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

March 23, 2020

Mr. James Barstow
Vice President, Nuclear Regulatory Affairs
and Support Services
Tennessee Valley Authority
1101 Market Street, LP 4A-C
Chattanooga, TN 37402-2801

SUBJECT: SEQUOYAH NUCLEAR PLANT, UNITS 1 & 2 – STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION (EPID NO. L-2019-JLD-0010)

Dear Mr. Barstow:

The purpose of this letter is to document the staff's evaluation of the Sequoyah Nuclear Plant, Units 1 & 2 (Sequoyah) flooding focused evaluation (FE) which was submitted in response to Near-Term Task Force (NTTF) Recommendation 2.1 "Flooding." The U.S. Nuclear Regulatory Commission (NRC) has concluded that based on the licensee's evaluation and the staff's independent assessment, no further response or regulatory actions are required to address the reevaluated flood hazard at the site.

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the NRC issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, under Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's 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. ML12056A048).

By letter dated March 12, 2015 (ADAMS Accession No. ML15071A462), Tennessee Valley Authority (TVA, the licensee) responded to this request for Sequoyah by providing its flood hazard reevaluation report (FHRR). By letter dated September 3, 2015 (ADAMS Accession No. ML15240A134), the NRC issued an interim staff response (ISR) letter for Sequoyah. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Sequoyah that are a suitable input for further assessments as the site's response to the 50.54(f) letter. As stated in the ISR letter, because the local intense precipitation (LIP) and streams and rivers flood-causing mechanisms at Sequoyah are not

Enclosure 1 transmitted herewith contains Security-Related Information and Critical Electric Infrastructure Information (CEII). When separated from Enclosure 1, this document is decontrolled.

bounded by the plant's CDB, additional assessments of those flood hazard mechanisms are expected to be performed by the licensee.

By letter dated October 11, 2019 (ADAMS Accession No. ML19284F762, non-public, CEII, security-related information), the licensee submitted an FE for Sequoyah. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood mechanism is bounded based on a reevaluation of the flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is LIP. The purpose of this letter is to provide the NRC's assessment of the Sequoyah FE.

The licensee provided an FHRR analysis update as Attachment A to the FE. The updated analysis utilizes a new site-specific probable maximum precipitation (PMP). In addition to the use of a site-specific PMP, the following key changes were made in the FHRR analysis update:

1. Updated the channel geometry and/or the overbank storage volumes of the stream course model consistent with recommendations from the U.S. Army Corps of Engineers.
2. Updated the dam stability analysis to account for a modification at Douglas dam.
3. Updated the rainfall distribution methodology to be consistent with the gridded rainfall data format used to develop the new PMP and to apply TVA's antecedent precipitation index.

In a letter to the NRC dated January 14, 2020 (ADAMS Accession No. ML20016A396), TVA submitted an application to revise the Sequoyah updated final safety analysis report (UFSAR) regarding changes to the hydrologic analysis. The same methodologies are used in the license amendment request (LAR) and the FHRR analysis update provided with the FE.

The staff did not perform a detailed evaluation of the methodology associated with the FHRR analysis update to complete the FE assessment. For the LIP flood-causing mechanism, the FHRR analysis update change was minor (decrease by 0.1 feet (ft.)) and remains bounded by the licensee's evaluation in the original FHRR. Both the original and updated analysis are not bounded by the CDB. For the streams and rivers flood-causing mechanism, the original FHRR hazard levels are below the CDB, when dam modifications are completed and an emergency action plan (EAP) is in place. The FHRR analysis update addresses the long-term actions associated with the EAP.

The staff will evaluate the methodology associated with the FHRR analysis update and associated flood levels as part of the LAR review. Since the same methodologies are used in the LAR and the FHRR analysis update in the FE, a detailed review of the methodologies is not required for the staff to complete its assessment of the FE.

In addition to the FHRR analysis update, TVA also provided an updated warning time analysis in Attachment B to the FE. The staff did not perform a detailed evaluation of the methodology associated with the updated warning time analysis. The only significant change in the results of the analysis of warning time is the use of revised "rain on the ground" thresholds where Stage I and Stage II actions are required to begin. Use of these revised Stage I and Stage II action levels does not reduce the effectiveness of the warning plan, as the CDB minimum time to prepare for operation in the flood mode is retained.

The staff will evaluate the updated warning time analysis as part of the LAR process and a separate evaluation for purposes of the licensee's response to the 50.54(f) letter is not needed.

The NRC staff performed its review of the Sequoyah FE in accordance with the guidance described in Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178). Guidance document NEI 16-05, Revision 1, has been endorsed by the NRC in Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16090A140). The NRC staff concludes that, if implemented as described, the licensee has effective flood protection for the beyond-design-basis LIP and streams and rivers flood-causing mechanisms at Sequoyah. This closes out the licensee's response for Sequoyah for the reevaluated flooding hazard portion of the 50.54(f) letter and the NRC's efforts associated with EPID No. L-2019-JLD-010.

If you have any questions, please contact me at 301-415-2621 or by email at Robert.Bernardo@nrc.gov.

Sincerely,

/RA/

Robert J. Bernardo, Project Manager
Integrated Program Management
and BDB Branch
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Office of Nuclear Reactor Regulation

Enclosures:
1. Staff Assessment Related to the Flooding Focused Evaluation for Sequoyah (Non-public, Security Related)
2. Staff Assessment Related to the Flooding Focused Evaluation for Sequoyah (Public)

Docket Nos. 50-327 and 50-328

cc w/encl 2: Listserv

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE FOCUSED EVALUATION FOR

SEQUOYAH NUCLEAR PLANT, UNITS 1 & 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, under Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 of the 50.54(f) letter 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 and combined licenses (ADAMS Accession No. ML12056A046). If the reevaluated hazard for any flood-causing mechanism is not bounded by the plant's design basis flood hazard, an additional assessment of plant response would be necessary. Specifically, the 50.54(f) letter stated that an integrated assessment (IA) should be submitted and described the information that the IA should contain. By letter dated November 30, 2012 (ADAMS Accession No. ML12311A214), the NRC staff issued Japan Lessons-Learned Project Directorate[1] (JLD) interim staff guidance (ISG) JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding."

