UNITED STATES
NUCLEAR REGULATORY COMMISSION
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August 10, 2017

Mr. James J. Hutto
Regulatory Affairs Director
Southern Nuclear Operating Co., Inc.
P.O. Box 1295, Bin 038
Birmingham, AL 35201-1295

SUBJECT: VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NOS. MF7987 AND MF7988)

Dear Mr. Hutto:

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), 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 NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 to the 50.54(f) letter 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 early site permits and combined licenses (ADAMS Accession No. ML12056A046). Concurrent with the reevaluation of flood hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12054A735). In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis flood hazard or the most recent flood hazard information, which may not be based on present-day methodologies and guidance, in the development of their mitigating strategies.

By letter dated December 21, 2016 (ADAMS Accession No. ML16356A455), Southern Nuclear Operating Company, Inc. (the licensee) submitted the mitigating strategies assessment (MSA) for Vogtle Electric Generating Plant, Units 1 and 2 (Vogtle). The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events. The purpose of this letter is to provide the NRC's assessment of the Vogtle MSA.

The NRC staff has concluded that the Vogtle MSA was performed consistent with the guidance described in Appendix G of Nuclear Energy Institute 12-06, Revision 2, as endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, Revision 1, and that the licensee has demonstrated that the mitigation strategies are reasonably protected from reevaluated flood hazards condition for beyond-design-basis external events. This closes out the NRC's efforts associated with CAC Nos. MF7987 and MF7988.

If you have any questions, please contact me at 301-415-1617 or at Frankie.Vega@nrc.gov.

Sincerely,

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

Enclosure:
Staff Assessment Related to the
Mitigating Strategies for Vogtle

Docket Nos.: 50-424 and 50-425

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO MITIGATION STRATEGIES FOR

VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2

AS A RESULT OF THE REEVALUATED FLOODING HAZARD

NEAR-TERM TASK FORCE RECOMMENDATION 2.1- FLOODING

1.0 INTRODUCTION

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), 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 NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 to the 50.54(f) letter 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 early site permits and combined licenses (ADAMS Accession No. ML12056A046). Concurrent with the reevaluation of flood hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12054A735). That order requires holders of operating reactor licenses and construction permits issued under 10 CFR Part 50 to modify the plants to provide additional capabilities and defense-in-depth for responding to beyond-design-basis external events, and to submit to the NRC for review a final integrated plan that describes how compliance with the requirements of Attachment 2 of the order was achieved. In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis flood hazard or the most recent flood hazard information, which may not be based on present-day methodologies and guidance, in the development of their mitigating strategies.

The NRC staff and industry recognized the difficulty in developing and implementing mitigating strategies before completing the reevaluation of flood hazards. The NRC staff described this issue and provided recommendations to the Commission on integrating these related activities in COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flood Hazards," dated November 21, 2014 (ADAMS Accession No. ML14309A256). The Commission issued a staff requirements memorandum on March 30, 2015 (ADAMS Accession No. ML15089A236), affirming that the Commission expects licensees for operating nuclear power plants to address the reevaluated flood hazards, which are considered beyond-design-basis external events, within their mitigating strategies.

Nuclear Energy Institute (NEI) 12-06, Revision 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide" (ADAMS Accession No. ML16005A625), has been endorsed by the NRC as an appropriate methodology for licensees to perform assessments of the mitigating strategies against the reevaluated flood hazards developed in response to the March 12, 2012, 50.54(f) letter. The guidance in NEI 12-06, Revision 2, and Appendix G in particular, supports the proposed Mitigation of Beyond-Design-Basis Events rulemaking. The NRC's endorsement of NEI 12-06, including exceptions, clarifications, and additions, is described in NRC Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, Revision 1, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML15357A163). Therefore, Appendix G of NEI 12-06, Revision 2, describes acceptable methods for demonstrating that the reevaluated flooding hazard is addressed within the Vogtle Electric Generating Plant, Units 1 and 2 (Vogtle) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated March 5, 2013 (ADAMS Accession No. ML13067A283, non-publicly available), as supplemented by letters dated May 24, 2013, March 6, 2014, and May 28, 2014 (ADAMS Accession Nos. ML13148A368, ML14072A370, and ML14148A491, respectively, Southern Nuclear Operating Company, Inc. (SNC, the licensee) submitted its flood hazard reevaluation report (FHRR) for Vogtle. By letter dated November 6, 2014, (ADAMS Accession No. ML14279A352), the NRC staff transmitted to the licensee a staff assessment of the information provided in the aforementioned letters. By letter dated November 3, 2015, (ADAMS Accession No. ML15300A140), the NRC issued a supplement to its staff assessment of flood-causing mechanisms reevaluation for Vogtle (hereafter referred to as the Mitigating Strategies Flood Hazard Information (MSFHI) letter). The MSFHI letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Vogtle, which are suitable input for the mitigating strategies assessment (MSA). For Vogtle, the mechanisms listed as not bounded by the CDB in the MSFHI letter are local intense precipitation (LIP) and failure of upstream dams on the Savannah River. The NRC staff review of the flood event duration (FED) and associated effects (AE) parameters associated with the LIP and failure of upstream dams on the Savannah River is provided below.

By letter dated December 21, 2016 (ADAMS Accession No. ML16356A455, non-publicly available), the licensee submitted the Vogtle MSA for review by the NRC staff. The MSA is intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events.

3.0 TECHNICAL EVALUATION

3.1 Mitigating Strategies under Order EA-12-049

The NRC staff evaluated the Vogtle strategies as developed and implemented under Order EA12-049, as described in the licensee's Final Integrated Plan (FIP) dated May 23, 2016 (ADAMS Accession No. ML16146A607). The NRC staff's safety evaluation for Vogtle is dated November 14, 2016 (ADAMS Accession No. ML16301A419). The Vogtle safety evaluation concluded that the licensee has developed guidance and proposed design that, if implemented appropriately, will adequately address the requirements of Order EA-12-049.

