



**Coal Combustion Residual (CCR) Landfill  
Unstable Area Demonstration**

**Clear Spring Ranch  
El Paso County, Colorado**

October 15, 2018  
Terracon Project No. 23185091

**Prepared for:**

Colorado Springs Utilities  
Colorado Springs, Colorado

**Prepared by:**

Terracon Consultants, Inc.  
Colorado Springs, Colorado

**Terracon**

terracon.com



October 15, 2018

Colorado Springs Utilities  
121 South Tejon Street, 4th Floor  
Colorado Springs, Colorado 80947



Attn: Mr. Brock Foster, P.E.  
P: (719) 668 4062  
E: bfoster@csu.org

Re: Coal Combustion Residual (CCR) Landfill  
Unstable Area Demonstration  
Clear Spring Ranch  
El Paso County, Colorado  
Terracon Project No. 23185091

Dear Mr. Foster:

We have completed the Coal Combustion Residual (CCR) Landfill – Unstable Area Demonstration for the above referenced site. This study was performed in general accordance with Terracon Proposal No. P23185091 dated August 13, 2018. This report presents the findings of our study based on the requirements in Section 257.64 – Unstable Areas of the EPA's CCR Rule. It is our opinion that the results of this demonstration meet the requirements of paragraph (a) in accordance with Section 257.64 - Unstable Area.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,  
**Terracon Consultants, Inc.**

  
Robert M. Hernandez, P.E.  
Geotechnical Department Manager



  
Ryan W. Feist, P.E.  
Principal

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**Note:** This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the **GeoReport** logo will bring you back to this page. For more interactive features, please view your project online at [client.terracon.com](http://client.terracon.com).

## ATTACHMENTS

PHOTOGRAPHY LOG  
SITE VICINITY PLAN  
SITE LOCATION PLAN  
SURFICIAL GEOLOGIC PLAN

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Clear Spring Ranch  
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**INTRODUCTION**

This report presents the findings of our CCR landfill unstable area study. The Clear Spring Ranch CCR Landfill is subject to the Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities rule published by the Environmental Protection Agency in the Code of Federal Regulations - 40 CFR Parts 257 and 261, dated April 17, 2015. The specific purpose of this study was to demonstrate compliance with Section 257.64 – Unstable Areas.

Terracon is also currently performing annual inspections at the above referenced site under Terracon Project No. 23155030 to observe that the design, construction, operation, and maintenance of the CCR unit is consistent with generally accepted engineering standards under the previously referenced regulation.

Maps showing the site and general geologic conditions are shown in the **Site Location** and **Surficial Geologic Plan** sections, respectively.

**SITE CONDITIONS**

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
<b>Parcel Information</b>	The Coal Combustion Residual (CCR) Landfill is located at Clear Spring Ranch in El Paso County, Colorado See <b>Site Location</b>
<b>Existing Improvements</b>	An existing and active landfill containing non-volatile fly ash, bottom ash, waste salt / fly ash mixture, spent sandblasting media, flue gas desulfurization waste, sediment from the Martin Drake Power Plant’s Storm Water Ponds, and ash derived from the co-combustion of biosolids, woody biomass, or other related solid fuels. The total capacity of the 75-acre landfill is 5 million cubic yards (CY) with about 2 million CY remaining.
<b>Existing Topography</b>	The active landfill has a relatively flat top with side slopes of about 3H:1V (Horizontal:Vertical) or flatter.

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We also collected photographs at the time of our site visit on September 14, 2017. Representative photos are provided in our [Photography Log](#).

