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10 CFR 50.54(f)
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ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Duke Energy Carolinas, LLC (Duke Energy)
McGuire Nuclear Station, Units 1 and 2
Docket No. 50-369, 50-370
Renewed License No. NPF-9 and NPF-17

Subject: Response to March 12, 2012, Request for Information Enclosure 2, Recommendation 2.1, Flooding, Required Response 3, Flooding Focused Evaluation Summary Submittal

References:

1. NRC Letter to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," dated March 12, 2012, (ADAMS Accession No. ML12053A340)
2. NRC Letter, Supplemental Information Related to Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Flooding Hazard Reevaluations for Recommendation 2.1 of the Near Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated March 1, 2013, (ADAMS Accession Number ML13044A561)
3. Duke Energy Letter, "Flooding Hazard Reevaluation Report, Response to NRC CFR 50.54(f) Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3 and 9.3 of Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated March 12, 2012," dated March 12, 2014, (ADAMS Accession No. ML14083A415)
4. Duke Energy Letter, "Response to May 28, 2014, NRC Request for Additional Information Regarding Flood Hazard Reevaluation Report (TAC Nos. MF3623 and MF3624)", dated July 2, 2014, which was withheld under 10 CFR 2.390 due to inclusion of Security-Sensitive Information.

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5. Duke Energy Letter, "Response to NRC Request for Additional Information Regarding Flood Hazard Reevaluation Report (FHRR) for the McGuire Nuclear Station, Units 1 and 2," dated June 3, 2015, (ADAMS Accession No. ML15173A113)
6. NRC Staff Requirements Memoranda to COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards", dated March 30, 2015, (ADAMS Accession Number ML15089A236)
7. NRC Letter, Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events, dated September 1, 2015, (ADAMS Accession Number ML15174A257)
8. Nuclear Energy Institute (NEI) Report, NEI 16-05, Revision 1, External Flooding Assessment Guidelines, dated June 2016, (ADAMS Accession Number ML16165A178)
9. U.S. Nuclear Regulatory Commission, JLD-ISG-2016-01, Revision 0, Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation; Focused Evaluation and Integrated Assessment, dated July 11, 2016, (ADAMS Accession Number ML16162A301)
10. NRC Letter, "McGuire Nuclear Station, Units 1 and 2 - Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request - Flood-Causing Mechanism Reevaluation (TAC Nos. MF3623 and MF3624)," dated September 3, 2015, (ADAMS Accession No. ML15230A070)
11. NRC Letter, "McGuire Nuclear Station, Units 1 and 2 - Staff Assessment of Response to 10 CFR 50.54(f) Information Request - Flood - Causing Mechanism Reevaluation (CAC NOS. MF3623 and MF3624)," dated October 31, 2016, (ADAMS Accession No. 16293A666)

On March 12, 2012, the NRC issued Reference 1 to request information associated with Near Term Task Force (NTTF) Recommendation 2.1 for Flooding. One of the Required Responses in Reference 1 directed licensees to submit a Flood Hazard Reevaluation Report (FHRR). For McGuire Nuclear Station, the FHRR was submitted on March 12, 2014 (Reference 3). Additional information was provided with References 4 and 5. Per Reference 2, the NRC considers the reevaluated flood hazard to be "beyond the current design/licensing basis of operating plants".

Following the Commission's directive to NRC Staff (Reference 6), the NRC issued a letter to industry (Reference 7) indicating that new guidance is being prepared to replace existing instructions, and provide for a "graded approach to flooding reevaluations" and "more focused evaluations of local intense precipitation and available physical margin in lieu of proceeding to an integrated assessment".

The Nuclear Energy Institute (NEI) prepared NEI 16-05, "External Flooding Assessment Guidelines" (Reference 8). The NRC endorsed NEI 16-05 (Reference 9) and recommended changes, which have been incorporated into NEI 16-05, Revision 1. NEI 16-05 indicates that each flood-causing mechanism not bounded by the Design Basis (DB) flood (using only stillwater and/or wind-wave run-up levels) should follow one of the following five assessment paths:

Path 1: Demonstrate Flood Mechanism is Bounded Through Improved Realism
Path 2: Demonstrate Effective Flood Protection
Path 3: Demonstrate a Feasible Response to Local Intense Precipitation (LIP)
Path 4: Demonstrate Effective Mitigation
Path 5: Scenario Based Approach

Non-bounded flood-causing mechanisms in Paths 1, 2, or 3 would only require a Focused Evaluation to complete the actions related to external flooding required by the March 12, 2012 10 CFR 50.54(f) letter. Mechanisms in Paths 4 or 5 require an Integrated Assessment. The enclosure to this letter provides the Flooding Focused Evaluation Summary Report for the McGuire Nuclear Station.

The flooding analysis documented in References 10 and 11 were utilized as input to this Flooding Focused Evaluation. The Flooding Focused Evaluation reaffirms that the McGuire Nuclear Station has reliable, passive protection of Key Structures, Systems, and Components (SSCs) to maintain Key Safety Functions (KSFs). For the Local Intense Precipitation (LIP), Streams and Rivers (referred to as Flooding in Reservoirs in MNS FHRR), Dam Failures, and Storm Surge and Seiche/Wind-Wave Runup passive protection features are solely relied upon to maintain KSFs. The McGuire Nuclear Station Flooding Focused Evaluation demonstrates that the site responses are adequate, that plenty of available physical margin exists for both existing passive features and the installed temporary barriers, and that these protective features and actions are reliable and achievable.

The Flooding Focused Evaluation follows Path 2 of NEI 16-05, Revision 1 (Reference 8), and utilized Appendix B and C for guidance on evaluating the site protection features. This submittal completes the actions related to external flooding required by the March 12, 2012 10 CFR 50.54(f) letter.

There are no regulatory commitments associated with this letter.

Please address any comments or questions regarding this matter to Joseph Hussey at 980-875-5045.

I declare under penalty of perjury that the foregoing is true and correct. Executed on June 27, 2017.

Sincerely,

SD Capps

Steven D Capps

Enclosure: Duke Energy - McGuire Nuclear Station - Flooding Focused Evaluation Enclosure xc:

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1. Executive Summary

McGuire Nuclear Station (MNS) has reevaluated its flooding hazard in accordance with the NRC's March 12, 2012, 10 CFR 50.54(f) request for information (RFI) [Reference 1]. The RFI was issued as part of implementing lessons learned from the Fukushima Dai-ichi accident; specifically, to address Recommendation 2.1 of the NRC's Near Term Task Force report. The response to this RFI was submitted to the NRC in a Flood Hazard Reevaluation Report (FHRR) on March 12, 2014 [Reference 2] and appears in the Mitigating Strategies Flood Hazard Information (MSFHI) documented in the NRC's "Interim Staff Response to Reevaluated Flood Hazards" letter dated September 3, 2015 [Reference 7]. No changes to the flooding analysis have been performed since the issuance of the MSFHI letter and as a result the FHRR/MSFHI analysis data serves as the input to the Focused Evaluation (FE).

The FHRR evaluated ten flooding hazards [Reference 2 - Table 3-1]. The mechanisms that were found to exceed the Current Design Basis (CDB) are listed below along with how the site is protected from each.

1. Local Intense Precipitation (LIP) – Flood protection of Key Safety Functions (KSFs) with temporary passive barriers
2. Streams and Rivers (referred to as Flooding in Reservoirs in MNS FHRR) – Flood protection of the site with permanent passive barriers
3. Dam Failures – Flood protection of the site with permanent passive barriers
4. Storm Surge and Seiche/Wind-Wave Runup – Flood protection of the site with permanent passive barriers

The Combined Effects (CE) / Probable Maxmim Flood (PMF) event postulated in the FHRR considers combinations of these scenerios as per Appendix H of NUREG-CR 7046 [Reference 26]. Table 3-1 of the MNS FHRR reported site inundation from results on combined effects in the MNS yard as Flood Elevation = 760.7 ft msl or 0.7 ft depth of inundation (the plant yard is located at EL. 760 ft msl). With the permanent passive barriers mentioned in flooding mechanisms 2, 3 and 4 above now in place, the MNS site is now flood protected from the worst-case scenerio CE/PMF event, and as a result flooding mechanisms 2, 3, and 4. Therefore, the combined effects in the MNS yard as reported in the MNS FHRR Table 3-1 is no longer credible.