A brief summary of Vogtle's FLEX strategies are listed below:

- For Phase 1, the Turbine Driven Auxiliary Feedwater (TDAFW) pump is initiated at the beginning of the extended loss of alternating current power (ELAP) event and is normally aligned to take suction from the condensate storage tank (CST). The TDAFW pump supplies four steam generators (SGs) for about 89 hours for core cooling. Operators are dispatched to manually position atmospheric relief valves (ARVs) to aid in heat removal after the expected closure of the main steam isolation valves during the ELAP.

  The Class 1E Station batteries and the associated distribution systems provide power to the systems, structures, and components (SSCs) and instrumentation used to maintain key safety functions throughout the ELAP event. The operators shed loads from the direct current (dc) system within 45 minutes of event initiation to extend the battery capacity to power the necessary SSCs and instrumentation. After load shedding, the installed batteries can maintain the necessary voltage for over 12 hours.

- For Phase 2, FLEX components are deployed from the FLEX storage building and staged throughout the Vogtle site for core cooling, RCS makeup, and SFP makeup. The TDAFW pump will continue to supply the SGs during Phase 2. FLEX pumps will be used to provide makeup water to the CSTs for both units from either the reactor makeup water storage tank (RMWST) or the nuclear service cooling water (NSCW) basins. A SG FLEX pump can also be used to supply the SGs if the TDAFW pump becomes unavailable. The boron injection FLEX pump (one for each unit) will be used to supply RCS makeup water from the boric acid storage tanks (BASTs) or refueling water storage tank (RWST), with injection capability available approximately 12 hours after the initiation of the ELAP event. The submersible FLEX pump can supply makeup water to the SFP. The 480V FLEX diesel generator (DG) (one per unit) will be deployed and started within 10 hours after initiation of the ELAP event to power the FLEX switchboard, which will supply power to the battery chargers, instrumentation for critical SSCs, and one portable FLEX boron injection pump.

- For Phase 3, equipment from the National SAFER [Strategic Alliance of FLEX Emergency Response] Response Center (NSRC) will be transported to on-site staging area B for interim staging prior to being transported to the final location in the plant.

3.2 Evaluation of Current FLEX Strategy against Reevaluated Hazard

For Vogtle, the mechanisms listed as not bounded by the CDB in the MSFHI letter are the upstream dam failure on the Savannah River and LIP. The licensee stated in its MSA that the water level resulting from an upstream dam failure on the Savannah River is over 40 feet (ft.) below the minimum plant grade. According to the licensee, this flooding mechanism is bounded by the FLEX design basis. The NRC staff notes that the licensee's mitigating strategies FIP describes the Vogtle site as a "dry" site for the purposes of developing its FLEX strategy. The staff has confirmed that the dam failure water level does not challenge the site grade level; thus, further evaluation of the FLEX strategy against the reevaluated Savannah River flooding mechanism is not required. The maximum water surface elevation for the LIP mechanism exceeds the CDB at Vogtle; thus, further evaluation is provided below.

LIP Flood

The licensee described in Section 3 of its MSA that the FHRR LIP analysis was updated based on NRC comments during the FHRR review. The licensee described that the reevaluated LIP maximum flood height increased from the 219.3 ft. mean sea level (MSL) flooding elevation referenced in the FHRR. Specifically, the licensee stated that the reevaluated LIP maximum flooding elevation could result in some areas within the power block being subjected to LIP flood waters and thus the LIP event was evaluated as part of the MSA evaluation. The MSA indicated nine main locations in which the maximum LIP flooding elevation exceeds the door sill or minimum wall penetration elevations. The licensee stated that water would ingress; however, the resulting flood levels inside the rooms would not affect SSCs necessary for the FLEX strategies for five of the locations. The remaining four locations that the LIP flood waters could potentially impact enactment of the overall FLEX strategy are:

- Unit 2 Diesel Fuel Oil Storage (DFOS) Building exterior wall;
- Unit 1 and Unit 2 Control Building;
- Unit 1 and Unit 2 Auxiliary Building; and
- Unit 1 and Unit 2 TDAFW Pump Rooms

The maximum LIP flooding elevation adjacent to the Unit 2 DFOS Building exceeds certain wall penetration elevations by 0.30 ft. Based on this result, the licensee plans to implement a modified FLEX strategy to protect this area of the site with temporary flood barriers.

The maximum LIP flooding elevation is projected to be as much as 0.49 ft. above the door sill elevation for the doors located on the north side of the Control Building. Based on this result, the licensee plans to implement a modified FLEX strategy to protect this area of the site with temporary flood barriers.

The licensee indicated that the grading along the south side of the Auxiliary Building will redirect LIP flooding away from the Auxiliary Building and its doors. However, since the projected LIP elevation exceeds the door sill elevations, LIP flood waters could potentially enter the Auxiliary Building through gaps between the door sill and the bottom of the doors. The licensee assessed that the resulting amount of water that enters the Auxiliary Building would result in a water level that is lower than the elevation of the Boron Injection FLEX pump, such that it would not prevent the RCS makeup strategy from being executed. In addition, flooding in the Nuclear Service Cooling Water (NCSW) tunnels could challenge certain Auxiliary Building penetrations. The licensee's MSA stated that penetrations providing a potential pathway for LIP flood waters would be further evaluated to ensure that the leakage rate through any existing seals will not impact the credited FLEX equipment, or alternative methods will be taken to prevent water from entering through the penetrations.

The maximum LIP flooding elevation on the south side of the Unit 2 AFW Pumphouse is projected to be 0.07 ft. above the door sill elevation that leads to the TDAFW pump room. The licensee assessed the amount of water that would enter the Unit 2 TDAFW pump room via this pathway. In addition, the maximum LIP flooding elevation outside the Units 1 and 2 CST Valve Gallery doors is projected to be 0.51 ft. above the door sill elevation. Since the CST Valve Gallery floor drains lead to the AFW Pumphouse Sump Rooms, this volume of water was also assessed.

The licensee concluded that the LIP flooding that enters the TDAFW pump rooms would be 2.3 inches (for Unit 1) and 3.56 inches (for Unit 2). The TDAFW pump concrete pads are 6 inches tall, which means that the LIP flood would not impact the TDAFW pump for each unit from being able to perform its SG makeup function under the postulated conditions.