## PROJECT DESCRIPTION

Item	Description
<b>Information Provided</b>	<p>The following was provided by UTILITIES for review as part of this study:</p> <ul style="list-style-type: none"><li>■ Soils and Foundation Investigation Proposed Ash Disposal Facilities R.D. Nixon Plant, Fountain, Colorado, prepared by The Fisherman Company, dated August 4, 1977.</li><li>■ Ash Disposal Site Study prepared by Layne Western Company, Inc., dated August 1977.</li><li>■ Proposed Sewage Sludge Disposal Site prepared by Lincoln DeVore, dated September 7, 1977.</li><li>■ Fly Ash Impoundment Study, prepared by Woodward-Clyde Consultants, dated January 3, 1978.</li><li>■ Logs from historical on-site exploratory borings performed by others (77-15 to 77-20, 77-22 to 77-28, FC-1 &amp; 1A, FC-2 &amp; 2A, FC 3A &amp; 3B, SC-1 &amp; 1A, SC-2, SC-5 to SC-14, and WW-7A)</li></ul> <p>The following information that was provided to us for our annual inspection reporting has also been reviewed as part of this study:</p> <ul style="list-style-type: none"><li>■ An excerpt from the Nixon Power Plant, Sand Canyon Ash Disposal Capacity Report, prepared by Woodward-Clyde Consultants, dated April 13, 1978</li><li>■ Clear Spring Ranch CCP Landfill, SHDF, Retention Dam, West of Retention Dam, K Series Boreholes, prepared by Kleinfelder, dated June 10, 2002</li><li>■ Ash Landfill Slope Stability Investigation for the Clear Spring Ranch Facility, prepared by Kleinfelder, dated November 17, 2009</li><li>■ State of Colorado, Approval of Slope Stability Analysis: Clear Spring Ranch Ash Landfill, dated January 29, 2009</li></ul>
<b>Project Background</b>	<p>In accordance with the previously referenced regulations, UTILITIES must demonstrate that the landfill is not located within an “Unstable Area” in accordance with Section 257.64 - Unstable Areas of the EPA’s CCR Rule. The purpose of our current scope of services is to provide information relative to the following rule:</p> <ul style="list-style-type: none"><li>■ 257.53 Definitions - Unstable area means a location that is susceptible to natural or human induced events or forces capable of impairing the integrity, including structural components of some or all of the CCR unit that are responsible for preventing releases from such unit. Unstable areas can include poor foundation conditions, areas susceptible to mass movements, and karst terrains.</li><li>■ 257.64 (a) An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to</li></ul>

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Item	Description
	<p>ensure that the integrity of the structural components of the CCR unit will not be disrupted.</p> <ul style="list-style-type: none"><li>■ 257.64 (b) The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:<ul style="list-style-type: none"><li>○ On-site or local soil conditions that may result in significant differential settling;</li><li>○ On-site or local geologic or geomorphologic features; and</li><li>○ On-site or local human-made features or events (both surface and subsurface).</li></ul></li><li>■ 257.64 (c) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.</li><li>■ 257.64 (d) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (d)(1) or (2) of this section.<ul style="list-style-type: none"><li>○ (1) For an existing CCR landfill or existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.</li><li>○ (2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.</li></ul></li></ul>
<b>Site History</b>	<p>The CCR landfill has been active since the late 1970's and is currently being used for disposal of relatively dry ash. Activity at the landfill during our previous and recent observations consisted of top-down cutting of slopes to mine Bottom Ash along the western terminus of the land fill. Actively mined slopes appeared stable and consistent with 3H:1V (Horizontal:Vertical) gradients observed along typical slopes of the landfill. The acceptable slope gradients of 3H:1V are based on the stability analyses presented in the November 17, 2009, Ash Landfill Slope Stability Investigation for the Clear Spring Ranch Facility, prepared by Kleinfelder.</p> <p>Most of the slopes at the site are sparsely to moderately vegetated with 1 foot to 3-foot high native weeds and grasses. Generally, we observed a 1 to 4-foot high soil berm at the crest of the perimeter slope.</p> <p>The perimeter earthen road at the toe of the landfill slopes generally had loose soil berms on the upslope and downslope edges of the roadway.</p>