For flood protection from the LIP event, frames were installed on vulnerable doorways in the MNS Auxiliary Building, which allow temporary passive barriers to be installed, relying on a warning time established with a trigger event as detailed in current flood protection procedures. The Auxiliary Building houses all KSFs. For flood protection from flooding mechanisms 2, 3, 4 stated above and from the CE/PMF event, permanent concrete barriers were installed on the earthen embankments tying into Cowans Ford Dam. These barriers protect the site and therefore all KSFs from these flooding mechanisms. Warning time is not necessary for these flooding mechanisms (other than the LIP) due to the fact that these barriers are considered to be permanent.

Therefore, this FE concludes that the strategy for maintaining key safety functions (KSFs) has effective flood protection through the demonstration of adequate Available Physical Margin (APM) and reliable flood protection features, and that the overall site response is adequate. This FE follows Path 2 of NEI 16-05, Rev. 1 and utilizes Appendicies B & C of that document for guidance on evaluating the site strategy. This submittal completes the actions related to External Flooding required by the March 12, 2012, 10 CFR 50.54(f) letter [Reference 1].

2. Background

On March 12, 2012, the NRC issued Reference 1 to request information associated with Near-Term Task Force (NTTF) Recommendation 2.1 for flooding. The RFI [Reference 1] directed licenses, in part, to submit a Flood Hazard Reevaluation Report (FHRR) to reevaluate the flood hazards for their sites using present-day methods and guidance used for early site permits and combined operating licenses. For McGuire Nuclear Station, Units 1 and 2, the FHRR was submitted on March 12, 2014 [Reference 2]. Additional information was provided to the NRC with References 4 and 5.

Following the Commission's directive to NRC Staff in Reference 12, the NRC issued a letter to the industry [Reference 13] indicating that new guidance was being prepared to replace instructions in Reference 9 and provide for a "graded approach to flooding reevaluations" and "more focused evaluations of local intense precipitation and available physical margin in lieu of proceeding to an Integrated assessment." NEI (Nuclear Energy Institute) prepared the new "External Flooding Assessment Guidelines" in NEI 16-05 [Reference 15], which was endorsed by the NRC in Reference 17. NEI 16-05 indicates that each flood-causing mechanism not bounded by the design basis flood (using only stillwater or wind-wave runup level) should follow one of the following five assessment paths:

- Path 1: Demonstrate Flood Mechanism is Bounded Through Improved Realism
- Path 2: Demonstrate Effective Flood Protection
- Path 3: Demonstrate a Feasible Response to LIP
- Path 4: Demonstrate Effective Mitigation
- Path 5: Scenario Based Approach

Non-bounded flood-causing mechanisms in Paths 1, 2, or 3 would only require an FE to complete the actions related to external flooding required by the March 12, 2012 - 10 CFR 50.54(f) letter. Mechanisms in Paths 4 or 5 require an Integrated Assessment. This FE followed Path 2 of NEI 16-05, Rev. 1 [Reference 15] and utilized Appendices B & C for guidance on evaluating the site strategy.

3. References

1. NRC Letter to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," dated March 12, 2012, ADAMS Accession No. ML12053A340
2. Duke Energy Letter, "Flooding Hazard Reevaluation Report, Response to NRC CFR 50.54(f) Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3 and 9.3 of Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated March 12, 2012," dated March 12, 2014, ADAMS Accession No. ML14083A415
3. NRC Letter, "McGuire Nuclear Station, Units 1 and 2: Request for Additional Information Regarding Flood Hazard Reevaluation Report (TAC Nos. MF3623 and MF3624)," dated May 28, 2014, ADAMS Accession No. ML14142A351
4. Duke Energy Letter, "Response to May 28, 2014 NRC Request for Additional Information Regarding Flood Hazard Reevaluation Report (TAC Nos. MF3623 and MF3624)", dated July 2, 2014, which was withheld under 10 CFR 2.390 due to inclusion of Security-Sensitive Information
5. Duke Energy Letter, "Response to NRC Request for Additional Information Regarding Flood Hazard Reevaluation Report (FHRR) for the McGuire Nuclear Station, Units 1 and 2," dated June 3, 2015 ADAMS Accession No. ML15173A113
6. NRC E-Mail, "McGuire Nuclear Station Units 1 and 2 - Request for Additional Information Regarding Flood Hazard Reevaluation Report," dated April 9, 2015, ADAMS Accession No. ML15100A366
7. NRC Letter, "McGuire Nuclear Station, Units 1 and 2 - Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request - Flood-Causing Mechanism Reevaluation (TAC Nos. MF3623 and MF3624)," dated September 3, 2015, ADAMS Accession No. ML15230A070
8. NRC Letter, "McGuire Nuclear Station, Units 1 and 2 - Staff Assessment of Response to 10 CFR 50.54(f) Information Request - Flood - Causing Mechanism Reevaluation (CAC NOS. MF3623 and MF3624)," dated October 31, 2016, ADAMS Accession No. ML16293A666
9. Letter from David L. Skeen, U.S. Nuclear Regulatory Commission, to Joseph E. Pollock, Nuclear Energy Institute, "Trigger Conditions for Performing an Integrated Assessment and Due Date for Response," dated December 3, 2012, ADAMS Accession No. ML12326A912
10. U.S. Nuclear Regulatory Commission, JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding," dated November 30, 2012, ADAMS Accession No. ML12311A214
11. COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and Reevaluation of Flooding Hazards," dated November 21, 2014, ADAMS Accession No. ML14238A616
12. NRC Staff Requirements Memoranda to COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," dated March 30, 2015, ADAMS Accession No. ML15089A236
13. NRC Letter, "Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events," dated September 1, 2015, ADAMS Accession No. ML15174A257
14. Nuclear Energy Institute (NEI), Report NEI 12-06, Revision 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," dated December 2015, ADAMS Accession No. ML16005A625

