Entergy

Entergy Operations, Inc.
P.O. Box 756
Port Gibson, MS 39150

Eric A. Larson
Vice President, Operations
Grand Gulf Nuclear Station
Tel. (601) 437-7500

GNRO-2017/00038

June 27, 2017

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

SUBJECT: Focused Evaluation of External Flooding
Grand Gulf Nuclear Station – Unit 1
Docket Nos. 50-416
License Nos. NPF-29

REFERENCES:

1. NRC letter to Entergy, *Request for Information (RFI) Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3 of the NTTF Review of Insights from the Fukushima Dai-ichi Accident*, dated March 12, 2012 (GNRI-20112/00059) (ML12053A340)
2. Entergy letter to NRC, *Required Response 2 to March 12, 2012, Request For Information, Enclosure 2, Recommendation 2.1;* Grand Gulf Nuclear Station, Unit 1 Flooding Hazard Re-Evaluation Report, dated March 11, 2013 (GNRO-2013/00020) (ML13071A457)
3. Entergy letter to NRC, *Grand Gulf Nuclear Station Request for Additional Information Regarding Flooding Hazard,* dated December 11, 2013, dated January 9, 2014 (GNRO-2014/00005) (ML14014A277)
4. *NRC Staff Requirements Memoranda to* COMSECY-15-0019, Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants dated July 28, 2015 (ML15209A682)
5. NRC Letter to Entergy, *Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events*, dated September 1, 2015 (ML15174A257)
6. Nuclear Energy Institute (NEI), *Report NEI 16-05 [Rev 1], External Flooding Assessment Guidelines*, dated June 2016 (ML16165A178)
7. U.S. Nuclear Regulatory Commission, *JLD-ISG-2016-01, Revision 0, Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation; Focused Evaluation and Integrated Assessment*, dated June 11, 2016 (ML16162A301)
8. NRC Letter to Entergy, *Grand Gulf Nuclear Station, Unit 1 Supplement to Staff Assessment of Response to 10 CFR 50.54(f) Information Request-Flood Causing Mechanism Reevaluation* dated December 4, 2015 *(CAC NO. MF1102)* (ML15329A043)

Dear Sir or Madam:

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). Entergy Operations, Inc. submitted the FHRR for Grand Gulf Nuclear Station (GGNS) on March 11, 2013 (Reference 2). Entergy provided a response to the request for additional information of the FHRR in Reference 3.

A second required response to Reference 1 directed licensees to submit an Integrated Assessment Report for any flood causing mechanism that was not bounded by the current design basis. In Reference 4, the NRC affirmed that licensees needed to address the reevaluated flooding hazards that were not bounded by the current design basis via a revised integrated assessment process that applied a graded approach. This requirement was confirmed by the NRC in more detail in Reference 5. Guidance for performing the revised process is included in Reference 6 and endorsed by the NRC in Reference 7. The revised process applicable to GGNS is the Focused Evaluation (FE). In Reference 8, the NRC concluded that the reevaluated flood hazards information, as summarized in the enclosure, is suitable input for the FE.

The enclosure to this letter provides the FE for External Flooding for GGNS. The Path 2 FE concluded that permanent passive protection is in place for the two flood causing mechanisms of Probable Maximum Flood (PMF) on Stream A and Dam Failure with PMF on the Mississippi River. Flood causing mechanism, local intense precipitation (LIP), has procedural controls in place that direct manual actions prior to an LIP. This submittal of the FE completes the actions related to external flooding required by Reference 1.

This letter contains no new Regulatory Commitments.

Should you have any questions concerning the content of this letter, please contact James Nadeau at 601-437-2103.

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

Sincerely,

Eric A. Larson
GGNS Site Vice President
EAL/sas

Attachment: 2017 Focused Evaluation for External Flooding at Grand Gulf Nuclear Station

cc: U.S. Nuclear Regulatory Commission
ATTN: Mr. Siva Lingham
Mail Stop OWFN 8 B1
Rockville, MD 20852-2738

U.S. Nuclear Regulatory Commission
ATTN: Mr. Kriss M. Kennedy (w/2)
Regional Administrator, Region IV
1600 East Lamar Boulevard
Arlington, TX 76011-4511

Mr. B. J. Smith (w/2)
Director, Division of Radiological Health
Mississippi State Department of Health
Division of Radiological Health
3150 Lawson Street
Jackson, MS 39213

ATTN: Mr. Joseph Sebrosky
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation
Mail Stop O-13F15M
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

NRC Senior Resident Inspector
Grand Gulf Nuclear Station
Port Gibson, MS 39150

Attachment to GNRO-2017/00038

2017 Focused Evaluation for External Flooding at Grand Gulf Nuclear Station

Entergy

ENTERGY NUCLEAR
Engineering Report Cover Sheet

Engineering Report Title:

2017 FOCUSED EVALUATION FOR EXTERNAL FLOODING AT GRAND GULF NUCLEAR STATION

Engineering Report Type:

New ☒ Revision ☐ Cancelled ☐ Superseded ☐
Superseded by: ______

Applicable Site(s)

IP1 ☐	IP2 ☐	IP3 ☐	JAF ☐	PNPS ☐	VY ☐	WPO ☐
ANO1 ☐	ANO2 ☐	ECH ☐	GGNS ☒	RBS ☐	WF3 ☐	PLP ☐

EC No. 71169

Report Origin: ☐ Entergy ☒ Vendor
Vendor Document No.: ENTCORP043-REPT-003

Quality-Related: ☐ Yes ☒ No

Prepared by:	ENERCON (See Page 2 for Signatures) Responsible Engineer (Print Name/Sign)	Date:	See Page 2
Design Verified:	N/A Design Verifier (if required) (Print Name/Sign)	Date:	
Reviewed by:	Tori L. Robinson / Tori L. Robinson Reviewer (Print Name/Sign)	Date:	6-12-17
Approved by:	Brandon Taylor / [signature] Supervisor / Manager (Print Name/Sign)	Date:	6-12-17

Title:	2017 FOCUSED EVALUATION FOR EXTERNAL FLOODING AT GRAND GULF NUCLEAR STATION	REPORT NO.:	ENTCORP043-REPT-003
		REVISION:	0
		Client:	Entergy
		Project Identifier:	ENTCORP043

Item	Cover Sheet Items	Yes	No
1	Does this Project Report contain any open assumptions, including preliminary information that require confirmation? (If **YES**, identify the assumptions.)	☐	☒
2	Does this Project Report supersede an existing Project Report? (If **YES**, identify the superseded Project Report.) **Superseded Project Report No.** ______________	☐	☒

Scope of Revision:
Initial Issue

Revision Impact on Results:
N/A

Safety-Related [1] ☐ **Non-Safety-Related** ☒

Originator: Brian Froese
Freddy Dahmash (Appendix 1 only)

Design Verifier [1] **(Reviewer for Non-Safety-Related):** Jessica Maddocks
Anu Gaur (Appendix 1 only)

Approver: Jared Monroe | **Date:**

Note 1: Design Verification is required for all safety-related Project Reports. A review is adequate for non-safety-related Project Reports.

ENERCON *Excellence—Every project. Every day*	REVISION STATUS SHEET	PAGE 3 OF 30
2017 FOCUSED EVALUATION FOR EXTERNAL FLOODING AT GRAND GULF NUCLEAR STATION	**REPORT NO.: ENTCORP043-REPT-003** **REVISION: 0**	

PROJECT REPORT REVISION STATUS

REVISION	DATE	DESCRIPTION
0		Initial Issue

ATTACHMENT REVISION STATUS

APPENDIX NO.	NO. OF PAGES	REVISION	ATTACHMENT NO.	NO. OF PAGES	REVISION
1	11	0			

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GRAND GULF NUCLEAR STATION FLOODING FOCUSED EVALUATION SUMMARY

1 EXECUTIVE SUMMARY

Grand Gulf Nuclear Station (GGNS) 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. This information was submitted to the NRC in a flood hazard reevaluation report (FHRR) on March 11, 2013 (Reference 2) and is provided in the Mitigating Strategies Flood Hazard Information (MSFHI) documented in the NRC's "Staff Assessment" letter dated November 25, 2014 (Reference 8) and "Supplement to [the] Staff Assessment" letter dated December 4, 2015 (Reference 9). The only change to the flooding analysis performed since the issuance of the MSFHI letters is a revision to the Local Intense Precipitation (LIP) calculation (Reference 11), which primarily revised the building modeling methodology and used a later version of the FLO-2D code (Build No. 14.03.07). The Supplement to the Staff Assessment identified several concerns with the original FLO-2D LIP model, one of which pertained to the treatment of building modelling. Responses to these concerns, based on the revised FLO-2D LIP model, are contained in Appendix 1 of this Focused Evaluation (FE). The FHRR and revised LIP calculation will serve as input to this FE. There are three (3) mechanisms that were found to exceed the Current Design Basis (CDB) flood level at GGNS. These mechanisms are listed below and included in this FE:

