UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 24, 2017

Mr. Peter A. Gardner
Site Vice President
Northern States Power Company - Minnesota
Monticello Nuclear Generating Plant
2807 West County Road 75
Monticello, MN 55362-9637

SUBJECT: MONTICELLO NUCLEAR GENERATING PLANT – STAFF ASSESSMENT OF RESPONSE TO 10 CFR 50.54(f) INFORMATION REQUEST – FLOOD-CAUSING MECHANISM REEVALUATION (CAC NO. MF7712)

Dear Mr. Gardner:

By letter dated March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information pursuant to Title 10 of the *Code of Federal Regulations*, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The request was issued as part of implementing lessons learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 2 to the 50.54(f) letter requested licensees to reevaluate flood-causing mechanisms using present-day methodologies and guidance. By letter dated May 12, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16145A233), Northern States Power Company, a Minnesota corporation (NSPM, the licensee), doing business as Xcel Energy, responded to this request for Monticello Nuclear Generating Plant (Monticello).

By letter dated September 4, 2016 (ADAMS Accession No. ML16248A004), the NRC staff sent the licensee a summary of its review of Monticello's reevaluated flood-causing mechanisms. The enclosed staff assessment provides the documentation supporting the NRC staff's conclusions summarized in the letter. As stated in the letter, because local intense precipitation at Monticello is not bounded by the plant's current design basis, additional assessments of the flood hazard mechanism are necessary.

The NRC staff has no additional information needs at this time with respect to NPSM's 50.54(f) response related to flooding.

This staff assessment closes out the NRC's efforts associated with CAC Nos. MF7712.

Enclosure 1 transmitted herewith contains Security-Related Information. When separated from Enclosure 1, this document is decontrolled.

If you have any questions, please contact me at (301) 415-1056 or e-mail at Lauren.Gibson@nrc.gov.

Sincerely,

Lauren K. Gibson, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No. 50-331

Enclosures:
1. Staff Assessment of Flood Hazard Reevaluation Report (Non-public, security-related information)
2. Staff Assessment of Flood Hazard Reevaluation Report (public)

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO FLOODING HAZARD REEVALUATION REPORT

NEAR-TERM TASK FORCE RECOMMENDATION 2.1

MONTICELLO NUCLEAR GENERATING PLANT

DOCKET NO. 50-263

1.0 INTRODUCTION

By letter dated March 12, 2012 (NRC, 2012a), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant as documented in the Near-Term Task Force (NTTF) report (NRC, 2011a). Recommendation 2.1 in that document recommended that the NRC staff issue orders to all licensees to reevaluate seismic and flooding for their sites against current NRC requirements and guidance. Subsequent staff requirements memoranda associated with SECY-11-0124 (NRC, 2011c) and SECY-11-0137 (NRC, 2011d), directed the NRC staff to issue requests for information to licensees pursuant to 10 CFR 50.54(f) to address this recommendation.

Enclosure 2 to the 50.54(f) letter (NRC, 2012a) requested that licensees reevaluate flood hazards for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits (ESPs) and combined licenses (COLs). The required response section of Enclosure 2 specified that NRC staff would provide a prioritization plan indicating Flooding Hazard Reevaluation Report (FHRR) deadlines for each plant. On May 11, 2012, the NRC staff issued its prioritization of the FHRRs (NRC, 2012c).

By letter dated May 12, 2016 (Xcel Energy, 2016), Northern States Power Company (NSPM, the licensee), doing business as Xcel Energy, provided the FHRR for the Monticello Nuclear Generating Station (Monticello). The NRC staff performed an audit as documented in the audit report (NRC, 2017).

On September 16, 2016, the NRC issued an interim staff response (ISR) letter to the licensee (NRC, 2016b). The purpose of the ISR letter is to provide the flood hazard information suitable for the assessment of mitigating strategies developed in response to Order EA-12-049 (NRC, 2012b) and the additional assessments associated with Recommendation 2.1: Flooding. The ISR letter also made reference to this staff assessment, which documents NRC staff's basis and conclusions. The flood hazard mechanism values presented in the letter's enclosures match the values in this staff assessment without change or alteration.

As mentioned in the ISR letter (NRC, 2016b), the reevaluated flood hazard results for the local intense precipitation (LIP) flood-causing mechanism is not bounded by the plant's current design basis (CDB). Consistent with the 50.54(f) letter and amended by the process outlined in

COMSECY-15-0019 (NRC, 2015a), Japan Lessons-Learned Division (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01, Revision 1 (NRC, 2016b) and JLD-ISG-2016-01, Revision 0 (NRC, 2016c), the NRC staff anticipates that the licensee will perform and document a focused evaluation for LIP and associated site drainage that assesses the impact of the LIP hazard on the site and evaluates and implements any necessary programmatic, procedural, or plant modifications to address this hazard exceedance.

Additionally, for any reevaluated flood hazards that are not bounded by the plant's CDB hazard, the licensee is expected to develop flood event duration (FED) parameters and associated effects (AE) parameters. These parameters will be used to conduct the mitigating strategies assessment (MSA) and focused evaluations or integrated assessments.

2.0 REGULATORY BACKGROUND

2.1 Applicable Regulatory Requirements

As stated above, Enclosure 2 to the 50.54(f) letter (NRC, 2012a) requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for ESPs and COLs. This section of the staff assessment describes present-day regulatory requirements that are applicable to the FHRR.

Sections 50.34(a)(1), (a)(3), (a)(4), (b)(1), (b)(2), and (b)(4), of 10 CFR, describe the required content of the preliminary and final safety analysis reports, including a discussion of the facility site with a particular emphasis on the site evaluation factors identified in 10 CFR Part 100. The licensee should provide any pertinent information identified or developed since the submittal of the preliminary safety analysis report in the final safety analysis report.

General Design Criterion 2 in Appendix A of 10 CFR Part 50 states that structures, systems, and components (SSCs) important to safety at nuclear power plants must be designed to withstand the effects of natural phenomena, such as earthquakes, tornados, hurricanes, floods, tsunamis, and seiches without the loss of capability to perform their intended safety functions. The design bases for these SSCs are to reflect appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area. The design bases are also to have sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

Section 50.2 of 10 CFR defines the design-basis as the information that identifies the specific functions that an SSC of a facility must perform, and the specific values or ranges of values chosen for controlling parameters as reference bounds for design which each licensee is required to develop and maintain. These values may be: (a) restraints derived from generally accepted "state of the art" practices for achieving functional goals; or (b) requirements derived from analysis (based on calculation, experiments, or both) of the effects of a postulated accident for which an SSC must meet its functional goals.

Section 54.3 of 10 CFR defines the "current licensing basis" (CLB) as "the set of NRC requirements applicable to a specific plant and a licensee's written commitments for ensuring compliance with and operation within applicable NRC requirements and the plant-specific design basis (including all modifications and additions to such commitments over the life of the license) that are docketed and in effect." This includes: 10 CFR Parts 2, 19, 20, 21, 26, 30, 40, 50, 51, 52, 54, 55, 70, 72, 73, 100, and appendices thereto; orders; license conditions; exemptions; and technical specifications, as well as the plant-specific design-basis information as documented in the most recent updated final safety analysis report (UFSAR). The licensee's commitments made in docketed licensing correspondence, which remain in effect, are also considered part of the CLB.

Present-day regulations for reactor site criteria (Subpart B to 10 CFR Part 100 for site applications on or after January 10, 1997) state, in part, that the physical characteristics of the site must be evaluated and site parameters established such that potential threats from such physical characteristics will pose no undue risk to the type of facility proposed to be located at the site. Factors to be considered when evaluating sites include the nature and proximity of dams and other man-related hazards (10 CFR 100.20(b)) and the physical characteristics of the site, including the hydrology (10 CFR 100.21(d)).

2.2 Enclosure 2 to the 50.54(f) Letter

Section 50.54(f) of 10 CFR states that a licensee shall at any time before expiration of its license, upon request of the Commission, submit written statements, signed under oath or affirmation, to enable the Commission to determine whether or not the license should be modified, suspended, or revoked. The 50.54(f) letter (NRC, 2012a) requested, in part, that licensees reevaluate the flood-causing mechanisms for their respective sites using present-day methodologies and regulatory guidance used by the NRC for the ESP and COL reviews.

2.2.1 Flood-Causing Mechanisms

Attachment 1 to Enclosure 2 of the 50.54(f) letter discusses flood-causing mechanisms for the licensee to address in its FHRR (NRC, 2012a). Table 2.2-1 lists the flood-causing mechanisms the licensee should consider and lists the corresponding Standard Review Plan (SRP) (NRC, 2007) section(s) and applicable ISG documents containing acceptance criteria and review procedures.

2.2.2 Associated Effects

In reevaluating the flood-causing mechanisms, the "flood height and associated effects" should be considered. Guidance document JLD-ISG-2012-05 (NRC, 2012d) defines "flood height and associated effects" as the maximum stillwater surface elevation plus:

- Wind waves and runup effects
- Hydrodynamic loading, including debris
- Effects caused by sediment deposition and erosion
- Concurrent site conditions, including adverse weather conditions
- Groundwater ingress
- Other pertinent factors

2.2.3 Combined Effects Flood

The worst flooding at a site that may result from a reasonable combination of individual flooding mechanisms is sometimes referred to as a "combined effects flood". It should also be noted that for the purposes of this staff assessment, the terms "combined effects" and "combined events" are synonyms. Even if some or all of these individual flood-causing mechanisms are less severe than their worst-case occurrence, their combination may still exceed the most severe flooding effects from the worst-case occurrence of any single mechanism described in the 50.54(f) letter (see SRP Section 2.4.2, Areas of Review (NRC, 2007)). Attachment 1 of the 50.54(f) letter describes the "combined effect flood" as defined in American National Standards Institute/American Nuclear Society (ANSI/ANS) 2.8-1992 (ANSI/ANS, 1992) as follows:

> For flood hazard associated with combined events, American Nuclear Society (ANS) 2.8-1992 provides guidance for combination of flood causing mechanisms for flood hazard at nuclear power reactor sites. In addition to those listed in the ANS guidance, additional plausible combined events should be considered on a site specific basis and should be based on the impacts of other flood causing mechanisms and the location of the site.

If two less severe mechanisms are plausibly combined per ANSI/ANS-2.8-1992 (ANSI/ANS, 1992), then the licensee will document and report the result as part of one of the hazard sections. An example of a situation where this may occur is flooding at a riverine site located where the river enters the ocean. For this site, storm surge and river flooding are plausible combined events and should be considered.

2.2.4 Flood Event Duration

Flood event duration was defined in JLD-ISG-2012-05 (NRC, 2012c) as the length of time during which the flood event affects the site. It begins when conditions are met for entry into a flood procedure, or with notification of an impending flood (e.g., a flood forecast or notification of dam failure), and includes preparation for the flood. It continues during the period of inundation, and ends when water recedes from the site and the plant reaches a safe and stable state that can be maintained indefinitely. Figure 2.2-1 illustrates flood event duration.

2.3 Actions Following the FHRR

For the sites where the reevaluated flood hazard is not bounded by the CDB flood hazard elevation for any flood-causing mechanisms, the 50.54(f) letter (NRC, 2012a) requests licensees and construction permit holders to:

- Submit an interim action plan with the FHRR documenting actions planned or already taken to address the reevaluated hazard; and

- Perform an integrated assessment to: (a) evaluate the effectiveness of the CDB (i.e., flood protection and mitigation systems); (b) identify plant-specific vulnerabilities; and (c) assess the effectiveness of existing or planned systems and procedures for protecting against and mitigating consequences of flooding for the flood event duration.

If the reevaluated flood hazard is bounded by the CDB flood hazard for all flood-causing mechanisms at the site, licensees were not required to perform an integrated assessment. COMSECY-15-0019 (NRC, 2015b) outlines a revised process for addressing cases in which the reevaluated flood hazard is not bounded by the plant's CDB. The revised process describes an approach in which licensees with LIP hazards exceeding their CDB flood will not be required to complete an integrated assessment, but instead will perform a focused evaluation. As part of the focused evaluation, licensees will assess the impact of the LIP hazard on their sites and then evaluate and implement any necessary programmatic, procedural, or plant modifications to address the hazard exceedance. For other flood hazard mechanisms that exceed the CDB, licensees can assess the impact of these reevaluated hazards on their site by performing either a focused evaluation or integrated assessment (NRC, 2015 and NRC, 2016a).

3.0 TECHNICAL EVALUATION

The NRC staff reviewed the information provided for the flood hazard reevaluation of the Monticello site. The licensee conducted the flood hazard reevaluation using present-day methodologies and regulatory guidance used by the NRC staff in connection with ESP and COL reviews.

To provide additional information in support of the summaries and conclusions in its FHRR, the licensee made several calculation packages and engineering analyses referenced available to the NRC staff via an electronic reading room. The NRC staff did not rely directly on these calculation packages in its review; they were found only to expand upon and clarify the information provided in the Monticello FHRR, and so those calculation packages were not docketed and cited.

Finally, there were some licensee documents reviewed in connection with the NRC staff's 2016 audit of the Monticello FHRR. Many of those documents examined as part of the audit were also not docketed by the licensee; that additional information was made available to the NRC staff via the electronic reading room. Nevertheless, for those documents reviewed by the NRC staff as part that audit, they were cited in the audit summary report (NRC, 2017) prepared by the NRC staff.

3.1 Site Information

The 50.54(f) letter (NRC, 2012a) includes the SSCs important to safety in the scope of the hazard reevaluation. The licensee included pertinent data concerning these SSCs in the Monticello FHRR. The NRC staff reviewed and summarized this information in the sections below.

