Comanche Station, Pueblo, Colorado

Groundwater Monitoring System Certification

for Compliance with the Coal Combustion Residuals (CCR) Rule

Comanche Station

Xcel Energy

August 1, 2016

CERTIFICATION

Groundwater Monitoring System for Compliance

with the Coal Combustion Residuals Rule

Public Service Company of Colorado, an Xcel Energy Company

Comanche Station, Pueblo, Colorado

I hereby certify that the groundwater monitoring system at Comanche Station is designed to meet the performance standard in Sections 257.91(a)(1) and (2) of the Federal Coal Combustion Residuals (CCR) Rule, and that the groundwater monitoring system has been designed and constructed to ensure that the groundwater monitoring will meet this performance standard for all active CCR units. Comanche Station is owned by the Public Service Company of Colorado (PSCo), an Xcel Energy Company, and is located in Pueblo, Colorado.

I am duly licensed Professional Engineer under the laws of the State of Colorado.

COLORADO LICENSED
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20-JUL-2016
PROFESSIONAL ENGINEER

Gokhan Inci, PE (Colorado PE 0048172) July 20, 2016

My license renewal date is October 31, 2017

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Abbreviation	Definition
ADF	Ash Disposal Facility
CCR	Coal Combustion Residuals
EPA	U.S. Environmental Protection Agency
TSS	Total Suspended Solids

1.0 Introduction

The U.S. Environmental Protection Agency's (EPA's) final Coal Combustion Residuals (CCR) Rule establishes a comprehensive set of requirements for the management and disposal of CCR (or coal ash) in landfills and surface impoundments by electric utilities. Comanche Station, located in Pueblo, Colorado (**Figure 1**), has two CCR units subject to the CCR Rule: an impoundment (Bottom Ash Pond) and a landfill (Ash Disposal Facility; ADF) (**Figure 2**).

This document supports compliance with the CCR Rule by demonstrating that the groundwater monitoring system at Comanche Station meets the requirements outlined in Section § 257.91 of the Rule, which states:

- Section § 257.91(f): *'The owner or operation must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet requirements of this section* [§257.91]. *If the groundwater monitoring system includes the minimum number of monitoring wells specified in paragraph (c)(1) of this section* [Section § 257.91], *the certification must document the basis supporting this determination*.'

Table 1 summarizes components required by groundwater monitoring systems, per the CCR Rule and the professional engineer's certification of compliance with these requirements. The remainder of this document provides information to support certification for the multiunit groundwater monitoring system for the two CCR units at Comanche Station.

Table 1. Summary of 40 CFR Section § 257.91 Groundwater Monitoring System Requirements and Site-Specific Compliance

Groundwater Monitoring System Requirements	Compliance with Requirement
(a) *Performance standard.* The owner or operator of a CCR unit must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that: (1) Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. A determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where: (i) Hydrogeologic conditions do not allow the owner or operator of the CCR unit to determine what wells are hydraulically upgradient; or (ii) Sampling at other wells will provide an indication of background groundwater quality that is as representative or more representative than that provided by the upgradient wells; and (2) Accurately represent the quality of groundwater passing the waste boundary of the CCR unit. The downgradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination in the uppermost aquifer. All potential contaminant pathways must be monitored.	**Yes.** The direction of groundwater flow has been determined at the site; the groundwater monitoring system includes the minimum number of wells at appropriate locations and depths to yield groundwater samples necessary to meet performance standards (a)(1) and (a)(2). See Sections 3 and 4.
(b) The number, spacing, and depths of monitoring systems shall be determined based upon site-specific technical information that must include thorough characterization of: (1) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow; and (2) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities and effective porosities.	**Yes.** The monitoring system was designed based on results of technical, site-specific data, including (b)(1) and (b)(2). See Sections 3 and 4.