1) Local Intense Precipitation (LIP and Associated Drainage)
2) Streams and Rivers (PMF on Stream A)
3) Failure of Dams and Onsite Water Control/Storage Structures (Dam Failure Flooding with PMF on Mississippi River)

Associated effects (AE) and flood event duration (FED) parameters for the LIP flooding mechanism were assessed and submitted as a part of the Mitigating Strategies Assessment (MSA) (Reference 21). These parameters were not developed for the PMF or Dam Failure flood mechanisms due to the maximum flood elevation being at or below the site grade elevation of 132.5 feet (ft) Mean Sea Level (MSL) (Reference 2, Section 2.1.1). This FE concludes that the strategy for maintaining key safety functions (KSFs) during all three (3) mechanisms has effective flood protection through the demonstration of adequate Available Physical Margin (APM), reliable flood protection features, and that the overall site response is adequate. This FE followed Path 2 of NEI 16-05, Rev. 1 and utilized Appendices B and C to 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.

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 licensees, in part, to submit a 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 GGNS, the FHRR was submitted on March 11, 2013 (Reference 2).

Following the Commission's directive to NRC Staff in Reference 3, the NRC issued a letter to the industry (Reference 6) indicating that new guidance is being prepared to replace instructions in Reference 24 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 prepared the new "External Flooding Assessment Guidelines" in NEI 16-05 (Reference 4), which was endorsed by the NRC in Reference 5. NEI 16-05 indicates that each flood-causing mechanism not bounded by the design basis flood (using only stillwater and/or wind-wave run-up 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 a 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.

3 TERMS AND DEFINITIONS

- AE – Associated Effects
- AIMs – Assumptions, Inputs, and Methods
- APM – Available Physical Margin
- CA – Corrective Action
- CDB – Current Design Basis
- EC – Engineering Change
- FED – Flood Event Duration
- FIAP – Flooding Impact Assessment Process
- FHRR – Flood Hazard Reevaluation Report
- FLEX – Diverse and Flexible Coping Strategies covered by NRC order EA-12-049
- Key SSC – A System Structure or Component relied upon to fulfill a Key Safety Function
- KSF – Key Safety Function, i.e. core cooling, spent fuel pool cooling, or containment function.
- LIP – Local Intense Precipitation
- MSA – Mitigating Strategies Assessment as described in NEI 12-06 Rev 2, App G
- MSFHI – Mitigating Strategies Flood Hazard Information
- MSL – Mean Sea Level
- NTTF – Near Term Task Force commissioned by the NRC to recommend actions following the Fukushima Dai-ichi accidents
- PM – Preventative Maintenance
- PMF – Probable Maximum Flood
- PMP – Probable Maximum Precipitation
- RFI – Request for Information
- TCA – Time Critical Action
- TSA – Time Sensitive Action
- VBS – Vehicle Barrier System
- WO – Work Order

4 FLOOD HAZARD PARAMETERS FOR UNBOUNDED MECHANISMS

The NRC has completed the "Staff Assessment" (Reference 8) and "Supplement to [the] Staff Assessment" (Reference 9) which contains the MSFHI related to GGNS' FHRR (Reference 2). In Reference 9, the NRC states that the "staff has concluded that the licensee's reevaluated flood hazard information 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 Grand Gulf. Further, the licensee's reevaluated flood hazard information is suitable for other assessments associated with Near-Term Task Force Recommendation 2.1 'Flooding.'" The enclosure to Reference 9 includes a summary of the CDB and reevaluated flood hazard parameters. In Table 3.1-1 of the enclosure to Reference 9, the NRC lists the following flood-causing mechanisms for the CDB 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.

In Tables 4.0-1 and 4.0-2 of the enclosure to Reference 9, the NRC lists flood hazard information (specifically flood event durations, stillwater elevations, associated effects and wind-wave run-up elevations) for the following flood-causing mechanisms that are not bounded by the CDB hazard flood level at GGNS:

- Local Intense Precipitation (LIP and Associated Drainage) – Herein referred to as the LIP
- Streams and Rivers (PMF on Stream A) – Herein referred to as the PMF
- Failure of Dams and Onsite Water Control/Storage Structures (Dam Failure Flooding with PMF on Mississippi River) – Herein referred to as Dam Failure

These are the reevaluated flood-causing mechanisms that are addressed in this FE. The three (3) non-bounding flood mechanisms for GGNS are described in detail in Reference 2, the FHRR submittal. Table 1 summarizes how these unbounded mechanisms are addressed in this FE:

Table 1 – Unbounded Flood Mechanisms

	Flood Mechanism	Summary of Assessment
1	Local Intense Precipitation (LIP)	Path 2 was determined to be pursued for all three (3) mechanisms at GGNS since all flooding vulnerabilities are addressed by flood protection features (see FIAP Path Determination Table, Section 6.3.3 of NEI 16-05). Adequate APM, reliability of passive and temporary flood protection features, and adequate site response are all demonstrated.
2	Streams and Rivers (PMF)	
3	Failure of Dams and Onsite Water Control/Storage Structures (Dam Failure)	

4.1 Revised Local Intense Precipitation Calculation

The LIP calculation was revised after submittal of the FHRR (Reference 2). This was done primarily to revise the building modeling methodology, specifically the treatment of roofs in the FLO-2D model, and use a later version of the FLO-2D code (Build No. 14.03.07). The treatment of roofs was identified in the "Supplement to [the] Staff Assessment" (Reference 9) as one of two potential concerns. Full responses to these concerns are contained in Appendix 1 of this FE. The AE and FED parameters based on the revised LIP model are captured in the GGNS MSA (Reference 21). A comparison of the flooding elevations is included below in Table 2. The APM calculated in Section 6.1 of this FE uses these revised LIP elevations.

Table 2 – LIP Elevations

Structure	LIP Calc Rev. 0 Maximum Flood Depth (ft) (Reference 22)	LIP Calc Rev. 1 Maximum Flood Depth (ft) (Reference 11)	Difference (ft)
Door 0C313	0.5	0.7	+0.2
Door 0CT5	0.8	1.0	+0.2
Door 1D301	0.5	0.5	0
Door 1D308	0.6	0.6	0
Door 1D309	0.4	0.6	+0.2
Door 1D310	0.7	0.8	+0.1
Door 1D312	0.7	0.8	+0.1
Door 1M110	0.6	0.7	+0.1
Door 1M111	0.4	0.5	+0.1
(Equipment/Switchgear) SSW Basin Alpha	0.3	0.3	0
Door 2M110	0.5	0.5	0
Door 2M111	0.8	0.8	0
(Equipment/Switchgear) SSW Basin Bravo	0.3	0.3	0

5 OVERALL SITE FLOODING RESPONSE

5.1 DESCRIPTION OF OVERALL SITE FLOODING RESPONSE

The site response for LIP is as follows:

GGNS will require temporary sandbags to be deployed to maintain KSFs during a LIP event. Without these sandbags, floodwaters may reach vulnerable doors and several pieces of Key SSCs. Therefore, sandbags will be deployed once the precipitation trigger described in procedure 05-1-02-VI-2, Hurricanes, Tornados, and Severe Weather (Reference 14), is reached. Per the FHRR (Reference 2, Section 6.1), placement of these sandbags will take two people approximately six (6) hours to install them at the nine (9) credited external PMP doors. However, this can be performed in a much shorter time with more people. Per CR-GGN-2011-07687 CA 20, the site successfully performed sandbag dike installation at the nine (9) external doors in two (2) hours with seven (7) personnel. The sandbags will keep water from ponding against the door, which could lead to water eventually entering the building.

With the deployment of the sandbags, all KSFs and SSCs important to safety will remain available during the LIP event. Though not credited in this FE, additional defense-in-depth is provided by FLEX (as confirmed in the MSA).

Deployment of sandbags is the only TCA required as part of the overall site response. There are no TSAs required. Additional actions, such as verifying external doors are closed, are also included in procedures 05-1-02-VI-2 (Reference 14) and 05-1-02-VI-1, Flooding (Reference 15).

The site response for Streams and Rivers is as follows:

This FE demonstrates that no doors, buildings, or propagation pathways that contain Key SSCs are challenged by flood waters during the PMF event. The calculated maximum water height is at grade elevation. Therefore, there is no impact to Key SSCs from this flooding event.

