Hazard Potential Classification

Lewis & Clark Station

Prepared for
Montana-Dakota Utilities Co.

November 2018

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Certification

I hereby certify that this report was conducted in accordance with the requirements of Part 257, Subpart D, chapter § 257.73 Structural integrity criteria for existing CCR surface impoundments, paragraph (2) Periodic hazard potential classification assessments.

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PE #: 12805PE

November 28, 2018
Date

1.0 Introduction

The US Environmental Protection Agency (EPA) published the federal rule "Disposal of Coal Combustion Residuals from Electric Utilities" in April 2015. This rule, 40 CFR Parts 257 and 261, provides a comprehensive set of requirements for the safe disposal of coal combustion residuals (CCRs), commonly known as coal ash, from coal-fired power plants. This rule requires that for all diked CCR surface impoundments covered by the rule, a hazard potential classification be determined according to the definitions set out with the rule, which is consistent with guidance from ASDSO (Association of State Dam Safety Officials) and FEMA (Federal Emergency Management Agency).

Montana-Dakota Utilities Co. (MDU) operates the Lewis & Clark Station (Lewis & Clark), a coal-fired steam-electric generating plant, near Sidney, Montana. Operation of the plant results in production of coal combustion residuals (CCR) that must be managed in accordance with the requirements of 40 CFR 257 Subpart D, Standards for Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments (CCR Rule). The East Scrubber Pond and the West Scrubber Pond comprise an existing single, multi-unit surface impoundment CCR unit, as defined by the CCR rule, referred to as the Scrubber Ponds. The Scrubber Ponds receive flue-gas desulfurization (FGD) sludge and some fly ash material. Since the Scrubber Ponds are diked surface impoundments, a hazard potential classification must be prepared.

This memorandum was previously published in October 2016, describing the site, classification criteria, and the conclusion that the site hazard potential classification was "low". Since then, the west and east scrubber ponds have been retrofitted, increasing the height of the dikes and the storage capacity. This memorandum reassesses the hazard potential classification according to the same methods and classification criteria as was done in October 2016.

Section 2.0 includes a description of the site and the surface impoundments that must be classified. The memorandum identifies the applicable federal rules (Sections 3.1 and 3.2), the Montana state rules (Section 3.3), and rules that are pertinent from neighboring states to provide additional useful guidance (Section 3.4 through 3.6). By cross referencing the facility description against the relevant guidelines, the memorandum closes with the assessment and determination of the hazard potential classification in Section 4.0.

2.0 Site Characterization

2.1 Site Description and Drainage

A map of the Lewis & Clark Station site is included as Figure 1. The site is located on the left bank of the Yellowstone River, next to the Highway 23 Bridge. The surrounding area is mostly agricultural. A BNSF railroad is located parallel to County Road 350 along the western border of the site and two stockpiles of coal, the generating station and supporting facilities, and the CCR surface impoundments are located on site.