Table 1. Summary of 40 CFR Section § 257.91 Groundwater Monitoring System Requirements and Site-Specific Compliance	
Groundwater Monitoring System Requirements	**Compliance with Requirement**
(c) The groundwater monitoring system must include the minimum number of monitoring wells necessary to meet the performance standards specified in paragraph (a) of this section, based on the site-specific information specified in paragraph (b) of this section. The groundwater monitoring system must contain: (1) A minimum of one upgradient and three downgradient monitoring wells; and (2) Additional monitoring wells as necessary to accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and the quality of groundwater passing the waste boundary of the CCR unit.	**Yes.** One upgradient and three downgradient wells that meet the performance standards are being monitored at each CCR unit (impoundment and landfill) in compliance with the CCR Rule. See Section 4.
(d) The owner or operator of multiple CCR units may install a multiunit groundwater monitoring system instead of separate groundwater monitoring systems for each CCR unit. (1) The multiunit groundwater monitoring system must be equally as capable of detecting monitored constituents at the waste boundary of the CCR unit as the individual groundwater monitoring system specified in paragraphs (a) through (c) of this section for each CCR unit based on the following factors:(i) Number, spacing, and orientation of each CCR unit; (ii) Hydrogeologic setting; (iii) Site history; and (iv) Engineering design of the CCR unit. (2) If the owner or operator elects to install a multiunit groundwater monitoring system, and if the multiunit system includes at least one existing unlined CCR surface impoundment as determined by §257.71(a), and if at any time after October 19, 2015 the owner or operator determines in any sampling event that the concentrations of one or more constituents listed in appendix IV to this part are detected at statistically significant levels above the groundwater protection standard established under §257.95(h) for the multiunit system, then all unlined CCR surface impoundments comprising the multiunit groundwater monitoring system are subject to the closure requirements under §257.101(a) to retrofit or close.	**Yes.** A multiunit system capable of detecting monitored constituents per (d)(1) was installed. See Sections 2 and 4.
(e) Monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space (*i.e.,* the space between the borehole and well casing) above the sampling depth must be sealed to prevent contamination of samples and the groundwater. (1) The owner or operator of the CCR unit must document and include in the operating record the design, installation, development, and decommissioning of any monitoring wells, piezometers and other measurement, sampling, and analytical devices. The qualified professional engineer must be given access to this documentation when completing the groundwater monitoring system certification required under paragraph (f) of this section. (2) The monitoring wells, piezometers, and other measurement, sampling, and analytical devices must be operated and maintained so that they perform to the design specifications throughout the life of the monitoring program.	**Yes.** Well design meets requirements (e). See Section 4. Groundwater monitoring system will be operated and maintained per (e)(2).
(f) The owner or operator must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of this section. If the groundwater monitoring system includes the minimum number of monitoring wells specified in paragraph (c)(1) of this section, the certification must document the basis supporting this determination.	**Yes.** System designed and constructed to meet the requirements of Section §257.91. Technical information to support certification and number of wells, per (c)(1). See Sections 2.0, 3.0 and 4.0.