The site response for Dam Failure is as follows:

This FE demonstrates that no doors, buildings, or propagation pathways that contain Key SSCs are challenged by flood waters during the Dam Failure event. The calculated maximum water height (including wave action) is well below grade elevation. Therefore, there is no impact to Key SSCs from this flooding event.

5.2 SUMMARY OF PLANT MODIFICATIONS AND CHANGES

As deployment of sandbags is already integrated into site procedures, there are no additional modifications or changes to account for the increased flood levels as discussed in the FHRR. A more permanent flood protection solution may be integrated in the future instead of using sandbags, however there are no current plans to change this approach.

6 FLOOD IMPACT ASSESSMENT

6.1 LOCAL INTENSE PRECIPITATION – PATH 2

6.1.1 DESCRIPTION OF FLOOD IMPACT

Using the revised flooding depths presented in Table 2 and updated protection height of 1.5 ft above ground level for doors that are protected with sandbags (Reference 2, Section 6.1), the revised APM table is presented in Table 3. This protection height of 1.5 ft aligns with EC 41518 (Reference 18) that implements protection of doors via sandbags.

Table 3 – LIP APM

Structure	Revised LIP Maximum Flood Depth (ft) (Reference 11)	Protection Height (ft) (Reference 2)	APM (ft)
Door 0C313	0.7	1.5*	0.8
Door 0CT5	1.0	1.0	0.0
Door 1D301	0.5	1.0	0.5
Door 1D308	0.6	1.5*	0.9
Door 1D309	0.6	1.5*	0.9
Door 1D310	0.8	1.5*	0.7
Door 1D312	0.8	1.5*	0.7
Door 1M110	0.7	1.5*	0.8
Door 1M111	0.5	1.5*	1.0
(Equipment/Switchgear) SSW Basin Alpha	0.3	0.625	0.3
Door 2M110	0.5	1.5*	1.0
Door 2M111	0.8	1.5*	0.7
(Equipment/Switchgear) SSW Basin Bravo	0.3	0.625	0.3

*Protection via sandbags now credited

6.1.2 ADEQUATE APM JUSTIFICATION AND RELIABILITY OF FLOOD PROTECTION

As indicated in Table 3, the minimum APM is 0.0 ft at Door 0CT5. Per NEI 16-05 Appendix B Section B.1, "Negligible or zero APM can be justified as acceptable if the use of conservative inputs, assumptions, and/or methods in the flood hazard reevaluation can be established." Since the AIMs used in this LIP analysis are conservative, this APM is adequate. The following are examples of conservatisms used in the revised LIP flood analysis (Reference 11):

1. Roof drains connected to subsurface drainage systems are assumed to be blocked and potential storage resulting from roof parapet walls was conservatively not incorporated.

2. All rooftops were conservatively assumed to be concrete in the assignment of Manning's roughness coefficients for modeling purposes.

3. The VBS openings were conservatively assumed to be 30-percent blocked and hence the calculated discharges were reduced by 30-percent. The Northwest Drainage Ditch Culvert and the Switchyard Channel Culverts were conservatively assumed to be 50-percent blocked and hence the calculated discharges were reduced by 50-percent. The NRC concurred with these assumptions in the Supplement to the Staff Response (Reference 9, Section 3.2).

Procedure 05-1-02-VI-2, Hurricanes, Tornados, and Severe Weather (Reference 14), provides explicit instruction on the number of sandbags and stacking configuration required for each door. These configurations follow the Army Corps of Engineers standard for Flood Fight Handbook recommendations, which is referenced in NEI 16-05 Appendix B as an accepted engineering practice. Therefore, these protection features are considered reliable and the doors are found to have adequate APM given that the maximum flood does not exceed the protected heights.

6.1.3 Adequate Overall Site Response

This evaluation, performed in accordance with NEI 16-05 Appendix C, has demonstrated the overall site response to a LIP event is adequate. Based on input described in the FHRR, sandbags will be used to protect nine (9) doors at GGNS. The following sections outline the results of evaluating the criteria in NEI 16-05 Appendix C. The deployment of sandbags will be referred to as a TSA in this FE since it is a task, manual action or decision that is identified as having time constraints per the definition in Section 4 of NEI 16-05. However, note that it is not listed as a TSA in the Grand Gulf Time Critical Operator Actions procedure GGNS-NE-16-00004 (Reference 19), which states that for Time Sensitive Operator Actions "GGNS may choose to include them in the TCA program".

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

The overall strategy for protecting GGNS from a LIP event contains relatively simple and straight forward actions as identified in 05-1-02-VI-2 (Reference 14), Hurricanes, Tornados, and Severe Weather. The only TSA is as follows, driven by a procedural rainfall trigger:

1. WHENEVER 24-hour weather forecast calls for rainfall amounts of 12 inches OR more, INSTALL sandbags at [the nine (9) PMP doors identified].

Procedure 05-1-02-VI-1 (Reference 15), Flooding, echoes this action and refers back to 05-1-02-VI-2 (Reference 14) for the sandbag installation instructions.

If water accumulates on the exterior of these doors for an extended period of time, it could ingress into these rooms and potentially impact Key SSCs. Therefore, the site uses these sandbags to protect against water accumulation at these doors.

6.1.3.2 Demonstration All TSAs Are Feasible

The triggering, deployment, setup, and testing of sandbags were developed in EC 41518 (Reference 18). Per this EC, PM tasks were created to install sandbag dikes at a minimum of one door once every two years and at every door every five years to ensure the required number of sandbags is stored in each storage container as well as to demonstrate the required action is feasible. Per the FHRR (Reference 2, Section 6.1), this action takes two people approximately six (6) hours to install sandbags at the nine (9) external doors. However, per the CR-GGN-2011-07687 CA 20, the site successfully performed sandbag dike installation at the nine (9) external doors on May 16, 2013 which required two (2) hours to complete with seven (7) personnel. This is also consistent with the WO that performed this task (Reference 20).

Given that the deployment trigger occurs when the 24-hour forecast value is received, there is significant margin available for completing this action. EC 41518 also notes that while installation of sandbags can be accomplished by two personnel, it can be performed by as many as are available. Since this action has already been validated via WO and will be periodically re-validated in the future, validation under the requirements of NEI 12-06 Appendix E for TSAs has been satisfied and this meets the guidance of NEI 16-05 Appendix C.

6.1.3.3 Establishing Unambiguous Procedural Triggers

Procedures 05-1-02-VI-2 (Reference 14) and 05-1-02-VI-1 (Reference 15) state that if the 24-hour anticipated rainfall amount is ≥12 inches over any 24-hour period, then sandbags are installed at the nine (9) PMP doors. These procedures can be initiated from a variety of symptoms, such as via a NOAA weather alert, weather tracking using commercial Internet weather sites (e.g. www.weather.com), a severe thunderstorm warning is issued to Claiborne or surrounding counties, a hurricane watch is issued to Claiborne County, or whenever the 24-hour weather forecast calls for rainfall amounts of ≥12 inches.

The trigger value of ≥12 inches over 24-hours was reviewed against the guidance provided in NEI 15-05 (Reference 16). Per the NOAA Precipitation Frequency Estimates at Port Gibson (Reference 17), the nearest location to GGNS, this is comparable to a 200-year storm and has an associated 1-hr rainfall amount of approximately 5.1 inches.

By contrast, the 1-hr LIP rainfall is 19.3 inches (31.4 inches total) and the 1-hr CDB rainfall is 16.4 inches (30.5 inches total). One half of these 1-hr values is 9.65 inches and 8.2 inches, respectively, which are both significantly higher and less common than the 1000-year flood by the same NOAA Precipitation Frequency Estimates. Therefore, this forecasted precipitation trigger of ≥12 inches over 24-hours is conservatively low and the Severe Weather procedure, 05-1-02-VI-2 (Reference 14) will be initiated more frequently than is recommended by the NEI 15-05 guidance.

6.1.3.4 Proceduralized and Clear Organizational Response to a Flood

05-1-02-VI-2 (Reference 14) and 05-1-02-VI-1 (Reference 15) provide clear guidance on actions that are required to be taken once severe weather or flooding is expected. The Shift Manager is ultimately responsible for all actions taken. There is only one TSA required as part of the site flood response. Both procedures direct the deployment of sandbags if the 24-hour forecast predicts ≥12 inches. As discussed in Section 6.1.3.2, the activity can be performed by more people as needed. Additional actions, such as verifying exterior doors are closed, do not detract or otherwise undermine the success of this TSA.