3.1.1 Detailed Site Information

The Monticello site is located on the western shore of the Mississippi River, in Wright County, Minnesota. The reactor complex (including both the powerblock and the controlled area) encompasses approximately 2,150 acres approximately 2.5 miles (mi) northwest (upstream) from the City of Monticello. The reactor site is 70 mi upstream from the larger city of Minneapolis-St. Paul. Geographically, the setting for the Monticello site is within the 'Central Lowlands,' a rural agricultural area generally defined by slight topography and numerous small lakes (Shimer, 1972). The topography of the Monticello site itself is characterized by relatively level bluffs, which rise sharply above the Mississippi River. The licensee noted that three distinct bluffs occur in the vicinity of the Monticello site at elevations 920, 930, and 940 feet National Geodetic Vertical Datum of 1929 (NGVD29). Approximately one mile north and south of the site another bluff rises to an elevation of 950 ft NGVD29. Unless otherwise stated, all elevations in this staff assessment are given with respect to the NGVD29.

Geologically, the Monticello site is underlain by unconsolidated, glacially-deposited drift material associated with the last continental ice-age. The licensee previously reported these deposits as mantle bedrock comprised of Paleozoic sandstones and shales at depths of 75 to 122 ft below the ground surface.

The reactor complex is located on a relatively flat plain whose natural elevation is about 930 ft NGVD29 that slopes slightly towards the river; the powerblock is comprised of compacted granular fill. The finished floor elevation of the reactor unit and other safety-related structures within the powerblock footprint structures that have been designated seismic Category I is 930 ft NGVD29, which is 25 ft above the mean water surface elevation (WSE) of the Mississippi River (NSPM, 2015). Table 3.0-1 summarizes the controlling reevaluated flood-causing mechanisms, including associated effects, the licensee computed to be higher than the powerblock elevation.

The licensee reported that the elevation of a majority of critical structure openings (i.e., seismic Category I) range in elevation from 931 ft to 935 ft. The licensee also reported that the Monticello site relies on certain active, as well as passive, flood-protection features and measures. Temporary features reported by the licensee (Xcel Energy, 2013) include the use of portable pumps, sandbags, plastic sheeting, steel plates, levees, etc. that are intended to protect safety-related SSCs from external flooding effects. As these features are temporary in nature, the licensee notes they must be installed prior to design-basis external flood levels attaining specific elevations (i.e., 930 ft NGVD29). The licensee has previously noted that the actual actions vary for each building (NSP, 1995). Incorporated features reported include: foundation walls; floor slabs; penetration seals; and flood detection instrumentation, etc. that were permanently incorporated into plant structures at the time of construction (Xcel Energy, 2013). The licensee also reported that an earthen levee/bin wall combination was recently constructed to prevent erosion of the channel slope adjacent to the reactor site along the Mississippi River bank. The earthen levee/bin wall is reported to have both an eastern segment as well as a western segment; both segments are 140 ft long and 12 ft high (Kuehl, 2014). Lastly, the licensee noted that the site does not rely upon any flood protection features external to the immediate plant area as part of the CLB that protect safety-related SSCs.

For the purposes of the FHRR analysis, the licensee estimated the size of the drainage area is about 13,900 square miles (mi^2). The Mississippi River near the Monticello Site is approximately 500 ft wide with a well-defined floodplain that includes oxbow-like meanders as well as river islands. Based on historic stream gauge data, the licensee reported that the average elevation of the river at the Monticello location is about 905 ft NGVD29; the maximum reported flood elevation at the site was 916 ft NGVD29 (NSPM, 2015).

The Mississippi River also serves as the ultimate heat sink for the Monticello site. The reactor's Service Water Intake Structure (SWIS) is located on the west bank of the river and connects to the powerblock cooling systems via a 151-ft long canal; the elevation of the intake structure foundation is 919 ft NGVD29. In the event of flooding on the Mississippi River, the licensee also reported that this structure would be allowed to flood, per design.

3.1.2 Design-Basis Flood Hazards

The CDB flood levels are summarized by flood hazard mechanism in Table 3.1-1. The licensee reported that the CDB flood hazard for the Monticello site is flooding due to flooding of the Mississippi River. The licensee noted that the Monticello site was not previously evaluated to determine its susceptibility to floods resulting from LIP, dam breaches or failures, channel migration, or a combined effects flood on the Mississippi River (Xcel Energy, 2016). The NRC staff confirmed that these flood-causing mechanisms were not specifically addressed in the UFSAR (NSPM, 2015) for the Monticello site. The NRC staff did note that other mechanisms were, nonetheless, screened from further consideration by the licensee as it was determined that the WSEs associated with these flooding mechanisms were bounded by the CDB (Xcel Energy, 2016). For example, the licensee reported that the Monticello site was not in a geographic location subject to certain types of marine-induced flooding scenarios that might occur as a result of surges, seiches, and tsunamis. Flooding due to ice-induced dams or jams was qualitatively evaluated by the licensee and determined to be bounded by the CDB (Xcel Energy, 2016).

The NRC staff reviewed the information provided in the FHRR and determined that sufficient information was provided to be responsive to Enclosure 2 of the 50.54(f) letter.

3.1.3 Flood-Related Changes to the Licensing Basis

The licensee noted that since the issuance of the operating license, no revisions to the flood hazard analysis have occurred and no significant changes to the flood protection strategies described in the current Monticello UFSAR (NSPM, 2015) have taken place. Existing flood protection requirements described in the UFSAR require that the below-grade surfaces of all safety-related buildings be coated with an impervious waterproofing material to protect against ground water ingress. To achieve the desired level of protection, the licensee also reported that there are permanently-installed safety-related features intended to protect power plant systems from inundation, as well as the static and dynamic effects of external flooding. Examples cited include external walls, penetration seals, flood detection instrumentation, etc. (Xcel Energy, 2013). The licensee also noted that when the WSE of the Mississippi River is predicted to exceed elevation 930 ft NGVD29, certain administrative procedures are initiated to provide additional flood protection to Class I and Class II structures. Those measures include the construction of a temporary levee protected by sandbags, as well as the installation of other temporary flood protection measures (steel plates, grout, or sandbags) to protect the openings of certain SSCs important to safety (Xcel Energy, 2013).

Following completion of the flooding walkdowns, several deficiencies and observations were identified by the licensee (Xcel Energy, 2013). To address the identified deficiencies and observations, the licensee planned to seal several penetrations to improve the overall reliability and response time to flooding. The licensee also initiated the preparation of an Engineering Change (EC) to install permanent flood protection features on and around the SWIS to reduce the amount of field work required during a flooding event and ultimately improve response time. The NRC staff reviewed the information provided in the FHRR and determined that sufficient information was provided to be responsive to Enclosure 2 of the 50.54(f) letter.

3.1.4 Changes to the Watershed and Local Area

The licensee reported that there are no significant changes reported to the Mississippi River watershed and environs since issuance of the UFSAR. Changes consistent with most nuclear plant sites have been made at Monticello since operations began, including the addition of the following permanent structures:

- Administration Buildings;
- Security Buildings;
- Warehouses;
- FLEX Equipment Storage Building; and
- Security barriers such as a vehicle barrier system (VBS).

Subsequent to operation of the reactor, the licensee received a 10 CFR Part 72 licensee for an independent spent fuel storage installation to be operated at the site. Any other unreported changes to the terrain would be implicitly accounted for in the hydrologic models used in the FHRR though the use of improved, higher-resolution topographic data for the region and site. The NRC staff reviewed the information provided in the FHRR and determined that sufficient information was provided to be responsive to Enclosure 2 of the 50.54(f) letter.

3.1.5 Current Licensing Basis Flood Protection and Pertinent Flood Mitigation Features

The Monticello site grade is at an elevation of 930 ft NGVD29, which is 14 ft higher than the maximum recorded high water level for the Mississippi River at the site and 9 ft higher than the 1,000-yr projected high-water level. The Walkdown Report (Xcel Energy, 2012 and 2013) states that the licensee designed buildings that contain SSCs to resist a hydrostatic load from a flood to an elevation of 930 ft NGVD29.

The licensee stated that the site has temporary barriers and manual actions requiring operator involvement including: installation of steel plates; construction of levees; deployment of sandbags; construction of berms; maintaining diesel oil storage levels; and weighting of floors to resist buoyant forces.

When the WSE in the Mississippi River is predicted to exceed 930 ft NGVD29, the licensee reported (Xcel Energy, 2012 and 2013) that a levee is to be constructed to protect all Class I structures, Class II structures that contain Class I equipment, and the Radwaste Building. The Off-Gas Stack, also a designated Class I structure, is outside the planned levee perimeter and would be protected using sandbags. The Off-Gas Storage Building is a Class II structure containing Class I equipment; however, all of the Class I equipment and components inside that building are located above the peak design basis flooding WSE. The licensee further stated that other temporary flood protection features such as steel plates, grouts, or sandbags may be used to provide additional defense-in-depth flood protection assurance when the WSE of the Mississippi River is expected to exceed 930 ft NGVD29.

The licensee noted that flood protection for the Diesel Generator Building up to a flood water-surface elevation of 933 ft NGVD29 would be provided by either the construction of a flood barrier around that building or, alternatively, by preventing the buckling of the building's floor slab through the pre-loading of the floor (Xcel Energy, 2013). Buckling prevention would be achieved artificially by exposing the entire floor area to a load of 200 pounds per square foot. In the event that the WSE of the Mississippi River elevation is expected to exceed 933 ft NGVD29, a flood barrier would be constructed around the Diesel Generator Building. Lastly, the licensee stated that the Emergency Diesel Oil Storage Tank is designed for a flood WSE of 932 ft NGVD29, with a minimum of 2 ft of fuel oil maintained in the tank. For flood water-surface elevation exceeding 932 ft NGVD29, the tank would be protected by a flood barrier or by a berm constructed around the tank.

The NRC staff reviewed the flood hazard information provided and determined that sufficient information on CLB flood protection and pertinent flood mitigation features was provided to be responsive to Enclosure 2 of the 50.54(f) letter (NRC, 2012a).

3.1.6 Additional Site Details to Assess the Flood Hazard

To provide additional information in support of the summaries and conclusions in the FHRR, the licensee made certain calculation packages available to the NRC staff via an electronic reading room. The NRC staff did not rely directly on those calculation packages in connection with its review; it was found only to expand upon and clarify the information provided in the FHRR, and so those calculation packages were not docketed or cited.

Lastly, in connection with the NRC staff's FHRR review, electronic copies of the computer input/output files used in the numerical modeling of LIP were also provided to the NRC staff in the context of the aforementioned audit process.

3.1.7 Results of Plant Walkdown Activities

The 50.54(f) letter (NRC, 2012a) requested that licensees plan and perform plant walkdown activities to verify that current flood protection systems are available, functional, and implementable. Other parts of the 50.54(f) letter asked the licensee to report any relevant information from the results of the plant walkdown activities (NRC, 2012a).

By letter dated November 27, 2012, the licensee submitted a Flooding Walkdown Report as requested in Enclosure 4 of the 50.54(f) letter for the Monticello site (Northern States Power Company, 2012). On June 20, 2014 (NRC, 2014), the NRC staff issued its assessment of the Walkdown Report, which documented its review of that licensee action and concluded that the licensee's implementation of the flooding walkdown methodology met the intent of the walkdown guidance.

3.2 <u>Local Intense Precipitation and Associated Site Drainage</u>

The licensee reported that the reevaluated flood hazard for LIP is based on a maximum WSE ranging from 920.6 to 935.8 ft NGVD29 (Xcel Energy, 2016) at multiple (12) door locations of structures considered important to safety. The maximum inundation depth attributed to LIP-related flooding occurred at the Reactor Building location. The effects of wind waves and run-up were not included in the flood hazard reevaluation. The licensee considered the LIP inundation depths too shallow to produce wind/wave effects. This flood-causing mechanism is not discussed in the licensee's CDB. No probable maximum flood (PMF) elevation was reported. The licensee reevaluated the flood hazard due to an LIP event using the U. S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC) Hydrologic Modeling System (HEC-HMS) (USACE, 2010a) and River Analysis System (HEC-RAS) (USACE, 2010b) software packages. The NRC staff considers the selection of the HEC-HMS and HEC-RAS computer code for LIP modeling to be reasonable.

3.2.1 Site Drainage and Elevations

The licensee reevaluated the flood hazard resulting from LIP due to a storm over an immediate drainage area of about 0.632 mi^2 that included the footprint of the Monticello powerblock, the site's VBS, and all contiguous natural drainage areas that could potentially affect flooding of the site. The licensee used a digital terrain model (DTM) to approximate the topographic ground surface corresponding to the Monticello powerblock site and environs (Figure 3.2-1). Data for that topographic model were acquired from a **Li**ght **D**etection **a**nd **R**anging (LiDAR) data combined with site survey data; the LiDAR data has a horizontal resolution of about 3.28 ft.

The NRC staff reviewed the licensee's approach to the development of the computation domain for HEC-RAS model against relevant regulatory criteria based on present-day methodologies and regulatory guidance. The NRC staff considers the approach described by the licensee to be reasonable.