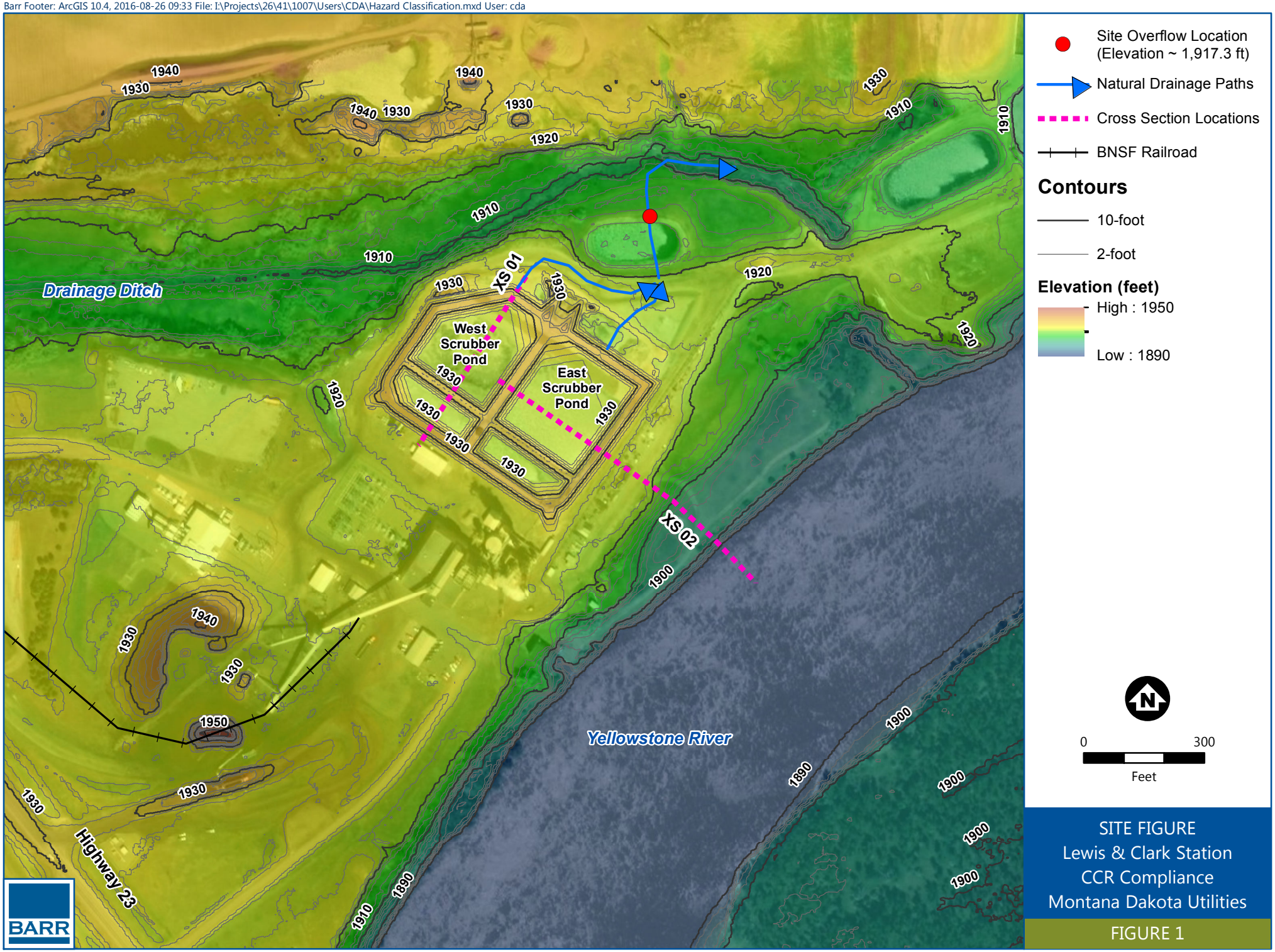
The surface impoundments consist of two basins, the West Scrubber Pond and the East Scrubber Pond, each with two cells established for management of CCR within each impoundment. The Scrubber Ponds each include an emergency spillway at elevation 1932.0 feet, which would direct an uncontrolled spill to the northeast, away from infrastructure and personnel. Natural stormwater drainage off of the site is mostly to the north, to a nearly-flat (i.e., horizontal slope) ditch that flows around the site, eventually draining into the Yellowstone River. This drainage area of the ditch is over 10 square miles and is mostly made up of agricultural land and some industrial areas. Some stormwater from a smaller portion of the site drains directly to the southeast to the Yellowstone River.

If one of the perimeter dikes were to breach towards the northeast, the release would first fill the Temporary Storage Pad (TSP), then fill the Sewage Lagoon, then flow to the drainage ditch on the north side of the site, eventually draining to the Yellowstone River. Water leaving the site due to a dike failure has the potential to leave the property by traveling upstream (west) in this drainage ditch due to its nearly-flat slope.

