Exelon Generation

10 CFR 50.54(f)

RS-15-255

September 30, 2015

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

R. E. Ginna Nuclear Power Plant
Renewed Facility Operating License No. DPR-18
NRC Docket No. 50-244

Subject: Response to NRC Audit Review Request for Additional Information Regarding Fukushima Lessons Learned - Flood Hazard Reevaluation Report

References:

1. Exelon Generation Company, LLC Letter to USNRC, Flood Hazard Reevaluation Report Pursuant to 10 CFR 50.54(f) Regarding the Fukushima Near-Term Task Force Recommendation 2.1: Flooding, dated March 11, 2015 (RS-15-069)
2. 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

In Reference 1, Exelon Generation Company, LLC (EGC) provided the Flooding Hazard Reevaluation Report (FHRR) for the R. E. Ginna Nuclear Power Plant in response to the March 12, 2012 Request for Information Enclosure 2, Recommendation 2.1, Flooding, Required Response 2, (Reference 2). The NRC conducted an audit/webinar review of the R. E. Ginna Nuclear Power Plant FHRR on August 27, 2015. In support of the FHRR audit, the NRC provided audit information needs items. The information provided by EGC to address the audit information needs items was subsequently reviewed by the NRC during the audit. Based on the audit review, the NRC identified items that required additional information.

The purpose of this letter is to provide the responses to the NRC requested additional information items identified during the R. E. Ginna Nuclear Power Plant FHRR audit review on August 27, 2015. The enclosure to this letter provides the individual responses to each of the items identified by the NRC during the audit.

This letter contains no new regulatory commitments. If you have any questions regarding this report, please contact Ron Gaston at (630) 657-3359.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 30th day of September 2015.

Respectfully submitted,

James Barstow
Director - Licensing & Regulatory Affairs
Exelon Generation Company, LLC

Enclosure: R. E. Ginna Nuclear Power Plant Response to NRC Audit Review Request for Additional Information Regarding Fukushima Lessons Learned - Flood Hazard Reevaluation Report

cc: NRC Regional Administrator - Region I
NRC Project Manager, NRR - R. E. Ginna Nuclear Power Plant
NRC Senior Resident Inspector – R. E. Ginna Nuclear Power Plant
Ms. Tekia Govan, NRR/JLD/PPSD/HMB, NRC

Enclosure

R. E. Ginna Nuclear Power Plant

Response to NRC Audit Review Request for Additional Information Regarding Fukushima Lessons Learned - Flood Hazard Reevaluation Report

(46 pages)

Information Need 1: All Flood Causing Mechanisms – Comparison of Reevaluated Flood Hazard with Current Design Basis

Background: *Recommendation 2.1 of the 50.54(f) letter provides instructions for the Flood Hazard Reevaluation Report (FHRR). Under Section 1, Hazard Reevaluation Report, Items c and d, licensees are requested to perform:*

c. Comparison of current and reevaluated flood causing mechanisms at the site. Provide an assessment of the current design basis flood elevation to the reevaluated flood elevation for each flood causing mechanism. Include how the findings from Enclosure 4 of this letter (i.e., Recommendation 2.3 flooding walkdowns) support this determination. If the current design basis flood bounds the reevaluated hazard for all flood causing mechanisms, include how this finding was determined.

d. Interim evaluation and actions taken or planned to address any higher flooding hazards relative to the design basis, prior to completion of the integrated assessment described below, if necessary.

The Ginna FHRR provides a comparison of the reevaluated flood hazards with the current licensing basis (CLB) instead of the current design basis. Section 3.0 of the report summarizes of this comparison.

Request: *Clarify and where necessary correct the comparison of the reevaluated flood hazard to the current design bases.*

Response:

Discussions in the FHRR which includes the terminology “design basis” indicates information developed to determine flooding hazard and requirements for flood protection, as indicated in Section 2.4 of the UFSAR (Ginna, 2011) and the 2012 Walkdown Report (Ginna, 2012).

By definition, Current Licensing Basis (CLB) (per 10CFR54.3(a)) includes any NRC requirements, current and effective licensee commitments, operation, and any design basis information for the site as documented in the most recent final safety analysis report.