In summary, the licensee concluded in its assessment of the LIP flood that for the Unit 2 DFOS and the Control Building, temporary flood barriers would need to be installed in both locations to ensure that FLEX equipment and pathways would be available to execute the overall FLEX strategy. This would involve modifying existing severe weather procedures to incorporate a warning time for the LIP flood event. The licensee also indicated that the existing seals for the wall penetrations for the DFOS Building, Control Building, Auxiliary Building, and TDAFW pump rooms will be evaluated and sealed as necessary to ensure that any LIP flood water will remain negligible so it will not impact the overall FLEX strategy.

To assess the warning time based upon the LIP flooding event, the Nuclear Energy Institute (NEI) developed a white paper, "Warning Time for Maximum Precipitation Events," Revision 6, submitted to the NRC by letter dated April 8, 2015 (ADAMS Accession No. ML15104A157). The NRC endorsed this white paper, with clarifications, by letter dated April 23, 2015 (ADAMS Accession No. ML15110A080). Subsequently, NEI incorporated the white paper into NEI 15-05, "Warning Time for Local Intense Precipitation Events," Revision 0. The Vogtle analysis of warning time for the LIP event is based upon the NEI 15-05 guidance, which provides parameters for establishing warning time into site procedures using information from relevant forecasting methods, triggering points, and site specific operator actions. The licensee concluded that based on the 6-hour rainfall, the smallest rainfall volume resulting in water surface elevations that exceed the Unit 2 Control Building Equipment Door sill is 23 inches. The rainfall depth over the first hour of the event is calculated to be 14.2 inches, which is considered to be the consequential rainfall depth. The licensee used a trigger of one-half of the consequential rainfall depth (approximately 7.1 inches), as recommended in the NEI 15-05 guidance. The severe weather guidance will be modified to direct operators to deploy temporary flood barriers for rainfall that is projected to be at least 7.1 inches. As far as deployment of FLEX equipment through the designated pathways that could be impacted by the LIP flood, the use of the temporary flood barriers near the Unit 2 DFOS Building and Control Building will allow flood water to be diverted away from those areas. The FLEX DG will be deployed to the alleyway between the Turbine and Control Building to power the station batteries. The licensee projected that the LIP flood water will recede within the first 3 hours after ELAP initiation. This would allow about 7 hours to deploy and stage the FLEX DG as required with the additional assistance of the temporary flood barriers being deployed beforehand.

The NRC staff reviewed the licensee's assessment of the reevaluated LIP event against the existing FLEX strategies as described in the NRC staff's safety evaluation for Order EA-12-049 compliance at Vogtle. The NRC staff finds the modification of the severe weather procedure to incorporate a warning time to pre-deploy the temporary flood barriers at the Unit 2 DFOS Building and north side of the Control Building to be acceptable based upon use of the NRC-approved NEI guidance for establishing warning time for LIP events.

The NRC staff also concludes that the licensee's continual evaluation of existing seal penetrations for the walls in the DFOS Building, Control Building, Auxiliary Building, and TDAFW pump rooms will be sufficient to ensure that any water ingress will remain negligible as it relates to FLEX strategy implementation. The NRC staff notes that issues with the ability to mitigate flooding events have been identified by licensees in the past. Recent examples include those found in Information Notice 2015-01, "Degraded Ability to Mitigate Flooding Events" (ADAMS Accession No. ML14279A268). In addition, NRC is cooperatively performing research with the Electric Power Research Institute to develop flood protection systems guidance that focuses on flood protection feature descriptions, design criteria, inspections, and available testing methods in accordance with a memorandum of understanding dated September 28, 2016 (ADAMS Accession No. ML16223A495). Therefore, the staff expects the licensee will continue to maintain flood protection features in accordance with their current licensing basis. The staff further expects that, as appropriate, continued research involving flood protection systems guidance will be performed and shared with licensees in accordance with the guidance provided in Management Directive 8.7, "Reactor Operating Experience Program" (ADAMS Accession No. ML122750292).

Regarding the FLEX strategy, the TDAFW pumps are located on top of concrete pads shown to be protected from any water ingress inside the TDAFW pump rooms and the licensee's temporary barrier installation, controlled by a procedure with an appropriate trigger point, will allow access and protect the station batteries and associated electrical equipment. Lastly, the NRC staff concurs that the LIP flooding will not impact the Boron Injection FLEX pump based on the licensee's analysis of accumulated water in the Auxiliary Building, as well as the general site grading which is sloped to limit any potential inflow.

3.3 Confirmation of the Flood Hazard Elevations in the MSA

The NRC staff reviewed the flood hazard elevations in the Vogtle MSA and confirmed the flood elevations for the combined dam failure flood-causing mechanism are consistent with the values in the site's MSFHI letter.

For the LIP flood-causing mechanism, the NRC staff commented in the MSFHI letter that the licensee's level-pool modeling approach used to estimate the flood evaluations did not take into account the spatially-varying topography within the power block area. The NRC staff noted this approach results in the maximum LIP flood elevation lower than the plant grade. To address the NRC staff's comment, the licensee updated the LIP modeling as described in the MSA letter. According to the licensee, the updated LIP flood analysis is based on a two-dimensional (2D) FLO-2D modeling software, "Two-dimensional Flood Routing Model by FLO-2D Software, Inc., Nutrioso, Arizona," to evaluate maximum water surface elevations, water depths, flow velocities, and resulting hydrostatic and hydrodynamic loads. Calculation package, "Local Intense Precipitation Maximum Flooding Elevation: VMSA-0040_1-X2CA91_Ver1_0-VogtleLIPCalc," included details regarding the licensee's updated LIP analysis. The staff reviewed this calculation package during the audit process, in accordance with NRC's generic audit plan for MSA reviews dated December 5, 2016 (ADAMS Accession No. ML16259A189).

The licensee reported in the MSA that the resulting LIP water surface elevations vary throughout the site, with the maximum LIP flood elevation of 220.51 ft. MSL at the Unit 1 and 2 CST Valve Gallery doors. This flood elevation is 1.51 ft. higher than the FHRR value or 0.51 ft. above the sill elevation for the CST Valve Gallery doors. The following describes the staff's review of the licensee's updated LIP modeling performed as part of the MSA review.