On June 30, 2015 (ADAMS Accession No. ML15153A104), the NRC staff issued COMSECY-15-0019, describing the closure plan for the reevaluation of flooding hazards for operating nuclear power plants. The Commission approved the closure plan on July 28, 2015 (ADAMS Accession No. ML15209A682). COMSECY-15-0019 outlines a revised process for addressing cases in which the reevaluated flood hazard is not bounded by the plant's design basis. The revised process describes a graded approach in which certain licensees with hazards exceeding their design basis flood will not be required to complete an IA, but instead will perform a focused evaluation (FE). As part of the FE, these licensees will assess the impact of the hazard(s) on their site and then evaluate and implement any necessary programmatic, procedural, or plant modifications to address the hazard exceedance.

Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178), has been endorsed by the NRC as an appropriate methodology for licensees to perform the FE in response to the 50.54(f) letter.

[1] The Japan Lessons-Learned Project Directorate was subsequently replaced by the Japan Lessons-Learned Division, which uses the same initials (JLD). No distinction is made between the two organizations in this evaluation.

The NRC's endorsement of NEI 16-05, including exceptions, clarifications, and additions, is described in NRC JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16162A301).

In the flood hazard reevaluation report (FHRR) submittal for Sequoyah Nuclear Plant, Units 1 & 2 (Sequoyah), Tennessee Valley Authority (TVA, the licensee) committed to submit an IA to address the required flood hazard impact assessments. By letter dated March 10, 2017 (ADAMS Accession No. ML17069A380), TVA informed the NRC of its intent to submit an FE, consistent with the changes discussed above, in lieu of an IA.

By letter dated October 11, 2019 (ADAMS Accession No. ML19284F762, non-public), the licensee submitted an FE for Sequoyah. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms, that: 1) a flood mechanism is bounded by the current design basis (CDB) based on further reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is local intense precipitation (LIP). The purpose of this staff assessment is to provide the results of the NRC's evaluation of the Sequoyah FE.

2.0 BACKGROUND

This NRC staff assessment is the last staff assessment associated with the information that the licensee provided in response to the reevaluated flooding hazard portion of the 50.54(f) letter. Therefore, the background section includes a discussion of the reevaluated flood information provided by the licensee and the associated staff assessments. The reevaluated flood information includes: 1) the FHRR; 2) the mitigation strategies assessment (MSA); and 3) the FE.

Flood Hazard Reevaluation Report

By letter dated March 12, 2015 (ADAMS Accession No. ML15071A462), TVA responded to the 50.54(f) letter for Sequoyah and submitted the FHRR. In this letter, TVA identified that the reevaluation results for LIP, streams and rivers, and flooding from the combined effects of a probable maximum flood (PMF) and wind are not bounded by the CDB for Sequoyah. Both the streams and rivers and combined effect flood-causing mechanisms do not exceed the CDB when credit is taken for an interim EAP installation of temporary engineered barriers **[[ ]]**. The licensee planned to submit an IA to assess the site impact from LIP and to review the long-term options for addressing **[[ ]]**. By letter dated March 10, 2017 (ADAMS Accession No. ML17069A380), TVA informed the NRC of its intent to submit an FE, consistent with the changes discussed in Section 1.0 above, in lieu of the IA.

(CEII)

By letter dated September 3, 2015 (ADAMS Accession No. ML15240A134), the NRC issued an interim staff response (ISR) letter for Sequoyah. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the CDB for Sequoyah and parameters that are a suitable input for the MSA and other assessments associated with NTTF Recommendation 2.1 "Flooding." The ISR letter is sometimes referred to as the Mitigating Strategies Flood Hazard Information (MSFHI) letter. The ISR letter identified that LIP and streams and rivers flood-causing mechanisms exceeded the CDB. The staff's evaluation which lead to this conclusion is

explained in Section 3.3 of the FHRR staff assessment (SA) dated July 13, 2016 (ADAMS Accession No. ML16194A115).

Because the LIP and streams and rivers flood-causing mechanisms at Sequoyah are not bounded by the plant's CDB, additional assessments of the flood hazard mechanisms are expected to be performed by the licensee. In the FHRR SA, the staff's conclusions regarding the LIP and streams and rivers flood-causing mechanisms remained unchanged from the information provided in the ISR letter. The staff notes that the FHRR staff assessment reflects the staff's review of the Sequoyah external flood hazards as provided in the FHRR and from the staff audit supporting the FHRR review.

Mitigation Strategies Assessment

By letter dated December 27, 2016 (ADAMS Accession No. ML16363A382, non-public, security-related information), the licensee submitted its MSA for Sequoyah. The MSAs were intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events. The mitigation strategies have been put in place to meet NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events." The NRC staff's safety evaluation (SE) for the licensee's compliance plans for Order EA-12-049 was issued on October 12, 2016 (ADAMS Accession No. ML16270A517). By letter dated July 13, 2017 (ADAMS Accession No. ML17171A155), the NRC issued its assessment of the Sequoyah MSA.

In SECY-16-0142, "Draft Final Rule – Mitigation of Beyond-Design-Basis Events [MBDBE] (RIN 3150-AJ49)," (ADAMS Accession No. ML16291A186) provisions were proposed that would have required the mitigation strategies to address the reevaluated flood hazard information on a generic basis. As reflected in the Affirmation Notice and Staff Requirements Memorandum (SRM) dated January 24, 2019 (ADAMS Accession No. ML19023A038), associated with SECY-16-0142, the Commission determined that addressing the reevaluated hazards in the mitigation strategies on a generic basis was not needed for adequate protection of public health and safety but should instead be assessed on a plant-specific, case-by-case basis under the requirements of 10 CFR Section 50.109, "Backfitting," and Section 52.98, "Finality of combined licenses; information requests."

The January 24, 2019, Affirmation Notice and SRM directed the staff to continue to use the 50.54(f) process to ensure that the NRC and its licensees will take the needed actions, if any, to ensure there is no undue risk to public health and safety due to the potential effects of the reevaluated flood hazards. The SRM further directed that the staff should continue these efforts, utilizing existing agency processes, to determine whether an operating power reactor license should be modified, suspended, or revoked considering the reevaluated hazard.

In a letter dated August 20, 2019 (ADAMS Accession No. ML19067A247), the NRC staff provided a path forward to treat the reevaluation of flood hazards in light of the Commission's direction in the Affirmation Notice and SRM dated January 24, 2019. The staff assessment documented herein was performed in accordance with the information in the August 20, 2019, letter, including a plant-specific determination on whether additional regulatory actions are warranted to address the reevaluated hazard.

