaf rust occurs in wet years and Mankin (1969) found several leaf spot and root rot fungi occurred on side-oats grama.

Seeds and Plant Production
Seed production experiments conducted in Nebraska in the 1950's found that side-oats grama response to nitrogen fertilization was dependent on moisture conditions during critical growth periods (Newell et al., 1962). Seed yields measured as whole spikes were substantially increased over unfertilized check plots by all rates of nitrogen applied. Under drought conditions the application of 60 and 90 pounds of nitrogen yielded whole spike yields of approximately equal amounts. Under favorable moisture conditions nitrogen fertilization improved the quality of the caryopsis by increased weight per 1000 caryopsis over unfertilized plots.

Seed of side-oats grama normally found on the open market consists of either whole spikes or individual florets, or mixtures of these, which vary widely in their content of germinable caryopsis. Thus, seeding rates of side-oats must be computed on the basis of purity and viability of the seed lot. Purity analysis of side-oats can be complicated by the inclusion of adhering glumes and spike fragments as part of the seed unit. As long as the seed unit has a germinable caryopsis in the spike it is considered viable and used in the computation of pure live seed by the seed analyst. Thus a spike may contain several germinable caryopses, but is counted only as one for the purpose of germination percentage.

The effect of burning on seed yield was studied by Newell etal. (1962) in fertilized and unfertilized plots. Although the seed yield results were numerically larger from both levels of fertilized plots when burned, the differences could not be proven to be statistically different. This finding is noteworthy since it proves that proper burning, if not conducted too late in the spring, does not reduce seed yield. Burning is a proven method of cleaning the field for the new seed crop year. Burning has also been known to help control cool season weeds and reduce disease inoculums for the new crop.

Thus, side-oats grama may be grown for seed in cultivated rows, and will respond to timely fertilization and irrigation applications.

Cultivars, Improved, and Selected Materials (and area of origin)
Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government". The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

'Butte' was selected at Nebraska AES, Lincoln, USDA-ARS and SCS cooperatively by E.C. Conard and L.C. Newell. It represents native collections from Holt and Platte Counties in Nebraska that were combined and tested as Nebraska 37. Repeated field plantings revealed superior germination and establishment characteristics when compared with other sources.

'El Reno' was released cooperatively in 1944 by the SCS, Manhattan, Kansas Plant Materials Center and Kansas AES. The original seed was collected in a field location near El Reno, Oklahoma in 1934. The material was outstanding for leafiness, forage production and vigor. It also ranked well for disease resistance, seed production, and winter hardiness. It is widely used in range seedings and is adapted to Kansas, Oklahoma and northern Texas.

'Haskell' was released in 1983 by the James E. "Bud" Smith Plant Materials Center, Texas AES and USDA-ARS. The seed for this release was originally collected in 1960 by J.C. Yeary, Jr. in Haskell, Texas. It was selected based on rhizome production and adaptation as far south as the Rio Grande Valley in Texas. It is also known for its high forage palatability and prolific seed production.

Killdeer was informally released in the late 1960's by the Bismarck Plant Materials Center in Bismarck, ND. It is composed of seed collected from native stands in 1956 near Bowman, Bowman County and Killdeer, Dunn County, North Dakota. Killdeer possesses outstanding vigor, leafiness, fair seed production, freedom from disease and persistence in a cold, semi-arid environment.

'Niner' was released in 1984 by SCS and the New Mexico and Colorado AES. The original seed for the release was collected by G.C. Niner and J.A. Anderson in 1957 west of Socorro, New Mexico. Niner was a bulk increase of the collection made by Niner and Anderson.

Pierre was informally released in 1961 by the Bismarck Plant Materials Center and the South Dakota AES. The original seed for the release was collected in 1954 in Stanley County west of Pierre, South Dakota. The release is described as outstanding in vigor, leafiness, freedom from disease, seedling vigor and persistence in a semi-arid environment.

'Premier' was released in 1960 cooperatively by Texas AES and USDA-ARS and NRCS. The original seed was collected in 1953 from a single plant growing between Cuauhtemoc and Chichuahua, Mexico. The release is described as having good seedling vigor, good seed yield, drought tolerance, upright growth form and leafiness.

'Trailway' was cooperatively released in 1958 by Nebraska AES and USDA-ARS. The original seed was collected in 1953 in northern Holt County by L.C. Newell. The release is described as winter hardy, long lived, late maturing with a somewhat indeterminate heading and flowering response. Requires most of the growing season to mature a crop in eastern Nebraska and may fail to produce seed in areas with a shorter growing season.

'Vaughn' was released in 1940 by the New Mexico AES and SCS Plant Science Division. The original seed was collected from native stands in 1935 near Vaughn, New Mexico. The release is described as slightly variable, but all have erect leaves, good seedling vigor and easy to establish.

Northern, Central and Southern Iowa Germplasms were released in 1995 as source identified releases, by the Elsberry Plant Materials Center, University of Northern Iowa, Iowa Department of Transportation, Iowa Crop Improvement Association and NRVC. They are all composite lines from collections made in Northern, Central and Southern Iowa.

References

Harlan, J.R. 1954. Side-oats Grama (*Bouteloua curtipendula)* Forage Crops Leaflet No. 18. Oklahoma A&M College, Stillwater, OK.

Leithead,H.L., Y.L. Yarlett, and T.N. Shiflet. 1971. 100 native forage grasses in 11 southern states. USDA-SCS Agric. Handb. 389. U.S. GOV. Print Office. Washington,D.C.

Mankin, C. J. 1969. Diseases of Grasses and Cereals in South Dakota. South Dakota State Univ., Agric. Exp. Stn. Tech. Bull. 35.

Newell, L.C., R.D. Staten, E.B. Jackson, and E.C. Conard. 1962. Side-oats Grama in the Central Great Plains. Nebraska Ag. Exp. Stn. Research Bull. 207.

Waller, S.S. and J.K. Lewis. 1979. Occurrence of C3 and C4 photosynthetic pathways in North American grasses. J. Range Manage. 32:12-82.

Weaver, J.E. and F.W. Albertson. 1944. Nature and recovery of grasslands from the great drought of 1933 to 1940. Ecol. Monogr. 14:393-479.

Prepared by and Species Coordinator

Richard Wynia, USDA NRCS Manhattan Plant Materials Center, Manhattan, Kansas

Edited: 070717 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Read about *Civil Rights at the Natural Resources Conservation Service*.

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

WESTERN WHEATGRASS

Pascopyrum smithii (Rydb.) A. Love

Plant Symbol = PASM

Contributed by: USDA NRCS Plant Materials Program

Robert H. Mohlenbrock
USDA NRCS 1989.
Midwestern Wetland Flora
@ USDA NRCS PLANTS

Alternate Names
Agropyron smithii Rydb.