2.2 Human Presence and Activity

Except for the people working onsite, there do not appear to be any permanent structures, or recreational sites within the likely path of a flood wave that could be generated due to a failure of the impoundments. Homes are located on the west side of Highway 23, but these homes are well protected by the elevation of the highway, which is between about 1,928 and 1,934 feet. Additionally, structures (homes, farm outbuildings, or industrial buildings) on the west side of County Road 350 are high enough that they would not be impacted by a flood wave, either. The volume of water contained within the CCR surface impoundments would not be enough to fill the drainage ditch to the north of the site up to a level that would begin to impact structures on the west side of the county road. However, the people that could be at risk from a failure of the dikes are those working on site.

The facility staff consists of about 24 people, working in shifts around the clock, with most people working the shift from 6 am to 2 pm. Most everyone's duties require them to be working both inside the plant and outside around the site. Based on information provided by the facility owner, staff spend in the order of 4 hours of every shift working outside the station buildings, but most of this time is in equipment or vehicles, with minimal time spent working on foot in proximity to the impoundments.



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SITE FIGURE
Lewis & Clark Station
CCR Compliance
Montana Dakota Utilities

FIGURE 1

2.3 Coal Combustion Residual Description

The CCR material in the East and West Scrubber Ponds is flue gas desulfurization solids. The CCR is very fine-grained and can be easily transported by flowing water. Therefore, it is expected that if the dikes were to fail, the water and a substantial portion of the CCR contained within the impoundment would flow like slurry or a sediment-laden flow would. This assessment therefore assumes that what is contained within the impoundments can flow freely with water.

2.4 Impoundment Geometry

The modifications to the East and West Scrubber Ponds (Scrubber Pond Project, March, 2018) include an emergency spillway for each pond which would redirect any uncontrolled spill to the northeast toward the Temporary Storage Pad (TSP) and potentially the Sewage Lagoon. The perimeter dikes are raised to elevation 1933.0 feet, and the controlling emergency spillway elevation is 1932.0 feet for both ponds. The existing ground elevation around the scrubber ponds varies, and is between about 1922 feet and 1926 feet on the northeast side of the ponds (Figure 2 and Figure 3). If the East or West Scrubber Pond were to fill, either due to a significant precipitation event or some operational issue, the ponds would fill to an elevation of 1932.0 feet, and then begin to spill to the northeast through the emergency spillways. Because the spillways are made of common fill, and are protected against erosion only on the outside slope of the berm, uncontrolled spills will likely result in erosion of the spillway and a more significant release from the ponds. Given a large enough event, the erosion in the spillway would continue until it reached the toe of the dike. With the grading that will occur in the TSP area northeast of the ponds, the expected toe of the dikes will be at an approximate elevation of 1926 feet. It is possible that erosion could continue through the base of the dike closer to natural ground at elevation 1924 feet or 1925 feet, but this is unlikely.

The northeast perimeter dikes are approximately 7.0 feet high (above the graded toe elevation 1926.0 feet). Storage can occur in the ponds up to elevation 1932.0 feet (six feet of water above the toe) and is presented in Table 1. The total storage of each impoundment above the toe of the dike is about 10 acre-feet (9.1 acre-feet and 10.6 acre-feet). Control structures in the interior dikes with stop logs at elevation 1930.5 feet hydraulically connect the two cells of each impoundment.

Table 1 Details of the height and storage volume of the East and West Scrubber Ponds

Measurement	East Scrubber Pond	West Scrubber Pond
Crest Elevation (feet)	1933.0	1933.0
Height to Crest (feet)	7.0	7.0
Emergency Spillway Elevation (feet)	1932.0	1932.0
Height of Water (feet)	6.0	6.0
Area at Emergency Spillway (acres)	2.2	1.9
Area at 1,926 feet (acres)	1.4	1.2
Volume of Storage (acre-feet), above elevation 1,926 feet	10.6	9.1
Volume of Storage (acre-feet) above elevation 1,924 feet	13.3	11.4

The areas and volumes presented in this table are based off of the design topographic surface. The as-built survey is not available at the time of developing this memorandum.