In the MSA staff assessment, the staff concluded that that the licensee demonstrated the capability to implement FLEX strategies against the reevaluated hazards described in the ISR letter. The NRC staff made its determination based on:

- 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 trigger and the physical characteristics of the haul paths and staging areas;
- Consideration that other time sensitive deployment activities occurring prior to 1 hour occur inside or on the roof of the Auxiliary Building 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; and
- A flood-causing mechanism (streams and rivers) that was determined to be not bounded in the ISR letter, was appropriately screened out of further review in the MSA given that additional information was provided that demonstrated that this reevaluated flood-causing mechanism is bounded by the CDB.

In its FE, the licensee revised the LIP and streams and rivers analyses (see Attachment A to the FE) from that provided in the FHRR. In addition, other flood-causing mechanisms that were bound by the CDB were revised and remain bounded. The FE LIP and streams and rivers are used to support the licensee's assessment of structures, systems, and components (SSCs) to provide key safety functions (KSFs) of core cooling, containment integrity, and spent fuel pool cooling. The changes to the LIP flood elevations, associated effects (AE), and flood event duration (FED) were minimal and do not affect the results submitted in the original FHRR and MSA. The revised streams and rivers flood elevations in the FE decreased, are bound by the CDB, and do not affect the conclusions reached in the FHRR or MSA.

The staff continues to conclude that FLEX strategies can be implemented assuming a flooding event of the magnitude described in the ISR letter and bounds the revised flood elevations provided in the FE. In the MSA, TVA concluded that the results from the original FHRR did not change the overall strategies and timelines for the staging and deployment of FLEX equipment. The mitigation strategies at Sequoyah can be implemented as designed. The staff concludes that implementation of FLEX strategies, assuming the ISR flood conditions, provide an important defense-in-depth function should the installed SSCs be unable to maintain the KSFs during the conditions associated with the flood levels found in the ISR letter.

Focused Evaluation

As noted in the ISR letter, the LIP and streams and rivers flood-causing mechanisms at Sequoyah are not bounded by the plant's CDB. Additional assessments of those flood hazard mechanisms are expected to be performed by the licensee.

By letter dated October 11, 2019 (ADAMS Accession No. ML19284F762, non-public, security-related information, critical energy infrastructure information (CEII)), TVA submitted the FE for Sequoyah. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood mechanism is bounded based on further reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded

mechanism is LIP. These options associated with performing an FE are referred to as Paths 1, 2, or 3, as described in NEI 16-05, Revision 1.

In November 2015, TVA Corporate Engineering identified a potential error in the Sequoyah FHRR Hydrologic Engineering Center-River Analysis System (HEC-RAS) hydrologic flooding simulation model (TVA Condition Report 1101784). This potential error could result in an overestimation of flood storage capacity in reservoirs within the HEC-RAS model and an underestimation of flooding levels at critical dams and at the Sequoyah plant site. This issue and the proposed changes to address the issue were discussed in detail with the NRC in a public meeting on April 4, 2016 (ADAMS Accession No. ML16117A551).

As a result of the HEC-RAS error, TVA has updated the FHRR flooding simulation models. The following key changes were made:

1. Probable Maximum Precipitation (PMP): updated to a Sequoyah site specific PMP based on an NRC reviewed Topical Report (TR) TVA-NPG-AWA16-A, "TVA Overall Basin Probable Maximum Precipitation and Local Intense Precipitation Analysis, Calculation CDQ0000002016000041, Revision 1" (ADAMS Accession No. ML19155A047). The NRC safety evaluation associated with the TR, dated March 18, 2019, can be found at ADAMS Accession No. ML19010A212.
2. Channel Geometry and Overbank Storage in Stream Course Model: updated the channel geometry and/or the overbank storage volumes of the stream course model consistent with recommendations from the United States Army Corps of Engineers.
3. Dam Modifications: updated dam stability analysis to account for a modification at Douglas dam.
4. PMP Areal Application and Loss Methods: updated the rainfall distribution methodology to be consistent with the gridded rainfall data format in TR TVA-NPG-AWA16-A and to apply TVAs antecedent precipitation index (API) rainfall runoff method.

The licensee provided an FHRR analysis update as Attachment A to the FE. Table A-5 of the FE tabulates the FHRR analysis update results. Except for the LIP flood-causing mechanism, the FHRR analysis update results are bounded by the CDB. The staff did not perform a detailed evaluation of the methodology associated with the FHRR analysis update for purposes of the FE. For the LIP flood-causing mechanism, the FHRR analysis update change was minor (decrease by 0.1 ft.) and remains bounded by the licensee's evaluation in the original FHRR. This minor change does not affect the staff's review of the FE. For the streams and rivers flood-causing mechanism, the original FHRR hazard levels are below the CDB (when dam modifications are completed and an EAP for **[[ ]]** is in place). The FHRR analysis update addresses the long-term actions associated with the EAP **[[ ]]**. The applicable EAP remains in place until the hydrology LAR review (discussed below) is complete and a determination that the applicable EAP is no longer required is made. All other FHRR flood-causing mechanism hazard levels were bound by the CDB and remain bound in the FHRR analysis update. Since the original FHRR and the FHRR analysis update are bounded by the CDB, the updated analysis does not affect the staff's review of the FE.

(CEII)

In addition to the FHRR analysis update, TVA provided a warning time analysis in Attachment B to the FE. The only significant change in the results of the analysis of warning time is the use of revised "rain on the ground" thresholds where Stage I and Stage II actions are required to begin. Use of these revised Stage I and Stage II action levels does not reduce the effectiveness of the

(CEII) warning plan, as there is still a minimum of **[[ ]]** to prepare for operation in the flood mode, which is equal to the CDB warning time. In its MSA, the licensee noted that mitigation of the LIP event requires no site protective actions to occur prior to the start of the LIP event rainfall or before the site is inundated. Therefore, a warning time for the LIP event is not required. The staff will evaluate the updated warning time analysis as part of the LAR process and a separate evaluation for purposes of the licensee's response to the 50.54(f) letter is not needed.

In a letter to the NRC dated January 14, 2020 (ADAMS Accession No. ML20016A396), TVA applied to revise the Sequoyah UFSAR regarding changes to the hydrologic analysis. The same methodologies are used in the LAR and the FHRR analysis update provided with the FE. The original FHRR results bound the FHRR analysis update in the FE and a detailed review of the FHRR analysis update is not required to complete the review of the FE. The staff will evaluate the methodology associated with the updated flood levels as part of the LAR review.

The licensee's FE provides a "Path 2" LIP evaluation (i.e., the licensee has effective flood protection for this event), and a "Path 1" streams and rivers evaluation (i.e., this event is bounded by the current design basis for the plant).

