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

August 22, 2017

Mr. Joseph W. Shea
Vice President, Nuclear Regulatory
Affairs and Support Services
Tennessee Valley Authority
1101 Market Street, LP 3R-C
Chattanooga TN 37402-2801

SUBJECT: WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NOS. MF7990 AND MF7991)

Dear Mr. Shea:

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*, 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 report (ADAMS Accession No. ML111861807).

Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their site(s) using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses. 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 have been based on present-day methodologies and guidance, in the development of their mitigating strategies.

By letter dated December 27, 2016 (ADAMS Accession No. ML16363A381, non-publicly available), Tennessee Valley Authority (the licensee) submitted its flooding mitigation strategies assessment (MSA) for Watts Bar Nuclear Plant, Units 1 and 2 (Watts Bar). 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 Watts Bar MSA.

The NRC staff has concluded that the Watts Bar 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 hazard conditions for beyond-design-basis external events. This closes out the NRC's efforts associated with CAC Nos. MF7990 and MF7991.

If you have any questions, please contact me at 301-415-3809 or at Juan Uribe@nrc.gov

Sincerely,

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

Docket Nos. 50-390 and 50-391

Enclosure:
1. Staff Assessment Related to the Mitigating Strategies for Watts Bar (non-public)
2. Staff Assessment Related to the Mitigating Strategies for Watts Bar (public)

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO MITIGATION STRATEGIES FOR WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2 AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM TASK FORCE RECOMMENDATION 2.1 – FLOODING (CAC NOS. MF7990 AND MF7991)

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 respective site(s) using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses. 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 have been 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 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). As discussed in JLD-ISG-2012-01, Appendix G of NEI 12-06, Revision 2, describes acceptable methods for demonstrating that the reevaluated flooding hazard is addressed within the Watts Bar Nuclear Plant, Units 1 and 2 (Watts Bar) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated June 16, 2015 (ADAMS Accession No. ML15169A904), Tennessee Valley Authority (TVA, the licensee) submitted its flood hazard reevaluation report (FHRR) for Watts Bar Nuclear Plant, Units 1 and 2 (Watts Bar). By letter dated September 3, 2015 (ADAMS Accession No. ML15239B292), the NRC issued an interim staff response (ISR) letter for Watts Bar. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Watts Bar, which were to be used in conducting the mitigating strategies assessment (MSA), as described in NEI 12-06. For Watts Bar, the mechanisms listed as not bounded by the CDB in the ISR letter are local intense precipitation (LIP) and streams and rivers. By letter dated December 1, 2015 (ADAMS Accession No. ML15310A085), the NRC issued a FHRR staff assessment that provided the documentation supporting the NRC staff's conclusions summarized in the ISR letter.

By letter dated December 27, 2016 (ADAMS Accession No. ML16363A381, non-publicly available), TVA submitted its MSA for Watts Bar, Units 1 and 2 for review by the NRC staff.

3.0 TECHNICAL EVALUATION

3.1 Mitigating Strategies under Order EA-12-049

By letter dated February 28, 2013 (ADAMS Accession No. ML13067A030), TVA submitted its Overall Integrated Plan (OIP) for Watts Bar in response to Order EA-12-049. At 6 month intervals following the submittal of its OIP, the licensee submitted reports on its progress in complying with Order EA-12-049. By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" (ADAMS Accession No. ML082900195). By letters dated December 20, 2013 (ADAMS Accession No. ML13343A036), and May 15, 2014 (ADAMS Accession No. ML14128A129), the NRC staff issued an Interim Staff Evaluation and audit report, respectively, on the licensee's progress. By letter dated March 12, 2015 (ADAMS Accession No. ML15072A116), TVA submitted its compliance letter and the Final Integrated Plan (FIP) in response to Order EA-12-049. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-049.

By letter dated March 27, 2015 (ADAMS Accession No. ML15078A193), the NRC staff issued a safety evaluation documenting the results of the NRC staff's review of the FLEX strategies for Watts Bar. The safety evaluation concluded that the integrated plans, if implemented as described, should adequately address the requirements of Order EA-12-049.