A simple volume accounting was conducted to determine the storage capacity of the TSP and the Sewage Lagoon, both northeast of the Scrubber Ponds and the first location that would store an uncontrolled spill. Because the two surface impoundments are physically and hydraulically separate, only the volume of one impoundment was used for this analysis. The TSP sump is designed at elevation 1917.0 feet, and stored water in the TSP would overflow to the northeast to the Sewage Lagoon at elevation 1922.0 feet (Scrubber Pond Project, Contract Documents, March, 2018). The storage available in the proposed graded TSP between elevation 1917.0 feet and 1922.0 feet is just under 1.0 acre-feet. In the Sewage Lagoon, storage could occur up to elevation 1917.3 feet based on available topographic data. The initial water level in the Sewage Lagoon can vary. Based on the available topographic data, it could be around 1914 to 1915 feet. The storage available is between 1.0 and 1.5 acre-feet. A release from either Scrubber Pond due to a failure of the dike via erosion of the emergency spillway would inundate and overtop the TSP, inundate and overtop the Sewage Lagoon, and spill into the ditch on the north side of the property and eventually release up to 6.6-8.6 acre-feet to the Yellowstone River.

Median daily flow of the Yellowstone River near the Lewis & Clark Station ranges between roughly 5,000 and 6,000 cfs, which is about 413 to 495 acre-feet passing by the site every hour. If either pond were to be entirely released into the Yellowstone River over the course of an hour, the volume would constitute approximately 3% of the river's volume over that same hour. There is a 95% chance that the daily flow is greater than about 3,000 cfs (roughly 2,000 cfs to 4,000 cfs on any day) which is equivalent to about 250 acre-feet of volume over an hour. A spill of an entire pond during the low probability (5%) low flows would constitute about 6% of the river's volume. Accounting for the small amount of storage in the TSP and Sewage Lagoon before overtopping any spill to the river, and the fraction of river flow is reduced to about 3%.

A dike failure to the southwest (towards the property, infrastructure, and primary employee activity) is less likely with the Scrubber Pond Project of 2018. However, a failure could still happen due to piping through the dike, potentially initiated by burrowing rodents. As presented in the Hazard Potential Classification report in 2016, there is potentially over 10 acre-feet of storage on the property before overtopping to the Yellowstone River. Most of the spill, if it were to occur to the southwest due to dike failure via piping, would be contained on the site.