3.2.2 Local Intense Precipitation

For ESPs and COLs, current NRC guidance for LIP evaluation is to select the appropriate probable maximum precipitation (PMP) event reported in the National Weather Service's Hydrometeorological Reports (or HMRs) applicable to the study site. For the Monticello site, the licensee considered a 1-hour (h), 1-mi2 precipitation depth. Consistent with guidance found in NUREG/CR-7046 (2011e), the licensee considered a storm with a duration extended to 6-h. The licensee evaluated both an all-season storm event, as well as a cool-season rain-on-snow event; upon review, the licensee concluded that the all-season storm was the controlling precipitation event at the Monticello site. Using the HMR-51 (NOAA, 1982) and HMR-52 (NOAA, 1982) methodology, the 1-h, 1-mi2 precipitation intensity estimated by the licensee was 16.76 in.; the precipitation intensity for the 6-h, 10-mi2 event was estimated as 23.60 in.

The licensee used the HMR-52 guidance to estimate the 5-minute (min), 15-min, and 30-min precipitation depths on the basis of the 1-h, 1-mi2 precipitation intensity. The licensee's PMP depth estimates for all durations using the HMR method are reported in Table 3.2-1; the cumulative precipitation graph is shown in Figure 3.2-2.

The NRC staff reviewed the licensee's approach to the development of the PMP estimate for the LIP model against relevant regulatory criteria based on present-day methodologies and regulatory guidance. In connection with that review, the NRC staff independently estimated the HMR-derived PMP values. As a result of these efforts, the NRC staff concluded that the approach described by the licensee as well as the results are reasonable.

3.2.3 Runoff Analysis

The physical features of the Monticello powerblock (e.g., permanent buildings, tanks, roadways, berms, the VBS) incorporated into the licensee's LIP model were described in either the FHRR or the complementary LIP flood calculation package (Xcel Energy, 2016). These documents also summarized key details concerning the LIP model. The licensee divided the modeling domain into 10 sub-basins covering the power block area, switchyard, parking lots, and some topographically-higher contributing areas (Figure 3.2-1). The licensee noted that the decisions on how to define the respective sub-basins were based on an examination of ground elevation data obtained from a LiDAR topographic survey, the elevations of various security barriers within the controlled area, and other as-built structures at the site. The licensee noted that the roofs of permanent buildings and other key structures were elevated in the LIP model to ensure that roof drainage would shed onto adjacent ground surfaces in order to maximize flood-related WSE estimates. Elevations of the building footprints inside the study area were increased by at least 10 ft higher than the surrounding land-surface elevation to simulate the taller roof drainage conditions necessary to discharge the rainfall; moreover, those rooftops provided no rainwater storage. As an additional conservatism, site drainage systems were also assumed to be blocked and non-functional allowing for additional rainwater accumulation. Lastly, the licensee stated that the short duration of the precipitation event combined with the high precipitation rate allowed for negligible infiltration by ground surface materials. The NRC staff reviewed the LIP model and found that the basins are appropriately delineated, and the model domain covers the entire reactor site.

Having defined the respective sub-basins, the licensee then used the HEC-HMS software to model overland flow within those domains. The U.S. Soil Conservation Service unit hydrograph method (SCS, 1986) was used to transform the PMP estimate into a probable maximum flow hydrograph for each of the 10 sub-basins; HEC-RAS was then used to model WSEs within the footprint of the powerblock. The licensee created seven hydraulic models using the HEC-RAS software covering the 10 sub-basins simulated in the HEC-HMS model. Four of the hydraulic models were constructed to examine whether flooding from the topographically-higher, off-site areas contiguous with the powerblock would overtop site barriers such as the VBS and, in doing so, increase WSEs within the powerblock. The remaining three HEC-RAS flow models were used to estimate the maximum WSEs at door locations of safety-related structures. As a downstream boundary condition in the HEC-RAS model, the licensee assigned a WSE of 919.5 ft NGVD29 corresponding to a 500-year flood on the Mississippi River for all channel reaches discharging into the river. The NRC staff identified and confirmed the locations of buildings and other structures present within the HEC-RAS modeling domain using available aerial imagery for the Monticello site. Buildings were modeled as obstructions that completely blocked the surface flow of water. The NRC staff also confirmed that the representation of those features with higher elevations would both promote surface flow away from and/or around those locations. Lastly, the NRC staff confirmed that a stage hydrograph elevation proposed as the Mississippi River downstream boundary condition was reasonable.

The HEC-HMS flow hydrographs were used as inflow hydrographs corresponding to reaches and cross sections in the HEC-RAS models. For some sub-basins, the licensee constructed multiple reaches in the model in order to characterize the various flowpaths in and around the powerblock. The existence of multiple reaches within a particular sub-basin required multiple sets of inflow hydrographs. The licensee stated that the flow distribution from one inflow hydrograph into the multiple reaches or cross sections within a sub-basin was implemented using a spatial weighting of the sub-basin hydrograph. However, in reviewing the model, it was not clear how the spatial weighting was determined or what the respective weighting assignments were. At the NRC staff's request, the licensee provided additional information as part of the audit (NRC, 2017) to explain how that spatial weighting scheme was achieved. Upon review, the NRC staff determined that the spatial weighting scheme used by the licensee was based on: (a) the percentage of drainage area corresponding to each reach within the sub-basin; and (b) the flow accumulation that was estimated from the accumulation of pixels in a Geographic Information System to a specific location of interest within the drainage area. The NRC staff reviewed the additional documents provided by the licensee in connection with the 2016 audit and confirmed that the approach used by the licensee to distribute the flow into different reaches and cross sections is reasonable.

Lastly, the Monticello FHRR states that Manning's roughness coefficient value, *n*, is a key parameter to determining how flow resistance by the ground surface controls water velocities and depths within the LIP model. Manning's coefficient values were used for two types of calculations: one is to determine the time of concentration for sheet flow and channelized flow in the unit hydrograph development for the HEC-HMS hydrologic model, and the other is to estimate flow depths within the HEC-RAS hydraulic model. The licensee assigned Manning's coefficient values to different land cover types in the HEC-RAS model based on an inspection of aerial imagery. For the unit hydrograph, the licensee assigned *n* values taken from *Technical Release 55* (USDA, 1986) and *HEC-RAS Reference Manual* (USACE, 2010b). Table 3.2-2 identifies which coefficient values were assigned to what type of land cover consistent with the references cited. In the HEC-RAS model, the licensee used a Manning's value of 0.02 based on Chow (1959) to represent the roughness coefficient for those cross sections extending over surfaces corresponding to asphalt paving or gravel roads. The NRC staff reviewed the methodology for assigning coefficient values and concluded that both the methodology and coefficient values selected were reasonable and consistent with present-day guidance and methods.

3.2.4 Water Level Determination

The licensee evaluated the flooding hazard at 12 critical door opening locations within the Monticello powerblock. For the purposes of the LIP analysis, the site's drainage system was conservatively assumed to be nonfunctional. The modeling results indicated that the maximum WSEs range from 920.6 ft NGVD29 at the Intake Structure Door (Door 209) location to 935.8 ft NGVD29 at the Railcar Entry (Door 24) location of the Turbine Building. At all critical door locations, the computed maximum WSEs exceeded the elevations of the door sills. The maximum flood depth above the door sill elevation varies from approximately 0.1 ft at the Railcar Entry (Doors 45 and 46) location of Reactor Building to 2.1 ft at the Off-Gas Stack (Door 193) location. Table 3.2-3 lists the maximum flood depths and the corresponding WSEs at 12 critical door locations (Table 3.2-3). The appendix at the end of this staff assessment contains figures illustrating the 12 critical door locations in relation to powerblock structures.

After independently executing the licensee's HEC-RAS computer code input files, the NRC staff confirmed the depths and locations of the maximum WSEs reported in the FHRR. The NRC staff found that: (a) mass balance errors were acceptably small; (b) flow pathways and areas of inundation appeared reasonable; (c) flow velocities were reasonable; and (d) no indication of numerical instabilities nor unexpected supercritical flow conditions were identified near potential flooding pathways associated with the 12 critical door locations. Based on these results, the NRC staff confirmed the results of the licensee's LIP simulations. The NRC staff further concluded that the maximum WSEs reported by the licensee were consistent with its independent calculations.

3.2.5 Conclusion

In summary, the NRC staff confirmed the licensee's conclusion that the reevaluated flood hazard for LIP and associated site drainage is not bounded by the CDB flood hazard. Therefore, the NRC staff expects that the licensee will submit a focused evaluation for LIP and associated site drainage for the Monticello site.

3.3 Streams and Rivers

The licensee reported that the reevaluated flood hazard for streams and rivers is based on a PMF stillwater surface elevation of [redacted] on the main stem of the Mississippi River at the Monticello reactor location. When wind wave and runup effects are considered, the reevaluated flood hazard elevation is [redacted] (Xcel Energy, 2016). The CDB PMF elevation for streams and rivers is based on a stillwater surface elevation of 939.2 ft NGVD29.

The reevaluation of flooding on streams and rivers described in the Monticello FHRR was performed by the USACE and the results subsequently adopted by the licensee for the purposes of the FHRR. Flows on the main stem of the Mississippi River are affected by the presence of a large number of locks and dams, some of which were designed, constructed, and are currently maintained by the USACE. To support development of the FHRR, by letter dated March 5, 2014 (Northern States Power Company, 2014), the licensee requested NRC assistance in obtaining information related to the performance of USACE dams, including all completed and pending dam failure analyses; any such failure analysis would also include some type of flood stage analysis. In response to this request, the NRC staff contracted with the USACE to perform both the PMF and dam failure analyses through Interagency Agreement NRC-HQ-13-I-03-0021, in which the USACE assisted the NRC in determining the safety significance of hydrologic and geotechnical issues and other features associated with dams that may affect the safe, reliable operation of downstream or nearby nuclear power plants. Applicable results of the USACE's analyses (USACE, 2015) were transmitted to the licensee on November 18, 2015 (NRC, 2015b). A non-public meeting was held between the NRC and USACE on July 9, 2015 (NRC, 2015), to discuss the licensee's questions and comments regarding the USACE PMF and dam failure analyses.

The USACE PMF analysis included three components: (a) the definition of the PMP event; (b) a simulation of the PMF associated with the PMP event; and (c) an evaluation the effect of combined flooding events. The PMF evaluation was limited to the portion of the Mississippi River watershed upstream of the Monticello site, which is an area of about 13,900 mi^2. Overland flow within that sub-basin following a simulated PMP event was achieved using HEC-HMS software (USACE, 2010a). Using synthetic unit hydrographs produced by the computer software as input, runoff volumes and discharges were computed at upstream and tributary locations within the 13,900 mi^2 Mississippi River sub-basin. The output from that computer analysis was subsequently used to route the river flow within main stem of the Mississippi River and estimate WSEs at the Monticello site; this was achieved using the HEC-RAS software (USACE, 2010b).

The USACE relied on the standard NOAA approach to estimate the PMP using the HMRs applicable to the Monticello site – specifically HMR-51 (NOAA, 1982) and HMR-52 (NOAA, 1982). Following HMR methodology, the USACE developed a standard depth-area-duration (DAD) curve for the Mississippi River watershed using HMR-52. Two PMP scenarios were considered – all-season and spring (including snow melt). The basin-wide PMP estimates for the Mississippi River watershed were converted to surface runoff (overland flow) using the USACE's HEC-HMS computer code (USACE, 2010b). The USACE determined that the maximum discharge on the Mississippi River at the Monticello location was [redacted]. Using the calibrated HEC-RAS model, the USACE determined that the maximum stillwater WSE at the Monticello site was [redacted] (Xcel Energy, 2016).

The licensee then evaluated wind-wave and runup effects coincident with the Mississippi River PMF at the Monticello site using the USACE's computed peak water elevation of [redacted]. The licensee used the *Automated Coastal Engineering System* (Leenknecht, Szuwalski, and Sherlock, 1992) and the *Coastal Engineering Manual* (USACE, 2008) to estimate those effects. Wind fetch length was estimated for the nine directions emanating from the reactor site, as shown in Figure 3.3-2. The critical fetch direction was oriented in such a way that any wind-generated waves would impact the northwestern face of the powerblock. At this location, the licensee reported that there is an earthen levee/bin wall combination to prevent erosion of the channel slope adjacent to the main stem of the Mississippi River. The maximum WSE for this combined effects flood was estimated by the licensee to be [redacted]. Consequently, the licensee reported that the combined effects flood on the Mississippi River does not pose a hazard to the Monticello powerblock.

The NRC staff reviewed the licensee's wind-wave evaluation for the stream and river flooding and determined that the licensee followed methods consistent with the NRC guidance and with standard engineering practice. The NRC staff also consulted currently-recognized hydrologic equations described in the USACE *Shore Protection Manual* and other sources for evaluating wind-wave and runup effects. The NRC staff's estimated wave run-up values indicate total water levels similar to, or slightly below, those reported by the licensee. The NRC staff concluded that the licensee's wind-wave estimates were reasonable

In summary, the NRC staff confirmed the licensee's conclusion that the reevaluated flood hazard for streams and rivers is bounded by the CDB flood hazard. Therefore, the NRC staff determined that flooding due to streams and rivers does not need to be analyzed in a focused evaluation or integrated assessment.

3.4 Failure of Dams and Onsite Water Control/Storage Structures

The licensee reported in its FHRR that the reevaluated hazard for dam-related flooding effects is not applicable to the Monticello site. Further, this flood-causing mechanism is not described in the licensee's CDB.