Uses
Erosion control: Western wheatgrass is an excellent erosion control plant because of its spreading rhizomes. It is widely used in seed mixtures for range seeding, revegetation of saline and alkaline areas, and in critical areas for erosion control in the central and northern Great Plains region. This grass protected watershed dams in Kansas from damage when they were overtopped during a 14-inch rainfall event.

Reclamation: Western wheatgrass is frequently used in the northern Great Plains for surface mine revegetation. Because of its strong rhizomes and adaptation to a variety of soils, it performs well as part of a reclamation mixture.

Livestock: Forage quality is high for pasture or range seedings.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description
Pascopyrum smithii (Rydb.) A. Love, western wheatgrass, is perhaps one of the best known and most commonly used native grasses. It is a long-lived, cool season species that has coarse blue- green leaves with prominent veins. Because of this bluish appearance it has sometimes been called bluestem wheatgrass or bluejoint. It is a sod former with very strong, spreading rhizomes. Stems arise singly or in clusters of a few and reach heights of 1 to 3 feet. The sheaths are hairy and the purplish auricles typically clasp the stem. The seed spike is erect and about 2 to 6 inches long.

Adaptation and Distribution
Western wheatgrass is adapted to fine and very fine soils and is replaced by thickspike wheatgrass on coarser soils. Although it is able to grow on a wide variety of soils it prefers the heavier but well drained soils. It requires moderate to high soil moisture content and is most common in the 10 to 14 inch annual precipitation zones. Above 20 inches per year it behaves as an increaser on rangelands, below 20 inches it is a decreaser. Its elevational range is 1,000 to 9,000 feet.

Western wheatgrass tolerates saline and saline-sodic soils, poor drainage and moderately severe drought. It will tolerate spring flooding, high water tables, and considerable silt deposition. It is very cold hardy and can grow in partial shade. It is grazing resistant and can survive fires if in the dormant stage; recovery from fire, however, is slow.

Western wheatgrass grows in association with many species, the more common being blue grama, buffalograss, needlegrasses, bluebunch wheatgrass, rough fescue, Idaho fescue, and prairie junegrass. It begins growth about 2 to 3 weeks before blue grama

and does not mature until much later in the growing season.

Western wheatgrass performs poorly in the East and is not recommended for any use in the region.

Western wheatgrass is distributed throughout the west and midwest portions of the United States. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment
Seed of western wheatgrass should be planted 1/2 to 1 inch deep in fine to medium soil. Seeding rates should be 5 to 15 pounds PLS per acre drilled or 20 to 25 PLS per row foot. If seed is broadcast or used on harsh sites, the rate should be doubled. This species should be seeded in early spring, late fall or in the period of late summer, early fall. It can be sodded.

Seedling vigor is fair and stands may be slow to establish. It has stronger rooting abilities than does thickspike wheatgrass but spreads more slowly and may take several years to become firmly established. Once established, it is very hardy and enduring. It is moderately compatible with other species and is moderately aggressive.

Management
Western wheatgrass greens up in March or early April and matures in August. If moisture is adequate, it will make fair summer or fall regrowth. If nitrogen is applied it will compete with warm season grasses.

Western wheatgrass is moderately palatable to elk and cattle all year although this quality diminishes in late summer. It is palatable to deer only in spring. It is preferred by cattle more than by sheep. It can be grazed if 50 to 60 percent of the annual growth is allowed to remain (3 or 4 inch stubble). Rest rotation of western wheatgrass is advised. In areas where it is dense, it makes an excellent hay as well as pasture.

Irrigation will improve western wheatgrass stands and aid establishment. Weed control and fertilization will also help. Pitting, chiseling, disking, and interseeding can be used to stimulate stands of western wheatgrass.

Pests and Potential Problems
The primary pests to western wheatgrass are grasshoppers, ergot, and stem and leaf rusts.

Cultivars, Improved, and Selected Materials (and area of origin)
'Ariba' western wheatgrass was released for dry land hay production, grazing, and conservation seedings in the western part of the Central Plains and in the southwestern United States. 'Flintlock' is a broad-based cultivar. It is recommended for conservation seeding, dry land hay production, and grazing in the Central Plains. 'Barton' is a strongly rhizomatous, leafy ecotype, intermediate in growth between northern and southern types. 'Barton' is relatively disease free and high in forage and seed production. 'Rosana' is a northern type western wheatgrass. Plants are blue-green, leafy, with moderately fine stems. Rhizomes produce a tight sod. 'Rosana' is recommended for reseeding depleted range lands and the reclamation of disturbed lands in the Northern Great Plains. 'Rodan' northern type western wheatgrass is moderately rhizomatous and forms a dense blue-green sward. Leaves are thinner and less heavily veined than other western wheatgrasses. Western wheatgrass seed is available at most farm seed stores.

Prepared By & Species Coordinator:
USDA NRCS Plant Materials Program

Edited: 05Feb2002 JLK; 060802 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

CRESTED WHEATGRASS
(DESERTORUM TYPE)
Agropyron desertorum (Fisch. ex Link) J.A. Schultes

Plant Symbol = AGDE2

Contributed by: USDA NRCS Idaho State Office

© Robert Soreng
Smithsonian Institution
@ USDA NRCS PLANTS

Alternate Names
standard crested wheatgrass, crested wheatgrass

Uses
Grazing/rangeland/hayland: Crested wheatgrass is commonly recommended for forage production. It is palatable to livestock and wildlife and is a desirable feed in spring, and in the fall if it re-grows enough. It is used for cattle and horse winter forage, but protein supplements are required to ensure good animal health. It withstands heavy grazing pressure (65% use and greater) once stands are established. The best forage types in order are Siberian, desertorum, and Hycrest.

Erosion control/reclamation: Crested wheatgrasses are useful for soil stabilization. They compete well with other aggressive introduced grasses, but because of this trait, they are not compatible in mixes with native species. Their drought tolerance, fibrous root systems, and good seedling vigor make these species ideal for reclamation in areas with 8 to 20 inches annual precipitation. These grasses can be used in urban areas where irrigation water is limited to provide ground cover and to stabilize ditchbanks, dikes, pipelines, powerlines and roadsides.

