Environment

Submitted to:
Colorado Springs Utilities
Colorado Springs, CO

Submitted by:
AECOM
Greenwood Village, Colorado
60508951
March 30, 2022

Coal Combustion Residuals (CCR) Landfill Run-on and Run-off Control System Plan Clear Spring Ranch El Paso County, Colorado

AECOM Environment

Submitted to:
Colorado Springs Utilities
Colorado Springs, CO

Submitted by:
AECOM
Greenwood Village, Colorado
60508951
March 30, 2022

Coal Combustion Residuals (CCR) Landfill Run-on and Run-off Control System Plan Clear Spring Ranch El Paso County, Colorado

Prepared By
Stephen Walker, P.E., Project Engineer

Reviewed By
Patrick Clem, P.E., Senior Engineer

Contents

List of Appendices

List of Figures

List of Acronyms

CCR	coal combustion residuals
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulations
cfs	cubic feet per second
CMP	Corrugated Metal Pipe
CSR	Clear Spring Ranch
CSU	Colorado Springs Utilities
CYs	cubic yards
DLD	dedicated land disposal unit
EDOR	Engineering Design and Operations Report
H:V	horizontal to vertical
NGVD29	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration
PMP	Probable Maximum Precipitation
RCRA	Resource Conservation and Recovery Act
TR-55	Technical Release 55
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
Utilities	Colorado Springs Utilities
WCC	Woodward Clyde Consultants

1.0 Introduction

This Run-on and Run-off Control System Plan has been prepared on behalf of Colorado Springs Utilities and is in general accordance with the Coal Combustion Residuals (CCR) Regulations (CCR Rule) as detailed in 40 Code of Federal Regulations (CFR) 257.81. This section discusses site background, regulatory drivers, and purpose.

1.1 Background

Clear Spring Ranch (CSR) is a 4,759-acre property located at the intersection of Interstate 25 and Ray Nixon Road, approximately 17 miles south of Colorado Springs (**Figure 1**). It was acquired in 1972 by the City of Colorado Springs on behalf of its enterprise Colorado Springs Utilities ("Utilities"). The primary land uses on the CSR property are those related to utility services: electric generation & transmission, water / wastewater treatment & delivery, and waste management.

Power generation at Utilities' Martin Drake and Ray Nixon Power Plants produces CCR. Utilities places these residuals in the CCR Landfill (or "the site") located in the southern part of CSR. Utilities' materials currently authorized by the Colorado Department of Public Health and Environment (CDPHE) and El Paso County for placement in the CCR Landfill are listed in the facility's Engineering Design and Operations Report (EDOR) (CSU, 2012). The location of the CCR Landfill is shown on **Figure 1**.

1.2 Regulations

The CCR Landfill is regulated by the CCR Rule promulgated by the United States Environmental Protection Agency (USEPA, 2015) under 40 CFR Part 257, Subtitle D of the Resource Conservation and Recovery Act (RCRA). The CCR Landfill is also regulated by the CDPHE Hazardous Materials and Waste Management Division under the Regulations Pertaining to Solid Waste Sites and Facilities (6 Code of Colorado Regulations 1007-2, Part 1) (Solid Waste Regulations) (CDPHE, 2022) and by the Local Governing Authority (i.e., El Paso County). The disposal area, as shown on **Figure 1**, is located within the boundaries established by the Clear Spring Ranch Certificate of Designation (CD-04-001) and Use Subject to Special Review (AL-05-006), which were approved by the Board of County Commissioners. This Run-on and Run-off Control System Plan was developed to meet the requirements of the CCR Rule, as detailed in 40 CFR 257.81.

1.3 Purpose

The purpose of this Run-on and Run-off Control System Plan is as follows.

1. Prevent run-on flow onto the active portion of the CCR Landfill during the peak discharge from a 24-hour, 25-year storm.
2. Collect and control run-off from the active portion of the CCR Landfill during the 24-hour, 25-year storm.
3. Document how the run-on and run-off control systems have been designed and constructed to meet 40 CFR 257.81.

2.0 Site Characterization

This section characterizes the site and includes a discussion of the site hydrology, hydrogeology, soil, and current conditions at the CCR Landfill.

2.1 Site Hydrology and Hydrogeology

The CCR Landfill is located in Sand Canyon, a small, west-east trending topographic depression that is bounded to the north and south by outcroppings of Pierre Shale. Approximately 50 feet of Quaternary sediments have been deposited in the canyon. These sediments, referred to as the Piney Creek Alluvium, consist of horizontal layers of clay, silty clay, sand, and gravel. Most of the alluvium is poorly-sorted and fine-grained with silt-sized materials predominating. Bedding is poorly defined except for a thin layer of gravel near the base of the deposit. The Piney Creek Alluvium is saturated beneath the CCR Landfill and forms the uppermost water-bearing zone in Sand Canyon. It is underlain by approximately 3,500 to 4,000 feet of Pierre Shale that forms a hydraulic barrier between the alluvium and deeper water-bearing formations, if present. Groundwater within the Piney Creek Alluvium flows to the east-southeast along the top of the alluvium-Pierre Shale contact. Water level measurements indicate that the saturated thickness of the alluvial water-bearing zone is approximately zero to 25 feet.

Approximately one mile east of the CCR Landfill, Sand Canyon intersects the north-south alluvial channel of Fountain Creek. The upgradient portion of Sand Canyon occupied by the CCR Landfill is cut off from Fountain Creek by the Retention Dam installed by Utilities in 1978. The Retention Dam, located approximately 3,000 feet downgradient (east) of the landfill (**Figure 1**), has a bentonite core and is keyed into the Pierre Shale bedrock. It captures surface water run-off from the CCR Landfill and also restricts groundwater flow. To enhance the dam's performance, Utilities installed a bentonite barrier wall through the upgradient toe of the dam in October 1994 and later added a french drain along the southern downgradient side of the dam to collect residual seepage water. The seepage intercepted by the french drain is pumped back to the upgradient side of the dam. The Retention Dam and french drain are intended to prevent releases that may occur from migrating downgradient to Fountain Creek.

2.2 Site Surficial Soil

According to the United States Department of Agriculture (USDA) Web Soil Survey (USDA, 2016), the CCR Landfill was constructed in an area consisting primarily of two soil types: Razor-Midway complex and Limon clay. The Razor-Midway complex is well drained and the surface layer consists of stony/cobbly clay loam ad clay to a depth of approximately 15 to 30 inches. Permeability of the soil is estimated to be moderately low to moderately high and the available water storage capacity is low to very low. The Limon clay is well drained and the surface layer consists of clay, silty clay, and silty clay loam to a depth of at least 60 inches. Permeability of the soil is estimated to be moderately low to moderately high and the available water storage capacity is high. A printout showing the locations of each soil type from the Web Soil Survey is provided in **Appendix A**.

2.3 Current Conditions

The current CCR Landfill extent is shown on **Figure 2** and includes topography from 2018 USGS Aerial LiDAR and topographic survey from December 23, 2021. The majority of the CCR Landfill is currently filled to an average elevation of approximately 5505 feet (30 to 55 feet above the surrounding ground surface) with a maximum future elevation of 5540 feet (minus the thickness that will be needed for final cover). Side slopes of 3:1 (horizontal to vertical [H:V]) are based on the stability analyses presented in the 2009 Ash Landfill Slope Stability Investigation (Kleinfelder, 2009). The current top of the CCR Landfill is sloped very gently toward the east.

Bottom ash is currently being mined out from the west side of the CCR Landfill (through top-down cutting of slopes). The mined bottom ash is being beneficially reused by other entities. Fly ash is currently being placed (through pushing up the slope in lifts of about 4 inches) and compacted on the east side of the CCR Landfill.

Utilities maintains a Coal Combustion Residuals Fugitive Dust Control Plan (CSU, 2021) to aid in ensuring that operations at the CCR Landfill are performed in accordance with the applicable air quality provisions of the CCR Rule, specifically those within 40 CFR Part 257.80 (a) through (d).

The working pad is the area on the landfill on which the trucks delivering ash to the working face travel and maneuver to dump their load as the landfill is built up to its final grade. The working pad portion of the landfill is typically covered with approximately six inches of bottom ash overlain by roughly three inches of gravel. The gravel provides for stability and dust control and also assists in minimizing the tracking of ash outside of the landfill.

Areas other than the active west side and east side have been covered with a minimum one-foot thick temporary soil cap. These areas have also been seeded in general accordance with the EDOR (CSU, 2012). The seed mixes currently for use on the CCR Landfill are provided within **Appendix B**. A similar seed mix may be used for reseeding.