15. Nuclear Energy Institute (NEI), Report NEI 16-05, Revision 1, "External Flooding Assessment Guidelines," dated June 2016, ADAMS Accession No. ML16165A178
16. U.S. Nuclear Regulatory Commission, JLD-ISG-2012-01, Revision 1, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events," dated January 22, 2016, ADAMS Accession No. ML15357A163.
17. U.S. Nuclear Regulatory Commission, JLD-ISG-2016-01, Revision 0, "Guidance for Activities Related to Near-Term-Task Force Recommendation 2.1, Flood Hazard Reevaluation; Focused Evaluation and Integrated Assessment," dated July 11, 2016, ADAMS Accession No. ML16162A301
18. Duke Energy Letter, "Notification of Full Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" and with Order EA-12-051, "Order Modifying Licenses With Regard To Reliable Spent Fuel Pool Instrumentation" - McGuire Nuclear Station Unit 1," dated November 18, 2014, ADAMS Accession No. ML14335A322
19. Duke Energy Letter, "Final Notification of Full Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" and with Order EA-12-051, "Order Modifying Licenses With Regard To Reliable Spent Fuel Pool Instrumentation" for McGuire Nuclear Station," dated December 7, 2015, ADAMS Accession No. ML15343A010
20. Duke Energy Letter, "Supplement to McGuire Nuclear Station, Units 1 and 2 Final Notification of Full Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" and with Order EA-12-051, "Order Modifying Licenses With Regard To Reliable Spent Fuel Pool Instrumentation", dated December 7, 2015, ADAMS Accession No. ML15343A010," dated May 5, 2016, ADAMS Accession No. ML16131A634
21. NRC Letter, "Supplemental Information Related to Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) regarding Flooding Hazard Reevaluations for Recommendation 2.1 of the Near Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," dated March 1, 2013, ADAMS Accession No. ML13044A561
22. Nuclear Energy Institute (NEI) White Paper, "Warning Time for Maximum Precipitation Events," dated April 8, 2015, ADAMS Accession No. ML15104A157 as endorsed by the NRC on April 23, 2015 (ADAMS Accession No. ML15110A080). The white paper was subsequently issued by NEI on May 1, 2015 as NEI 15-05, "Warning Time for Local Intense Precipitation Events"
23. Duke Energy White Paper, "McGuire Nuclear Site Trigger Determinations for Local Intense Precipitation" by Stanton Lanham, dated November 9, 2016 (stored as Attachment A of MCC-1100.00-00-0005)
24. Duke Energy Letter (McGuire Nuclear Station), "Duke Energy Flood Hazard Mitigating Strategies Assessment (MSA) Report Submittal," dated December 15, 2016, Duke Document MNS-16-089, ADAMS Accession No. ML16355A210
25. NRC Letter, "McGuire Nuclear Station, Units 1 and 2 - Flood Hazard Mitigation Strategies Assessment (CAC Nos. MF7941 and MF7942)", dated May 18, 2017, ADAMS Accession No. ML17124A087
26. NUREG/CR-7046; Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America
27. McGuire's UFSAR, Rev. 19
28. MC-1022-01.00, Rev. 51; "Earthwork and Drainage - Plant Area"
29. MC-1022-09.00, Rev. 16; "Earthwork and Drainage - Sections and Details"
30. MCC-1100.00-00-0003, Rev. 1; "Auxiliary Building Roof Loading and Sandbag Evaluation Due to Revised PMP Per NTTF Recommendation 2.1 (FLEX/Fukushima)"

31. MCC-1100.00-00-0005, Rev. 0; "McGuire Nuclear Station Flood Mitigating Strategies Assessment (MSA) Verification (NTTF Recommendation 2.1)"
32. MCC-1103.01-00-0014, Rev. 0; "Evaluation of Additional Flood Barriers on Dike Between EL. 775' and 779' in Response to NTTF Recommendation 2.1 (Fukushima)"
33. MCC-1103.01-00-0015, Rev. 0; "Slope Stability of EL. 775' Cross-Section of the East Embankment with Additional Surcharge from Concrete Block Flood Barrier (FERC) (NTTF 2.1)"
34. MCC-1612.00-00-0002, Rev. 2; "10 CFR 50.54(f) Recommendation 2.3 Fukushima Near-Term Task Force (NTTF) Flood Walk-Downs"
35. MCC-1612.02-00-0001, Rev. 0; "Dry Cask Storage Area Flood Analysis for NTTF Flood Hazard Reevaluation (Fukushima)"
36. MCM-1100.00-0003.001 through MCM-1100.00-00-0003.005; Supporting Calculations for the FHRR
37. MCM-1100.00-0011.001, Rev. 0; "HDR Calculation 10037355-001 - Hydraulic Analysis of Consequential Rainfall Determination"
38. MCM-1182.00-0506.001 through MCM-1182.00-0506.008; Presray Corporation Portable Flood Barrier Vendor Documents
39. MCS-1154.00-00-0003, Rev. 14; "Design Basis Specification for Reactor Building Structures"
40. MCS-1154.00-00-0004, Rev. 14; "Design Basis Specification for Auxiliary Building Structures"
41. MCS-1465.00-00-0012, Rev. 3; "Design Basis Specification for Flooding from External Sources"
42. MCS-1465.00-00-0026, Rev. 1; "Design Specification for Flexible Response to Extended Loss of All AC Power"
43. OP/0/B/6100/031, Rev. 2; "Response to Local Intense Precipitation (LIP) or Probable Maximum Flood (PMF) External Flooding Event"
44. TO/0/A/9100/658, Rev. 1; "Interim Guidance to Respond to an LIP or PMF Flooding Event" **Deleted and Superseded by OP/0/B/6100/031**
45. AD-EG-ALL-1214, Rev. 0; "Condition Monitoring of Structures"
46. AD-EG-MNS-1214, Rev. 1; "Condition Monitoring of Structures"
47. EC 111708; "Addition of Roof Scuppers to Auxiliary Building and Fuel Buildings"
48. EC 111739; "Additional Flood Protection Features at Aux Building Doors"
49. EC 112499; "Addition of Flood Barriers on McGuire's Dike Between EL. 75' and 779' in Response to NTTF Recommendation 2.1 (Fukushima)"
50. McGuire Work Order (W/O) # 02132219 - Task # 28
51. McGuire Work Order (W/O) # 20038336 - Model Work Order for PM of Temporary Flood Barriers
52. PIP M-12-01952 (ARs 01903843 and 01903925) - Corrective Action # 110 - "McGuire Nuclear Station FLEX Strategy Timing Study" (stored as Attachment C of MCC-1100.00-00-0005)
53. CMPR-MC-MC-FLEX-3-01/2017-QTR; FLEX Building 3 Quarterly PM/Inspection Report by Safe Industries (Fusion Record ID Number: 017939437)
54. United States Department of Agriculture - Soil Conservation Service Document SCS-TP-61, "Handbook of Channel Design for Soil and Water Conservation" (June 1954)

4. Acronyms and Definitions

- AD-EG-ALL - Administrative Engineering Procedure for All Duke Plants
- AD-EG-MNS - Administrative Engineering Procedure for MNS
- AE - Associated Effects
- APM - Available Physical Margin
- BDB - Beyond Design Basis
- BDBEE - Beyond Design Basis External Event
- CDB – Current Design Basis
- CE - Combined Effects
- CLB - Current Licensing Basis
- DB – Design Basis
- EC - Engineering Change
- FE - Focused Evaluation
- FERC - Federal Energy Regulatory Commission
- FHRR – Flood Hazard Reevaluation Report
- FLEX – Flexible and Diverse Coping Strategies
- KSF - Key Safety Function(s)
- LIP – Local Intense Precipitation
- MC - McGuire Drawing
- MCC - McGuire Calculation
- MCS - McGuire Specification
- MNS - McGuire Nuclear Station, Units 1 and 2
- MSA - Mitigating Strategies Assessment
- MSFHI – Mitigating Strategies Flood Hazard Information (from the FHRR and MSFHI letter)
- MSL – Mean Sea Level (based on National Geodetic Vertical Datum [NGVD] 1929)
- NEI – Nuclear Energy Institute
- NRC - Nuclear Regulatory Commission
- NTTF - Near-Term Task Force
- OP - Operating Procedure
- PM - Preventative Maintenance
- PMF – Probable Maximum Flood
- PMP – Probable Maximum Precipitation
- PQPF - Probabilistic Quantitative Precipitation Forecast
- RFI - Request for Information
- SNSWP - Standby Nuclear Service Water Pond
- SSC – Structures, Systems, and Components
- TSA - Time Sensitive Action
- UFSAR - Updated Final Safety Analysis Report
- USACE - United States Army Corps of Engineers
- W/O - Work Order

Inundation: Defined by the FHRR as the time period from > 0.1 ft of water above grade until the time where water recedes to a level within 0.1 ft from the end of simulation (i.e. steady state).