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

- Operators will take prompt actions to minimize Reactor Coolant System (RCS) inventory losses by isolating potential letdown paths. RCS makeup to account for reactor coolant pump seal leakage and RCS inventory contraction is initially provided from the safety injection system cold leg accumulators. Decay heat is removed by steaming to the atmosphere from the steam generators (SGs) through the atmospheric relief valves, and makeup to the SGs is initially provided by the turbine-driven auxiliary feedwater pump (TDAFWP).

- Phase 2 of FLEX includes aligning and placing into service the pre-staged 480 volt (V) FLEX diesel generators (DGs) and the 6.9 Kilovolt (kV) FLEX DGs. The 480 V FLEX DGs would provide charging current to the 125 Volt direct current (Vdc) vital batteries and ensure that 125 Vdc vital battery power (control) and the 120 Volt alternating current (Vac) vital instrument power (instrument indication) remain available.

- If the 125 Vdc vital chargers are not energized and thus not supplying the 125 Vdc vital batteries, then TVA's plan directs operators to complete an extended load shed for any vital battery not being supplied its required load within 90 minutes following the start of the ELAP [extended loss of ac Power] event. This would ensure that the 125 Vdc vital batteries could supply power for an 8-hour coping duration and provide sufficient time to align and connect the FLEX DGs to the Watts Bar electrical distribution system.

- Following dc load stripping and prior to battery depletion, the pre-staged 480 Vac generators will be aligned to the Watts Bar electrical distribution system. These generators will be used to repower essential battery chargers as well various FLEX pumps and FLEX loads. The 6.9 kV 3 MW FLEX DGs are also staged to power various plant systems at approximately 5 hours into the event.

- Procedures to initiate RCS makeup and boration will be started at 3.5 hours following event initiation and injection will occur within 5 hours of the ELAP with loss of normal access to the ultimate heat sink event. Operators will provide reactor coolant makeup using the Safety Injection (SI) pumps from either the refueling water storage tank (RWST) or the Boric Acid Tanks (BATs) and inject through the normal flow paths. The FLEX high-pressure motor-driven pumps, will be available at 8.5 hours to inject into the RCS from either the RWST or the BATs.

- The Watts Bar units have ice condenser containment buildings. TVA performed a containment evaluation and determined that no immediate containment cooling or action is required. The licensee's containment evaluation concluded that temperature and pressure stays within acceptable levels in the early phase of the event. At approximately 60 hours into the event, the containment analysis recommends a 10 minute run of a Containment Air Return Fan. This operation ensures ice condenser doors open and enhance flow through the ice condenser to mitigate containment conditions for a significant period of time past 72 hours of the event.

- To support long term containment integrity, if needed, TVA plans to utilize the 6.9 kV FLEX DGs to power hydrogen igniters for hydrogen mitigation and provide the Lower Compartment Coolers (LCCs) with cooling water supplied by the Essential Raw Cooling

Water (ERCW) system headers fed by deployed diesel powered low pressure (LP) FLEX pumps.

3.2. Licensee Evaluation of Current FLEX Strategies Against Reevaluated Hazard(s)

The licensee has assessed the potential impacts of the LIP and streams and rivers flood-causing mechanisms, as described in the ISR letter, against the mitigating strategies designed to meet Order EA-12-049. The purpose of the MSA was to determine if the licensee's mitigating strategies are adequate as-is, need to be modified, or new mitigating strategies need to be developed to address exceedances as described in the ISR letter.

Overall, the licensee determined in its evaluation that LIP and streams and rivers (which has been revised, as discussed below) do not impact the site and therefore, the current FLEX strategies can be implemented without any changes to the overall strategy or timeline at Watts Bar, including deployment and staging of equipment.

3.2.1 Summary of Mitigating Strategies Assessment

The licensee described in its FIP that implementation of the FLEX strategies at Watts Bar is divided into three phases. In general, the first phase is to initially cope by relying on installed plant equipment and on-site resources, the second phase is to transition from installed plant equipment to the onsite FLEX equipment, and the third phase is to obtain additional capability and redundancy from off-site equipment. Watts Bar is located on the Tennessee River with plant grade at elevation 728 feet (ft.) mean sea level (MSL).