As of the December 2021 survey date, the landfill was approximately 75 acres (including the west mining area and the east expansion area) and held approximately 3,802,500 cubic yards (CYs). The west portion of the landfill contained approximately 554,000 CYs of bottom ash and the east portion contained approximately 3,248,500 CYs of fly ash.

3.0 Run-On and Run-Off Calculations

The standard engineering methods provided in USDA's Technical Release 55 *Urban Hydrology for Small Watersheds* (TR-55) (USDA, 1986) were used to determine drainage basins and compute curve numbers, run-off volumes, and peak discharges for each drainage basin.

3.1 Drainage Basins

The CCR Landfill area, as well as areas up-gradient of the CCR Landfill, has been divided into eight drainage basins as shown on **Figure 3**. The drainage basins were developed by evaluating the surveyed landfill and surrounding topography, determining general flow directions, and bounding each basin along the drainage divide.

After dividing the CCR Landfill area into drainage basins, they were then further divided into sub-drainage basins for the purpose of curve number calculations as discussed in the next section.

3.2 Curve Number Calculations

A curve number is an empirical parameter used in hydrology to determine the approximate amount of direct run-off from a rainfall event in a particular area. Determination of curve numbers depend on the watershed's soil and cover conditions which TR-55 represents as hydrologic soil group, cover type, and hydrologic conditions. Curve numbers range from 30 to 100 with lower numbers indicating low run-off potential and larger numbers indicating increasing run-off potential.

Each of the drainage basins surrounding the CCR Landfill was further divided into sub-drainage basins based on land type. The following land types were identified based on site observations and aerial photography:

1. Bare Soil (used for the working pad on the west side of the landfill where bottom ash is being mined and used for the working pad on the east side of the landfill where fly ash is being placed)
2. Bottom Ash (used for the open face at the west side of the landfill where bottom ash is being mined)
3. Fly Ash (used for the open face at the east side of the landfill where fly ash is being placed)
4. Dedicated Land Disposal (DLD) (used for the open DLD areas north of the landfill where digested biosolids are land disposed)
5. Range (used for open range areas north and south of the landfill)
6. Vegetated Cover Soil (used for top and side slopes of the landfill that have received cover soil and seeding)

The range and vegetated cover soil was further evaluated to be in good, fair, or poor condition based on approximate percent of ground cover.

The USDA Web Soil Survey (USDA, 2021), as discussed above, was used to determine hydrologic soil group (A, B, C, or D) which is based primarily on soil texture. Group A soils (i.e. sand, loamy sand, or sandy loam) have low run-off potential and high infiltration rates while Group D soils (i.e. clay, clay loam and silty clay) have high run-off potential and low infiltrations rates.

Table 2-2 from TR-55 (provided within **Appendix C**) was then used to determine curve numbers for each land cover scenario. An area-weighted average curve number calculation for each drainage basin is provided within **Appendix D**. The weighted average provides an overall curve number applicable to each drainage basin.

3.3 Run-Off Volume and Peak Discharge Calculations

Run-off volumes and peak discharges were calculated based on the 25-year, 24-hour storm event for each drainage basin per the methods provided in TR-55. The 25-year, 24-hour rainfall is 3.79 inches as determined using the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Point Precipitation Frequency Estimates for Colorado website. Runoff calculations are provided in **Appendix D**. The curve number, flow length, slope, and Manning's roughness coefficient were the primary input parameters used for each drainage basin. Flow length and slope were determined using topographic information provided by UTILITIES. Manning's roughness coefficient was determined using Table 3-1 from TR-55 (provided within **Appendix C**). An area-weighted average Manning's value was calculated (similar to the curve number calculations) for each drainage basin as provided within **Appendix D**.

4.0 Run-On and Run-Off Controls

Run-on and run-off from the CCR Landfill area is currently controlled primarily by two engineered features (as shown on **Figure 1**): 1) a storm water diversion structure, which is comprised of a diversion channel and an earthen diversion berm; and 2) a Retention Dam. These drainage improvements were constructed at the CSR site prior to initiation of the CCR disposal operation in 1978, as discussed in the site design report prepared by Woodward Clyde Consultants (WCC) in 1977 (WCC, 1977). Additional existing run-on and run-off controls consist of several drainage channels (some are constructed and some are natural) and several culverts as discussed below per each drainage basin.

As required by 40 CFR 257.81, run-on from the 24-hour, 25-year storm is diverted around the CCR Landfill as described in this section. Also as required by 40 CFR 257.81, 24-hour, 25-year run-off from the active portions of the CCR Landfill is collected and controlled down-gradient of the CCR Landfill at the Retention Dam and handled in accordance with the surface water requirements under 40 CFR 257.3-3.

4.1 Diversion Channel

The diversion channel diverts flows coming from the Sand Canyon watershed above the site to the northernmost tributary of the adjacent Crooked Canyon watershed (thus avoiding the CCR Landfill disposal area). The channel consists of a trapezoidal cross section with 3:1 (H:V) side slopes, a 50-foot bottom width, a depth of approximately 8.5 feet, and a channel slope of approximately 0.4 percent, that has sufficient capacity to carry the 500-year design flood (3,570 cubic feet per second [cfs]). An additional diversion berm was also designed and constructed on the downstream side of the channel so that flows up to and including the design Probable Maximum Precipitation (PMP) flow (24,800 cfs) would be diverted. The location of the diversion channel is shown on **Figure 1** and **Figure 2**.

URS conducted a hydrologic analysis of the CSR watershed in 2008 (URS, 2009). URS found that the calculated 100-year, 24-hour rainfall event will cause a maximum flow in the Sand Canyon drainage area of 1,363 cfs. The design capacity of the diversion channel alone is in excess of 2.5 times this modeled flow. Based on the URS analysis, the diversion channel at CSR surpasses the 25-year, 24-hour requirements of the CCR Rule.

4.2 Retention Dam

The Retention Dam was designed to store and evaporate flow from the on-site area below the diversion channel for design storms up to one-half the PMP. The dam consists of an earthen embankment structure with a crest height of approximately 5440 feet, referenced to the National Geodetic Vertical Datum of 1929 (NGVD29) and an emergency spillway with a crest elevation of approximately 5432 feet NGVD29. The design storage volume for the one-half PMP storm event was 730 acre-feet with a water-surface elevation of 5432 feet NGVD29. The location of the Retention Dam is shown on **Figure 1**.

The 2008 hydrologic analysis of the CSR watershed (URS, 2009) modeled inflow to the Retention Dam at 146.8 acre-feet, or approximately 20% of the capacity of the Retention Dam. Based on the URS analysis, the pond created by the Retention Dam at CSR surpasses the 25-year, 24-hour requirements of the CCR Rule. Furthermore, there is no modeled outflow from the Retention Dam during the 100-year, 24-hour flood event, which means that flows generated on the CSR, including the CCR Landfill, are contained on-site. The 100-year peak stage of 5,425.3 feet NGVD29 has been mapped as the 100-year approximate floodplain at the Retention Dam.

4.3 Run-on and Run-off Controls by Drainage Basin

Additional run-on and run-off controls vary for each drainage basin as detailed within this section.

4.3.1 Drainage Basin 1

Drainage Basin 1 includes the DLDs located north of the CCR Landfill plus the northwest portion of the filled and vegetated CCR Landfill. Run-off from these areas combines prior to flowing through two existing 36-inch diameter corrugated metal pipe (CMP) culverts (CULV 1a and CULV 1b as shown on **Figure 2**) located on the north side of the CCR Landfill. These two culverts, as currently designed and installed, will route a portion of the 25-year, 24-hour storm event under the perimeter access road according to the calculations within **Appendix D**. A remainder of the run-off, however, is anticipated to back-up into the DLDs and then flow over the road and into CHANNEL 4 (as discussed within Section 4.3.4) during such a storm event. Run-on to the CCR Landfill is not anticipated based on review of the provided topography, the calculated run-off volume from this basin (**Appendix D**), and an evaluation of the existing CHANNEL 4. Run-off leaving Drainage Basin 1 combines with flows from Drainage Basin 4 and ultimately ends up being contained by the Retention Dam.

4.3.2 Drainage Basin 2

Drainage Basin 2 includes the northern part of the open face on the west side of the CCR Landfill where bottom ash is currently being mined and hauled off-site for beneficial reuse. Run-off from this area does not leave the basin based on review of the provided topography. Run-on is controlled and prevented based on the nature of the topography in this area.