5. Characterization of Flood Hazard Parameters for Unbounded Mechanisms

The NRC has completed the "Interim Staff Response to Reevaluated Flood Hazards" [Reference 7], which contains the Mitigating Strategies Flood Hazard Information (MSFHI) related to McGuire Nuclear Station's (MNS) Flood Hazard Reevaluation Report (FHRR) [Reference 2], as well as their "Staff Assessment" [Reference 8]. Note that no changes were made from the MSFHI in the Staff Assessment. In Reference 7, the NRC states that the "NRC staff has concluded that the licensee's reevaluated flood hazards information, as summarized in the enclosure, is suitable for the assessment of mitigating strategies developed in response to Order EA-12-049 (i.e., defines the mitigating strategies flood hazard information described in guidance documents currently being finalized by the industry and NRC staff) for McGuire. Further, the NRC staff has concluded that the licensee's reevaluated flood hazard information is suitable input for other assessments associated with Near-Term Task Force Recommendation 2.1 'Flooding'." The enclosure to Reference 7 includes a summary of the current design basis (CDB) flood hazards and the reevaluated flood hazard parameters, respectively. In Table 1 of the enclosure to Reference 7, the NRC lists the following flood-causing mechanisms for the design basis flood:

- Local Intense Precipitation;
- Streams and Rivers;
- Failure of Dams and Onsite Water Control/Storage Structures;
- Storm Surge;
- Seiche;
- Tsunami;
- Ice-Induced Flooding; and
- Channel Migrations/Diversions.

The FHRR evaluated ten flooding hazards [Reference 2 - Table 3-1]. Below are flooding mechanisms exceeding Current Design Basis (CDB) as per the MNS FHRR:

1. Local Intense Precipitation (LIP)
2. Streams and Rivers (referred to as Flooding in Reservoirs in MNS FHRR)
3. Dam Failures
4. Storm Surge and Seiche/Wind-Wave Runup

The Combined Effects (CE) / Probable Maximum Flood (PMF) event considers combinations of these scenerios as per Appendix H of NUREG/CR 7046 [Reference 26]. The worst case CE/PMF scenerio also exceeded the CDB. The CE/PMF event in the MNS FHRR is considered to be the highest flood elevation at the Lake Norman Reservoir resulting in the Combined Effects at the MNS yard and downstream at the Standby Nuclear Service Water (SNSWP) Dam.

As is shown in both References 2 and 7, it was found that the LIP event results in a flood level on the plant site of EL. 761.1 ft msl due to local precipitation.

For the flooding mechanisms 2 and 3 , the maximum water levels of 777.9 ft msl and 778.5 ft msl respectively (shown in Table 2 of Reference 7) represent the water levels on Lake Norman. Wind wave runup (part of flooding mechanism 4 stated above) was determined to be minimal representing 778.54 ft msl [Reference 2 - Table 3-1]. Due to the high water levels on Lake Norman, the protective embankments north of the site were originally overtopped, resulting in an on-site water level of 760.7 ft msl [Reference 2 - Table 3-1]. This is no longer the case due to the installation of permanent barriers on the embankment as discussed in Section 7 of this document.

Tables 5.1 and 5.2 below summarize the applicable flood mechanism parameters on site.

Table 5.1 – Detailed Flood Mechanism Parameters for the LIP Event (On Site)

Flood Scenario Parameter		*Current Design Basis Flood Hazard*	*Reevaluated Flood Hazard*	*Bounded (B) or Not Bounded (NB)*
Flood Level and Associated Effects	1. Max Stillwater Elevation (ft. MSL) (on-site)	760.4	761.1	NB (Note 2)
	2. Max Wave Run-up Elevation (ft. MSL)	N/I	N/A	N/A (Note 3)
	3. Max Hydrodynamic (lb/ft)/Debris Loading (lb)	N/I	Minimal	B (Note 4)
	4. Effects of Sediment Deposition/Erosion	N/I	Minimal	B (Note 5)
	5. Other associated effects (identify each effect)	N/I	N/A	N/A (Note 6)
	6. Concurrent Site Conditions	N/I	N/A	N/A (Note 7)
	7. Effects on Groundwater	N/I	N/A	N/A (Note 8)
Flood Event Duration	8. Warning Time (hours)	N/I	72	(Note 9)
	9. Period of Site Preparation (hours)	N/I	24	(Note 10)
	10. Period of Inundation (hours)	N/I	2.5	(Note 11)
	11. Period of Recession (hours)	N/I	N/A	(Note 12)
Other	12. Plant Mode of Operations	N/I	All	(Note 13)
	13. Other Factors	N/I	None	N/A (Note 14)

N/A = Not Applicable N/I = Not Included

Additional notes, 'N/A' justifications (why a particular parameter is judged not to affect the site), and explanations regarding the bounded/non-bounded determination.

1. All numbers in this table are rounded to the nearest tenth.

2. The Current Design Basis PMP flood level is 760.375 ft msl or 0.375 ft above the site grade [Reference 27 - Section 3.4]. Most plant yard structures are affected by the LIP with inundation levels of 0.2 ft at the Unit 2 Turbine Building to 1.4 ft at the Waste Solidification Building (not part of the main complex and does not contain any SSCs with KSFs) [Reference 2 - Table 2.1.4-1]. Pre-staged engineered flood barriers will be installed using warning time per OP/0/B/6100/031 on Auxiliary Building doors, which protect all SSCs with KSFs in the Auxiliary Building.

3. Consideration of wind-wave action for an LIP event is not explicitly required by NUREG/CR-7046 and is judged to be negligible because of limited fetch lengths and flow depths.

4. Existing design basis features for flooding are located and designed to elevations up to 760.5 ft msl [Reference 27 - Section 3.4]. The worst flooding elevation is 761.1 ft msl, so approximately 0.7 ft of water would exert external loads on all structures. This level of water would exert a linear load on all structures of 15.3 lb/ft (0.5 x 0.7 ft x [0.7 ft x 62.4 lb/ft^3]). This amount of loading would have a negligible effect on all structures on site due to the use of steel and concrete for construction. The hydrodynamic and hydrostatic loads are also bounded by the design basis maximum tornado wind and missile loads on all Category 1 structures [Reference 27 - Section 3.3]. The debris load for the LIP event would be negligible due to the absence of heavy objects at the plant site and due to low flow velocities. In addition, the pre-staged flood barriers that are installed on Auxiliary Building doors prior to the LIP event are designed for flood elevations up to 30" (2.5 ft) [Reference 38].

5. The Current Design Basis does not discuss sediment deposition or erosion. The maximum flow velocity, due to the LIP event, of 3.1 feet per second (fps) [Reference 2 - Table 2.1.4-1] is below the suggested maximum flow velocities for the ground cover types (concrete and gravel) in the plant yard [Reference 54 - Appendix - Table 2]. Therefore, significant erosion is not expected for the LIP flood. Similarly, the relatively low velocities and flow depths are not expected to have the power to transport significant amounts of sediment and cause significant deposition during the LIP flood. The flood models utilized in the FHRR do not show abrupt changes in direction and magnitude of velocity vectors that would cause significant deposition [Reference 2].

6. By inspection of the Current Design Basis, MSFHI letter, and the FHRR, there are no other associated effects associated with an LIP event.

7. High winds could be generated concurrent to an LIP event. However, manual actions are not required to protect the plant from LIP flooding during the actual event, so this concurrent condition is not applicable. Water levels on site are so low that winds would not create any significant wave action in the yard. All Category 1 structures are protected against wind and tornado loads [Reference 27 - Section 3.3].

8. The majority of the plant area is paved or gravel. Based on information contained in McGuire's UFSAR - Former Appendix 2D, soils on site are generally characterized as Unified Soil Classification System (USCS) ML or MH (low plasticity to high plasticity silts) which are characterized by small soil particle size and low permeability. These land use and soil type parameters would limit the volume of rainfall infiltrated during a short-duration (1 hour) LIP event and groundwater seepage would likely be minimal. In addition, the plant is protected from groundwater ingress by a Category 1 groundwater drainage system which maintains groundwater levels below 717 ft msl for the Reactor Building and 712 ft msl for the Auxiliary Building [Reference 2 - Section 1.2.2.3].