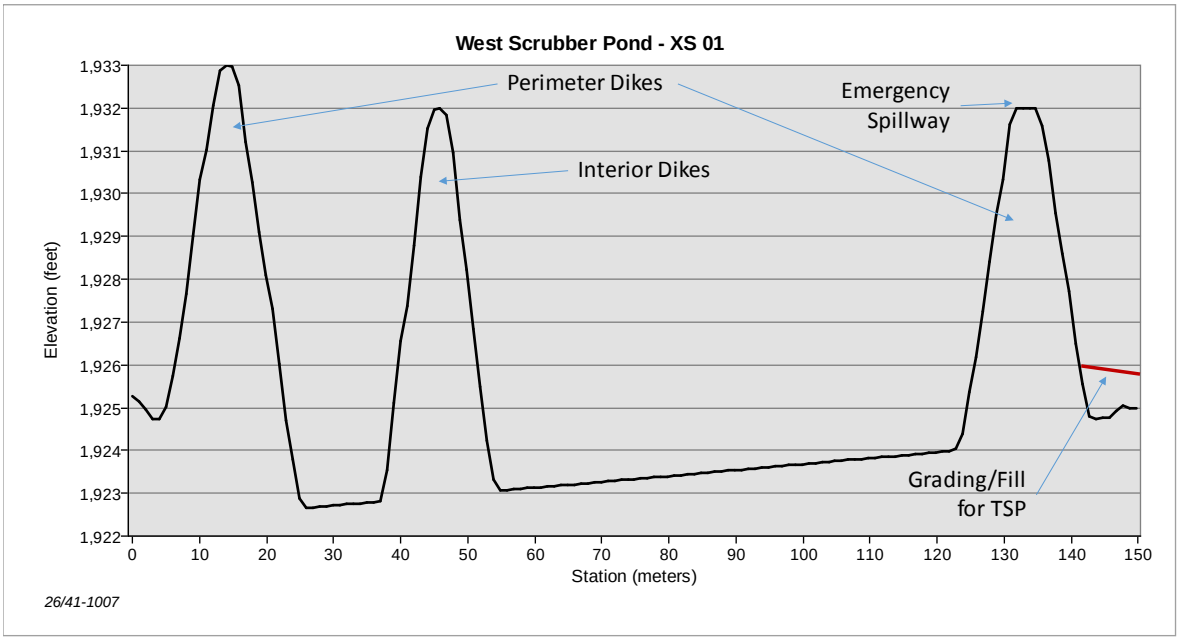

Figure 2 **Cross section of the West Scrubber Pond – XS01**

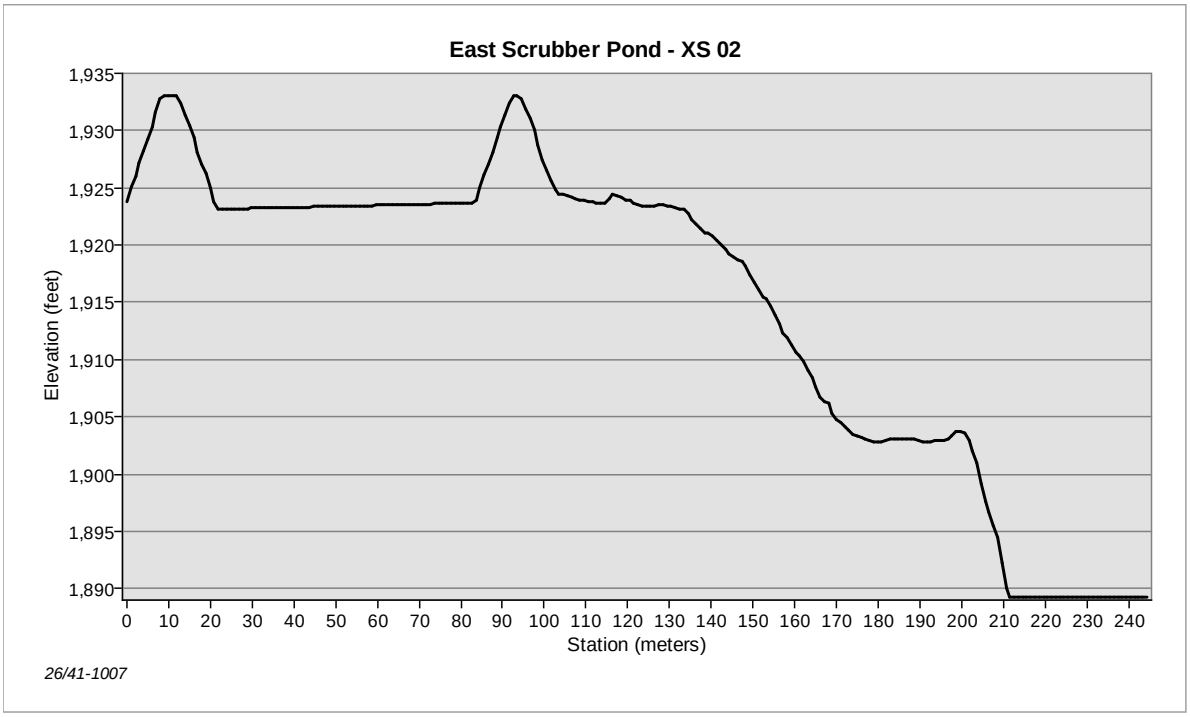

Figure 3 **Cross section of the East Scrubber Pond – XS02**

3.0 Hazard Potential Classification from Agencies in the Region

This section discusses the rules and guidelines from the CCR rule, existing guidelines from FEMA, the state of Montana, and other neighboring states. While the rules of other states do not directly apply, they do shed some light on the approaches and methods used in nearby locations, hence considered, to offer guidance for the hazard potential classification of this particular site.

3.1 Environmental Protection Agency (EPA)

The federal rule "Disposal of Coal Combustion Residuals from Electric Utilities" requires that coal ash impoundments be classified in one of three hazard potential classifications (section 257.73 (a)(2)(i)):

- High Hazard – those where failure or mis-operation will probably cause loss of human life
- Significant Hazard – those where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environment damage, disruption to lifeline facilities, or impact other concerns. These dams are often located in predominantly rural or agricultural areas, but could be located in areas with population and significant infrastructure.
- Low Hazard – those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

The federal rule also states in the preamble (page 21318) that the Assessment Program concluded that impoundments with heights less than five feet *or* those retaining less than 20 acre-feet were unlikely to cause *significant* environmental or economic loss should they undergo a catastrophic failure (italics added). Furthermore, it indicates that the Agency's review of Mine Safety and Health Administration (MSHA) and FEMA guidance also noted that "small" units were unlikely to cause significant losses should they fail.

What is not clearly described in the rule or preamble is what "probable" means with regard to the loss of human life, what "small" means in terms of size, or what "significant" damage or disruption is. For these relatively subjective terms, other federal and state rules were examined, limited to Montana and other nearby western states.

3.2 Federal Emergency Management Agency (FEMA)

