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

November 18, 2016

Mr. Bryan C. Hanson
President and Chief Nuclear Officer
Exelon Generation Company, LLC
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: R. E. GINNA NUCLEAR POWER PLANT – STAFF ASSESSMENT OF RESPONSE TO 10 CFR 50.54(f) INFORMATION REQUEST – FLOOD-CAUSING MECHANISM REEVALUATION (CAC NO. MF6098)

Dear Mr. Hanson:

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 March 11, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15072A009), Constellation Nuclear Energy Group, LLC (the licensee) responded to this request for R. E. Ginna Nuclear Power Plant (Ginna).

By letter dated December 4, 2015 (ADAMS Accession No. ML15334A453), the NRC staff sent the licensee a summary of its review of Ginna'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 (LIP) and streams and rivers reevaluated flood hazard mechanisms at Ginna are not bounded by the plant's current design-basis, 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 the streams and rivers flood-causing mechanism, the NRC staff anticipates that the licensee will submit (1) an integrated assessment or (2) a focused evaluation confirming the capability of existing flood protection or describing new flood protection capabilities for this mechanism.

This staff assessment closes out the NRC's efforts associated with CAC No. MF6098.

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
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No. 50-244

Enclosure:
Staff Assessment of Flood Hazard
Reevaluation Report

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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

R. E. GINNA NUCLEAR POWER PLANT

DOCKET NO. 50-244

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), "Conditions of Licenses" (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, 2011b). 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 operating licenses (COLs). The required response section of Enclosure 2 specified that NRC staff would provide a prioritization plan indicating the 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 March 11, 2015 (CENG, 2015), Exelon Generation Company, LLC (Exelon, the licensee), doing business as Constellation Nuclear Energy Group, LLC (CENG), provided its FHRR for R. E. Ginna Nuclear Power Plant (Ginna). The NRC staff conducted a site audit with the licensee on August 27, 2015. The licensee provided responses to information requests made by NRC staff during the audit (Exelon, 2015). The NRC staff issued an audit summary report summarizing additional information obtained during this audit (NRC, 2016b).

By letter dated December 4, 2015, the NRC 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 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, the reevaluated flood hazard results for the local intense precipitation (LIP) and streams and rivers flood-causing mechanisms are 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, 2015b; NRC, 2016b), the NRC staff anticipates that for LIP, the licensee will perform and document a focused evaluation 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. For the streams and rivers flood-causing mechanism, the NRC staff anticipates that the licensee will submit (1) a revised integrated assessment or (2) a focused evaluation confirming the capability of existing flood protection or describing new flood protection capabilities for this mechanism consistent with the process outlined in COMSECY-15-0019 (NRC, 2015b).

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 flood-related associated effects (AE) parameters. These parameters will be used to conduct the mitigating strategies assessment (MSA) and focused evaluations or revised 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 final safety analysis report. 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 that the licensee should consider, and the corresponding Standard Review Plan (SRP) (NRC, 2007) sections 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 run-up 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 Effect 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." 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.

2.2.5 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.

- 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 are 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).

3.0 <u>TECHNICAL EVALUATION</u>

The NRC staff reviewed the information provided for the reevaluation of the Ginna site. 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 Ginna FHRR, the licensee made calculation packages available to the staff via an electronic reading room. When the NRC staff relied directly on some of these calculation packages in its review, they or portions thereof were docketed. Certain other calculation packages were found only to expand upon and clarify the information provided on the docket, and so are not docketed or cited.

The Ginna FHRR describes the site-specific information related to the flood hazard reevaluation. The licensee used National Geodetic Vertical Datum 1929 (NGVD29) for elevations in the Ginna FHRR (CENG, 2015). All elevations in this NRC staff assessment are relative to NGVD29.

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 Ginna FHRR. The NRC staff reviewed and summarized this information as follows in the sections below.

3.1.1 Detailed Site Information

The Ginna site, is located in Wayne County, New York, approximately 15 mi (24 km) east of Rochester, New York and approximately 40 mi (64 km) west of Oswego, New York. The Nine Mile Point Nuclear Station, Units 1 and 2 (NMP) site is located about 50 mi (80 km) east of the Ginna site. The licensee stated that the Ginna Site is within the same hydroclimatic setting as the NMP site. It is bordered on the south and east by Deer Creek and Mill Creek. Deer Creek and Mill Creek converge immediately south of the Ginna site. In the Ginna FHRR, Section 1.2.1, the licensee adopted the convention that the combined stream reach is called Deer Creek, although other sources refer to this as Mill Creek. Deer Creek drains into Lake Ontario immediately east of the Ginna site. The Ginna site is located within the combined Deer Creek and Mill Creek watersheds (Figure 3.1-3); the Deer Creek, Mill Creek, and combined watershed areas are approximately 3.7 mi^2 (9.6 km^2), 10.8 mi^2 (28.0 km^2), and 14.5 mi^2 (38.1 km^2), respectively (CENG, 2015).

The site grade at the powerblock (the reactor containment building, auxiliary building, turbine building, and related smaller structures) is elevation 270.0 ft (82.30 m) NGVD29 (CENG, 2015). Table 3.1-1 provides the summary of controlling reevaluated flood-causing mechanisms, including associated effects, which the licensee computed to be higher than the powerblock elevation. Ginna site features locations are shown in Figure 3.1-1.

3.1.2 Design Basis Flood Hazards

The CDB flood levels for Ginna are summarized by flood-causing mechanism in Table 3.1-2. Based on NRC staff's discussions during the audit with CENG, the licensee indicated that the current licensing basis (CLB) and CDB are equivalent (Exelon, 2015 and NRC, 2016b). The licensee presented CDB flood level information in the Ginna FHRR, Section 1.3, Table 2.2-6 and Section 3.1. 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 (NRC, 2012a).

3.1.3 Flood-Related Changes to the Licensing Basis

The licensee noted in the Ginna FHRR that there have been no flood-related changes or changes to flood protection measures beyond the flood protection measures in place for the CDB (CENG, 2011; CENG, 2012). The NRC staff reviewed the information provided and determined that sufficient information on the flood-related changes to the licensing basis was provided to be responsive to Enclosure 2 of the 50.54(f) letter (NRC, 2012a).

3.1.4 Changes to the Watershed and Local Area

In the Ginna FHRR, Section 1.6, the licensee states that there have been minimal changes to the local site topography and configuration of current structures at the Ginna site since the plant operations began in 1970 (CENG, 2011; NRC, 2000a; NRC, 2000b). The licensee incorporated the location and configuration of all current structures into the reevaluation of the hydrology as described in the Ginna FHRR.

The licensee also stated in the Ginna FHRR that a change was proposed in 2011 to regulate the surface water elevation in Lake Ontario to a more consistent level. The effect of this change is discussed in Section 3.5 of this staff assessment. The licensee did not identify any other watershed changes since Revision 23 to the Ginna's Updated Final Safety Analysis Report (UFSAR) (CENG, 2011).

3.1.5 Current Licensing Basis Flood Protection and Pertinent Flood Mitigation Features

In the Ginna FHRR, the licensee stated that there are no changes either to the licensing basis flood elevations or to flood protection design features. The licensee also stated that the Ginna site is protected from Lake Ontario flooding by a revetment with a top elevation of 261.0 ft (79.55 m) NGVD29. The NRC staff reviewed the information provided in the Ginna FHRR 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

The licensee made available for review electronic copies of the input/output files for the computer models and calculation packages used in connection with the flood hazard reevaluations. 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 (NRC, 2012a).

3.1.7 Results of Plant Walkdown Activities

The 50.54(f) letter requested that licensees perform a plant walkdown to verify that current flood protection systems were 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 plant walkdown activities.

By letter dated November 27, 2012 (CENG, 2012), the licensee provided the requisite flood walkdown report for the Ginna site. The NRC staff prepared a staff assessment report, dated June 16, 2014 (NRC, 2014a), to document its review of that report. The NRC staff concluded that the licensee's flooding walkdown methodology met the intent of the 50.54(f) letter.

3.2 <u>Local Intense Precipitation</u>

The licensee reported in the Ginna FHRR that the reevaluated flood hazard for LIP results in a stillwater-surface elevation ranging from 255.8 ft (77.97 m) NGVD29 at the turbine building, screen house, and diesel generator building, to 270.9 ft (82.57 m) NGVD29 at the reactor containment and control buildings (Figure 3.1-1) (CENG, 2015). Wind wave and runup effects were determined to be minimal. The reevaluated LIP flood hazards at all locations are shown in Table 3.2-1.

This flood-causing mechanism is discussed in the licensee's CDB. The CDB probable maximum flood elevation for LIP is based on a stillwater-surface elevation of 254.5 ft (77.57 m) NGVD29 near the screen house. Wind wave and runup effects were evaluated, and determined to be minimal as part of the CDB analysis.

The licensee described the use of the hierarchical hazard assessment (HHA) approach to the LIP hazard at the Ginna site. The licensee used FLO-2D (Version 2012.02 Professional) to estimate LIP hazards (CENG, 2015). The licensee developed LIP parameters based on National Weather Service hydrometerological reports (HMR) 51 and 52 (HMR 51 and HMR 52) (NOAA, 1978; NOAA, 1980) resulting in a 1-h, 1-mi^2 probable maximum precipitation (PMP) total depth of 16 inches (40.6 cm) and 22.4 inches (56.9 cm) for the 6-h PMP. The licensee used a front-loading precipitation distribution (5.4 inches (13.7 cm) in the first 5 minutes) to evaluate the PMP. The licensee developed a 6-h PMP hydrograph, leading with the 1-h PMP during the first hour, and a uniform precipitation rate for the 5 hours that followed. The licensee conservatively assumed no infiltration or other losses during the LIP event.

The licensee's FLO-2D model was developed using a 30 ft by 30 ft (9.1 m by 9.1 m) computational grid. The licensee surveyed land elevations to configure the model topography. The licensee assigned land surface roughness parameters according to land cover categorization and FLO-2D guidance. The licensee manually incorporated buildings into the model through direct grid cell elevation specification and attempted to make the adjustments to ensure that general runoff directions were considered. The licensee identified three channel segments within the FLO-2D model grid: (1) Deer Creek, (2) Mill Creek, and (3) the Discharge Canal (Figure 3.1-1). A single outlet pathway was configured for the model for each channel that allowed for discharge to the Lake Ontario portion of the model grid. The licensee designed the model channels with a normal flow condition. The licensee noted that such a condition aided in achieving a stable model and reduced mass conservation errors. The licensee's model configuration is based on the assumption of complete blockage of the Driveway Bridge and the culverts on the Ginna Access Road (Figure 3.1-1). The FLO-2D simulations indicated peak water surface elevations at safety-related SSCs ranging from 255.8 ft (77.97 m) NGVD29 to 270.9 ft (82.57 m) NGVD29.

The NRC staff reviewed the licensee's PMP determination, LIP model development, LIP model parameters and input, and LIP model results. During the audit, the NRC staff requested that the licensee clarify the difference between the 6-h PMP values of 22.4 inches (56.9 cm) used in the FLO-2D model and 23.5 inches (59.7 cm) reported in the Ginna FHRR as being based on HMR-51 (NRC, 2016b). The licensee acknowledged the difference in the 6-h precipitation depths and demonstrated that there was a small difference in LIP model simulation results in maximum flow depths (less than 0.1 ft (0.03 m)) and maximum flow velocity (less than 0.1 ft/s (0.03 m/s)) at structure locations reported in the Ginna FHRR (NRC, 2016b). The NRC staff independently performed the FLO-2D model run using the HMR-51 6-h PMP value and confirmed the licensee's conclusion that the maximum water surface elevations (WSEs) at critical locations provided in the Ginna FHRR are reasonable. While the Ginna FHRR results are based on a different 6-h PMP precipitation total than what was derived from the HMR-51, the NRC staff determined that the results of these differences were insignificant.

The NRC staff examined the model input files and found that the grid elevations are used correctly in the FLO-2D model. Elevation data collected from different sources were converted to a single datum to make the elevation data consistent. Based on the computational watershed boundary and the level of the flood discharge it can produce, the selected model grid size is reasonable and able to capture the spatial variability of flood depth at the site.

