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

July 25, 2017

Mr. Joel P. Gebbie
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SUBJECT: DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2 – REVISED STAFF ASSESSMENT OF RESPONSE TO 10 CFR 50.54(f) INFORMATION REQUEST – FLOOD-CAUSING MECHANISM REEVALUATION (CAC NOS. MF6096 AND MF6097)

Dear Mr. Gebbie:

By letter dated June 15, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17164A308), the U.S. Nuclear Regulatory Commission (NRC) transmitted to you the staff assessment for the Donald C. Cook Nuclear Plant, Units 1 and 2 (D.C. Cook) flood hazard reevaluation report (FHRR). The purpose of this letter is to transmit the revised NRC staff assessment of the D.C. Cook FHRR as described in the March 6, 2015, letter (ADAMS Accession No. ML15069A334), submitted by Indiana Michigan Power Company (the licensee) for D.C. Cook.

This letter supersedes the June 15, 2017, letter with changes to each section documented in the enclosure to this letter.

BACKGROUND

By letter dated March 12, 2012, the 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 March 6, 2015, the licensee responded to this request for D.C. Cook.

By letter dated December 4, 2015 (ADAMS Accession No. ML15334A413), the NRC staff sent the licensee a summary of its review of D.C. Cook'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 the local intense precipitation flood-causing mechanism at D.C. Cook is not bounded by the plant's current design basis, an additional assessment of the flood hazard mechanism is necessary.

The NRC staff has no additional information needs with respect to the licensee's 50.54(f) response related to flooding. This staff assessment closes out the NRC's efforts associated with CAC Nos. MF6096 and MF6097.

If you have any questions, please contact me at (301) 415-6197 or e-mail at Tekia.Govan@nrc.gov.

Sincerely,

Tekia Govan, Project Manager
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Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos. 50-315 and 50-316

Enclosure:
Revised Staff Assessment Related to the Flood
Hazard Reevaluation Report for D.C. Cook

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO FLOODING HAZARD REEVALUATION REPORT

NEAR-TERM TASK FORCE RECOMMENDATION 2.1

DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-315 AND 50-316

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 NRC's Near-Term Task Force (NTTF) report (NRC, 2011b). Recommendation 2.1 in that document recommended that the NRC staff issue orders to all licensees to reevaluate seismic and flooding hazards 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 a request 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 flood hazard reevaluation report (FHRR) deadlines for individual plants. On May 11, 2012, the staff issued its prioritization of the FHRRs (NRC, 2012c).

By letter dated March 6, 2015 (I&M, 2015b), Indiana Michigan Power Company (I&M, the licensee), provided it's FHRR for Donald C. Cook Nuclear Plant, Units 1 and 2 (D.C. Cook). The NRC staff conducted a site audit with the licensee on July 15, 2015. The NRC staff issued an audit report summarizing additional information obtained during this audit (NRC, 2015c). The licensee provided a supplement to the D.C. Cook FHRR dated November 10, 2016 (IMP, 2016a).

By letter dated December 4, 2015, the NRC staff issued an interim staff response (ISR) letter to the licensee (NRC, 2015b). 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 Enclosure 2 of the 50.54 (f) letter. 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 ISR letter's enclosures match the values in this staff assessment without change or alteration.

As mentioned in the ISR letter, the reevaluated flood hazard results for the local intense precipitation (LIP) is not bounded by the plant's current design basis (CDB) hazard.

Consistent with the 50.54(f) letter and amended by the process outlined in COMSECY-15-0019 and Japan Lessons-Learned Division (JLD) Interim Staff Guidance (ISG) JLD-ISG-2016-01, Revision 0 (NRC, 2015a and NRC, 2016b), the NRC staff anticipates that the licensee will perform 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 revised integrated assessments.

Note: The NRC staff issued the D.C. Cook FHRR staff assessment on June 15, 2017. Subsequent to the issuance of the D.C. Cook FHRR staff assessment, the NRC staff noted the following items that have since been corrected in this version of the D.C. Cook FHRR staff assessment. This staff assessment supersedes the June 15, 2017, staff assessment with changes to each section documented below.

Page	Section	Documented changes to the revised D.C. Cook FHRR staff assessment
6	3.1.2	The first sentence of this section references Table 3.1.1 when summarizing the CDB flood levels for the flood-causing mechanisms. The document has been corrected to reference Table 3.1.2, which provides the CDB flood levels.
7	3.2	The NRC staff clarified, in the first paragraph, that the reevaluated flood hazard for LIP is based on the maximum stillwater-surface elevation of 609.9 feet (ft.).
7	3.2	In the second paragraph, the NRC staff corrected the version of the FLO-2D build from Build 14.11.09 to Build 14.03.7.
8	3.2	In paragraph 4, the NRC staff revised the assessment to reference Case 2 in NUREG/CR-7046 as opposed to Case 3. And the last two sentences of paragraph 5 were removed to eliminate reference to NUREG/CR-7046, Case 3 information.
11	3.5	In paragraph 3, the NRC staff revised the assessment to correct the calculated storm surge elevation from 593.0 ft. to 593.3 ft.
32	Figure 3.5-1	Figure was not applicable to the D.C. Cook site and was removed from the staff assessment.

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; and
- 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 NRC staff 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, 2012d) 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, 2015a) 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 a revised integrated assessment (NRC, 2015a and NRC, 2016b).

3.0 TECHNICAL EVALUATION

The NRC staff reviewed the information provided for the flood hazard reevaluation of D.C. Cook (IMP, 2015b). 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.

To provide additional information in support of the summaries and conclusions in the D.C. Cook FHRR, the licensee made calculation packages 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 D.C. Cook FHRR, and so those calculation packages were not docketed or cited.

3.1 Site Information

The 50.54(f) letter includes the SSCs important to safety in the scope of the hazard reevaluation. The licensee included pertinent data concerning these SSCs in the D.C. Cook FHRR. The NRC staff reviewed and summarized this information as follows in the sections below.

3.1.1 Detailed Site Information

The D.C. Cook FHRR (IMP, 2015b) described the site specific information related to the flood hazard evaluation. The D.C. Cook site is located on the southeastern bank of Lake Michigan in Berrien County, MI, about 2 miles north of the town of Bridgman, MI. The site consists of 650 acres with approximately 4,350 ft. of lake-frontage.