4.3.3 Drainage Basin 3

Drainage Basin 3 includes the southern part of the open face on the west side of the CCR Landfill where bottom ash is currently being mined and hauled off-site for beneficial reuse. It also includes the southwest portion of the filled and vegetated CCR Landfill plus the open/range area to the south. Run-off from these areas combines into a natural drainage channel prior to flowing through an existing 15-inch diameter metal culvert (CULV 3 as shown on **Figure 2**) located on the south side of the CCR Landfill. This culvert, as currently designed and installed, will route a portion of the 25-year, 24-hour storm event according to the calculations within **Appendix D**. The remainder of the run-off, however, is anticipated to back-up and temporarily pond within Drainage Basin 3 until CULV 3 can eventually drain the area during such a storm event. Run-on to the CCR Landfill is not anticipated based on review of the provided topography and the calculated run-off volume from this basin (**Appendix D**). Run-off leaving Drainage Basin 3 combines with flows from Drainage Basin 5 and ultimately ends up being contained by the Retention Dam.

4.3.4 Drainage Basin 4

Drainage Basin 4 includes the northeast portion of the filled and vegetated CCR Landfill plus a small triangular portion of open/range area to the north. Run-off from these areas combines and joins with the outflow from Drainage Basin 1 prior to flowing through a drainage channel (CHANNEL 4 as shown on **Figure 2**) and then through an existing 30-inch culvert (CULV 4 as shown on **Figure 2**) located at the northeast corner of the CCR Landfill. This drainage channel, as currently designed and installed, should be just large enough to route the run-off from a 25-year, 24-hour storm event according to the calculations within **Appendix D**. The culvert, as currently designed and installed, will route a portion of the 25-year, 24-hour storm event according to the calculations within **Appendix D**. The remainder of the run-off, however, is anticipated to back-up into Drainage Basin 4 prior to flowing over the road and into CHANNEL 7 (as discussed within Section 4.3.7) during such a storm event. Run-on to the CCR Landfill is controlled by the berms constructed within Drainage Basin 6 as discussed below. Run-off leaving Drainage Basin 4 combines with flows from Drainage Basin 7 and ultimately ends up being contained by the Retention Dam.

4.3.5 Drainage Basin 5

Drainage Basin 5 includes the southeast portion of the filled and vegetated CCR Landfill plus the open/range area to the south. Run-off from these areas combines and joins with the outflow from Drainage Basin 3 prior to flowing through a natural drainage which ultimately leads to the Retention Dam, as discussed above. The natural drainage is sized adequately according to the calculations within **Appendix D**.

4.3.6 Drainage Basin 6

Drainage Basin 6 includes the open face on the east side of the CCR Landfill where fly ash is currently being placed. Run-off from this area does not leave the basin, but instead will infiltrate into the surface or temporarily pond in this area prior to infiltration or evaporation. A two-foot high soil berm has been constructed along the north and east sides of Drainage Basin 6 with the intent of preventing run-on from entering the basin from the north and preventing run-off from leaving the basin from the east.

4.3.7 Drainage Basin 7

Drainage Basin 7 includes the DLDs located northeast of the CCR Landfill, a portion of open/range area located in between DLDs and the Supernatant Lagoons to the north and northeast of the CCR Landfill, a portion of the open/range area located east of the CCR Landfill, and the east facing slope adjacent to the active fill area at the southeast corner of the landfill. Run-off from this area combines and joins with the outflow from Drainage Basin 4 prior to flowing into a constructed drainage channel (CHANNEL 7 as shown on **Figure 2**). The constructed drainage channel is sufficient to route the run-off from a 25-year, 24-hour storm event according to the calculations within **Appendix D**. CHANNEL 7 flows to the east and disperses into overland flow east of the CCR Landfill prior to re-concentration within a natural drainage channel. The natural drainage channel flows to the Retention Dam. Run-on to the CCR Landfill is not anticipated based on a review of the provided topography east of the CCR Landfill.

4.3.8 Drainage Basin 8

Drainage Basin 8 consists of DLD land, Solids Handling Building and associated infrastructure (such as digesters, parking area, etc.), and open range land located north of the landfill and east of Drainage Basin 1. Runoff from sub-basin 8a flows south via overland and channelized flow to a culvert under an access road crossing, northeast of the supernatant lagoons. Sub-basin 8b consists of a 16 acre hill that flows into CHANNEL 8. Flow from 8a and 8b continues through CHANNEL 8 to another culvert, CULV 5 shown in Figure 3. The channel has the capacity to handle the runoff from 8a and 8b generated by the 25-year, 24-hour storm. The culvert must be cleaned out and inspect to verify capacity. If the channel were to overtop as a result of a blocked culvert, the flow would drain into CHANNEL 7, where it would make its way east via natural topography into the Retention Dam. CHANNEL 7 has the capacity to convey additional flow from Drainage Basin 8. Sub-basin 8c is a small, 2.3 acre area that flows into CHANNEL 7 via a 12-inch culvert (CULV 6) and natural topography.

5.0 Inspections and Maintenance of Run-On and Run-Off Controls

5.1 Inspections

Throughout operation, the CCR Landfill is inspected weekly by a qualified person for appearance of actual or potential structural weakness and other conditions which are disrupting or have the potential to disrupt the operation or safety of the CCR Landfill. The run-on and run-off control system is one of the items inspected each week. Inspections are documented with a CSR CCR Landfill Weekly Inspection Checklist (provided in **Appendix E**).

The CCR Landfill is also inspected annually during operations by a qualified professional engineer to ensure that the design, construction, operation, and maintenance of the CCR Landfill are consistent with recognized and generally accepted good engineering standards. The inspection includes visual observation of the CCR Landfill, including observation of erosion control measures for slopes and the perimeter road, observation of erosion that may be contributing to landfill material transport off-site, and observation of the run-on and run-off controls (including drainage channels and culverts).

The qualified professional engineer prepares an inspection report in accordance with 40 CFR 257.84 to document the inspection and make maintenance recommendation. Noted deficiencies or releases identified during the inspection are remedied as soon as feasible. The 2021 annual inspection occurred on September 21, 2021 and is documented in a report by Terracon (Terracon, 2021).

5.2 Maintenance

Erosion rills/gullies/channels will be repaired by tracking a bulldozer up and down the slopes (in areas that have not yet been seeded), hand raking (for small areas), or by grading or backfilling (for larger areas). Storm water may be redirected by construction of temporary berms. Erosion control blankets or wattles may be placed on slopes as needed. The use of riprap or other forms of armoring may be evaluated for use in drainage channels and on steep slopes. Re-seeding bare areas or application of soil amendments may be used to promote vegetation growth.

Eroded drainage channels and culvert inlet/outlets will be graded and repaired as necessary to return the controls to design conditions. Ponding within drainage channels will be repaired/graded such that positive grade is maintained. Debris/sediment/vegetation blocking drainage channels and/or culverts will be removed. Crushed culverts or otherwise mal-functioning culverts will be replaced or repaired as needed to maintain design capacity.

6.0 Amendment, Recordkeeping, and Notification

6.1 Amendment of the Plan

As required by 40 CFR 257.81(c)(2), Utilities may amend this Run-on and Run-off Control System Plan at any time provided the revised plan is placed in the facility's operating record. Utilities will amend this plan whenever there is a change in conditions that would substantially affect the plan.

As required by 40 CFR 257.81(c)(4), Utilities will revise this Run-on and Run-off Control System Plan every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the subsequent plans. Utilities may complete any required plan prior to the required deadline provided that Utilities places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. Any amendment of this plan will be certified by a qualified professional engineer.

6.2 Recordkeeping

Utilities will maintain their files with Run-on and Run-off Control System Plans (this version plus subsequent revisions), inspections, maintenance, and other pertinent documents within the facility's operating record for a period of at least five years in accordance with 40 CFR 257.105.

6.3 Notification

Utilities will notify CDPHE whenever the Run-on and Run-off Control System Plan (along with subsequent updates), inspection reports, and/or documentation of maintenance has been placed in the operating record in accordance with the notification requirements specified in 40 CFR 257.106.

7.0 Certification

Certification Statement 40 CFR § 257.81(c)(5) – Coal Combustion Residuals (CCR) Landfill Run-on and Run-off Control System Plan, Clear Spring Ranch, El Paso County, Colorado

CCR Unit – Colorado Springs Utilities, Clear Spring Ranch, CCR Landfill

I, Stephen Walker, being a Registered Professional Engineer in good standing in the State of Colorado, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the information contained in the CCR Landfill Run-on and Run-off Control System Plan dated March 30, 2022 meets the requirements of 40 CFR § 257.81.

