Technical Memorandum

Date:	Tuesday, October 16, 2018
Project:	NC1 OPPD
To:	OPPD
From:	Greg Shafer, PE
Subject:	NC1 Ash Disposal Area 'Unstable Areas' Evaluation, Demonstration and Certification

Purpose

The Coal Combustion Residual (CCR) Rule, specifically CFR Title 40, Part 257, Section 257.64, states that, "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 ensure that the integrity of the structural components of the CCR unit will not be disrupted."

An unstable area is defined in Section 257.53 as 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."

The purpose of this technical memorandum is to review and summarize the existing conditions and determine if the active CCR landfill also known as the NC1 Ash Disposal Area (NC1 Ash Landfill) is within an Unstable Area. The following factors are required to be considered in this evaluation:

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

Differential Settlement

The compressibility of soils consists of consolidation settlement and immediate settlement. Consolidation settlement is a result of a volume change in saturated soils due to the expulsion of water occupying the void spaces. Immediate settlement is due to the elastic deformation of dry soils and of moist and saturated soils without any change in the water content. (Reference 1: DAS, 2nd Edition). Materials typical of large settlement include soft and highly plastic clays which take a large amount of time to dissipate the pore water pressure that develops over time during the loading. The soil materials below the NC1 Ash Landfill are sandy and will dissipate

water quickly, and are not susceptible to large settlements or differential settlement over time (References 1 and 6 listed at the end of the memo).

The soil profile below the NC1 Ash Landfill consists of alluvial clay, silt, sand and gravel. It is described in the Hydrogeologic Investigations Report, SCS Engineers, October 4, 1995, as unconsolidated (alluvium) deposits. Geologically, unconsolidated refers to not consolidated or cemented together such as sandstone, siltstone, shale or limestone (USGS). In general, there are silts and clays overlying well graded sand (SW is the unified soil classification symbol for well graded sand). Also per the hydrogeologic report, "limestone and shale bedrock was found at depths ranging from approximately 77 feet to 103.5 feet". The elevation of the top of bedrock is found in figure 3-2 of the above referenced report.

An evaluation of maximum total settlement of the landfill was conducted by Black and Veatch in the original permit documents. Reference: Landfill Settlement calculations, May 25, 1995. The maximum total settlement was estimated to be 1.7 feet. Preliminary estimates of the settlement range from less than an inch along the outside perimeter to approximately 1.7 feet in the center, approximately 580 feet away. The resulting differential settlement deflection ratio (maximum differential movement in the span length – EM 1110-1-1904 (USACE Engineer Manual) is approximately 1/340 and is not considered excessive for earthen structures. Typically, a deflection ratio of 1/100 or greater is considered excessive with embankments (Reference: Bureau of Reclamation, Design Standards No. 13 Embankment Dams, Chapter 5, pg. 5-17). Based on these existing conditions and future capping system grades, differential settlement is not excessive and will not cause the area to be unstable.

Geologic or Geomorphologic Features

The general geologic features of the site are described in the Hydrogeologic Investigations Report, SCS Engineers October 4, 1995. The materials at the surface and below consist of alluvial silts, clays, sands and combinations of those. Bedrock, as described by the report as "limestone and shale bedrock was found at depths ranging from approximately 77 feet to 103.5 feet."

There was no indication of encountering karst deposits, which is a distinctive topography that indicates dissolution (also called chemical solution) of underlying soluble rocks by surface water or ground water. The limestone encountered as the bedrock is not considered at risk for dissolution.

Alluvial soil deposits are not known to have mass movements. They can be susceptible to erosion and possibly subject to scour, which could lead to slope instability if along a water way. But, since the Missouri River (or any other water way) is over a half mile away, there is no concern for mass movements or slope instability.

The borings included split spoon sampling which provides an indicator of strength based on the number of hammer blows (drops). The higher the blow count, the higher relative density and consistency (stiffness) of the materials sampled. The materials encountered during installation of MW-1 through MW-6 were characterized as loose (<10 blows per foot) to medium dense (<50

blows per foot). During installation of MW-1 there were two samples with blow counts of 5 and 6 blows per foot, which is considered loose. None of the materials were very loose (<5 blows). The shear strength for granular soils includes the effective stress and friction angle. Overall shear strengths determined and utilized for slope stability ranged from 1.7 KSF to 4.7 KSF (Reference 6). Based on this general information and the slope stability results, the existing soils are capable of supporting the loads. This was also demonstrated with the slope stability performed as part of the original Nebraska Department of Environmental Quality (NDEQ) Permit Application.

Seismic Considerations

Seismic impact zones are defined as an area having a 2% or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10 g in 50 years. The site location in Otoe County southeast of Nebraska City was located on the USGS Seismic-Hazard Maps for the Conterminous United States, 2008, Peak Horizontal Acceleration with 2 Percent Probability of Exceedance in 50 Years. See attached USGS Seismic-Hazard Map. The peak horizontal acceleration at that location is below the 0.10 g threshold and is not considered in a seismic impact zone. It is noted that the slope stability calculation within the NDEQ permit, did take the seismic acceleration into account which determined an acceptable factor of safety.

Human-made Features or Events

The human-made features include the plant; the transformer area; two substations (near the CCR landfill but not within the landfill); a plant runoff pond; and USACE levee near the CCR landfill. There are also transmission power line structures within the CCR landfill. There are no movements associated with these features and they do not impact the stability of the area.

Professional Engineer Certification

"I hereby certify that this Technical Memorandum for the CCR landfill known as the NC1 Ash Landfill at the Nebraska City Station, owned and operated by Omaha Public Power District (OPPD), meets the requirements of the Coal Combustion Residual Rule 40 CFR, Section 257.64. I am a duly licensed Professional Engineer under the laws of the State of Nebraska."