The NRC staff reviewed the Manning's n values created by the licensee's application of the FLO-2D software. The NRC staff plotted them in a geographical information system to verify whether n values are assigned correctly. The NRC staff noticed that the n values (0.08) in several grid elements representing forested areas along Mill Creek and Deer Creek and the east side of the plant are much lower than those recommended in the FLO-2D manual. The NRC staff ran the model with the licensee's original n value of 0.08 in forested areas, and then ran a modified model with a modified n value of 0.4 for those forested areas and compared the two models' results for maximum water depths at critical grid elements. The NRC staff found the difference in results was not significant, and the minimal difference in maximum water depth between the two models (original and revised "n" values) indicates that the model results are not sensitive to the Manning's n coefficient.

The NRC staff reviewed the topography used in the LIP model and determined that site channels were correctly represented. The NRC staff independently reviewed the model locations of the buildings and determined that the locations were consistent with those apparent in the image used by Google Earth (Google, n.d.). The NRC staff reviewed other numerical parameters controlling model stability and those use to calculate and identify maximum WSE, velocities, and hydrodynamic pressures under the 6-h PMP. The NRC staff determined that the FLO-2D model was run in a manner consistent with the FLO-2D Data Input and Pocket Guide (FLO-2D, n.d.).

The NRC staff reviewed the licensee's methodology for representing building structures obstructing flow and calculation of runoff from building rooftops in the LIP model which the licensee accomplished by amending the model topography to account for the presence of buildings. The NRC staff concluded that these representations were incorporated by the licensee in a manner consistent with Section 11.4 of ANSI/ANS 2.8-1992 (ANSI/ANS, 1992), but that the approach was not the standard for FLO-2D applications. The NRC staff noted that compared to the standard FLO-2D approach for incorporating the presence of buildings, the licensee's approach with raised heights of grid elements to represent buildings could potentially store more water on buildings' rooftops, reducing the overland flow on the site. The NRC staff performed a FLO-2D model simulation independently using the standard approach and compared the two models results. The NRC staff's results did not show a significant difference in maximum WSEs or water depths at critical locations between the two models.

The NRC staff verified that FLO-2D simulated values of maximum LIP flood elevations at the Ginna site range from 255.8 ft (77.97 m) near the screen house to 270.9 ft (82.97 m) NGVD29 at the reactor containment and control buildings, and that these values are consistent with those documented in the Ginna FHRR (CENG, 2015) and relevant calculation packages.

The NRC staff confirmed that the licensee's reevaluation of the hazard from LIP and associated drainage used present-day methodologies and regulatory guidance. The NRC staff also confirmed the licensee's conclusion that the reevaluated flood hazard for LIP is not bounded by the CDB flood hazard. Therefore, the NRC staff expects that the licensee will submit a focused evaluation consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015c).

3.3 Streams and Rivers

The licensee reported in the Ginna FHRR that the reevaluated flood hazard for streams and rivers results in a peak stillwater-surface elevation that range from 258.2 ft (78.70 m) NGVD29 at the turbine building, where wind waves and runup are not applicable, to 258.2 ft (78.70 m) NGVD29 at the screen house, where wave effects are applicable, to 273.5 ft (83.36 m) NGVD29 at the proposed standby feedwater pump building annex, where wind waves and runup results in an elevation of 274.4 ft (83.64 m) NGVD29. A summary table of peak WSEs for all controlling scenarios, which are described in the section below, is provided in Table 3.3-1. Bold values in this table represent values provided in the ISR letter (NRC, 2015b). Building locations are shown in Figure 3.1-1.

The streams and rivers flood-causing mechanism is discussed in the licensee's CDB. The CDB probable maximum flood elevation for streams and rivers is based on stillwater-surface elevations that range from 256.6 ft (78.21 m) NGVD29 at the turbine building, screen house, and diesel generator building, to 273.8 ft (83.45 m) NGVD29 at the auxiliary building. A summary of CDB flood elevations is provided in Table 3.1-2.

3.3.1 Probable Maximum Precipitation

The licensee derived 72-h cool season and all-season PMPs using the HMR 52 software (BOSS, 1988), which uses the algorithms developed based on the two publications, HMR 51 and HMR 52 (NOAA, 1978; 1982). The all-season PMP was the controlling mechanism for flooding and was used in the analysis. As a composite rainfall input to a hydrological model for stream flow analysis, the licensee incorporated an antecedent, 72-h rainfall with 40 percent of the PMP and 72-h no rainfall followed by the 72-h PMP. As stated in its FHRR, the licensee applied a central temporal distribution for the 72-h PMP in the hydrologic model. The licensee also performed an additional model run with an end temporal distribution of the PMP to examine the sensitivity of peak streamflow to PMP temporal distributions. The licensee demonstrated that the peak flow at the Ginna site is not sensitive to the PMP temporal distribution (NRC, 2016b). The NRC staff reviewed the PMP analysis and concludes that the analysis is reasonable and consistent with present-day methodologies and guidance.

3.3.2 Probable Maximum Flood

To calculate the probable maximum flood (PMF) for the streams near the Ginna site, the licensee constructed a hydrological model using Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) from the U.S. Army Corps of Engineers (USACE, 2010) for stream flow analysis, including two watersheds (Deer Creek and Mill Creek) that contribute to potential flooding at the site. The licensee assumed no initial loss and no base flow, and selected a Soil Conservation Service (SCS) unit hydrograph (UH) method in the HEC-HMS model to generate stream flows. The licensee estimated SCS UH parameters considering sheet flow, shallow concentrated flow, and open channel flow using the equations in the

National Engineering Handbook part 630 from the U.S. Department of Agriculture (USDA, 2007). To estimate the infiltration loss, the licensee calculated curve number values based on soil type and a composite land use and further adjusted them for an antecedent wet condition. The composite land use was area-weighted from 15 land use categories within each watershed. The NRC staff reviewed the licensee's model and concludes that the watershed boundaries are identified correctly, and the model assumptions and methods used to estimate the model parameters are reasonable based on present-day guidance and methodology.

To account for the effect of nonlinear basin response to the PMF, the licensee modified the calibrated model by increasing peak flow by 20 percent and reducing the time to peak by 33 percent, as recommended in NUREG/CR-7046 (NRC, 2011e). The computed PMF after nonlinear adjustment at Deer Creek near the site is 28,460 ft^3/s (805.4 m^3/s), combining flows from both the Deer Creek and Mill Creek watersheds. The licensee rounded the PMF peak flow to 28,500 ft^3/s (806.6 m^3/s), which is greater than the peak flow of 26,000 ft^3/s (735.8 m^3/s) in the CDB but less than the peak flow (38,700 ft^3/s (1,095.2 m^3/s)) estimated in the previous study in 1982 (CENG, 2015). The licensee described their improvement in the PMF calculation by using more detailed watershed information to estimate UH parameters compared to the previous study in 1982 (Exelon, 2015). The NRC staff agrees that the licensee's approach is consistent with the methodology outlined in NUREG/CR-7046 (NRC, 2011e).

3.3.3 PMF Water Surface Elevations

The licensee constructed a two-dimensional hydraulic model with FLO-2D PRO software to compute the maximum WSEs at the Ginna site due to the PMF in Deer Creek. Key model assumptions include no runoff loss, completely blocked drainage system components, and exclusion of functionally-active security barriers that re-direct the overland flow away from the site during the PMF event.

The FLO-2D model domain, boundary, grid size, and surface topography used in the PMF analysis were the same as those used in the LIP analysis. Details regarding staff's review of this model are discussed in Section 3.2. The segments of Mill Creek and Deer Creek that are incorporated in the model contribute flow from the two watersheds to the power plant area under the PMF event. The PMF hydrographs for Mill Creek and Deer Creek were added as channel inflows to the uppermost gradient channel grid elements of Mill Creek and Deer Creek near the model boundary.

The NRC staff determined that the licensee reasonably assigned the area reduction factors and width reduction factors in FLO-2D for grid elements representing buildings to obstruct the overland flow and to simulate runoff from the building rooftops to the ground. Small trailers, small storage containers, and likely movable objects are not included as obstructions in the model, which staff found to be a reasonable assumption for this application.

The licensee determined the land cover types based on the land use classes defined by National Land Cover Data 2006 (USGS, 2012) and then assigned the Manning's n roughness coefficient to each land cover type based on the FLO-2D Reference Manual (FLO-2D, 2012). The NRC staff viewed the plant site in available aerial imagery and noted that the roughness parameters selected by the licensee were best estimates based on the ground cover. During an audit conducted on August 27, 2015, the licensee described their rationale for selecting the roughness values (Exelon, 2015). The NRC staff reviewed the licensee's response and evaluated the roughness using the NRC staff's independently determined best-estimate values as part of a sensitivity test. The NRC staff's results produced WSE values that were higher than the licensee's results. However, when the NRC staff's results were compared to the CDB at each building, the classification of bounded or not bounded remained the same for all but one building. In particular, the NRC staff's result for the standby auxiliary feedwater pump building was approximately 3 in (8 cm) higher than the CDB, which is within both the model error and the range of accuracy of the PMF analysis. Therefore, the NRC staff concludes that the licensee's roughness n values used in the FLO-2D model and presented in the FHRR are reasonable.

The reevaluated maximum PMF WSEs at the Ginna site using the FLO-2D model ranges from 258.1 ft (78.67 m) NGVD29 near the screen house to 273.5 ft (83.36 m) NGVD29 at the proposed standby auxiliary feedwater pump building annex. The maximum flood elevations at the critical locations of reactor containment building, turbine building, control building, screen house and diesel generator building are not bounded by, or not included in, the CDB. At other critical locations of the site, the flood elevations due to the PMF are bounded by the CDB as show in Table 3.3-1.

3.3.4 PMF Flooding Combined with Storm Surge and Other Effects

The licensee described combined effects scenarios which included the PMF with storm surge and other flooding mechanisms. In particular, the licensee identified two combined effects scenarios which were determined to be unbounded by the CDB flood elevation. These scenarios were designated by the licensee as scenarios H.1 and H.4.2. A summary table of peak WSEs for these scenarios is provided in Table 3.3-1.

3.3.4.1 Scenario H.1: Deer Creek PMF with Critical Wind Speed and Direction

This scenario combines the PMF on Deer and Mill creeks along with the maximum wind-generated effects in Deer Creek to investigate potential flooding along the southern end of the site. This scenario was combined with a 25-year storm surge, wind waves, and the maximum controlled water level in Lake Ontario.

First, the licensee evaluated the potential for wind-generated effects at the Ginna site by determining the greatest straight-line fetch for buildings exposed to PMF floods. Using a 2-year return period wind speed, the licensee applied the CEDAS-ACES software Version 4.03 (CENG, 2015, Enclosure 3; Veri-Tech, 2016) to calculate wind-wave parameters (height and period) and wave runup. The NRC staff confirmed that the licensee's value for the 2-year wind speed for Rochester was reasonable using information from the National Institute of Standard Technology (NIST) (NIST, 2015). The licensee then added wave runup to the PMF stillwater elevation in Deer Creek for the portion of the Ginna site exposed (i.e., the southern end of the site) to PMF flooding (CENG, 2015, Enclosure 3).

The licensee calculated a wave height of 0.7 ft (0.23 m) and wave period of 1.21 seconds (CENG 2015, Enclosure 4). The licensee used the wave height and period, nearshore slope of 0.025, and water depth of 5.2 ft (1.58 m) to compute the runup wave height (CENG, 2015, Enclosure 3). The licensee reported maximum wave runup at the southern end of the site during the Deer Creek PMF was 0.9 ft (0.27 m), which should be applied to the standby auxiliary feedwater pump building and its proposed annex building. Wave runup elevations along the south wall of the auxiliary building ranged from 273.5 ft (83.36 m) NGVD29 to 275.3 ft (83.91 m) NGVD29 (CENG, 2015). Other locations were not sensitive to wave effects in Scenario H.1 (CENG, 2015).

The NRC staff reviewed figures in the Ginna FHRR and confirmed the nearshore water depth is consistent with that represented in the PMF flow model along the south edge of the proposed standby auxiliary feedwater building annex. The NRC staff compared the licensee's maximum straight-line fetch and maximum flood depth estimates, and verified that these were reasonably determined using information presented in the combined effects flood analysis (CENG, 2015, Enclosure 3). The NRC staff reviewed figures in the Ginna FHHR and determined that the ground slope in these areas was milder than what was used by the licensee in their CEDAS-ACES modeling by about 50 percent. The NRC staff used the licensee's value and the methods described in the USACE Shore Protection Manual (USACE, 2002) and confirmed the licensee's wave runup estimate. The staff decreased the ground slope used by the licensee by 50 percent and found that the wave runup decreased by less than 4 percent. The NRC staff confirmed that that the licensee's ground slope value was reasonable, and that the remaining values were reasonable and consistent with the reported values (CENG, 2015, Enclosure 3).