6.1.3.5 Detailed Flood Response Timeline

The sandbags required to protect Key SSCs and prevent the loss of a KSF are stored by procedure near the PMP doors. The configuration and placement of the sandbags in front of the doors will be completed in accordance with the sketches attached to 05-1-02-VI-2 (Reference 14). This action has been previously validated as being completed within two (2) hours using seven (7) personnel to install the bags to the necessary height.

6.1.3.6 Accounting for the Expected Environmental Conditions

Given the short amount of time expected to complete the action, it is highly unlikely that conditions will deteriorate enough to impede placement of sandbags. Sandbags are stored by procedure near the PMP doors. The most recently validated time of two (2) hours using seven (7) personnel is significantly less than the 24-hour warning time.

6.1.3.7 Demonstration of Adequate Site Response

The site response to a LIP has been demonstrated as adequate by meeting the guidelines in NEI 16-05 Appendix C. There is only one TSA, which has previously been validated via WO-GGN-00336989 (Reference 20) and will continue to be periodically re-validated.

6.2 PMF on Stream A – Path 2

6.2.1 Description of Flood Impact

The primary feature protecting the site from a PMF is 'site topography and grading', which is a Type 1 feature per NEI 16-05 Appendix B Section B.1. Table 4 presents site grade and the APM for buildings housing safety-related SSCs.

Table 4 – PMF Flood Elevations

Re-evaluated Flood Hazard	Site Grade	APM
132.5 ft MSL	132.5 ft MSL	0.0 ft

The associated effects due to this flood were not evaluated since the maximum water elevation does not surpass site grade nor impact any Key SSCs. The protection feature (site grade and topography) is permanent and passive, requiring no manual actions. Note, the PMF on Stream A is the controlling Streams and Rivers flood. The PMF on the Mississippi River, Stream B, and the Bayou Pierre are all below site grade.

6.2.2 Adequate APM Justification and Reliability of Flood Protection

As demonstrated in Section 6.2.1, site grade and topography, with a nominal grade elevation of 132.5 ft MSL, is reliable in protecting the plant from the PMF. Per NEI 16-05 Appendix B Section B.1 "Negligible or zero APM can be justified as acceptable if the use of conservative inputs, assumptions, and/or methods in the flood hazard reevaluation can be established". Since the AIMs used in this analysis are conservative, this APM is adequate. The following are examples of conservatisms used in the PMF flood analysis (Reference 12):

1. The conservative antecedent rainfall condition (ARC) III curve number (relative to ARC II), which describes runoff potential of the watershed, was used for the PMF simulation.

2. The PMF was constructed using an antecedent storm consisting of 40 percent of the PMP depths during the first 72 hours, (i.e. antecedent conditions) followed by a dry 72-hour period, and finally followed by the full 72-hour PMP storm.

3. The PMP was calculated using the conservative methodology of HMR-51 and HMR-52.

6.2.3 Adequate Overall Site Response

There are no required manual actions for this response to be successful and, therefore, an evaluation of the overall site response is not necessary.

6.3 Dam Failure Flooding with PMF on Mississippi River – Path 2

6.3.1 Description of Flood Impact

The primary feature protecting the site from Dam Failure is 'site topography and grading', which is a Type 1 feature per NEI 16-05 Appendix B Section B.1. Table 5 provides site grade and APM for buildings housing safety-related SSCs.

Table 5 – Dam Failure Flood Elevations

Re-evaluated Flood Hazard	Site Grade	APM
117.4 ft MSL	132.5 ft MSL	15.1 ft

The associated effects due to this flood were not evaluated since the maximum water elevation does not reach site grade nor impact any Key SSCs. The protection feature (site grade and topography) is permanent and passive, requiring no manual actions.

6.3.2 Adequate APM Justification and Reliability of Flood Protection

As demonstrated in Section 6.3.1, site grade and topography, with a nominal grade elevation of 132.5 ft MSL, is reliable in protecting the plant from Dam Failure. The APM of 15.1 ft was determined to be adequate since it meets the established criteria for uncertainties in the hydraulic model used to estimate flood levels in NEI 16-05 Appendix B Section B.1, "The minimum freeboard (e.g. margin) requirement, specified in 44 CFR 65.10(b)(1)(i) to account for uncertainty in the estimated flood level, is 3 feet overall and 4 feet within 100 feet on either side of a flow constriction (e.g. bridge)."

6.3.3 Adequate Overall Site Response

There are no required manual actions for this response to be successful and, therefore, an evaluation of the overall site response is not necessary.

7 CONCLUSION

The FHRR showed that three (3) flooding mechanisms were not bounded by the CDB and were required to be evaluated in this FE. The first mechanism, LIP, was calculated to generate a water level that exceeds the protected height of exterior doors, which lead to Key SSCs. Therefore, GGNS will place sandbags around the nine (9) exterior PMP doors (where the door seal is not credited) upon receipt of the precipitation forecast trigger. This FE demonstrated the site response is adequate, given this action has ample margin to be completed and the sandbags are also stored by procedure near the PMP doors.

The second and third mechanisms not bounded by the CDB are the PMF on Stream A and dam failure flooding with PMF of the Mississippi River. All buildings that have Key SSCs have been shown to have adequate APM since the flood water will not exceed the exterior door thresholds. Therefore, no water intrusion or accumulation is anticipated in rooms with Key SSCs and the plant will be able to maintain all KSFs throughout the event. There are no manual actions relied on, and no Key SSCs are impacted from these events.

Finally, for all three (3) mechanisms, the MSA has demonstrated that mitigating strategies developed within FLEX will be available to maintain/restore KSFs as a defense-in-depth measure. Additional information can be found in the MSA (Reference 21).

This submittal completes the actions related to External Flooding Response required by the March 12, 2012 10 CFR 50.54(f) RFI. It is not anticipated that Phase 2 decision making will be necessary based on the information provided in this FE.

8 REFERENCES

1. NRC Letter, 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.

2. GNRO-2013/00020, Required Response 2 for Near-Term Task Force Recommendation 2.1: Flooding – Hazard Reevaluation Report, Grand Gulf Nuclear Station, Unit 1, Docket No. 50-416, License No. NPF-29, dated March 11, 2013.

3. 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.

4. Nuclear Energy Institute (NEI), Report NEI 16-05, Rev. 1, External Flooding Assessment Guidelines.

5. U.S. Nuclear Regulatory Commission, JLD-ISG-2016-01, Rev. 0, Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation; Focused Evaluation and Integrated Assessment.

6. NRC Letter, Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events, dated September 1, 2015.

7. Nuclear Energy Institute (NEI), Report NEI 12-06, Rev. 2, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide.

8. Grand Gulf Nuclear Station, Unit 1 – Staff Assessment of Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (TAC No. MF1102), dated November 25, 2014.

9. Grand Gulf Nuclear Station, Unit 1 – Supplement to Staff Assessment of Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (CAC No. MF1102), dated December 4, 2015.

10. NUREG/CR-7046, Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America, November 2011.

11. 32-9195573-000, Rev. 001, Flood Hazard Re-evaluation – Local Intense Precipitation – Generated Flood Flow and Elevations at Grand Gulf Nuclear Station.

12. 32-9195577-000, Rev. 000, Flood Hazard Re-evaluation – Probable Maximum Flood on Streams and Rivers – Local Streams A and B Flow and Elevations.

13. 32-9195574-000, Rev. 000, Grand Gulf Nuclear Station Flood Hazard Re-evaluation – Probable Maximum Precipitation.

14. 05-1-02-VI-2, Rev. 131, Hurricanes, Tornados, and Severe Weather.

15. 05-1-02-VI-1, Rev. 115, Flooding.

16. Nuclear Energy Institute (NEI), Report NEI 15-05, Rev. 6, Warning Time for Local Intense Precipitation Events.

17. Hydrometeorological Design Studies Center NOAA, Precipitation Frequency Data Server, NOAA <http://hdsc.nws.noaa.gov/hdsc/pfds/> [Accessed February, 2017].

18. EC 41518, Rev. 000, New Strategy for Protecting PMP External Doors 1X701D308, 1X701D312, 1X701D309, 1X701D310, 1Y401M110, 1Y401M111, 2Y402M110, 2Y402M111 and SZ10OC313 from PMP Hazard.

19. GGNS-NE-16-00004, Rev. 000, Time Critical Operator Actions for Grand Gulf Nuclear Station.

20. WO-GGN-00336989, Rev. 000, Install Sandbags and Storage IAW EC41518.

21. GGNS-SA-16-00001, Rev. 000, 2016 Mitigating Strategies Assessment for Flooding Documentation Requirements at Grand Gulf Nuclear Station.

22. 32-9195573-000, Rev. 000, Flood Hazard Re-evaluation – Local Intense Precipitation – Generated Flood Flow and Elevations at Grand Gulf Nuclear Station.