For LIP, the licensee evaluated the current FLEX strategies against a reevaluated hazard of 729.2 ft. MSL. Portable and pre-staged equipment required to implement the FLEX strategies will be maintained in the FLEX Equipment Storage Building (FESB), Auxiliary Building (AB), intake pumping station, and 5th DG Building in locations functionally above the PMF level, or in areas of pre-flood access and distribution, or will be capable of submersible operation. To support core cooling, the licensee stated that the Low Pressure (LP) FLEX Pumps staged in the intake pumping station would have to be relocated to higher ground prior to the arrival of floodwaters.

In Attachment 1 of the MSA titled, "Watts Bar Nuclear Plant LIP Effect on FLEX Timeline," the licensee provided a detailed sequence of events timeline describing the site's FLEX actions as a result of a reevaluated LIP hazard event. The licensee stated that the LP FLEX pumps are the only externally deployed FLEX equipment during the relatively short LIP inundation period (bounding timeframe). These pumps are deployed 1-hour after the initiating ELAP event, and the action takes 4.5-hours to complete. These pumps are deployed from the FESB to the intake channel. The licensee looked at the haul routes with regards to the LIP event flooding. From the initiation of the event, the assessment showed that approximately 1.4 ft. of water would exist above the haul road during a LIP event with the water receding to haul road grade within 1.5 hours.

The licensee stated in its MSA that after an ELAP is declared, personnel are dispatched to the FESB in order to connect the FLEX equipment to the trucks and open the FESB doors. At approximately 80 minutes from the start of the event, the dispatched personnel can travel the haul route. When compared to the approximately 90 minute inundation period for a LIP event

and taking into account that floodwaters have receded based on runoff, minimal to no impact is expected to occur to the FLEX deployment strategies. Finally, the licensee stated that simulation of these activities indicates that an additional 1 hour of margin (or more) is built into the time for deployment of the LP FLEX pumps; therefore there is additional margin if a deployment delay should occur. The licensee also described in its MSA that other time sensitive deployment activities occurring prior to 1-hour, such as aligning and placing into service the pre-staged 480v FLEX DGs, take place inside or on the roof of the AB and are not affected by the LIP event.

With regards to flooding from streams and rivers, the licensee provided additional information in its MSA to discuss with combined effects of wind wave activity. The probable maximum flood (PMF) elevation of [[ ]] was confirmed in the ISR letter along with the wind wave elevation of [[ ]].

As a result of this hazard exceedance, the licensee discussed the FLEX strategies including the deployment and prestaging equipment above the flood levels. The 480 V and 6.9 kV FLEX generators, as well as their fuel oil makeup source are stored above the flood height and are therefore not expected to be impacted. The LP FLEX pump will be moved higher and higher as the flood rises and its final deployment is above the maximum flood height with wind waves. The high pressure (HP) and intermediate pressure (IP) FLEX pumps are stored in the AB and function while submerged.

Finally, the licensee stated in its MSA that warning time will allow for more pre staging of FLEX equipment including hoses and cables. The warning time shown in the MSA that is allowable for Stage I and Stage II is 27 hours. The licensee stated that the pre-staging of the FLEX equipment should take less than 5 hours.

3.3 NRC Staff Technical Evaluation

The NRC staff has reviewed the information presented in the MSA, as well as supporting documentation. This included:

- Review of licensing documents and previous NTTF flooding submittals;
- Review of the topographical features of the site; and
- Review and documentation of existing mitigating strategies under Order EA-12-049.

As part of its MSA review, the NRC staff sought to confirm if the unbounded reevaluated hazard(s) impacted any of the FLEX storage location(s), any staging areas, haul paths, connection points, activities, timelines, etc. The NRC staff also reviewed the flood hazard elevations in the MSA in order to confirm if the elevations matched the values provided in the Watts Bar ISR letter. As previously stated, the following reevaluated flood-causing mechanisms were identified as not bounded by the CDB: LIP and streams and rivers.

