Environment

Submitted to:
Colorado Springs Utilities
Colorado Springs, CO

Submitted by:
AECOM
Greenwood Village, Colorado
60508951
October 12, 2016

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

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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, 2015) 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 December 15, 2015. The majority of the CCR Landfill is currently filled to an 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 relatively flat.

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 used for aggregate replacement in the production of cement. Fly ash is currently being placed (through pushing up the slope in lifts of about 4 inches) and compacted within the east expansion area of the CCR Landfill.

Utilities maintains a Coal Combustion Residuals Fugitive Dust Control Plan (CSU, 2015) 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 used on the CCR Landfill are provided within **Appendix B**.

As of the December 2015 survey date, the landfill was approximately 75 acres (including the west mining area and the east expansion area) and held approximately 3,563,000 cubic yards (CYs). The west portion of the landfill contained approximately 549,000 CYs of bottom ash and the east portion contained approximately 3,014,000 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 seven drainage basins as shown on **Figure 3**. The drainage basins were developed by evaluating the 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, 2016), 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 3.8 inches as determined with the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 precipitation frequency estimator (NOAA, 2014). Runoff calculations are provided within **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 5440 feet, referenced to the National Geodetic Vertical Datum of 1929 (NGVD29) and an emergency spillway with a crest elevation of 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 DLD 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 DLD 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 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 and installation of a two-foot high compacted soil berm along the northeast corner of Drainage Basin 2 (specifically along the divide between 2b and 1a as shown on **Figure 3**). The intent of the soil berm is to prevent run-off from leaving the basin and allow run-off to temporarily pond in this area during a 25-year, 24-hour storm event prior to infiltration or evaporation. 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 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. 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**.

4.3.5 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 compacted 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.

4.3.6 Drainage Basin 7

Drainage Basin 7 includes a portion of open/range area located in between the DLD 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.

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 2015 annual inspection occurred on August 22, 2015 and is documented in a report by Terracon (Terracon, 2015).

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 maintain. 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 first subsequent plan. 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, Emily J. Nebel, 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 October 17, 2016 meets the requirements of 40 CFR § 257.81.