For the purposes of the Ginna Flood Hazard Re-evaluation Report, the two terms, design basis and licensing basis, can be considered to have the same meaning. Additionally, Table 3.4-1 of the FHRR provides a comparison of the design basis flood levels for the Ginna site against the controlling re-evaluated flood hazard.

References:

Ginna, 2011. R. E. Ginna Nuclear Power Plant Updated Final Safety Analysis Report Revision 23, December 6, 2011.

Ginna, 2012. Response to 10 CFR 50.54(f) Request for Information Recommendation 2.3 Flooding, Constellation Nuclear Energy Group, November 27, 2012, NRC Accession No. ML12335A029.

Information Need 2: All Flood Causing Mechanisms – Location of Site Features

Background: *The FHRR for the Ginna site includes several figures that show some of the site locations that are mentioned but lacks annotations or figures that shows all of the site locations that are referred to in the FHRR clearly. In FHRR Figures 2.1-2, 2.1-3, 2.2-11, 2.2-12, 2.2-13, for example, the cell identification number are not sufficiently clear to reference the location of these site locations for the purpose consistent with this information need.*

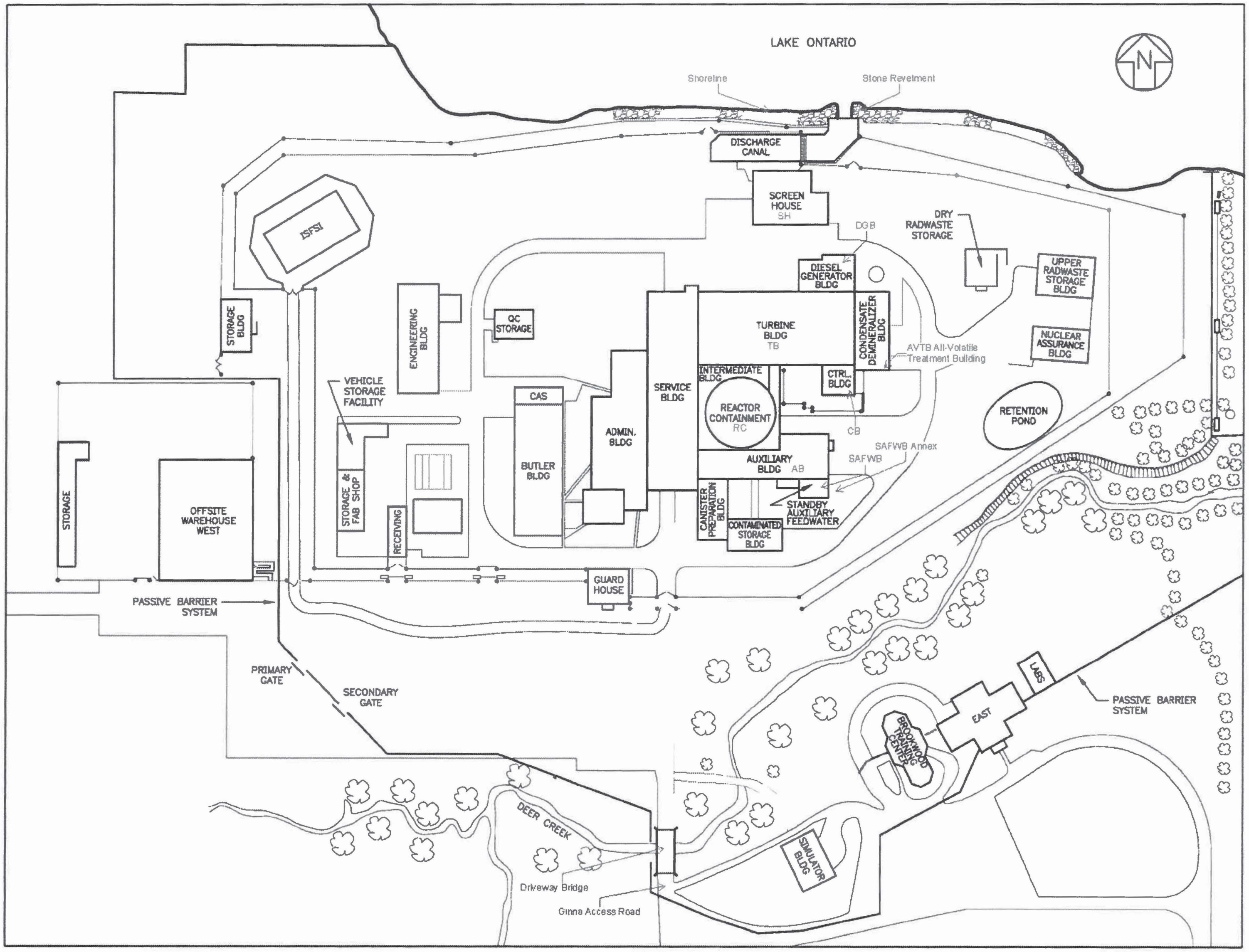
Request: *Describe the buildings and site feature locations discussed in the FHRR. Figure 1.2-1 could be modified or additional similar figures provided to illustrate the location of the structures listed in Table 1 to Table 4 of Enclosure 1 "Flood Hazard Reevaluation Tables for Flood-Causing Mechanism and Combined-Effects Floods Not Bound by the Reevaluated Hazard", RC, TB, CB, SH, and DGBs, AB, AVTB, SAFWB, SAFWB Annex, Canister Preparation Building, Contaminated Storage Building, and the ("shoreline" or "stone" revetment), Ginna Access Road (and Culverts) and Driveway Bridge.*