Stephen Walker
Printed Name

March 30, 2022
Date

8.0 References

Colorado Department of Public Health and Environment (CDPHE). 2022. Hazardous Materials and Waste Management Division. 6 Code of Colorado Regulations 1007-2, Part 1, Regulations Pertaining to Solid Waste Sites and Facilities, Effective January 14, 2022.

Colorado Springs Utilities (CSU). 2012. Engineering Design and Operations Report, Appendix A Coal Combustion Products Disposal Operations. Colorado Springs Utilities. Updated June 25, 2012.

CSU. 2021. Coal Combustion Residuals Fugitive Dust Control Plan. Colorado Springs Utilities. December 2021.

Kleinfelder. 2009. Geotechnical Engineering Services, Ash Landfill Slope Stability Investigation, Clear Spring Ranch Facility, Southwest of Interstate 25 and Ray Nixon Road, Southwest of Fountain, CO. Prepared by Kleinfelder. November 17, 2009.

National Oceanic and Atmospheric Administration (NOAA). 2014. NOAA Atlas 14 Point Precipitation Frequency Estimates: CO. US Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Office of Water Prediction. Available online at http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=co. Page last modified August 27, 2014.

Terracon. 2022. Coal Combustion Residual (CCR) Landfill Annual (2021) Inspection. Prepared by Terracon Consultants, Inc. January 17, 2022.

URS. 2009. Letter of Map Revision For Clear Spring Ranch. Prepared by URS for Colorado Springs Utilities. February 17, 2009.

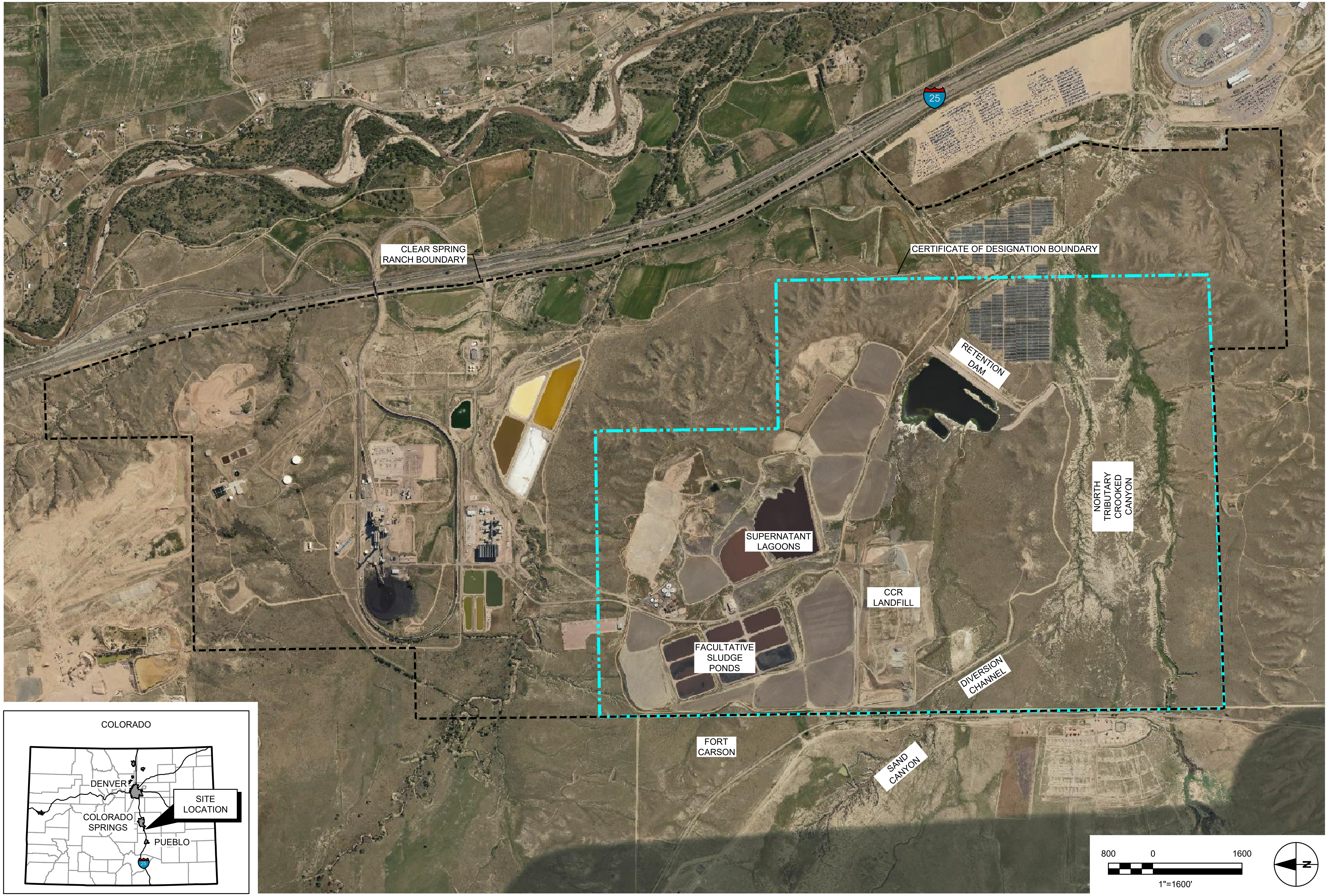
United States Department of Agriculture (USDA). 1986. Urban Hydrology for Small Watersheds, Technical Release 55. Natural Resources Conservation Service – Conservation Engineering Division, United States Department of Agriculture. June, 1986.

USDA. 2016. Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed August 9, 2016.

U.S. Environmental Protection Agency (USEPA). 2015. 40 CFR Parts 257 and 261 Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. Federal Register, v.80, no. 74, April 17, 2015, 201 pp.

Woodward Clyde Consultants (WCC). 1977. Site Design Report. Prepared by Woodward Clyde Consultants. 1977.