3.0 TECHNICAL EVALUATION

As described in the ISR letter, the LIP and the streams and rivers flood-causing mechanisms exceeds the CDB. The Sequoyah FE addresses both flood-causing mechanisms. This technical evaluation characterizes flood parameters and evaluates the following flood impact assessment topics for the LIP unbounded flood-causing mechanism: a description of the impact of the unbounded hazard; an evaluation of available physical margin (APM) and reliability of flood protection features; and the overall site response.

3.1 Characterization of Flood Parameters

The flood parameters that are used as inputs to the Sequoyah FE staff's assessment are based on the FHRR updated analysis provided as attachment A to the FE. Table 3.1-1 presents a comparison of the design basis flood elevations to the Table 11-1 from the original FHRR and the FHRR analysis update provided as Attachment A to the FE. The FHRR analysis updates incorporate the changes to the FHRR simulation models as discussed in Section 2.0. The FHRR analysis update flood elevations are bound by the CDB flood elevations except for LIP.

For the LIP flood-causing mechanism, the staff's assessment credits passive protection features to demonstrate that SSCs and the associated KSFs are protected from the LIP flooding mechanism.

For the streams and rivers flood-causing mechanism, the staff confirmed that the peak flooding elevations are below the CDB flood elevations for all critical structures without needing to credit
(CEII) the EAP at **[[ ]]**. Therefore, no additional flood protection strategy beyond the existing design basis is needed to address the streams and rivers flood-causing mechanism and key SSCs remain protected.

Table 3.1-1 - Summary of Hazard Refinement Changes in Water Surface Elevations for Unbounded Mechanisms

Flood Mechanism	CDB	FHRR/ISR	MSA	Update in FE
Local Intense Precipitation	705.7	706.3	706.3	706.2
(CEII) Streams and Rivers (Note A)	722.0	**[[ ]]**	**[[ ]]**	**[[ ]]**
Streams and Rivers, DG building	723.2	**[[ ]]**	**[[ ]]**	**[[ ]]**
Streams and Rivers, ERCW Pumping Station	726.2	**[[ ]]**	**[ ]]**	**[[ ]]**
Streams and Rivers, Unit 2 RB	726.2	**[[ ]]**	**[[ ]]**	**[[ ]]**
Streams and Rivers, Unit 1 RB	726.2	**[[ ]]**	**[[ ]]**	**[[ ]]**

*In its FE, the licensee identified a non-conservative error in the significant wave height calculation used in the FHRR and MSA for the essential raw cooling water (ERCW) pump station. A correction to FHRR Table 9.4-2 was provided as Table A-3 in the FE. The 0.4 ft. error does not affect the conclusions in the FHRR nor in the MSA since the resulting flood elevation remains bound by the CDB.

NOTE A: In Table 11-1 of the original FHRR, the reevaluated streams and rivers flood-causing (CEII) mechanism flood elevation **[[ ]]** was noted as bounded by the CDB bounding elevation of **[[ ]]**. However, the NRC FHRR Staff Assessment (Section 3.3.10) concluded that the streams and rivers mechanism was not bounded by the CDB. The NRC conclusion was based on the CDB representative location for streams and rivers is an elevation of 723.2 ft. at the diesel generator building. The FHRR notes that the (CEII) location with the greatest WSE of **[[ ]]** is at the Unit 1 Shield Building.

To clarify the FHRR conclusions, the NRC recommended that TVA document their explanation for the CDB bounding the original FHRR results for this mechanism in the FE. The explanation was provided by TVA in Section A.8 of Attachment A to the FE. The licensee provided a table (Comparison of Combined Effects of Flood and Wind[2]) in Attachment A to the FE. Those values are included in Table 3.1-1, comparing the CDB flood hazard to the original FHRR hazard for each critical structure, as well as the FHRR analysis update values from the FE. Using this information, the licensee clarified that the original FHRR streams and rivers flood elevation is bounded by the CDB when a building-to-building comparison is made. (CEII) Because these comparisons are valid when the EAP **[[ ]]** is credited, the long-term options related to the EAP will be reviewed in the FE.

In a similar way to the explanation provided above, Table 3-2 of the licensee's MSA compares the wind wave height on critical structures to the comparable CDB parameter. In that table, the CDB bounds the comparable flood hazard combined with wind effects at each critical structure. The NRC staff has compared the information from Table 3-2 of the MSA to the information summarized in Table 3.1-1 and confirmed that the elevations are identical with the one exception noted in Table 3.3-1. In the MSA staff assessment, the staff reviewed the information provided by the licensee in the MSA, and concluded that the streams and rivers FCM, as clarified in the MSA, is bounded by the CDB. No further evaluation of the

[2] The combined effects wind wave elevations at Critical Structures information was also provided in Table 3-2 of the licensee's MSA submittal and is identical to the "original FHRR" information provided in the FE

streams and rivers flood-causing mechanism was necessary to complete the MSA staff assessment.

In the FE, Sequoyah followed Path 1 of NEI 16-05, Revision 1 to address the streams and rivers flood-causing mechanism. As noted, TVA discovered an issue with the HEC-RAS stream course model used to determine the FHRR streams and rivers flood-causing mechanism. The overbank storage error was discussed with the U. S. Army Corps of Engineers (USACE), which confirmed the original method used by TVA was in error. As discussed with the NRC in a public meeting held on April 4, 2016 (ADAMS Accession No. ML16117A551), TVA has corrected the HEC-RAS storage volume modeling issue. The modifications made, along with the updated channel geometry, are consistent with the recommendations from the USACE. The FHRR analysis update included application of the NRC-approved site-specific PMP. In addition, (CEII) modifications at **[[ ]]** have been completed and the dam stability analysis was updated to account for the completed modifications. No credit is taken for the EAP at **[[ ]]**. With these changes, the updated elevation of **[[ ]]** (stillwater) and **[[ ]]** (wind wave) flood elevations are bound by the CDB. The NRC staff finds this approach to be reasonable, that the streams and rivers flood-causing mechanism flood elevation is bound by the CDB, and concludes that Path 1 from NEI 16-05, Revision 1, is appropriate. No additional flood protection strategy beyond the existing design basis is needed.