Response:

Please see Figure 2-1 (revised from FHRR Figure 1.2-1) for locations of buildings identified in Table 1 through Table 4 of Enclosure 1.

Culverts were assumed to be non-functional during the FHRR flood mechanisms, and as a result were not identified in any drawings provided with the FHRR.

Figure 2-1: Ginna Site Layout



<u>Information Need 4: Stream and River Flooding</u>

<u>Background:</u> *FLO-2D simulated water depth due to stream flooding. The staff evaluated Manning's n values assigned in the FLO-2D in a same way described in Information Need 4 and noticed that several cells' n values for shrubs or grass are considered very low, i.e., 0.08. These areas (see figure in Information Need 4) are along the pathway that slowdown the stream overflow from southwest to northeast based on the velocity vector plot.*

<u>Request:</u> *Describe the justification of n values assigned for vegetation areas surrounding the plant (not just circled examples below in the figure) especially areas near the plant and structures.*

Figure showing examples of Manning's n values used for vegetation areas in FLO-2D model for stream flooding analysis

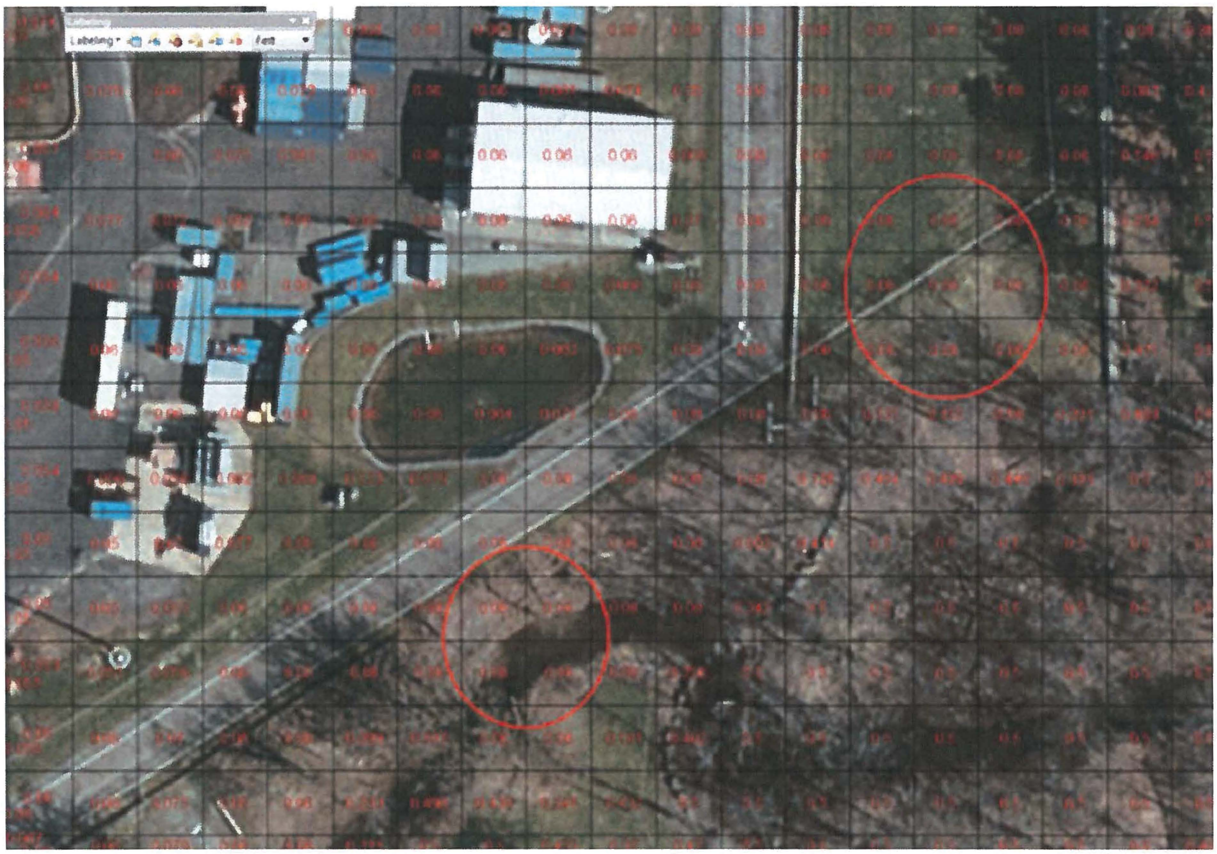


Figure showing vegetation areas surrounding the plant with recent aerial photograph.

<u>Original Response:</u>

The assigned Manning's roughness coefficients were based on land use classes (polygons) as defined in the 2006 National Land Cover Data (NLCD2006; USGS, 2011), recommended Manning's roughness coefficients contained in the FLO-2D reference manual (FLO-2D, 2012a) and engineering judgment, as described in the Ginna PMF Elevations Calculation (AREVA, 2013). A Manning's roughness coefficient GIS shapefile was created by assigning Manning's roughness coefficients to the land classes defined in the NLCD2006 data. The land cover types