23. ANSI/ANS-2.8-1992, Determining Design Basis Flooding at Power Reactor Sites, July 28, 1992.

24. 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.

Appendix 1 – LIP FLO-2D Model Concerns

The purpose of this appendix is to address concerns with the LIP FLO-2D model that were identified by the NRC, as described in the Supplement to the Staff Assessment (Reference 9). The following are the GGNS responses to the two (2) issues identified:

Supplement to the Staff Assessment Concern #1:

"In the FHRR, the licensee stated that buildings were represented as obstructions to flow, but provided no description of how precipitation falling on building roofs was represented in the model. The NRC staff found that, in the licensee's FLO-2D model, precipitation falling on roofs did not enter the overland flow domain on the ground."

GGNS Response:

Revision 1 of the LIP calculation (Reference 11) revised the building modeling methodology with the latest build of the FLO-2D software program (Build 14.03.07), which was the most recent FLO-2D Build at the time the calculation was revised. The primary purpose of this revision was to revise the building modeling methodology by correcting the modeling issues of concern indicated in Section 3.2 of the NRC staff assessment document (Reference 9) to properly mimic and implement the desired conditions, and to perform the LIP simulation with the FLO-2D software program (Build 14.03.07).

Buildings at GGNS were incorporated into the FLO-2D model by manually adjusting grid element elevations based on the site survey and the high resolution ortho-imagery. Grid elements representing buildings were represented in the model as elevated grid elements. The grid element elevations representing areas occupied by buildings were assigned an arbitrary elevation higher than surrounding grade (at least 5 feet higher than the surrounding topography). The arbitrary elevations used for the buildings are not the actual rooftop elevations. Uniform elevations were assigned to grid elements representing a single building to ensure that runoff from rooftops is uniformly distributed to the surrounding areas. For buildings with different rooftop elevations adjacent to each other (as estimated based on aerial photographs, the relative change in rooftop elevations were represented as a 2-feet relative difference in building grid element elevations. The peak 1-hour duration LIP depth of 19.3 inches is less than the relative change in elevation of 2 feet. Therefore, to be conservative, water will not build up high enough to drive flow.

To be conservative, the surface areas of the grid elements representing the buildings within the FLO-2D model were included in the calculation of the total volume of rainfall at the site. Assigning higher elevations to the building grid elements also ensured that the building grid elements were obstructions to overland flow. Elevating building grid elements allows for FLO-2D to recognize those grid elements are obstructions relative to lower ground grid elements, and results in runoff from the building rooftops to the ground surface in accordance with Section 11.4 of ANSI/ANS 2.8 – 1992 (Reference 23). To evaluate the worst case for site surface drainage, roof drains connected to subsurface drainage systems are assumed to be blocked and potential storage resulting from roof parapet walls was conservatively not incorporated. Ultimately, this resulted in slightly higher elevations at the critical door locations since they are adjacent to building grid elements. These revised elevations are included in Table 2 and Table 3 and, as demonstrated, the slightly higher elevations do not impact SSCs important to safety.

Supplement to the Staff Assessment Concern #2:

"The NRC staff also identified additional modeling issues related to the LIP FLO-2D simulations, such as inaccurate water budgets and unrealistic stage hydrographs (e.g., FHRR Figures 3.1-9, 3.1-10, 3.1-14, and 3.1-16), which show high flood stages even after the ending of the postulated PMP event. Also, the NRC staff was unable to verify the accuracy of water budgets and long-tails on the simulated stage hydrographs presented in FHRR Figures 3.1-9, 3.1-10, 3.1-14, and 3.1-16."

GGNS Response:

The mass balance, storage, and water budget calculations are verified and validated in Appendix F of both Revision 0 and Revision 1 of the LIP calculation (References 22 & 11). Using the latest revision as an example, Revision 1 shows that the total inflow reported by the software is 620.13 acre-ft, and the total floodplain outflow and storage is 620.13 acre-ft (100.31 acre-ft storage, and 519.82 acre-ft floodplain outflow hydrographs which is also equal to the total outflow from the grid system).

Revision 1 of the LIP calculation also checked and verified the hydrographs of concern indicated above for correctness, verification and validation by checking the topography at these locations and the representative FLO-2D grid cells assigned to the doors of interest. In addition, the time-series output parameters (i.e., maximum flow depth, maximum water surface elevation) were investigated by assessing the output results and recreating all the hydrographs again following the FLO-2D model revisions and adjustments as indicated in Concern # 1 response.

The assessment shows that all the new resulting hydrographs representing the doors of concern are realistic and consistent with the topography and ground elevations surrounding these doors. The longer recession limbs on some of the simulated stage-duration hydrographs are reasonable, as those represent ponding for longer duration in low elevation spots. This is provided in detail for each of the indicated doors for clarity.

1) Door 0CT5 (Grid Cell 25481 with elevation 132.67 ft-site datum). Figure 1.1 represents the stage-duration relationship for this door. It shows approximately 0.2 ft flow depth at the end of the simulation (15 hours). The assessment shows that this grid cell and other close by cells are relatively flat, and have relatively lower elevations compared to the outer surrounding cells as shown in Figure 1.1. Therefore, ponding for longer duration with a relatively constant flow depth is expected, which justifies the longer recession limbs and shallow depth shown in the stage-duration hydrograph in Figure 1.2.

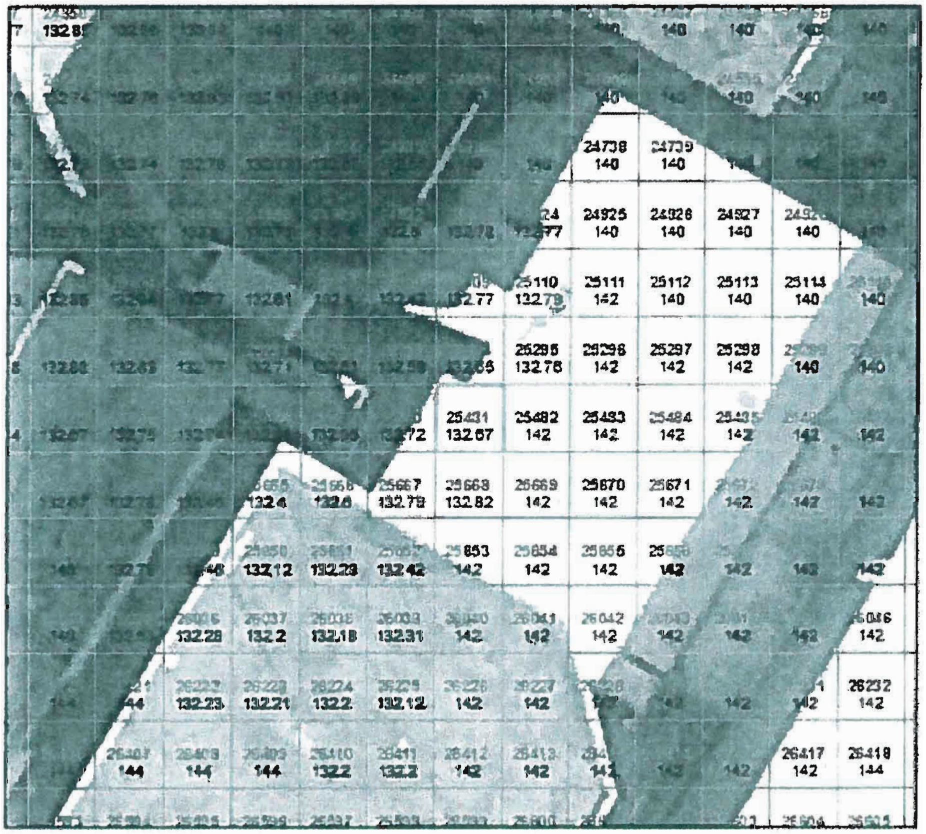

Figure 1.1: FLO-2D Grid Cell Elevation for Door 0CT5 (No. 25481)