## GEOTECHNICAL CHARACTERIZATION

### Regional Geology

The proposed area is located within the Colorado Piedmont section of the Great Plains physiographic province. The Colorado Piedmont, formed during Late Tertiary and Early quaternary time (approximately two-million years ago), is a broad, erosional trench which separates the Southern Rocky Mountains from the High Plains. Structurally, the site lies along the western flank of the Denver Basin. During the Late Mesozoic and Early Cenozoic Periods (approximately seventy million years ago), intense tectonic activity occurred, causing the uplifting

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of the Front Range and associated downwarping of the Denver Basin to the east. Relatively flat uplands and broad valleys characterize the present-day topography of the Colorado Piedmont in this region.

### Site Specific Geology

Surficial geologic conditions at the site, as mapped by the United States Geological Survey (USGS) (Moore, D.W. et al.), consists of alluvial sand, silt, clay, and gravel (post-Piney Creek alluvium, Piney Creek Alluvium, and pre-Piney Creek alluvium of Hunt, 1954, and Scott, 1960; Broadway Alluvium). The Pierre Shale formation underlies mapped surficial units at this site.

### Typical Profile

Site specific drilling and exploration was beyond Terracon's scope of services for this project. Based on a review of the previously performed geotechnical studies prepared by others, subsurface conditions generally consist of variable thicknesses of clay, silt, sand, and gravel, followed by Pierre Shale bedrock. A general summary of reviewed native subsurface conditions near the landfill is shown below:

Stratum	Approximate Depth to Bottom of Stratum	Material Description	Consistency/Density
1	2 to 33 feet	Lean and fat clay with varying amounts of sand and gravel	Medium stiff to very stiff
2	15 to 27 feet	Sand and gravel with varying amounts of silt, clay, and cobbles	Medium dense to dense
3 <sup>1</sup>	Undetermined	Pierre shale	Hard to very hard

<sup>1</sup> Borings where this stratum was observed terminated at depths of approximately 9.5 to 55 feet below site grade

### Groundwater

During 2017 & 2018, groundwater was measured by UTILITIES at depths of approximately 2 to 13 feet beyond the toe of the active landfill within monitoring wells surrounding the CCR Landfill. These observations represent groundwater conditions at the time of the respective field explorations, and

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<sup>1</sup>Moore, David W., Straub, Arthur W., Berry, Margaret E., Baker, Michael L., and Brandt, Theodore R., 2002, **Geologic Map of the Pueblo 1° x 2° Quadrangle, Colorado**, Miscellaneous Field Studies Map MF-2388

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may not be indicative of other times, or at other locations. Groundwater levels can be expected to fluctuate with varying seasonal and weather conditions.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors. Therefore, groundwater levels during continued construction or at other times in the life of the facility may be higher or lower than the levels previously indicated.

## **POTENTIAL GEOLOGIC HAZARDS**

The following potential geologic hazards have been researched as part of our study.

### **Unstable or Potentially Unstable Slopes and Landslide Areas**

Surficial geologic conditions at the site as mapped by the United States Geological Survey indicates that evidence of landslide susceptibility has not been observed at the site. The area surrounding the landfill is relatively flat, and areas of active or recent landslide movement based on surrounding site features does not appear geologically feasible.

Based on the Ash Landfill 2017 Volumetric Survey, dated December 22, 2017, the landfill varies from about 30 feet above the surrounding ground surface within the Bottom Ash area to the west and about 50 to 70 feet high at the eastern terminus. The lowest elevation at the toe of the landfill slope appears to be at the southeast corner at El. 5444. The highest elevation at of the landfill also appears to be at the southeast corner of the landfill at El. 5520. The side slopes are generally at a gradient of about 3H:1V.