Emily J. Nebel
Printed Name

October 17, 2016
Date

8.0 References

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Figures

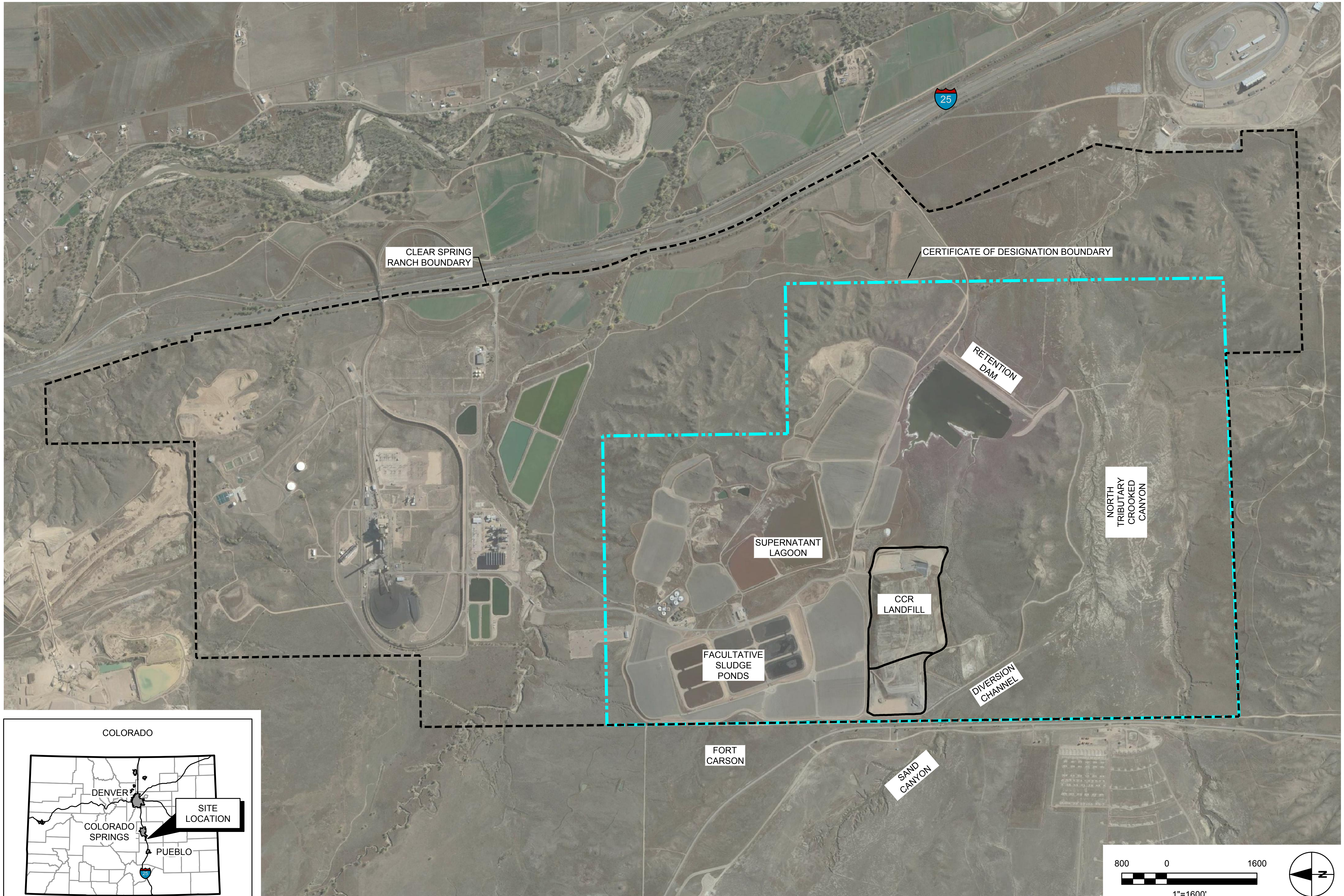

Figure: 1