The site grade and design-basis of features related to plant safety is elevation 594.6 ft. National Geodetic Vertical Datum of 1929 (NGVD29). All elevations in this staff assessment are given with respect to the NGVD29. Table 3.1-1 provides the summary of controlling reevaluated flood-causing mechanisms, including associated effects, the licensee computed to be higher than the powerblock elevation. The D.C. Cook FHRR states that the site is on a flat area above the Lake Michigan shoreline and at an elevation of 609 ft. for most of the protected area. The site grade falls to 594 ft. for the area west of the screen house and turbine building. The plant is flood protected from the maximum (monthly mean) high lake water level, but a design-basis seiche event when the lake is at its maximum recorded level will cause flooding in the turbine building screen house.

3.1.2 Design-Basis Flood Hazards

The CDB flood levels are summarized by flood-causing mechanism in Table 3.1-2 of this staff assessment. The licensee presented CLB flood elevation information in the D.C. Cook FHRR, Table 4-1. The licensee stated that the only mechanism that has a CDB is seiche. The licensee reported that all other mechanisms were not evaluated in terms of CLB flood elevations. The NRC staff reviewed the information provided 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 reported in the D.C. Cook FHRR that there are no flood related changes to the CLB. The NRC staff reviewed the information provided 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 in the D.C. Cook FHRR that there have been a number of new structures, security barriers, and area paving that have been added since the initial plant license. The D.C. Cook FHRR, Table 2-1, includes all of the specific areas and plant structures that may impact the site flooding analysis. The NRC staff reviewed the information provided 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 licensee reported that there are no changes in the CLB and CDB. The licensee stated in the DC Cook FHRR that the site CDB flood was based on a weather-driven seiche occurring on Lake Michigan with a maximum water height of 11 ft. above record high lake level. This flood would result in water reaching an elevation of 594.6 ft. NGVD29. In the D.C. Cook FHRR, Section 2.3, the licensee described the flood mitigation features for the safety-related buildings at the site. The NRC staff reviewed the information provided and determined that sufficient information was provided to be responsive to Enclosure 2 of the 50.54(f) letter.

3.1.6 Additional Site Details to Assess the Flood Hazard

The licensee made available for review, electronic copies of the input/output files used for a numerical model related to the analysis of LIP. The NRC staff reviewed that material and determined that sufficient information had been provided in response to Enclosure 2 of the 50.54(f) letter.

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 requests described in 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 26, 2012 (IMP, 2012), the licensee provided the requisite flood walkdown report for D.C. Cook. The NRC staff issued a staff assessment on June 18, 2014 (NRC, 2014), which documented its review of the flooding walkdown report and concluded that the licensee's implementation of flooding walkdown methodology met the intent of the 50.54(f) letter.

3.2 Local Intense Precipitation and Associated Site Drainage

The licensee reported in the D.C. Cook FHRR that the reevaluated flood hazard for LIP and associated site drainage is based on the maximum stillwater-surface elevation of 609.9 ft. NGVD29 (see Tables 4.1-1 and 4.1-2). This flood-causing mechanism is not discussed in the licensee's CDB for flooding related to LIP.

To reevaluate the hazards for the LIP event, the licensee used the two-dimensional (2D) hydrodynamic computer model FLO-2D Pro, Build 14.03 (referred to hereafter as FLO-2D). The NRC staff confirmed this version of the model was applied during a D.C. Cook site audit (NRC, 2015c). The computational boundary of the model was delineated based on the D.C. Cook topographic data (IMP, 2015b). The licensee used the 6-hour (h) 1-square-mile (1-mi^2) site-specific LIP hyetograph as input to the FLO-2D model (IMP, 2015b).

The reevaluation of flood hazard for LIP is based on the 6-h, 1-mi^2 site-specific probable maximum precipitation (ssPMP) of 20.2 in (IMP, 2015a; 2016a). The licensee created the front-end, 6-h distribution for the synthetic PMP hydrograph and used equal increments of rainfall for the remaining 5 hrs. of the storm to obtain the 20.2 in of precipitation estimated using the site-specific PMP approach. The total rainfall for the 1-h rainfall is approximately 12.8 in. NUREG/CR-7046 (NRC, 2011e) recommends the use of the 1-h, 1-mi^2 PMP. However, as the

6-h, 1-mi^2 ssPMP encompasses the 1-h, 1-mi^2 PMP, the licensee used the 6-h storm as a conservative approach.

The licensee modeled the D.C. Cook site and its surrounding area using a 10-ft. by 10-ft. square FLO-2D grid over the 0.2 mi^2 contributing watershed with elevations from a combination of 2013 regional Light Detection and Ranging (LiDAR) maps. The boundary of the site includes all on-site buildings and was delineated based on the topography. The licensee assumed an overall conservative nature for the model such that all rainfall is converted directly to runoff and that all drainage routes (e.g., culverts) are partially blocked. These assumptions are consistent with Case 2 in NUREG/CR-7046 (NRC, 2011e). Rainwater infiltration into natural sands in the area (dune sand) was derived from U.S. Soil Conservation Service (SCS) information and no evaporation losses were considered (IMP, 2016a).

Consistent with NUREG/CR-7046, the onsite storm drain system (yard drainage) is considered to be operational at 25-percent capacity. Buildings within the watershed are considered to be solid and impervious. Security barriers, consisting of both concrete jersey barriers and heavy steel fencing are considered pervious where they might block water from access to the site (upstream) and impervious where they might allow off site (downstream) to make the estimation of flood levels conservative.

By visual assessment of the imagery, the licensee assigned a Manning's n coefficient of flow resistance for each land cover. The higher, more conservative values from the suggested ranges provided in the FLO-2D reference manual (FLO-2D, n.d.) were used in the licensee's model. The licensee also noted that the lower *n* value is more reflective of the maintenance of the grass at the D.C. Cook site and that the overall conservativeness of the model would account for slight variation in roughness coefficients.