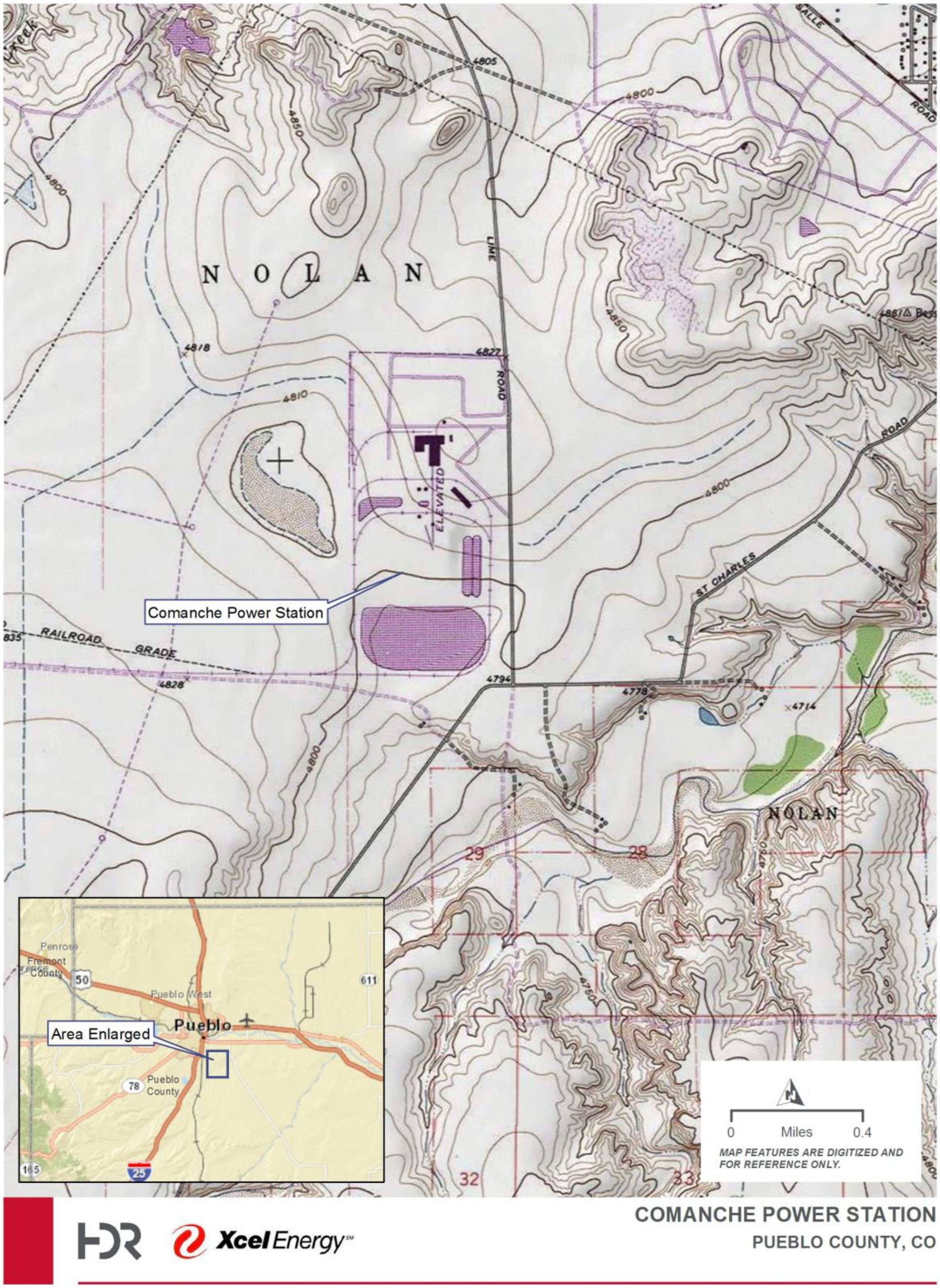

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Figure 1. Vicinity Map for Comanche Station