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: 10/12/16

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

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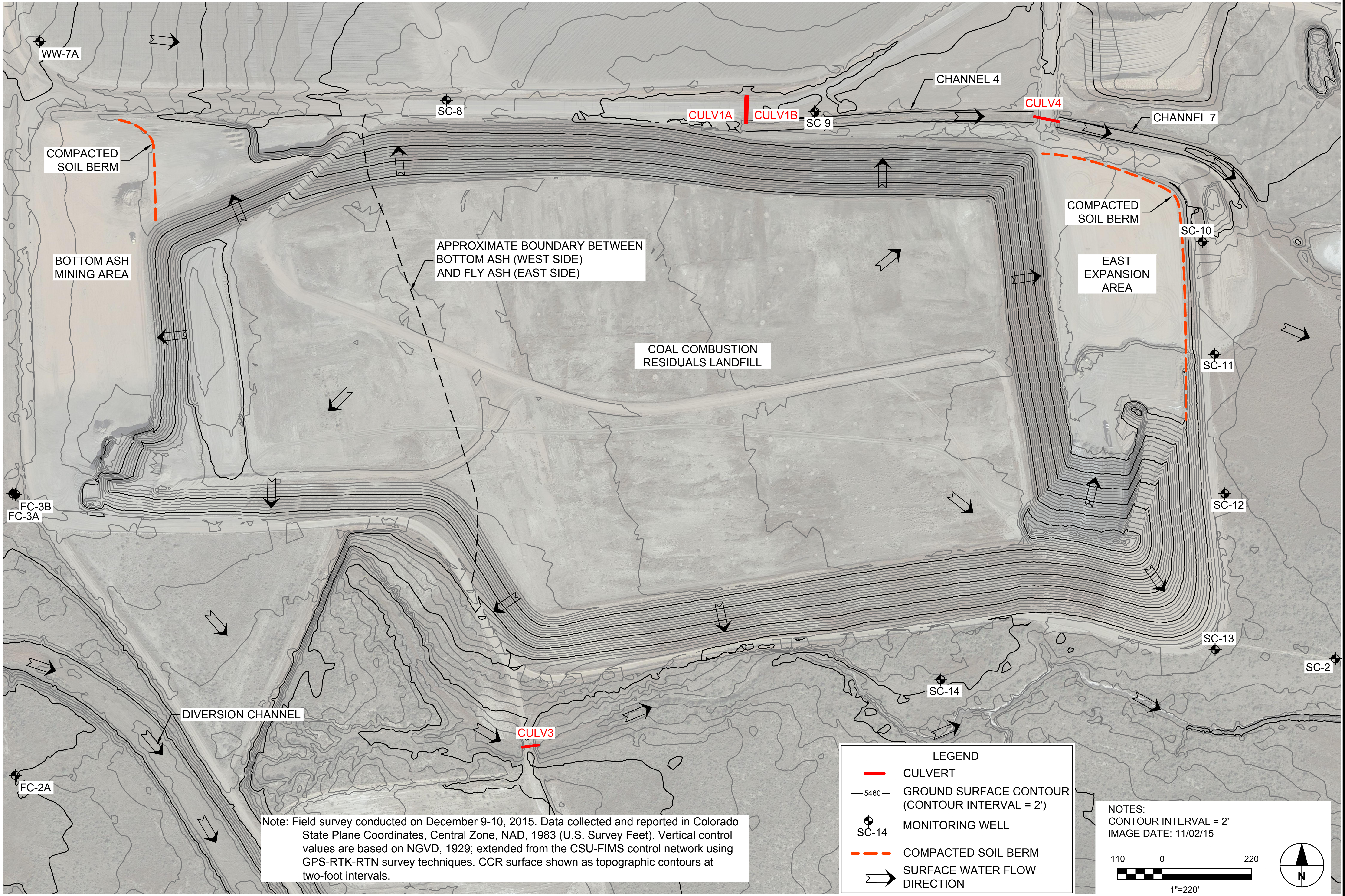