shown on a recent aerial photograph of the site area may be slightly different from those defined in the NLCD2006 dataset since land cover changes seasonally and over time.

Selected Manning's n values for the area in question of 0.08 are conservative for shrub and grass areas. The range of Manning's n values for floodplain areas of brush and light tree cover (in summer) is between 0.04 and 0.08, with a normal value of 0.06 (Chow, 1959). The Manning's n-value of 0.08, used in the PMF reevaluation analysis at Ginna (AREVA, 2013) is reasonable for varying land cover consisting of grass, brush and small areas of trees. The area of interest is shown in Figure 4-1.

<u>Follow-Up Response (based on discussion during 8/27/15 audit webinar)</u>

<u>Technical justification for FLO-2D Manning n-values</u>

1. Roughness values used in FLO-2D vary by depth, with relatively higher values for shallower depths.

FLO-2D uses the continuity and dynamic wave momentum equations in its computations. The friction slope component of the dynamic wave momentum equation as implemented in FLO-2D is based on Manning's equation (FLO-2D, 2012a). Manning's roughness coefficients used in FLO-2D for overland flow accounts for surface roughness conditions (vegetation, concrete, etc.) in addition to non-uniform and unsteady flow conditions, which are the flow conditions being simulated. Manning's roughness coefficients are a function of flow depth (FLO-2D, 2012a) with shallow flows (generally depths less than 0.5 feet) requiring higher Manning's roughness coefficients to account for increased resistance due to relatively greater surface roughness conditions. FLO-2D assumes a limiting depth for complete submergence of surface roughness to be 3 feet (FLO-2D, 2012b). FLO-2D has the option of using depth variable Manning's roughness coefficients in its computations. When the depth variable roughness option is used, the following rules apply to the Manning's roughness coefficients used in computations (FLO-2D, 2012b):