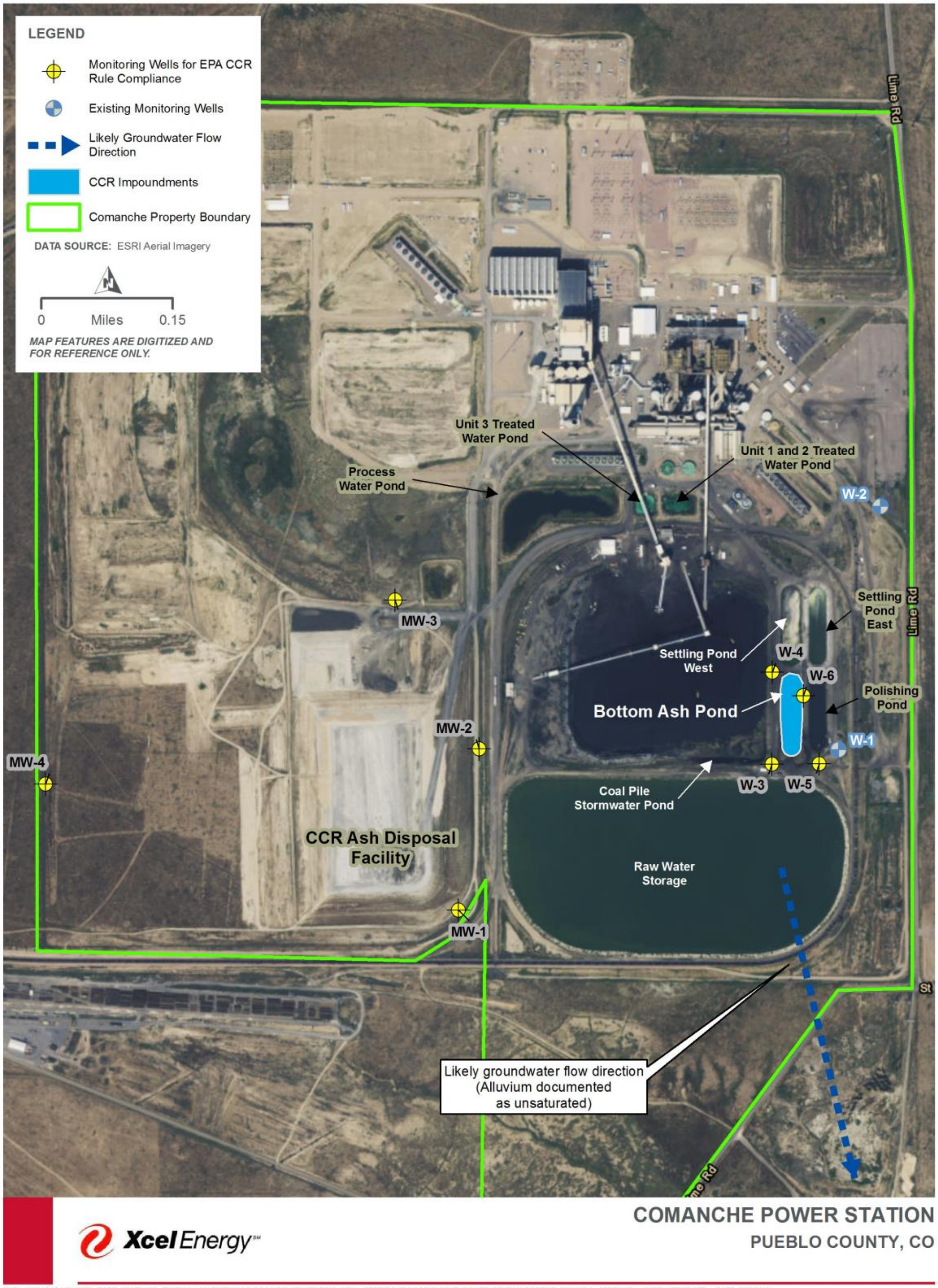

Figure 2. Comanche Station – CCR Units and Monitoring Well Location Map

2.0 Facility Description

Comanche Station is a coal-fired plant consisting of three units (Units 1, 2, 3) that burn Powder River Basin coal. Unit 1 was built in 1973, Unit 2 was built in 1975, and Unit 3 was built in 2010 (Tetra Tech, 2012). Comanche Station currently has two CCR units subject to the CCR Rule: a landfill and an impoundment (**Figure 2**). The sections that follow provide a brief description of the CCR units.

Additional ponds at the facility include process water, settling, polishing, and raw water storage ponds. These units do not hold CCR, and therefore are not considered CCR units, in compliance with the CCR Rule:

> *"CCR surface impoundments do not include units generally referred to as cooling water ponds, process water ponds, wastewater treatment ponds, storm water holding ponds, or aeration ponds. These units are not designed to hold an accumulation of CCR, and in fact, do not generally contain significant amounts of CCR."*

2.1 CCR Landfill

The CCR landfill, also know as the CCR Ash Disposal Facility (**Figure 2**), is an approximately 280-acre engineered ash monofill consisting of eight permitted disposal cells. Currently, disposal is occurring in one 40-acre cell in the southeast corner of the permitted landfill, which was constructed with a clay liner (Xcel Energy, 2005). The additional disposal cells will be constructed in phases as needed to contain ash and waste from power generating activities. Fly ash from all three units is collected in silos for disposal in the landfill. Bottom ash is also permitted to be disposed in the on-site landfill, if needed. Water treatment sludge (lime from an on-site treatment system), process water pond sediment, coal impurities, and excavation soils are also permitted for disposal at the landfill (Tetra Tech, 2015).