The licensee also reported in its FE that a non-conservative error was identified by TVA in the significant wave height calculation for the ERCW pumping station. This error has been (CEII) corrected, with a final PMF elevation increase to **[[ ]]**, or 0.4 ft. above that reported in Table 9.4-2 of the original FHRR. The licensee states that the error does not affect the conclusions in Table 11-1 of the original FHRR. The staff has reviewed the updated PMF elevation and table 11-1 of the original FHRR. The increased flood height at the ERCW station remains below the controlling flood height in the original FHRR and the NRC's ISR letter of (CEII) **[[ ]]**. The staff concludes that this change does not impact the conclusions in the original FHRR SA, the ISR letter, or the MSA SA.

For the LIP flood-causing mechanism, Sequoyah followed Path 2 of NEI 16-05, Revision 1. The staff reviewed the FHRR analysis update. Since the peak flooding elevation of 706.2 ft. exceeds the safety-related building entry elevations of 706 ft., the staff assessed the applicable buildings regarding the lowest key SSC elevation and determined that the key SSCs remain protected during the LIP event. The staff also notes that this conclusion is also valid if the ISR level of 706.3 is used.

The staff did not perform a detailed evaluation of the methodology associated with the FHRR analysis update provided in Attachment A of the FE. For the LIP flood-causing mechanism, the FHRR analysis update change was minor (decrease by 0.1 ft.) and remains bound by the licensee's evaluation in the original FHRR. Both the original and updated analysis are not bound by the CDB. The staff's assessment credits passive protection features to demonstrate that SSCs and the associated KSFs are protected from the LIP flooding mechanism, even at the slightly higher ISR level. The methodology used to determine the new LIP hazard level has no meaningful effect on the conclusions reached by the staff.

For the streams and rivers flood-causing mechanisms, the original FHRR hazard levels are (CEII) below the CDB (when dam modifications are completed and an EAP for **[[ ]]** is in place). The FHRR analysis update addresses the long-term actions associated with the (CEII) EAP **[[ ]]**. The FHRR analysis update

states that the EAP is no longer required. The EAP will remain in place until the hydrology LAR review (discussed below) is complete. All other FHRR flood-causing mechanism hazard levels were bound by the CDB and remain bound in the FHRR analysis update. With the exception of LIP (discussed above), the original FHRR and the FHRR analysis update are bound by the CDB. Thus, the methodologies used in the FHRR analysis update does not affect the staff's conclusions reached in its assessment of the FE.

In addition to not impacting the staff's evaluation of the FE, the new flood hazard analysis detailed methodologies will be reviewed as part of a license amendment review. In a letter to the NRC dated January 14, 2020 (ADAMS Accession No. ML20016A396), TVA provided an application to revise the Sequoyah UFSAR regarding changes to the hydrologic analysis. In the interest of efficiency, the staff has determined that a detailed review of the methodologies will be done during the LAR review. An identical, detailed evaluation for purposes of the licensee's response to the 50.54(f) letter is not needed. The staff considers this reasonable for the following reasons:

- The topical report used to provide input to the site-specific PMP has been approved for use by the NRC
- The stream course model updates are consistent with recommendations from the US Army Corps of Engineers.
- Dam modifications discussed in the FHRR have been completed and are used to update the dam stability analysis.
- The same methodologies are used in both the FHRR analysis update and the LAR.
- The LIP flood-causing mechanism change was minor.
- The streams and rivers flood-causing mechanism is bound by the CDB with the EAP in place and remains bound with the FHRR analysis update levels.
- The warning time analysis retains the design basis warning time.
- The staff considers it reasonable that the conclusions reached in the FE assessment will not be affected, up to the flood levels noted in the original ISR levels.
- Any results identified during the LAR review that may adversely impact the conclusions described in this staff assessment (i.e., an increase in the applicable FCM critical flood height or a decrease in the design basis warning time) will be reviewed and the impact on the site assessed as part of the LAR review.

3.2 Evaluation of Flood Impact Assessment for Local Intense Precipitation

3.2.1 Description of Impact of Unbounded Hazard

The LIP evaluation in the FE generated a maximum ponding level of 706.2 ft, which exceeds the safety-related building entry point levels of 706 ft. The LIP flood elevation exceeds the 706.0 ft. door threshold elevations for a maximum of 20 minutes. Figure 3-2 of the licensee's FHRR provides a site layout. Based on this potential for in-leakage, the licensee reviewed the key SSCs in each potentially affected building.

The buildings that could be affected by the LIP flood levels have access at elevation below (or close to) elevation 706 ft. Access doors to buildings containing safety-related SSCs from ground elevation 706 ft. are highlighted in Figure 12-1 of the licensee's FHRR. In both the FHRR and FE, the licensee states that safety-related buildings with exterior entry doors and potentially subject to LIP flooding are the Auxiliary/Control Buildings, the Main Steam Valve

Vaults (MSVV), and the Condenser Circulating Water Intake Pumping Station (FHRR, Section 12.1). Additionally, although the Service, Office, and Turbine Buildings do not contain safety-related SSCs, these buildings provide internal access to the Auxiliary and Control Building entry doors and are potential water ingress paths.

The potential for LIP flood water entry into buildings housing safety-related equipment required for safe shutdown was assessed by the licensee in the FHRR using a LIP flood level of 706.3 ft. This bounds the FHRR analysis update level of 706.2 ft. in the FE. In its FE, the licensee summarized the impact assessment conclusions from the original FHRR. Based on the FHRR impact assessment, the licensee states that key safety-related equipment is not affected by the LIP event described in the FE. In addition, the licensee states that LIP associated effects are expected to be negligible due to the low flow velocities and shallow water depths.
The plant structures that contain safety-related equipment and systems, as well as the major exterior accesses, are specified in the Sequoyah UFSAR. The site topography and geographical characteristics, site physical features and plant layout were reviewed by NRC staff as noted in the FHRR audit report dated October 30, 2015 (ADAMS Accession No. ML15294A203). The access doors, as well as any other openings at or below the LIP flood height, that could allow water into the safety-related buildings were reviewed by the licensee using site drawings and a licensee walkdown conducted in February 2015. In addition to external doors, access to the Auxiliary Building is available via internal doors from the Service Building at elevation 690 ft., and access to the Control Building is available via internal doors from the Turbine Building at elevation 685 ft.

The licensee states in its FE that no LIP floodwater in-leakage is expected into the Auxiliary Building and Control Building based on design of the personnel and equipment access entry locations. No LIP floodwater in-leakage is expected into the MSVV based on the height of the louvered opening and curbing around the personnel access doors which provide protection to elevation 706.5 ft. No credit is taken for flood mitigation actions in the FE LIP event. Nuclear Power Group (NPG) standard procedure NPG-SPP-07.1.8, “Severe Weather and Natural Disasters,” states that in heavy rains, plant areas prone to ground water intrusion are inspected. In addition, plant conditions are reviewed to determine if any penetrations in an external flood barrier are open and the necessary actions are taken to seal penetrations. However, no time sensitive operator actions are required to protect the safety-related SSCs during a LIP event. Details of the licensee evaluations and staff review follow.