3.3.4.2 Scenario H.4.2, Alternatives 1, 2, and 3: Deer Creek PMF with Lake Ontario Surge

The licensee evaluated several precipitation-driven floods in Deer Creek in combination with storm surge from Lake Ontario and other effects. These alternatives consider wind waves and either the 100-yr or maximum controlled level in Lake Ontario. These alternatives also include dam failures; however, as the NRC staff noted in Section 3.4, this conservative assumption does not impact the flooding results at the site. The NRC staff also noted that peak flood elevations at the Ginna site for these alternatives are approximately the same as the Deer Creek PMF Scenario H.1.

The licensee determined that the 25-year Lake Ontario storm surge was 1.0 ft (0.29 m) based on analysis of hourly water levels recorded at Rochester, NY, during the period 1962 to 2012. The antecedent water surface elevation in Lake Ontario was set to equal the current maximum-controlled water level for Lake Ontario of 248.0 ft (75.59 m) NGVD29. The licensee used CEDAS-ACES to estimate wave runup overtopping flow rates along the shoreline revetment, assuming a stillwater level of 248.8 ft (75.83m) NGVD29 at the revetment toe. The stillwater level is used to compute the available freeboard in their estimation of wave runup overtopping flow rates. These overtopping flow rates are given per unit of revetment length (e.g., with units of $ft^3/s/ft$ or ft^2/s). The licensee divided the revetment into seven sections for their analysis. Six sections are treated as rough-impermeable structures and one (representing the discharge canal) portion is treated as a smooth-permeable structure. The licensee showed that the wave runup overtopping flow rate along the discharge canal section was two to three orders of magnitude larger per unit width than all other revetment sections.

The computed overtopping flow rates were smaller than 2 ft^3/s (0.06 m^3/s) for all but one segment of the revetment. The overtopping flow rate for this one revetment segment was 194.1 ft^3/s (5.49 m^3/s).

The NRC staff evaluated the sensitivity of the calculations to the amount of revetment section freeboard for both smooth- and rough-revetment cases. The NRC staff used standard methods described in the USACE Shore Projection Manual (USACE, 2002) and Douglass (1986) to evaluate the sensitivity for both rough- and smooth-impermeable revetment sections. The NRC staff found a 0.2-ft (0.06-m) decrease of the freeboard yielded a less than a 10 percent increase in wave runup overtopping rates associated the discharge canal. The NRC staff found larger increases in overtopping rates for other sections, but they were relatively insignificant when compared to that of the discharge canal section overtopping flow rates. The NRC staff concluded that at a 0.2-ft (0.06-m) level of uncertainty in the available freeboard, there was no indication that the licensee flood hazard estimates would be significantly changed.

3.3.5 Conclusion

The NRC staff reviewed the information provided by the licensee regarding the PMF analysis and confirms that the licensee's reevaluation of the hazard from flooding of streams and rivers used present-day methodologies and regulatory guidance. The NRC staff also confirmed the licensee's conclusion that the reevaluated hazard for flooding from streams and rivers is not bounded by the CDB flood hazard. Therefore, the NRC staff expects that the licensee will submit a focused evaluation for this hazard, including the identified combined events, confirming the capability of flood protection and available physical margin or a revised integrated assessment consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015a).

3.4 <u>Failure of Dams and Onsite Water Control/Storage Structures</u>

The licensee reported in the Ginna FHRR that the reevaluated hazard for failure of dams and onsite water control or storage structures does not inundate the plant site, but did not report a probable maximum flood elevation. This flood-causing mechanism is not discussed in the licensee's CDB.

The licensee evaluated the potential for dam failures to impact Lake Ontario and the potential for Ginna site flooding due to dam failures in the Deer Creek and Mill Creek watersheds. The licensee also considered combined effects flooding, including dam failures combined with Lake Ontario probable maximum storm surge (PMSS), Deer Creek PMF, and wind-wave effects. The combined effects flood results are discussed in Section 3.3 of this staff assessment. The licensee stated that the addition of dam failure flooding to the Deer Creek PMF scenario did not meaningfully impact results at the Ginna site.

The licensee stated that there are no onsite water control or storage structures above site grade that could contribute to flooding of safety-related SSCs due to their failure.

3.4.1 Dam Failure Effects on Lake Ontario Levels

The NRC staff noted that Lake Ontario receives about 80 percent of its inflow from Lake Erie and that there are no dams on the Niagara River which connect the two lakes (NRC, 2014b). The NRC staff identified the Robert Moses Niagara Power Plant more than 80 miles (129 km) to the southwest of the Ginna site that withdraws and discharges water from the Niagara River.

However, even uncontrolled releases from this facility, when compared to the volume of Lake Ontario, would not result in a meaningful rise in the lake level near the site.

The NRC staff also performed a bounding analysis of dam failure in the Oswego River basin as part of the Nine Mile Point review (NRC, 2014b). The NRC staff confirmed that dam failures could not meaningfully change the elevation of Lake Ontario.

3.4.2 Local Flooding from Deer Creek and Mill Creek Dam Failures

The licensee reevaluated the flood hazard associated with Deer Creek and Mill Creek with regard to sunny-day dam failures. The licensee used the New York State Inventory of Dams database (NYDEC, n.d.) to identify three dams within the Deer Creek and Mill Creek watersheds: Macinnes Marsh Dam, William Daly Marsh Dam, and Fruitland Mill Dam, as shown on Figure 3.1-3. The licensee obtained dam and reservoir characteristics for each of these dams in order to estimate a combined and unattenuated dam failure peak flow of about 1,698 ft^3/s (48.05 m^3/s). Calculated peak flow rates from failures of the three dams are provided in Table 3.4-1.

The NRC staff reviewed the licensee's analysis of sunny-day dam failure and confirmed that the three dams identified by the licensee are the only dams within the Deer Creek and Mill Creek watersheds that may affect the site. The NRC staff noted that the sunny-day dam failure peak flows as estimated by the licensee were consistent with those derived by staff using a peak flow estimation method (Pierce, Thornton, and Abt, 2010).

The total unattenuated peak flow from failure of the three dams, as calculated for Deer Creek downstream of the confluence of Deer Creek and Mill Creek, was about 1,698 ft^3/s (48.05 m^3/s). The staff compared this peak flow to the table showing the relation between flow rate and WSE (UniStar, 2008, Table 2.4-1) and reproduced as Table 3.4-2 in this staff assessment. The staff observed that the calculated peak flow is less than necessary to exceed the Ginna site grade.

3.4.3 Conclusion

The NRC staff confirmed the licensee's conclusion that the reevaluated hazard from flooding from failure of dams and onsite water control or storage structures does not impact the Ginna site. Therefore, the flooding from failure of dams and onsite water control structures does not need to be analyzed in a focused evaluation or integrated assessment.

3.5 <u>Storm Surge</u>

The licensee reported in the Ginna FHRR that the reevaluated flood hazard, including associated effects, for storm surge is based on a stillwater-surface elevation of 248.0 ft (75.59 m) NGVD29, and an elevation of 251.1 ft (76.54 m) NGVD29 including wind waves and runup. The combined effects of a Deer Creek PMF with Lake Ontario surge storm surge is considered in Section 3.3 of this staff assessment.

This flood-causing mechanism is discussed in the licensee's CDB. The CDB PMF elevation for storm surge is based on a stillwater-surface elevation of 253.3 ft (80.25 m) NGVD29, and an elevation of 260.9 ft (79.52 m) NGVD29 including wind waves and runup.

The licensee used the HHA approach to reevaluate the PMSS. The licensee analyzed 1-h and 6-min water level data to identify the historical storm with the highest wind speeds and storm surges and thus developed a design storm to characterize the PMSS. The licensee stated that it used ANSI/ANS-2.8-1992 (ANSI/ANS, 1992) guidance to determine the antecedent Lake Ontario WSE to initiate the calculation of the PMSS at the Ginna site. The licensee calculated the PMSS at the Ginna site based on the design storm and the antecedent water surface elevation as inputs to the Great Lakes Storm Surge Planning Program (SSPP) model (Schwab and Lynn, 1987).

The licensee used statistical analysis of historical wind speeds and storm surges to develop the design storm. The licensee developed the design storm wind speeds and track, based on a February 17, 2006, event, which had the highest wind speed and largest surge. The licensee scaled-up the wind speeds such that the maximum wind speed was 100 mph (161 km/h) and scaled down the atmospheric pressures such that the minimum pressure was 950 mbar.

The licensee selected the lesser of the 100-year and the maximum controlled WSE for Lake Ontario as the antecedent WSE based on NUREG/CR-7046 guidance (NRC, 2011e). The 100-year and regulated maximum WSEs of Lake Ontario were determined to be 249.1 ft (75.93 m) NGVD29 and 248.0 ft (75.59 m) NGVD29, respectively. Thus, the licensee used the regulated maximum WSE as the antecedent condition for the PMSS reevaluation.

The licensee used the SSPP model to predict a 3.2 ft (0.98 m) setup at the Ginna site associated with winds coming from W to WNW, which resulted in a total PMSS elevation of 251.1 ft (76.54 m) NGVD29 at the Ginna site. The licensee also examined the sensitivity of wind setup to a range of wind directions from west-southwest to north-northeast and found that the wind setup varied from 1.1 ft (0.34 m) to 3.2 ft (0.98 m).

The licensee considered the combined effect of the worst historic surge with wind-wave activity, using the highest historical surge observed at Rochester, which was 1.3 ft (0.40 m), with Lake Ontario at its regulated maximum WSE. This resulted in a Lake Ontario storm surge water level of 249.3 ft (75.99 m) NGVD29 at the Ginna site.

The NRC staff reviewed historical storm surges along the south shore of Lake Ontario based on records from Oswego and Rochester, NY (Zuzek, 2011) and NOAA data for Oswego, NY (NOAA station 9052030), and Rochester, NY (NOAA station 90520589 (NOAA, n.d.); and reviewed a compilation of the highest 10 recorded surges at Oswego, about 40 mi (64 km) east of the Ginna site (Zuzek, 2011). The NRC staff's review of the NOAA station data for Rochester showed that for the storms identified by Zuzek (2011), the surge elevations were in all cases lower at Rochester than those for Oswego. The largest surge height at Oswego in this compilation was 1.2 ft (0.36 m), substantially smaller than the licensee's estimated value of 3.2 ft (0.98 m) at the Ginna site. The NRC staff compared hourly water levels at Oswego and Rochester, and found that they differ by less than 1 ft (0.30 m).

The NRC staff also confirmed the results of the licensee's use of SSPP for both design storm and the wind-direction sensitivity tests that were reported in the FHRR Table 2.4-6. The NRC staff determined, through inspection of the SSPP documentation figure, that the location was the closest to the Ginna site where SSPP results are provided. The NRC staff found the surge elevations are equivalent to those reported by the licensee at the precision reported (i.e., 0.1 ft (0.03 m)).

In conclusion, the NRC staff considered the conservatism of licensee's estimate of surge, the sensitivity to wind direction, the correlation between the Oswego and Rochester historical records, and the confirmation of the SSPP model results. The NRC staff confirmed the licensee's conclusion that the reevaluated flood hazard for flooding from storm surge is bounded by the CDB. Therefore, flooding from storm surge does not need to be analyzed in a focused evaluation or an integrated assessment.

3.6 Seiche

The licensee reported in the Ginna FHRR that the reevaluated hazard for seiche does not inundate the plant site, but did not report a probable maximum flood elevation. This flood-causing mechanism is not discussed in the licensee's CDB. The licensee discussed in the Ginna FHRR the reevaluated seiche hazards associated with Lake Ontario and the Ginna Discharge Canal.

The licensee used the HHA approach described in NUREG/CR-7046 (NRC, 2011e) to determine whether a seiche in Lake Ontario could result in flooding of the Ginna site. First, the licensee determined the natural periods of Lake Ontario seiche modes. The licensee then performed a spectral analysis of historical WSEs in Lake Ontario to assess the relative strength of seiches, surges, tides, day-night cycles, seasonal to annual cycles, and regulation. Based on its review of available data, the licensee concluded that seiches at the primary period deflect to the northeast, away from the Ginna site, but that seiches at the secondary period deflect toward the Ginna site. However, the license further stated that because there is no resonance indicated at the second natural period and energy associated with second natural periods is less than half that associated with the primary natural period, the flooding hazard potential associated with seiche on Lake Ontario is negligible at the Ginna site. The NRC staff reviewed observational data of Lake Ontario water surface elevations (NOAA, 2013) and concur with the licensee's conclusion.