9. The consequential rainfall for a 1 hour LIP event was determined to be 8.00" in 1 hour per Reference 37. NEI 15-05 [Reference 22 - Section 5.2.2.C.2] suggests the use of 1/2 of the consequential rainfall amount for the trigger rainfall amount. This would result in a trigger value of 4.00" in 1 hour. NEI 15-05 - Section 5.3 then requires this 4.00" rainfall amount to be spread out over a period of 24 hours due to accuracy limitations in weather forecast models. Due to this methodology, the false trigger rate at McGuire was found to be unreasonably high [Reference 23], and as a result the alternate trigger method allowed by NEI 15-05 - Section 5.2.2.C.3 was used. Reference 23 determined that using a trigger

value of 5.35" of rainfall over a 24 hour period for MNS met the intent of NEI 15-05 with adequate conservatism. Per References 22 and 23, the rainfall amount for an LIP event was found to be predictable, and therefore its use to install pre-staged flood protection features is acceptable. Per OP/0/B/6100/031, if the T-72 hour PQPF forecast at the 95th percentile calls for 5.35" of rain (or more) over a 24 hour period, then a monitoring trigger is initiated. If the forecast still calls for the 5.35" rainfall amount at the T-24 hour point, then the flood barriers are installed.

10. Reference 50 conducted a dry run for installing the barriers using a single two man crew and the worst case door. It was found by Reference 50 that all flood barriers could be installed by a single two man crew in approximately 83 minutes (1.4 hours). The performance of this dry run meets the requirements of NEI 12-06 - Appendix E [Reference 14] for a Level B anticipatory action (warning time is greater than 6 hours). Therefore, 24 hours is more than adequate for the installation of the eleven pre-staged flood barriers prior to the LIP event.

11. Per Reference 2 - Table 2.1.4-1 the maximum period of inundation for the LIP event on the main plant yard is 2 hours and 29 minutes (at the Unit 2 Diesel Generator Building). This period includes the time when water levels on site reach 0.1 ft above grade until the point at which waters recede to a point of steady state (within 0.1 ft of the final water level) [Reference 2 - Section 2.1.4]. Water levels at the end of the simulation are minimal and would not affect any SSCs, movement or actions, or access on the site.

12. Per the FHRR, inundation times discussed in this table include water recession from the site. See note 11 above for additional details for how the LIP flood inundation times were modeled.

13. The plant mode of operation during the Current Design Basis PMP flood was not detailed in McGuire's UFSAR. The same is true for the MSFHI. As part of OP/0/B/6100/031 [Reference 43], if the 5.35" precipitation amount is still forecast within 24 hours of the predicted event, management may take the precaution of shutting down both units.

14. By inspection of the Current Design Basis, MSFHI letter, and the FHRR, there are no other factors to consider for the LIP event beyond those discussed above.

Table 5.2 – Detailed Flood Mechanism Parameters for Streams & Rivers (Flooding in Reservoirs), Dam Failures, Storm Surge and Seiche/Wind-Wave Runup and a CE/PMF Event

Flood Scenario Parameter		*Current Design Basis Flood Hazard*	*Reevaluated Flood Hazard*	*Bounded (B) or Not Bounded (NB)*
Flood Level and Associated Effects	1. Max Stillwater Elevation (ft. MSL)	767.9	778.5	NB (Note 1)
	2. Max Wave Run-up Elevation (ft. MSL)	774.75	778.54 (minimal)	NB (Note 1)
	3. Max Hydrodynamic (lb/ft)/Debris Loading (lb)	N/A	N/A	N/A (Note 2)
	4. Effects of Sediment Deposition/Erosion	N/A	N/A	N/A (Note 2)
	5. Other associated effects (identify each effect)	N/A	N/A	N/A (Note 2)
	6. Concurrent Site Conditions	N/A	N/A	N/A (Note 2)
	7. Effects on Groundwater	N/A	N/A	N/A (Note 2)
Flood Event Duration	8. Warning Time (hours)	N/A	N/A	N/A (Note 2)
	9. Period of Site Preparation (hours)	N/A	N/A	N/A (Note 2)
	10. Period of Inundation (hours)	N/A	N/A	N/A (Note 2)
	11. Period of Recession (hours)	N/A	N/A	N/A (Note 2)
Other	12. Plant Mode of Operations	N/A	N/A	N/A
	13. Other Factors	N/A	None	N/A

N/A = Not Applicable N/I = Not Included

Additional notes, 'N/A' justifications (why a particular parameter is judged not to affect the site), and explanations regarding the bounded/non-bounded determination.

1. Table 3-1 of the FHRR lists a maximum stillwater elevation of 778.5 ft msl at Lake Norman Reservoir for Streams & Rivers (Flooding in Reservoirs) and Dam Failures, which was found to overtop the protective embankment on the north of the site at the EL. 780 ft msl to the EL. 775 ft msl transition zone. The CE/PMF at the Lake Norman Reservoir adds 0.04 ft for wave runup, which is minimal, producing a maximum water elevation of 778.54 ft msl. However, the resulting on-site flood level of EL. 760.7 ft msl from the CE/PMF event (Combined effects MNS Yard in Table 3-1 of FHRR) is no longer valid due to the installation of permanent concrete flood barriers on the EL. 780 ft msl to EL. 775 ft. msl transition zone. These barriers increased the height of the protective embankments to a minimum elevation of 779 ft msl [Reference 29]. The maximum water level on Lake Norman due to the Failure of Dams, Storm Surge and Seiche/Wind-Wave Runup, and CE/PMF was found to be EL. 778.54 ft msl per the FHRR, and the water level on Lake Norman due to the Streams and Rivers (Flooding in Reservoirs) Mechanism was found to be EL. 777.9 ft msl. Per

Reference 7, wave runup was found to be minimal and was not reported for any of these mechanisms. All of these levels are lower than the passive protection that the embankment now provides (minimum of 779 ft msl), thus eliminating the flood hazard due to these mechanisms.

2. Given the Streams and Rivers (Flooding in Reservoirs), Dam Failures and CE/PMF mechanisms are now permanently flood protected as stated in Note 1, these events no longer inundate the site. Therefore, debris loading, sediment deposition/eroding, concurrent site conditions, effects on groundwater, and flood event durations are all no longer applicable.

The on-site flood levels listed in Table 5.1 will overtop several current licensing basis passive flood protection features for the Auxiliary Building, which contains SSCs with key safety functions (i.e., minimum exterior door thresholds at EL. 760.5 ft msl per Reference 27 - Section 3.4). All SSCs with KSFs that are located in the Auxiliary Building below the flood levels listed in Table 5.1 are conservatively assumed to be affected by these events (every plant system has the potential to be affected due to the layout of the Auxiliary Building). Overtopping of these features and the associated increased loading on other protective features will be the focus of this document.

Flooding on site (FHRR [Reference 2] - Table 3-1 Combined Effects MNS Yard) at Elev. 760.7 ft msl due to a CE/PMF event overtopping the earthen embankment adjacent to Cowans Ford Dam is no longer a hazard due to the installation of permanent concrete barriers on the embankment which raise the minimum height of the embankment to EL. 779 ft msl, which is higher than the CE/PMF maximum water level at the Lake Norman reservoir of 778.54 ft msl. Therefore, for all events besides an LIP event, McGuire can be considered a dry site.

The on-site LIP flood levels would not affect SSCs with KSFs in the Reactor Buildings due to their design and location in relation to those flood levels [Reference 2].

The FHRR evaluated the Standby Nuclear Service Water Pond Dam for these Beyond Design Basis External Events (BDBEE), including downstream flooding effects, and found that the existing structure met current USACE and FERC acceptance standards and therefore is not considered in this Focused Evaluation [Reference 2 - Section 3.1].

All other SSCs subject to these BDBEE flood levels do not have key safety functions and therefore do not need to be considered here.