Wildlife: Birds and small rodents eat crested wheatgrass seeds; deer, antelope and elk graze it, especially in spring and fall. Upland and song birds utilize stands for nesting.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description
Crested wheatgrasses *Agropyron cristatum*, *Agropyron desertorum*, and Siberian wheatgrass *Agropyron fragile* are perennial grasses commonly seeded in the western United States. They are long-lived, cool season, drought tolerant, introduced grasses with extensive root systems. Crested wheatgrass grows from 1 to 3 feet tall and seed spikes may be 1.5 to 3 inches long. Spiklets flattened, closely overlapping, located divergent (flatwise) at a slight angle on the rachis flower stem. The lemmas generally narrow to a short awn and glumes are firm, keeled, tapering into a short bristle. Culms are erect, in a dense tuft and leafy. Leaves are flat, smooth below, slightly coarse above and vary in width from 2 to 6 mm.

Adaptation and Distribution
Crested wheatgrasses are adapted for non-irrigated seedings where annual precipitation averages 8 inches or more and where the frost free period is generally less than 140 days. The desertorum type is adapted to the Northwest, Intermountain and Great Plains regions with at least 8 inches of annual precipitation below 6500 feet elevation. It does well

on shallow to deep, moderately course to fine textured, moderately well to well drained and weakly acidic to moderately alkaline soils. Under saline conditions, vigor and production are reduced. The desertorum type is more saline tolerant and equal to or more productive than other crested wheatgrass types. All wheatgrasses are cold tolerant, can withstand moderate periodic flooding in the spring, and are very tolerant of fire. They will not tolerate long periods of inundation, poorly drained soils or excessive irrigation.

Crested wheatgrass is distributed throughout much of the West and Midwest. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Web site.

Establishment
Crested wheatgrass should be seeded with a drill at a depth of 1/2 inch or less on medium to fine textured soils and 1 inch or less on coarse textured soils. Single species seeding rates recommended for all crested wheatgrasses are 5 to 7 pounds Pure Live Seed (PLS) or 20 to 30 PLS per square foot. If used as a component of a mix, adjust to percent of mix desired. For critical areas, increase the seeding rate to 40 to 50 PLS per square foot. Mulching and light irrigations on highly disturbed areas are beneficial for stand establishment.

Best seeding results are obtained in very early spring on heavy to medium textured soils and in late fall on medium to light textured soils. Late summer (August to mid September) seedings are not recommended unless irrigation is available. If weed control is needed, application of 2,4-D should not be made until plants have reached the four to six leaf stage. Mow weeds that are beginning to bloom to reduce weed seed development. New stands may also be damaged by grasshoppers and other insects; pesticides may be required.

Management
Crested wheatgrasses produce leaves in the spring about 10 days after bluegrass species and about 2 to 3 weeks earlier than native wheatgrasses. New stands of crested wheatgrass should not be grazed until they are firmly established and have started to produce seed heads. Six inches of new growth should be attained in spring before grazing is allowed in established stands. Three inches of stubble should remain at the end of the grazing season to maintain the long term health of the plant.

Crested wheatgrasses are low maintenance plants; however, spring/fall deferment or grazing rotations are recommended to maintain plant health and to maximize forage production potential. Crested wheatgrass can be used for hay production and will make nutritious feed, but is more suited to pasture use. Light, infrequent applications of nitrogen (25 pounds/acre) and irrigation will increase total biomass production and lengthen the green period.

Environmental Concerns
Crested wheatgrasses are long-lived, spread primarily via seed, but may also spread via rhizomes in the case of the cristatum types. They are not considered "weedy" or invasive species. Most seedings do not spread beyond original plantings, or if they do spread, the rate of spread is not alarming. They will cross with each other, but do not cross with native species. Crested wheatgrasses resist winter annual competition better than native species because they germinate earlier and grow more rapidly at colder temperatures. Due to commonly being planted in monocultures (single species) stands in the past, some feel crested wheatgrasses are not ecologically appropriate. It is important to consider multiple species mixes to avoid this conception.

Cultivars, Improved, and Selected Materials (and area of origin)
'Nordan' (central Asia/former USSR) has good seedling vigor and seed quality and long term forage yields are as good or better than other types. 'Summit' (former USSR) is considered very similar to 'Nordan.' *Agropyron cristatum* x *Agropyron desertorum* (Hycrest type) is a hybrid between the cristatum and desertorum types which results in a plant with excellent seedling vigor. 'Hycrest' (central Asia/former USSR) is easier to establish than either of its parents and is more productive during the establishment period than either parent. Long term productivity exceeds the cristatum type and is equal to the desertorum type.

Prepared By & Species Coordinator:
Dan Ogle, Plant Materials Specialist
USDA NRCS Idaho State Office, Boise, Idaho

Edited: 31Jan2002 JLK; 24may06jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 14th and Independence Avenue, SW, Washington, DC 20250-9410 or call 202-720-5964 (voice or TDD). USDA is an equal opportunity provider and employer.

Read about Civil Rights at the Natural Resources Convervation Service.

USDA United States Department of Agriculture

A Conservation Plant Released by the Natural Resources Conservation Service
Los Lunas Plant Materials Center, Los Lunas, NM

‘Pastura’ little bluestem

Schizachyrium scoparium (Michx.) Nash

‘Pastura’ little bluestem (*Schizachyrium scoparium*)

‘Pastura’ little bluestem was released in 1964 by the New Mexico State University’s Los Lunas Agricultural Science Center and the Los Lunas Plant Materials Center in Los Lunas, New Mexico.

Description
‘Pastura’ little bluestem is a warm-season, long-lived, perennial, native grass having good seed and forage production, and good seedling vigor.

‘Pastura’ is a bunchgrass of medium height having uniform size, growth habit, and color. It is of the green type in contrast to the bluish-green type commonly found further east. Plants are erect, non-lodging at maturity, with dense, basal leaf growth averaging 12 inches in height; culms average 24 inches. Little bluestem is a cross-pollinated species.

Source
The original seed was collected in 1957 between Glorieta and Rowe, New Mexico. It was under evaluation until its release in 1964.

Conservation Uses
For this species, ‘Pastura’ little bluestem produces an average amount of high-quality forage. This variety has a uniform appearance, with good basal leaf growth of a greater density than other strains tested.

Area of Adaptation and Use
‘Pastura’ is well-suited for range plantings on light-textured soils of the foothills and plains in central and eastern New Mexico and eastern Colorado. In these areas, it has produced more seed and forage than native collections originating further east. ‘Pastura’ is well adapted to adverse climatic conditions, particularly extremes in temperature and precipitation.

Establishment and Management for Conservation Plantings
Keep the established fields free of weeds by using the recommended herbicide(s) for this species.

Ecological Considerations
‘Pastura’ little bluestem does not appear to have insect problems in either range plantings or seed production plantings.

Seed and Plant Production
Under irrigation, ‘Pastura’ little bluestem grows well on light- to medium-textured soil. Plant in late spring to early summer after the soil has warmed.