The license also considered the potential for seiche formation in the Ginna discharge canal. The licensee considered the generation of seiches in the canal from external sources (waves, astronomical, and earthquakes), but concluded that while wave periods were comparable to the natural period of the canal, the orientation of the landward canal wall was such that wave reflection would inhibit lateral seiches. The licensee concluded that the canal is protected from meteorological forcing, canal geometry is such that it provides protection from wave-induced seiche development, astronomical forcing is insignificant, and the maximum expected earthquake would not create a seiche hazard in the canal.

The NRC staff confirms the licensee's conclusion that the reevaluated hazard from flooding from seiche is bounded by the CDB. Therefore, flooding from seiches does not need to be analyzed in a focused evaluation or a revised integrated.

3.7 Tsunami

The licensee reported in the Ginna FHRR that the reevaluated flood hazard for tsunami is based on a stillwater-surface elevation of 250.2 ft (76.26 m) NGVD29. Including wind waves and runup results in an elevation of 259.2 ft (79.00 m) NGVD29. This flood-causing mechanism is not discussed in the licensee's CDB because the site is not subject to oceanic tsunamis (CENG, 2015).

In the Ginna FHRR, Section 2.6, the licensee stated that tsunami-induced flooding would not affect the safety-related SSCs due to the site's inland location. The licensee searched the Global Historical Tsunami Database (NOAA, n.d.) for events that occurred from 2000 BC to present in the Great Lakes region. The licensee eliminated events associated with meteorological events, and found that the largest tsunami within the geographic search area was 9 ft (2.7 m) in Lake Erie. In Lake Ontario, the largest increase in water level recorded in the Global Historical Tsunami Database was 5 ft (1.52 m) from a meteorological cause, rather than an earthquake-induced tsunami. The licensee concluded that significant tsunamis generated from seismic events were improbable at the Ginna site. The licensee considered submarine landslide-induced tsunami hazards at the Ginna site identifying two areas with steep bathymetry within Lake Ontario. However, the licensee determined that the Ginna site would be minimally affected by submarine landslides. The licensee identified one steep-gradient area rising about 280 ft (85.34 m) above the elevation of the lake, that could produce landslides and thus a tsunami. However, the licensee determined that such a tsunami would not be directed toward the Ginna site. Accordingly, the licensee concluded that there is a negligible risk from tsunamis, including wave runup, at the Ginna site.

The NRC staff verified that the maximum Lake Ontario WSE was reported to be 250.2 ft (76.26 m) NGVD29. The NRC staff reviewed the Global Historical Tsunami Database (NOAA, n. d.) and confirmed the licensee's conclusion the 9-ft tsunami was the largest in the database within an appropriately selected search region. The NRC staff noted that the licensee's reevaluated tsunami hazard elevation of 259.2 ft (79.00 m) NGVD29 is about 11 ft (3.35 m) below the Ginna site grade of 270.0 ft (82.30 m) NGVD29.

The NRC staff also noted that the tsunami hazard elevation calculated by the licensee was greater than that modeled by Lynett and Liu (2002) using COULWAVE (Cornell University Long and Intermediate Wave Modeling Package). Lynett and Liu estimated a maximum PMF water elevation in Lake Ontario of 256 ft (78.03 m) NGVD29, which is 14 ft (4.27 m) below the Ginna site grade of 270.0 ft (82.30 m) NGVD29.

The NRC staff confirmed the licensee's conclusion that the reevaluated hazard from flooding from tsunami does not impact the plant site. Therefore, flooding from a tsunami does not need to be analyzed in a focused evaluation or an integrated assessment.

3.8 Ice-Induced Flooding

The licensee reported in the Ginna FHRR that the reevaluated hazard for ice-induced flooding does not inundate the Ginna site, and did not report a probable maximum flood elevation (CENG, 2015). This flood-causing mechanism is discussed in the licensee's CDB, but no impact on the site was identified.

Due to the close proximity and same hydroclimatic setting of the Ginna and NMP sites, the licensee adopted the conclusions of the previous analysis done for NMP with regard to this flood-causing mechanism (CENG, 2015). The licensee noted that the mouths of the Genesee River and Allen Creek are more than 10 mi (16 km) (shoreline distance) from the Ginna site, and so ice jams on those water bodies would not lead to inundation of the Ginna site. The licensee screened out ice-induced flooding as a plausible flood-causing mechanism for the Ginna site.

The NRC staff evaluated the potential for ice-induced flooding from the Oswego and Saint Lawrence rivers in its staff assessment for flooding hazard at the NMP site (NRC, 2014b). The NRC staff independently searched the USACE Cold Regions Research and Engineering Laboratory Ice Jam database (USACE, n.d.-a) for all records of historical ice jams associated with Irondequoit-Ninemile Watershed (UGSS HUC# 04140101) within which the site is located and found no instances closer to the site than the one reported by the licensee in the Ginna FHRR. The NRC staff confirmed that the Ginna site would not be inundated by ice jams on these water bodies because of the distance between them, and because of their proximity to Lake Ontario which has a dominant effect on water levels.

The NRC staff confirms the licensee's conclusion that the flood hazard from ice-induced flooding alone would not inundate the site. Therefore, ice-induced flooding does not need to be analyzed in a focused evaluation or an integrated assessment.

3.9 Channel Migrations or Diversions

The licensee reported in the Ginna FHRR that the reevaluated hazard for channel migrations or diversions does not inundate the plant site, but did not report a PMF elevation (CENG, 2015). This flood-causing mechanism is not discussed in the licensee's CDB.

The Ginna FHRR, Section 2.8, states that there is "very limited potential for upstream diversion or rerouting of Lake Ontario" to impact safety-related facilities or water supplies at the Ginna site. The licensee stated in the Ginna FHRR that migration of Deer Creek toward the site is "not anticipated to occur due to plant site management and practices" (CENG, 2015). The licensee concluded that, based on historical and geomorphological information, there is a negligible hazard to the Ginna safety-related SSCs due to channel migrations or diversions.

The NRC staff noted that Lake Ontario is situated in a large topographic basin largely surrounded by highland areas and streamflow erosion of the lakeshore would be very small. The NRC staff reviewed the site geology as discussed in the Ginna UFSAR Revision 23 (CENG, 2011), which describes two potential slope failures near the Ginna site and concludes that is not a plausible cause of diversion of either creek. The staff noted that the Lake Ontario shoreline is protected against shoreline migration by the armor stone revetment. The NRC staff noted that controlling the migration of small streams, such as Deer Creek and Mill Creek, should this ever occur, is a common and standard engineering practice.

Based on the review of the information in the Ginna FHRR, the NRC staff concurs with the licensee that the hazard for flooding from channel migrations or diversions flooding would not impact the site. Therefore, channel migration or diversion flooding does not need to be analyzed in focused evaluation or integrated assessment.

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

4.1 Reevaluated Flood Height 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 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 flooding from LIP and streams and rivers are the hazard mechanisms not bounded by the CDB. Consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015a), NRC staff anticipates the licensee will submit focused evaluation for LIP and either a focused evaluation or integrated assessment for flooding from streams and rivers.

4.2 Flood Event Duration for Hazards Not Bounded by the CDB

The NRC staff reviewed information provided in CENG's 50.54(f) response (CENG, 2015; NRC, 2016b) regarding the FED parameters needed to perform the additional assessments of the plant response for flood hazards not bounded by the CDB. The FED parameter values for the flood-causing mechanisms identified in Section 4.1 of this staff assessment are summarized in Table 4.2-1.

The licensee did not provide FED parameters for hazards not bounded by the CDB, and stated that this information would be provided as part of future assessments of plant response (Exelon, 2015). The NRC staff will review these FED parameters as part of its evaluation of future assessments, if applicable to the assessment and hazard mechanism.

4.3 Associated Effects for Hazards Not Bounded by the CDB

The NRC staff reviewed information provided in CENG's 50.54(f) response (CENG 2015, NRC 2016b) 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 AE parameters not submitted as part of the FHRR are noted as "Not Provided" in Table 4.3-1. The NRC staff will review these AE parameters as part of future additional assessments of plant response, if applicable to the assessment and hazard mechanism.

The licensee stated in the Ginna FHRR that detailed impacts of both hydrodynamic and hydrostatic loading resulting from the LIP will be addressed as part of future assessments of plant response (Exelon, 2015). The licensee stated that minimal impacts are expected based on the estimated velocities associated with the LIP event. The licensee stated that, based on consideration of stability of ground surfaces that minimal effects related to sediment loading, erosion, or deposition are expected as a result of the LIP event. The licensee did not provide an assessment of concurrent conditions, including adverse weather or other pertinent factors, which would have a bearing on LIP impacts at the site. The licensee stated that there were no applicable groundwater effects associated the LIP event. The NRC staff confirmed the low flow velocities and shallow flow depths based on the review of the licensee's LIP analysis, and confirms that the AE parameters associated with LIP would be minimal.

The licensee stated in the Ginna FHRR that detailed impacts of both hydrodynamic and hydrostatic loading resulting from the PMF and combined events flooding scenario will be addressed as part of future assessments of plant response (Exelon, 2015). The licensee stated that minimal impacts due to these loading are expected based on the estimated water velocities. The licensee stated that, based on consideration of stability of ground surfaces that minimal effects related to sediment loading, erosion or deposition are expected as a result of these event. The licensee did not provide or identify within the Ginna FHRR an assessment of associated effects of concurrent conditions, including adverse weather or other pertinent factors, which could have a bearing on the plant response. The licensee stated that there were no applicable groundwater effects associated with these events.

The licensee is expected to develop the missing AE parameters for these flood-causing mechanisms to conduct the additional assessment. For AE parameters noted as minimal or not applicable, the staff confirms the licensee's AE parameter results are reasonable for use in additional assessments outlined in COMSECY-15-0019 (NRC, 2015a) and associated guidance.

4.4 Conclusion

Based upon the preceding analysis, NRC staff confirmed that the reevaluated flood hazard information defined in the 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, and associated guidance.

The licensee is expected to develop FED parameters and applicable flood AEs to conduct the MSA and the focused evaluations or revised integrated assessments. The NRC staff will evaluate the missing FED parameters (i.e., warning time, period of inundation, and recession time) marked as "Not Provided" in Table 4.3-1 during its review of the MSA and focused evaluations or integrated assessments.

5.0 CONCLUSION

The NRC staff has reviewed the information provided for the reevaluated flood-causing mechanisms for Ginna. Based on the review of available information provided in CENG's 50.54(f) response (CENG 2015, NRC 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, NRC staff confirmed the licensee's conclusions that (a) the reevaluated flood hazard results for LIP, and streams and rivers are not bounded by the CDB flood hazard, (b) additional assessments of plant response will be performed by the licensee for LIP, and streams and rivers, and (c) the reevaluated flood-causing mechanism information is an 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.

6.0 REFERENCES

Notes: (1) 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. (2) "n.d." indicates no date is available or relevant, for example for sources that are updated by parts. "n.d.-a", "n.d.-b" indicate multiple undated references from the same source.

U.S. Nuclear Regulatory Commission Documents and Publications

NRC (U.S. Nuclear Regulatory Commission), 2000a, "Review of Ginna Individual Examination of External Events (IPEEE) Submittal," ADAMS Accession No. ML003773799.

NRC, 2000b, "Review of Ginna Individual Examination of External Events (IPEEE)," dated February 27, 2001, ADAMS Accession No. ML010530110 (not publicly available).

NRC, 2007, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," NUREG-0800, 2007. ADAMS stores the Standard Review Plan as multiple ADAMS documents, which are most easily accessed through the web page http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/ sr0800/.

NRC, 2009, "Tsunami Hazard Assessment at Nuclear Power Plant Sites in the United States of America," NUREG/CR-6966, March 2009, ADAMS Accession No. ML091590193.

NRC, 2011a, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," SECY-11-0093, July 12, 2011, ADAMS Accession No. ML11186A950.

NRC, 2011b, "Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident," Enclosure to SECY-11-0093, July 12, 2011, ADAMS Accession No. ML111861807.

NRC, 2011c, "Recommended Actions To Be Taken without Delay from the Near-Term Task Force Report," SECY-11-0124, September 9, 2011, ADAMS Accession No. ML11245A158.

NRC, 2011d, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," Commission Paper SECY-11-0137, October 3, 2011, ADAMS Accession No. ML11272A111.