The Hazard Potential Classification System for Dams by FEMA (April 2004) and Selecting and Accommodating Inflow Design Floods for Dams by FEMA (FEMA P-94, August 2013) both describe the hazard potential classifications as:

- High Hazard – those where failure or mis-operation will probably cause loss of human life
- Significant Hazard – those where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities or impact other concerns
- Low Hazard – those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the dam owner's property.

These descriptions are accompanied by the following definitions and statements from FEMA.

> *"**PROBABLE:** Likely to occur; reasonably expected; realistic."*
>
> *"… postulating every conceivable circumstance that might remotely place a person in the inundation zone whenever a failure may occur should not be the basis for determining the conservatism in dam design criteria."*
>
> *"… Improbable loss of life exists where persons are only temporarily in the potential inundation area. For instance, this hazard potential classification system does not contemplate the improbable loss of life of the occasional recreational user of the river and downstream lands, passer-by, or non-overnight outdoor user of downstream lands. … High usage areas of any type should be considered appropriately. …"*

FEMA thus offers complementary, useful background and qualifications to help making the potentially subjective, initial qualitative assessment of the hazard classification that would apply to a given impounding facility like the surface impoundments assessed herein.

3.3 Montana State Engineer's Office

Rules from the state of Montana are focused on high hazard dams, both in the Montana Code (Title 85, Chapter 15, Dam Safety Act) and Montana Rules (Chapter 36.14, Dam Safety). High hazard dams according to these rules are limited to those that impound 50 acre-feet or more of water at the maximum normal operating pool, not counting dead storage which would be below the downstream natural ground elevation.

3.4 Colorado State Engineer's Office

In Colorado, with the exception of non-jurisdictional dams, the hazard potential classification of a dam is based solely on the potential effects of the dam failure flood wave, and does not consider the impacts of environmentally harmful or toxic substances released.