For ease of cultivation and irrigation, plant in rows with a spacing of approximately 3 feet (spacing may be adjusted to fit conventional equipment). Plant seed about ½ inch deep with rows in beds or beside shallow furrows so that the seedbed can be irrigated without getting water directly on the row before the seedlings have emerged and begun to grow.

Apply 80 to 100 lbs. nitrogen on established stands at the time of the first irrigation. A color change in the seed heads and early seed shattering indicate the time to harvest seed. The seed heads and, consequently, the whole field becomes a uniformly brownish color.

Use an all-crop type of combine to harvest seed; cut the air flow to a minimum; operate the cylinder at high speed. Spread and dry the harvested material to avoid heating.

Availability
Foundation seed is produced by the Los Lunas Plant Materials Center. Foundation seed is available to certified growers through New Mexico State Seed Certification.

For more information, contact:
Los Lunas Plant Materials Center
1036 Miller Road
Los Lunas, NM 87031
Tele: 505-865-4684
FAX: 505-865-5163
http://plant-materials.nrcs.usda.gov/nmpmc/

Citation
Conservation Plant Release Brochure for 'Pastura' little bluestem (*Andropogon scoparius)* (Michx.) Nash. USDA-Natural Resources Conservation Service, Los Lunas Plant Materials Center, Los Lunas, NM 87031. Published April 1964; edited 21Oct2014ds

For additional information about this and other plants, please contact your local USDA Service Center, NRCS field office, or Conservation District <http://www.nrcs.usda.gov/>, and visit the PLANTS Web site <http://plants.usda.gov> or the Plant Materials Program Web site <http://www.plant-materials.nrcs.usda.gov>

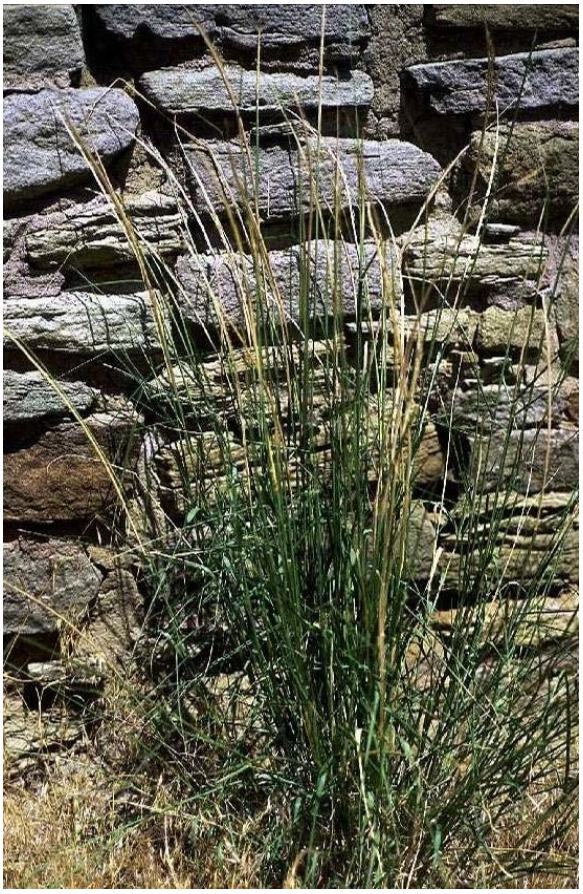
United States Department of Agriculture

This is a cooperative release between New Mexico State University's Los Lunas Agricultural Science and the USDA-Natural Resources Conservation Service's Los Lunas Plant Materials Center.

SAND DROPSEED

Sporobolus cryptandrus (Torr.) A. Gray

Plant Symbol = SPCR



Sand dropseed © Robert Soreng USDA-NRCS

Alternative Scientific Names: *Agrostis cryptandra* Torr. and *Vilfa cryptandra* (Torr.) Trin.

Description

General: Grass Family (Poaceae). Sand dropseed is a long-lived perennial warm season bunchgrass, native throughout North America (Monsen et al., 2004; Ogle et al., 2009). The scientific name, *Sporobolus*, comes from the Greek *sporos* (seed) and *bolos* (a throw), and the common name, dropseed, both refer to the seeds which fall or may be ejected from the inflorescence when the mucilaginous fruit wall dries (Peterson, et al., 2003). Mature plants range from 11 to 40 inches tall. Plants are typically erect but may also be decumbent. The collar is a conspicuous tuft of white hairs which may be up to 0.16 inches long. Leaf blades are 0.08 to 0.25 inches wide and 3 to 10 inches long. The inflorescence is a panicle, 6 to 16 inches long and 1 to 5 inches wide, initially contracted and spike-like, but opening with maturity into a pyramidal shape as the inflorescence escapes the subtending sheath (Welsh et al., 2003). Spikelets contain a small, single brown to purplish floret, 0.06 to 0.1 inches long. The glumes, lemmas and paleas are membranous (Peterson, et al., 2003) and contain a 1 mm long caryopsis (Welsh et al., 2003).

This species produces a dense, sand binding network of roots which can spread up to 2 feet laterally and over 8 feet deep (Coupland and Johnson, 1965).

Sand dropseed is a prolific seed producer. In one study, a single panicle yielded approximately 10,000 seeds (Brown, 1943). Seeds are very small; there are approximately 5.6 million seeds/lb, and 67 pounds of seed per bushel.

Distribution: Sand dropseed is native throughout North America but is most important as a rangeland species in the Southwest and certain parts of the Snake, Salmon, and Clearwater River drainages in Idaho and Oregon (USDA, 1937). For current distribution, consult the Plant Profile page for this species on the PLANTS web site.

Habitat: In the Intermountain West, sand dropseed is commonly associated with Indian ricegrass, bluebunch wheatgrass and galletta grass in sagebrush, desert shrub and pinyon-juniper plant communities. In its southern range, it is often found growing with side-oats grama and *Muhlenbergia* species. It is common in the short-grass prairies and chaparral communities. It also can be found in a variety of habitats in South Texas, from deep sands where it is a member of the climax plant community to heavier soils where it is an early successional colonizer.

Adaptation

Sand dropseed is extremely drought tolerant and is adapted to sites receiving 7 to 16 inches annual precipitation (Ogle et al., 2009; USDA 2009). Its fine root system allows sand dropseed to extract water at depths between 0 and 30 cm more effectively than broom snakeweed (*Gutierrezia sarothrae*) (Wan et al., 1993). During periods of summer drought the leaves roll up to reduce surface area and evapotranspiration (Wan et al. 1993). It is considered to be one of the most drought resistant species in short-grass prairie (Wan et al. 1993).