NRC, 2011e, "Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United State of America," NUREG/CR-7046, November 2011, ADAMS Accession No. ML11321A195.

NRC, 2012a, letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation and Michael R. Johnson, Director, Office of New Reactors, to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding the Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," March 12, 2012, ADAMS Accession No. ML12056A046.

NRC, 2012b, letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation and Michael R. Johnson, Director, Office of New Reactors, to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Order EA-12-049, March 12, 2012, ADAMS Accession No. ML12054A736.

NRC, 2012c, letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation, to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, "Prioritization of Response Due Dates for Information Pursuant to 10 CFR 50.54(f) Regarding Flooding Hazard Reevaluations for Rec. 2.1 of the NTTF Review of Insights from the Fukushima Dai-ichi Accident," May 11, 2012, ADAMS Accession No. ML12097A510.

NRC, 2012d, "The Estimation of Very-Low Probability Hurricane Storm Surges for Design and Licensing of Nuclear Power Plants in Coastal Areas," NUREG/CR-7134, October 2012.

NRC, 2013a, "Guidance for Performing a Tsunami, Surge, or Seiche Hazard Assessment," Japan Lessons-Learned Project Directorate, Interim Staff Guidance JLD-ISG-2012-06, Revision 0, January 4, 2013, ADAMS Accession No. ML12314A412.

NRC, 2013b, "Interim Staff Guidance For Assessment of Flooding Hazards Due to Dam Failure," Japan Lessons-Learned Project Directorate, Interim Staff Guidance JLD-ISG-2013-01, Revision 0, July 29, 2013, ADAMS Accession No. ML13151A153.

NRC, 2014a, "Calvert Cliffs Nuclear Power Plant, Units 1 and 2, and R. E. Ginna Nuclear Power Plant - Staff Assessment of Flooding Walkdown Reports Supporting Implementation of Near-Term Task Force Recommendation 2.3 Related to the Fukushima Dai-Ichi Nuclear Power Plant Accident," June 26, 2014, ADAMS Accession No. ML14170B022.

NRC, 2014b, "Nine Mile Point Nuclear Station Units 1 and 2 – Staff Assessment of Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (TAC Nos. MF1104 AND MF1105)," July 24, 2014, ADAMS Accession No. ML14153A410.

NRC, 2015a, "Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants," COMSECY-15-0019, June 30, 2015, ADAMS Accession No. ML15153A104.

NRC, 2015b, "R. E. Ginna Nuclear Power Plant – Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," December 4, 2016, ADAMS Accession No. ML15334A453.

NRC, 2016a, "Compliance with Order EA-12-049 Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Interim Staff Guidance JLD-ISG-2012-01, Revision 1 and Comment Resolution, January 22, 2016, ADAMS Accession No. ML15357A142.

NRC, 2016b, "NRC Report for the Audit of R.E. Ginna Nuclear Power Plant, LLC's Flood Hazard Reevaluation Report Submittals Relating to the Near-Term Task Force Recommendation 2.1 – Flooding for R.E. Ginna Nuclear Power Plant (CAC No. MF6098)," June 9, 2016, ADAMS Accession No. ML16152A116.

NRC, 2016c, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation; Focused Evaluation and Integrated Assessment," Interim Staff Guidance JLD-ISG-2016-01, Revision 0, July 11, 2016, ADAMS Accession No. ML16162A301.

Codes and Standards

ANSI/ANS (American National Standards Institute/American Nuclear Society), 1992, ANSI/ANS-2.8-1992, "Determining Design Basis Flooding at Power Reactor Sites," American Nuclear Society, LaGrange Park, IL, July 1992.

Other References

CENG (Constellation Energy Nuclear Group, LLC), 2011, "R.E. Ginna Nuclear Power Plant, Updated Final Safety Analysis Report (UFSAR), Revision 23.

CENG, 2012, "R.E. Ginna Nuclear Power Plant ... Response to 10 CFR 50.54(f) Request for information, Recommendation 2.3, Flooding, Attachment (1), R.E. Ginna Nuclear Power Plant Response to Recommendation 2.3 Flooding," dated November 27, 2012, ADAMS Accession No. ML12335A029.

CENG, 2015, "Flood Hazard Reevaluation Report Pursuant to 10 CFR 50.54(f) Regarding the Fukushima Near-Term Task Force Recommendation 2.1: Flooding," dated March 13, 2015, ADAMS Accession No. ML15072A008.

Douglass, S. L., "Review and Comparison of Methods for Estimating Irregular Wave Overtopping Rates. Coastal Engineering Research Center," U.S. Army Corps of Engineers Technical Report CERC-86-12, 1986.

Exelon (Exelon Generation Company, LLC), 2015, "R. E. Ginna - Response to NRC Audit Review Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report," September 30, 2015, ADAMS Accession No. ML15273A138.

FEMA (Federal Emergency Management Agency), 2012, "Guidelines and Standards for Flood Hazard Mapping Partners: Great Lakes Coastal Guidelines," Federal Emergency Management Agency, Appendix D.3 Update, May, 2012.

FLO-2D (FLO-2D Software, Inc.), 2012, FLO-2D Pro Reference Manual, Nutrioso, AZ, http://www.flo-2d.com.

FLO-2D (FLO-2D Software, Inc.), n. d., FLO-2D Pocket Guide Pro Model, Nutrioso, AZ, http://www.flo-2d.com/wp-content/uploads/2013/11/Pocket-GUIDE-PRO.pdf.

Google, n.d., "Google Maps," (Web site), https://www.google.com/maps, accessed January 26, 2016.

Hamblin, P.F., 1982, "On the Free Surface Oscillations of Lake Ontario," Limnology and Oceanography, vol. 27, no. 6, pp. 1039-1049.

IJC (International Joint Commission), 2014, "Lake Ontario St. Lawrence River Plan 201: Protecting Against Extreme Water Levels, Restoring Wetlands and Preparing for Climate Change," June 2014, ISBN:E95-2/18-2014E-PDF 978-1-100-24424-2. Available at http://www.ijc.org/files/tinymce/uploaded/LOSLR/IJC_LOSR_EN_Web.pdf

Lynett, P., and Liu, P.L.F., 2002, "A numerical study of submarine-landslide-generated waves and run-up," Proceedings of the Royal Society of London A, vol. 458, pp. 2885-2910.

NIST (National Institute of Standards and Technology), 2015, "Extreme Wind Speeds Software: Excel," (Web page), http://itl.nist.gov/div898/winds/excel.htm, accessed June 22, 2015.

NOAA (National Oceanic and Atmospheric Administration), 1978, Probable Maximum Precipitation Estimates, United States, East of the 105th Meridian, NOAA Hydrometeorological Report No. 51, June 1978, available online at http://nws.noaa.gov/oh/hdsc/PMP_documents/HMR51.pdf.

NOAA, 1980, "Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," NOAA Hydrometeorological Report No. 53, http://nws.noaa.gov/oh/hdsc/PMP_documents/HMR53.pdf, August 1980.

NOAA, 1982, "Application of Probable Maximum Precipitation Estimates, United States, East of the 105th Meridian," NOAA Hydrometeorological Report No. 52, http://nws.noaa.gov/oh/hdsc/PMP_documents/HMR52.pdf, August 1982.

NOAA, n. d. "Great Lakes Water Level Data: Six Minute Water Level," http://tidesandcurrents.noaa.gov/sitemap.html.

NOAA ,n.d, 2013, "Water Levels in the Great Lakes Change Because of Meteorological Effects, Not Tides," http://oceanservice.noaa.gov/facts/gltides.html, updated January 11, 2013.

NOAA, n.d., "Global Historical Tsunami Database," http://www.ngdc.noaa.gov/nndc/struts/form?t=101650&s=70&d=7, accessed July 17, 2012.

NYDEC (New York State Department of Environmental Conservation), n.d., "New York State Dams Inventory,' http://www.dec.ny.gov/pubs/42978.html, under "Natural Resources and Environmental Protection Maps", accessed April 28, 2015.

Nuclear Energy Institute (NEI), 2015a, "Endorsement Letter for LIP Warning Time White Paper," dated April 23, 2015, ADAMS Accession No. ML15110A080.

NEI, 2015b, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," NEI 12-06, Revision 2, December 2015, ADAMS Accession No. ML16005A625.

Pierce, M. W., Thorton, C.I., and Abt, S. R., 2010, "Predicting Peak Outflow from Breached Embankment Dams," Prepared for National Dam Safety Review Board Steering Committee on Dam Breach Equations, http://www.damsafety.org/media/documents/RESEARCH/ResearchReports/ PredictPeakOutflwBrchEmbkDms2010.pdf.

Rabinovich, A. B., 2009, "Seiches and Harbor Oscillations," In Kim, Y.C., ed., Handbook of Coastal and Ocean Engineering, World Scientific, Singapore, 2009, pp. 193-236.

Resio, D., Bratos, S., Thompson, E., Vincent, L., and Demirbilek, Z., eds., 2008, "Coastal Engineering Manual, Part II, Hydrodynamics, Chapter II-2 Meteorology and Wave Climate," Engineer Manual 1110-2-1100, U.S. Army Corps of Engineers, Washington, DC. Available online at http://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/ EM_1110-2-1100_Part-02.pdf.

Schwab, D. J. and E. Lynn, "Great Lakes Storm Surge Planning (SSPP)," NOAA Tech. Memo. GLERL-65, 12 pp, National Oceanic and Atmospheric Administration, 1987.

Unistar, 2008, "Nine Mile Point 3 Combined License Application, Final Safety Analysis Report, Rev. 0," Chapter 2.0, Site Characteristics, Section 2.04, Hydrologic Engineering," ADAMS Accession No. ML082900653.

Unistar, 2009, "Nine Mile Point 3 Combined License Application, Final Safety Analysis Report, Rev. 1 - Chapter 2.0, Site Characteristics, Section 02. 05 Geology, Seismology and Geotechnical through figure 2.5-2," ADAMS Accession No. ML090970449.

USACE (U.S. Army Corps of Engineers), 2002, "Shore Protection Manual, Volume 2," U.S. Army Coastal Engineering Research Center.

USACE, n.d.-a, "Ice Jam Database," (Web site) U.S. Army Corps of Engineers, Cold Region Research and Engineering Laboratory (CRREL), https://rsgisias.crrel.usace.army.mil/apex/f?p=524:1

USACE, 2010, "River Analysis System (HEC-RAS), Version 4.1.0," Hydrologic Engineering Center, U. S. Army Corps of Engineers, January 2010.

USDA (U.S. Department of Agriculture), 2007, "National Engineering Handbook, Part 630 Hydrology National Engineering Handbook-Chapter 6 Stream Reaches and Hydrologic Units."

USDA Natural Resources Conservation Service (NRCS).

USGS, 2012. (U.S. Geological Survey), 2006, "The National Land Cover Database (NLCD)," February 2011, Edition 1.0, http://www.mrlc.gov/nlcd06_data.php.

Veri-Tech (Veri-Tech, Inc.), 2016, Web page for distribution of the Coastal Engineering Design and Analysis System (CEDAS), http://www.veritechinc.com.

Zuzek, P., 2011, "Update on Great Lakes Coastal Methodology: Event versus Response Approach," Presentation at Association of State Floodplain Managers (ASFMP) 2011 Annual Conference, http://www.greatlakescoast.org/2011/05/24/presentations-from-asfpm-2011-annual-conference, May 2011.

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

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[1] that May Exceed the Powerblock Elevation, 270.0 ft NGVD29[1]	Reevaluated Flood Hazard, NGVD29
Local Intense Precipitation and Associated Drainage	270.9 ft (82.57 m)
Streams and Rivers[2]	258.2 ft (77.05 m) to 273.5 ft (83.36 m)

[1]Flood height and associated effects as defined in JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding" (NRC, 2012d).
[2]This includes two combined event scenarios including streams and river, Lake Ontario surge and wave effects of Deer Creek And Lake Ontario (NRC, 2015b).