The licensee identified, based on general site and plant configuration and plant walkdown, 10 critical area locations where LIP runoff could impact SSCs important to safety of the plant as shown on Figure 3.2-1. These 10 locations are identified to be locations of potential SSC vulnerability where predicted flood elevations exceed surveyed threshold elevations and have the potential to produce adverse conditions. Additional realistic or conservative assumptions used in the LIP modeling are:

- Watershed surfaces are assigned a realistic site-specific SCS Curve Number (CN) based on soil type, vegetation, and land use;
- Runoff from the rooftop of parapet style building roofs is allowed to flow to an internal storm drain within the building, then offsite not to adjacent ground surface cells;
- Security barriers on the upstream edges of the model are not considered to block incoming storm water and are omitted from the model;
- Jersey barriers on the downstream edges of the site are considered impervious;
- Delay barriers on the downstream edges of the protected area are assumed to be 50 percent porous;
- The D.C. Cook protected storm drain is considered to be operational at 25 percent capacity - consistent with NUREG/CR-7046, Appendix B.2, Case 2: "Fully Functional

Site Grading and Partially Blocked Drainage Channels (NRC, 2011e)." The combined outfall section is adequate to convey inflow from all trench drains; and

- No evaporation losses were considered. Buildings within the watershed are considered to be solid and impervious.

In order to determine the significance of the use of a ssPMP on the estimated LIP flood hazard at the D.C. Cook site, the NRC staff independently evaluated the sensitivity of the licensee's FLO-2D model to that parameter using the value obtained alternatively from Hydrometeorological Report 51 (HMR 51) (National Oceanic and Atmospheric Association (NOAA), 1982). The HMR-based 1-hr PMP value was 17.5 in or about 27 percent larger than the licensee's ssPMP value of 12.8 in. Aside from changing the PMP value, no other changes were made to the licensee-provided model. A comparison of maximum water surface elevations at the same 10 monitoring locations to those reported by the licensee in the D.C. Cook FHRR revealed that the maximum differences in estimated water depths owing to the use of an HMR-derived PMP value was about 0.2 ft. In light of these small differences, the NRC staff concluded that the licensee's application of a ssPMP does not impact the maximum water-level estimates compared to those for the HMR-based flood levels, and that staff's review of the ssPMP values or methodology was not necessary for the purposes of the 50.54(f) letter.

The NRC staff reviewed details of the licensee's FLO-2D model implementation and determined that the approaches and assumptions were conservative and appropriate. The model output files reviewed by NRC staff did not report any errors related to model stability or mass balance. Based on a confirmatory run of the licensee-provided FLO-2D model, the NRC staff determined that the licensee's conclusions, based on results produced by the model, are reasonable.

The NRC staff confirmed that the licensee's reevaluation of the hazard for LIP and associated site drainage used present-day methodologies and regulatory guidance. The NRC staff also confirmed the licensee's conclusion that the reevaluated flood hazard for LIP and associated drainage is not bounded by the CDB flood hazard. Therefore, the NRC staff expects that the licensee will submit a focused evaluation for the LIP and associated site drainage flood-causing mechanism for the D.C. Cook site.

3.3 Streams and Rivers

The licensee reported in the D.C. Cook FHRR that the reevaluated flood hazard for streams and rivers is screened out because no surface water channels, rivers, or streams are present within or adjacent to drainage paths, which contribute surface water runoff to the D.C. Cook protected area or other important-to-safety locations. This flood-causing mechanism is not discussed in the licensee's CDB.

The licensee focused on the streams and rivers flooding assessment on the northeast side of the property (IMP, 2015a; 2016b). The licensee stated that there are no hydrologic features identified by the U.S. Geological Survey's (USGS) National Hydrography Dataset (USGS, 2013), such as perennial or intermittent streams in the vicinity of the area. The Thornton Valley is the only nearby channel, and a preliminary screening dismisses the need for a PMF of this drainage feature since it is not adjoining, adjacent to, or in the same drainage basin or watershed as the SSCs important to safety. The licensee identified that local topography defines a watershed basin division between the Thornton Valley drain and the onsite watersheds (see Figure 3.3-1 of this staff assessment). There is no indication that a PMF event on the Thornton Valley drain watershed would present a flooding hazard to the D.C. Cook site.

The NRC staff confirmed the licensee's conclusion that the streams and rivers flood-causing mechanism could not inundate the D.C. Cook site. Therefore, the NRC staff determined that streams and rivers flooding does not need to be analyzed in a focused evaluation or an additional assessment.

3.4 Failure of Dams and Onsite Water Control/Storage Structures

The licensee reported in the D.C. Cook FHRR that the reevaluated hazard for failure of dams and onsite water control or storage structures is based on a water-surface elevation of 588.6 ft. NGVD29, which considers wind waves and runup effects as this value is based on a historical maxima. This flood-causing mechanism is not discussed in the licensee's CDB.

The licensee reported the use of the hierarchical hazard assessment approach to reevaluate dam failure flood hazards. The licensee stated that there are no onsite water control/storage structures that could inundate SSCs important to safety. Alternatively, the licensee considered a postulated failure of the locks between Lake Superior and Lakes Huron and Michigan, which could potentially be contributing to a rise in the water level of Lake Michigan at the plant site. Water is continually flowing from the headwaters of Lake Superior via the St. Mary's River to Lakes Huron and Michigan, which are connected by the deep Straits of Mackinac and are considered to be one lake hydraulically, having a common water level. Assumptions for this flooding analysis were conservatively based on existing physical conditions. The water level in Lakes Michigan and Huron depends, in part, on discharge from Lake Superior through a lock system. The analysis conservatively assumed that the entire lock system between Lake Superior and Lakes Michigan and Huron fails along with man-made water diversion structures, simultaneously. Historical evidence suggests that water levels on Lake Michigan and Lake Huron were 5 ft. higher within the last 1,000 years, than they have been since the recording of lake levels in 1865 according to the U.S. Army Corps of Engineers (USACE) (USACE, 1999). The D.C. Cook CDB uses a maximum lake elevation of 583.6 ft. as a component of a maximum flood height at Lake Michigan. Therefore, the licensee determined that a conservatively assumed 5 ft. increase due to dam failure on Lake Michigan would result in a maximum water elevation of 588.6 ft. NGVD29 for this flood-causing mechanism.

The NRC staff confirmed the licensee's conclusion that the reevaluated flood hazard for failure of dams and onsite water control or storage structures remains below the plant grade and determined this mechanism is bounded by the CDB for flooding from Lake Michigan (elevation 594.6 ft.). Therefore, the NRC staff determined that flooding from failure of dams or on-site water storage facilities would not inundate the plant site and, therefore, does not need to be analyzed in a focused evaluation or an additional assessment.