A potential LIP floodwater ingress point into the Auxiliary Building is through the railroad bay door A112. The six railroad bay access covers and their embedded frames, and the railroad door and its embedded frames, provide a semi-airtight closure. The railroad door is interlocked with the bay covers as well as four air lock internal doors to provide an airlock. If the railroad door is open, the covers and the air lock doors within the railroad bay are interlocked closed. There is no safety-related equipment housed in the railroad bay area or the waste packaging areas. There is no equipment required for safe shutdown in the rooms below the railroad bay. Given the airlock operation, the water volume entering the adjacent waste packaging and fuel handling areas from the railroad bay will be minimal. In addition, the Moderate Energy Line Break (MELB) internal flooding height is 2 inches or more in the fuel handling area. Any minimal leakage through the railroad bay door will not impact the plant capability to perform a safe shutdown. Even if the railroad bay door is open, minimal to no leakage is expected through the internal airlock doors. Any water ingress through the railroad bay door, even if open, will not impact the ability to perform a safe shutdown.

The staff reviewed the operation of the railroad bay doors. Considering the physical size of the railroad bay, the operations of the internal airlock doors, and the height and duration of any LIP flood waters above elevation 706 ft., the staff considers it reasonable that little to no leakage beyond the internal airlock doors is expected and no safety-related SSCs will be affected.

An additional water ingress point to the Auxiliary Building is through the personnel and equipment access air lock on elevation 690.0 ft. The LIP flood water can reach this location via the Plant Office Building and Service Building (discussed below in the Control Building section). The LIP flood waters can enter the Service Building through multiple doors and openings at elevation 706 ft. and then propagate downstairs to elevation 690 ft. where a pathway exists from the Service Building corridor to the Auxiliary Building personnel entrance door A56 providing access to door A57 leading into Auxiliary Building and door A58 leading into the Chemistry Laboratory area. An access to the Auxiliary Building from the Chemistry Laboratory exits via an airlock through doors A55 and A60. Water entering the Service Building will spread through the 706 ft. elevation first and then propagate to the 690 ft. elevation through staircases and other openings and will also enter the 685 ft. elevation of the Turbine Building. The 685 ft. elevation in the Turbine Building contains large open areas. The long, torturous path, plus the large open areas in the Turbine Building serve to minimize the water depths in the 690 ft. elevation corridor leading to the Auxiliary Building access door A56. The Service Building and Turbine Building are not safety-related structures and do not house any safety-related equipment. The main access to the Auxiliary Building (Door A57) and the Chemistry Laboratory door into the Auxiliary Building (Door A55) are Auxiliary Building Secondary Containment Envelope (ABSCE) doors and are designed to be watertight. No LIP water leakage through these locations is expected.

The staff reviewed this potential water ingress path. Due to the torturous pathway and large open areas available to accumulate water in the Service and Turbine Buildings, the amount of water that can potentially reach doors A57 and A55 is limited. The main access to the Auxiliary Building (Door A57) and the Chemistry Laboratory door into the Auxiliary Building (Door A55) are ABSCE doors, which are watertight by design. Therefore, the staff concludes that it is reasonable that any minimal LIP water leakage through these locations will not impact any safety-related equipment.

The Control Building does not have external access doors directly subject to the LIP flooding. However, the licensee identified that floodwater can enter through normally closed Plant Office and Service Building access doors and one Turbine Building door (Door T52) at elevation 706.0 ft. This in-leakage can potentially expose Control Building entry doors at elevation 685.0 ft. and 706.0 ft. to floodwater. The LIP floodwaters at all other Turbine Building external personnel and equipment doors is below the CDB 706.0 ft. critical door elevation.

The LIP flood water leakage through Plant Office and Service Building exterior doors would flow onto floor elevation 706.0 ft. in the Plant Office and Service Buildings and migrate to the 706.0 ft. elevation of the Turbine Building directly, or gravity drain through floor openings, stairwells, and grating floors to Service Building floor elevation 690.0 ft. and then to the Turbine Building floor elevation 685.0 ft. Access to the Control Building is available through doors C14/C15 and through an equipment hatch. Door C14 is a watertight door and door C15 is a pressure-tight personnel access door. The equipment hatch is provided with a gasketed seal which will preclude water ingress. The licensee's internal flooding calculation (Calculation Package 3C37-0686-001) determined that there is no water ingress through doors C14/C15 and through the equipment hatch.

Water entering Turbine Building elevation 685 ft. will propagate to the Turbine Building elevation below. However, the Turbine Building does not provide other access points below flood elevation into the Control Building except door C27. Door C27, which provides access from the Turbine Building into the Control Building at elevation 685.0 ft., is designed watertight which will preclude water propagation into the Control Building. Therefore, water entering the Turbine Building will not enter the Control Building and will migrate to the Turbine Building basement and sumps.

The Turbine Building basement and sumps can retain over 500,000 cubic feet of flood water before reaching elevation 685.0 (the lowest elevation with doors between the Turbine Building and Control Building). No safety-related components are impacted by floodwaters at this level in the Turbine Building. In its FE, the licensee states that, in the unlikely event that a 3 foot personnel exterior door (such as the Turbine Building door at elevation 706.0 ft) is fully open, less than 1,000 cubic feet of water would enter the Turbine Building. Leakage through the normally closed Plant Office Building and Service Building doors during the 20 minutes when the flood waters from the LIP event is 0.2 ft. above the 706.0 entry threshold would not be significant. This volume is easily contained in the Turbine Building basement and sumps.

Using the audit process, performed in accordance with a generic audit plan dated July 18, 2017 (ADAMS Accession No. ML17192A452), the NRC staff reviewed TVA Internal Flooding Analysis (TVA Calculation MON-000-000-2010-0203, “SQN Probabilistic Risk Assessment-Internal Flooding Analysis,” R2, December 31, 2013). Based on the information provided in the flooding analysis, the staff confirmed that the licensee’s assessment of the available volume of flood water retention available in the Turbine Building basement prior to flood water reaching elevation 685.0 ft. is conservative and finds that the licensee’s assessment of in-leakage into the Turbine Building is reasonable. The licensee assessed this in-leakage using the updated FHRR LIP flood level of 706.2 ft. for a duration of 20 minutes.