Table 3.1-2. Current Design-Basis Flood Hazards

Flooding Mechanism	Stillwater Elevation, NGVD29	Associated Effects (Waves and Runup)	Current Design Basis Flood Elevation, NGVD29	Reference
Local Intense Precipitation and Associated Drainage, Screen House	254.5 ft (77.57 m)	Minimal	254.5 ft (77.57 m)	FHRR Section 1.3
Streams and Rivers	256.6 ft[1] (78.21 m), 272.0 ft[2](82.91 m), 273.0 ft[3](83.21 m), and 273.8 ft[4](83.45 m)	Not applicable	256.6 ft (78.21 m) to 273.8 ft (83.45 m)	FHRR Table 2.2-6
Failure of Dams and Onsite Water Control/Storage Structures	Not included in DB	Not included in DB	Not included in DB	FHRR Section 3.1.3
Storm Surge	253.3 ft (77.21 m)	7.7 ft (2.35 m)	260.9 ft (79.52 m)	FHRR Section 1.3
Seiche	Not included in DB	Not included in DB	Not included in DB	FHRR Section 3.1.5
Tsunami	Not included in DB	Not included in DB	Not included in DB	FHRR Section 3.1.6
Ice-Induced	No impact on the site identified	No impact on the site identified	No impact on the site identified	FHRR Section 3.1.7
Channel Migrations or Diversions	Not included in DB	Not included in DB	Not included in DB	FHRR Section 3.1.8

Source: Interim Status Letter (NRC, 2015b, Table 1)
"Not included in DB" indicates that the mechanism was not evaluated for the current design-basis.
"No impact on the site identified" indicates that the mechanism was evaluated, but was not found to affect the site.
[1]Design-basis flood elevation for Turbine Building, Screen House, and Diesel Generator Building.
[2]Design-basis flood elevation for Reactor Containment Building, Control Building, and All-Volatile-Treatment Building.
[3]Design-basis flood elevation for Standby Auxiliary Feedwater Pump Building.
[4]Design-Basis flood elevation for Auxiliary Building.

Table 3.2-1. Reevaluated Local Intense Precipitation Flood Hazards

Structure	Reevaluated Hazard		
	Peak Water Surface Elevation, NGVD29	Maximum Flow Depth	Maximum Flow Velocity
Reactor Containment Building	270.9 ft (82.57 m)	0.7 ft (0.21 m)	0.4 ft/s (0.12 m/s)
Auxiliary Building, main area	270.7 ft (82.51 m)	0.2 ft (0.06 m)	0.5 ft/s (0.15 m/s)
Auxiliary Building, south wall	270.7 ft (82.51 m)	0.2 ft (0.06 m)	0.5 ft/s (0.14 m/s)
Turbine Building	255.8 ft (77.97 m)	1.8 ft (0.55 m)	1.5 ft/s (0.45 m/s)
Control Building	270.9 ft (82.57 m)	0.5 ft (0.15 m)	0.6 ft/s (0.18 m/s)
All-Volatile-Treatment Building	270.8 ft (82.54 m)	0.1 ft (0.03 m)	0.8 ft/s (0.24 m/s)
Standby Auxiliary Feedwater Pump Building	270.2 ft (82.36 m)	0.2 ft (0.06 m)	0.6 ft/s (0.18 m/s)
Proposed Standby Auxiliary Feedwater Pump Building Annex	270.5 ft (82.45 m)	0.6 ft (0.18 m)	0.8 ft/s (0.24 m/s)
Screen House	255.8 ft (77.97 m)	2.1 ft (0.64 m)	0.7 ft/s (0.21 m/s)
Diesel Generator Building	255.8 ft (77.97 m)	2.1 ft (0.64 m)	3.0 ft/s (0.91 m/s)

Table 3.3-1. Reevaluated Streams and Rivers Flood Hazards[1,2]

	Reevaluated Hazard Peak Flood Elevation, NGVD29				
	PMF Scenario[3]	Combined Event Scenarios			
Location		PMF with Critical Wind Speed (Scenario H.1) [4,8]	1/2 PMF, Highest Historic Storm Surge, and Wind Waves (Scenario H.4.2, Alternative 1)[5]	PMF, 25-year Storm Surge, and Wind Waves (Scenario H.4.2, Alternative 2)[6],	25-year Flood in Deer Creek, Probable Maximum Storm Surge, and Wind Waves (Scenario H.4.2, Alternative 3)[7]
Reactor Containment Building	**272.4 ft (83.03 m)**	**272.4 ft (83.03 m)**	No effect[3]	**272.4 ft (83.03 m)**	No effect
Auxiliary Building, main area	272.6 ft (83.09 m)	273.5 ft (83.36 m)	No effect	272.6 ft (83.09 m)	No effect
Auxiliary Building, south wall	272.6 ft (83.09 m)	273.5 ft (83.36 m)	No effect	272.6 ft (83.09 m)	No effect
Turbine Building	258.1 ft (78.67 m)	258.1 ft (78.67 m)	No effect	255.0 ft (77.72 m)	**258.2 ft (78.70 m)**
Control Building	**272.4 ft (83.03 m)**	**272.4 ft (83.03 m)**	No effect	**272.4 ft (83.03 m)**	No effect
All-Volatile-Treatment Building	271.3 ft (82.69 m)	271.3 ft (82.69 m)	No effect	271.3 ft (82.69 m)	No effect
Standby Auxiliary Feedwater Pump Building	**272.8 ft (83.15 m)**	**273.7 ft (83.42 m)**	No effect	272.8 ft (83.15 m)	No effect
Proposed Standby Auxiliary Feedwater Pump Building Annex	**273.5 ft (83.36 m)**	**274.4 ft (83.64 m)**	270.3 ft (82.39 m)	273.5 ft (83.36 m)	No effect

Screen House Building	258.1 ft (78.67 m)	258.1 ft (78.67 m)	**258.2 ft (78.70 m)**	254.9 ft (77.69 m)	254.9 ft (77.69 m)
Diesel Generator Building	258.3 ft (78.73 m)	258.3 ft (78.73 m)	254.9 ft (77.69 m)	**258.4 ft (78.76 m)**	**258.4 ft (78.76 m)**

Notes:

[1]Bolded values are the peak water surface elevations for the scenario and building. At some buildings, more than one scenario produced identical peak flood elevations and both scenarios have been identified. At other locations, all scenarios were found to produce peak elevations below the CDB, and hence have no values in bold. Bolded values are as provided the ISR letter (NRC, 2015b).

[2]"No effect" indicates that this location is not flooded under this flood scenario.

[3]See Section 3.3.3 and FHRR (CENG, 2015, Tables 2.2-6 and 2.9-1)

[4]FHRR (CENG, 2015, Enclosure 1 Table 3)

[5]FHRR (CENG, 2015, Section 2.9.2.2.1 and Table 2.9-5)

[6]FHRR (CENG, 2015, Section 2.9.2.2.2 and Table 2.9-6)

[7]FHRR (CENG, 2015, Section 2.9.2.2.3 and Table 2.9-7)

[8]Wind-wave runup of 0.9 ft is included peak elevations for these locations: Auxiliary Building, Standby Auxiliary Feedwater Pump Building and the Proposed Standby Auxiliary Feedwater Pump Building Annex (CENG, 2015, Enclosure 1 Table 3).

Table 3.4-1. Peak Flow Rates from Sunny-day Dam Failures on Deer Creek and Mill Creek

Dam	Macinnes Marsh Dam	Fruitland Mill Dam[2]	William Daly Marsh Dam
State ID[1]	045-2684	045-0330	045-1903
River or Stream[1]	Deer Creek	Fish Creek	Mill Creek
Construction Type[1]	Earth	Rockfill	Earth
Height[1]	5 ft (1.52 m)	10 ft (3.05 m)	6 ft (1.83 m)
Normal Volume[1]	43 acre-ft (53008 m^3)	Unknown	8 acre-ft (9862 m^3)
Maximum Volume[1]	Unknown	Unknown	18 acre-ft (22189 m^3)
Peak Flow during Failure[3]	373 ft^3/s (10.6 m^3/s)	1025 ft^3/s (29.01 m^3/s)	301 ft^3/s (8.52 m^3/s)
Peak Flow[4]	373 ft^3/s (10.6 m^3/s)	1025 ft^3/s (29.01 m^3/s)	301 ft^3/s (8.52 m^3/s)

[1] Staff's review of upstream dams identified by licensee in New York State Dams Inventory (NYDEC, n.d.)

[2] The licensee refers to Fruitland Mills Dam rather than Fruitland Mill Dam.

[3] As reported in the FHRR (CENG, 2015, Table 2.3-1) for sunny-day dam failure.

[4] Peak flows are based on formula developed by Pierce, Thornton, and Abt (2010).

Table 3.4-2. Deer Creek Overflow Summary Table

Total Deer Creek Flow	Elevation at Screen House, NGVD29[1]	Elevation at Deer Creek near Ginna site,[2] NGVD29[1]
14,600 ft^3/s (413.2 m^3/s) (channel capacity)	253.5 ft (77.27 m)	270.0 ft (82.30 m)
15,000 ft^3/s (425 m^3/s)	253.55 ft (77.28 m)	270.1 ft (82.33 m)
16,000 ft^3/s (453 m^3/s)	253.7 ft (77.33 m)	270.6 ft (82.48 m)
17,300 ft^3/s (490 m^3/s)	254.0 ft (77.42 m)	271.1 ft (82.63 m)
18,000 ft^3/s (509 m^3/s)	254.2 ft (77.48 m)	271.4 ft (82.74 m)
20,000 ft^3/s (566 m^3/s)	254.8 ft (77.66 m)	272.1 ft (82.94 m)
20,600 ft^3/s (583 m^3/s)	255.0 ft (77.72 m)	272.3 ft (83.00 m)
22,000 ft^3/s (623 m^3/s)	255.4 ft (77.85 m)	272.8 ft (83.15 m)
24,000 ft^3/s (679 m^3/s)	256.0 ft (78.03 m)	273.3 ft (83.30 m)
26,000 ft^3/s (736 m^3/s)	256.0 ft (78.03 m)	273.8 ft (83.45 m)
28,000 ft^3/s (792 m^3/s)	257.8 ft (78.58 m)	274.2 ft (83.58 m)
30,000 ft^3/s (849 m^3/s)	259.0 ft (78.94 m)	274.5 ft (83.67 m)
35,000 ft^3/s (991 m^3/s)	261.6 ft (79.74 m)	275.1 ft (83.85 m)
38,700 ft^3/s (1,095 m^3/s) (probable maximum flood)	262.3 ft (79.95 m)	275.7 ft (84.03 m)

Source: Ginna UFSAR Revision 23 (CENG, 2011, Table 2.4-1)

[1] Elevations in the Ginna USFAR are given relative to mean sea level (msl); this datum is taken to be equivalent to NGVD29 in the FHRR and in this Staff Assessment.

[2] Approximately 100 ft (30.5 m) west of bridge over Deer Creek leading to Ginna site.

Table 4.1-1. Reevaluated Flood Hazards for Flood-Causing Mechanisms Not Bounded by the CDB

Mechanism	Stillwater Elevation, NGVD29	Wind Waves	Reevaluated Flood Hazard, ft (m) NGVD29	Reference
Local Intense Precipitation				
LIP 6-h event: Reactor Containment	270.9 ft (82.57 m) NGVD29	Minimal	270.9 ft (82.57 m) NGVD29	FHRR Table 2.1-1
LIP 6-h event: Auxiliary Building	270.7 ft (82.51 m) NGVD29	Minimal	270.7 ft (82.51 m) NGVD29	FHRR Table 2.1-1
LIP 6-h event: Turbine Building	255.8 ft (77.97 m) NGVD29	Minimal	255.8 ft (77.97 m) NGVD29	FHRR Table 2.1-1
LIP 6-h event: Control Building	270.9 ft (82.57 m) NGVD29	Minimal	270.9 ft (82.57 m) NGVD29	FHRR Table 2.1-1
LIP 6-h event: All-Volatile-Treatment Building	270.8 ft (82.54 m)NGVD29	Minimal	270.8 ft (82.54 m) NGVD29	FHRR Table 2.1-1
LIP 6-h event: Standby Auxiliary Feedwater Pump Building	270.2 ft (82.36 m) NGVD29	Minimal	270.2 ft (82.36 m) NGVD29	FHRR Table 2.1-1
LIP 6-h event: Proposed Standby Auxiliary Feedwater Pump Building Annex	270.5 ft (82.45 m) NGVD29	Minimal	270.5 ft (82.45 m) NGVD29	FHRR Table 2.1-1
LIP 6-h event: Screen House	255.8 ft (77.97 m) NGVD29	Minimal	255.8 ft (77.97 m) NGVD29	FHRR Table 2.1-1
LIP 6-h event: Diesel Generator Building	255.8 ft (77.97 m) NGVD29	Minimal	255.8 ft (77.97 m) NGVD29	FHRR Table 2.1-1