For the updated LIP flood analysis, the licensee used the same FHRR LIP scenario. That is, the rainfall scenario is based on a 6-hr-10-mi^2 probable maximum precipitation (PMP) estimated using the guideline provided by the National Oceanic and Atmospheric Association's (NOAA's)) Hydrometeorological Reports (HMRs) 51 and 52 (NOAA, 1982). The total cumulative depth of the 6-hr PMP is 31 inches. For the LIP flood modeling, the licensee incrementally arranged the

6-hr PMP to create a front-loaded temporal distribution where the most intense rainfall having value of 6.2 inches occurs in the first 5 minutes.

The licensee's LIP FLO-2D model covers a total area of 1.37 mi^2 and encompasses the full contributing drainage area to the plant site. Since the area exceeds the 1-mi^2 limit for the 1-hr-1-mi^2 PMP criteria defined in the HMR-52, the licensee adopted a 6-hr-10-mi^2 PMP. The licensee stated that the use of the 10-mi^2 PMP is in accordance with the definition of the LIP event per NUREG/CR-7046, "Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America." The licensee also justified in its MSA that the amount of precipitable water available for a storm event longer than 6-hrs would be minimal due to the high-intensity rainfall rate during the first hour of the event. Therefore, the licensee stated that any increase in maximum flood levels due to longer than 6-hour duration storm events is unlikely. The staff reviewed the licensee's estimation of the PMP value and its distribution during the original FHRR review and concluded in its MSFHI letter that the licensee's LIP scenario is reasonable for the purposes of the MSA since it follows the guideline provided by NUREG/CR-7046.

The licensee used the FLO-2D Pro Build No. 16.02.14 to simulate LIP-induced flood elevations. The computational domain of the LIP model encompasses the entire Vogtle site, including the Units 1 and 2 area, the Units 3 and 4 area, and the watershed basin contributing to the area surrounding to the plant (see Figure 3.2.0-1 of this assessment). A uniform 10-ft. square grid scheme was applied over the model domain, having a total of 380,895 grid cells. The licensee mentioned this grid resolution allowed for representing each building by at least one grid cell and enabled the representation of roads and channels adequately. The NRC staff confirmed based on a review of the Google maps that the licensee's model boundaries are adequate to capture the effects of runoff from the plant buildings and surrounding areas.

The licensee's FLO-2D input files include data relating to elevation, Manning's roughness coefficient (or n-value), rainfall, and flow blockage for each grid cell. For the elevation data, the licensee created and used a Digital Elevation Model (DEM) for the plant site using the following four maps:

(1) The existing topographic maps for Units 3 and 4 and some of the surrounding area;
(2) LiDAR points covering Units 1 and 2 provided by SNC;
(3) Plans and profiles for Units 1 and 2; and
(4) LiDAR data from the Georgia Department of Natural Resources in NAVD88 [National Vertical Datum of 1988] used to fill in the areas that drain toward the site but are outside of the areas covered by topographic sources listed above.

The licensee determined Manning's n-values for different land use type using the guideline provided by the FLO-2D Reference Manual. Using aerial imagery maps, the licensee assigned the n-values of: 0.035 for the areas paved by asphalt, concrete, and gravel; 0.04 for building and structure areas; and 0.36 for forest and grass areas. Using the Google map and the FLO-2D Reference Manual, the NRC staff confirmed that the licensee's n-values and their spatial distributions are adequate.

To simulate the LIP flood within the power block area, the licensee used the following realistic or conservative assumptions:

- The FLO-2D model was constructed using the current security barrier alignment surrounding Units 1 and 2 and the future site grading information for Units 3 and 4 as shown on Figure 3.2.0-1 of this assessment.
- Placement of any future security barriers for Units 3 and 4 were not taken into account in the model because they are still under construction. This approach is conservative as runoff from the Units 3 and 4 area to the Units 1 and 2 was uninterrupted.
- Drainage culverts outside of the Power Block Area for all units were not included in the FLO-2D model.
- The model incorporates the steam tunnels that run between the Turbine Building and the reactors. The tunnels extend from the areas adjacent to the east and west walls of the Turbine Building and are generally directed south alongside each of the Containments. For much of their reach, the tunnels are open on top with a heavy grated cover that allows rainfall and runoff to enter and drain. These tunnels therefore act as runoff storage.
- Runoff losses were ignored during the LIP event in order to maximize the runoff. That is, no infiltration or evapotranspiration was considered in the modeling.
- The model uses Area Reduction Factor (ARF) and Width Reduction Factor (WRF) options to account for the flow conditions near steam tunnels and buildings. Some examples are provided below:

    - An ARF value of 0.2 is assigned to the steam tunnel grid elements located east and west of the Turbine Building to prevent overestimation of the storage capacity of the stream tunnels.
    - An ARF value of 0.3 is assigned to the steam tunnel grid elements east and west of the Containments and Auxiliary Building to account for the effects of increased building areas modeled by the 10-ft square grid scheme.
    - An ARF value of 0.2 is assigned to the steam tunnel grid elements located east and west of the Turbine Building where tunnels are not open on top (no grate).
    - WRFs of 1.0 are added along the boundary of some of the grid elements representing the steam tunnels.

The licensee provided the maximum water surface elevations at selected monitoring locations near safety-related building doors (MSA Table 5-1) and at major haul pathways (MSA Table 5-2). Figure 3.2.0-2 of this assessment displays the spatial distribution of the maximum LIP flood inundation depths within the model area. The licensee reported a maximum LIP flood elevation within the power block area of approximately 220.5 ft. MSL. This maximum flood level would occur at the CST Valve Gallery Doors for both Units 1 and 2 (see Figures 3.2.0-3 and 3.2.0-4 of this assessment).

The NRC staff reviewed the licensee-provided LIP FLO-2D model output files and confirmed the maximum flood elevations reported in the MSA. The staff performed a confirmatory run of the licensee-provided FLO-2D model and found no significant numerical instability in its solution or any water budget errors. Therefore, the staff conclude that the licensee's updated LIP flood modeling is acceptable for use in the MSA.