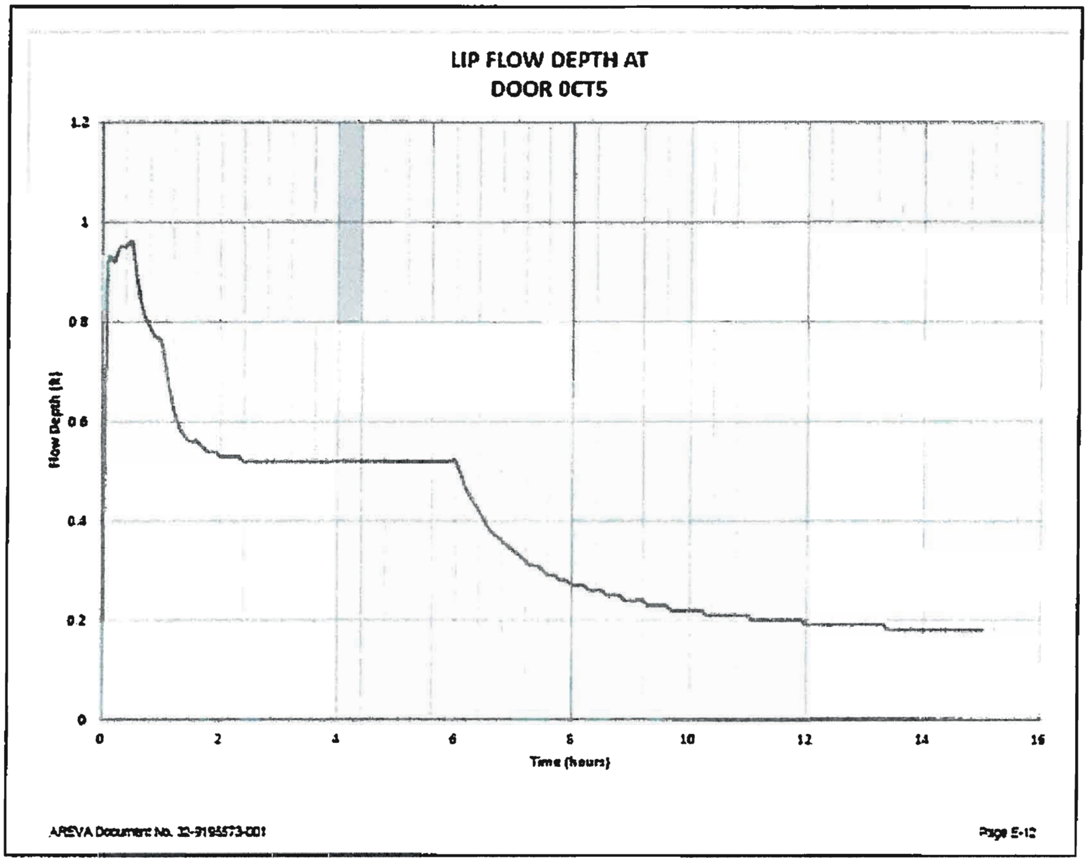

Figure 1.2: Stage Duration Hydrograph for Door 0CT5 (Grid Cell No. 25481)

2) Door 1D312 (Grid Cell 25467 with elevation 132.79 ft-site datum). Hydrograph No. 2 represents the stage-duration relationship for this door. It shows approximately 0.05 ft flow depth at the end of the simulation (15 hours). The assessment shows that this grid cell and other close by cells are relatively flat, and have relatively lower elevations compared to the outer surrounding cells as shown in Figure 1.3. Therefore, ponding for long duration with a relatively constant flow depth is expected, which justifies the longer recession limbs and depth shown in the stage-duration hydrograph, as shown in Figure 1.4. With time, the flow depth is expected to reach 0 ft.

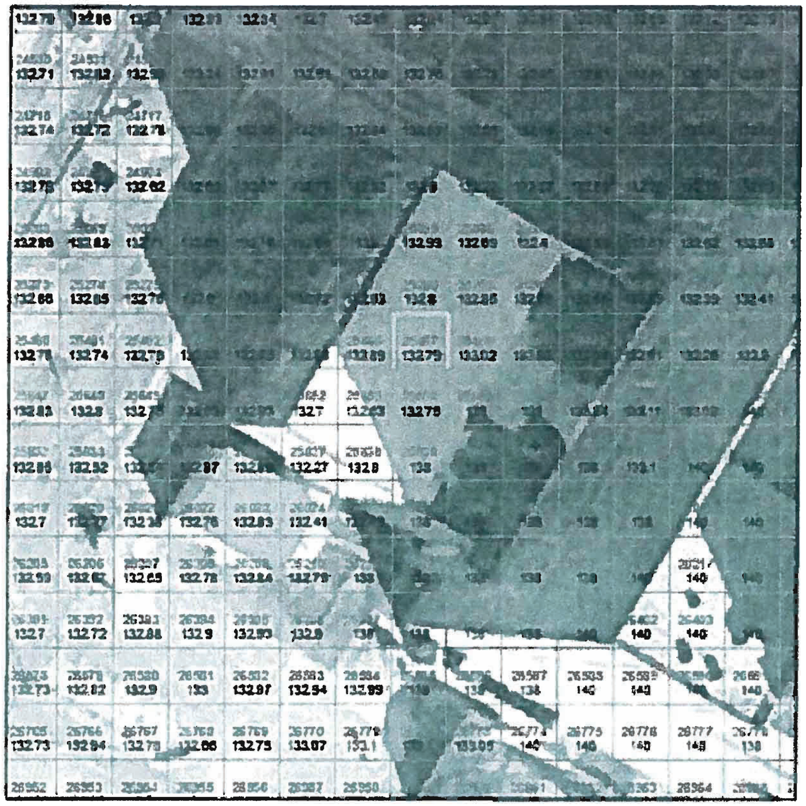

Figure 1.3: FLO-2D Grid Cell Elevation for Door 1D312 (No. 25467)

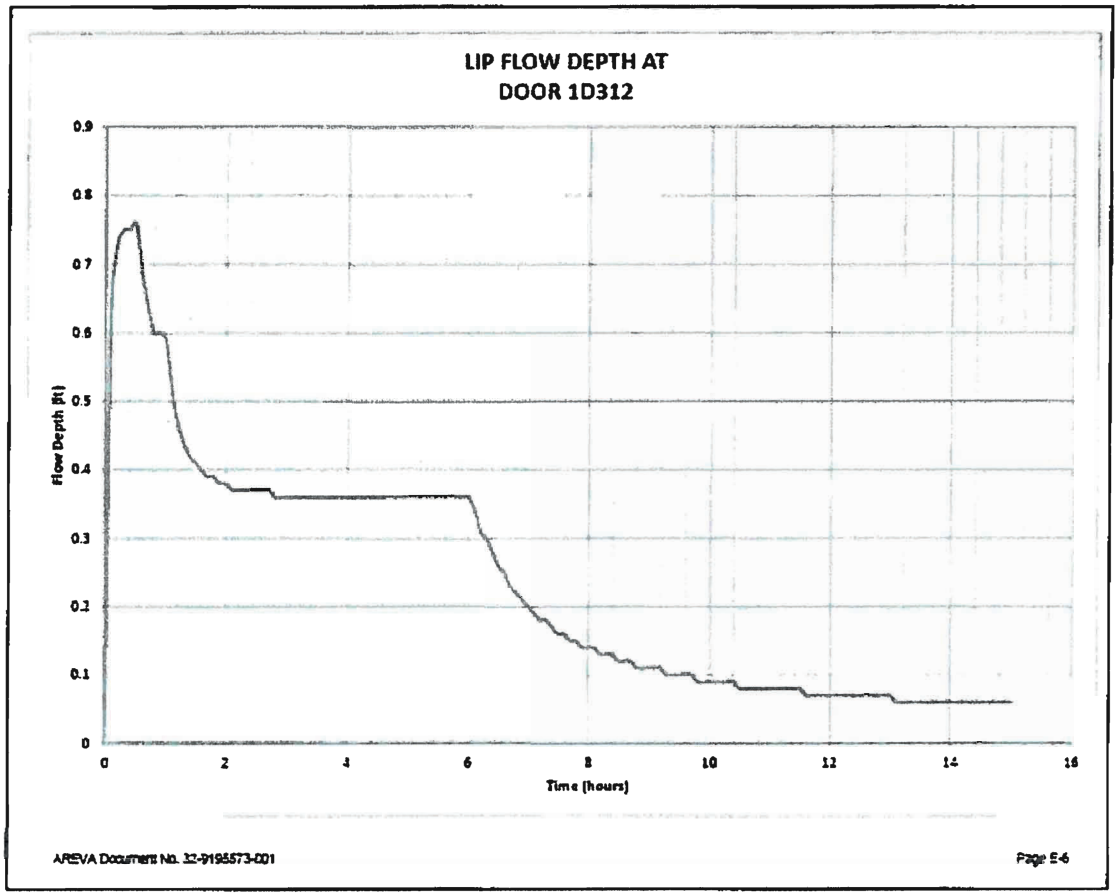

Figure 1.4: Stage Duration Hydrograph for Door 1D312 (Grid Cell No. 25467)

3) Door 1D310 (Grid Cell 25838 with elevation 132.8 ft-site datum). Hydrograph No. 3 represents the stage-duration relationship for this door. It shows approximately 0.05 ft flow depth at the end of the simulation (15 hours). The assessment shows that this grid cell and other close by cells have relatively lower elevations compared to the outer surrounding cells as shown in Figure 1.5. Therefore, ponding for long time with a relatively constant flow depth is expected, which justifies the longer recession limbs and depth shown in the stage-duration hydrograph, as shown in Figure 1.6. With time, the flow depth is expected to reach 0 ft.