Streams and Rivers				
Reactor Building (stillwater: PMF, total water level: PMF, H.1, H.4.2)	272.4 ft (83.03 m) NGVD29	Not Applicable	272.4 ft (83.03 m) NGVD29	FHRR Table 2.2-6, FHRR Sections 2.9.3 and 3.1.9
Turbine Building (stillwater: PMF, total water level: PMF, H.4.2)	258.2 ft (78.70 m) NGVD29	Not Applicable	258.2 ft (78.70 m) NGVD29	FHRR Sections 2.9.3, 3.1.9 and FHRR Enclosure 1 Table 4
Control Building (stillwater: PMF, total water level: PMF, H.1, H.4.2)	272.4 ft (83.03 m) NGVD29	Not Applicable	272.4 ft (83.03 m) NGVD29	FHRR Table 2.2-6, FHRR Sections 2.9.3 and 3.1.9
Standby Auxiliary Feedwater Pump Building (stillwater: PMF, total water level: H.1)	272.8 ft (83.15 m) NGVD29	0.9 ft (0.27 m)[1]	273.7 ft (83.42 m) NGVD29	FHRR Table 2.2-6, FHRR Enclosure 1 Tables 2 and 3
Proposed Standby Auxiliary Feedwater Pump Building Annex (stillwater: PMF, total water level: H.1)	273.5 ft (83.36 m) NGVD29	0.9 ft (0.27 m)[1]	274.4 ft (83.64 m) NGVD29	FHRR Enclosure 1 Tables 2 and 3
Screen House (stillwater: PMF, total water level: H.4.2)	258.2 ft (78.70 m) NGVD29	Not Applicable	258.2 ft (78.70 m) NGVD29	FHRR Sections 2.9.3, 3.1.9 and FHRR Enclosure 1 Table 4
Diesel Generator Building (stillwater: PMF; total water level: H.4.2)	258.4 ft (78.76 m) NGVD29	Not Applicable	258.4 ft (78.76 m) NGVD29	FHRR Sections 2.9.3, 3.1.9 and FHRR Enclosure 1 Table 4

Notes:

1. For Combined-effect flood Scenario H.1, the licensee stated the reevaluated wind-wave runup was 0.9 (0.27 m) at the Standby Auxiliary Feedwater Pump Building and the Proposed Standby Auxiliary Feedwater Pump Building Annex.

Table 4.2-1. Flood Event Durations 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	Not Provided	Not Provided	Not Provided
Streams and Rivers	Not Provided	Not Provided	Not Provided

Notes:

a. 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

	Flooding Mechanism	
Associated Effect	**Local Intense Precipitation**	**Streams and Rivers**
Hydrodynamic loading at plant grade	Minimal[1,2]	Minimal[1,2]
Debris loading at plant grade	Minimal[2]	Minimal[2]
Sediment loading at plant grade	Minimal[3]	Minimal[3]
Sediment deposition and erosion	Minimal[3]	Minimal[3]
Concurrent conditions, including adverse weather	Not provided	Not provided
Other pertinent factors (e.g., waterborne projectiles)	Not provided	Not applicable[1]
Groundwater	Not applicable[4]	Not applicable[4]

Source: Exelon (2015)

[1] .The licensee stated that impacts of both hydrodynamic and hydrostatic loading at all critical locations for the site will be addressed during the Integrated Assessment phase of work' (Exelon, 2015).

[2] No adverse effects are expected because of slow flow velocities and shallow flow depths.

[3] No adverse effects are expected because of slow, but not stagnant, flow velocities; erosion-resistant surfaces of well-established grass or concrete; and conservative assumptions that culverts are blocked by sediment and debris which are already considered in flow calculations.

[4] Safety-related structures were designed to resist loads associated with groundwater levels up to grade.

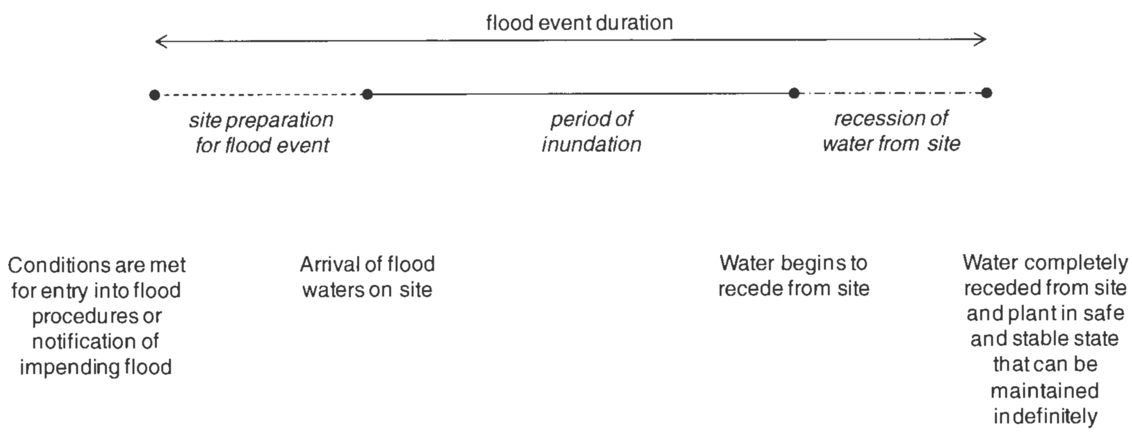
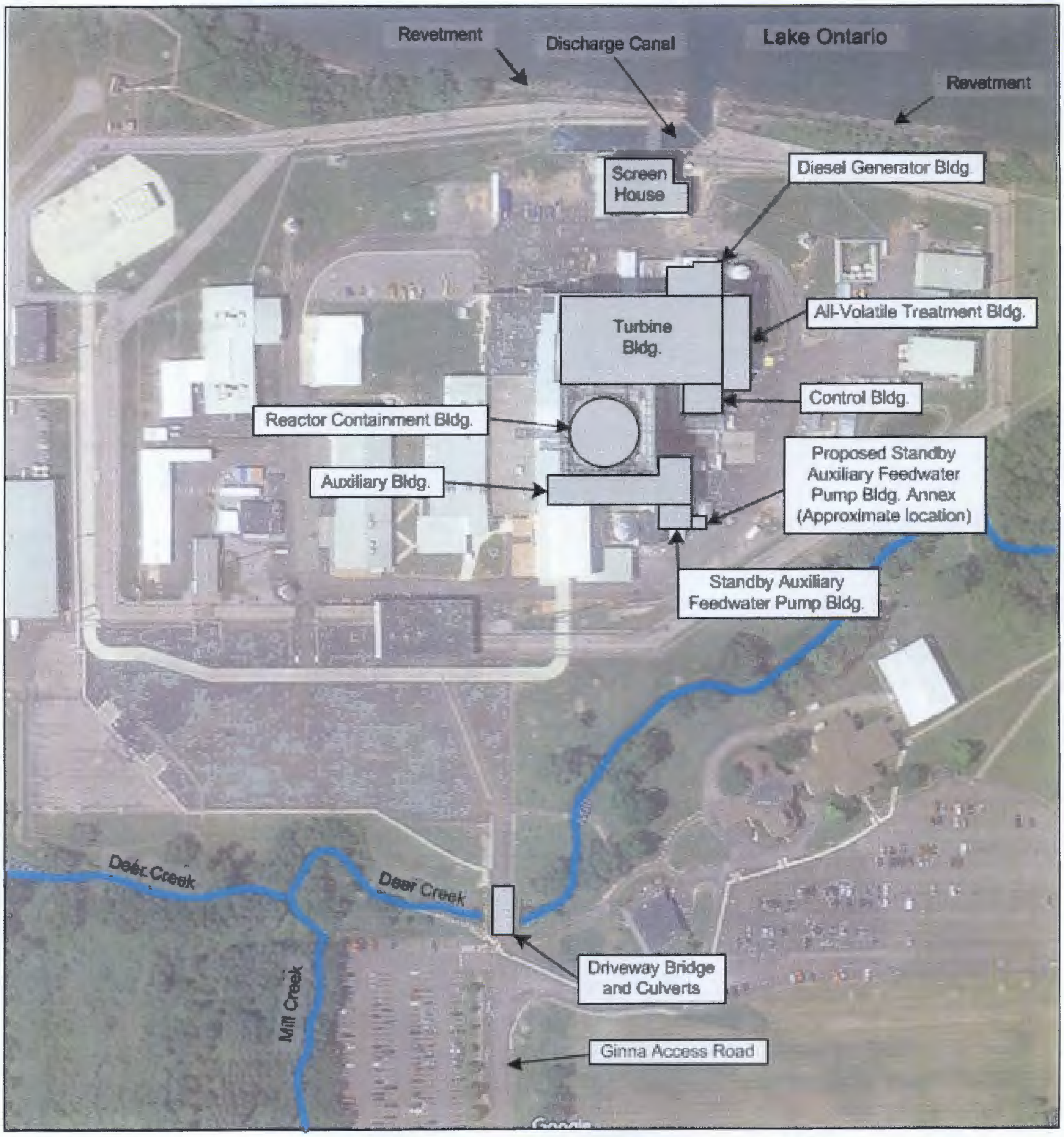


Figure 2.4-1. Flood Event Duration



Source: Exelon (2015, Figure 2-1). Base from Google Maps (Google, n.d.)