The effects of potential dam breaches and failures at the Monticello site were considered by the USACE as part of their PMF analysis conducted at the request of the NRC staff (NRC, 2015b). In performing that analysis, the USACE noted that it followed JLD-ISG-2013-01 (NRC, 2013b). Upon completion of that analysis and in connection with a July 9, 2015, public meeting on the findings of that analysis, the USACE stated that "... all dams were screened out in terms of flood risk to the power plant site regardless of failure mode ...." (NRC, 2015c). Based on the information provided by the USACE, it can be concluded that potential upstream dam breaches and failures regardless of failure mode do not increase the flood hazard at the Monticello nuclear power plant site. This conclusion was adopted by the licensee and was subsequently reported in the licensee's FHRR as the reevaluated hazard result for this flood-causing mechanism.

The NRC staff agrees with the licensee's conclusion that the PMF from the dam failure flood-causing mechanism alone could not inundate the Monticello site. In summary, the NRC staff determined that flooding due to dam failure does not need to be analyzed in a focused evaluation or integrated assessment.

3.5 Storm Surge

The licensee reported in the Monticello FHRR that the reevaluated hazard for storm surge-related flooding effects is not applicable at the Monticello site. The site is not in a geographic location amenable to the occurrence of marine-driven storms capable of generating a storm surge. The site is inland, in the approximate center of the continent, and is located about 128 mi from the nearest large body of water (Lake Superior), to the northeast); the next nearest large body of water capable of generating storm surge is Lake Michigan about 314 mi to the southeast. Consequently, this flood-causing mechanism is not considered physically plausible and thus was not considered in the licensee's CDB. Based on hydrological evidence in the site region, the licensee concluded that storm surge will not affect the Monticello site.

In connection with its examination of the FHRR, the NRC staff reviewed the potential hazard from storm surge-related flooding against the relevant regulatory criteria based on present-day methodologies and regulatory guidance. Based on geographic evidence in the site region, the NRC staff concluded that there is no potential for flooding from storm surge to occur at the Monticello site.

In summary, the NRC staff confirmed the licensee's conclusion that flooding due to storm surge flood-causing mechanism could not impact the Monticello site. Therefore, the NRC staff determined that flooding due to storm surge does not need to be analyzed in a focused evaluation or integrated assessment for the Monticello site.

3.6 Seiche

The licensee reported in the Monticello FHRR that the reevaluated hazard for seiche-related flooding effects are not applicable at this particular site. The Monticello site is not adjacent to any large body of water (marine or non-marine) with a free surface area large enough to generate seiche-driven waves. Consequently, this flood-causing mechanism is not considered physically plausible and thus was not considered in the licensee's CDB. Based on hydrological evidence in the site region, the licensee concluded that storm seiche-related flooding will not affect the Monticello site.

In connection with its examination of the FHRR, the NRC staff reviewed the potential hazard from seiche-related flooding against the relevant regulatory criteria based on present-day methodologies and regulatory guidance. Based on geographic evidence in the site region, the NRC staff concluded that there is no potential for seiche-like flooding behavior to occur at the Monticello site.

In summary, the NRC staff confirmed the licensee's conclusion that the PMF from seiche-induced flooding does not impact the Monticello site. Therefore, the NRC staff determined that flooding due to seiche does not need to be analyzed in a focused evaluation or integrated assessment for the Monticello site.

3.7 Tsunami

The licensee reported in the Monticello FHRR that the reevaluated hazard for tsunami-related flooding effects is not applicable. The Monticello site is not in a geographic location amenable to the occurrence of tsunamis; the site is inland and not located on or near a coastline where tsunami-like waves can make land after forming following a tectonic disturbance on the ocean floor. The Monticello site is approximately 1,000 mi inland from potential tsunamigenic sources such as the Atlantic Ocean and the Gulf of Mexico; there are no records of tsunamigenic activity associated with Hudson Bay, Lake Superior, or Lake Michigan. The licensee observed that there are reports of tsunami-like waves on the Mississippi River that were attributed to the 1811-1812 New Madrid earthquakes; however, these were reported several hundred miles downriver. The NRC staff determined that the literature describing this earthquake is silent though, on whether these effects were observed as far north as Minnesota.

Consequently, this flood-causing mechanism is not considered physically plausible based on these types of scenarios and thus was not considered in the licensee's CDB. Based on hydrological evidence in the site region, the licensee concluded that tsunami-related flooding will not affect the Monticello site.

In connection with its examination of the Monticello FHRR, the NRC staff reviewed the hazard potential from tsunami-related flooding, including associated effects, against the relevant regulatory criteria based on present-day methodologies and regulatory guidance. Based on geographic evidence in the site region, the NRC staff concluded that there is no potential for tsunami-like phenomena to affect the Monticello site. This inland location is well-away from the influence of recognized tsunamigenic sources (e.g., Gutenberg, 1939). Furthermore, although the literature indicates that solitons or soliton-like features occurring on the free surface can travel for great distances (e.g., Russell, 1845, Bartsch-Winkler and Lynch, 1988), it is not apparent that such phenomena occurred on the main stem of the Mississippi River at the Monticello location in connection with past New Madrid earthquakes.

In summary, the NRC staff confirmed the licensee's conclusion that the PMF from tsunami-induced flooding alone could not inundate the Monticello site. Therefore, the NRC staff determined that flooding from tsunami does not need to be analyzed in a focused evaluation or integrated assessment for the Monticello site.

3.8 Ice-Induced Flooding

The licensee reported in its FHRR that the reevaluated flood hazard due to for ice-induced flooding effects is based on a stillwater WSE of 917.3 ft NGVD29; wind waves and runup effects were not included in the calculation. This flood-causing mechanism was not previously quantified for the purposes of the licensee's CDB.

For the purposes of its FHRR, the licensee queried the USACE's *Cold Regions Research and Engineering Laboratory* (CRREL) ice jam database for historic reports of ice jams in the vicinity of the Monticello site. Results of that query indicated that there were two events where there were significant increases in the WSE near the reactor site; both events occurred at the same location about 35 mi downstream on the main stem of the Mississippi River (USACE, 2014). The first event, in 1965, was a 15-ft high ice jam that produced a 10 ft-increase in the WSE on the river whereas the second later ice jam event in 1984 resulted in only a WSE increase of 8.7 ft in height. The licensee noted that the CRREL database contains no records of historic ice jams on the Mississippi River at the Monticello site proper. The licensee subsequently superimposed the 1965 ice jam WSE increase onto the winter base flow of the Mississippi River and evaluated the WSE increase at multiple river locations near the site, including the Clearwater Bridge (Route 24), approximately 13 mi upstream from the site, the islands immediately across from the site, and the Highway 25 Bridge located about 2.5 mi downstream in the city of Monticello, all of which were judged to be capable of potentially forming an ice jam. With the exception of the Clearwater Bridge location, results from the licensee's superposition analysis indicated that the composite increase in the WSE at the Monticello site was less than the operating floor elevation of the reactor's SWIS of 919 ft NGVD29. In the case of the Clearwater Bridge location, the simplified superposition technique produced a WSE estimate that exceeded SWIS CDB. Consequently, the licensee then performed a more detailed flooding analysis using the HEC-RAS computer code (USACE, 2010a), indicted that the CDB for the Monticello SWIS is not exceeded. As a consequence, the licensee concluded that this flood-causing mechanism could be screened-out from further consideration for the purposes of the FHRR analysis as it produced WSEs that were less than the CDB for the SWIS (919 ft NGVD29); the flood analysis results were also less than the nominal ground elevation for the powerblock (930 ft NGVD29).

The NRC staff independently reviewed the potential for flooding due to ice jams on the main stem of the Mississippi River at the location of the reactor. A review of the literature (Paterson, 1966; Matthai, 1968; and Paterson and Gamble, 1968) revealed that there were no historical reports of ice jams on the Mississippi River at the Monticello site location. The NRC staff reviewed the CRREL database and confirmed ice jam reports described by the licensee in the FHRR. In the matter of the licensee's HEC-RAS flood hazard calculations, the NRC staff independently estimated WSEs based on ice jam failures at the reactor site using a bounding calculation approach based on empiric hydraulic equations. Two different methods were used, both relied on estimating river discharges at the Monticello site using the U.S. Bureau of Reclamation's (USBR's) recommended dam breach flow equations (USBR, 1982 and 1983). In the first method, a mathematical expression using the USBR river discharge estimates, the shallow water wave celerity approximation, and the horizontal dimension of the Mississippi River channel in the vicinity of the Monticello site (about 500 ft) were used to estimate a WSE at that location. In the second method, the river discharge estimates using the USBR equation was used again to develop a mathematical expression to estimate the WSE increase that also relied on the Manning's velocity equation and the river distance the ice dam/jam was from the Monticello site. As a conservatism, no fluid mass losses due to infiltration or attenuation were assumed in the analysis. The results of the NRC staff's analysis found that the estimated WSE increase due to the failure of an ice dam/jam was less than the WSE estimated by the licensee and below the site grade of the powerblock. As an additional review measure, the NRC staff repeated the analysis described above using the licensee's estimated peak flow discharge estimates reported in the FHRR. The results of that analysis also confirmed the estimated WSE due to ice dam/jam failure was less than the elevation of the SWIS.

In summary, the NRC staff confirmed the licensee's conclusion that the reevaluated hazard for flooding due to ice jams is bounded by the CDB flood hazard at the Monticello site. Therefore, the NRC staff determined that ice-induced flooding does not need to be analyzed in a focused evaluation or integrated assessment for the Monticello site.

3.9 Channel Migrations or Diversions

The licensee reported that the reevaluated hazard for dam-related flooding effects is not applicable to the Monticello site. This flood-causing mechanism is not described in the licensee's CDB.

The hazard potential for this flood-causing mechanism was previously considered during initial licensing for the Monticello site (NSPM, 1969) as well as in the subsequent (NSP, 1995). During both reviews, the licensee determined that the course of the Mississippi River could be diverted as a result of some transient flooding event. The licensee stated that this particular flooding scenario would be a sufficiently slow-developing event such that adequate time would be available to safely shutdown the plant. For the purposes of the FHRR, the licensee provided some discussion concerning channel migration/diversion-induced flooding; however, that discussion was focused on reports that flow conditions of the Mississippi River at the Monticello site had diminished in the three decades following the construction of the power plant. The licensee reported that the change in flow conditions had caused increased sedimentation and lower water velocities near the reactor's intake structure; such changes were not due to channel migrations and/or diversions *per se*. Nevertheless, under reduced flow conditions, it is generally recognized that the potential for channel migration also diminishes. NUREG/CR-7046 (NRC, 2011e) acknowledges that there are no well-established predictive models for estimating the potential for channel diversion in a riverine environment. However, the potential for channel migrations or diversions to take place at a particular reactor site can be assessed by visually-inspecting applicable topographic maps such as those prepared by the U.S. Geological Survey (USGS, 2015). Such maps can be examined for what would be considered to be (classic) topographic/geomorphic evidence of past channel migrations or diversions (Fairbridge, 1968). In its independent evaluation of the FHRR, the NRC staff examined historic USGS topographic maps of the Mississippi River basin in the vicinity of the reactor site for past evidence of channel migration or river meandering phenomenon, as well as more recently-published topographic maps of the Mississippi River basin for evidence of meandering or channel diversion subsequent to the initial publication of the USGS' topographic maps. Examination of both sets topographic maps of the area suggest that the course of the Mississippi River has remained relatively fixed for the last century. Based on these comparisons, the NRC staff to conclude that there is no evidence of river meandering and/or channel diversion for at least the last century.

In summary, the NRC staff confirmed the licensee's conclusion that the reevaluated hazard for flooding due to PMF from channel migration or diversions alone is bounded by the CDB flood hazard at the Monticello site. Therefore, the NRC staff determined that channel migration/ diversion-related flooding does not need to be analyzed in a focused evaluation or integrated assessment for the Monticello site.

4.0 REEVALUATED FLOOD ELEVATION, EVENT DURATION, AND ASSOCIATED EFFECTS FOR HAZARDS NOT BOUNDED BY THE CDB

4.1 Reevaluated Flood Elevation for Hazards Not Bounded by the CDB

Section 3 of the staff assessment documents the NRC staff review of the licensee's flood hazard water height results. Table 4.1-1 contains the maximum flood height results, including wave effects, for flood mechanisms not bounded by the CDB. The NRC staff agrees with the licensee's conclusion that the LIP flood hazard mechanism is not bounded by the CDB. Consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015a) and

JLD-ISG-2016-01, Revision 0 (NRC, 2016c), the NRC staff anticipates the licensee will submit a focused evaluation for LIP.

4.2 Flood Event Duration for Hazards Not Bounded by the CDB

The NRC staff reviewed information provided in Xcel Energy's 50.54(f) response (Xcel Energy, 2016) regarding the FED parameters needed to perform the additional assessments of the plant response for flood hazards not bounded by the CDB. The FED parameters for the flood-causing mechanisms not bounded by the CDB are summarized in Table 4.2-1 and Table 4.2-2.

The maximum WSEs generated during the LIP event in excess of the CDB were described at 11 locations for multiple structures within the Monticello powerblock are described in the Table 3.2-3. The licensee reported duration of inundation across the powerblock is about 1.2 h whereas the time necessary for flood waters to recede from the site would be on the order of 5.3 h regardless of the structure or location in question (Xcel Energy, 2016).

The licensee used results from 2-dimentional numerical modeling, as described in the FHRR (Xcel Energy, 2016), to determine the inundation and recession durations. The NRC staff confirmed that the licensee's reevaluation of the flood event duration parameters for LIP and associated drainage uses present-day methodologies and regulatory guidance; the NRC staff views the values reported reasonable based on the magnitudes of the estimated flooding hazards.