2.2 CCR Impoundment

Ash generated from the combustion of coal at the Comanche Station is sluiced to the impoundment (also known as the Bottom Ash Pond, **Figure 2**). The ash is then excavated from the impoundment and transported to the landfill. According to historic documents, the impoundment was constructed in 1972 with a 3-foot thick clay liner. The impoundment is 513 feet long by 138 feet wide and 26 feet deep with a surface area of 1.6 acres. The primary influent is from the bottom ash sluiced from Units 1, 2, and 3 to settle out bottom ash. Additional sources include continuous deionization softeners waste, brine and rinse, and activated carbon filter backwash and brine (Tetra Tech, 2013). The CCR impoundment discharges to the polishing pond (**Figure 2**).

3.0 Site Hydrogeology/Geology

Prior investigation reports are available documenting hydrogeologic and geotechnical studies completed at the Comanche Station. These include:

- Feasibility Investigation, Two Ash Disposal Areas (Woodward-Clyde Consultants, 1987);
- Geotechnical Investigation, Unit 3 (URS, 2005);
- Coal Ash Disposal Facility Design and Operations Plan (Xcel Energy, 2005);
- Surface Water Impoundment Infiltration Characterization Analysis (GeoTrans, Inc., 2009);
- Inventory and Preliminary Classification Report, Waste Impoundments (Tetra Tech, 2012);

- Sitewide Monitoring Plan, Ash Disposal Facility (Tetra Tech, 2014); and
- Engineering Design and Operations Plan, Ash Disposal Facility (Tetra Tech, 2015).

Comanche Station is underlain by unconsolidated colluvium consisting of stiff clays and silts, with interbedded sand and gravel west and northwest of CCR landfill. Typical colluvium thickness is less than 20 feet but ranges between 5 and 75 feet (Woodward-Clyde, 1987; URS, 2005). The Pierre Shale is the uppermost bedrock at the Comanche Station. A water table does not exist regionally in the Pierre Shale (Xcel Energy, 2005). Underlying the approximate 1,450 feet of shale deposits is the Dakota Sandstone, the uppermost bedrock aquifer in this area (Tetra Tech, 2012).

Because a water table does not appear to exist in the colluvium, there is no measureable horizontal groundwater flow direction or hydraulic gradient at the site. A potential south-southeasterly flow gradient is assumed based on the ground surface topography, which slopes to the south-southeast towards the St. Charles River. The alluvial aquifers associated with the Arkansas River (north), the St. Charles River (south), and Salt Creek (west) do not extend beneath the site (Xcel Energy, 2005).

The shallow unconsolidated colluvium deposits beneath the site have been predominantly unsaturated, with some isolated areas of perched water (GeoTrans, Inc. 2009). Areas of perched water are likely controlled by the bedrock topography where infiltrating meteoric waters flow along the bedrock contact (GeoTrans, Inc. 2009). The conceptual model for surface water infiltration is that it migrates vertically into low-permeability bedrock and/or is trapped in topographic lows in the bedrock surface prior to migrating vertically (GeoTrans, Inc. 2009). Given the lack of a laterally extensive shallow groundwater system in the colluvium deposits beneath the site and the depth of the uppermost aquifer (Dakota Sandstone), a wet/dry monitoring well system has been selected to detect changes in perched groundwater conditions and/or potential contaminants from the ash landfill and CCR impoundment.

4.0 Monitoring Wells

The CCR Rule requires, at a minimum, one upgradient and three downgradient monitoring wells per CCR unit to be completed in the uppermost aquifer. Section 257.9 of the Rule states that the operator: *"…may install a multiunit groundwater monitoring system instead of separate groundwater monitoring systems for each CCR unit."* In addition, the CCR Rule states that downgradient monitoring wells should be installed to: *"accurately represent the quality of groundwater passing the waste boundary of the CCR unit. The downgradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination in the uppermost aquifer."*

Based on the CCR requirements, hydrogeological data, and site visits, eight wells were sited for CCR compliance and serve as two upgradient and six downgradient monitoring wells **(Figure 2)**.

<u>Landfill/ADF</u>
Tetra Tech (2014) documented four existing monitoring wells (MW-1, MW-2, MW-3, and MW-4) that surround the ADF. The well locations are shown on **Figure 2**. Given the lack of a laterally extensive shallow groundwater system in the colluvium deposits beneath the site and the depth of the regional potentiometric surface, a wet/dry monitoring wells design was deemed appropriate for the monitoring wells. Wells MW-1, MW-2, MW-3, and MW-4 incorporate a 2-foot sump consisting of blank casing below the well screen to capture infiltrating perched water.