In all, the staff determined the reevaluated flood hazards reported in the MSA letter are adequate for use in the MSA. Flood hazards not bounded by the CDB are summarized in Table 3.2.0-1 of this assessment.

3.4 Evaluation of Flood Event Duration

The NRC staff reviewed information provided by SNC regarding the FED parameters needed to perform the MSA for flood hazards not bounded by the CDB. The FED parameters for the flood-causing mechanisms not bounded by the CDB are summarized in Table 3.2.1-1 of this assessment.

For the LIP flood-causing mechanism, the licensee determined the preparation time based on warning time for consequential flooding as defined by the guideline of NEI 15-05. That is, using the LIP FLO-2D model discussed in the previous section, the licensee analyzed the potential risk for a local thunderstorm that could produce consequential flooding at the site. As a result, the licensee identified that storm events of more than one-half of the PMP value (or 7.1 inches) would create consequential flooding at the site. However, the licensee determined, based on the historical weather data that no local thunderstorms over or nearby the site were found that produced hourly accumulations equal to or greater than one-half of the PMP. In addition, only larger synoptic-scale weather events produce a longer period and higher accumulation of rainfall that would be required to challenge the site. Such synoptic-scale weather systems can be reliably forecasted in advance. Therefore, the licensee determined that the site will have more than 12 hours for the preparation for the LIP flood-causing mechanism. The licensee also reported the periods of inundation and recession of 8.5 hours and 11 hours, respectively. The licensee used the two-dimensional FLO-2D model in its assessment of these FED parameters. The NRC staff reviewed the FLO-2D output files and determine that the LIP FED parameters provided in the MSA are acceptable for use in the MSA.

The licensee stated in its MSA that the FED parameters for the dam failure flood-causing mechanism are not applicable because the reevaluated flood levels for this mechanism will not inundate the plant site. The NRC staff agrees with the licensee's characterization of the dam failure mechanism as described in the site's MSFHI letter.

In summary, the NRC staff agrees with the licensee's conclusion related to determining the FED parameters for the flood-causing mechanism that are not bounded by the CBD as the approach is consistent with the guideline provided by Appendix G of NEI 12-06, Revision 2. Based on this review, the NRC staff determined that the licensee's FED parameters are reasonable for use in the MSA.

3.5 Evaluation of Associated Effects

The NRC staff reviewed information provided by SNC regarding the associated effects (AE) parameters for flood hazards not bounded by the CDB. The AE parameters related to water surface elevation (i.e., stillwater elevation with wind waves and runup effects) are discussed below and summarized in Table 3.2.0-1 of this assessment. The AE parameters not directly associated with water surface elevation are discussed below and are summarized in Table 3.2.2-1 of this assessment.

For the LIP flood-causing mechanism, the licensee concluded in its MSA that the associated effects would be minimal for the following reasons:

- Wave run-up would be minimal in the power block area due to the short duration of the LIP-induced peak flood elevation and the short fetch length.

- Potential debris generated by the LIP flood-causing mechanism would be from unsecured materials located inside the power block area. Procedurally-controlled housekeeping practices described by the licensee minimizes the amount of material/debris that can be moved by the LIP runoff. Therefore, hydraulic or debris loads during the LIP event would be minimal.
- Relatively-high flow velocities associated with the LIP flood-causing mechanism will only occur on the asphalt or paved areas. As a result, any adverse site impacts from potential sediment deposition and erosion are minimal.
- High winds could be generated concurrent to a LIP flood-causing mechanism. However, the winds associated with the LIP flood-causing mechanism are anticipated to be less than those evaluated in the current FLEX strategy which accounts for high winds and debris resulting from a tornado or hurricane.
- The majority of the plant area is paved or covered with concrete or gravel, limiting effectively the volume of rainfall infiltrated during the LIP flood-causing mechanism. Therefore, groundwater seepage would likely be minimal.

The NRC staff confirmed the licensee's conclusion related to the AE parameters for the LIP flood-causing mechanism by reviewing the licensee-provided model output files. The NRC staff confirmed the maximum inundation of approximately 2.9 ft. and maximum water velocity of 3.4 ft./s at the haul path within the power block area. Correspondingly, the NRC staff agrees with the licensee's conclusion that the AE parameters for the LIP flood-causing mechanism are minimal.

For the dam failure flood-causing mechanism, the licensee concluded that AE parameters are not applicable as the reevaluated flood elevations for this flood-causing mechanism will not inundate the plant site. The NRC staff agrees with the licensee's conclusion as this approach is consistent with the guideline provided by Appendix G of NEI 12-06, Revision 2.

In summary, the NRC staff concludes the licensee-provided AE parameters for flood causing mechanisms that are not bounded by the CDB are acceptable for use in the MSA.

3.6 Conclusion

The NRC staff has reviewed the information provided in the Vogtle MSA related to the original FLEX strategies, as evaluated against the reevaluated hazard(s) described in Section 3.2 of this staff assessment, and found that the licensee has adequately assessed the MFSHI for the reevaluated LIP flood event to determine that the FLEX strategy can be implemented as currently designed with the modification of existing severe weather procedures. The NRC staff made its determination based upon:

- The inclusion of the warning time in the severe weather procedures for projected rainfalls at 7.1 inches in order to deploy temporary flood barriers at the Unit 2 DFOS Building and north side of the Control Building;

- The licensee's ongoing evaluation of existing seals for the wall penetrations in the DFOS Building, Control Building, Auxiliary Building, and TDAFW pump rooms with resealing as needed; and

- The existing water diversion features near the Auxiliary Building and concrete pads in the TDAFW pump rooms that will protect existing SSCs and FLEX equipment so that they will function as required for the overall FLEX strategy.

The staff notes that the procedural revisions, penetration evaluations, and flood protection modifications that the licensee describes in its MSA are subject to future NRC inspection.

Therefore, assuming completion of the procedural revisions, penetration evaluations, and flood protection modifications described in the licensee's MSA report, the NRC staff concludes that the licensee has demonstrated the capability to deploy the original FLEX strategies, as designed, against a postulated beyond-design-basis event for the LIP, including associated effects and flood event duration, as described in NEI 12-06, Revision 2 and ISG-2012-01, Revision 1.