Sand dropseed is most common at lower elevations in sandy soils but can also be found on coarse soils at upper elevations to 8,000 ft (Jensen et al., 2001; Ogle et al., 2009). It is adapted to slightly acidic to slightly basic soils and has a salt tolerance of less than 4 mmhos/cm (Dickerson, 1998).

Uses
Erosion control/rehabilitation of disturbed areas: Sand dropseed is widely used in disturbed area plantings in the Southwest, Intermountain West and short-grass prairies of the Great Plains. The fibrous root system effectively stabilizes sand dunes and hills. Its abundant seed production makes it a pioneer plant in disturbed areas and an invader of sandy soils. It has also been noted as an early native colonizer in sites suffering from water stress (Coupland, 1958).

Ethnobotany
Sand dropseed seed has been used to make bread and porridge by Apache, Hopi and Navajo tribes (Castetter et al., 1936; Colton, 1974; Vestal, 1952). The plant has also been used to create a cold infusion that is applied to sores and bruises on the legs of horses (Vestal, 1952).

Status
Threatened or Endangered: This species is listed as threatened in Connecticut and New Hampshire (New Hampshire Natural Heritage Bureau, 2006; State of Connecticut, 2004), and rare in Pennsylvania (Commonwealth of PA, 2009). It is not considered a rare plant in the western United States. Please consult the PLANTS Web site (http://plants.usda.gov/) and your State Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Weedy or Invasive: This plant may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. Please consult with your local NRCS Field Office, Cooperative Extension Service office, state natural resource, or state agriculture department regarding its status and use.

Please consult the PLANTS Web site (http://plants.usda.gov/) and your state's Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Planting Guidelines
Seedbed preparation should begin well in advance of planting. Establish a clean, weed-free seedbed by either tillage or herbicides. Prior to planting, the site should be firm and have accumulated soil moisture.

In some areas, sand dropseed requires overwintering or scarification for successful germination. The seed coat is very hard and impermeable. Seed lots frequently contain up to 50% hard seed; however, the seed can retain high levels of viability for many years under proper seed storage conditions. One seed lot that was twenty year old recorded 75% viability (USDA, 1937). Older seed generally has better germination and establishment than younger seed (Monsen et al., 2004).

For rangeland plantings, use 0.5 to 1.0 lbs pure live seed (PLS)/ac for solid stands (Allison, 1988; Ogle et al., 2009). Drill or broadcast seed onto the surface to 1/8 inch depth into lightly prepared sandy and fine soils. Seed can be planted slightly deeper into coarse soils. Follow seeding with a light harrowing or cultipacking. Establishment is dependent upon spring and summer soil moisture. Sand dropseed seedlings have low vigor, but once established the plants are able to withstand severe summer drought periods. Due to slow development, grazing should be deferred for at least two years to ensure good establishment.

Management
This species spreads naturally from seed once established (Plummer et al., 1955) and increases on depleted rangelands and wastelands (Welsh et al., 2003). Sand dropseed plants are able to withstand heavy use due to their protected root crown, late maturity and because they are less preferred than other species (Monsen et al., 2004). However, plants can be killed by overgrazing as a result of continued close cropping. When grazed properly, sand dropseed increases on poor condition, low seral ecological sites (USDA, 1937).

Pests and Potential Problems
There are no potential problems or pests associated with sand dropseed.

Environmental Concerns
There are no potential problems or pests associated with sand dropseed.

Control
Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method.

Seeds and Plant Production
For seed production fields, sand dropseed should be seeded at a rate of 0.5 lbs/ac in 20 to 36 inch row spacing in a firm weed-free seedbed. In the Southwest it is possible to have multiple harvests in a single growing season (USDA-NRCS, 2016). Seed

shatters readily, however portions of the mature inflorescence are held in the sheath preventing some seed loss (Majerus 2009). Seed yields range from 250 to 1,000 lbs/ac with an average of 90% PLS. Fields will produce good seed yields for two to three years before needing to be re-established.

Cultivars, Improved, and Selected Materials (and area of origin)

Borden County Germplasm sand dropseed was released in 2000 by the James E. 'Bud' Smith Plant Materials Center in Knox City, Texas. The original collection was made near Gail, Texas in MLRA 78B. Its primary intended use is for rangeland seeding for livestock and wildlife. It is recommended for use in central and western Texas and western Oklahoma in MLRAs 42, 77, 78, 80A, 80B, 81A, 81B and 84B. Generation 0 seed is maintained by the Plant Materials Center and is available in limited quantities for seed increase (USDA-NRCS, 1999).

Nueces Germplasm sand dropseed was cooperatively released in 2016 by the E. "Kika" de la Garza Plant Material Center and *South Texas Natives*. It was selected for its vigor, forage production, and seed quality throughout the intended area of use. Nueces Germplasm is recommended for use in Rio Grande Plains (MLRA 83 A-E, and Gulf Coast Prairies and Marshes of Texas (MLRA 150A and B) in critical site revegetation and for inclusion in range seeding mixes. Nueces Germplasm is adapted to a wide variety of soil types throughout the Rio Grande Plains. Sand dropseed is widely distributed throughout North America, however Nueces Germplasm has not been tested outside of the recommended area of use.

Literature Cited

Allsion, C. 1988. Seeding New Mexico rangeland. New Mexico State University, Cooperative Extension Service, Circular 525.

Brown, H.R. 1943. Growth and seed yields of native prairie plants in various habitats of the mixed-prairie. Transactions, Kansas Academy of Science. 46: 87-99.

Castetter, E.F., and M.E. Opler. 1936. Ethnobiological studies in the American Southwest III. The Ethnobiology of the Chiricahua and Mescalero Apache. University of New Mexico Bulletin 4(5):1-63.

Colton, H.S. 1974. Hopi history and ethnobotany. P 364. In Horr, D.A. (ed.) Hopi Indians. Garland: New York.

Commonwealth of Pennsylvania. 2009. The Pennsylvania Code. [Online]. Available at http://www.pacode.com/index.html (accessed 9 Dec 2009).

Coupland, R.T. 1958. The effects of fluctuations in weather upon the grasslands of the Great Plains. Botanical Review. 24(5): 273-317.

Dickerson, J.D., B. Wark, D. Burgdorf, R. Maher, T. Bush, B. Poole, and C. Miller. 1998. Vegetating with native grasses in northeastern North America. USDA-NRCS Plant Materials Program and Ducks Unlimited Canada. Syracuse, NY.

Houck, M.J. 1999. Borden County Germplasm sand dropseed. USDA-NRCS. James E. 'Bud' Smith Plant Materials Center. Knox City, TX.