The four existing monitoring wells (MW-1, MW-2, MW-3, and MW-4) that surround the ADF meet the requirements of the CCR Rule for groundwater monitoring. Because of the lack of water table in the colluvium, the shallow groundwater flow direction can only be estimated. However, the facility is surrounded by monitoring wells (**Figure 2**); therefore, all possible water quality conditions will be represented in the collection of shallow groundwater. Upgradient and downgradient wells have been designated based upon the likely groundwater flow direction. The upgradient well (MW-3) is located north of the ADF in a low lying area. MW-3 periodically contains 1.5 to 2 feet of water in the sump, likely due to infiltration of surface water runoff during high precipitation events. The downgradient wells (MW-1, MW-2, MW-4) are located southeast, east, and west, respectively, from the facility. Historically, MW-1, MW-2, and MW-4 are dry.

<u>Impoundment/Bottom Ash Pond</u>
In 1997, monitoring well W-3 was installed near the CCR impoundment and the nearby settling and polishing ponds to investigate the presence or absence of perched water and the integrity of the 3-foot thick pond liner systems (GeoTrans, Inc. 2009). W-3 contains perched water, however it was concluded that the source of perched water was not the surface impoundments (GeoTrans, Inc. 2009).

Based on the CCR requirements, hydrogeological data, and site visits, the existing well W-3 meets the requirements of the CCR Rule for groundwater monitoring and serves as a downgradient monitoring well. Three new wells, W-4, W-5, and W-6 were sited for CCR compliance to serve as the additional monitoring wells. As with the landfill/ADF wells, because of the lack of water table in the colluvium, the shallow groundwater flow direction is estimated and as used to designate upgradient and downgradient wells.

4.1 Well Construction

The boreholes for monitoring wells were drilled by a licensed well driller. Each well is constructed with 2-inch diameter, Schedule 40 PVC casing and screen with 0.010-inch screen slots. Between 5 and 20 feet of screen was installed in each well. Where perched water was not encountered, the well screen was placed approximately 5 feet above the top of the bedrock contact to intersect the colluvium-bedrock contact (unless the contact was too shallow). To capture infiltrating perched water[1], 10-foot long sumps consisting of blank casing were placed beneath the screens to be consistent with Colorado Department of Public Health and Environment well design recommendations (Tetra Tech, 2014).

Well construction included 10-20 washed silica sand for the filter pack approximately 5 feet above the well screen. Annular seals of coated bentonite pellets extend from the top of the filter pack to the surface and were hydrated after placement. Monitoring wells were developed and surveyed.

[1] Previously constructed wells W-1, W-2, and W-3 incorporated a 2-foot sump to capture infiltrating perched water. Due to the lack of a laterally extensive shallow groundwater system in the colluvium deposits beneath the site and the depth of the uppermost aquifer (Dakota Sandstone), a wet/dry monitoring well system is an effective way to detect changes in perched groundwater conditions and/or potential contaminants from the ash landfill and CCR impoundment.

Table 2. Monitoring Well Construction

Well I.D.	Northing (UTM NAD 83 Zone 13, meters)	Easting	Elevation TOC (ft)	Well Total Depth (ft bgs)	Screen Interval (ft bgs)	Well Stickup (ft)	Well Type	Static WL (ft amsl) March 2016	Well Permit Number	Depth to Water (ft BTOC)	Approximate Depth of Pierre Shale if encountered (ft BGS)
MW-1	4228054.61	536733.11	4806.73	11 (2 ft sump)	4-9	1.89	2-inch PVC	dry	32282	dry	9
MW-2	4228350.96	536770.80	4800.45	13 (2 ft sump)	6-11	1.65	2-inch PVC	dry	32283	dry	10
MW-3	4228624.19	536615.92	4798.45	11 (2 ft sump)	4-9	1.67	2-inch PVC	4788.85	32284	9.9	7
MW-4	4228286.31	535973.39	4826.47	29 (2 ft sump)	7-27	2.42	2-inch PVC	dry	32285	dry	27
W-3	4228322.28	537309.21	4807.41	29	14-29	1.04	2-inch PVC	4791.46	210286	16.2	29
W-4	4228491.35	537310.48	4812.47	23.4 (10 ft sump)	3.4-13.4	3.63	2-inch PVC	4789.67	299843	22.8	14
W-5	4228323.54	537396.38	4807.46	23.5 (10 ft sump)	3.5-13.5	3.83	2-inch PVC	4795.13	299844	12.33	14
W-6	4228447.93	537367.35	4811.89	25 (10 ft sump)	5-15	3.90	2-inch PVC	4796.51	299844	15.38	15