The staff also reviewed any potential impact considering the original FHRR LIP flood level of 706.3 ft. with a duration above 706 ft. of 44 minutes. Even if a factor of 10 (i.e., 10,000 cubic feet of floodwater, or less than 2 percent of the total floodwater retention capacity) is applied to the licensee’s leakage values, the over 500,000 cubic foot capacity of the Turbine Building basement and sumps will easily contain this amount of floodwater. Doors from the Turbine Building to the Control Building that are exposed to the LIP floodwater on its path to the basements and sumps are either designed water-tight or pressure tight and are not expected to leak. Therefore, the staff considers it reasonable that significant in-leakage to the Control Building from the Turbine Building is not expected, even when the slightly higher ISR LIP flood level and duration is considered.

The condenser circulating water intake pumping station structure is underground and subject to flooding through the personnel access door. Consistent with Chapter 2 of the UFSAR, the licensee noted in the FE that the safety-related submersible fire/flood mode pumps located in this building are designed to operate submerged and the cable tunnel is designed for a submerged operating condition. Therefore, the LIP flooding does not adversely impact the safety-related equipment housed in this structure.

The LIP flood water ingress could potentially occur at the MSVV external personnel access doors and external louvers. The LIP flood water level at this location is 706.2 ft. The personnel access doors each have 6-inch concrete curbing with a top elevation of 706.5 ft., as shown on plant drawings. The curbing was verified during licensee walkdowns. The external louvers have a

bottom elevation of 706.5 ft. Thus, each potential ingress path is above the expected LIP floodwater level with margin. In addition, the internal flood elevation is 4 inches or more, so any minimal splashing will not have an impact. The licensee concluded that, since the maximum LIP floodwater was 706.2 ft., the MSVV is protected by design and no LIP floodwater is expected to impact SSCs in the MSVV. An evaluation of the available physical margin (0.3 ft.) is provided in Section 3.2.2.

The staff has reviewed the licensee's information. The staff concludes that safety-related equipment within the MSVV is unlikely to be impacted because of the physical protection up to an elevation of 706.5 ft. Any minimal splashing of LIP floodwaters over the curbing or into the louvered openings will not have an impact on SSCs within the MSVV because of the minimum MELB internal flood height of 4 inches. The staff's evaluation of the acceptability of the available physical margin is provided in the next section

The licensee discussed two additional areas in the FHRR. Although there are exterior doors at elevation 706.0 ft., there is no safety-related SSCs at or below the LIP flood height within the Additional Equipment Building (AEB, also called the Upper Head Injection Room). The AEB includes two rooms. Access to these rooms is through exterior doors located at elevation 706.0 ft. which have no threshold or curb. The MELB flood height analysis for these room is 66 inches and 41 inches, respectively. This is well above the LIP flood level of 706.2 ft. These two rooms do not provide a water pathway to other areas at elevation 706.0 ft. Thus, there is no impact on safety-related equipment in these rooms from the LIP flood levels.

The Particular, Iodine and Noble Gas (PING) Monitoring Station rooms (706.38-A1 and 706.08-A2) have external access doors and provide access to steam valve instrument rooms 706.0-A12 and 706.0-A13. The floor elevation of room 706.38-A1 is 706.4 ft. which protects the steam valve instrument room 706.0-A12. The entrance elevation of room 706.08-A2 is 706.08 ft. There is no equipment required for safe shutdown in room 706.08-A2, and steam valve instrument room 706.0-A13 does not have any equipment below elevation 706.3 ft. The door to the PING room has neoprene seals designed to prevent or minimize any potential ingress of flood water. Therefore, water ingress due to the LIP flooding into rooms 706.08-A2 and 706.0-A13 does not affect any safety-related equipment nor the plant's ability to perform a safe shutdown.

In Section 12.1 of its FHRR, the licensee states that the LIP flood water (706.3 ft.) will exceed the critical elevation of 706.0 ft. for a maximum duration of 44 minutes. In its FE, the licensee used the updated PMP in the Sequoyah site LIP drainage analysis. The results of the updated site drainage analysis show the 706.2 ft. maximum water surface elevation at the Reactor, Auxiliary/Control, and Turbine Building locations are above the 706.0 ft. potential water intrusion locations for approximately 20 minutes. This updated result is bounded by the LIP flood elevation and FED results submitted in the FHRR and MSA.

In the FE, the licensee states that the LIP associated effects, such as debris loads, hydrodynamic loads, and hydrostatic loads are expected to be negligible. The licensee states in its MSA that the AE and FED parameters for both LIP and riverine flooding are minimal. In its assessment of the licensee's MSA, the NRC staff concluded that the licensee's justifications and methods related to the AE and FED parameters are appropriate and reasonable. Since the FHRR analysis update water levels are below those used in the MSA, the staff considers it reasonable to conclude that the associated effects due to LIP will be negligible.

Based on the discussions above, the staff concludes that key SSCs and their associated key safety functions are effectively protected against the LIP flood levels identified in the FE because:

- Exterior doors and hatches would prevent/minimize water intrusion into safety-related areas of the plant.
- Interior doors from non-safety related areas, leading to safety-related areas, that are subject to LIP floodwater ingress are designed water-tight or pressure-tight. Any leakage through these doors will be minimal and does not impact any safety-related SSCs.
- Curbing around non-leak tight exterior doors to the MSVV provide protection to a level above the expected LIP flood level.
- There are multiple drainage paths to direct water in-leakage into the turbine building to the basement and sumps. The turbine building basement and sumps have sufficient volume to retain any floodwater in the basement and preclude flooding of any safety-related equipment in adjacent areas.
- Potential in-leakage water depths are bounded by MELB flood heights.
- LIP floodwaters exceed the design basis elevation of 706.0 ft. for a short amount of time.
- The debris loads, hydrodynamic loads, and hydrostatic loads due to the LIP flood levels are minimal.

Therefore, the staff concludes that the licensee has met the guidance in NEI 16-05, Revision 1, as endorsed by the NRC, of a Path 2 evaluation (i.e., “effective flood protection”) for the FE LIP event. Key safety functions, without reliance on FLEX, can reasonably be expected to be met with installed plant equipment.