6. Overall Site Flooding Response

6.1. Description of Overall Site Flooding Response

The site response for an LIP event is as follows:

McGuire Nuclear Station will require temporary passive flood barriers to be deployed at external doors on the Auxiliary Building in order to maintain key safety functions (KSFs) during an LIP event. Without the installation of the staged flood barriers, water is conservatively assumed to flow into the building through the un-sealed portions of the door frames, causing flooding and affecting SSCs with KSFs below EL. 761.1 ft msl. Procedure OP/0/B/6100/031 [Reference 43] lists all doors which would be affected and which have temporary passive flood barriers staged nearby. The current design basis external flood protection features for the Auxiliary Building consist of passive door thresholds at a minimum elevation of 760.5 ft msl [Reference 27 - Section 3.4]. This means an additional 0.6 ft of water (above the CLB protection) could act against the temporary flood barriers as well as existing flood barriers for the duration of inundation (i.e., external concrete walls of the Auxiliary Building and Reactor Buildings) [References 2 and 24].

MNS relies on warning time to install these temporary passive flood barriers as described in Section 5 - Table 5.1 - Note 9 (above). This involves a 72 hour warning time with a site preparation time of 24 hours before the event. As described in Section 5 - Table 5.1 - Note 9, the total time to stage the temporary flood barriers was found to be approximately 1.4 hours, leaving plenty of margin for these actions to occur.

Besides the temporary passive barriers, McGuire relies upon permanent existing passive barriers to protect SSCs with key safety functions from the reevaluated LIP event. These permanent passive features include the concrete walls and roof of the Auxiliary and Reactor Buildings, existing door thresholds, as well as existing seals for penetrations below the LIP flood elevation.

While not needed for LIP event protection, the FLEX strategies and Procedure OP/0/B/6100/031 (the LIP and CE/PMF response procedure) as described involve the staging of portable pumps as well as the use of heavy debris removal equipment, which would provide additional defense-in-depth [References 24, 42, and 43].

The site response for flooding mechanisms including Streams & Rivers (Flooding in Reservoirs), Dam Failures, Storm Surge and Seiche/Wind-Wave Runup, and CE/PMF event is as follows:

The difference between the LIP flood mechanism and other flood mechanisms is how the FHRR originally postulated flooding of the site would occur. The LIP event deposited water directly on-site, while other events flooded the site by overtopping the embankments north of the plant yard.

For events other than the LIP, the maximum water levels on Lake Norman reach EL. 778.54 ft msl, which was originally above the top of the embankment west of the yard where it transitioned from EL. 780 ft msl to EL. 775 ft msl [Reference 2 - Section 2.8]. This allowed flooding into the western portion of the site, inundating the Dry Cask Storage Area and affected the spent fuel casks stored in that area.

The original response [Reference 44] called for staged pumps to remove water in the dry cask area and for placing sand bags at exterior doors of the Auxiliary Building. An analysis was run to determine if the FHRR's inundation time for the Dry Cask Storage Area would compromise the spent fuel casks [Reference 35]. Reference 35 found that integrity of the spent fuel was not challenged.

Since the original response, permanent passive concrete barriers were installed per Engineering Change (EC) 112499 [Reference 49]. These barriers are approximately 400 ft in length within the EL. 780 ft msl to EL. 775 ft msl embankment transition area, raising the height of the embankment/barrier to a minimum of EL. 779 ft msl [Reference 29] (0.46 ft above the highest posutlated water level on Lake Norman due to Streams and Rivers, Dam Failures, Storm Surge and Secihe/Wind-Wave Runup, or a CE/PMF event of 778.54 ft msl) [References 2 and 35]. The new concrete barriers and their effect on the earthen embankment were evaluated by References 32 and 33 and found to be acceptable. These concrete barriers prevent overtopping and erosion of the earthen embankments, preventing flooding in the western portion of the plant yard and preventing the flooding in the Dry Cask Storage Area as postulated in the FHRR.

Due to the installation of the new permanent concrete barriers on the earthen embankment, flooding due to overtopping of the embankments (combined effects in MNS yard as reported in Table 3-1 of MNS FHRR) is no longer a credible scenario, and therefore, McGuire is considered a dry site for all events other than an LIP.

6.2. Summary of Plant Modifications and Changes

The necessary plant changes to ensure proper flooding protection for the beyond design basis flooding scenarios outlined in the FHRR were listed in Attachment 3 of the FHRR [Reference 2]. Some of these actions were temporary and have since been superceded by permanent changes. A summary of required changes per Attachment 3 of the FHRR and the actual plant changes which have been implemented are discussed below:

LIP-2 (permanent solution which supercedes LIP-1):

Commitment Description: Frames will be installed on vulnerable doorways in the MNS Auxiliary Building. Approved site procedure(s) will be in place that will ensure temporary flood doors will be installed in the frames prior to an LIP event.

Implementation Description: Temporary passive frames/barriers were installed on all vulnerable Auxiliary Building doors per EC 111739 [Reference 48]. These barriers are installed with the use of warning time (as discussed earlier) per procedure OP/0/B/6100/031 [Reference 43].

LIP-4 (permanent solution which supercedes LIP-3):

Commitment Description: New scuppers will be installed in the parapet walls of site roofing as needed to limit the quantity of LIP related flood water that collects on site roofing, thereby preventing a roofing failure and the subsequent influx of roof water into the Auxiliary Building.

Implementation Description: New scuppers were installed per EC 111708 [Reference 47]. An analysis was also performed per calculation MCC-1100.00-00-0003 [Reference 30] which found the new roof loadings due to the BDB LIP (and enveloped CE/PMF event) to be acceptable.

CE/PMF-1:

Commitment Description: Barriers will be placed on the transition earth embankment between the 775 ft msl and 780 ft msl embankments to protect this area from the 778.5 ft msl water level associated with the Combined Effects/PMF event.
Implementation Description: Permanent concrete barriers were installed on the earthen embankments per EC 112499 [Reference 49]. These barriers are shown on drawing MC-1022-09.00 [Reference 29]. Calculations MCC-1103.01-00-0014 [Reference 32] and MCC-1103.01-00-0015 [Reference 33] qualify the new barriers and the earthen embankments to withstand the loads from the maximum postulated flood levels.

CE/PMF-2:
Commitment Description: Approved site procedure(s) will be in place that will ensure, prior to a Combined Effects/PMF event, the above LIP-1 and LIP-2 regulatory commitments will be implemented as applicable, additional plant staffing will be available onsite as needed to ensure the required plant capabilities are maintained, a diesel powered pump(s) and supporting equipment will be staged as needed to maintain flood water level in the spent fuel dry cask yard area below the level of the dry cask lower cooling air inlets.
Implementation Description: Staffing and pre-staging of equipment for a CE/PMF were originally detailed in Procedure TO/0/A/9100/658 [Reference 44]. The flood levels in the dry cask storage area are no longer applicable due to the installation of the concrete barriers, which prevent the previously postulated overtopping of the earthen embankments north of the dry cask area. As defense-in-depth, these actions are still in place for the CE/PMF event in OP/0/B/6100/031 [Reference 43].

7. Flood Impact Assessment

7.1 Local Intense Precipitation (LIP) - Path 2

7.1.1 Description of Flood Impact

Table 5.1 shows a maximum flood elevation in the McGuire plant yard due to an BDB LIP event of 761.1 ft msl. As stated previously, all external Auxiliary Building doors are protected from flood waters up to EL. 760.5 ft msl by existing door thresholds [Reference 27 - Section 3.4]. Other structures, such as the Reactor Building, which contain SSCs with key safety functions are not affected by these beyond design basis flood levels due to existing passive barriers such as concrete walls, roofs, and seals.

All SSCs with KSFs in the Auxiliary Building, below EL. 761.1 ft msl are conservatively assumed to be affected by these flood waters as the water could flow through unprotected doors listed in OP/0/B/6100/031 [Reference 43]. Due to the arrangement of the Auxiliary Building, this flood could potentially affect every system in the plant.