Figures



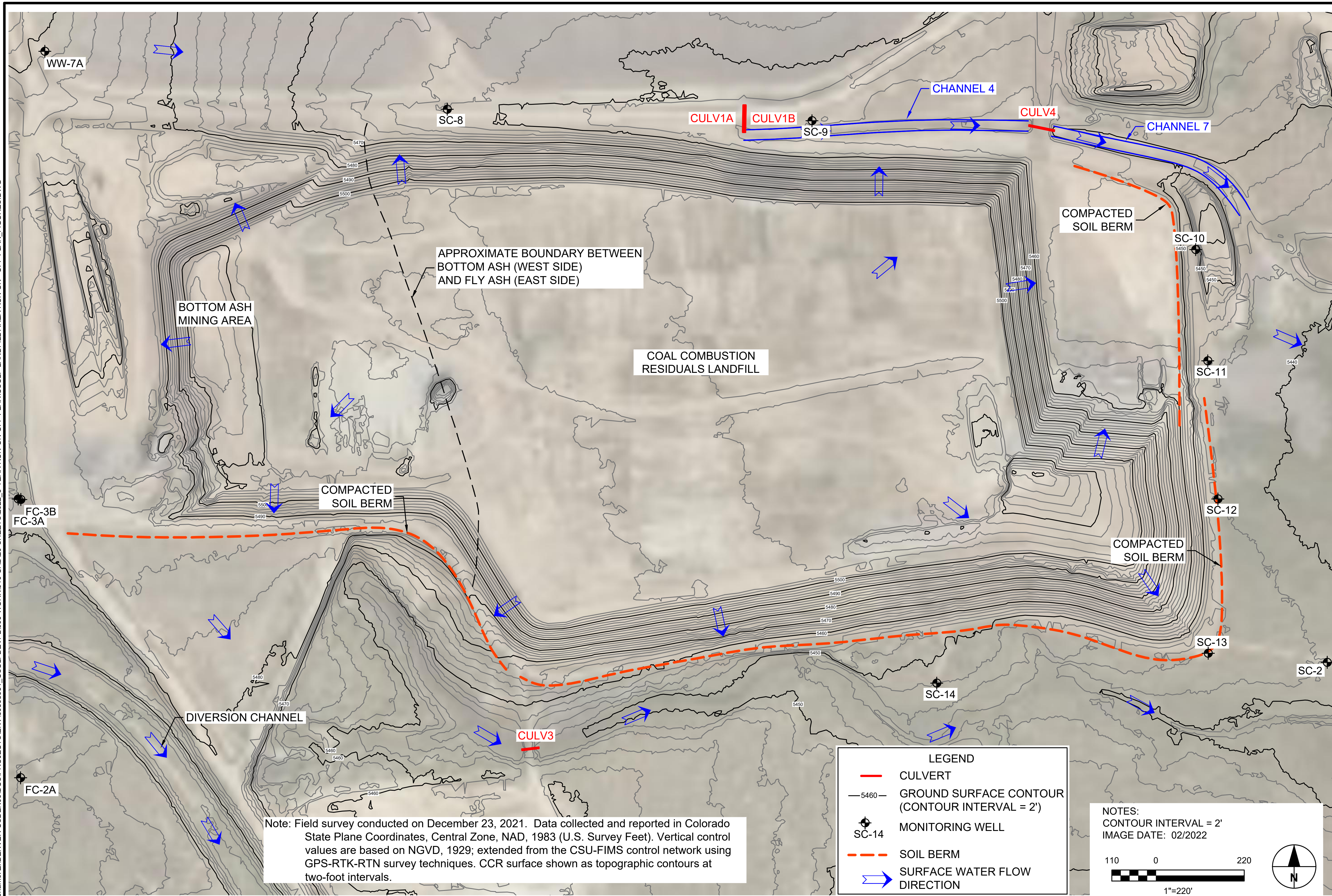
AECOM

Figure: 1

SITE LOCATION MAP

CCR Landfill Run-On and Run-Off Control System Plan
Colorado Springs Utilities Clear Spring Ranch Facility
El Paso County, Colorado
Project No.: 60508951 Date: 02/01/2022

Last saved by: STEVE.WALKER(2022-03-10) Last Plotted: 2022-03-30
Filename: Z:\DENVER-USDEN06\DCS\PROJECTS\ENV\60508951_CSULFDEVPL\900-WORK\910-CAD\20-SHEETS\2022_5-YEAR RUN-ON-OFF PLAN\CSULF-LANDFILL AREA RUN ON - OFF PLAN_FIGURES.DWG
Project Management Initials: Designer: Checked: Approved: ANSI B 11" x 17"



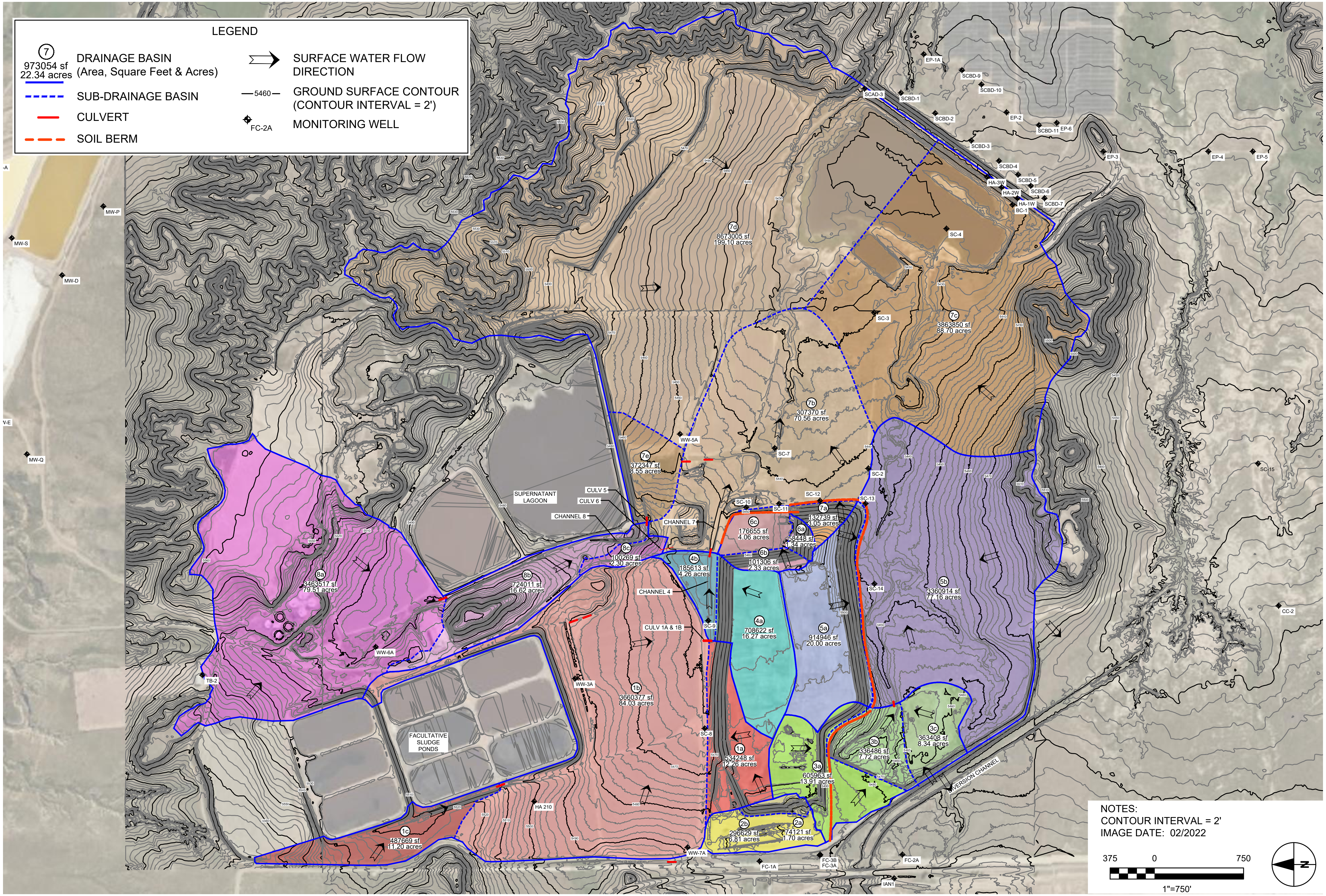
AECOM

Figure: 2

CCR LANDFILL PLAN - EXISTING CONDITIONS

CCR Landfill Run-On and Run-Off Control System Plan
Colorado Springs Utilities Clear Spring Ranch Facility
El Paso County, Colorado
Project No.: 60508951 Date: 02/01/2022

Last saved by: STEVE.WALKER(2022-03-10) Last Plotted: 2022-03-30
Filename: Z:\DENVER-USDEN06\DCS\PROJECTS\ENV\60508951_CSULFDEVPL\900-WORK\910-CAD\20-SHEETS\2022_5-YEAR RUN-ON-OFF PLAN\CSULF-LANDFILL AREA RUN ON - OFF PLAN_FIGURES.DWG
Project Management Initials: Designer: Checked: Approved: ANSI B 11" x 17"



AECOM

Figure: 3

CCR LANDFILL PLAN
RUN-ON SUB-BASINS

CCR Landfill Run-On and Run-Off Control System Plan
Colorado Springs Utilities Clear Spring Ranch Facility
El Paso County, Colorado
Project No.: 60508951 Date: 02/01/2022

ANSI B 11" x 17"
Project Management Initials: Designer: Checked: Approved:

Last saved by: STEVE.WALKER(2022-03-10) Last Plotted: 2022-03-30
Filename: Z:\DENVER-USDEN06\DCS\PROJECTS\ENV\60508951_CSULFDEVPL\900-WORK\910-CAD\20-SHEETS\2022_5-YEAR RUN-ON-OFF PLAN\CSULF-LANDFILL AREA RUN ON - OFF PLAN_FIGURES.DWG