Slope stability analyses of the CCR Landfill was beyond the scope of our services. Kleinfelder performed slope stability analyses of the CCR Landfill as part of a November 17, 2009 study. The lowest presented Factor of Safety for slope stability analyses was 2.6. The January 29, 2009 State of Colorado letter indicated the slope stability analysis was acceptable. Furthermore, the State of Colorado letter indicated “in its present condition as well as proposed final configuration, the ash landfill is at a low risk to be impacted by slope stability issues.” No apparent signs of slope instability were observed during our site visit. It is our opinion that the risk for unstable, potentially unstable slopes, or landslide areas to impact the CCR Landfill is considered low.

### **Underlying Soils with Potential for Excessive Differential Movement**

Site soils reviewed in borings performed by others near the landfill consisted of clay and sand with varying amounts of silt, gravel, and cobble. Thickness of soils varied from 2 feet to 33 feet, followed by the Pierre Shale bedrock. Relative consistency of clays was reported to be medium stiff to very stiff, and sandy soils were reported to be medium dense to dense in relative density.

The CCR landfill has been active since the late 1970's. Movement of the landfill in the form of unsatisfactory differential movement has not been observed based on conversations with

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representatives at Colorado Springs Utilities. Yearly surveys performed by Terracon at the site since 2015 have not observed unsatisfactory settlement prone areas of the landfill and reported elevation grade changes at the site have been as expected when compared to ongoing construction activities.

Based on the reviewed subsurface conditions in the provided soil borings performed by others, length of time the facility has been in operation, conversations with Colorado Springs Utilities, and satisfactory performance of the landfill to date, it is our opinion that the soils underlying the landfill have not shown the potential to cause unsatisfactory differential movement of the landfill.

### **Expansive Soils and Expansive Bedrock**

The site of the landfill is not within a United States Geological Survey mapped area of potentially swelling soils and bedrock. It is our opinion that the clay soils observed in borings performed by others likely have low to moderate swell potential. It is our opinion the observed shale bedrock should be considered to have moderate to high expansive potential.

Movement in the form of unsatisfactory differential movement has not been observed based on conversations with representatives at Colorado Springs Utilities since the CCR landfill has been under active construction. Heaving that may indicate subsurface soil or bedrock expansion has not been observed or reported. Yearly surveys performed at the site have also not identified areas of unsatisfactory movement.

Heaving of expansive soils and bedrock are generally known to cause distress in buildings and roadways, not large, earthen constructed structures. Based on the length of time the facility has been in operation, conversations with Colorado Springs Utilities, and satisfactory performance of the landfill to date, it is our opinion that potentially expansive soils and bedrock do not appear to be causing unsatisfactory differential movement of the landfill.

### **Collapsible Soils**

Mapping completed by the United States Geological Survey indicates the site is not located in an area that contains eolian sand deposits known to have collapse potential. It is our understanding that unsatisfactory differential movement of the landfill has not been reported since construction began. Based on the reviewed data and the satisfactory performance of the landfill to date, it is our opinion that the risk for collapsible soils at this site is very low.

### **Debris Flow and Debris Fans**

The existing development is not located in an area geologically known for debris flows or debris fans. It is our opinion that the potential for outside debris flow or debris fans is nonexistent.

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### **Rockfall**

The location of the CCR Landfill is not located in an area with exposed crops of rock that have the potential for rock fall. Therefore, it is our opinion that the potential for rockfall to occur on the site is nonexistent.

### **Shallow Water Tables and Groundwater Springs**

During 2017 & 2018, groundwater was measured by UTILITIES at depths of approximately 2 to 13 feet below existing site grade within monitoring wells surrounding the CCR Landfill. Reportedly, groundwater seepage has been observed downgradient of the existing landfill near a UTILITIES groundwater monitoring well SC-7 within an approximate 10-foot deep drainage valley. Evidence of other seepage water along the slopes surrounding the site was not observed at the time of our site visit. The site of the CCR Landfill is located outside of the mapped USGS Depth to Water Table in the Colorado Springs – Castle Rock Area (<sup>2</sup>Hillier and Hutchinson). Based on our site observations and information reviewed to date, it is our opinion that the observed depth to water tables and groundwater springs do not appear to impact the site, and the chance of future impact is considered low.