3.5 Storm Surge

The licensee reported in the D.C. Cook FHRR that the reevaluated elevation for the flooding due to storm surge is a stillwater elevation of 590.3 ft. NGVD29, and a total maximum (combined effects) water elevation of 593.3 ft. NGVD29. A separate flood elevation for this particular flood-causing mechanism is not included in the licensee's CDB, although the CDB for flooding (seiche) from Lake Michigan is elevation 594.6 ft. NGVD29.

The licensee evaluated the potential for storm surge flooding by selecting a peak (base) water elevation for Lake Michigan, and then superimposing a stochastically-determined storm surge, including wave runup. The licensee estimated the peak (base) Lake Michigan water surface elevation using historical data (NOAA, 2012, and USACE, 2012a; 2012b), which was an elevation of 583.2 ft. NGVD29. For the stochastic portion of the analysis, the licensee applied the Empirical Simulation Technique (EST; Scheffner et al., 1999a and 1999b) after first identifying 150 historic severe storm events as input data. Hydrodynamic storm surge modeling was performed using the Advanced CIRculation (ADCIRC) model (Luettich et al., 1992 and 2004). Wave runup were derived from data developed by the USACE in their comprehensive ADCIRC study of water levels in Lake Michigan (Jensen, 2012; Melby, 2012; Nadal-Caraballo, 2012; Scheffner et al., 2013). The licensee's final results are summarized in the D.C. Cook FHRR, Table 3-3, and results in a stillwater elevation of 590.3 ft. NGVD29 (D.C. Cook FHRR, Figure 3-14) plus 3.0 ft. of wave runup for a maximum (total) reevaluated storm surge elevation of 593.3 ft. NGVD29.

Due to the complexity associated with stochastic/probabilistic storm surge analyses and their limited application in NRC licensing applications, the NRC staff first performed a simpler deterministic storm surge analysis to determine if the licensee's values were reasonable. The NRC staff selected the previously-developed Great Lakes Storm Surge Planning Program model developed by NOAA (Schwab and Lynn, 1987). The NRC staff selected a sustained wind speed of 100 miles per hour (mph) and varied the wind direction by 10-degree increments between 10- and 360-degrees to determine the wind direction which produced the highest storm surge elevation at the site. The results of the NRC staff analysis was a maximum storm surge elevation of 593.3 ft. NGVD29, which is less than the CDB for flooding from Lake Michigan.

As part of the D.C. Cook audit, NRC staff requested information regarding use of wave information from Holland, MI, as being representative of the site's wave characterization. The licensee provided a response by letter dated October 27, 2015 (IMP, 2015c). The response included a figure that showed bathymetry profiles near both Holland, MI, and the D.C. Cook site, and the licensee sufficiently demonstrated their bathymetric similarities. The NRC staff used this information to compute a bottom slope of 0.0071 for the D.C. Cook site.

The NRC staff performed wave runup calculations based on guidance in Chapter VI-5 of the USACE Coastal Engineering Manual (CEM) (USACE, 2002). The NRC staff applied fetch length and storm duration limits to estimate the maximum offshore wave height of approximately 35 ft. based on waves approaching the site perpendicular to the shoreline. The NRC staff found that the maximum wave height observed in offshore Lake Michigan was 22.9 ft. on September 30, 2011 (NOAA/NWS, n.d.). Nearshore, the gentle beach slope at the D.C. Cook site (UFSAR, 2015; Figures 2.6-1, 2.6-9 and 2.6-10) would dampen the offshore waves and result in spilling breakers at the site. Thus, the NRC staff calculated a maximum wave runup of approximately 0.9 ft. (using maximum historical offshore parameters) and 1.4 ft. (using maximized fetch for 100-mph winds approaching directly onshore) at the D.C. Cook site. Using the maximum of these two values results in a total water surface elevation of 594.4 ft. NGVD29, which is less than the CDB for flooding from Lake Michigan of 594.6 ft. NGVD29. Therefore, since the licensee's reevaluated results are approximately equal to staff's deterministic results, and both are below the CDB for flooding from Lake Michigan, the NRC staff determined review of the licensee's stochastic methodology was not necessary for the purposes of the 50.54(f) letter.

The NRC staff confirmed the licensee's conclusion that the reevaluated storm surge flood-causing mechanism is bounded by the CDB for flooding from Lake Michigan (elevation 594.6 ft.). The NRC staff also confirmed the licensee's conclusion that flooding from storm surge alone could not inundate the D.C. Cook site. Therefore, the NRC staff determined that flooding from storm surge does not need to be analyzed in a focused evaluation or an additional assessment.

3.6 Seiche

The licensee reported in the D.C. Cook FHRR that the reevaluated hazard for site flooding from seiche would not inundate the site. This flood-causing mechanism is described in the licensee's CDB, and the maximum computed flood elevation from Lake Michigan is 594.6 ft. NGVD29.

The licensee describes its evaluation of site flooding from seiche hazards against the relevant regulatory criteria based on present-day methodologies and regulatory guidance.

The NRC staff reviewed the licensee's results and confirmed the licensee's statements regarding wind effects on seiche resonance. The NRC staff agrees with the licensee's conclusion that the primary storm surge will occur along the eastern and/or southern shorelines of the lake with potential seiches propagating to the west and/or north after the squall line has passed completely over the lake (Bechle and Wu, 2014). For Lake Michigan, the mean seiche period for primary mode oscillation along the long axis is approximately 9-h while the cross-lake primary mode period is approximately 2-h with typical seiche events lasting for 1- to 3-days with amplitudes of 1 to 5 ft. (USACE, 2012a; 2012b).

The NRC staff confirmed the licensee's conclusion that the seiche flood-causing mechanism could not inundate the D.C. Cook site. The NRC staff confirmed that the reevaluated hazard for flooding from seiche is bounded by the CDB flood hazard. Therefore, the NRC staff determined that flooding from seiche does not need to be analyzed in a focused evaluation or an additional assessment.

3.7 Tsunami

The licensee reported in the D.C Cook FHRR that the reevaluated hazard for site flooding from tsunami would not inundate the site. This flood-causing mechanism is not described in the licensee's CDB.

The licensee described its evaluation of the D.C Cook site flooding from tsunami hazards against the relevant regulatory criteria based on present-day methodologies and regulatory guidance below.