4.0 CONCLUSION

The NRC staff has reviewed the information provided in the Vogtle MSA related to current FLEX strategies, as evaluated against the reevaluated hazard described in Section 3 of this staff assessment, and found that:

- Impacts to the FLEX strategies have been adequately identified;
- Revised sequence of events and FLEX procedures are not required to account for the reevaluated LIP flood hazard provided flood preparation procedures are revised and flood protection modifications are implemented; and
- The licensee has provided an adequate description and justification of flood protection features necessary to implement the FLEX strategy to account for the reevaluated LIP flood hazard.

The NRC staff concludes that the licensee has demonstrated the capability to deploy modified FLEX strategies against a postulated BDB event for the LIP flood-causing mechanism, including associated effects and flood event duration, as requested in the COMSECY-14-0037, and affirmed in the corresponding SRM. The NRC staff confirmed that the Vogtle flood hazard MSA was performed consistent with the guidance in Appendix G of NEI 12-06, Revision 2, as endorsed by JLD-ISG-2012-01, Revision 1. Based on the licensee's appropriate flood hazard characterization, methodology used in the Vogtle MSA evaluation, and the description of its combination of strategies (i.e., current FLEX strategy and modified FLEX strategy), the NRC staff concludes that the licensee has demonstrated that the mitigation strategies, if appropriately implemented, are reasonably protected from reevaluated flood hazard conditions.

Table 3.2.0-1. Reevaluated Flood Hazards for Flood-Causing Mechanisms for Use in the MSA.

Flood-Causing Mechanism	Stillwater Elevation (ft. MSL)	Waves/Runup	Reevaluated Hazard Elevation (ft. MSL)	Reference
Local Intense Precipitation and Associated Drainage	220.5	Minimal	220.5	MSA Table 6-1
Failure of Dams and Onsite Water Control/Storage Structures	166.0	3.4 ft. for Wind Effects	178.1	FHRR Section 2.3

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

Table 3.2.1-1. 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	More than 12 hours or use NEI 15-05 (NEI, 2015) for warning time.	8.5 hours	11 hours
Failure of Dams and Onsite Water Control/Storage Structures (1)	Not Applicable	Not Applicable	Not Applicable

Source: MSA

Notes

1. The FED parameters for the dam failure flood-causing mechanism are not applicable as the reevaluated flood levels for this mechanism will not inundated the plant site.

TABLE 3.2.2-1. ASSOCIATED EFFECTS PARAMETERS NOT DIRECTLY ASSOCIATED WITH TOTAL WATER HEIGHT FOR FLOOD-CAUSING MECHANISMS NOT BOUNDED BY THE CDB.

Associated Effects Parameter	Local Intense Precipitation and Associated Drainage	Failure of Dams and Onsite Water Control/Storage Structures (1)
Hydrodynamic loading at plant grade	Minimal	Not Applicable
Debris loading at plant grade	Minimal	Not Applicable
Sediment loading at plant grade	Minimal	Not Applicable
Sediment deposition and erosion	Minimal	Not Applicable
Concurrent conditions, including adverse weather - Winds	Minimal	Not Applicable
Groundwater ingress	Minimal	Not Applicable
Other pertinent factors (e.g., waterborne projectiles)	Minimal	Not Applicable

Source: MSA

Notes:

1. The AE parameters for the dam failure flood-causing mechanism are not applicable as the reevaluated flood levels for this mechanism will not inundated the plant site.