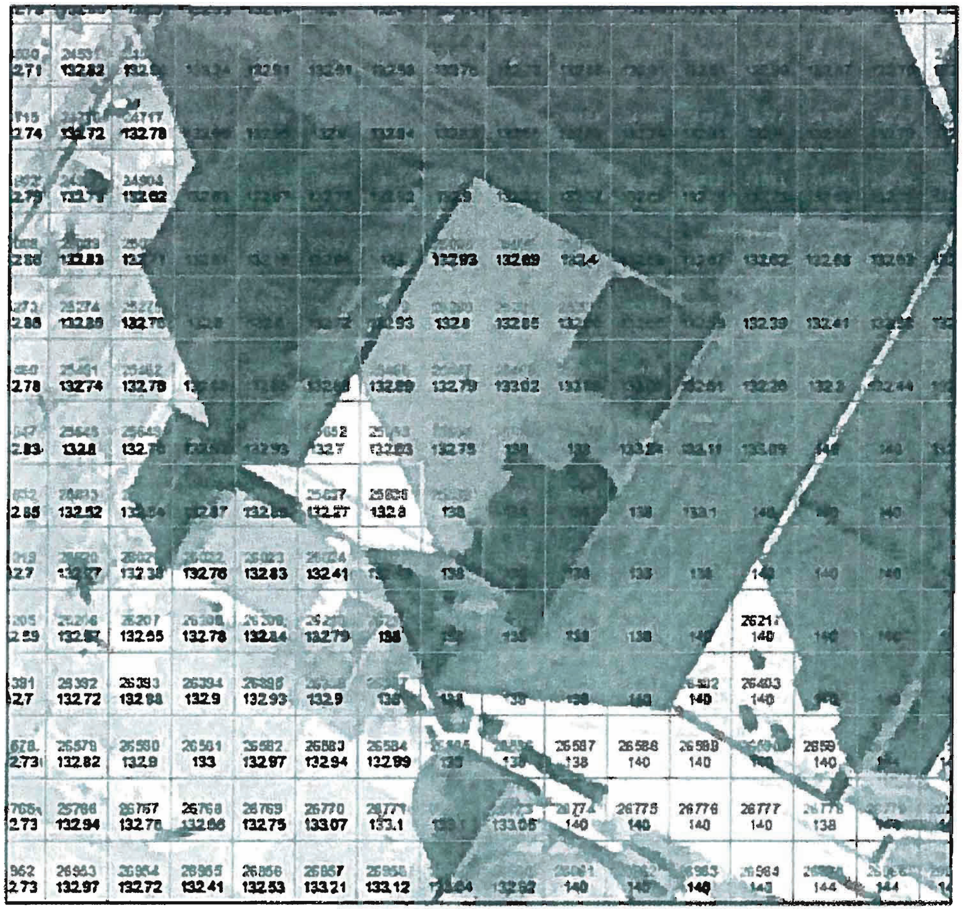

Figure 1.5: FLO-2D Grid Cell Elevation for Door 1D310 (No. 25838)

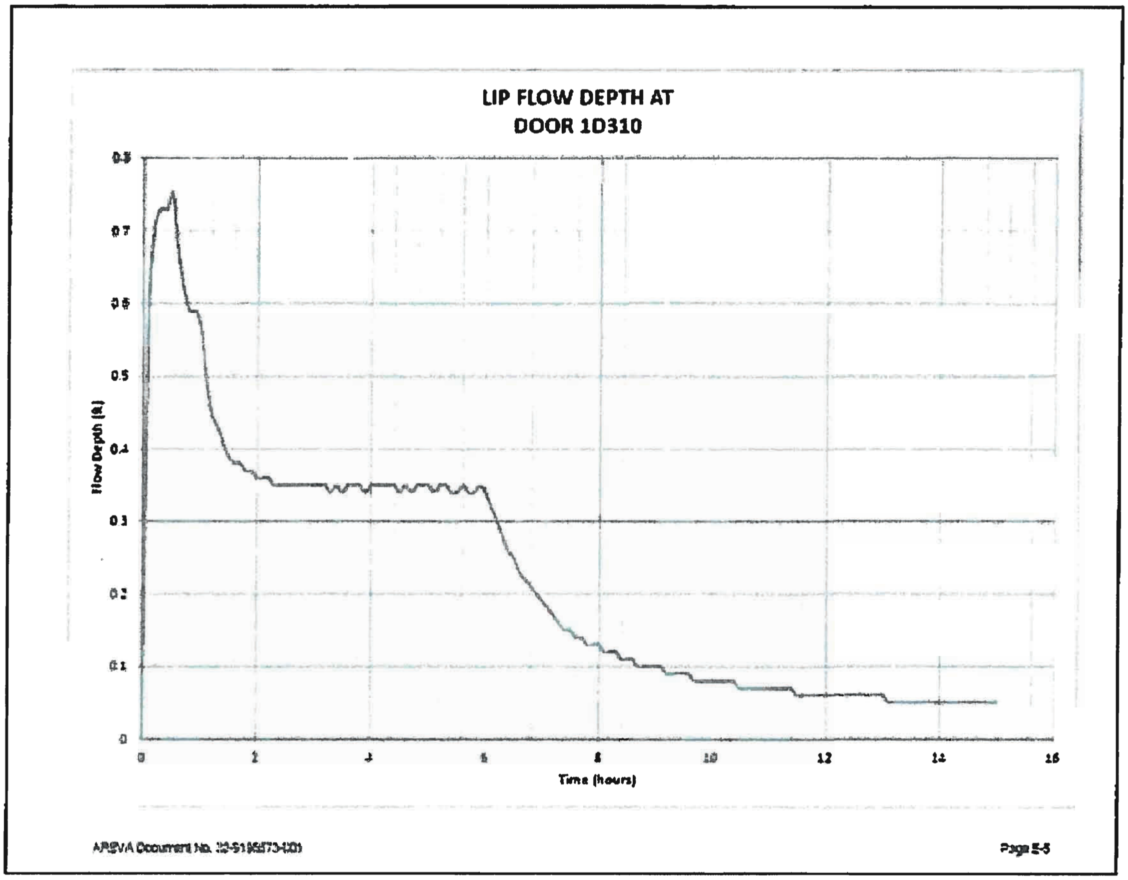

Figure 1.6: Stage Duration Hydrograph for Door 1D310 (Grid Cell No. 25838)

4) Door 2M111 (Grid Cell 19367 with elevation 132.74 ft-site datum). Hydrograph No. 4 represents the stage-duration relationship for this door. It shows approximately 0.3 ft (4 inch) of flow depth at the end of the simulation (15 hours). The assessment shows that this grid cell has considerable lower elevation (around 0.5 ft) compared to the surrounding cells as shown in Figure 1.7. Therefore, ponding for long time with a relatively constant flow depth is expected, which justifies the longer recession limbs and depth shown in the stage-duration hydrograph, as shown in Figure 1.8.