7.1.2 Adequate APM Justification and Reliability of Flood Protection

Utilizing guidance from NEI 16-05 - Appendix B, APM and reliability must be demonstrated for the following passive features which McGuire relies upon for protection against the beyond design basis LIP flood event:

1. Existing concrete walls/floors/roofs for the Auxiliary Building and Reactor Buildings;
2. Existing seals for penetrations into the Auxiliary Building; and
3. Temporary passive flood barriers installed prior to a BDB LIP event on several Auxiliary Building doors.

There are no active components which McGuire relies upon for protection against the BDB LIP flooding event.

Note that per Reference 27 - Section 3.4, design basis flood protection is provided up to EL. 760.5 ft msl, which means the beyond design basis LIP event produces flood levels 0.6 ft above the existing design basis. This would translate to an additional equivalent static linear load of 11.2 lb/ft (0.5 x 0.6 ft x [0.6 ft x 62.4 lb/ft^3]) acting on any flood protective features above EL. 760.5 ft msl. Also note that the site does have a storm drainage system, which functions properly during normal rain events. The FHRR conservatively assumed that this storm drainage system would not function at all [Reference 2]. This conservative assumption, among others, adds additional undocumented margin to this analysis.

Per Section 5 of this document - other loadings such as debris, wind/wave, and dynamic loading from an LIP flood event were found to be negligible.

Each passive feature is evaluated further below:

1. Existing concrete walls/floors/roofs for the Auxiliary Building and Reactor Buildings:

Per Reference 27 - Chapter 3 and References 39 and 40, the Auxililiary Building and Reactor Building exterior walls are designed to withstand design basis wind, tornado, and missile loads, which far exceed the very small load exerted by the increased BDB flood level. This comparison demonstrates more than adequate available physical margin. The slight increase in hydrostatic loading below the ground surface would be minimal and would not impact the current design due to such small increases in flood levels compared to the robust design on the concrete walls and foundations.

The Reactor Building roofs consist of domes with parapets and roof drainage. This domed design does not allow extra water to accumulate due to a BDB LIP event, and therefore, no additional analysis is necessary.

The Auxiliary Building roof is flat and can allow additional water to accumulate. Adequate APM was demonstrated for the beyond design basis LIP roof loading in calculation MCC-1100.00-00-0003 [Reference 30].

Calculation MCC-1612.00-00-0002 [Reference 34] documents walkdowns and analyses of these physical features for the NTTF Recommendation 2.3 response. Attachment 2 of that calculation details preventative maintenance (PM) and inspection programs for these existing passive features. The routine PMs and inspections demonstrate adequate reliability of these flood protection features. All passive civil features, including these, are inspected every 5 years (nominally) per References 45 and 46.

2. Existing seals for penetrations into the Auxiliary Building:

The existing below grade seals, subject to beyond design basis flooding, were evaluated as part of the NTTF Recommendation 2.3 walkdowns. Significant APM was demonstrated for these seals in calculation MCC-1612.00-00-0002 [Reference 34]. Attachment 2 of that calculation details preventative maintenance (PM) and inspection programs for the seals, showing adequate reliability and monitoring for these features. All passive civil features, including these, are inspected every 5 years (nominally) per References 45 and 46.

3. Temporary passive flood barriers installed prior to a BDB LIP event on several Auxiliary Building doors:

The temporary passive flood barriers installed on exterior Auxiliary Building doors are installed per procedure OP/0/B/6100/031 [Reference 43]. These doors were engineered to withstand flood levels of 30" [Reference 38], which is much greater than the flood levels (1.1 ft or 13.2 in) produced by a flood up to EL. 761.1 ft msl (site yard level is EL. 760 ft msl [Reference 28]). Calculation MCC-1100.00-00-0003 [Reference 30] showed that maximum water levels against the two doors on the Auxiliary Building roof were approximately 10", which is only 1/3 of the qualified protection level of the temporary barriers. This leaves an available physical margin of 20" for these temproary flood barriers.

These temporary passive barriers are inspected on a 2 year frequency by model work order (W/O) # 20038336 [Reference 51] per the vendor's recommendation. This inspection/PM program ensures reliable performance of these barriers.

In summary, the listed items below illustrate the LIP APM, which is derived from the maximum water surface elevation, due to the LIP event, to the top of the temporary passive barriers used at several Auxiliary Building exterior doors:

- Maximum water surface elevation due to LIP on the ground surface is expected to be EL. 761.1 ft msl. This water level occurs 0.6 ft above the Auxiliary Building exterior door sills @ EL. 760.5 ft msl.
- Maximum water surface elevation due to LIP on the roof is expected to be 10 inches (0.83 ft) above the roof surface.
- Rated design water level against each temporary passive flood barrier at the Aux. Building exterior doors is 30 inches (2.5 ft)
- APM for the LIP event on the ground surface is approximately 1.9 ft (barrier rated water height of 2.5 ft - 0.6 ft = 1.9 ft)
- APM for the LIP event on the roof surface is approximately 1.7 ft (barrier rated water height of 2.5 ft - 0.83 ft = 1.67 ft)

7.1.3 Adequate Overall Site Response

This evaluation, performed in accordance with NEI 16-05 Appendix C, demonstrates the overall site response to the beyond design basis Local Intense Precipitation event is adequate. The following sections outline the results of evaluating the criteria in NEI 16-05 - Appendix C.

7.1.3.1 Defining Critical Path and Identifying Time Sensitive Actions (TSAs)

The overall strategy for protecting McGuire Nuclear Station from a beyond design basis Local Intense Precipitation event is very straightforward and involves only a few time sensitive actions. The rest of the plant's protection relies on passive flood protection features, which are permanent parts of the plant structure. The critical path actions and TSAs have been identified during the NEI 12-06 validation process and are performed in accordance with Appendix E of that document [Reference 14]. The critical path and TSAs include:

1. Identifying a Severe Weather Event [Critical Path Action]
2. Establishing Command and Control [Critical Path Action]
3. Dispatching Crews to Complete all Actions in Procedure OP/0/B/6100/031 (Installation of the Temporary Passive Barriers on the Auxiliary Building Doors) [Critical Path and Time Sensitive Action]

7.1.3.2 Demonstrate all TSAs are Feasible

The TSAs for MNS's response to the BDB LIP event (including proper weather monitoring, the use of triggers and warning times, and installation of the temporary flood barriers) have been validated and evaluated for feasibility using the guidance provided in NEI 12-06 - Appendix E and G [Reference 31]. These evaluation results are the basis for determining that the overall strategy is adequate. References 24, 31, and 50 found that all of the temporary barriers could be installed in approximately 1.4 hours. It was determined in Sections 5 and 6 of this report that plenty of margin exists to install these temporary barriers since the action trigger to do so is 24 hours before the event per OP/0/B/6100/031 [Reference 43].

7.1.3.3 Establish Unambiguous Procedural Triggers

Per OP/0/B/6100/031 [Reference 43] - Step 2.1 of Attachment 1 - MNS will receive confirmed reports from the on-duty meteorologist that within the next 72 hours rainfall at the site is predicted to be 5.35 inches or more over a 24 hour period using the Probabilistic Quantitative Precipitation Forecast (PQPF) at the 95th percentile. This monitoring trigger will start monitoring and actions outlined in procedure OP/0/B/6100/031. All monitoring and actions triggers, as discussed in Section 5 of this report, are based on guidance from NEI 15-05 [Reference 22] and information from References 23 and 37. Organization and material alignment begins at the 72 hour period per the OP procedure. At 48 hours before the predicted event (if it is still predicted), additional mobilization and organization will be performed. Finally, at the 24 hour point before the event, the temporary flood barriers will be installed. Weather is monitored at defined points per the OP procedure based on industry guidance.

The triggers for the actions outlined above are unambiguous since definitive time periods, monitoring tools, triggering values, sequential and dependent actions, and responsible personnel are all clearly defined in the flooding response procedure.