0.0 < flow depth < 0.2 ft (0.06 m)	*n = SHALLOWN value*
0.2 ft (0.06 m) < flow depth < 0.5 ft (0.15 m)	*n = SHALLOWN / 2.*
0.5 ft (0.15 m) < flow depth < 3 ft (1 m)	$n = Specified\ n\ value\ x\ 1.5\ x\ e^{-\left(\frac{0.4xDepth}{s}\right)}$
3 ft (1 m) < flow depth	*n = specified n-value*

For the Ginna PMF reevaluation analysis, the variable roughness option was used and a "SHALLOWN" value of 0.2 was used. Unlike the specified Manning's n values, the "SHALLOWN" is a global value and does not vary spatially (Chapter 4 of FLO-2D, 2012b). The selected "SHALLOWN" value of 0.2 is a conservative representation of varying floodplain land cover types ranging from concrete to trees. The "SHALLOWN" value of 0.2 is also conservative because most of the site area (where shallow flow conditions are most likely to occur) is paved. The specified Manning's roughness coefficients for the Ginna reevaluation work were applicable for flow depths greater than 3 feet, indicating flow conditions where surface roughness is completely submerged (FLO-2D, 2012b). It is noted that flood depths in the vicinity of the Deer Creek channel are well above 3 ft, occasionally exceeding 10 ft deep (see Figure 4-2). Therefore, the specified Manning's roughness values used are judged to be appropriate for PMF-type flood analyses and may not strictly adhere to those shown in Table 1 of the FLO-2D reference manual.

2. Other technical standards or resources, other than the FLO-2D manual, recommend a more reasonable range of Manning n-values (appropriate for a 2D model) for deeper flow depth conditions.

A review of Manning's n values applied to other 2D models including Riverflow2D and HEC-RAS 2D was performed. The Riverflow-2D reference manual states in practical applications of 2D models, the n values required can be 30 percent lower than those normally used for 1D model on the same river reach (Hydronia, 2014).

Recommended Manning's n values for overland areas from ASCE HEC-RAS 2D training materials have also been included as Table 4-2 and 4-3 in this response. Two separate tables for Manning's n values are included in the training materials: one table for shallow flow conditions and another table for typical flow conditions. The table for the shallow flow conditions is the FLO-2D reference manual Manning's n table. However, the Manning's n values for typical flow conditions are much less than those in the FLO-2D reference manual and similar to those presented in standard references such as Chow, 1959.

<u>Review of Selected Manning's n-values</u>

A review of the selected Manning's n-values for the Ginna PMF reevaluation was performed. Figure 4-2 presents an overlay of the Manning's n-value shapefile used in the reevaluation calculation and an orthophotograph of the site area. The map shows the assigned Manning's n-values for each land use classification. The land use class definitions are included as Table 4-1. It is acknowledged that the NLCD dataset used as a source for delineating land use classification is somewhat coarse relative to small-scale variation in land cover apparent in the orthophotographs. However, the assigned land use classes appear to reasonably represent the apparent land use classes at the site based on the orthophotograph.

A map showing an overlay of the FLO-2D predicted flood depths and the assigned (specified) Manning's n-values is included as Figure 4-3. This map indicates that flood depths in the area in question (area with a Manning's n value of 0.08 on the southeastern end of the plant) are generally between 5 and 23 feet. Surface roughness in this area is completely submerged (FLO-2D, 2012b) during the PMF, indicating that the use of the upper end of the Manning's n range for the land cover type of "light brush and trees, in summer" (0.040 to 0.080) in Chow, 1959 is conservative. The value of 0.080 is also in the upper end of the recommended range in HEC-RAS 2D for non-shallow flow conditions and land cover types of pervious areas, minimal (grassed) to thick (trees) vegetation (0.030 to 0.120). This composite land cover is representative of the area in question. Other areas with deep flows during the PMF, including the area south of the creek, were assigned the FLO-2D recommended higher Manning's n values.