The classifications as defined by the Colorado State Engineer's Office are as follows:

- The high hazard potential classification according to Colorado rules is based solely on the potential for loss of human life. The criteria for determining expected loss of human life are:

- No loss of life is expected to occur if the depth of flow is two feet or less and the product of the flow depth and the flow velocity at the critical location is less than seven.
- Judgment and sound reason must be used in determining the potential for loss of life at locations where the flow depth is less than two feet and the product of depth and velocity is greater than seven, or where the depth of flow is greater than two feet and the product of depth and flow is less than seven.

- The significant hazard potential classification according to Colorado rules is a dam for which significant damage is expected to occur, but no loss of human life is expected from failure of the dam. Significant damage is defined as damage sufficient to render structures or facilities uninhabitable or inoperable. Significant damage is also defined as damage to structures where people generally live, work or recreate, or public or private facilities. Relevant guidelines for defining these structures are:
  - Habitable industrial or commercial facilities where people live, work, or recreate that are attached to foundations and connected to utilities
  - Water, gas, or power lines that are considered to be major lifeline utilities.
- A low hazard dam is a dam for which loss of human life is not expected and significant damage to structures and public facilities is not expected. The flood due to failure of the dam may cause damage less than that defined as significant damage to man-made improvements, without expected loss of life. Minor damage to unimproved roads and small irrigation structures is considered within the class of low hazard, as is sheet flooding of agricultural lands and farm out-buildings.
- A no public hazard or NPH dam is a dam for which no loss of human life is expected, and for which damage only to the dam owner's property will result from failure of the dam. The classification study must adequately show that damage would not occur to adjacent properties beyond the point where the flood exits the dam owner's property.

Regarding non-jurisdictional dams, Section 4.2.5.2 of the State of Colorado's Department of Natural Resources' Rules and Regulations for Dam Safety and Dam Construction defines them as dams creating a reservoir with a capacity of 100 acre-feet or less, a surface area of 20 acres or less, and a height of 10 feet or less. Figure 4 presents all the dam classifications per the State of Colorado.

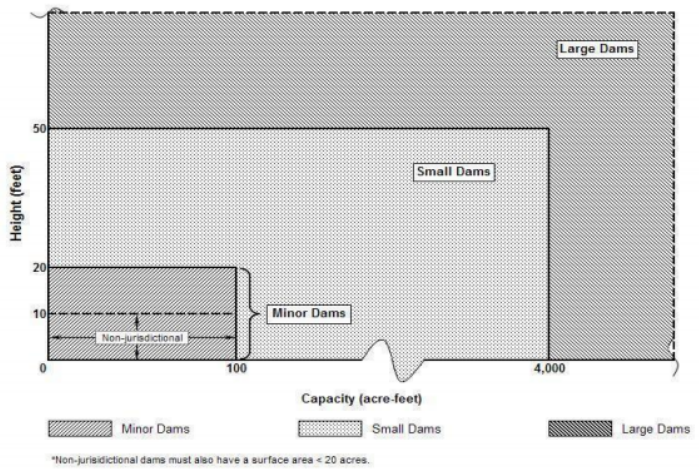

Figure 4 **Schematic of classifying the size of Colorado dams, from large to non-jurisdictional**

3.5 Wyoming State Engineer's Office

The laws and regulations of Wyoming do not provide a system of dam classification, but the Safety of Dams law applies for dams with a height greater than 20 feet and a storage volume of more than 50 acre-feet, and also when habitable buildings are immediately downstream.