7.1.3.4 Proceduralized and Clear Organization Response to a Flood

OP/0/B/6100/031 provides clear guidance on the responsibilities for all groups at the station. Clear direction is given to all levels of staff at the site from station management down to individual maintenance crews for each required action. Signoffs are included in the procedure to ensure that each key party has been informed of the impending event and that they have begun their required preparation. All necessary pre-job meetings and staging of equipment is performed before the 24 hour action trigger. Station management, a Unit Threat team, and the Technical Support Center are organized and established prior to the 24 hour point before the predicted event to provide clear direction for individual crews.

OP/0/B/6100/031 has been determined to have very clear guidelines for severe weather preparations and organizational response. The individual steps required for each group are provided in detailed attachments to the procedure in order to stage and perform all required actions. Enough detail is provided, including pictures, to allow successful implementation of the procedure. OP/0/B/6100/031 has individual crews go over the procedure 48 hours before the event (24 hours before the action trigger) to ensure all questions are resolved.

7.1.3.5 Detailed Flood Response Timeline

The timeline for all actions required to protect MNS against a BDB LIP event is clearly defined in procedure OP/0/B/6100/031. All time sensitive actions in the procedure have been validated using guidance from NEI 12-06 - Appendix E [Reference 31]. The only time sensitive action required during an LIP event is the installation of the temporary barriers at various external Auxiliary Building doors. The temporary barriers are installed on the Auxiliary Building doors 24 hours prior to the predicted event. Reference 50 found that it took approximately 1.4 hours to install these doors, leaving a margin of 22.6 hours for this action. In addition, any required augmented staff is required to be on site and established prior to the 24 hour point before the predicted event per the procedure.

7.1.3.6 Accounting for the Expected Environmental Conditions

The environmental conditions expected during the deployment of the temporary barriers on the doors are expected to have a minimal impact on these tasks. Advanced warning of the event will provide sufficient time to have all necessary items in place prior to the onset of severe weather. Given the short amount of time expected to complete the TSAs, it is unlikely that conditions will deteriorate enough to impede the staging and installation of these flood protection features. Plenty of margin has also been demonstrated to account for any unanticipated environmental conditions prior to the event. During the actual event, OP/0/B/6100/031 ensures enough staff will be present to deal with any other unanticipated circumstances. Designated FLEX equipment located on site is available to clear debris from the storm and to ensure access to all necessary locations is available as added defense-in-depth.

7.1.3.7 Demonstration of Adequate Site Response

The site response to a beyond design basis LIP event has been demonstrated (above) as adequate by meeting the guidelines in NEI 16-05 - Appendix C. All TSAs were identified and determined to be feasible per NEI 12-06 - Appendix E & G guidance, as shown above. The time margin available for each required action was shown previously to be very large. The organizational structure and command and control is clearly laid out in OP/0/B/6100/031, and checklists are provided in that procedure with all required steps/actions for successful completion. Finally, the environmental conditions during the site response are expected to have a minimal impact as described above, and plenty of margin and defense in depth is provided in case unanticipated conditions are encountered.

7.2 Streams and Rivers (Flooding in Reservoirs), Dam Failues, Storm Surge and Seiche/Wind-Wave Runup, and Combined Effects Probable Maximum Flood (CE/PMF) - Path 2

7.2.1 Description of Flood Impact

Table 5.2 discusses a maximum water level of 778.54 ft msl on Lake Norman and a resulting flood elevation in the McGuire plant yard due to a BDB CE/PMF event of 760.7 ft msl. This on site flood level is no longer applicable due to the installation of permanent concrete barriers on the earthen embankments north of the site. Flood levels on Lake Norman would no longer overtop the embankment and produce floods which would affect SSCs with KSFs. Due to the topography of that area as shown in Reference 28, water flowing over Cowans Ford Dam and its eastern embankment could not flow back onto the site.

7.2.2 Adequate APM Justification and Reliability of Flood Protection

Utilizing guidance from NEI 16-05 - Appendix B, APM and reliability must be demonstrated for the following passive features which McGuire relies upon for protection against the reevaluated water levels due to the events discussed above.

1. Earthen embankments north of the plant yard; and
2. Permanent concrete barriers installed on the earthen embankment (EL. 775 ft msl to EL. 780 ft msl transition zone)

1. Earthen embankments north of the plant yard:

The earthen embankments were evaluated for the flood loads and surcharge loads due to the permanent concrete barriers in calculation MCC-1103.01-00-0015 [Reference 33] as well as in the FHRR [Reference 2] and the associated vendor calculations [Reference 36]. These features are designed to protect against water levels on Lake Norman up to a minimum elevation of 779 ft msl [Reference 29]. As stated above, the maximum water level on Lake Norman from any of these events is 778.54 ft msl, which provides an available physical margin of 0.46 ft (779 - 778.54). Adequate physical margin has therefore been demonstrated in the analyses for this event.

The earthen embankments are inspected independently by FERC on a 5 year frequency [Reference 34 - Attachment 2], demonstrating adequate reliability. These structures are also inspected by MNS every 5 years (nominally) as part of the civil structure inspection program [Reference 45 and 46].

2. Permanent passive concrete barriers installed on the earthen embankment (EL. 775 ft msl to EL. 780 ft msl transition zone)

The permanent concrete barriers were evaluated for the CE/PMF loading in calculation MCC-1103.01-00-0014 [Reference 32]. Adequate physical margin was demonstrated in this analysis and in the dicsussion above.

These structures are also inspected by MNS nominally every 5 years as part of the civil structure inspection program [Reference 45 and 46], demonstrating adequate reliability.

In summary, the listed items below illustrate the CE/PMF APM which is derived from the maximum water surface elevation, due to the CE/PMF event, to the top of the permanent passive barriers located on the earthen embankment:

- Maximum water surface elevation on the lake, due to the CE/PMF event, is expected to be EL. 778.54 ft msl
- Minimum elevation of the top of the permanent passive barriers is EL. 779 ft msl
- APM for the CE/PMF event is approximately 0.46 ft (EL. 779.0 ft msl - EL. 778.54' ft msl)

7.2.3 Adequate Overall Site Response

Due to the protection provided by the passive features discussed above, no site response is required for McGuire for flooding mechanisms other than a LIP event.

8. Conclusion

The FHRR showed that several flooding mechanisms were not bounded by the CLB, and these were required to be evaluated in this FE.

The first flooding mechanism, a beyond design basis LIP, was estimated to generate flood water levels on site that would exceed the external door thresholds leading into the Auxiliary Building. There are many SSCs with key safety functions located below the maximum flood level of EL. 761.1 ft msl in the Auxiliary Building which could be affected. Therefore, McGuire Nuclear Station will install temporary barriers at these doors upon receipt of a pre-defined severe weather warning for extreme precipitation. This FE demonstrates that the site response to this event is adequate, that plenty of available physical margin exists for both existing passive features and the installed temporary barriers, and that these protective features and actions are reliable and achievable.

The other flooding mechanisms discussed were Streams and Rivers (Flooding in Reservoirs), Dam Failures, Storm Surge and Seiche/Wind-Wave Runup, and a CE/PMF event (as defined in the FHRR). The FHRR estimated that flooding would occur in the plant yard due to overtopping of the earthen embankment north of the site (due to the CE/PMF event). It was determined that this flood event (and all other non-LIP mechanisms) could no longer occur due to the installation of permanent barriers (after the FHRR analysis was performed) on the earthen embankment north of the plant yard.

Finally, for both of the BDB flood mechanisms discussed in this report, the Flood Hazard MSA has demonstrated that mitigating strategies (FLEX) will be available to maintain/restore KSFs as a defense-in-depth measure. Additional information can be found in the Flood Hazard MSA submittal [Reference 24].

This submittal completes the actions related to External Flooding required by the March 12, 2012 - 10 CFR 50.54(f) letter [Reference 1]. It is not anticipated that Phase 2 decision making will be necessary based on the information provided in this Focused Evaluation.