For LIP, the NRC staff confirmed that the stillwater surface elevation reported in the MSA matches the value in the ISR letter of 729.2 ft. MSL. The NRC staff notes that wind/wave contributions were determined to be minimal. With regards to warning time, no protective actions prior to the LIP event rainfall are required at Watts Bar and therefore are not credited.

With regards to the deployment of equipment, the NRC staff notes that the first externally deployed equipment (LP FLEX pumps) occurs 1 hour after the start of the LIP event and dispatched personnel can begin travel on the haul routes at approximately 80 minutes from the start of the event. At this point of the deployment timeline, it is expected that the 1.4 ft. of peak water above the haul path will have substantially receded to 4 inches (or less) of water over the haul road. Therefore, the NRC staff agrees that it is reasonable to assume that FLEX deployment vehicles are capable of navigating through the potential water that remains at the time of deployment. In addition, the licensee has shown that the strategy for deployment of the LP FLEX pumps includes an additional 1-hour of margin (based on actual simulations), which provides additional margin should the licensee need to delay the deployment.
As stated in the MSA, all other outdoor FLEX deployment actions take place sufficiently after the end of the LIP inundation period and therefore, no impact is expected to occur. In addition, the LIP event does not impact other pre-staged equipment or the FESB.

The NRC staff notes that the Phase 2 FLEX response activities (RCS makeup and boration, SG makeup) are scheduled to begin 1-hour after the initiating event and are all located internal to plant structures. As a result, the NRC staff agrees that no impact is expected to occur as a result of the reevaluated LIP hazard. Finally, the NRC staff also notes that RCS makeup and boration activities have been previously reviewed by the NRC and documented in the March 27, 2015, safety evaluation (Section 3.2.3.2 "Thermal-Hydraulic Analyses).

The other pumps and DGs used during an ELAP event (coincident with the LIP period of inundation) are pre-staged and inside their respective buildings. The LIP event does not impact the ability to set up and operate these pieces of FLEX equipment. As a result of the above, the NRC staff agrees LIP is not expected to impact the FLEX response at Watts Bar.

For streams and rivers, the NRC staff confirmed that the elevations reported in the MSA match the values in the ISR letter. With regards to storage of FLEX equipment, the licensee stated in its MSA that the FESB floor elevation is 742.0 ft. MSL and the PMF plus wind wave elevation is [[ ]]. As a result, the reevaluated flood hazard elevation should not affect the FESB or the equipment stored inside, which includes the 6.9 kV FLEX DGs that are pre-staged inside.

Watts Bar credits warning time in order to prepare for potential PMF flood conditions. The site has a 27 hour Stage 1 and Stage II flood operations time allowed to prepare the site for the flood. During this time, the licensee will pre-stage FLEX equipment as described in the MSA as well as in the March 27, 2015 safety evaluation. With regards to the first deployed equipment, the LP FLEX pumps would initially be deployed below the predicted flood height at the Intake Pumping Station, with elevation 710.0 ft. MSL. As the floods rise, the pump would be relocated to higher elevations including the cooling tower basin at 728.0 ft MSL, and the 5th DG Building at 742.0 ft. MSL. Ultimately, the final deployment location is above the expected PMF and wind wave elevation of [[ ]]. Other equipment used by Watts Bar to mitigate and ELAP event are shown to be protected from the reevaluated PMF flood as well. Equipment such as the 480 V FLEX DGs are stored on the roof of the auxiliary building. The HP and IP FLEX pumps are designed to be used submerged and are stored and operated in the AB.

As a result of the above, the NRC staff agrees that the streams and rivers reevaluated hazard is not expected to impact the FLEX response at Watts Bar.

3.3.1 Evaluation of Flood Event Duration

The NRC staff reviewed information provided by TVA regarding the flood event duration (FED) parameters 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 3.3.1-1.