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Figure: 2

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: 10/12/16

Last saved by: SCHWARTZE(2016-10-11) Last Plotted: 2016-10-12
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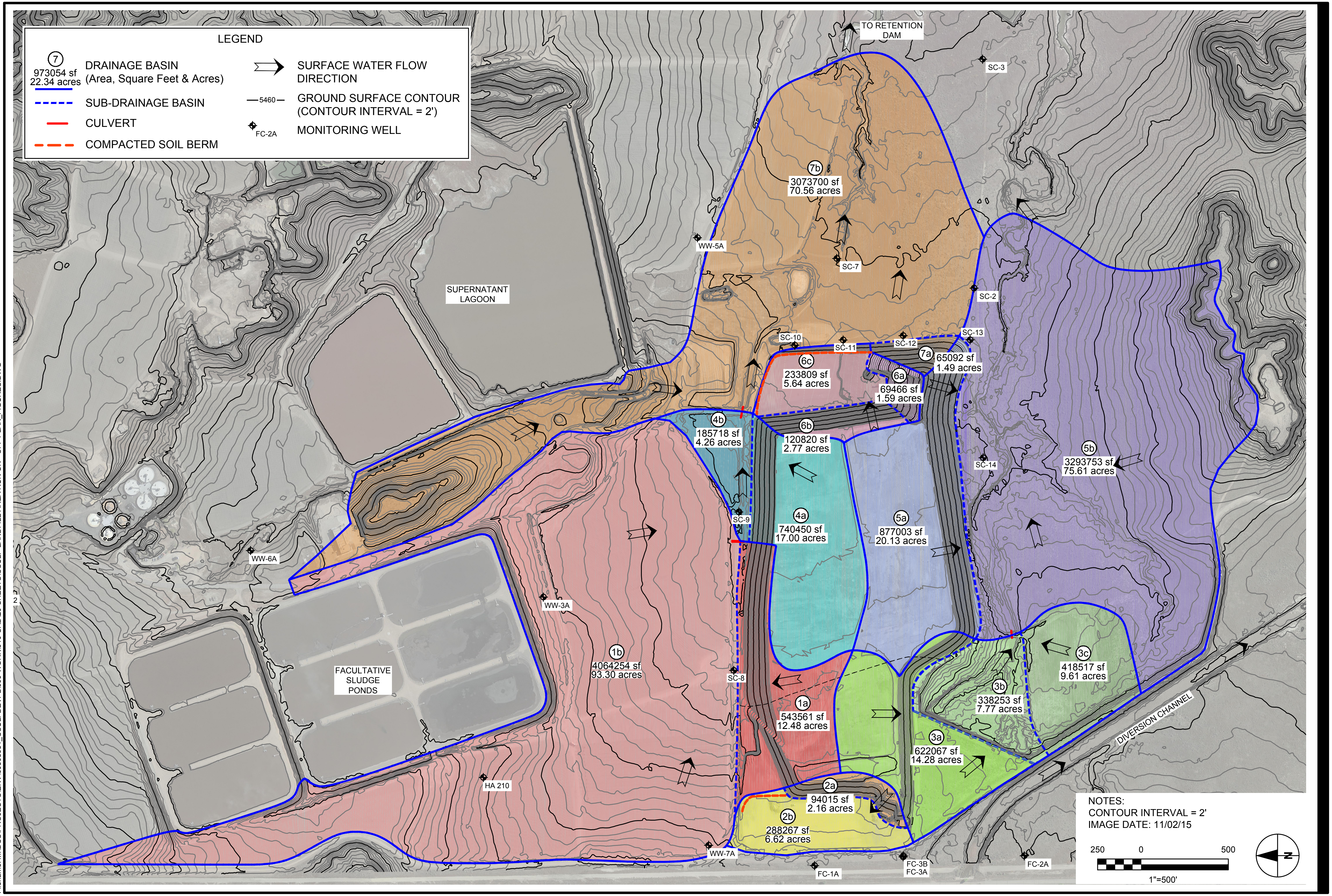

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Figure: 3

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: 10/12/16

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Appendix A
Web Soil Survey Information

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


75
43
75
Military Reservation Boundary
43
113
43
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82
47
43
43

El Paso County Area, Colorado

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

Description of Limon, Occasionally Flooded

Setting

Landform: Alluvial fans, flood plains
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
Natural 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: Occasional
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Salt Flat (R069XY033CO)

Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 13, Sep 22, 2015

El Paso County Area, Colorado

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: 50 percent
Midway and similar soils: 30 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: Concave, linear
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
Natural 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 in profile: 15 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 15.0
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: Alkaline Plains (R069XY047CO)
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
Natural 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 in profile: 15 percent
Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 15.0
Available water storage in profile: 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: Shaly Plains (R069XY046CO)
Other vegetative classification: SHALY PLAINS (069AY045CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 13, Sep 22, 2015

Appendix B
Seed Mixes

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

El Paso Mix: 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:
New Seeding
Broadcast: 20-25 lbs/acre
Drilled: 15-20 lbs/acre
Overseeding
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