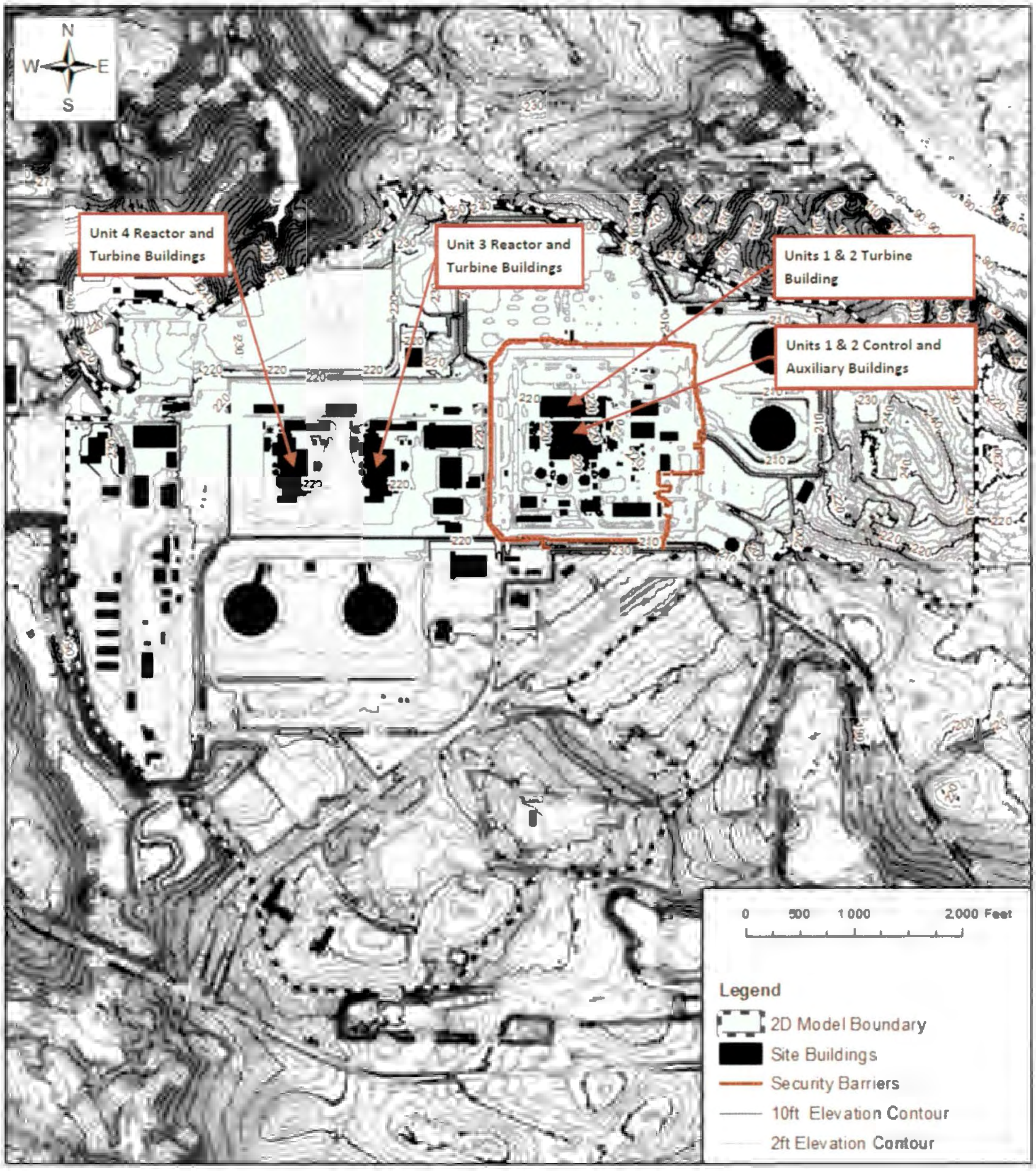

Figure 3.2.0-1. Site topographic map with FLO-2D model boundary and security barriers (taken from SNC (calc. package - VMSA-0040_1-X2CA91_Ver1_0-VogtleLIPCalc).

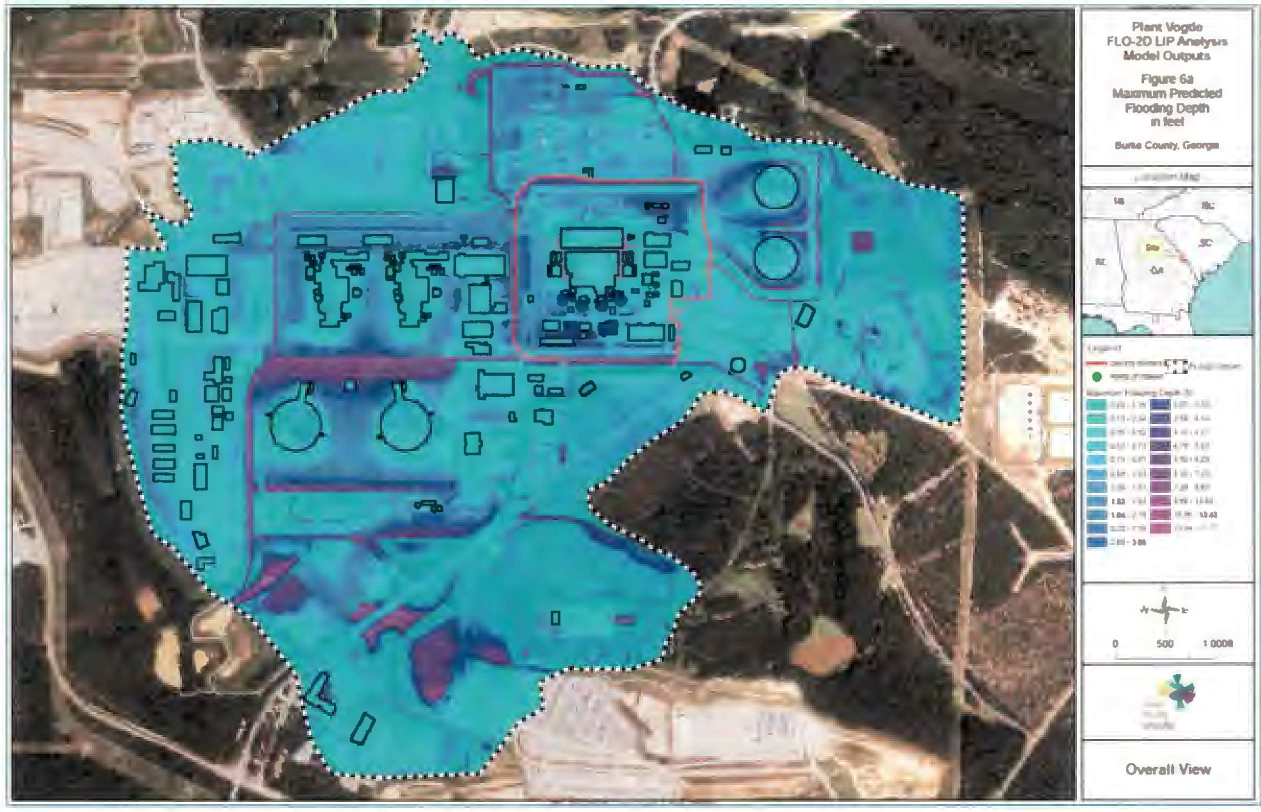

Figure 3.2.0-2. Map showing the maximum inundation depths for the LIP flood-causing mechanism using the FLO-2D model (taken from calc. package - VMSA-0040_1-X2CA91_Ver1_0-VogtleLIPCalc).