Defense-in-Depth

In addition to the staff concluding that Sequoyah meets the Path 2 guidance in NEI 16-05, Revision 1, for the LIP event, the staff also concludes that Sequoyah would effectively meet Path 3 guidance for this event by demonstrating a feasible flood response for LIP. The feasible flood response for the higher ISR LIP event was evaluated by the staff and found to be acceptable as documented in the MSA staff assessment dated July 13, 2017 (ADAMS Accession No. ML17171A155). No changes to the mitigation strategies described in the licensee’s final integrated plan were necessary to address the ISR LIP flood elevation. Mitigation of the LIP event does not require any protective actions to occur before the site in inundated. The information in the FE does not change the conclusions in the MSA staff assessment.

3.2.2 Evaluation of Available Physical Margin and Reliability of Flood Protection Features

Sequoyah flood protection from a LIP event does not rely on active features or operator actions. Flood protection in the LIP event is provided by passive civil/structural and architectural design features. These features are periodically inspected under the Sequoyah Structures Monitoring program, TVA Periodic Instruction, 0-PI-DXX-000-100.31.1, “Structures Monitoring for Maintenance Rule and License Renewal.” The staff audited this procedure and notes that it also includes periodic monitoring of doors and hatches designed to be airtight, watertight, or pressure containing.

During a LIP event, flood water leaking into the Control and Auxiliary Buildings is prevented by the design of the Control and Auxiliary Building access doors and hatches. For example:

1. Doors are designed as airtight, watertight, or pressure containing and minimal or no leakage is expected
2. Interlocks prevent opening air lock doors simultaneously
3. Interlocks prevent opening internal railroad bay doors and the external bay door simultaneously
4. Doors are Auxiliary Building Secondary Containment Enclosure doors and are designed watertight

The only access to a room with safety-related SSCs with non-sealed doors and external openings that are near the LIP flood height is the MSVV. During a LIP event with a maximum flood elevation of 706.2 ft., leakage into the MSVV is prevented by the elevation of the installed entry curbs and the height of the lowest vent louver opening. External doors are protected by concrete curbs to elevation 706.5 ft. The external ventilation louver opening has a lower elevation of 706.5 ft. This provides a physical margin of 0.3 ft. above the LIP level of 706.2 ft.

Per NEI 16-05 Appendix B, Section B.1, negligible or zero APM can be justified as acceptable if the use of conservative assumptions, inputs, and/or methods are used. The following are examples of conservatisms used in the licensee's LIP flood analysis:

1. All site surfaces are considered impervious, so no infiltration is credited.
2. All catch basins and storm culverts are assumed to be blocked and unavailable for drainage.
3. The plant drainage channels are postulated to experience partial, although severe, blockage that significantly reduces the conveyance capacity of the channels.
4. No credit is taken for operator actions to minimize ingress of water.

The NRC staff reviewed the licensee's assumptions, inputs and methods used for the LIP analysis in the original FHRR. These conservatisms were retained for the FHRR analysis update values provided in the FE. Based on these conservatisms, the NRC staff concludes that adequate APM is available for the LIP event described in the FE. The minor difference between the original FHRR LIP flood height (706.3 ft.) and the flood height used in the FE (706.2 ft.) does not affect the staff's conclusion.

Based on the above evaluation, the NRC staff concludes that existing margins are adequate and protective features are reasonably reliable to provide effective flood protection from the LIP event to maintain KSFs for the LIP event, consistent with Appendix B of NEI 16-05, Revision 1.

3.2.3 Overall Site Response

The licensee stated in its FE that site response to a LIP event relies on normal passive/civil structural and architectural design features. No specific operator actions are required to respond to a LIP event. Mitigation of the LIP event requires no site protective actions to occur prior to the start of the LIP rainfall or before the site is inundated. Sequoyah flood preparation activities are
(CEII) defined in AOP-N.03, "External Flooding." A minimum of **[[ ]]** is provided by the stage I/stage II warning system, and those times are not changed in the updated warning time
(CEII) analysis in Attachment B to the FE. The staff audited AOP-N.03 and confirmed the **[[ ]]** of stage I/stage II warning times are included in this procedure.

The licensee also stated in Attachment B to the FE that calculations were performed to determine the appropriate weather monitoring thresholds for a LIP event. These thresholds will be used by TVA's River Operations Group to provide flood warnings to the Sequoyah Operations group. These warnings, together with river flood modeling by TVA's River Operations, assure adequate time is provided for Sequoyah to perform the required design basis flood mode operations activities before site flooding begins. In addition, regardless of the rain on the ground values or other conditions, a Stage II shutdown warning is given when plant grade is projected to (CEII) be reached in **[[ ]]**. The rain on the ground values will be evaluated as part of the upcoming Sequoyah hydrology license amendment request. By using these thresholds, the site procedures will have updated weather monitoring triggers based on the latest hazard information and methodologies.

In addition, as outlined in the MSA, the licensee demonstrated the capability to deploy its FLEX strategies against a postulated beyond-design-basis flooding event up to the ISR flood levels and that the FLEX strategies are reasonably protected against the reevaluated flooding hazard. If implemented and maintained as described in the MSA, the FLEX strategies are expected to provide an additional layer of protection against the reevaluated LIP flooding hazard.

4.0 AUDIT REPORT

The July 18, 2017 (ADAMS Accession No. ML17192A452), generic audit plan describes the NRC staff's intention to issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's FE. Because this staff assessment appropriately summarized the results of the audit, the NRC staff concludes a separate audit report is not necessary, and that this staff assessment serves as the audit report described in the staff's July 18, 2017, letter.

5.0 CONCLUSION

Based on the staff's review that was performed in accordance with the guidance described in NEI 16-05, Revision 1, as endorsed by JLD-ISG-2016-01, the staff concludes that Sequoyah has effective flood protection for the LIP event as described in the FE and that the streams and rivers water levels are bound by the CDB. The staff concludes that, because the licensee meets Path 2 FE guidance for the LIP flood event, and Path 1 FE guidance for the streams and rivers flood event, an integrated assessment is not needed to support NRC Phase 2 decisionmaking. Sequoyah screens out for an integrated assessment based on the guidance found in JLD-ISG-2016-01. As such, the staff concludes that, in accordance with Phase 2 of the process outlined in the 50.54(f) letter, additional regulatory actions associated with the reevaluated flood hazard are not warranted. The staff further concludes that the licensee has satisfactorily completed providing responses to the 50.54(f) activities associated with the reevaluated flood hazards.

SUBJECT: SEQUOYAH NUCLEAR PLANT, UNITS 1 & 2 – STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION (EPID NO. L-2019-JLD-0010) DATED MARCH 23, 2020

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