Jensen, K., H. Horton, R. Reed, R. Whitesides, and USDA-ARS-FRRL. 2001. Intermountain Planting Guide. USDA-ARS-FRRL in conjunction with Utah State University Extension, Logan, UT.

Majerus, M.E. 2009. Forage and reclamation grasses of the Northern Great Plains and Rocky Mountains. Valley Printers. Bridger, MT.

Monsen, S.B., Stevens, R. and N. Shaw. 2004. Grasses. P 295-424. In S.B. Monsen, R. Stevens, and N.L. Shaw [compilers]. Restoring western ranges and wildlands. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. General Technical Report RMRS-GTR-136-vol-2.

Mower, K.J., and H.D. Smith. 1989. Diet similarity between elk and deer in Utah. The Great Basin Naturalist 49(4): 552-555.

New Hampshire Natural Heritage Bureau, 2006. Rare plant list for New Hampshire. NH-DRED, Division of Forests and Lands, Concord, NH.

Ogle, D., and B. Brazee. 2009. Estimating initial stocking rates. USDA-NRCS, ID-TN 3. Boise, ID.

Ogle, D., L. St. John, M. Stannard, and L. Holzworth 2009. Grass, grass-like, forb, legume, and woody species for the Intermountain West. USDA-NRCS, ID-TN 24. Boise ID.

Peterson, P.M., S.L. Hatch, and A.S. Weakley. 2003. *Sporobolus*. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 12+ vols. New York and Oxford. Vol. 25, pp. 115-139

Plummer, A.P., Hull, A.C., Stewart, G., and J.H. Robertson. 1955. Seeding rangelands in Utah, Nevada, southern Idaho and western Wyoming. Agric. Handb. 71. USDA-FS. Washington DC.

Roebuck, C.M. 1982. Comparative food habits and range use of pronghorn and cattle in the Texas Panhandle. Ph.D. Diss. Texas Tech University, Lubbock, TX.

State of Connecticut. Department of Environmental Protection. 2004. Connecticut's endangered, threatened and special concern species 2004. Hartford, CT.

Stubbendieck, J., G.Y. Friisoe, & M.R. Bolick. 1994. Weeds of Nebraska and the Great Plains. Nebraska Department of Agriculture, Bureau of Plant Industry. Lincoln, NE.

USDA-FS. 1937. Range Plant Handbook. Washington, DC.

USDA-NRCS. 2006. Seeding rates and production estimates for seed production of conservation species. USDA-NRCS. James E. 'Bud' Smith Plant Materials Center. Knox City, TX.
USDA-NRCS. 2009. The PLANTS Database [Online]. Available at http://plants.usda.gov (accessed 10 December 2009). USDA-NPDC, Baton Rouge, LA.
Vestal, P. 1952. The ethnobotany of the Ramah Navaho. Papers of the Peabody museum of American archaeology and ethnology 40(4): 1-94.
Wan, C, R.E. Sosebee, and B.L. McMichael. 1993. Soil water extraction and photosynthesis in *Gutierrezia sarothrae* and *Sporobolus cryptandrus*. J. Range Manage. 46(5): 425-430.
Weaver, J.E., and J.W. Albertson. 1956. Grasslands of the Great Plains: their nature and use. Johnson Publishing Co., Lincoln, NE.
Welsh, S.L., N.D. Atwood, S. Goodrich, and L.C. Higgins. 2003. A Utah Flora. Third Edition, revised. Brigham Young University, Provo, UT.
Wyoming Game and Fish Department. 2009. Plant species commonly used by sage grouse. [Online]. Available at http://gf.state.wy.us/wildlife/nongame/SpeciesofSpecialConcern/index.asp (accessed 10 Dec 2009). WYGF, Cheyenne, WY.

Citation

Tilley, D., L. St. John, and D. Ogle. 2009. Plant guide for sand dropseed (*Sporobolus cryptandrus*). USDA-Natural Resources Conservation Service, Idaho Plant Materials Center. Aberdeen, ID.

Published February 2010

Edited 5Aug2016 sdm

For more information about this and other plants, please contact your local NRCS field office or Conservation District at http://www.nrcs.usda.gov/ and visit the PLANTS Web site at http://plants.usda.gov/ or the Plant Materials Program Web site:
http://plant-materials.nrcs.usda.gov.

PLANTS is not responsible for the content or availability of other Web sites.

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

SWITCHGRASS

Panicum virgatum L.

Plant Symbol = PAVI2

Contributed by: USDA NRCS Plant Materials Program

Robert H. Mohlenbrock
From the Southern Wetland Flora (1991)
@ plants.usda.gov

Uses

Livestock: Switchgrass is noted for its heavy growth during late spring and early summer. It provides good warm-season pasture and high quality hay for livestock.

Erosion Control: Switchgrass is perhaps our most valuable native grass on a wide range of sites. It is a valuable soil stabilization plant on strip-mine spoils, sand dunes, dikes, and other critical areas. It is also suitable for low windbreak plantings in truck crop fields.

Wildlife: Switchgrass provides excellent nesting and fall and winter cover for pheasants, quail, and rabbits. It holds up well in heavy snow (particularly 'Shelter' and 'Kanlow' cultivars) and is useful on shooting preserves. The seeds provide food for pheasants, quail, turkeys, doves, and songbirds.

Biofuel Source: Interest in switchgrass as a renewable biofuel resource has been increasing in recent years, primarily in the Southern United States. The Booneville, Arkansas, Plant Materials Center (PMC) and the Plant and Soil Science Department of Oklahoma State University (OSU) are cooperating to evaluate several upland types of switchgrass for use as a biomass energy resource. Selections of upland types of switchgrass have been evaluated by OSU for several years. The development of hybrid progeny with substantial heterosis for increased biomass yield will ultimately result in improved hybrid cultivars for the Central and Southern United States. The PMC is in the process of assessing several improved lines along with commercially available cultivars for dry-matter potential and environmental adaptation. Results of this study may contribute to producers cashing in on a growing demand for renewable fuels and a decrease on our dependency on fossil fuels.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Weediness

This plant may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. Please consult with your local NRCS Field Office, Cooperative Extension Service office, or state natural resource or agriculture department regarding its status and use. Weed information is also available from the PLANTS Web site at plants.usda.gov.

Description

Panicum virgatum L., switchgrass, is native to all of the United States except California and the Pacific Northwest. It is a perennial sod-forming grass that grows 3 to 5 feet tall and can be distinguished from other warm-season grasses, even when plants are young, by the white patch of hair at the point where the leaf attaches to the stem. The stem is round and usually has a reddish tint. The seed head is an open, spreading panicle.