### **Flood Prone Areas**

Based on a review of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps, the site is located within an area determined to be outside the 500-year floodplain.

### **Steeply Dipping Bedrock**

The site is not within a mapped (Himmelreich Jr, and Noe, 1999) zone of areas susceptible to differential heave in expansive, steeply dipping bedrock.

### **Faults**

Faulting is not known to traverse the site based on mapping performed by the United States Geological Survey. The nearest mapped fault is the Ute Pass Fault, located approximately 10 miles to the northwest. The location of the CCR Landfill is not located in an area known to be seismically active. Therefore, it is our opinion that the risk for faults to impact the site is considered low.

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<sup>2</sup>Hillier, Donald E., and Hutchinson, E. Carter., 1980, **Depth to Water Table in the Colorado Springs – Castle Rock Area**, Colorado. Miscellaneous Investigation Series Map I-857-H.

## **GEOLOGIC HAZARDS AND DEVELOPMENT CONSTRAINTS**

### **Conclusions**

Our study considered the following factors:

- On-site or local soil conditions that may result in significant differential settling;
- On-site or local geologic or geomorphologic features; and
- On-site or local human-made features or events (both surface and subsurface).

Based on a review of the provided geotechnical data for the site, our review of the available geologic literature, and our site observations, the existing CCR Landfill does not appear to be in a geologically unstable area that would result in significant differential movement that would disrupt the operation of the facility.

Unstable areas include poor foundation conditions for support of the existing landfill and areas susceptible to mass movements, such as landslides, debris flow, and debris fans. Subsurface soil and bedrock formations beneath the landfill are not conducive to karst terrains. Therefore, the existing landfill is not considered to be in an unstable area subjected to karst deposits.

Human-made features such as access roads, soil/water retention/spreading areas, drainage berms and drainage channels were observed at the time of our site visit near the existing landfill. Information reviewed did not indicate that subsurface human-made features are present near the existing landfill. It is our opinion that the observed human-made features would not result in the landfill being within an unstable area.

### **GENERAL COMMENTS**

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from previous site explorations. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we can provide further evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

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Our services and any correspondence or collaboration are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

## **ATTACHMENTS**

## PHOTOGRAPHY LOG



View at Western Crest of Landfill Looking West



View at Southern Crest of Landfill Looking South



View at Southern Crest of Landfill Looking East



View at Northern Crest of Landfill Looking North



View of Northeast Slopes of the Landfill



View of Eastern Slope of Landfill



View of Southern Slope of the Landfill



View of Western Slope of Landfill

## **SITE VICINITY AND LOCATION PLANS**

### **Contents:**

Site Vicinity Plan  
Site Location Plan  
Surficial Geologic Plan

Note: All attachments are one page unless noted above.