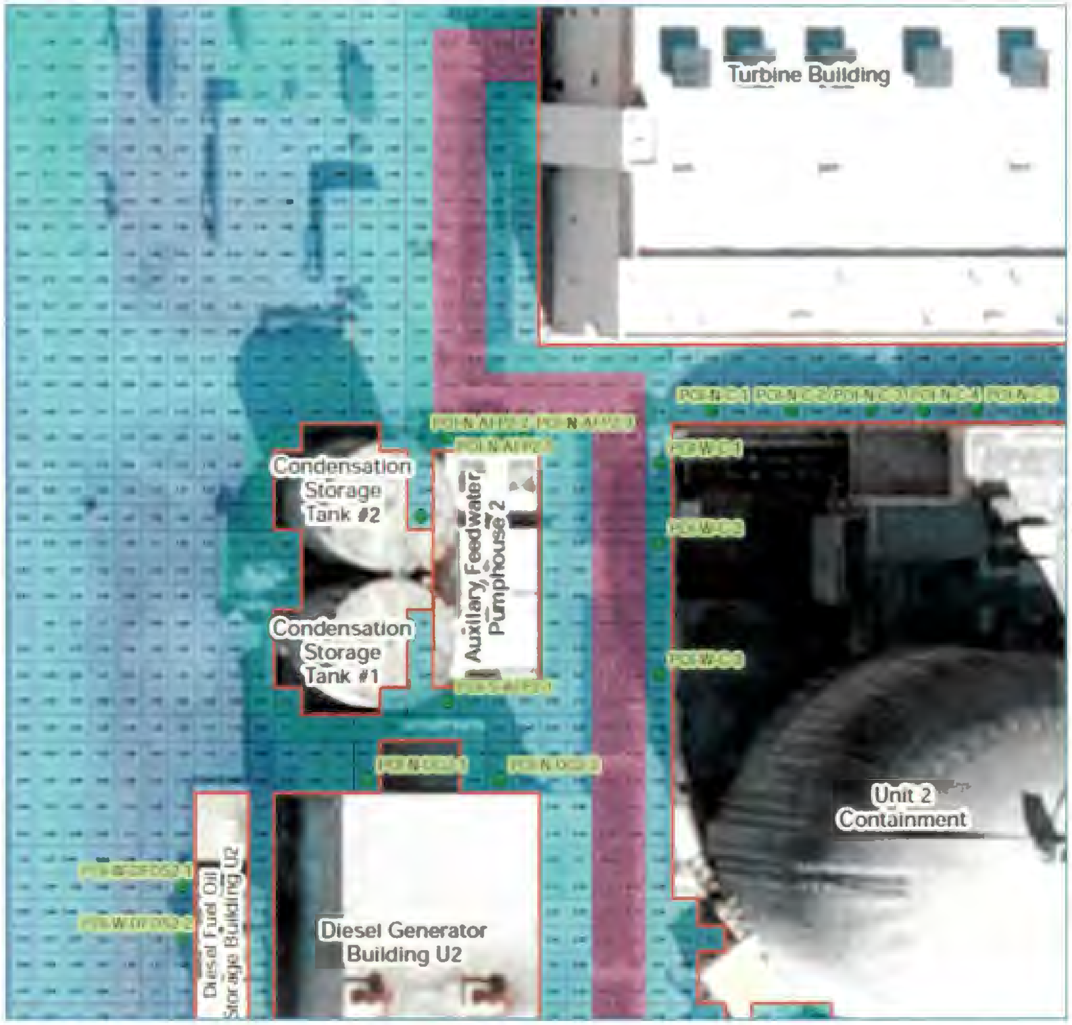

Figure 3.2.0-3. Example of points of interest near the Unit 2 Condensation Storage Tanks (taken from calc. package - VMSA-0040_1-X2CA91_Ver1_0-VogtleLIPCalc).

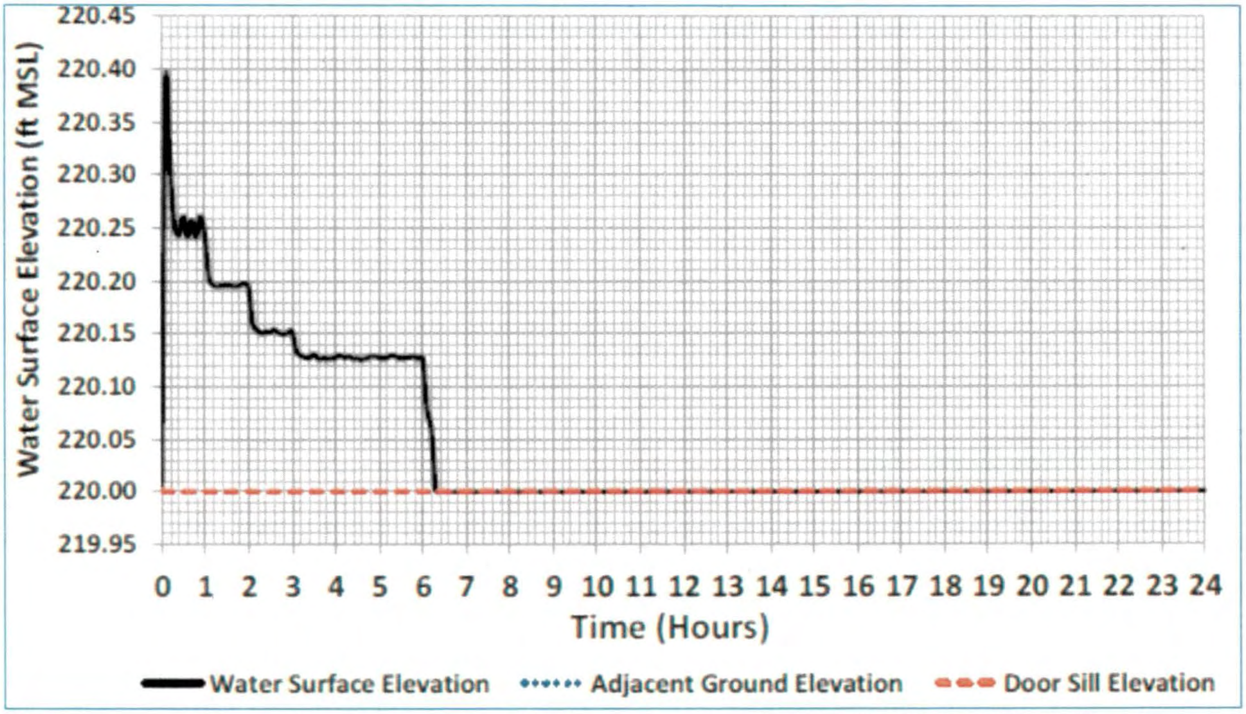

Figure 3.2.0-4. Example of a simulated LIP hydrograph at POI-E-AFP1-1 (CST Gallery Door for Unit 1) using FLO-2D (taken from calc. package - VMSA-0040_1-X2CA91_Ver1_0-VogtleLIPCalc).

VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT DATED AUGUST 10, 2017

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