Adaptation and Distributions

On suitable soils, switchgrass is climatically adapted throughout the most of the United States. Moderately deep to deep, somewhat dry to poorly drained, sandy to clay loam soils are best. It does poorly on heavy soils. In the East, it performs well on shallow and droughty soil.

Switchgrass is distributed throughout the majority of the United States, excluding the far west states. For a

current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment
Switchgrass should be seeded in a pure stand when used for pasture or hay because it can be managed better alone than in a mixture. Its slick, free-flowing seed can be planted with most seed drills or with a broadcast spreader. In the Southeast, a planting rate of approximately 10 pounds PLS per acre is recommended. Seedbeds should be firmed with a roller prior to the drilling or broadcasting of seed. If seeds are planted using the broadcast method, the area should be rolled afterward to help cover the seed. When drilled, seeds should be planted 1/4 inch deep. No-tillage seedings in closely grazed or burned sod also have been successful, where control of sod is accomplished with clipping, grazing, or proper herbicides.

Phosphorus and potassium should be applied according to soil tests before or at seeding. Nitrogen, however, should not be used at seeding time because it will stimulate weed growth.

Management
To control weeds during establishment, mow switchgrass to a height of 4 inches in May or 6 inches in June or July. Grazing is generally not recommended the first year, but a vigorous stand can be grazed late in the year if grazing periods are short with at least 30 days of rest provided between grazings. Switchgrass is the earliest maturing of the common native warm-season grasses and it is ready to graze in early summer.

Established stands of switchgrass may be fertilized in accordance with soil tests. Phosphorus and potassium may not be needed if the field is grazed since these elements will be recycled back to the soil by the grazing animal. Apply nitrogen after switchgrass has begun to produce using a single application in mid-to-late May or a split application in both May and early July. Avoid high rates of nitrogen because carry-over could spur cool-season grass growth and harm young plants the following spring.

Switchgrass will benefit from burning of plant residues just prior to initiation of spring growth. Burning fields once every 3 to 5 years decreases weed competition, eliminates excessive residue and stimulates switch grass growth. Switchgrass used for wildlife food and cover should be burned once every 3 to 4 years to reduce mulch accumulations that inhibit movement of hatchlings and attract nest predators.

Under continuous grazing management, begin grazing switchgrass after it has reached a height of 14 to 16 inches, and stop when plants are grazed to within 4 inches of the ground during late spring, 8 inches in early summer, and 12 inches in late summer. A rest before frost is needed to allow plants to store carbohydrates in the stem bases and crown. Plants may be grazed to a height of 6 to 8 inches after frost. The winter stubble is needed to provide insulation.

With management intensive systems, grazing can begin in the first paddocks when plants reach a height of 10 inches and should not be grazed below a stubble height of 6 to 8 inches. Grazed paddocks need to be rested 30-60 days before being grazed again.

Pests and Potential Problems
Grasshoppers and leafhoppers can be major pests in new seedings. Some stands are impacted by damping off and seedling blight. Leaf rust occasionally affects forage quality.

Cultivars, Improved, and Selected Materials (and area of origin)
'Alamo' (TX), 'Blackwell' (OK), 'Cave-In-Rock' (IL), 'Dacotah' (ND), 'Forestburg' (SD), 'Kanlow' (OK), 'Nebraska 28' (NE), 'Shawnee,' 'Shelter' (WV) (cultivars); Grenville (NM) (informal release); Miami (Dade Co, FL), Stuart (Stuart, FL), Wabasso (Wabasso, FL) (source identified releases). Seeds are available from most commercial sources and through large agricultural supply firms.

Control
Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA, NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Prepared By & Species Coordinator:
USDA NRCS Plant Materials Program

Edited: 16Jan2001 JLK; 28sep05 jsp; 24may06jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the

PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

WEEPING LOVEGRASS

Eragrostis curvula (Schrad.) Nees

Plant Symbol = ERCU2

Contributed by: USDA NRCS Plant Materials Program

USDA NRCS National Plant Materials Center
Beltsville, MD

Uses

Erosion control: Weeping lovegrass is used as a temporary cover for erosion control purposes. On surface mine spoil, it provides almost immediate cover on steep outer slopes where spoil is rather acidic and of low fertility.

Crops: Weeping lovegrass is used as a nurse crop when seeding sericea lespedeza, coastal panic grass, or switchgrass. When seeding black locust or bristly locust, it serves as a companion species.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

Eragrostis curvula (Schrad.) Nees, weeping lovegrass, is a rapidly growing warm-season bunchgrass that was introduced into the U. S. from East Africa. The many long, narrow leaves emerging from a tight tuft are pendulous, with the tips almost touching the ground. The drooping leaf characteristic gives rise to the name "weeping" lovegrass. Leaf height is rarely above 12 inches. The seed heads are open panicles, reaching a height of 30 to 40 inches and containing numerous small, fine seeds.

Adaptation

Weeping lovegrass prefers a light-textured, well-drained soil, and will thrive on soils of low fertility. Climatic conditions determine its range of adaptation. Low winter temperatures will prevent regrowth and cause the grass to act as an annual or a short-lived perennial.

Weeping lovegrass is distributed throughout the southern United States. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment

This grass is easy to establish by seed. Seed alone at a rate of 3 to 5 pounds per acre, or 1 to 2 pounds per acre in mixtures with other species. Seeds will germinate quickly and plant growth is rapid. The seed is extremely fine, requiring mechanical seeding equipment to have small seed attachments. If seeded with a 'hand' cyclone seeder, the lovegrass seed should be mixed with a diluent or a carrier (cornmeal, sand, or fine sawdust) for uniform distribution of seed. Do not cover seed more than 1/2 to 1 inch on sandy soils; 1/4 inch is sufficient on silt loams. Cultipacking soil before seeding is helpful.

Sites too steep or stony for use of mechanical equipment can be seeded without soil scarification. Broadcast seeding by air or use of hydroseeders is successful if seeding rates are increased to compensate for poor seedbed. Where possible, the soil should be scarified and firmed.

Normally, weeping lovegrass can be planted after danger of severe frost is over, and anytime throughout the summer with success. Lime and fertilizer needs are similar to that for tall fescue and ryegrass when used for temporary cover.

Management
Because of its short duration, there is no management required for weeping lovegrass. It is palatable to livestock and should be protected where this possibility exists.

Pests and Potential Problems
There are no serious pests of weeping lovegrass.

Cultivars, Improved, and Selected Materials (and area of origin)
'A-67', 'Ermelo', and 'Morpa'. Seed is commercially available from most of the large seed companies**.**

Prepared By & Species Coordinator:
USDA NRCS Plant Materials Program

Edited: 01Feb2002 JLK; 06jun06 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

What is this table from?