The licensee based their tsunami evaluation on historical records, databases and relevant scientific literature (NRC, 2009) which resulted in the following conclusions:

- As an inland site, the D.C. Cook site is not subject to oceanic tsunamis; however, tsunami-like waves (seiches) have occurred in the Great Lakes region. Most of the reported waves were caused by meteorological conditions, but two were related to earthquakes and one to a landslide (NOAA, 2014a; 2014b);

- The potential for earthquake-generated tsunamis are limited because the required level of seismic activity for development of a tsunami, i.e., an earthquake with a magnitude greater than 6.5, is essentially absent within a 100-mile radius of the D.C. Cook site;

- Subaqueous landslides are unlikely to generate an observable tsunami-like wave due to the limited bathymetric relief of ridges and their respective vertical slopes and orientation (NOAA, 2013a; 2013b); and

- Subaerial landslides around the west, north, and east perimeter of the Lake Michigan is unlikely to affect D.C. Cook because topographic trends would direct any resultant tsunami-like wave away from the site. The exception is the southwest lake perimeter, where the topography is oriented such that a landslide and resultant tsunami-like wave, if it occurred, would be directed toward D.C. Cook. However, given a landslide, it would cause little, if any, effect to the D.C. Cook site because of the limited topographic relief and slope angles.

The NRC staff reviewed the methodologies and references used by the licensee to determine the severity of the tsunami phenomena reflected in this analysis and noted that they are consistent with present-day methodologies and guidance.

The NRC staff confirmed the licensee's conclusion that the reevaluated hazard for flooding from tsunami is bounded by the CDB flood hazard. Therefore, the NRC staff determined that flooding from tsunami does not need to be analyzed in a focused evaluation or an additional assessment.

3.8 Ice-Induced Flooding

The licensee reported in the D.C. Cook FHRR that the reevaluated hazard for ice-induced flooding does not inundate the plant site and would be bounded by flooding due to storm surge. This flood-causing mechanism is not discussed in the licensee's CDB.

The licensee concluded in its FHRR that ice-induced flooding is not a credible event at the D.C. Cook site for the following reasons:

- Lake Michigan surface ice is common during winter and can cover over 90 percent of the lake's surface, with the surface ice cover forming from the shore outwards toward the center of the lake. However, there is negligible risk that surface ice will result in any flooding impact on the plant site because the lake surface is well below the lowest elevation of the plant grade (i.e., about 6 ft. of margin). The D.C. Cook site has no historical records of flooding issues due to lake ice affecting the plant;

- There are no perennial streams close to the site that would accumulate and contribute to the potential for ice-induced flooding at the plant site. Surface runoff is minor and is restricted to a small intermittent stream that traverses the eastern portion of the site and discharges into Lake Michigan; and
- Any potential for ice flooding at the plant site related to Lake Michigan is bounded by the storm-surge flood-causing mechanism discussed in Section 3.5 of this staff assessment.

The NRC staff confirmed that the licensee's reevaluation of the hazard from ice-induced flooding used present-day methodologies and regulatory guidance. The NRC staff confirmed the licensee's conclusion that the reevaluated hazard for ice-induced flooding of the site is bounded by the CDB flood hazard. Therefore, the NRC staff determined that ice-induced flooding does not need to be analyzed in a focused evaluation or an additional assessment.

3.9 Channel Migrations or Diversions

The licensee reported in the D.C. Cook FHRR that the reevaluated hazard for channel migrations or diversions does not inundate the plant site. This flood-causing mechanism is not discussed in the licensee's CDB.

The licensee stated in the D.C. Cook FHRR that cooling water canals and channels are not part of the plant design. Therefore, the licensee screened out channel migration or diversion as a plausible flood-causing mechanism for the D.C. Cook site. The NRC staff evaluated the potential for flooding resulting from channel migrations and diversions using the licensee provided site layout and Google maps. The NRC staff agreed with the licensee's conclusion for this flood-causing mechanism.

The NRC staff confirmed the licensee's conclusion that the channel migrations or diversions flood-causing mechanism could not inundate the D.C. Cook site. Therefore, channel migration or diversion flooding does not need to be analyzed in a focused evaluation or an additional assessment.

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 this staff assessment documents the NRC staff review of the licensee's flood hazard water elevations results. Table 4.1-1 of this staff report contains the maximum flood height results, including waves and run-up, for flood mechanisms not bounded by the CDB, which are presented in Table 3.1-1 of this staff assessment. The NRC staff agrees with the licensee's conclusion that LIP flood-causing mechanisms are not bounded by the CDB. Consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015a), the NRC staff anticipates the licensee will submit a focused evaluation for LIP and associated site drainage.

4.2 Flood Event Duration for Hazards Not Bounded by the CDB

The NRC staff reviewed information provided in licensee's 50.54(f) response (IMP, 2015b, 2015c, and 2016b) regarding the FED parameters needed to perform the additional assessment of 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 of this staff assessment.

For the LIP flood-causing mechanism, the licensee stated in the D.C. Cook MSA (IMP, 2016b) that the plant response to a LIP flood event does not credit warning time because entrance into the FLEX support guideline is based on loss of all alternating current power and other equipment/system conditions and not based on potential weather conditions. The NRC staff notes that the licensee may adopt (as needed) the warning time procedures followed by the alternative trigger method allowed by NEI 15-05 (NEI, 2015a).

The D.C. Cook MSA provides the periods of inundation ranging from 2 to 7 hrs. depending on the locations within the power block area, and the period of recession of up to 3 days. The licensee used the 2-D numerical model described in the D.C Cook FHRR to determine these inundation and recession periods. The NRC staff reviewed the licensee's model and concluded that the licensee's modeling and the estimation of the FED parameters are acceptable for use in the D.C. Cook MSA, as they used present-day methodologies and regulatory guidance.

The NRC staff determined that the licensee-provided FED parameters for the LIP flood-causing mechanism are acceptable as the approach to estimate these parameters is consistent with the guideline provided by Appendix G of NEI 12-06, Revision 2 (NEI, 2015b).

4.3 Associated Effects for Hazards Not Bounded by the CDB

The NRC staff reviewed the information provided in licensee's 50.54(f) letter response (IMP, 2015b, 2015c, 2016b) regarding the AE parameters for flood hazards not bounded by the CDB. The AE parameters related to water surface elevation (i.e., stillwater elevation with wind waves and runup effects) were previously reviewed by the NRC staff, and were transmitted to the licensee via an ISR dated December 4, 2015 (NRC, 2015b). The AE parameters not directly associated with water surface elevation are discussed below and are summarized in Table 4.3-1 of this staff assessment.