**CCR LANDFILL SITE VICINITY PLAN**

CCR Landfill Geologic Evaluation ■ Colorado Springs, Colorado  
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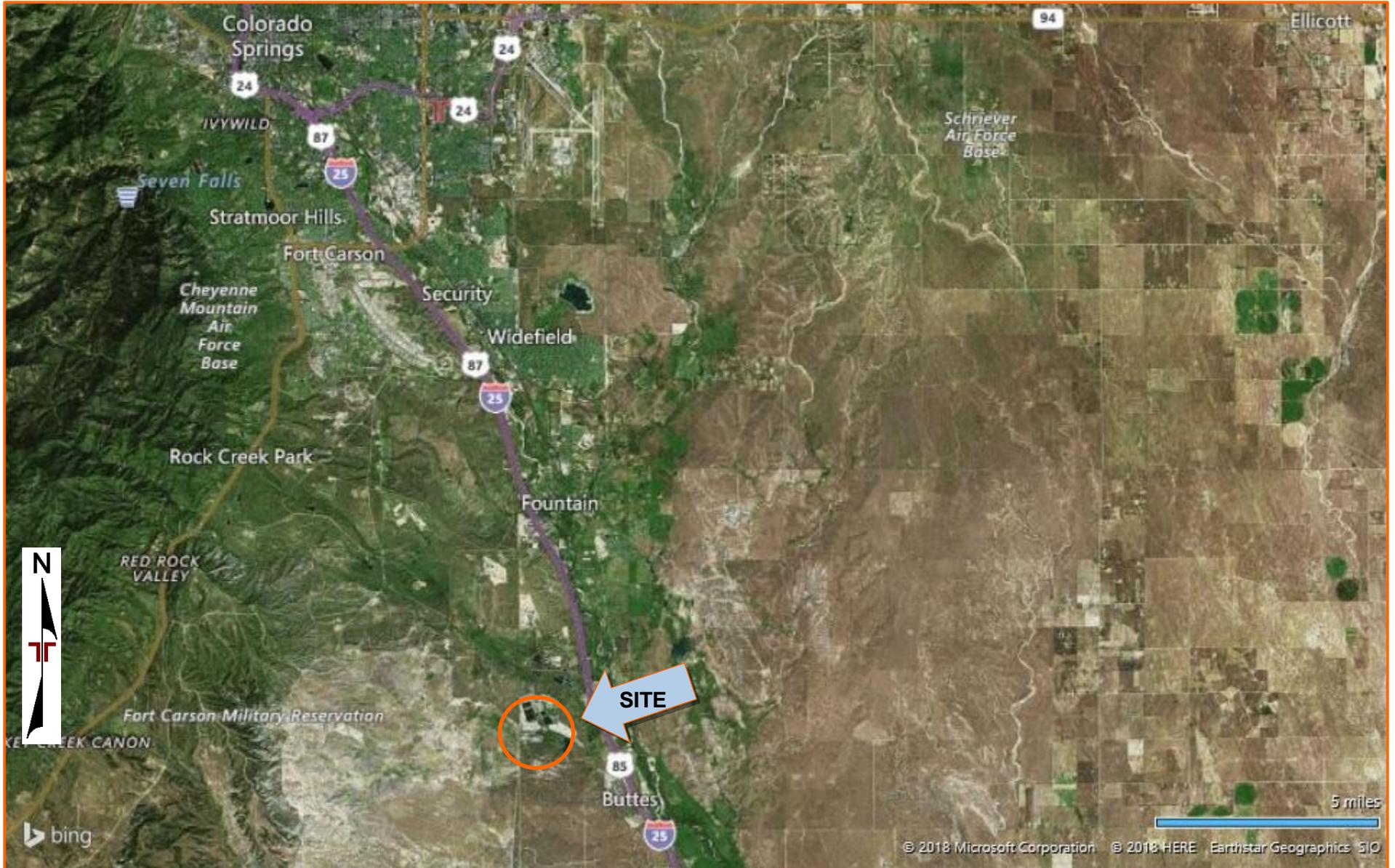


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

**CCR LANDFILL SITE LOCATION PLAN**

CCR Landfill Geologic Evaluation ■ Colorado Springs, Colorado  
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AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

## CCR LANDFILL SURFICIAL GEOLOGIC PLAN

CCR Landfill Geologic Evaluation ■ Colorado Springs, Colorado  
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### SURFICIAL LANDFILL DEPOSITS

**Alluvial sand, silt, clay, and gravel (asa)**  
**(Holocene and late Pleistocene)** –  
Deposits are described as post-Piney Creek  
alluvium, Piney Creek Alluvium, and pre-  
Piney Creek alluvium