Print Name: Gregory M Shafer

Signature:

Date: October 16, 2018

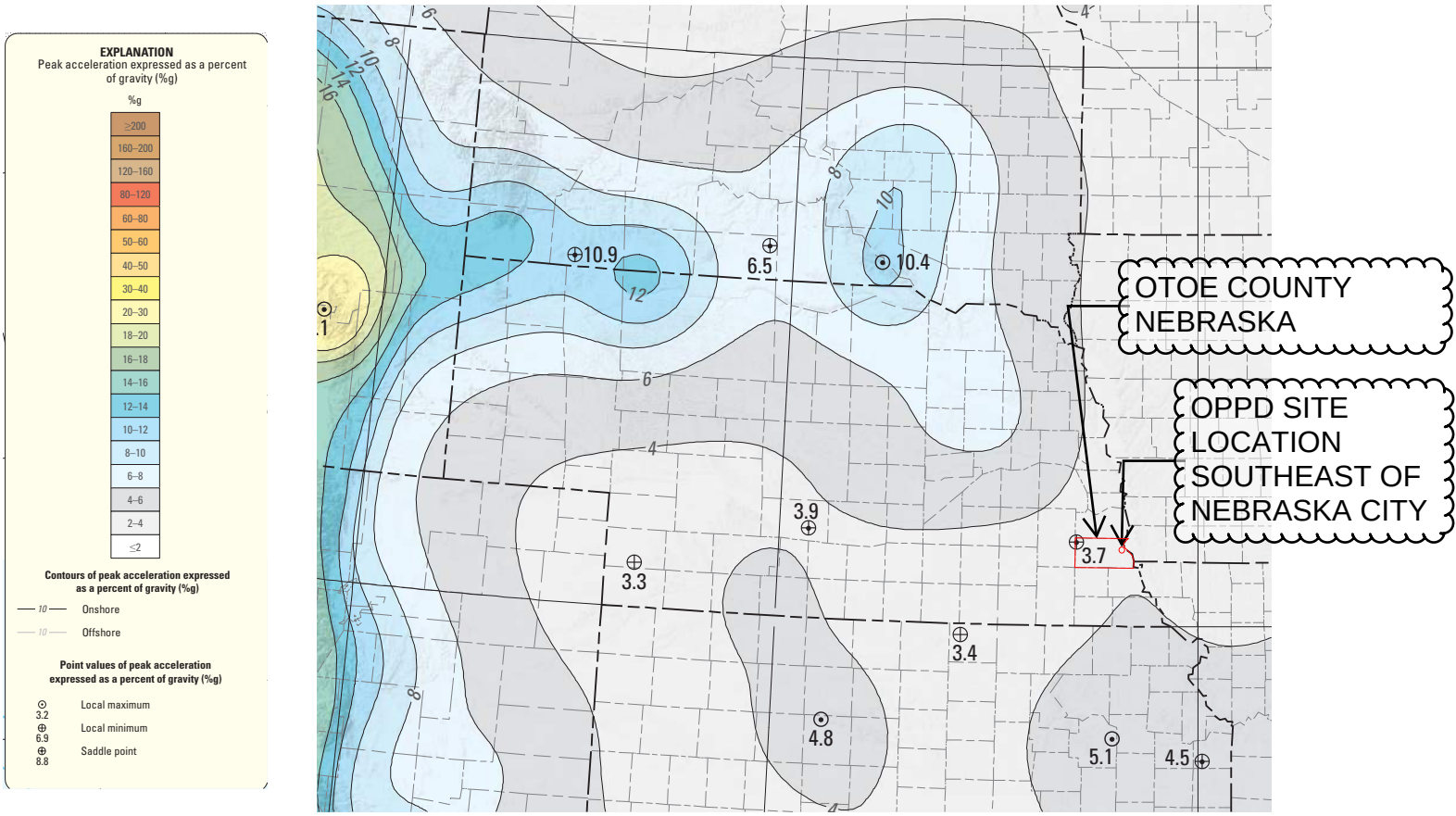
License #: E-11178

My license renewal date is December 31, 2018.

References

1. Principles of Foundation Engineering, Braja Das, 2nd Edition, pg. 156.
2. Hydrogeologic Investigations Report, SCS Engineers, October 4, 1995
3. Bureau of Reclamation, Design Standards No. 13 Embankment Dams, Chapter 5, pg. 5-17.
4. USACE Engineer Manual – EM 1110-1-1904, Engineering and Design.
5. USGS Seismic-Hazard Map peak acceleration 2 percent probability of exceedance in 50 years; Nebraska excerpt. Attached.
6. Black & Veatch Calculations within current permit renewal, May 16, 2016 (original calculations 1995).

FIGURE 1: NEBRASKA EXCERPT OF 2014 PEAK HORIZONTAL ACCELERATION WITH 2 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS (10 PERCENT IN 250 YEARS)



Seismic-Hazard Maps for the Conterminous United States, 2014

Peak Horizontal Acceleration with 2 Percent Probability of Exceedance in 50 Years

By

Mark D. Petersen,[1] Morgan P. Moschetti,[1] Peter M. Powers,[1] Charles S. Mueller,[1] Kathleen M. Haller,[1]Arthur D. Frankel,[1] Yuehua Zeng,[1] Sanaz Rezaeian,[1] Stephen C. Harmsen,[1] Oliver S. Boyd,[1] Edward H. Field,[1] Rui Chen,[2] Nicolas Luco,[1]Russell L. Wheeler,[1] Robert A. Williams,[1] Anna H. Olsen,[1] and Kenneth S. Rukstales[1]

2015

[1]U.S. Geological Survey
[2]California Geological Survey, Sacramento, Calif.