4.3 Associated Effects for Hazards Not Bounded by the CDB

The NRC staff reviewed information provided in the licensee's 50.54(f) response (Xcel Energy, 2016) regarding AE parameters needed to perform future additional assessments of plant response for flood hazards not bounded by the CDB. The AE parameters directly related with maximum water elevation, such as wave effects, are provided in Table 4.1-1. The AE parameters not directly associated with total water elevation are listed in Table 4.3-1.

The licensee reported hydrostatic and hydrodynamic loads at impacted door locations due to LIP-related flooding at the Monticello site. Based on the relatively low flood depths and corresponding flow velocities, the NRC staff agreed that these associated effects are minimal.

The NRC staff reviewed the AE parameters provided by the licensee and the NRC staff confirms the licensee's AE parameter results are reasonable for use in future assessments of plant response.

4.4 Conclusion

Based upon the preceding analysis, the NRC staff confirmed that the reevaluated flood hazard information defined in Section 4 is an appropriate input to the additional assessments of plant response as described in the 50.54(f) letter (NRC, 2012a), COMSECY-15-0019 (NRC, 2015a), and associated guidance.

5.0 CONCLUSION

The NRC staff reviewed the information provided for the reevaluated flood-causing mechanisms for the Monticello site. Based on its review of the above available information provided in Xcel

Energy's 50.54(f) response (Xcel Energy, 2016), the NRC staff concludes that the licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance used by the NRC staff in connection with ESP and COL reviews.

Based upon the preceding analysis, the NRC staff confirmed that the licensee responded appropriately to Enclosure 2, Required Response 2, of the 50.54(f) letter, dated March 12, 2012. In reaching this determination, the NRC staff confirmed the licensee's conclusions that: (a) the reevaluated flood hazard result for LIP is not bounded by the CDB flood hazard; (b) additional assessments of plant response will be performed for the LIP flooding mechanism; and (c) the reevaluated flood-causing mechanism information is appropriate input to the additional assessments of plant response as described in the 50.54(f) letter, COMSECY-15-0019 (NRC, 2015a), and associated guidance. The NRC staff has no additional information needs with respect to the licensee's 50.54(f) response.

6.0 REFERENCES

Notes: ADAMS Accession Nos. refers to documents available through NRC's Agencywide Documents Access and Management System (ADAMS). Publicly-available ADAMS documents may be accessed through http://www.nrc.gov/reading-rm/adams.html.

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Table 2.2-1. Flood-Causing Mechanisms and Corresponding Guidance

FLOOD-CAUSING MECHANISM	SRP SECTION(S) AND/OR JLD-ISG
Local Intense Precipitation and Associated Drainage	SRP 2.4.2 SRP 2.4.3
Streams and Rivers	SRP 2.4.2 SRP 2.4.3
Failure of Dams and Onsite Water Control/Storage Structures	SRP 2.4.4 JLD-ISG-2013-01
Storm Surge	SRP 2.4.5 JLD-ISG-2012-06
Seiche	SRP 2.4.5 JLD-ISG-2012-06
Tsunami	SRP 2.4.6 JLD-ISG-2012-06
Ice-Induced	SRP 2.4.7
Channel Migrations or Diversions	SRP 2.4.9

SRP refers to the Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition (NRC, 2007).
JLD-ISG-2012-06 refers to the "Guidance for Performing a Tsunami, Surge, or Seiche Hazard Assessment" (NRC, 2013a).
JLD-ISFG-2013-01 refers to the "Guidance for Assessment of Flooding Hazards Due to Dam Failure" (NRC, 2013b).

Table 3.0-1. Summary of Controlling Flood-Causing Mechanism at the Monticello Site.

REEVALUATED FLOOD-CAUSING MECHANISMS AND ASSOCIATED EFFECTS THAT MAY EXCEED THE POWERBLOCK ELEVATION 930.0 ft NGVD29[1]	WSE (NGVD29)
Local Intense Precipitation and Associated Drainage *(at multiple locations – see Table 3.2-3)*	< 938.5 ft

[1]Flood height and associated effects as defined in JLD-ISG-2012-05.

Table 3.1-1. Current Design Basis Flood Hazard Elevations at the Monticello Nuclear Power Plant Site.

FLOOD-CAUSING MECHANISM	STILLWATER ELEVATION (NGVD29)	ASSOCIATED EFFECTS	CDB FLOOD ELEVATION (NGVD29)	REFERENCE(S)
Local Intense Precipitation and Associated Drainage	Not Included in the CDB**	Not Included in the CDB	Not Included in the CDB	FHRR Section 1.5, 2.1.3, and Table 5
Streams and Rivers	939.2 ft	Minimal	939.2 ft	UFSAR Section 1.5.1
Failure of Dams and Onsite Water Control/Storage Structures	Not Included in the CDB	Not Included in the CDB	Not Included in the CDB	UFSAR Section 1.5
Storm Surge	Not Included in the CDB	Not Included in the CDB	Not Included in the CDB	UFSAR Section 1.5
Seiche	Not Included in the CDB	Not Included in the CDB	Not Included in the CDB	UFSAR Section 1.5
Tsunami	Not Included in the CDB	Not Included in the CDB	Not Included in the CDB	UFSAR Section 1.5
Ice-Induced	No Impact to the Site Identified	No Impact to the Site Identified	No Impact to the Site Identified	UFSAR Section 1.5.2
Channel Migrations or Diversions	Not Included in the CDB	Not Included in the CDB	Not Included in the CDB	UFSAR Section 1.5

* Considered by the licensee to not applicable to the Monticello Site and therefore not included in the current design basis (CDB).

Table 3.2-1. HMR-51/52 derived PMP Depths for the All-Season LIP Calculation at the Monticello Site. (Xcel Energy, 2016)

DURATION	AREA	MULTIPLIER	PMP SCENARIO	HMR-52 PMP DEPTH
5 min	1 mi^2	0.345	1-hr, 1-mi^2	5.78 in.
15 min	1 mi^2	0.55	1-hr, 1-mi^2	9.22 in.
30 min	1 mi^2	0.777	1-hr, 1-mi^2	13.02 in.
60 min	1 mi^2	0.71	6-hr, 10-mi^2	16.76 in.
360 min	10 mi^2	N/A	N/A	23.60 in.

Table 3.2-2. Range of Manning's Coefficient Values (n) Considered in the Local Intense Precipitation Re-Analysis at the Monticello Site.

FLOW TYPE	LAND COVER TYPE	LICENSEE-ASSIGNED n VALUE	RECOMMENDED N-VALUE			REFERENCE
			Minimum	Normal	Maximum	
Sheet	Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011	---	0.011	---	USDA (1986)
	Grass (dense)	0.24	---	0.24	---	USDA (1986)
	Woods (light underbrush)	0.40	---	0.40	---	USDA (1986)
Channelized	Flood plains (pasture no brush, short grass)	0.03	0.025	0.03	0.035	USACE (2010b)
	Flood plains (trees, cleared land with tree stumps, no sprouts)	0.04	0.03	0.04	0.05	USACE (2010b)
	Asphalt (smooth-rough)	0.013–0.016	0.013	0.016	---	USACE (2010b)

Table 3.2-3 Reevaluated flood hazard elevations for the 12 critical opening locations based on the HEC-HMS and HEC-RAS models simulations for LIP analysis.
Source: Xcel Energy, 2016.

CRITICAL OPENING STRUCTURE/ LOCATION [1]	OPENING INVERT/SILL LEVEL (NGVD29)	REEVALUATED MAXIMUM WSE (NGVD29)	MAX. WATER DEPTH
13.8 KV Room (Door 1)	931.0 ft[2]	931.5 ft [1]	+ 0.5 ft[3]
Emergency Diesel Generator (Door 7) – *West 3-ft wide Man Door*	931.0 ft	931.4 ft	+ 0.4 ft
Emergency Diesel Generator (Door 8) – *East 3-ft wide Man Door*	931.0 ft	931.4 ft	+ 0.4 ft
Railcar Entry (Door 24) – *Turbine Building*	935.0 ft	935.8 ft	+ 0.8 ft
Railcar Entry (Doors 45 and 46) – *Reactor Building*	935.0 ft	935.1 ft	+ 0.1 ft
West Roll-Up Door (Door 119) – *Turbine Building Addition*	931.3 ft	931.4 ft	+ 0.2 ft
East Roll-Up Door (Door 120) – *Turbine Building Addition*	931.3 ft	931.5 ft	+ 0.3 ft
Off Gas Stack (Door 193)	932.5 ft	935.6 ft	+ 2.1 ft
Intake Structure Door (Door 209) – *Interior between Screen House and Intake Structure*	919.5 ft	920.6 ft	+ 1.1 ft
EFT Room (Door 341)	932.8 ft	933.2 ft	+ 0.4 ft
Fuel Oil Transfer Pump House (Door 483)	931.0 ft	931.3 ft	+ 0.1 ft

(1) Door locations are depicted in figures found in the appendix.
(2) Reported values are rounded to the nearest one-tenth of a foot.
(3) The updated values from the licensee (Figure A-1) after the audit and were rounded to 931.5 and 0.5 in Fields's email (Fields, 2016).

Table 4.1-1. Reevaluated Flood Hazard Elevations (NGVD29) for Flood-Causing Mechanisms Not Bounded by the Monticello CDB

FLOOD-CAUSING MECHANISM	STILLWATER ELEVATION	ASSOCIATED EFFECTS	REEVALUATED FLOOD HAZARD	REFERENCE
Local Intense Precipitation *(Turbine Building and other locations)*	< 935.8 ft	Minimal	< 935.8 ft	FHRR

Note 1: Reevaluated hazard mechanisms bounded by the current design basis (see Table 1) are not included in this table.

Note 2: Reported values are rounded to the nearest one-tenth of a foot.

Table 4.2-1. Flood Event Duration for Flood-Causing Mechanisms Not Bounded by the Monticello CDB.

FLOOD-CAUSING MECHANISM	TIME AVAILABLE FOR PREPARATION FOR FLOOD EVENT	DURATION OF INUNDATION OF SITE	TIME FOR WATER TO RECEDE FROM SITE
Local Intense Precipitation and Associated Drainage	NEI 15-05 (NEI, 2015)	≈ 1.2 h	≈ 5.3 h

Table 4.3-1. Associated Effects Parameters not Directly Associated with Total Water Height for Flood-Causing Mechanisms not Bounded by the Monticello CDB

FLOOD-CAUSING MECHANISM	MAXIMUM VELOCITY	MAXIMUM FLOW DEPTH	MAXIMUM HYDROSTATIC LOAD	MAXIMUM HYDRODYNAMIC LOAD	DEBRIS LOADING EFFECTS	SEDIMENT LOADING EFFECTS
Local Intense Precipitation and Associated Drainage	< 6.9 fps	< 0.8 ft[1]	Minimal	Minimal	Minimal	Minimal

(1) Reported values are rounded to the nearest one-tenth of a foot.

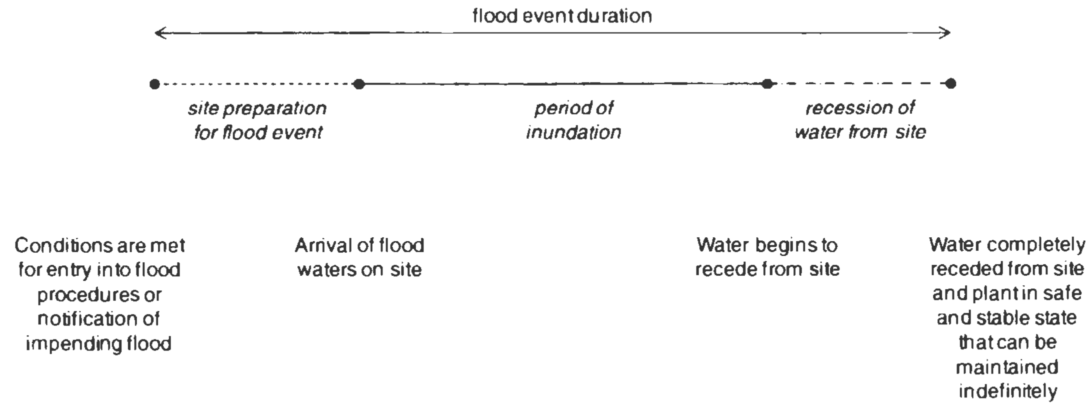


Figure 2.2-1. Flood Event Duration

Source: JLD-ISG-2012-05 (NRC, 2012c), Figure 6.