Appendix A
Web Soil Survey Information

United States Department of Agriculture

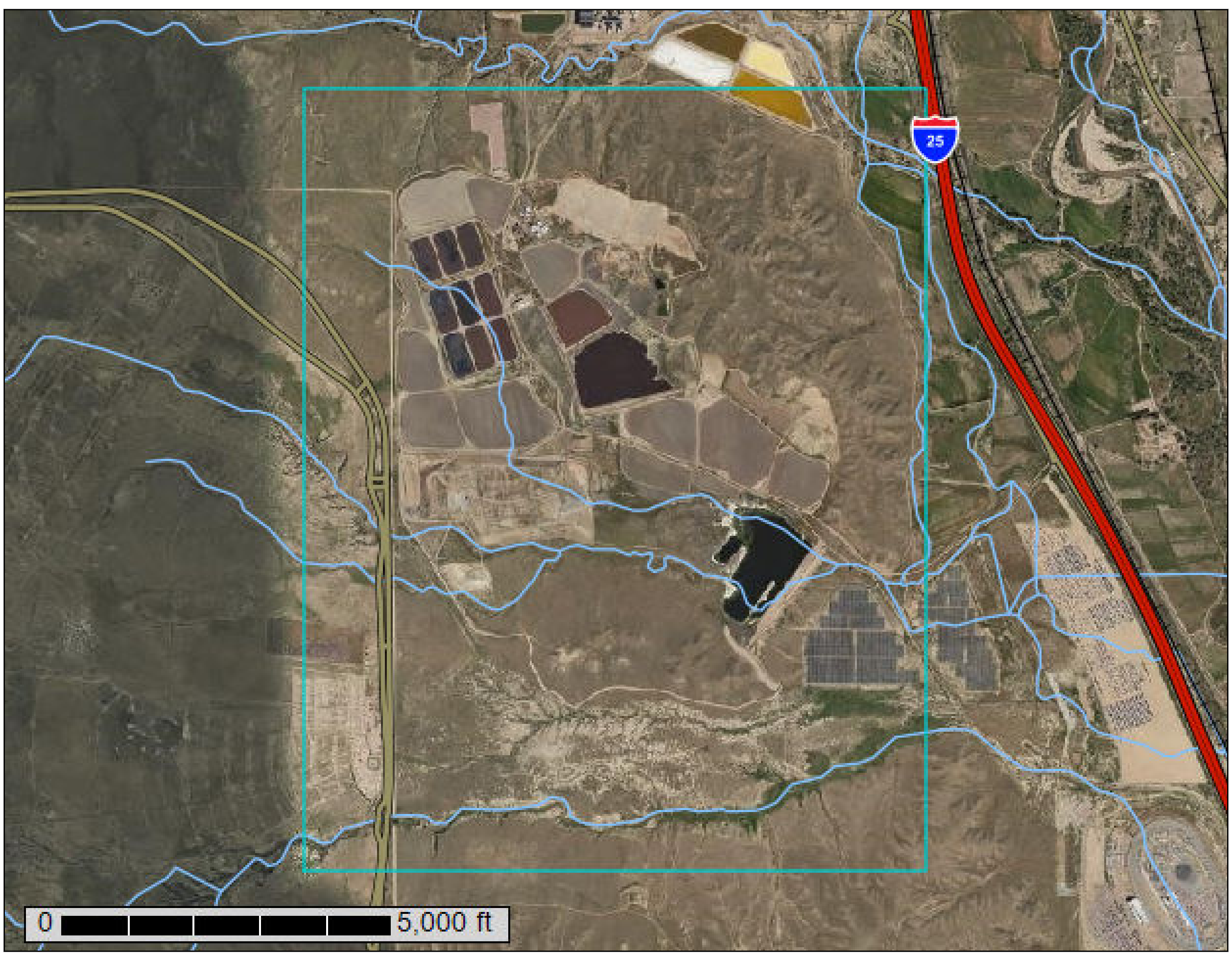
NRCS

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



February 3, 2022

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

How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

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

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

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

Custom Soil Resource Report
Soil Map

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 19, Aug 31, 2021

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

Date(s) aerial images were photographed: Aug 14, 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
43	Kim loam, 1 to 8 percent slopes	411.8	16.0%
47	Limon clay, 0 to 3 percent slopes	860.6	33.5%
54	Midway clay loam, 3 to 25 percent slopes	51.8	2.0%
75	Razor-Midway complex	335.1	13.0%
82	Schamber-Razor complex, 8 to 50 percent slopes	575.5	22.4%
107	Wilid silt loam, 0 to 3 percent slopes	122.6	4.8%
NOTCOM	No Digital Data Available	213.8	8.3%
Totals for Area of Interest		**2,571.1**	**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

43—Kim loam, 1 to 8 percent slopes

Map Unit Setting

National map unit symbol: 368k
Elevation: 5,300 to 5,600 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Kim and similar soils: 98 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kim

Setting

Landform: Fans, hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous loamy alluvium

Typical profile

A - 0 to 6 inches: loam
C - 6 to 60 inches: loam

Properties and qualities

Slope: 1 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 (0.60 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: 20 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R069XY006CO - Loamy Plains, LRU's A and B 10-14 Inches, P.Z.
Hydric soil rating: No

Minor Components

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

47—Limon clay, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 368p
Elevation: 5,200 to 6,200 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Limon, Occasionally Flooded

Setting

Landform: Flood plains, alluvial fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium derived from shale

Typical profile

A - 0 to 4 inches: clay
AC - 4 to 12 inches: silty clay
C - 12 to 60 inches: silty 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 low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: OccasionalNone
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 10.0
Available water supply, 0 to 60 inches: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: R069XY033CO - Salt Flat LRU's A and B
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

54—Midway clay loam, 3 to 25 percent slopes

Map Unit Setting

National map unit symbol: 368y
Elevation: 5,200 to 6,200 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Midway

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium over residuum weathered from shale

Typical profile

A - 0 to 4 inches: clay loam
C - 4 to 13 inches: clay
Cr - 13 to 17 inches: weathered bedrock

Properties and qualities

Slope: 3 to 25 percent
Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Drainage class: Well drained

Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 15 percent
Maximum salinity: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 15.0
Available water supply, 0 to 60 inches: Very low (about 2.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: R069XY046CO - Shaly Plains LRU's A and B
Other vegetative classification: SHALY PLAINS (069AY046CO)
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

75—Razor-Midway complex

Map Unit Setting

National map unit symbol: 369p
Elevation: 5,300 to 6,100 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Razor and similar soils: 60 percent
Midway and similar soils: 35 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Razor

Setting

Landform: Hills

Landform position (three-dimensional): Side slope
Down-slope shape: Linear, concave
Across-slope shape: Linear
Parent material: Clayey slope alluvium over residuum weathered from shale

Typical profile

A - 0 to 4 inches: stony clay loam
Bw - 4 to 22 inches: cobbly clay loam
Bk - 22 to 29 inches: cobbly clay
Cr - 29 to 33 inches: weathered bedrock

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 5 percent
Maximum salinity: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum: 15.0
Available water supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: R069XY047CO - Alkaline Plains LRU's A and B
Other vegetative classification: ALKALINE PLAINS (069AY047CO)
Hydric soil rating: No

Description of Midway

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium over residuum weathered from shale

Typical profile

A - 0 to 4 inches: clay loam
C - 4 to 13 inches: clay
Cr - 13 to 17 inches: weathered bedrock

Properties and qualities

Slope: 3 to 25 percent
Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 15 percent
Maximum salinity: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 15.0
Available water supply, 0 to 60 inches: Very low (about 2.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: R069XY046CO - Shaly Plains LRU's A and B
Other vegetative classification: SHALY PLAINS (069AY045CO)
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

82—Schamber-Razor complex, 8 to 50 percent slopes

Map Unit Setting

National map unit symbol: 369y
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

Schamber and similar soils: 55 percent
Razor and similar soils: 43 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Schamber

Setting

Landform: Breaks
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: Alluvium derived from granite and/or colluvium derived from granite and/or eolian deposits derived from granite

Typical profile

A - 0 to 5 inches: gravelly loam
AC - 5 to 15 inches: very gravelly loam
C - 15 to 60 inches: very gravelly sand

Properties and qualities

Slope: 8 to 50 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): 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)
Available water supply, 0 to 60 inches: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: R069XY064CO - Gravel Breaks LRU's A and B
Hydric soil rating: No

Description of Razor

Setting

Landform: Breaks
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey slope alluvium over residuum weathered from shale

Typical profile

A - 0 to 3 inches: clay loam
Bw - 3 to 9 inches: clay loam
Bk - 9 to 31 inches: clay
Cr - 31 to 35 inches: weathered bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 5 percent
Maximum salinity: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum: 15.0

Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: R069XY047CO - Alkaline Plains LRU's A and B
Other vegetative classification: ALKALINE PLAINS (069AY047CO)
Hydric soil rating: No

Minor Components

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

107—Wilid silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2qnmq
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: 125 to 175 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Wilid

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess and/or eolian deposits

Typical profile

A - 0 to 6 inches: silt loam
Bt - 6 to 10 inches: silty clay loam
Btk - 10 to 30 inches: silty clay loam