For LIP, the re-evaluated analysis discussed in the FHRR utilized a steady state Hydrologic Engineering Center and River Analysis System (HEC-RAS) model to estimate the flood elevation at critical door locations. Since the steady state model cannot provide flood event duration parameters, the licensee ran an unsteady-flow simulation of the HEC-RAS model to estimate flood event durations parameters. The licensee notes in the MSA report that flood elevations at critical exterior door locations slightly decreased when compared to those of the steady-flow HEC-RAS model results reported in the FHRR. However, the licensee reported higher FHRR flood elevation values in the MSA report. The licensee stated in the MSA that based on the results of the unsteady-flow simulation, the period of inundation is 1.5 hours (the recession period at the haul road is included in the inundation period). Based on the new model results, the licensee determined that mitigation of the LIP event does not require any protective actions to occur prior to the start of the rainfall event and therefore, warning time is not credited. The NRC staff had previously reviewed and determined that the licensee's LIP HEC-RAS model is acceptable and follows present-day methodologies and regulatory guidance. As part of its MSA review, the NRC staff performed a confirmatory simulation of the licensee-provided HEC-RAS model in unsteady-flow mode consistent with the MSA. The staff used the licensee's inflow hydrographs generated by the HEC-HMS model as input data to the unsteady-flow HEC-RAS model for computing water surface elevations during the flood event. The NRC staff confirmed that the results of the licensee's unsteady-flow computation are reasonable. Therefore, the staff concluded that the licensee's FED parameters for the LIP event are acceptable for use in the MSA analysis.

Based on the FHRR numerical model, a warning time of 75 hours and a period of inundation of 114 hours for the riverine flood-causing mechanism was found to be reasonable by the NRC in the September 3, 2015, staff assessment. In its MSA report, the licensee states that the warning time for FLEX Stage I and II is 27 hours, the FLEX pre-stage warning time to be 12.5 hours, and additional communication and forecasting computational time to be 4 hours; for a total period of site preparation of 43.5 hours. The NRC staff's review of the licensee's reported period of 43.5 hours for preparation time was found to be acceptable. This is, in part, because it is a shorter period (and therefore more conservative) than the warning time of 75 hours, which was previously found to be reasonable as documented in the staff assessment.

In its FHRR, the licensee had previously reported that the inundation period at the plant site was 114 hours. The site inundation starts at 219 hours 40 minutes after starting of the pre-storm (i.e., March 15th) or at 75 hours after starting of the main storm (i.e., March 21st). However, in its MSA, the licensee stated that the CDB periods of inundation and recession are not applicable because all design-basis preparation activities necessary to protect the plant facilities will be implemented prior to site inundation. The licensee also stated in its MSA that the off-site access road from Knoxville may be blocked by flood waters for 209 hours beginning at the start of the inundation which occurs at 170 hours after the pre-storm starts (i.e., March 15th). That is, the inundation at the plant site and access road ends at 333 hours 40 minutes, which is approximately 379 hours after the start of the pre-storm. Therefore, a recession time of approximately 45 hours was estimated based on the licensee's numerical modeling results. The NRC staff previously confirmed in its review of the FHRR that the licensee's riverine flood

modeling followed present-day methodologies and regulatory guidance. As a result, the NRC staff concludes that the licensee's FED parameters are acceptable for the purposes of the MSA analysis.

3.3.2 Evaluation of Associated Effects

The NRC staff reviewed the information provided by the licensee regarding associated effects (AE) parameters for hazards not bounded by the CDB. The AE parameters related to water surface elevation (i.e., stillwater elevation with wind waves and runup effects) were previously reviewed by staff, and were transmitted to the licensee via the ISR letter. The AE parameters not directly associated with water surface elevation are discussed below and are summarized in Table 3.3.2-1 of this assessment.

For LIP, the licensee stated in its MSA that all AEs including hydrostatic and hydrodynamic loads, debris, erosion and deposition, groundwater ingress, and other associated effects are minimal due to the shallow water depths and relatively-slow water velocities. The NRC staff confirmed the licensee's conclusion by comparing the results of the licensee's unsteady-flow HEC-RAS modeling and the NRC staff's confirmatory simulation as previously described in Section 3.3.1 above. Through this comparison, the NRC staff identified that the inundation depths and small water velocities reported in the FHRR are reasonable and the resulting hydrostatic and hydrodynamic loads at the plant are minimal. Therefore, the NRC staff concluded that the licensee's AE parameters for the LIP flood-causing mechanism are acceptable for use in the MSA analysis.