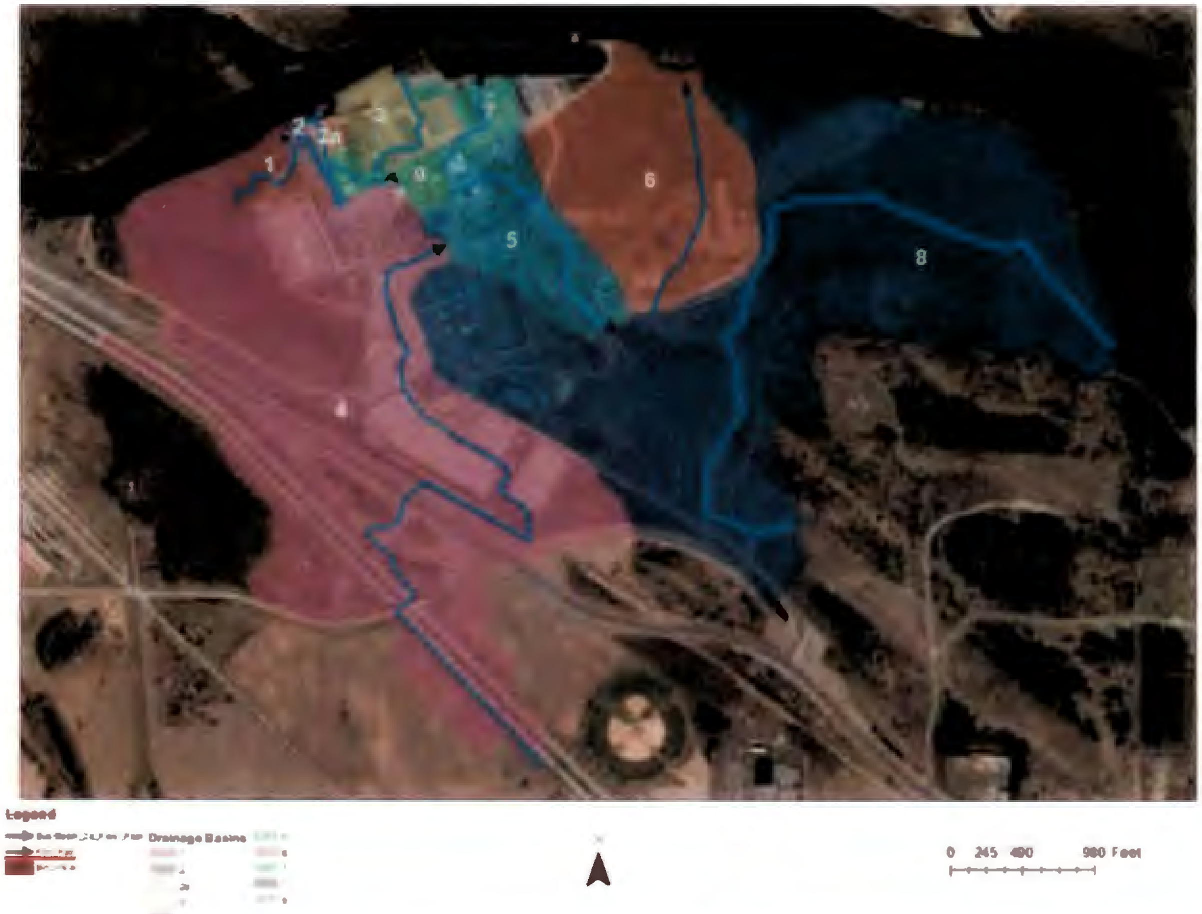


Figure 3.2-1. Drainage Sub-Basins (Areas) and Flow Path Directions Applicable to the Monticello LIP Analysis (Xcel Energy, 2016)

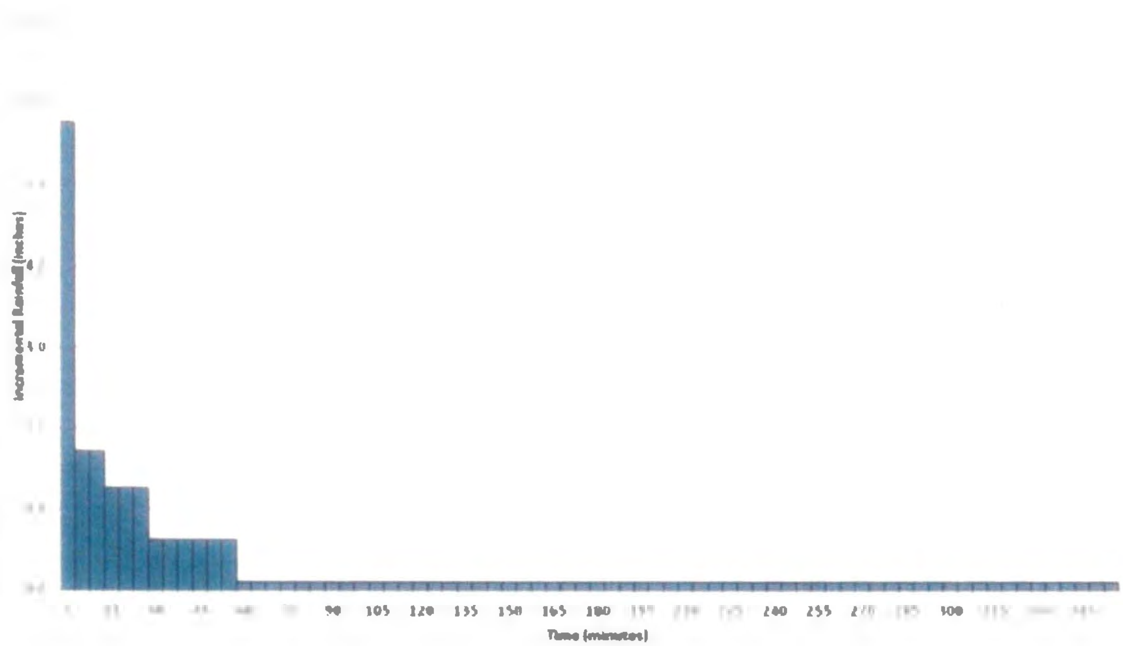


Figure 3.2-2. All-Season PMP Hyetograph Used in the Monticello LIP Analysis. (Xcel Energy, 2016)

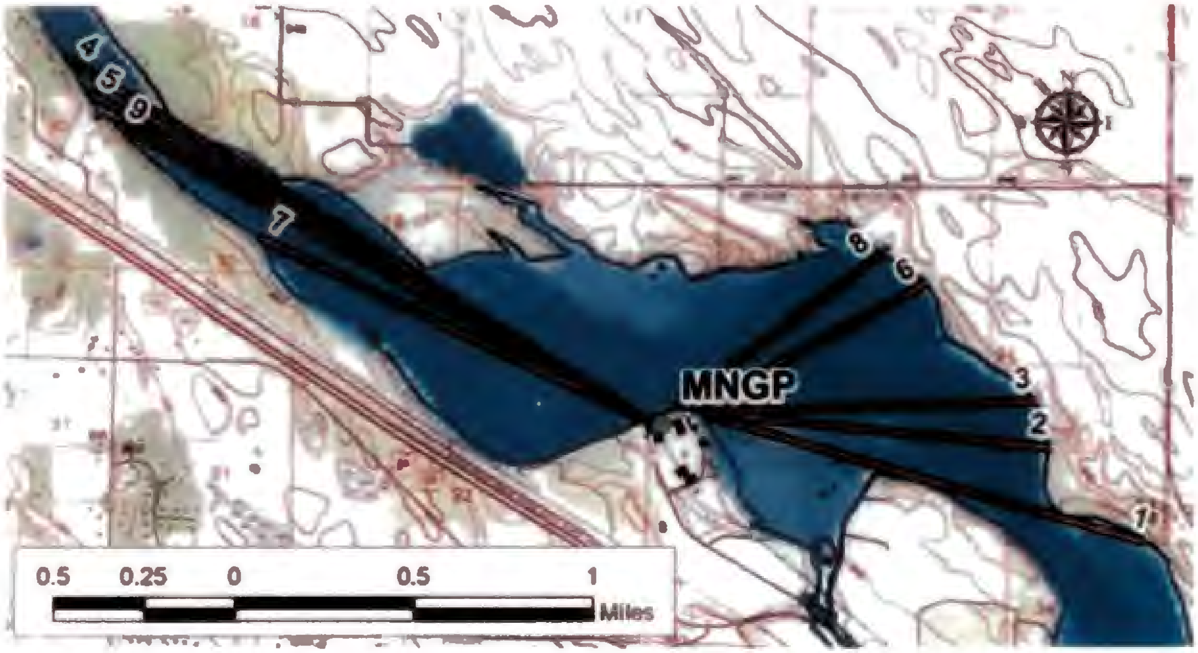
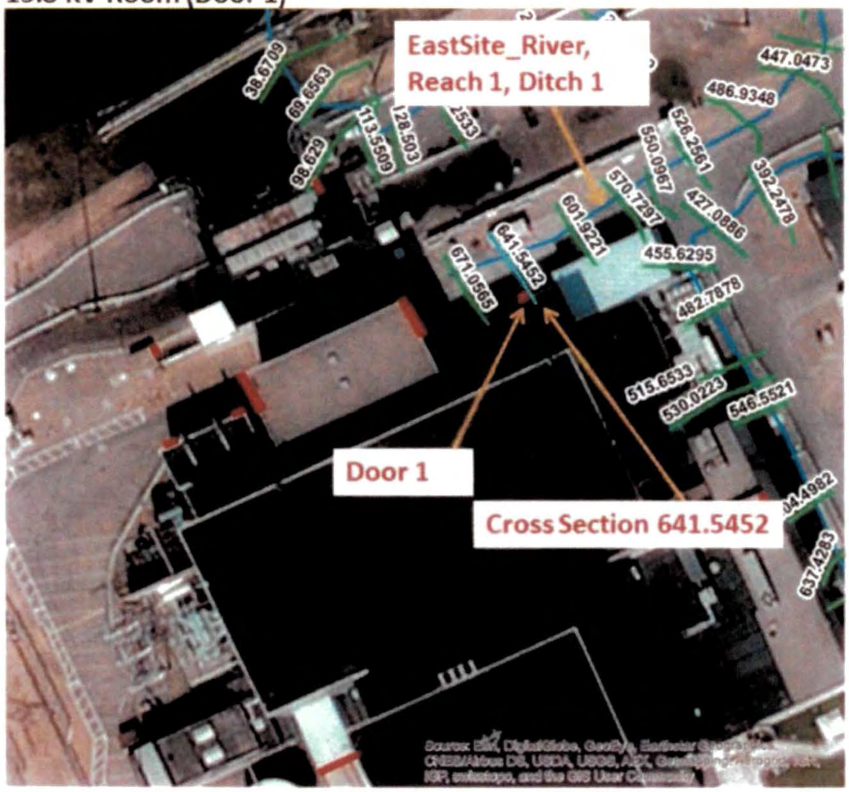


Figure 3.3-2. The Nine Fetch Orientations Considered in Connection with the Wind/Wave Analysis for the Streams and Rivers Flood Reevaluation. (Xcel Energy, 2016)

Appendix Containing Figures Illustrating Critical Door Locations Identified in Connection with the Local Intense Precipitation Analysis for the Monticello Nuclear Power Plant Site

Figures obtained from Fields 2016

13.8 KV Room (Door 1)



Source:
Calculation
180999.51 1005 Rev. 2
Table 5.4-5
Door 1
WSE 933.09 ft NGVD29 – corrected to 931.49 ft

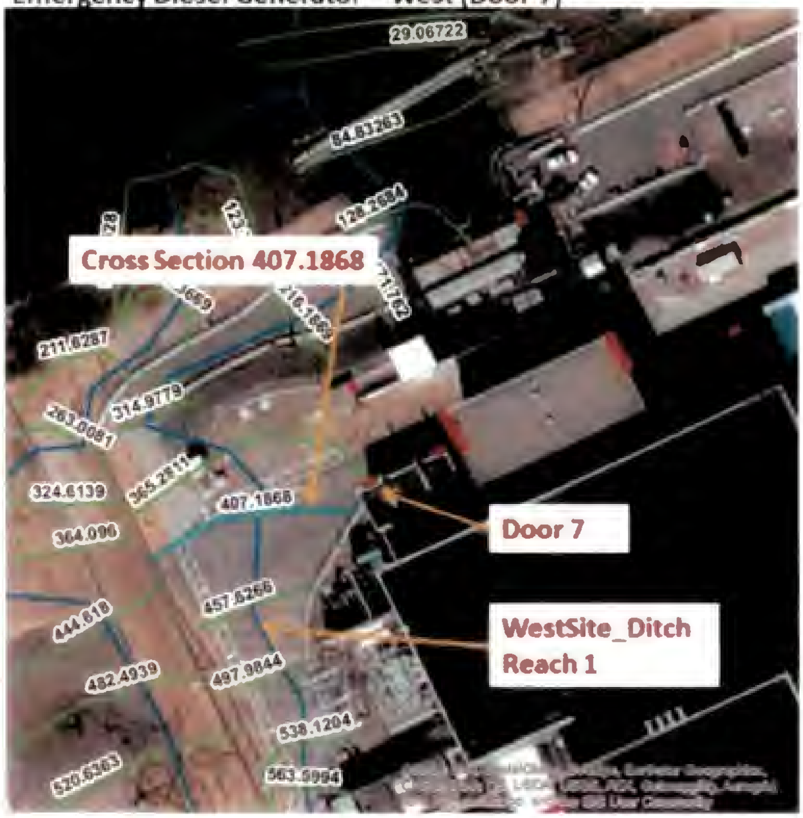
Appendix B, HEC-RAS Output, pg 215 of 921
Referenced Cross Section 641.5452

W.S. Elev (ft)
931.86 ft NAVD88 (HEC-RAS)
931.49 ft NGVD29 (Table)
NAVD88 = NGVD29 + 0.37 ft

Sub-Basin 3
Figure 5.3.6-1 is a reference figure in the calculation for this figure.