Bk1 - 30 to 44 inches: silty clay loam
Bk2 - 44 to 79 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 40 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Nonsaline to slightly saline (0.5 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water supply, 0 to 60 inches: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: C
Ecological site: R069XY006CO - Loamy Plains, LRU's A and B 10-14 Inches, P.Z.
Forage suitability group: Loamy (G069XW017CO)
Other vegetative classification: Loamy Plains #6 (069XY006CO_2), Loamy (G069XW017CO)
Hydric soil rating: No

Minor Components

Minnequa

Percent of map unit: 5 percent
Landform: Pediments, ridges
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R069XY006CO - Loamy Plains, LRU's A and B 10-14 Inches, P.Z.
Other vegetative classification: Loamy (G069XW017CO)
Hydric soil rating: No

Almagre

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Summit, footslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R069XY006CO - Loamy Plains, LRU's A and B 10-14 Inches, P.Z.
Other vegetative classification: Loamy Plains #6 (069XY006CO_2), Loamy (G069XW017CO)
Hydric soil rating: No

Manzanola

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Footslope, toeslope

Landform position (three-dimensional): Talf
Down-slope shape: Linear, concave
Across-slope shape: Linear
Ecological site: R069XY006CO - Loamy Plains, LRU's A and B 10-14 Inches, P.Z.
Other vegetative classification: Loamy Plains #6 (069XY006CO_2), Clayey (G069XW001CO)
Hydric soil rating: No

NOTCOM—No Digital Data Available

Map Unit Composition

Notcom: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Notcom

Properties and qualities

References

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix B
Seed Mixes

<u>El Paso Mix:</u> A mixture of hardy, cool season grasses and warm season grasses that are drought tolerant and adapt well to the Northern Great Intermountain regions. It provides a good, palatable spring forage and fair regrowth in the fall. This mix may produce a hay crop depending upon available moisture. Widely adapted to many soil types and elevations of 3,000 to 10,000 feet. Ideal for areas not receiving regular irrigation. *Meets specs for El Paso County.*

Characteristics:
Grows 36-60 inches at full potential
Great forage and hay producer

Germination:
5-28 days for all seeds. This germination rate varies because it has 5 seeds ranging from 5-10 day germination to 21-28 day germination.

Seeding Rate:
<u>New Seeding</u>
Broadcast: 20-25 lbs/acre
Drilled: 15-20 lbs/acre
<u>Overseeding</u>
Broadcast: 10-15 lbs/acre
Drilled: 5-10 lbs/acre

Formulation:
40% Crested wheatgrass
40% Perennial ryegrass
10% Switchgrass
5% Blue grama
5% Sideoats grama

Dryland Pasture Mixture

A mixture of hardy, cool season grasses that are drought tolerant and adapt well to the Northern Great Intermountain regions. It provides a good, palatable spring forage and fair regrowth in the fall. This mix may produce a hay crop depending upon available moisture. Widely adapted to many soil types and elevations of 3,000 to 10,000 feet. Ideal for areas not receiving regular irrigation.

Characteristics:

- Grows 30-48 inches at full potential
- Great forage and hay producer

Seeding Rate:

New Seeding
- Broadcast: 20-25 lbs/acre
- Drilled: 15-20 lbs/acre

Overseeding
- Broadcast: 10-15 lbs/acre
- Drilled: 5-10 lbs/acre

Mix contains:

25% Paiute Orchardgrass

Bunchgrass with germination in 14-21 days.
One of the earliest species to exhibit growth in the spring, making tremendous forage potential during cool conditions. Performs well on different textured soils. Is a great forage and hay producer.

20% Tetraploid Perennial Rye

Bunchgrass with germination in 5-10 days.
One of the most widely used grasses and is adaptable to a wide variety of soils and climate conditions. It is leafy and fine stemmed.

20% Hycrest Crested Wheatgrass

Bunchgrass with germination in 14-21 days.
A hybrid cross between Standard and Desert wheatgrass, resulting in a plant with excellent seedling vigor that establishes quickly. It is taller and has higher forage yield potential than its parents.

15% Pubescent Wheatgrass

A long-lived perennial, cool season, introduced sod-forming grass.
Adapted to a wide range of conditions, including low-fertility soils and is saline soil tolerant, making it drought and winter tolerant. Pubescent Wheatgrass yields high quality hay and pasture grass.

10% Lincoln Smooth Brome

Sod-forming grass with germination in 10-14 days.
Smooth brome is resistant to drought and extremes in temperature. Lincoln smooth brome is the most widely used of the cultivated brome grasses.

10% Russian Wildrye

A long-lived perennial, cool season, introduced bunchgrass.
Russian Wildrye is exceptionally cold and drought tolerant and is one of the most versatile forage grasses available for dryland pastures.

Formulations & varieties are subject to change without notice!

Arkansas Valley Seed, Inc.
4300 Monaco Street, Denver, CO 80216
303-320-7500
877- 907-3337
www.avseeds.com

Appendix C
Tables from Technical Release 55

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

1 Average runoff condition, and I_a=0.2S
2 Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.
3 Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2/]	A [3/]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a, = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

1 The n values are a composite of information compiled by Engman (1986).
2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 When selecting n , consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

Appendix D
Supporting Calculations

Curve Numbers used for Run-on and Run-off Control System Plan

CN	Land Type	Cover Description	Hydrologic Soil Group	Soil Map Unit	Manning
91	Bare Soil	Newly Graded Areas	C	Soil Type 47	0.05
77	Bottom Ash	Newly Graded Areas	A	NA	0.05
94	Fly Ash	Newly Graded Areas	D	NA	0.05
91	DLD	Newly Graded Areas	C	NA	0.05
80	Range - North	Pasture or Range, Good	D	Soil Type 75/82	0.13
77	Range - North & East	Pasture or Range, Good	C/D	Soil Type 47/75/82	0.13
74	Range - South	Pasture or Range, Good	C	Soil Type 47	0.13
79	Range - South	Pasture or Range, Fair	C	Soil Type 47	0.13
70	Vegetated Cover Soil	Brush/Weed/Grass Mix, Fair	C	Soil Type 47	0.15
77	Vegetated Cover Soil	Brush/Weed/Grass Mix, Poor	C	Soil Type 47	0.15

CSU Landfill Weighted-Average Curve Number Calculation

Sub-Basin	Current Land Type	Area (acres)	Curve Number	Manning
1a	Vegetated Cover Soil, Fair	12.26	70	0.15
1b	DLD	84.03	91	0.05
1c	DLD	11.20	91	0.05
1	Total	107.49	**88.6**	**0.061**
2a	Bottom Ash	1.7	77	0.05
2b	Bottom Ash	6.81	77	0.05
2	Total	8.51	**77.0**	**0.050**
3a	Vegetated Cover Soil, Fair	13.91	70	0.15
3b	Range - South, Good	7.72	74	0.13
3c	Range - South, Fair	8.34	79	0.13
3	Total	29.97	**73.5**	**0.139**
4a	Vegetated Cover Soil, Fair	16.27	70	0.15
4b	Range - North	4.26	80	0.13
4	Total	20.53	**72.1**	**0.146**
5a	Vegetated Cover Soil, Fair	20	70	0.15
5b	Range - South, Good	77.16	74	0.13
5	Total	97.16	**73.2**	**0.134**
6a	Fly Ash	1.34	94	0.05
6b	Vegetated Cover Soil, Fair	2.33	70	0.15
6c	Bare Soil	4.06	91	0.05
6	Total	7.73	**85.2**	**0.080**
7a	Vegetated Cover Soil, Poor	3.05	77	0.15
7b	Range - North & East	70.56	77	0.05
7c	Range - North & East	84.93	77	0.05
7d	DLD	192.89	91	0.05
7e	DLD	8.55	91	0.05
7	Total	359.98	**84.8**	**0.051**
8a	DLD	79.51	91	0.05
8b	Vegetated Cover Soil, Fair	16.62	70	0.15
8c	Vegetated Cover Soil, Fair	2.3	70	0.15
8	Total	98.43	**87.0**	**0.133**