For streams and rivers, the licensee stated in its MSA that all AEs including hydrostatic and hydrodynamic loads, sediment deposition and erosion, debris, groundwater ingress, and other associated effects are minimal due to the extended warning time and site-preparation activities. As stated in the MSA, the site-preparation activities would be completed prior to site inundation. The NRC staff reviewed the licensee's justifications and discussions related to these AE parameters and concludes they are reasonable for the purposes of the MSA. In summary, the NRC staff concluded that the licensee's methods are appropriate and the AE parameters are reasonable for the purposes of the MSA analysis.

3.4 Conclusion

The NRC staff has reviewed the information provided in the Watts Bar MSA related to the original FLEX strategies, as assessed against the reevaluated hazards. The NRC staff concludes that the licensee has reasonably demonstrated its capability to implement FLEX strategies, as designed, against the reevaluated hazards described in the ISR letter.

The NRC staff made its determination based upon:

- Consideration that a reevaluated LIP hazard is not expected to impact the storage, deployment and/or staging areas of FLEX equipment given the estimated floodwaters present during the deployment and the physical characteristics of the haul paths and staging areas.

- Consideration that the other time sensitive deployment activities occurring prior to 1-hour take place inside or on the roof of the AB and are not affected by the LIP event.

- All Phase 1 and 2 strategies, as currently designed, contain sufficient margin to allow local floodwaters to recede prior to any established FLEX actions or equipment deployment. As a result, implementation timelines should not be impacted.

- The availability of warning time for streams and rivers, which was determined using accepted methodology, and its incorporation into plant procedures. This warning time allows for additional staging of FLEX equipment for the streams and rivers combined effects event.

Therefore, the NRC staff concludes that the licensee has demonstrated to have the capability to implement the original FLEX strategies, as designed, under the conditions associated with the reevaluated LIP, and streams and rivers mechanisms (including AEs and FED parameters), as described in NEI 12-06, Revision 2, and JLD-ISG-2012-01, Revision 1.

4.0 CONCLUSION

The NRC staff has reviewed the information presented by the licensee in the MSA for Watts Bar. The NRC staff confirmed that the licensee's flood hazard MSA for Watts Bar 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 use of the hazards characterized in the NRC staff's ISR letter, the methodology used in the Watts Bar MSA evaluation, and the description of its current FLEX strategy in the Watts Bar MSA and supporting documentation; the NRC staff concludes that the licensee has demonstrated that the mitigation strategies appear to be reasonably protected from reevaluated flood hazards conditions.

Table 3.3.1-1. 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	Not Credited(2)	1.5 hours	Minimal
Streams and Rivers	43.5 hours	114 hours	45 hours (1)

Notes:
(1): Based on information provided to support the MSA.
(2): If needed, develop warning time using the guidelines of NEI 15-05, "Warning Time for Local Precipitation Events"

Table 3.3.2-1. 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	Streams and Rivers[1]
Hydrodynamic loading at plant grade	Minimal	Minimal Impact for MSA
Debris loading at plant grade	Minimal	Minimal Impact for MSA
Sediment loading at plant grade	Minimal	Minimal Impact for MSA
Sediment deposition and erosion	Minimal	Minimal Impact for MSA
Concurrent conditions, including adverse weather - Winds	Minimal	Minimal Impact for MSA
Groundwater ingress	Minimal	Minimal Impact for MSA
Other pertinent factors (e.g., waterborne projectiles)	Minimal	Minimal Impact for MSA

Source: Watts Bar MSA

Note:

(1) Reasonable for the purposes of the MSA due to the duration of the warning time and site preparations prior to any site inundation.

WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT DATED AUGUST 22, 2017

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NAME	JMiller	SLent	TBrown	NSanfilippo	JUribe
DATE	6/28/2017	7/20/2017	8/3/2017	8/3/2017	8/22/17

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