Figure 3.1-1. Ginna Site Features

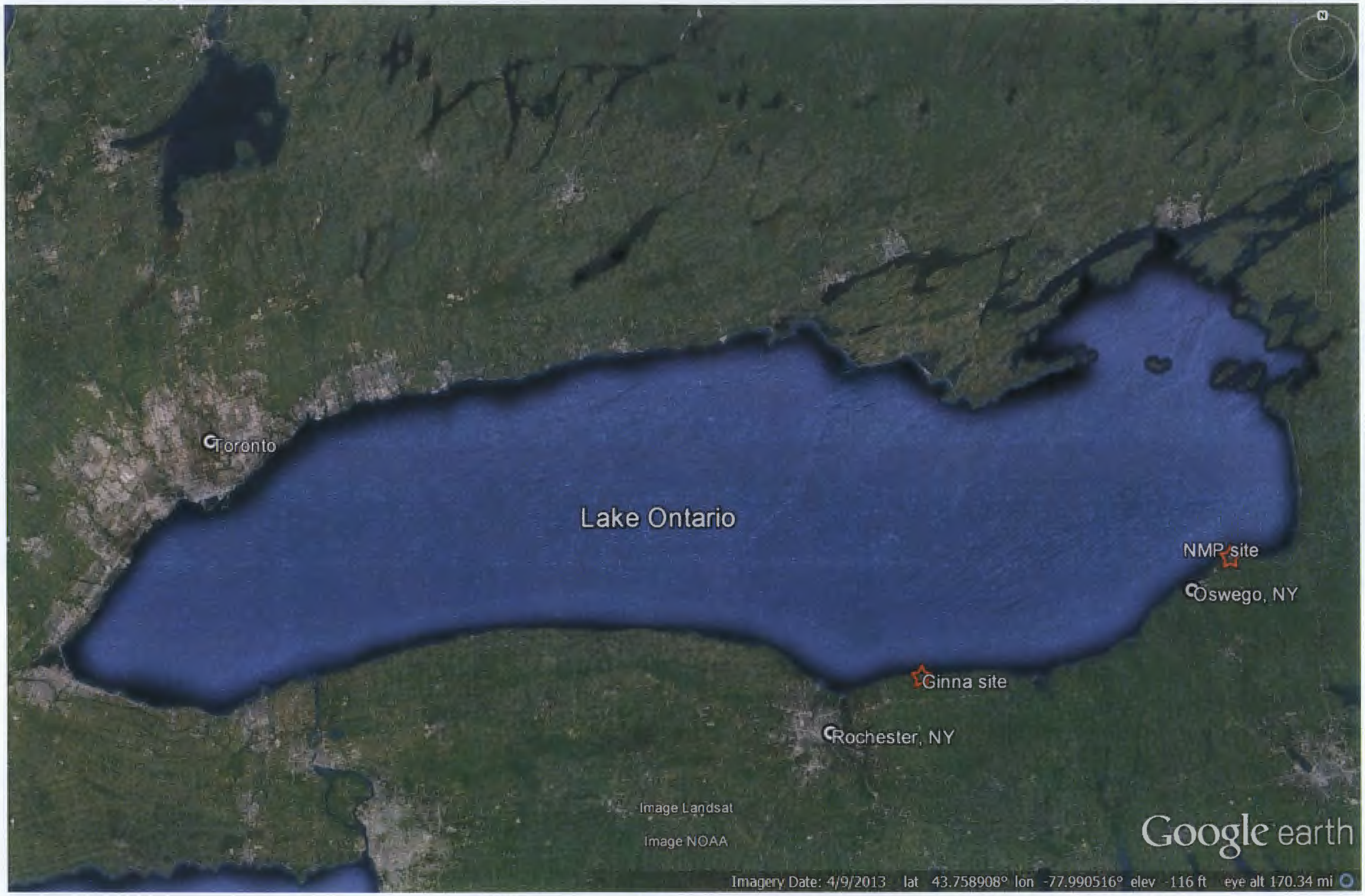
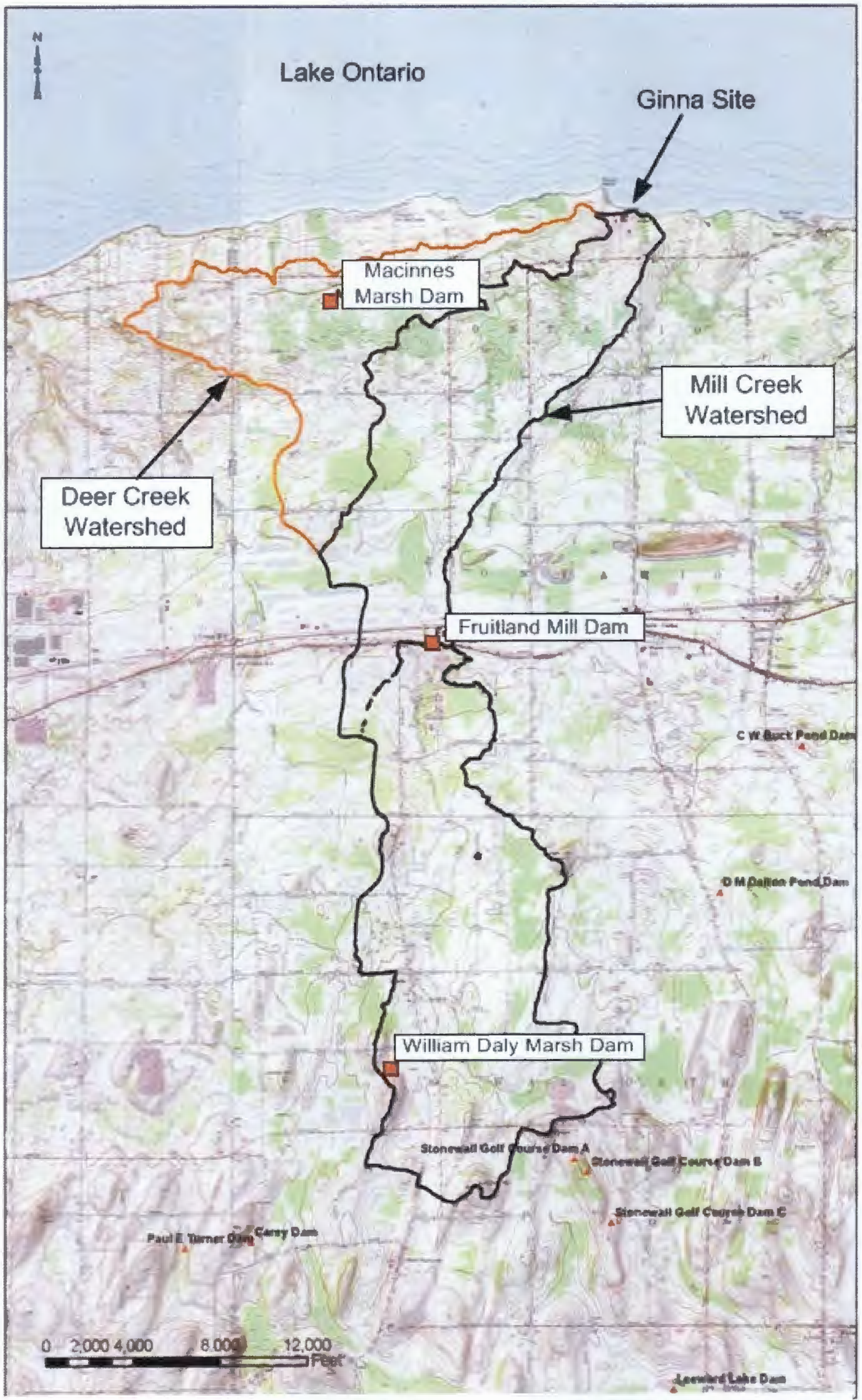


Figure 3.1-2 Regional Setting of Ginna Site



Modified from Ginna FHRR (CENG, 2015, Figure 2.3.1)

Figure 3.1-3. Watersheds and Dams Affecting the Ginna Site

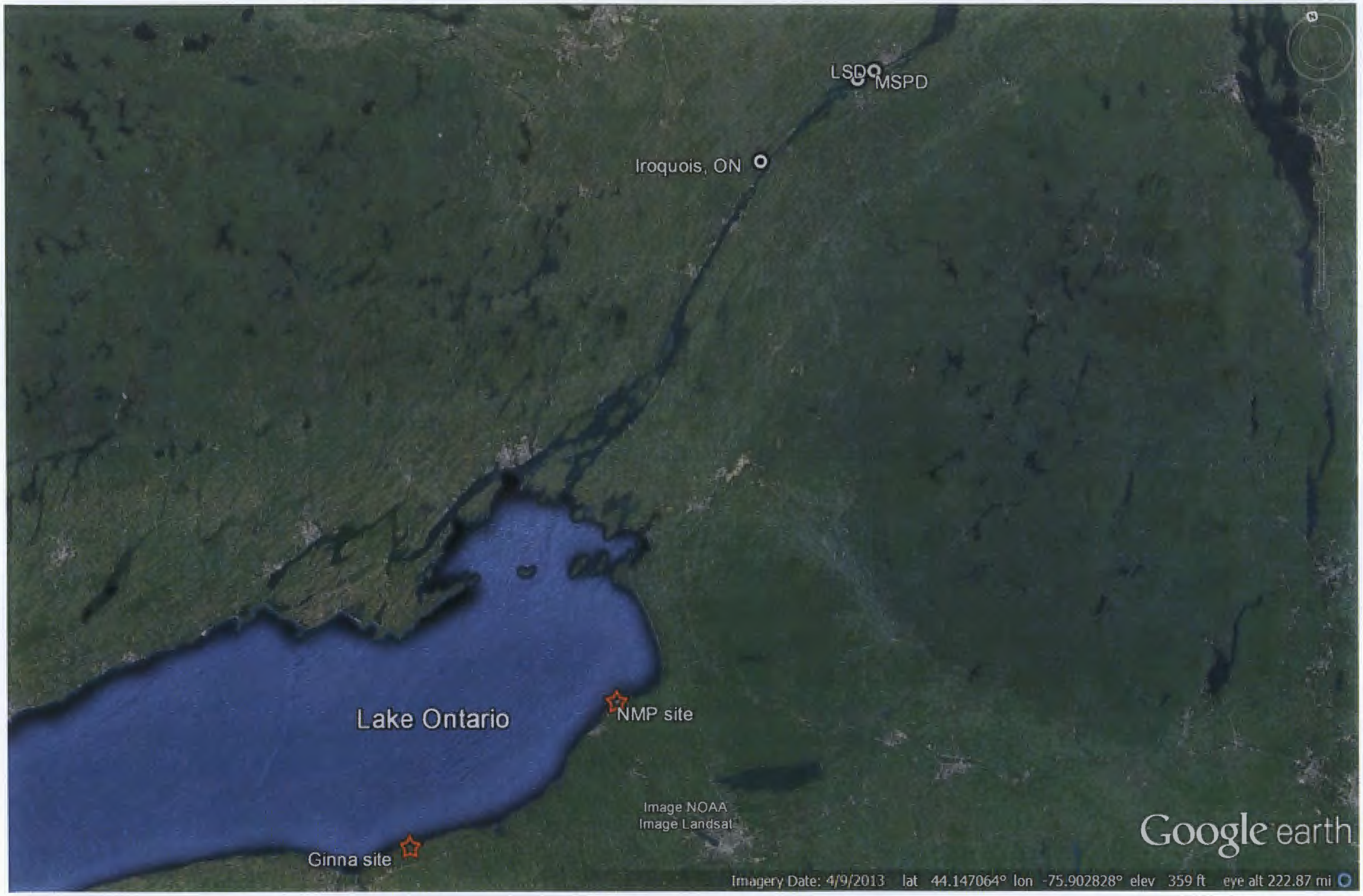


Figure 3.4-1. Dams that Control the Lake Ontario Water Level
(1) Water control structure near Iroquois, Ontario, (2) Long Sault Dam (LSD), and
(3) Moses-Saunders Power Dam (MSPD)

Figure 3.7-1. Features Relevant to Tsunami Flood Hazard at Ginna site. Note: 100-mile line is shown for scale.

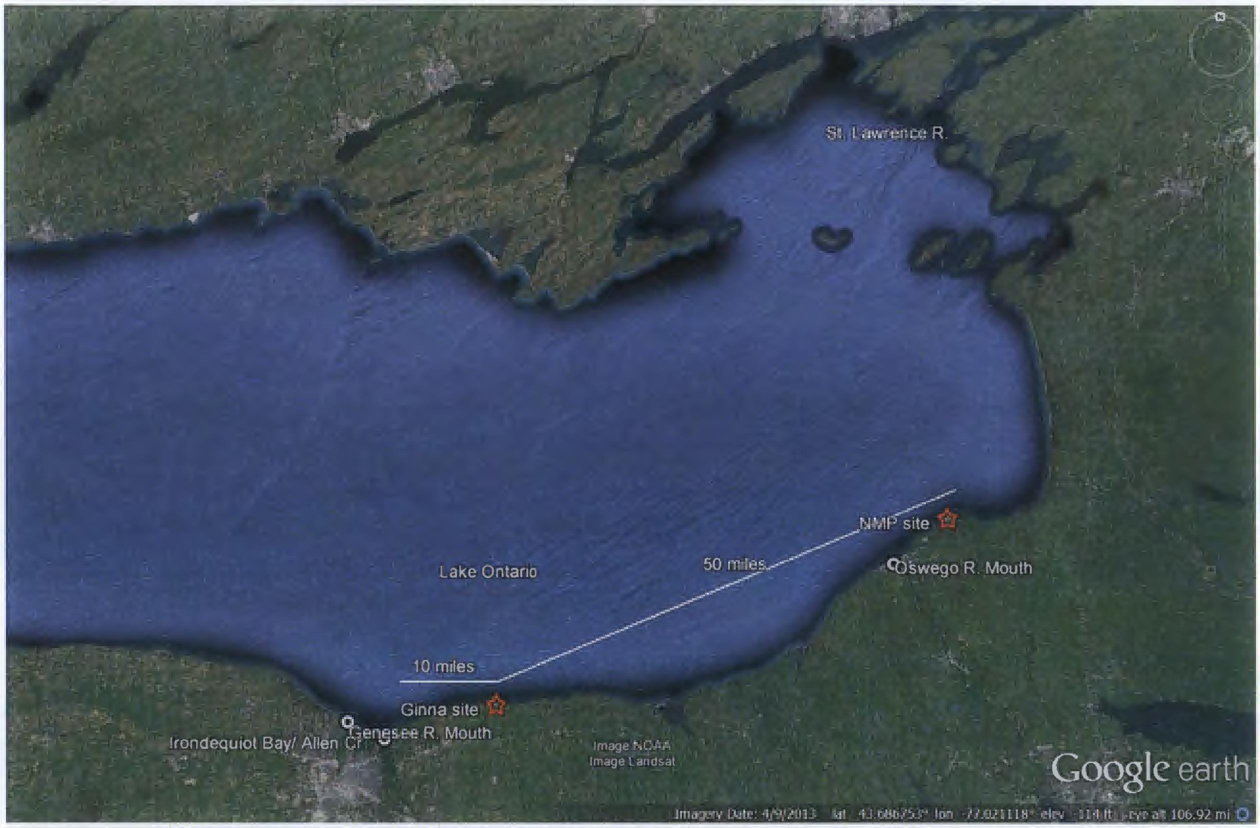


Figure 3.8-1. Locations of relevant to ice-induced flooding evaluation at Ginna site. Note: 50-mile and 10-mile lines shown for scale.

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

Sincerely,

/RA/

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

Docket No. 50-244

Enclosure:
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