Appendix C
Tables from Technical Release 55

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

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2/]	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 bankfull 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	12.48	70	0.15
1b	DLD	93.30	91	0.05
1	Total	105.78	**88.5**	**0.062**
2a	Bottom Ash	2.16	77	0.05
2b	Bare Soil	6.62	91	0.05
2	Total	8.78	**87.6**	**0.050**
3a	Vegetated Cover Soil, Fair	14.28	70	0.15
3b	Range - South, Good	7.77	74	0.13
3c	Range - South, Fair	9.61	79	0.13
3	Total	31.66	**73.7**	**0.139**
4a	Vegetated Cover Soil, Fair	17.00	70	0.15
4b	Range - North	4.26	80	0.13
4	Total	21.26	**72.0**	**0.146**
5a	Vegetated Cover Soil, Fair	20.13	70	0.15
5b	Range - South, Good	75.61	79	0.13
5	Total	95.74	**77.1**	**0.134**
6a	Fly Ash	1.59	94	0.05
6b	Vegetated Cover Soil, Fair	2.77	70	0.15
6c	Bare Soil	5.64	91	0.05
6	Total	10.00	**85.7**	**0.078**
7a	Vegetated Cover Soil, Poor	1.49	77	0.15
7b	Range - North & East	70.56	77	0.05
7	Total	72.05	**77.0**	**0.052**

Run-off and Peak Discharge Calculations

	Drainage Basin	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Area (ft^2)	4607777	382457	1379110	926086	4170434	435600	3138498
	Area (acres)	105.78	8.78	31.66	21.26	95.74	10.00	72.05
Am	Area (square miles)	0.16528	0.01372	0.04947	0.03322	0.14959	0.01563	0.11258
	Storm Event	25yr, 24hr	25yr, 24hr	25yr, 24hr	25yr, 24hr	25yr, 24hr	25yr, 24hr	25yr, 24hr
P	Design rainfall (inches)	3.8	3.8	3.8	3.8	3.8	3.8	3.8
P	2-yr, 24-hr rainfall (inches)	1.94	1.94	1.94	1.94	1.94	1.94	1.94
CN	Curve Number CN	88.5	87.6	73.7	72.0	77.1	85.7	77.0
S	Potential Max Retention (inches)	1.30	1.42	3.57	3.89	2.97	1.67	2.99
Ia	Initial Abstraction (inches)	0.26	0.28	0.71	0.78	0.59	0.33	0.60
Q	Run-off (inches)	2.59	2.50	1.43	1.32	1.66	2.34	1.66
Q	**Run-off (acre-ft)**	**22.85**	**1.83**	**3.78**	**2.34**	**13.28**	**1.95**	**9.95**
L	Total Flow Length (ft)	4500	875	1375	1750	2625	900	4250
L	Sheet Flow Length (ft)	100	100	100	100	100	100	100
L	Concentrated Flow Length (ft)	4400	775	1275	1025	525	800	2150
L	Channel Flow Length (ft)	0	0	0	625	2000	0	2000
s	Total Slope (ft/ft)	0.024	0.032	0.022	0.029	0.033	0.078	0.027
s	Sheet Flow Slope (ft/ft)	0.030	0.180	0.010	0.005	0.110	0.220	0.130
s	Concentrated Flow Slope (ft/ft)	0.023	0.013	0.023	0.046	0.116	0.060	0.035
s	Channel Flow Slope (ft)	0.000	0.000	0.000	0.003	0.007	0.000	0.013
n	Manning coefficient for sheet flow	0.062	0.050	0.139	0.146	0.134	0.078	0.052
Tt	Sheet Flow Travel Time (hrs)	0.088	0.036	0.260	0.357	0.097	0.047	0.043
V	Concentrated Flow Average Velocity (ft/s)	2.47	1.83	2.43	3.47	5.50	3.95	3.01
Tt	Concentrated Flow Travel Time (hrs)	0.495	0.117	0.146	0.082	0.027	0.056	0.198
a	Cross-Sectional Flow Area of Channel (ft^2)	NA	NA	NA	51	41.4	NA	48.0
pw	Wetted Perimeter of Channel (ft)	NA	NA	NA	28	28.6	NA	30.4
n	Manning coefficient for open channel flow	NA	NA	NA	0.030	0.030	NA	0.030
V	Channel Flow Average Velocity (ft/s)	0	0	0	4.19	5.32	0	7.68
Tt	Channel Flow Travel Time (hrs)	0.000	0.000	0.000	0.041	0.104	0.000	0.072
Tc	Total Time of Concentration (hrs)	0.58	0.15	0.41	0.48	0.23	0.10	0.31
	Ia/P	0.07	0.07	0.19	0.20	0.16	0.09	0.16
qu	Unit peak Discharge (csm/in)	525	925	550	500	730	1000	650
	Percentage of Pond or Swamp (%)	0	0	0	0	0	0	0
Fp	Pond Adjustment Factor	1	1	1	1	1	1	1
qp	**Peak Discharge (cfs)**	**224.9**	**31.8**	**39.0**	**22.0**	**181.8**	**36.5**	**121.3**