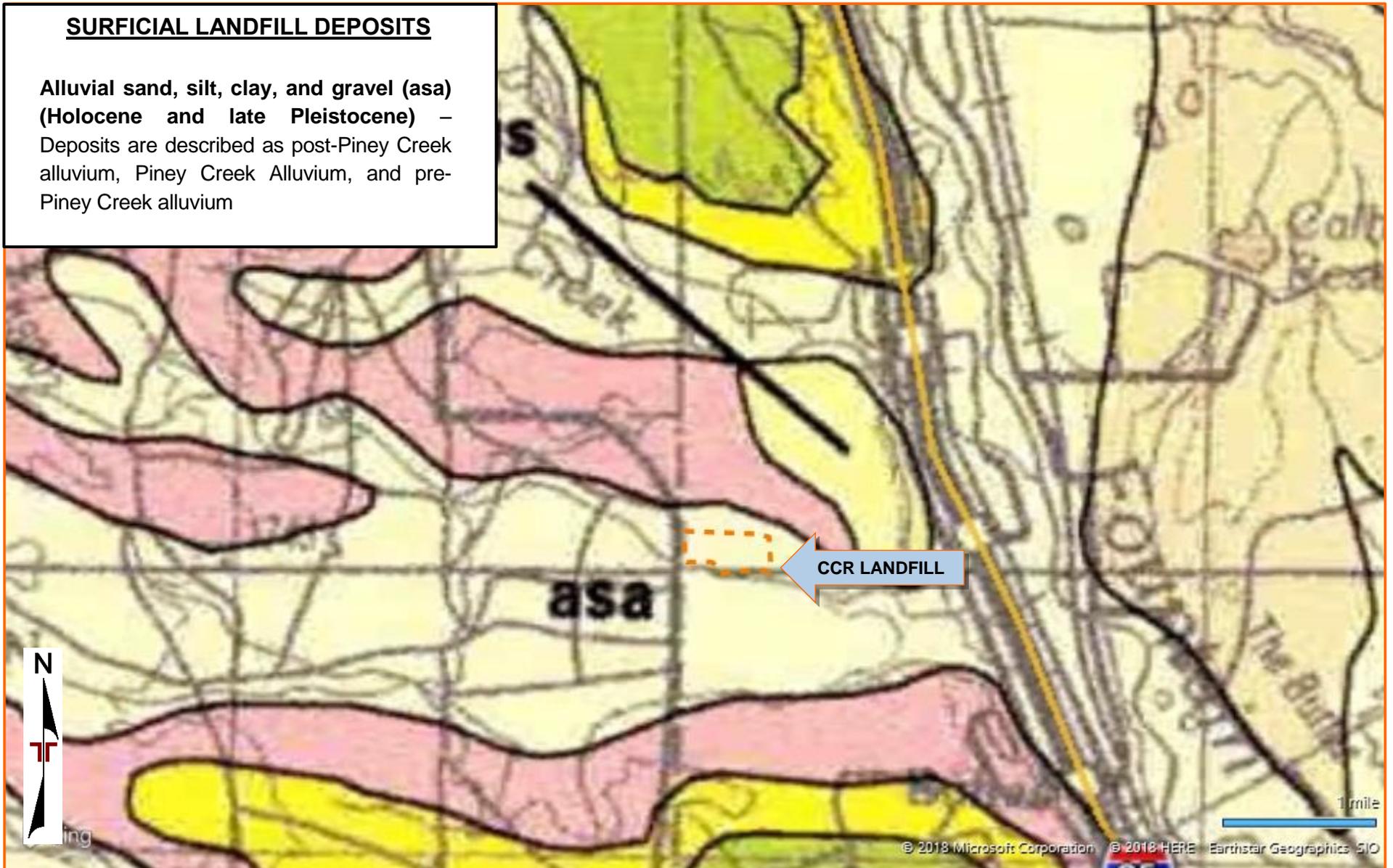


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SURFICIAL GEOLOGY BASED ON MAPPING PERFORMED BY  
THE UNITED STATES GEOLOGIC SURVEY PUEBLO 1 X 2  
DEGREE QUADRANGLE, MISCELLANEOUS FIELD MAP MF-2388