In conclusion, the Manning n-values assigned in the FLO-2D model are judged to be appropriate for the existing land cover and modeled PMF flow depths with a reasonable degree of conservatism.

References:

AREVA, 2013. AREVA Document No. 32-9190274-000, "Flood Hazard Re-evaluation – Probable Maximum Flood Elevations near R.E. Ginna Nuclear Power Plant", GZA GeoEnvironmental, Inc., Revision 0, 2013.

Chow, 1959. "Open-channel hydraulics", McGraw Hill Book Company, Inc., 1959.

FLO-2D, 2012a. FLO-2D Professional Version Reference Manual, FLO-2D Software Inc., Nutrioso, Arizona, 2012.

FLO-2D, 2012b. FLO-2D Professional Version Data Input Manual, FLO-2D Software Inc., Nutrioso, Arizona, 2012.

Hydronia, 2014. “RiverFLO-2D Plus User’s Guide”, Hydronia, LLC, March, 2014.

USGS, 2011. The National Land Cover Database 2006, by U.S. Geological Survey, http://www.mrlc.gov/nlcd06_data.php, U.S. Geological Survey, February 2011, Edition 1.0, accessed August 27, 2012.

Table 4-1: Specified Manning's n-Values and NLCD2006 Land Use Classes

NLCD 2006 CODE	NLCD DEFINITION	MANNING'S N
11	Water	0.025
12	Perennial Ice Snow	0.05
21	Low Intensity Residential	0.1
22	High Intensity Residential	0.08
23	Commercial/Industrial/Transportation	0.06
24	Developed High Intensity	0.05
31	Bare Rock/Sand/Clay	0.08
41	Deciduous Forest	0.4
42	Evergreen Forest	0.6
43	Mixed Forest	0.5
51	Dwarf Scrub	0.35
52	Shrub/Scrub	0.4
71	Grasslands/Herbaceous	0.35
72	Sedge/Herbaceous	0.35
73	Lichens	0.35
74	Moss	0.35
81	Pasture/Hay	0.3
82	Cultivated Crops	0.25
90	Wood Wetlands	0.1
95	Emergent Wetlands	0.1

Table 4-2: ASCE HEC-RAS 2D Training Manning's n Values for Shallow Flow

Surface	n-value
Dense turf	0.17 - 0.80
Bermuda and dense grass, dense vegetation	0.17 - 0.48
Shrubs and forest litter, pasture	0.30 - 0.40
Average grass cover	0.20 - 0.40
Poor grass cover on rough surface	0.20 - 0.30
Short prairie grass	0.10 - 0.20
Sparse vegetation	0.05 - 0.13
Sparse rangeland with debris	
0% cover	0.09 - 0.34
20 % cover	0.05 - 0.25
Plowed or tilled fields	
Fallow - no residue	0.008 - 0.012
Conventional tillage	0.06 - 0.22
Chisel plow	0.06 - 0.16
Fall disking	0.30 - 0.50
No till - no residue	0.04 - 0.10
No till (20 - 40% residue cover)	0.07 - 0.17
No till (60 - 100% residue cover)	0.17 - 0.47
Open ground with debris	0.10 - 0.20
Shallow glow on asphalt or concrete (0.25" to 1.0")	0.10 - 0.15
Fallow fields	0.08 - 0.12
Open ground, no debris	0.04 - 0.10
Asphalt or concrete	0.02 - 0.05

[1]Adapted from COE, HEC-1 Manual, 1990 and the COE, Technical Engineering and Design Guide, No. 19, 1997 with modifications.