Table 2. Permissible Shear and Velocity for Selected Lining Materials[1]

Boundary Category	Boundary Type	Permissible Shear Stress (lb/sq ft)	Permissible Velocity (ft/sec)	Citation(s)
Soils	Fine colloidal sand	0.02 - 0.03	1.5	A
	Sandy loam (noncolloidal)	0.03 - 0.04	1.75	A
	Alluvial silt (noncolloidal)	0.045 - 0.05	2	A
	Silty loam (noncolloidal)	0.045 - 0.05	1.75 – 2.25	A
	Firm loam	0.075	2.5	A
	Fine gravels	0.075	2.5	A
	Stiff clay	0.26	3 – 4.5	A, F
	Alluvial silt (colloidal)	0.26	3.75	A
	Graded loam to cobbles	0.38	3.75	A
	Graded silts to cobbles	0.43	4	A
	Shales and hardpan	0.67	6	A
Gravel/Cobble	1-in.	0.33	2.5 – 5	A
	2-in.	0.67	3 – 6	A
	6-in.	2.0	4 – 7.5	A
	12-in.	4.0	5.5 – 12	A
Vegetation	Class A turf	3.7	6 – 8	E, N
	Class B turf	2.1	4 - 7	E, N
	Class C turf	1.0	3.5	E, N
	Long native grasses	1.2 – 1.7	4 – 6	G, H, L, N
	Short native and bunch grass	0.7 - 0.95	3 – 4	G, H, L, N
	Reed plantings	0.1-0.6	N/A	E, N
	Hardwood tree plantings	0.41-2.5	N/A	E, N
Temporary Degradable RECPs	Jute net	0.45	1 – 2.5	E, H, M
	Straw with net	1.5 – 1.65	1 – 3	E, H, M
	Coconut fiber with net	2.25	3 – 4	E, M
	Fiberglass roving	2.00	2.5 – 7	E, H, M
Non-Degradable RECPs	Unvegetated	3.00	5 – 7	E, G, M
	Partially established	4.0-6.0	7.5 – 15	E, G, M
	Fully vegetated	8.00	8 – 21	F, L, M
Riprap	6 – in. d_{50}	2.5	5 – 10	H
	9 – in. d_{50}	3.8	7 – 11	H
	12 – in. d_{50}	5.1	10 – 13	H
	18 – in. d_{50}	7.6	12 – 16	H
	24 – in. d_{50}	10.1	14 – 18	E
Soil Bioengineering	Wattles	0.2 – 1.0	3	C, I, J, N
	Reed fascine	0.6-1.25	5	E
	Coir roll	3 - 5	8	E, M, N
	Vegetated coir mat	4 - 8	9.5	E, M, N
	Live brush mattress (initial)	0.4 – 4.1	4	B, E, I
	Live brush mattress (grown)	3.90-8.2	12	B, C, E, I, N
	Brush layering (initial/grown)	0.4 – 6.25	12	E, I, N
	Live fascine	1.25-3.10	6 – 8	C, E, I, J
	Live willow stakes	2.10-3.10	3 – 10	E, N, O
Hard Surfacing	Gabions	10	14 – 19	D
	Concrete	12.5	>18	H

[1] Ranges of values generally reflect multiple sources of data or different testing conditions.

A. Chang, H.H. (1988).
B. Florineth. (1982)
C. Gerstgraser, C. (1998).
D. Goff, K. (1999).
E. Gray, D.H., and Sotir, R.B. (1996).
F. Julien, P.Y. (1995).
G. Kouwen, N.; Li, R. M.; and Simons, D.B., (1980).
H. Norman, J. N. (1975).
I. Schiechtl, H. M. and R. Stern. (1996).
J. Schoklitsch, A. (1937).
K. Sprague, C.J. (1999).
L. Temple, D.M. (1980).
M. TXDOT (1999)
N. Data from Author (2001)
O. USACE (1997).

REFERENCES

Chang, H.H. (1988). *Fluvial Processes in River Engineering*, John Wiley and Sons, New York and other cities, citing Fortier, S., and Scobey, F.C. (1926). "Permissible canal velocities," *Transactions of the ASCE*, 89:940-984.

Fischenich and Allen (2000). "Stream management," Water Operations Technical Support Program Special Report ERDC/EL SR-W-00-1, Vicksburg, MS.

Florineth, F., (1982). Begrünungen von Erosionszonen im Bereich über der Waldgrenze. Zeitschrift für Vegetationstechnik 5, S. 20-24 (In German).

Gerstgraser, C. (1998). "Bioengineering methods of bank stabilization," GARTEN & LANDSCHAFT, Vol. 9, September 1998, 35-37.

Goff, K. (1999). "Designer linings," *Erosion Control*, Vol. 6, No. 5.

Gray, D.H., and Sotir, R.B. (1996). *Biotechnical and soil bioengineering: a practical guide for erosion control*. John Wiley and Sons, New York.

Julien, P.Y. (1995). *Erosion and sedimentation.* Cambridge University Press, New York.

Kouwen, N.; Li, R.-M.; and Simons, D.B. (1980). "A stability criteria for vegetated Waterways." *Proceedings, International Symposium on Urban Storm Runoff*. University of Kentucky, Lexington, KY, 28-31 July 1980, 203-210.

Norman, J. N. (1975). "Design of stable channels with flexible linings," Hydraulic Engineering Circular 15, U.S. Dept. of Transportation, Federal Highway Adm., Washington, DC.

Schiechtl, H. M., and Stern, R. (1996). *Water Bioengineering Techniques for Watercourse Bank and Shoreline Protection*. Blackwell Science, Inc. 224 pp.

Schoklitsch, A. (1937). *Hydraulic structures; a text and handbook*. Translated by Samuel Shulits. The American Society of Mechanical Engineers, New York.

Shields, A. (1936). "Anwendung der ahnlichkeits-mechanik und der turblenz-forschung auf die geschiebebewegung," *Mitt. Preuss. Versuchsanst. Wasser. Schiffsbau*, 26, 1-26 (in German).

Sprague, C.J. (1999). "Green engineering: Design principles and applications using rolled erosion control products," *CE News Online*, downloaded from http://www.cenews.com/edecp0399.html.

Temple, D.M. (1980). "Tractive force design of vegetated channels, *Transactions of the ASAE*, 23:884-890.

TXDOT (1999). "Field Performance Testing of Selected Erosion Control Products," TXDOT / TTI Hydraulics and Erosion Control Laboratory, Bryan, TX.

USACE TR EL 97-8