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)	112.4	4.4	53	15.2	0.0105	62.0	0.65	7.4	0.022	0.216				existing two CMP culverts, 36" diameter (flow divided by two), length = ~62', elevation drop = 0.49' (1a) and 0.81' (1b) - Water will backup and flow over road
CULV 3 (existing)	39.0	2.1	26	3.4	0.0197	39.0	0.77	11.3	0.012	0.216				existing metal culvert (badly corroded), 15" diameter, length = ~39', elevation drop = 0.77' - Water will backup
CULV 4 (existing)	246.8	4.4	53	15.1	0.0154	61.0	0.94	16.4	0.012	0.216				existing steel culvert, ~30" diameter, length = ~61', elevation drip = 0.94' - Water will backup and flow over road

*Uses mannings equation solved for diameter, assumes full flow

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)	246.8	24.1	3.2	0.33	5.0	46.27	29.92	1.55	0.0065	625	4.0	5.34	0.030	earth channel, weedy (vert drop should equal 4)
Natural Drainage w/in SB 5	220.8	22.9	3.0	0.33	5.0	41.45	28.63	1.45	0.0070	2000	14.0	5.33	0.030	earth channel, weedy, existing natural channel is sized correctly (vert drop should equal 14)
CHANNEL 7 (existing)	368.1	24.5	3.3	0.33	5.0	47.97	30.37	1.58	0.0130	2000	26.0	7.67	0.030	earth channel, weedy (vert drop should equal 26)

*Uses mannings equation for open channel flow

Appendix E
Weekly Inspection Checklist

CSR CCR Landfill Weekly Inspection Checklist

Inspection to meet Regulatory Weekly Inspection Requirement §257.84 of the
HAZARDOUS AND SOLID WASTE MANAGEMENT SYSTEM; DISPOSAL OF COAL COMBUSTION RESIDUALS FROM ELECTRIC UTILITIES
[RIN-2050-AE81; FRL-9149-4]

Date of Inspection: ______________________ **(cannot be more than 7 days from the Date of Previous Inspection and must be done after any storm event)**

Time of Inspection: ______________________ Date of Previous Weekly Inspection: ______________________

Name of Qualified Inspector: ______________________

Signature of Qualified Inspector: ______________________

Inspection Criteria: (Circle One)

1. Deterioration of landfill	YES	NO
2. Malfunctions of the landfill	YES	NO
3. Run On and Run Off control System Functioning	YES	NO
4. Appearance of Actual or Potential Structural Weakness	YES	NO
5. Waste is Placed and covered Properly	YES	NO
6. Landfill slopes are stable	YES	NO
7. Surface water percolation minimized (i.e. reduce ponding)	YES	NO
8. Dust Controlled (Visible)	YES	NO
a. Method	WATER	OTHER______________________
9. Shut down due to high winds	YES	NO

10. List below and other conditions which are disrupting or have the potential to disrupt the operation or safety of the Landfill

Must be filed with the Nixon Operating Record as required by §257.105(g)(8)
For the purposes of this rule, the Coal Crew Supervisor (Operations Supervisor II) and any Coal System Specialist is considered Qualified Person for the Weekly Inspection