Notes:
TOC = top of casing
BTOC = below top of casing
BGS = below ground surface
amsl = above mean sea level

5.0 Groundwater Quality Sampling

5.1 Schedule

Sampling is conducted at a frequency compliant with CCR Part 257.94. Eight rounds of upgradient and downgradient monitoring well sampling will be completed before October 17, 2017. These samples will represent background water quality. Groundwater sampling will be conducted quarterly between fourth quarter 2015 and third quarter 2017. After eight rounds of sampling to establish background water quality, semi-annual (twice per year) groundwater detection monitoring will be initiated. Groundwater quality sampling will be conducted in all upgradient and downgradient monitoring wells unless wells are dry. In accordance with the CCR Rule, groundwater samples will not be field filtered. The field parameters of turbidity, pH, and temperature will be measured using an YSI Professional Plus (or an equivalent) portable water quality instrument that has been calibrated prior to use.

5.2 Analytical testing

Analytical testing of groundwater samples will be performed by TestAmerica or other EPA certified laboratory. Samples will be analyzed for the parameters shown on **Table 3**, which include all of the parameters in Appendices III and IV of Part 257 for the initial eight background sample events, plus Total Suspended Solids (TSS). For subsequent events, it is anticipated the parameters listed in Appendix III will be analyzed, unless assessment monitoring is required. For quality control, one field duplicate sample and one field equipment blank sample will be collected for each sample event. The laboratory will analyze matrix spike/matrix spike duplicates at a rate of 5 percent, per laboratory quality control standards.

Table 3. Groundwater Quality Parameters
Appendix III Constituents for Detection Monitoring
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids (TDS)
Appendix IV Constituents for Assessment Monitoring
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride

Table 3. Groundwater Quality Parameters
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 combined
Additional Parameters
Total Suspended Solids (TSS)

6.0 Reporting

The CCR Rule 297.90(e) identifies the reporting requirements for the groundwater monitoring program for the CCR units. The annual reporting documents will be developed no later than January 31, 2018 and annually thereafter. The annual reports will be placed in the Comanche operating record. The data validation, verification, and statistical methods used to analyze each specified constituent in each monitoring well are described in a separate Statistical Methods Certification document.

Annual reports will summarize key monitoring actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year. For CCR compliance, Xcel Energy will file the report in the facility operating records.

Xcel will comply with the CCR Rule recordkeeping requirements specified in § 257.105(h), notification requirements specified in § 257.106(h), and internet requirements specified in § 257.107(h).

7.0 References

GeoTrans, Inc., 2009. Surface Water Impoundment Infiltration Characterization Analysis, Public Service Company of Colorado, Comanche Station, Pueblo, Colorado. December 1, 2009.

Tetra Tech, 2012. Inventory and Preliminary Classification Report, Waste Impoundments, Comanche Station, Pueblo, Colorado. November 1, 2012.

Tetra Tech, 2013. Closure Plan, Type A Waste Impoundments, Comanche Station, Pueblo, Colorado. June 28, 2013.

Tetra Tech, 2014. Sitewide Monitoring Plan, Ash Disposal Facility, Comanche Station, Pueblo, Colorado. August 29, 2014.

Tetra Tech, 2015. Engineering Design and Operations Plan, Ash Disposal Facility, Comanche Station, Pueblo, Colorado. January 13, 2015.

URS, 2005. Geotechnical Investigation, Unit 3, Comanche Station, Pueblo, Colorado. March 2, 2005.

Woodward-Clyde Consultants, 1987. Feasibility Investigation, Two Ash Disposal Areas for Comanche Power Station, Pueblo, Colorado. March 1987.

Xcel Energy, 2005. Comanche Station Coal Ash Disposal Facility Design and Operations Plan. August 24, 2005.