Legend
- Critical Door
- Cross Section
- Referenced Cross Section
- River/Reach
- 123.45 Cross Section Number

Emergency Diesel Generator – West (Door 7)



Source
Calculation
180999 51 1005 Rev
Table 5.4-5
Door 7
WSE 931 41 ft NGVD29

Appendix B, HEC RAS
Output, pg 894 of 921
Referenced Cross Section
407.1868

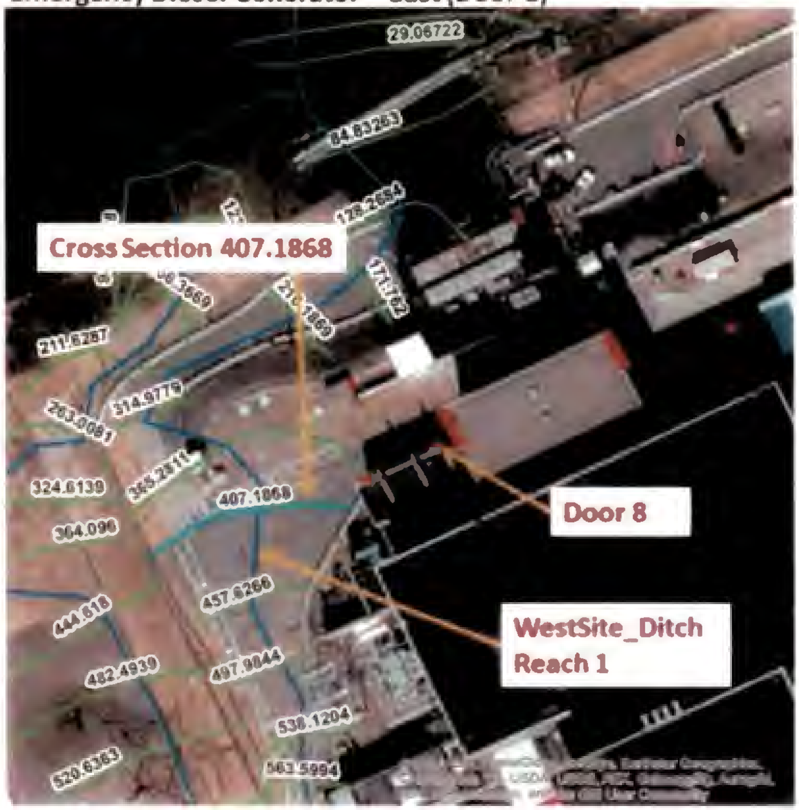
W.S. Elev (ft)
931.78 ft NAVD88 (HEC-RAS)
931.41 ft NGVD29 (Table)
NAVD88 = NGVD29 + 0 37 ft

Sub-Basin 2a

Figure 5.3.4-1 is a reference figure in the calculation for this figure.

Legend
- Critical Door
- Cross Section
- Referenced Cross Section
- River/Reach
- 123.45 Cross Section Number

Emergency Diesel Generator – East (Door 8)



Source
Calculation
180999.51 1005 Rev.
Table 5 4-5
Door 8
WSE 931 41 ft NGVD29

Appendix B, HEC-RAS
Output, pg 894 of 921
Referenced Cross Section
407.1868

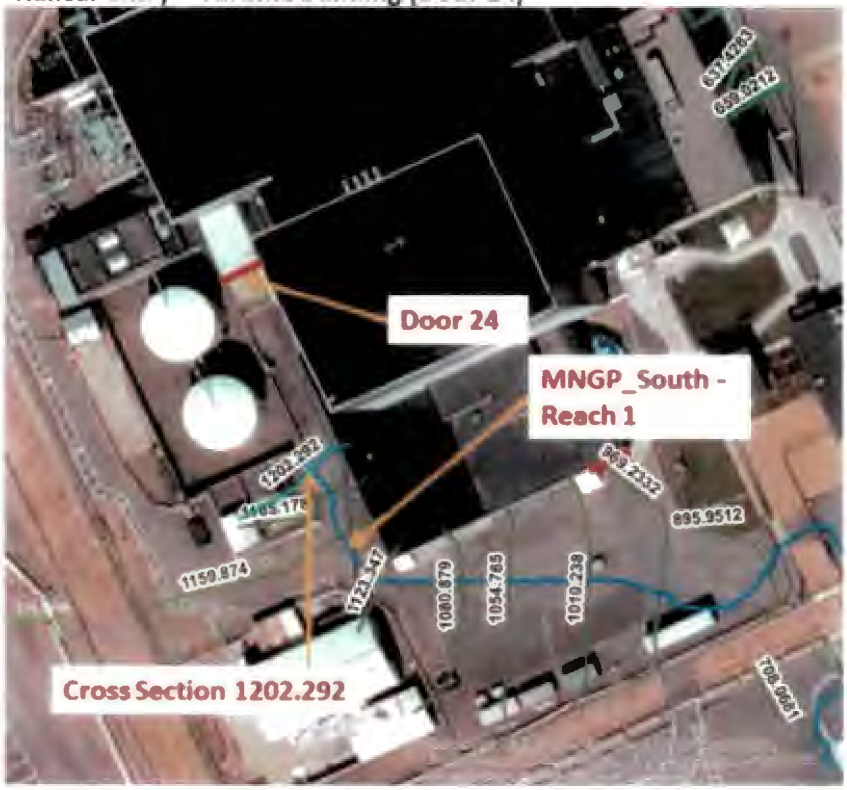
W.S. Elev (ft)
931.78 ft NAVD88 (HEC RAS)
931.41 ft NGVD29 (Table)
NAVD88 = NGVD29 + 0 37 ft

Sub-Basin 2a

Figure 5.3.4-1 is a reference figure in the calculation for this figure

Legend
Critical Door
Cross Section
Referenced Cross Section
River/Reach
123.45 Cross Section Numbe

Railcar Entry – Turbine Building (Door 24)



Source:
Calculation
180999 51 1005 Rev
Table 5 4-
Door 24
WSE 935 83 ft NGVD29

Appendix B, HEC-RAS
Output, pg 728 of 921
Referenced Cross Section
1202.292

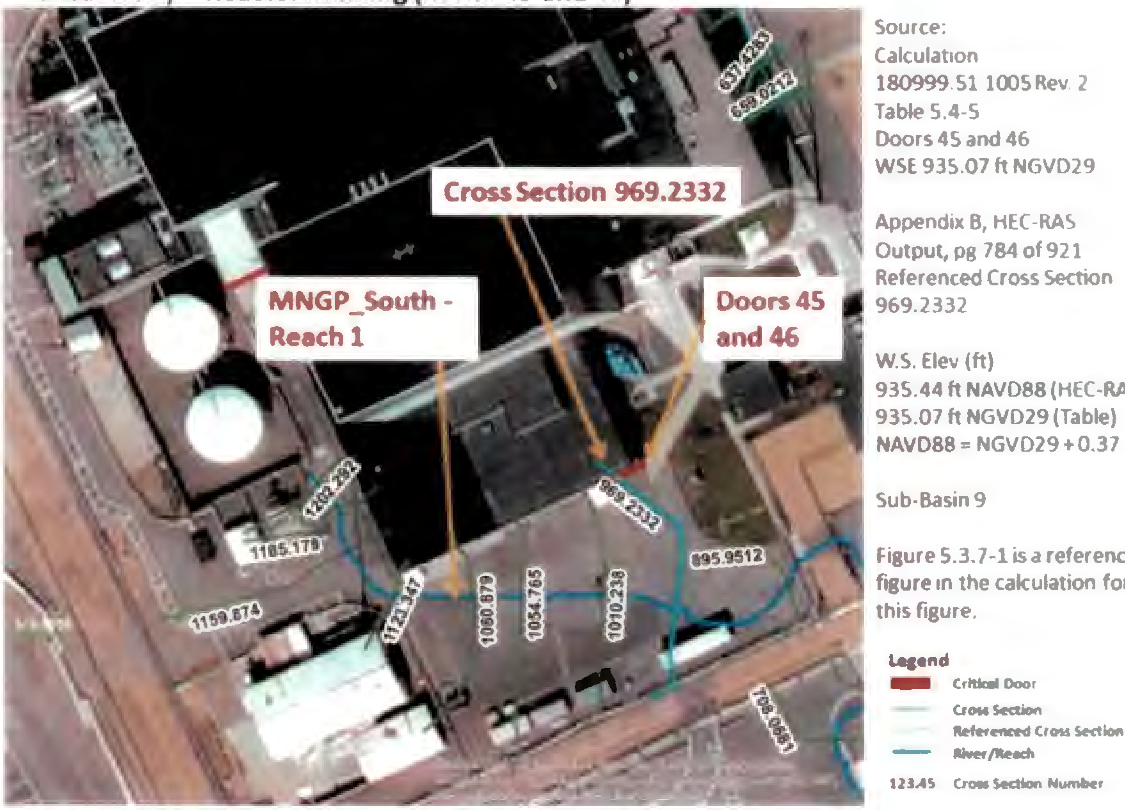
W.S. Elev (ft)
936.20 ft NAVD88 (HEC-RAS)
935.83 ft NGVD29 (Table)
NAVD88 = NGVD29 + 0.37 ft

Sub-Basin 9

Figure 5.3 7-1 is a reference figure in the calculation for this figure

Legend
Critical Door
Cross Section
Referenced Cross Section
River/Reach
123.45 Cross Section Number

Railcar Entry – Reactor Building (Doors 45 and 46)



Source:
Calculation
180999.51 1005 Rev. 2
Table 5.4-5
Doors 45 and 46
WSE 935.07 ft NGVD29

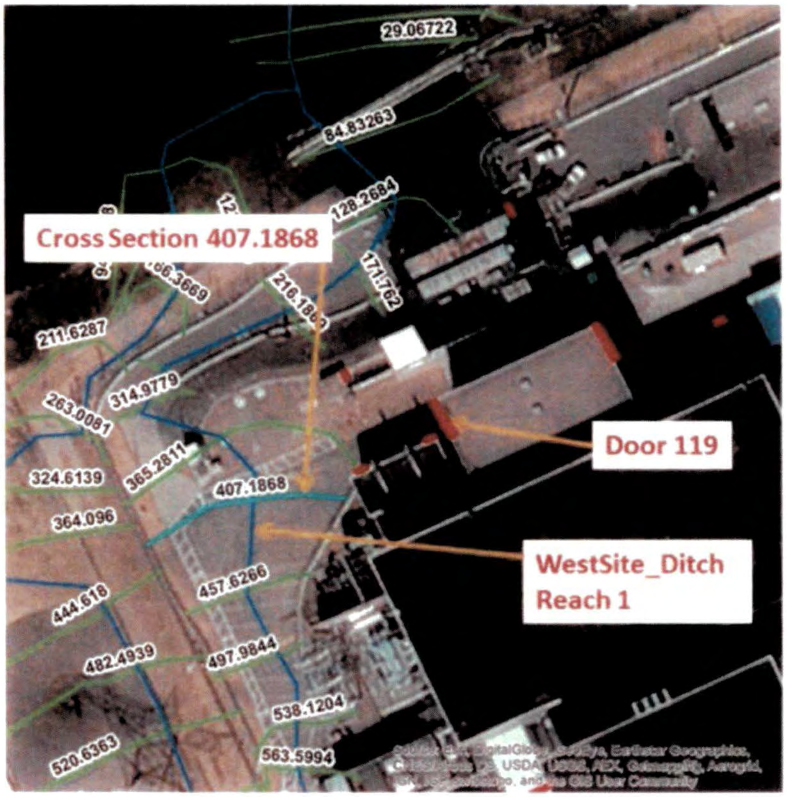
Appendix B, HEC-RAS Output, pg 784 of 921
Referenced Cross Section 969.2332

W.S. Elev (ft)
935.44 ft NAVD88 (HEC-RAS)
935.07 ft NGVD29 (Table)
NAVD88 = NGVD29 + 0.37 ft

Sub-Basin 9

Figure 5.3.7-1 is a reference figure in the calculation for this figure.

MNGP West Roll-Up Door-Turbine Building Addition (Door 119)



Source:
Calculation
180999.51.1005 Rev. 2
Table 5.4-5
Door 119
WSE 931.41 ft NGVD29

Appendix B, HEC-RAS Output, pg
894 of 921
Referenced Cross Section 407.1868

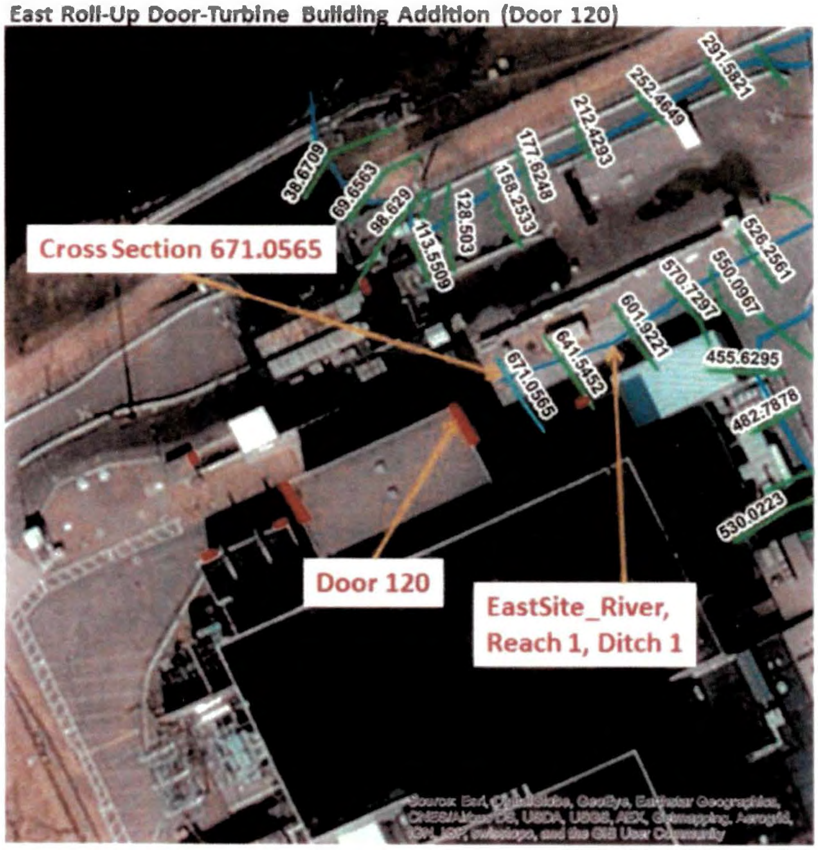
W.S. Elev (ft)
931.78 ft NAVD88 (HEC-RAS)
931.41 ft NGVD29 (Table)
NAVD88 = NGVD29 + 0.37 ft