For the LIP flood-causing mechanism, the licensee concluded in the D.C. Cook FHRR that the AE parameters related to water-borne loads, including hydrostatic, hydrodynamic, debris, and sediment loads, would induce minimal impacts to plant operations due to the shallow water depths and slow water velocities. The licensee concluded that other associated effects, including sediment deposition and erosion, concurrent site conditions, and effects on groundwater intrusion are insignificant at the plant site. The licensee estimated the water depths and velocities using a two-dimensional numerical modeling method as described in the D.C. Cook FHRR. The NRC staff reviewed the LIP modeling and concluded that the modeling approach used present-day methodologies and regulatory guidance. The NRC staff determined that the licensee's assessment of the AE parameters for the LIP flood-causing mechanism are acceptable for use in the D.C. Cook MSA.

The NRC staff determined that the licensee-provided AE parameters for the LIP flood-causing mechanism are acceptable as the approach to estimate these parameters is consistent with the guideline provided by Appendix G of NEI 12-06, Revision 2 (NEI, 2015b).

4.4 Conclusion

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

5.0 CONCLUSION

The NRC staff has reviewed the information provided for the reevaluated flood-causing mechanisms for the D.C. Cook site. Based on its review of available information provided the licensee's 50.54(f) response (IMP, 2015b; 2016b), 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 the reevaluated flood hazard results for the LIP flood-causing mechanisms is not bounded by the CDB flood hazard; additional assessments of plant response will be performed for the LIP flood-causing mechanisms; and the reevaluated flood-causing mechanism information is appropriate input to the additional assessments of plant response as described in the 50.54(f) letter and COMSECY-15-0019.

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

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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http://www.lre.usace.army.mil/Missions/GreatLakesInformation/GreatLakesWaterLevels/HistoricalData.aspx

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WMO, 1998, Guide to Wave Analysis and Forecasting (2nd edition), World Meteorological Organization, WMO-No. 702.

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

Flood-Causing Mechanism	SRP Section(s) and 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

Notes:

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

Table 3.1-1 - Summary of Controlling Flood-Causing Mechanisms

Reevaluated Flood-Causing Mechanisms and Associated Effects that May Exceed the Powerblock Elevation, (594.6 ft. NGVD29)[1]	ELEVATION, ft. NGVD29
Local Intense Precipitation and Associated Drainage	
CL 1: 1-DR-TUR201 (Turbine Building Unit 1 West Rollup Door)	594.8
CL2: 2-DR-TUR220 (Turbine Building Unit 2 West Rollup Door)	596.0
CL3: 2-DR-TUR260 (Turbine Building Unit 2 East Rollup Door)	609.2
CL4: Valve-Shed RWST 1-TK-33	609.9
CL5: Valve-Shed PWST/CST 1	609.9
CL6: Valve-Shed RWST 2-TK-33	609.5
CL7: Valve-Shed PWST/CST 2	609.6
CL8: Supplemental DGs	609.6
CL9: 1-DR-TUR253 (Turbine Building Unit 1 East Rollup Door)	609.8
CL10: 12-DR-AUX381 (Auxiliary Building North Rollup Door)	609.9

[1]Flood height and associated effects as defined in JLD-ISG-2012-05, Guidance for Performing the Integrated Assessment for External Flooding" (NRC, 2012d).

Table 3.1-2 - Current Design Basis Flood Hazards

Flooding Mechanism	Stillwater Elevation, ft. NGVD29	Associated Effects ft.	Current Design Basis Flood (CDB) Elevation, ft. NGVD29	Reference
Local Intense Precipitation and Associated Drainage	Not included in CDB	Not included in CDB	Not included in CDB	FHRR Table 4-1
Streams and Rivers	Not included in CDB	Not included in CDB	Not included in CDB	FHRR Table 4-1
Failure of Dams and Onsite Water Control/Storage Structures	Not included in CDB	Not included in CDB	Not included in CDB	FHRR Table 4-1
Storm Surge	Not included in CDB	Not included in CDB	Not included in CDB	FHRR Table 4-1
Storm Surge at Screenwell	Not included in CDB	Not included in CDB	Not included in CDB	FHRR Table 4-1
Seiche	594.6	Not included in CDB	594.6	FHRR Table 4-
Tsunami	Not included in CDB	Not included in CDB	Not included in CDB	FHRR Table 4-1
Ice-Induced	Not included in CDB	Not included in CDB	Not included in CDB	FHRR Table 4-1
Channel Migrations or Diversions	Not included in CDB	Not included in CDB	Not included in CDB	FHRR Table 4-1

Source: IMP (2015a; 2016a), NRC (2015c)

Table 4.1-1 - Reevaluated Hazard Elevations for Flood-Causing Mechanisms Not Bounded by the CDB

Flood-Causing Mechanism	Stillwater Elevation (ft. NGVD29)	Waves/Run-up	Reevaluated Hazard Elevation (ft. NGVD29)	Reference
Local Intense Precipitation and Associated Drainage				
CL 1: 1-DR-TUR201 (Turbine Building Unit 1 West Rollup Door)	594.8	Minimal	594.8	FHRR Table 3-2
CL2: 2-DR-TUR220 (Turbine Building Unit 2 West Rollup Door)	596.0	Minimal	596.0	FHRR Table 3-2
CL3: 2-DR-TUR260 (Turbine Building Unit 2 East Rollup Door)	609.2	Minimal	609.2	FHRR Table 3-2
CL4: Valve-Shed RWST 1-TK-33	609.9	Minimal	609.9	FHRR Table 3-2
CL5: Valve-Shed PWST/CST 1	609.9	Minimal	609.9	FHRR Table 3-2
CL6: Valve-Shed RWST 2-TK-33	609.5	Minimal	609.5	FHRR Table 3-2
CL7: Valve-Shed PWST/CST 2	609.6	Minimal	609.6	FHRR Table 3-2
CL8: Supplemental DGs	609.6	Minimal	609.6	FHRR Table 3-2
CL9: 1-DR-TUR253 (Turbine Building Unit 1 East Rollup Door)	609.8	Minimal	609.8	FHRR Table 3-2
CL10: 12-DR-AUX381 (Auxiliary Building North Rollup Door)	609.9	Minimal	609.9	FHRR Table 3-2