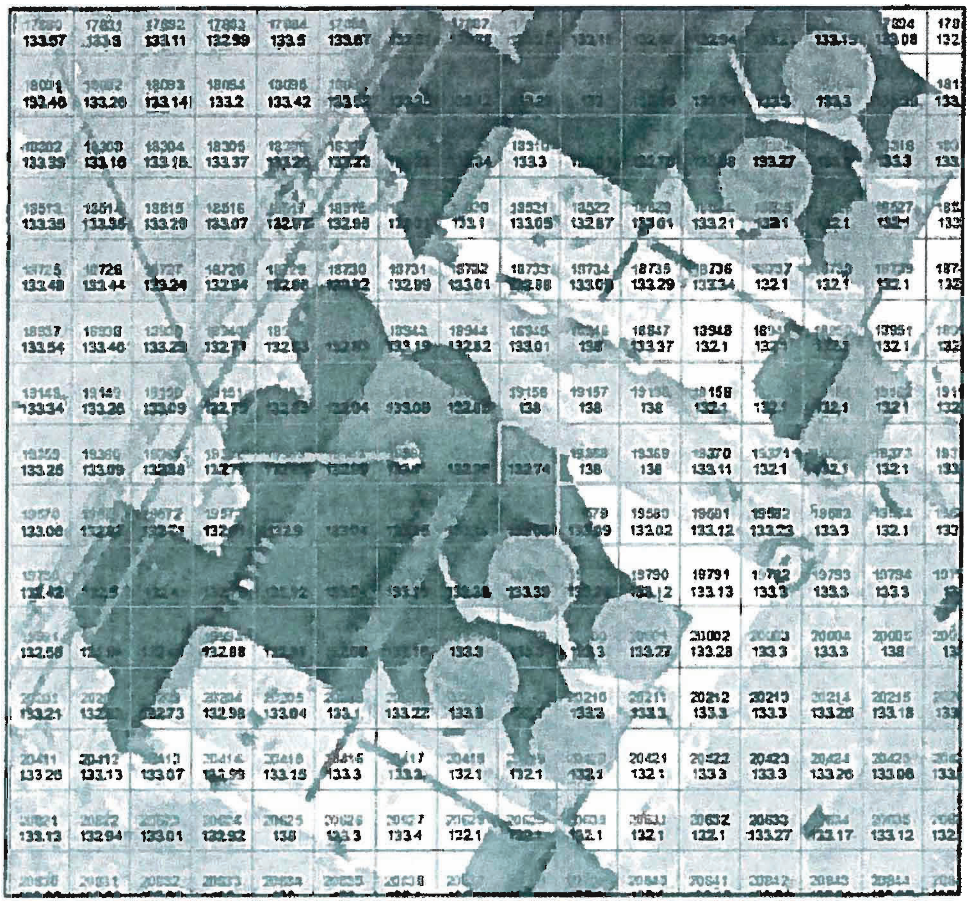

Figure 1.7: FLO-2D Grid Cell Elevation for Door 2M111 (No. 19367)

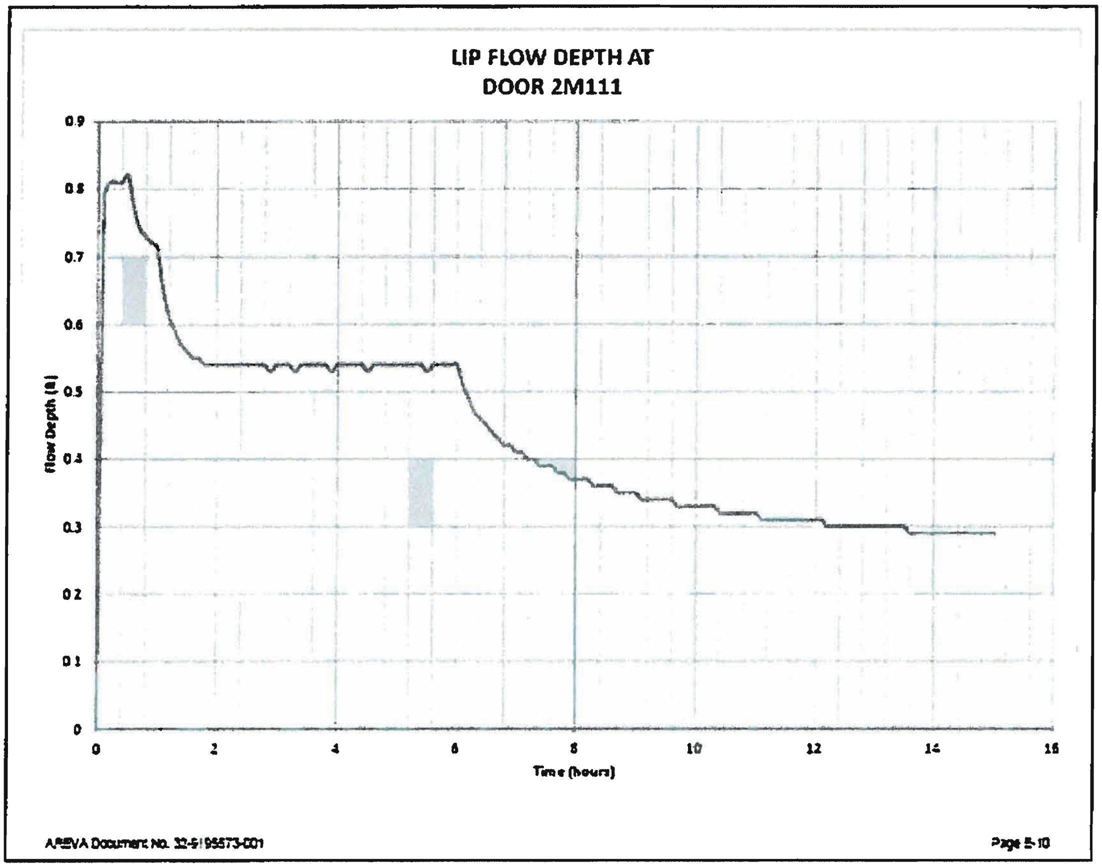

Figure 1.8: Stage Duration Hydrograph for Door 2M111 (Grid Cell No. 19367)

5) Door 2M110 (Grid Cell 19579 with elevation 133.09 ft-site datum), which is nearby Door 2M111 was also checked for comparison purposes and validation of the assessment approach. The results show 0.0 ft of flow depth starting at approximately 11 hrs of the simulation until the end of the simulation (15 hours). The assessment shows that this grid cell has considerable higher elevation compared to grid cell 19367 representing Door 2M111 as shown in Figure 1.7. Therefore, ponding for long time with a relatively constant flow depth is not expected, which justifies the full drain (flow depth down to zero) shown in the stage-duration hydrograph, as shown in Figure 1.9.

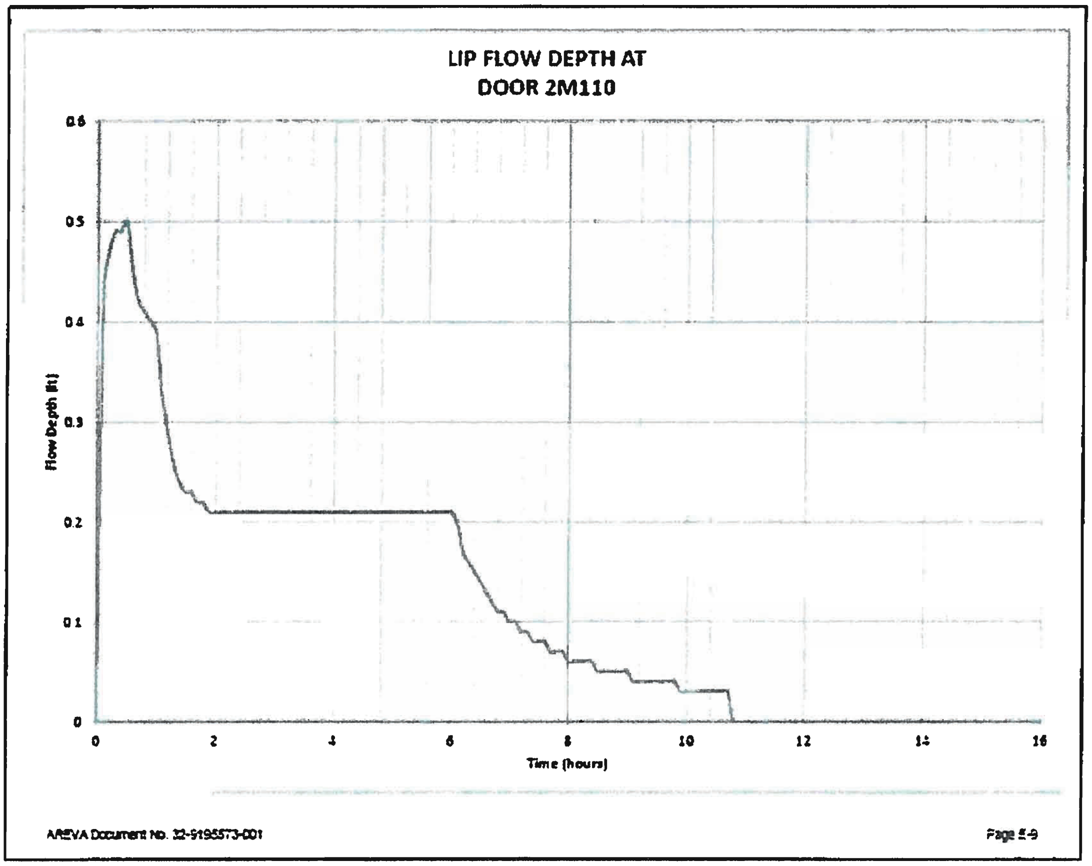

Figure 1.9: Stage Duration Hydrograph for Door 2M110 (Grid Cell No. 19579)