Run-off and Peak Discharge Calculations

	Drainage Basin	1	2	3	4	5	6	7	8
	Area (ft^2)	4682264	370696	1305493	894287	4232290	336719	15680729	4287611
	Area (acres)	107.49	8.51	29.97	20.53	97.16	7.73	359.98	98.43
Am	Area (square miles)	0.16795	0.01330	0.04683	0.03208	0.15181	0.01208	0.56247	0.15380
	Storm Event	25yr, 24hr	25yr, 24hr	25yr, 24hr	25yr, 24hr	25yr, 24hr	25yr, 24hr	25yr, 24hr	25yr, 24hr
P	Design rainfall (inches)	3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79
P	2-yr, 24-hr rainfall (inches)	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94
CN	Curve Number CN	88.6	77.0	73.5	72.1	73.2	85.2	84.8	87.0
S	Potential Max Retention (inches)	1.29	2.99	3.60	3.87	3.67	1.74	1.79	1.50
Ia	Initial Abstraction (inches)	0.26	0.60	0.72	0.77	0.73	0.35	0.36	0.30
Q	Run-off (inches)	2.59	1.65	1.41	1.32	1.39	2.29	2.26	2.44
Q	**Run-off (acre-ft)**	**23.20**	**1.17**	**3.53**	**2.26**	**11.25**	**1.47**	**67.71**	**20.03**
L	Total Flow Length (ft)	4500	875	1375	1750	2625	900	4250	4000
L	Sheet Flow Length (ft)	100	100	100	100	100	100	100	100
L	Concentrated Flow Length (ft)	4400	775	1275	1025	525	800	2150	3900
L	Channel Flow Length (ft)	0	0	0	625	2000	0	2000	0
s	Total Slope (ft/ft)	0.024	0.032	0.022	0.029	0.033	0.078	0.016	0.029
s	Sheet Flow Slope (ft/ft)	0.030	0.180	0.010	0.005	0.110	0.220	0.220	0.130
s	Concentrated Flow Slope (ft/ft)	0.023	0.013	0.023	0.046	0.116	0.060	0.010	0.026
s	Channel Flow Slope (ft)	0.000	0.000	0.000	0.003	0.007	0.000	0.013	0.000
n	Manning coefficient for sheet flow	0.061	0.050	0.139	0.146	0.134	0.080	0.051	0.133
Tt	Sheet Flow Travel Time (hrs)	0.087	0.036	0.261	0.357	0.097	0.049	0.034	0.090
V	Concentrated Flow Average Velocity (ft/s)	2.47	1.83	2.43	3.47	5.50	3.95	1.63	2.60
Tt	Concentrated Flow Travel Time (hrs)	0.495	0.117	0.146	0.082	0.027	0.056	0.366	0.417
a	Cross-Sectional Flow Area of Channel (ft^2)	NA	NA	NA	51	41.4	NA	48	NA
pw	Wetted Perimeter of Channel (ft)	NA	NA	NA	28	28.6	NA	30.4	NA
n	Manning coefficient for open channel flow	NA	NA	NA	0.030	0.030	NA	0.030	NA
V	Channel Flow Average Velocity (ft/s)	0	0	0	4.19	5.32	0	8	0.00
Tt	Channel Flow Travel Time (hrs)	0.000	0.000	0.000	0.041	0.104	0.000	0.072	0.000
Tc	Total Time of Concentration (hrs)	0.58	0.15	0.41	0.48	0.23	0.10	0.47	0.51
	Ia/P	0.07	0.16	0.19	0.20	0.19	0.09	0.09	0.08
qu	Unit peak Discharge (csm/in)	525	925	550	500	730	1000	650	525
	Percentage of Pond or Swamp (%)	0	0	0	0	0	0	0	0
Fp	Pond Adjustment Factor	1	1	1	1	1	1	1	1
qp	**Peak Discharge (cfs)**	**228.4**	**20.3**	**36.4**	**21.2**	**154.0**	**27.6**	**825.2**	**197.1**

Fill in these cells (non-highlighted cells are calculated)

Culvert Sizing

Section	Q	Required Diameter	Required Diameter	Area	Slope	Length	Vert. Drop	Velocity	mannings	constant				notes
	cfs	ft	inches	ft^2	ft/ft	ft	ft	ft/s						
CULV 1a and 1b (existing)	228.4	5.7	69	25.9	0.0105	62.0	0.65	8.8	0.022	0.216				existing two CMP culverts, 36" diameter, max capacity approx. 179 cfs; Water will backup and flow over road
CULV 3 (existing)	36.4	2.0	25	3.3	0.0197	39.0	0.77	11.1	0.012	0.216				existing metal culvert (badly corroded), 15" diameter; Water will backup and flow over access
CULV 4 (existing)	249.5	4.4	53	15.2	0.0154	61.0	0.94	16.4	0.012	0.216				= ~61', elevation drip = 0.94' - Water will backup and flow over road
CULV 4 (recommended)	249.5	5.42	65	23.0	0.0171	70.0	1.20	10.8	0.022	0.216				to be replaced by: three CMP culverts, 48" diameter, length = ~70'
CULV 5 (existing)	197.1	5.13	62	20.7	0.0143	35.0	0.50	9.5	0.022	0.216				existing culvert - to be cleaned out and inspected. Requires two 48" culverts or equivalent
CULV 6 (existing)	2.2	0.97	12	0.7	0.0125	40.0	0.50	3.0	0.022	0.216				existing culvert - 12" sufficient

*Uses mannings equation solved for diameter, assumes full flow; checked with orifice equation

Channel Sizing

Section	Q	Top Width	Depth	Side slope	Bot Width	Area	wet P	Hyd Radius	Slope	Length	Vert. Drop	Velocity	mannings	notes
	cfs	ft	ft	ft/ft	ft	ft^2	ft	ft	ft/ft	ft	ft	ft/s		
CHANNEL 4 (existing)	249.5	37.1	3.2	0.33	18.0	87.61	55.64	1.57	0.0018	625	1.1	2.85	0.030	earth channel, capacity = 325 cfs
Natural Drainage w/in SB 5	190.5	170.0	10.0	0.33	20.0	950.00	191.17	4.97	0.0000	2000	0.0	0.20	0.030	earth channel, weedy, existing natural channel has a high capacity (8,000+ cfs)
CHANNEL 7 (existing)	446.7	44.5	3.3	0.33	25.0	112.97	69.99	1.61	0.0033	2000	6.7	3.95	0.030	earth channel, capacity = 605 cfs
CHANNEL 8 (existing)	197.1	30.2	4	0.33	6.0	72.48	37.28	1.94	0.0012	1850	20.00	2.72	0.030	earth channel, capacity = 216 cfs

*Uses mannings equation for open channel flow

Appendix E
Weekly Inspection Checklist

CLEAR SPRING RANCH CCR LANDFILL - WEEKLY INSPECTION CHECKLIST

Inspection per U.S. EPA Hazardous and Solid Waste Management System Disposal of Coal Combustion Residuals Rule §257.84. Person performing inspection must have completed Utilities' CCR Landfill Qualified Inspector Training. Place completed weekly inspection documentation in the Landfill's operating record. Contact the Nixon Materials Handling Operations Supervisor or Colorado Springs Utilities - Environment, Health, & Safety - Technical Services Section with any questions.

Name of Qualified Inspector: ____________________

Signature of Qualified Inspector: ____________________

Inspection Date*: __________ Date of Previous Inspection: __________ (*Inspection date cannot be more than 7 days from the date of the previous inspection.)

Findings from prior inspection and conditions that required follow-up action or repair?____________________

____

Describe the corrective actions performed here: ____________________

____

- ▼ Are any erosion rills, gullies, or channels present on the landfill's side slopes? If Yes, note the location and depth here: Yes / No

____

- ▼ Does the landfill's cover show evidence of significant ponding, erosion, settlement, sparse vegetation, or subsidence? Yes / No
  If yes, note the location and describe here: ____________________
- ▼ Are the landfill's side slopes stable? Yes / No
- ▼ Other signs of actual or potential structural weakness? Yes / No
- ▼ Are any nuisance conditions (e.g. dust etc.) present? Yes / No
- ▼ Are the stormwater control berms intact and maintaining their required height? If No – note which berms require maintenance: ☐ landfill toe ☐ perimeter road ☐ working face ☐ other Yes / No

- Are the storm water drainages and culverts free from excess sediment, debris and vegetation overgrowth? Yes / No
  If no, note the location requiring maintenance and detail here: ______________________________

- Waste is being placed and covered in accordance with the Landfill's EDOP? Yes / No

- Have any unapproved wastes been placed in the landfill? Yes / No

- Are any other conditions present that are disrupting or have the potential to disrupt the operation or safety of the landfill. If yes, describe here: ______________________________ Yes / No

Comments and Planned Actions, Including Timeframe and Schedule for Repairs:______________________________

____

____

____

All "Yes" Answers Must Be Promptly Reported to the Nixon Materials Handling Operations Supervisor.

Date Next Inspection is Due: ____________