Sub-Basin 2a

Figure 5.3.4-1 is a reference figure
in the calculation for this figure

Legend
- Critical Door
- Cross Section
- Referenced Cross Section
- River/Reach
- 123.45 Cross Section Number

East Roll-Up Door-Turbine Building Addition (Door 120)



Source:
Calculation
180999 51.1005 Rev. 2
Table 5.4-5
Door 120
WSE 931.53 ft NGVD29

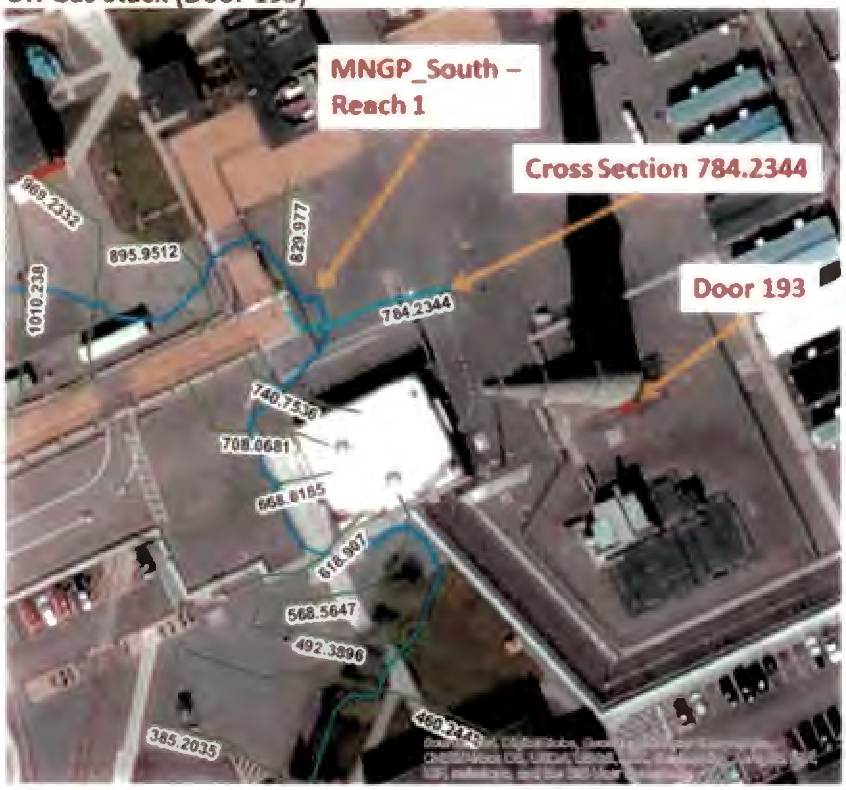
Appendix B, HEC-RAS Output, pg
214 of 921
Referenced Cross Section
671.0565

W.S. Elev (ft)
931.90 ft NAVD88 (HEC-RAS)
931.53 ft NGVD29 (Table)
NAVD88 = NGVD29 + 0.37 ft

Sub-Basin 3
Figure 5.3.6-1 is a reference figure in the calculation for this figure

Legend
- Critical Door
- Cross Section
- Referenced Cross Section
- River/Reach
- 123.45 Cross Section Number

Off Gas Stack (Door 193)



Source:
Calculation
180999.51 1005 Rev. 2
Table 5.4-5
Door 193
WSE 934.63 ft NGVD29
(estimated)

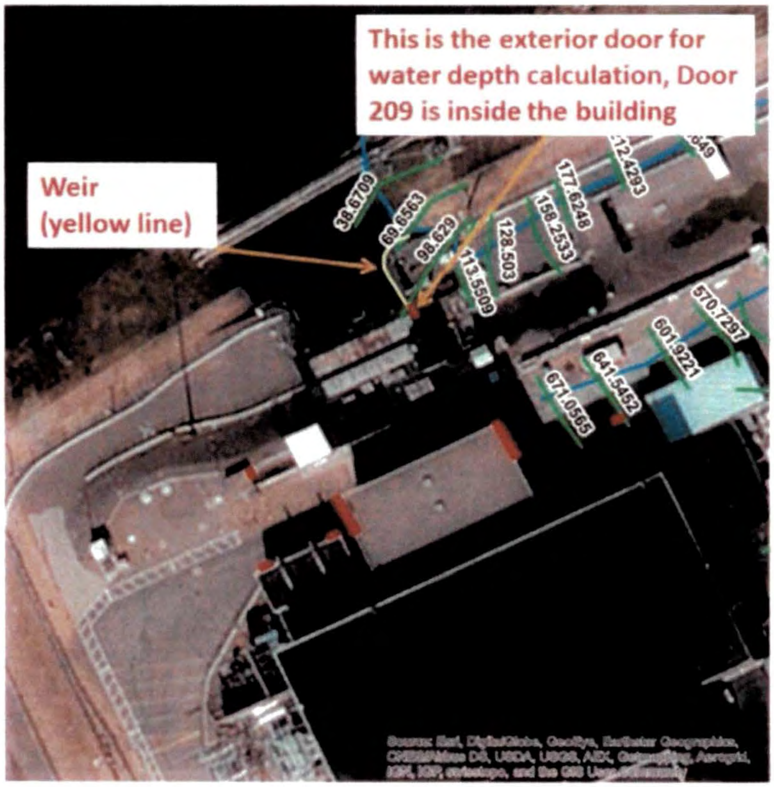
Appendix B, HEC-RAS Output,
pg 826 of 921
Referenced Cross Section
784.2344

W.S. Elev (ft)
935.01 ft NAVD88 (HEC-RAS)
934.64 ft NGVD29 (Table has 934.63, this was an estimation of nearby cross sections)
NAVD88 = NGVD29 + 0.37 ft

Sub-Basin 9
Figure 5.3.7-1 is a reference figure in the calculation for this figure.

Legend
Critical Door
Cross Section
Referenced Cross Section
River/Reach
123.45 Cross Section Number

MNGP Intake Structure Door – Interior between Screenhouse and Intake Structure (Door 209) – Weir equation used, no modeled cross section or reach association



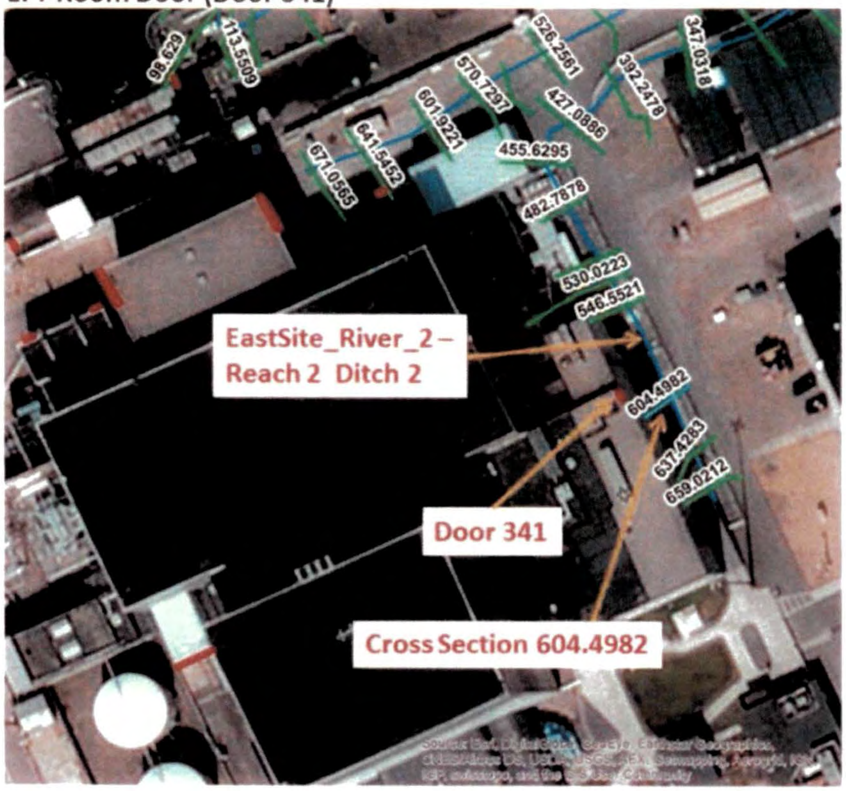
Source:
Calculation
180999.51 1005 Rev. 2
Table 5.4-5
Door 209
Sub-Basin 3

Figure 5.3.6-1 is a reference figure in the calculation for this figure.

WSE 920.62 ft NGVD29

Calculation Pg 53 of 71
This page shows the weir calculation. Second to last paragraph contains the water depth on the weir of 1 62 ft that corresponds to a WSE of 920.62 ft NGVD29

EFT Room Door (Door 341)



Source:
Calculation
180999.51.1005 Rev. 2
Table 5.4-5
Door 341
WSE 933.20 ft NGVD29

Appendix B, HEC-RAS
Output, pg 160 of 921
Referenced Cross Section
604.4982

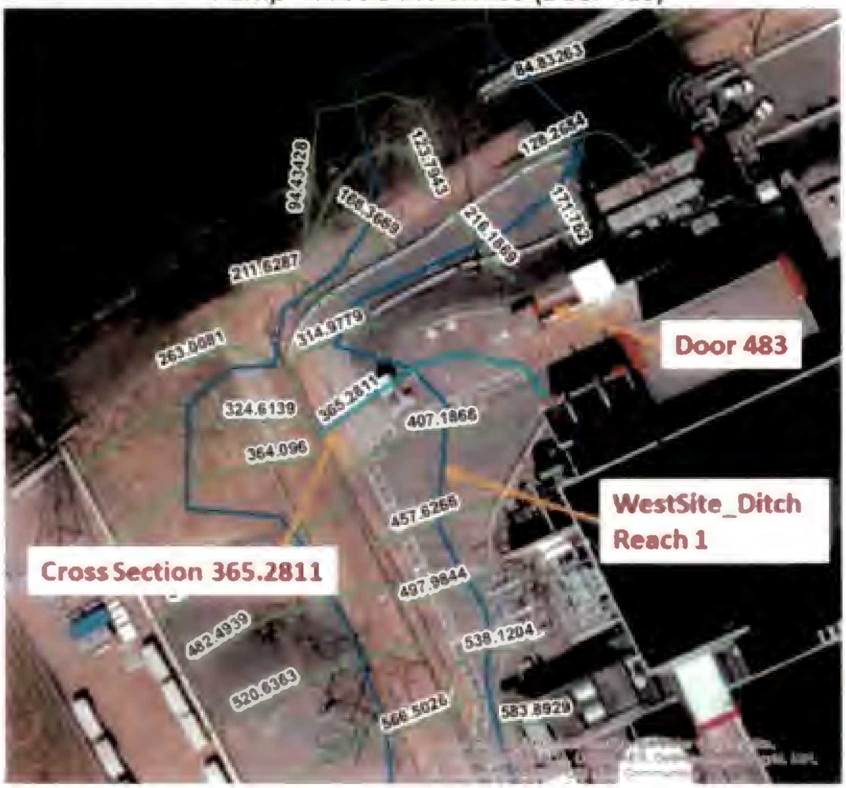
W.S. Elev (ft)
933.57 ft NAVD88 (HEC-RAS)
933.20 ft NGVD29 (Table)
NAVD88 = NGVD29 + 0.37 ft

Sub-Basin 3

Figure 5.3.6-1 is a reference figure in the calculation for this figure.

Legend
Critical Door
Cross Section
Referenced Cross Section
River/Reach
123.45 Cross Section Number

Fuel Oil Transfer Pump House Door Closed (Door 483)



Source:
Calculation
180999.51 1005 Rev. 2
Table 5.4-5
Door 483
WSE 931.29 ft NGVD29

Appendix B, HEC-RAS
Output, pg 895 of 921
Referenced Cross Section
365 2811

W.S Elev (ft)
931.66 ft NAVD88 (HEC-RAS)
931.29 ft NGVD29 (Table)
NAVD88 = NGVD29 + 0.37 ft

Sub-Basin 2a

Figure 5.3.4-1 is a reference figure in the calculation for this figure.

Legend
Critical Door
Cross Section
Referenced Cross Section
River/Reach
123.45 Cross Section Number

MONTICELLO NUCLEAR GENERATING PLANT – STAFF ASSESSMENT OF RESPONSE TO 10 CFR 50.54(f) INFORMATION REQUEST – FLOOD-CAUSING MECHANISM REEVALUATION DATED APRIL 24, 2017

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***via email**

OFFICE	NRR/JLD/JHMB/PM	NRR/JLD/LA	NRO/DSEA/RHM1/BC
NAME	LKGibson (FVega for)	SLent	CCook*
DATE	04/19/2017	04/18/2017	4/11/2017
OFFICE	NRR/JLD/JHMB/BC	NRR/JLD/JHMB/PM	
NAME	NSanfilippo	LKGibson (FVega for)	
DATE	04/20/2017	04/24/2017	

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