Source: AEP (2015) NRC (2015c)

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

Table 4.1-2 - Reevaluated Hazard Elevations for Flood-Causing Mechanisms Not Bounded by the CDB: LIP Flood Elevations at Eight Additional Locations Identified in the MSA report (IMP, 2016b)

Flood-Causing Mechanism	Stillwater Elevation (ft. NGVD29)	Waves/Run-up	Reevaluated Hazard Elevation (ft. NGVD29)	Reference
Local Intense Precipitation and Associated Drainage				
ML11: Service Building Extension Northwest	606.4	Minimal	606.4	MSA Table 7-1
ML12: Service Building Annex Northeast	609.0	Minimal	609.0	MSA Table 7-1
ML13: Service Building Annex Southeast	609.7	Minimal	609.7	MSA Table 7-1
ML14: Top of Ramp for CL2, 2-DR-TUR220	595.9	Minimal	595.9	MSA Table 7-1
ML15: Bottom of Ramp for CL2, 2-DR TUR220	596.0	Minimal	596.0	MSA Table 7-1
ML16: Low Point in Primary Plant Access Road used for FLEX Deployment	601.8	Minimal	601.8	MSA Table 7-1
ML17: Service Building Extension Northeast Corner	608.0	Minimal	608.0	MSA Table 7-1
ML18: Auxiliary Building Track Bay East Wall	609.8	Minimal	609.8	MSA Table 7-1

Source: from D.C. Cook MSA, Table 7-1 (IMP, 2016b)

Table 4.2-1 - Flood Event Duration for Flood-Causing Mechanisms Not Bounded by the 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 [(1)]	Use NEI 15-05 Guide (NEI, 2015a)	2 to 7 hours	Up to 3 days

Notes: from D.C. Cook MSA (IMP, 2016b)

1. The licensee has the option to use NEI guideline 15-05 (NEI, 2015a) to estimate the warning time necessary for flood preparation.

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

Associated Effects Factor	Local Intense Precipitation[1]
Hydrodynamic loading at plant grade	Minimal
Debris loading at plant grade	Minimal
Sediment loading at plant grade	Minimal
Sediment deposition and erosion	Minimal
Concurrent Conditions, including adverse weather	Minimal
Groundwater ingress	Minimal
Other pertinent factors (e.g., waterborne projectiles)	Minimal

[1]Information provided in MSA Table 7-3 (IMP, 2016b)

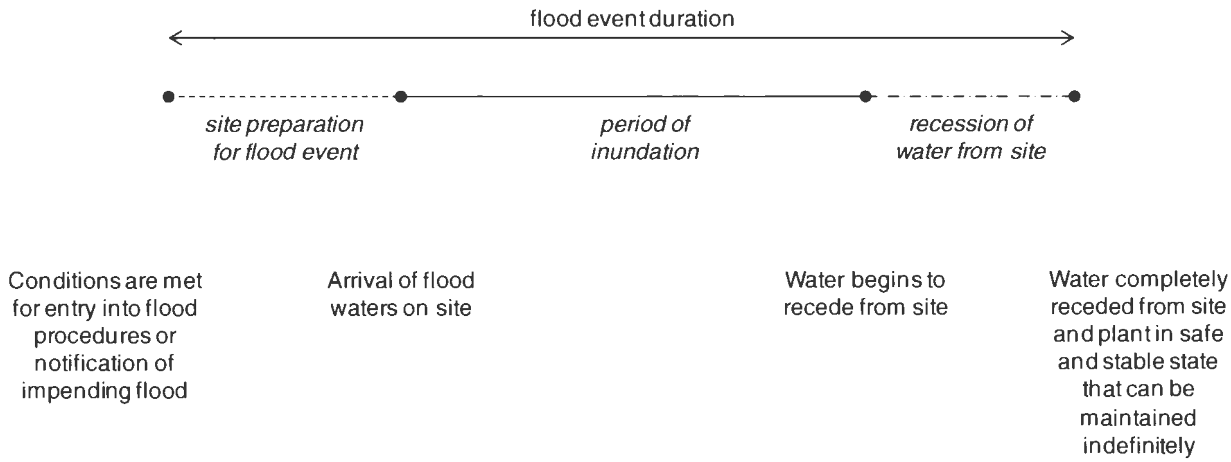

Figure 2.2-1 - Flood Event Duration (NRC JLD-ISG-2012-05, Figure 6)