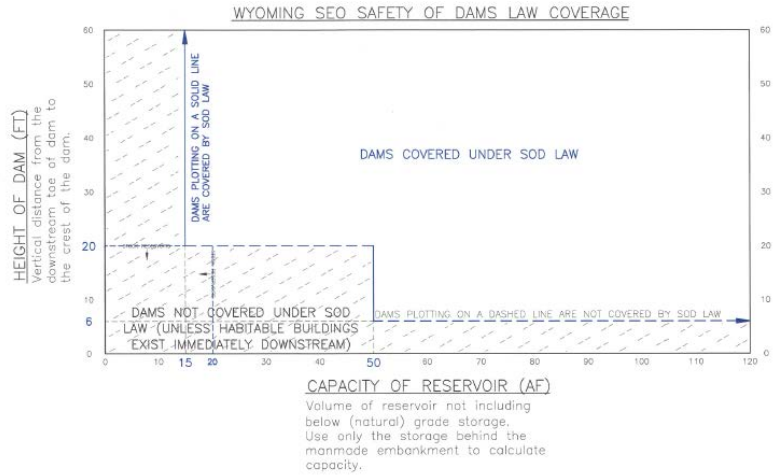

Figure 5 **Wyoming guidance on dam regulation by size**

3.6 North Dakota State Engineer's Office

In North Dakota, dam safety guidelines are contained in the North Dakota Dam Design Handbook (June, 1985). Dams are categorized according to the potential hazard to property or loss of life if the dam should suddenly fail. The categories are:

- Low – those dams located in rural or agricultural areas where there is little possibility of future development. Failure of low hazard dams may result in damage to agricultural land, township and county roads, and farm buildings other than residences. No loss of life is expected if the dam fails.

- Medium – those dams located in predominantly rural or agricultural areas where failure may damage isolated homes, main highways, railroads or cause interruption of minor public utilities. The potential for the loss of a few lives may be expected if the dam fails.
- High – those dams located upstream of developed and urban areas where failure may cause serious damage to homes, industrial and commercial buildings and major public utilities. There is a potential for the loss of more than a few lives if the dam fails.

4.0 Hazard Potential Classification

The assessment of the hazard potential classification is as follows:

- Regarding EPA and FEMA rules and guidance (see Sections 3.1 and 3.2):
    - Based on information provided by the facility owner, staff spend minimal time working on foot in close proximity to the impoundments, limiting their exposure to a pond's failure, consequently resulting in no probable loss of human life within the facility boundaries should the CCR impoundments fail. Additionally, the emergency spillways now directs the initial uncontrolled spill to the northeast, away from infrastructure and personnel.
    - The configuration of the site (see Figure 1), including the storage capacity of the TSP and the Sewage Lagoon, means that a potential release of one of the CCR impoundments can be reduced, with about 6.6-8.6 acre-feet potentially leaving the site if either CCR impoundment fails. This can be directly compared to the median rate of ~450 acre-feet every hour that flows through the Yellowstone River, or the low-probability (5%) rate of ~250 acre-feet every hour. Therefore, while economic or environmental losses resulting from the CCR impoundments failing are expected to occur, they are considered low outside the facility boundaries.
    - The federal rule (EPA) states that impoundments retaining less than 20 acre-feet were unlikely to cause significant environmental or economic loss should they undergo a catastrophic failure.
- Regarding the state rules (see Sections 3.3 through 3.6)
    - The combined storage capacity of the CCR impoundments is 20-25 acre-feet, depending on the elevation assumed for the dike toe (see Table 1), which is less than the threshold of 50 acre-feet to be classified as a high hazard dam per the State of Montana
    - The capacity, surface area and height of the CCR impoundments is 20-25 acre-feet, about 4.0 acres, and 7.0 feet (see Table 1), respectively, which is less than the upper limits of 100 acre-feet, 20 acres, and 10 feet for a dam to be classified as non-jurisdictional per the State of Colorado
    - The capacity, and height of the CCR impoundments is 20-25 acre-feet, and 7.0 feet (see Table 1), respectively, which is less than the upper limits of 50 acre-feet, and 20 feet for a dam to be covered under Safety of Dam law per the State of Wyoming, and there are no habitable buildings immediately downstream of the CCR impoundments
    - The CCR impoundments are located in an agricultural area with little possibility of future development, and with no loss of life expected

Based on the site information and analysis of potential conditions presented above, the hazard classification recommended for the surface impoundments at the MDU Lewis & Clark Station is "low".