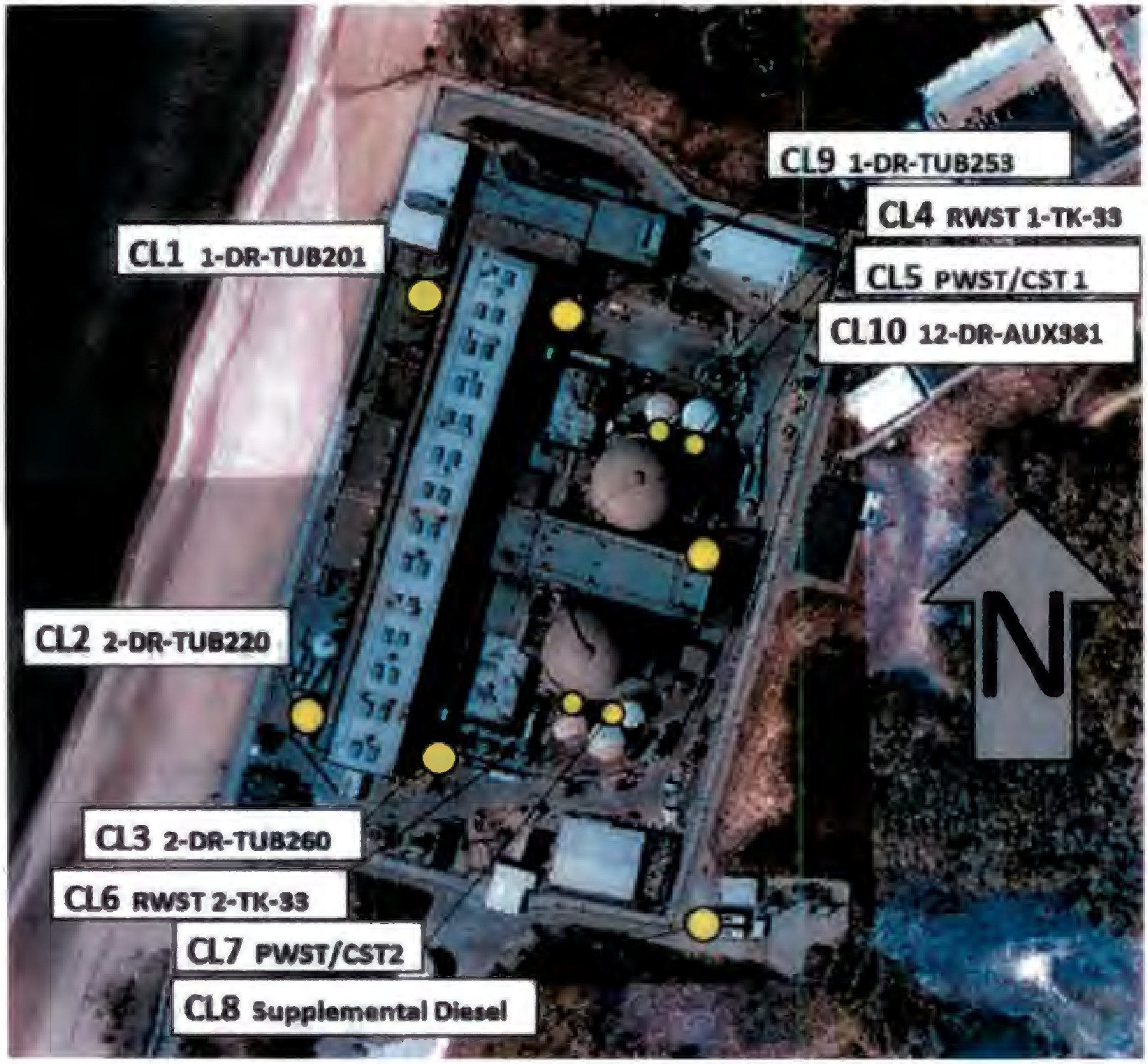

Figure 3.2-1 – D.C. Cook site critical monitoring locations selected for LIP flood analysis (from D.C. Cook FHRR, Figure 3-4 (IMP, 2015b))

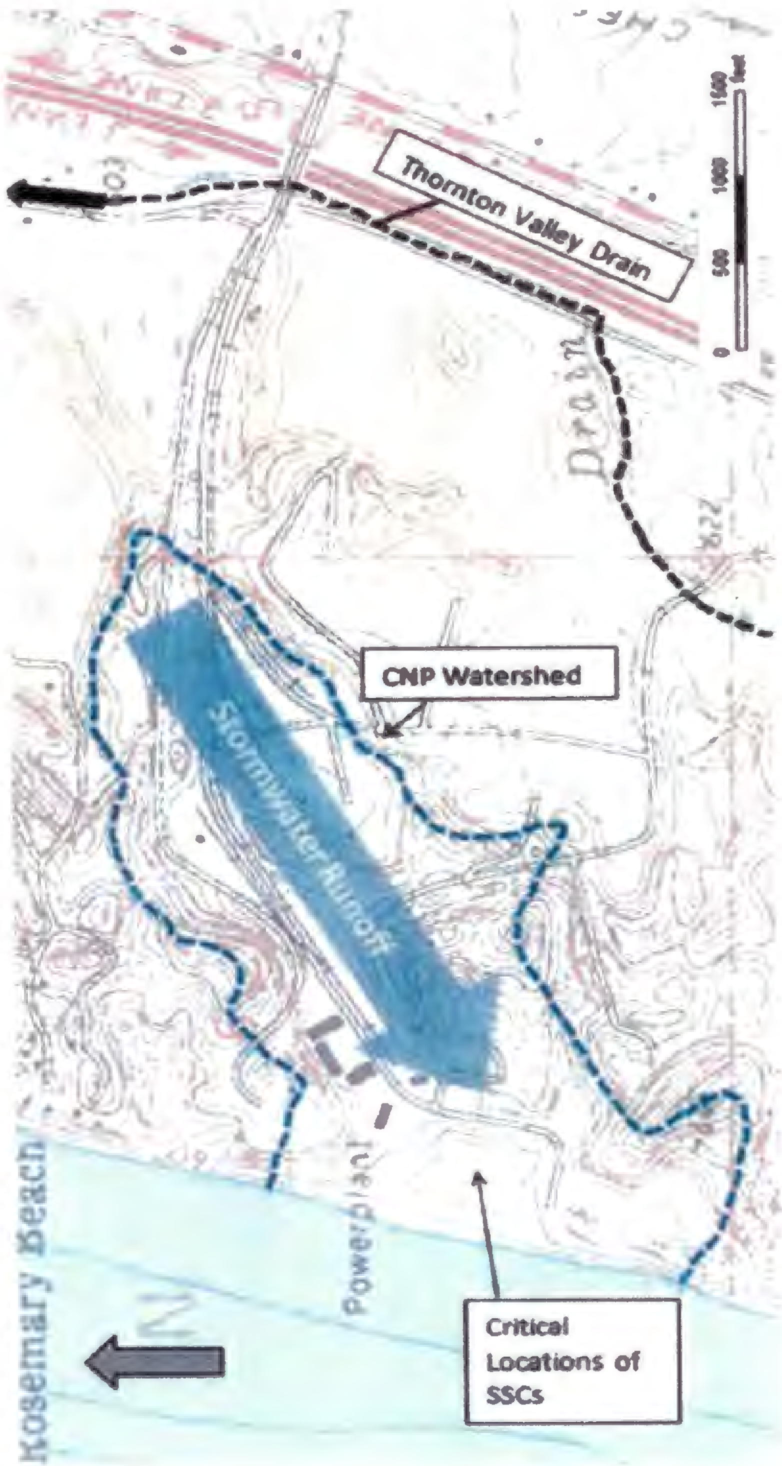

Figure 3.3-1 - Watershed draining to CNP critical locations taken from the D.C. Cook FHRR Figure 3-5 (IMP, 2016a))

DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2– STAFF ASSESSMENT OF RESPONSE TO 10 CFR 50.54(f) INFORMATION REQUEST – FLOOD-CAUSING MECHANISM REEVALUATION DATED JULY 25, 2017

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