Source: FLO-2D Reference Manual, FLO-2D Software, 2012

Take Home Messages

1. Above table is recommended for 2D modeling of shallow flow conditions.

Table 4-3: ASCE HEC-RAS 2D Training Manning's n Values for Non-Shallow Flow

Land Use Type	Manning's 'n'
Residential areas – high density	0.2 – 0.5
Residential areas – low density	0.1 – 0.2
Industrial/commercial	0.2 – 0.5
Open pervious areas, minimal vegetation (grassed)	0.03 – 0.05
Open pervious areas, moderate vegetation (shrubs)	0.05 – 0.07
Open pervious areas, thick vegetation (trees)	0.07 – 0.12
Waterways/channels – minimal vegetation	0.02 - 0.04
Waterways/channels – vegetated	0.04 – 0.1
Concrete lined channels	0.015 – 0.02
Paved roads/car park/driveways	0.02 – 0.03
Lakes (no emergent vegetation)	0.015 – 0.35
Wetlands (emergent vegetation)	0.05 – 0.08
Estuaries/Oceans	0.02 – 0.04

Source: Australian Rainfall & Runoff Revision Projects, Project 15: Two Dimensional Modelling in Urban rand Rural Floodplains, November 2012

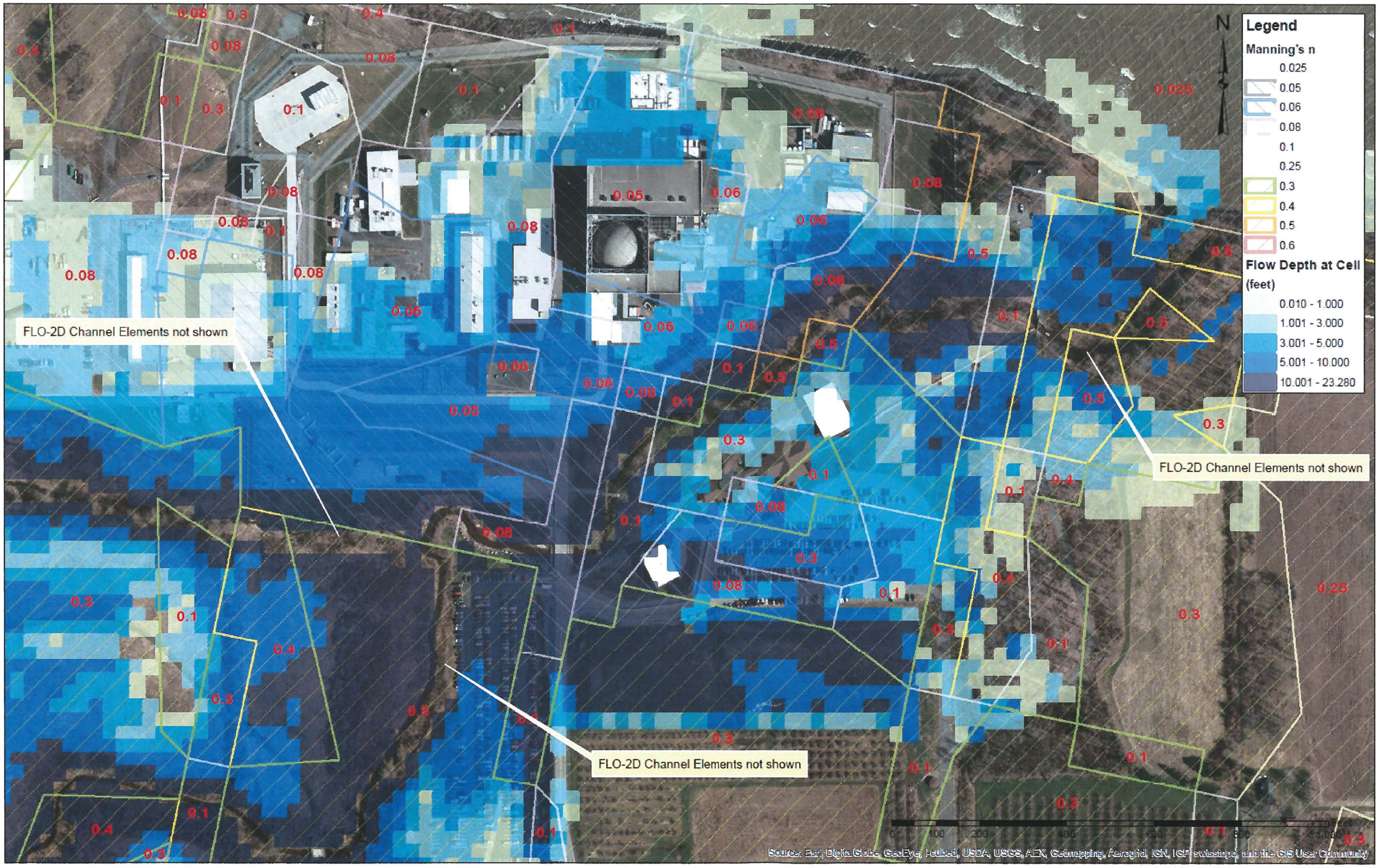
<u>Take Home Messages</u>

1. Above table is recommended for 2D modeling of non-shallow flow conditions.

Figure 4-1: Google Earth Image of the Site

Figure 4-2: Overlay of Specified Manning's n-values on Orthophotograph of the Site Area

Figure 4-3: Comparison of flow depths with specified Manning's n-values



Information Need 6: Storm Surge Datum Conversions

Background: *FHRR Table 1.1-1 states that 0.7 ft should be added to elevations given with respect to IGLD85 to get elevations with respect to NGDV29. The FHRR states the antecedent water level in Lake Ontario is 247.3 ft IGLD85 (Section 2.4.2.3) and then states the PMSS height is 3.2 ft (Section 2.4.3) and the predicted PMS elevation is 251.1 ft NGVD29 and 250.5 ft IGLD85; a 0.6 ft difference which is inconsistent with FHRR Table 1.1-1.*

Request: *Explain the discrepancy introduced when converting between datums which may be attributed to rounding, and if necessary, provide the correct value.*

Response:

The datum conversion shown in FHRR Table 1.1-1 contains typographical errors. The correct datum conversion from elevation in IGLD85 to elevation in NGVD29 is 0.62 ft (AREVA, 2013). Please see Table 6-1 below for the correct datum conversion information:

Table 6-1: Datum conversion relationships for Ginna.

		To:			
		MSL (ft)	IGLD85 (ft)	NGVD29 (ft)	NAVD88 (ft)
From:	MSL	0	-0.62	0	-0.69
	IGLD85	0.62	0	0.62	0.07
	NGVD29	0	-0.62	0	-0.69
	NAVD88	0.69	-0.07	0.69	0

The datum conversions in the FHRR are based on calculation documents which used the conversions shown in Table 6-1. Based on review of the FHRR and supporting calculations, the typographical errors noted above were confined to the FHRR Table 1.1-1. Elevations reported throughout the FHRR report use appropriate conversion factors.

References:

AREVA, 2013. AREVA Document No. 32-9190277-000, “Flood Hazard Re-evaluation – Probable Maximum Storm Surge - R.E. Ginna Nuclear Power Plant”, GZA GeoEnvironmental, Inc., Revision 0, 2013.

Information Need 7: Stream and River Flooding

Background: *The FHRR presents that the peak flow from flood re-evaluation for PMF is 28,460 (rounded to 28,500) cfs, which is about three-fourth of the peak flow (38,700 cfs) estimated in the previous study in 1982. FHRR Section 2.2.3 explains that the discrepancy is mainly caused by dividing the watershed into two contributory watersheds (Deer Creek and Mill Creek) in the re-evaluation flow model, which results in a less composite peak flow due to difference in peak time between two peak flows. The staff found that the peak flow for re-evaluation PMF is 20,530 cfs for Mill Creek and 8,140 cfs for Deer Creek. The sum of two peak flow without considering difference in peak timing is 28,670 cfs, which is much less than the previous flow study.*

Request: *Justify why the reevaluated PMF is conservative and bounding in terms of peak flow.*

If necessary, provide a comparison between the reevaluation PMF model and the previous PMF model.

Response:

A more detailed comparison between the reevaluated PMF (AREVA, 2013) and the previous circa 1982 studies (NUS, 1981 and NRC, 1982) was performed to further our understanding of the differences in methods applied for each. In general, the reevaluation uses a more detailed approach than the 1982 study, including up-to-date watershed input data such as land use and soil types. The following key differences were identified:

1. The reevaluation simulated the response of the watershed in greater detail, using two subwatersheds to represent the distinct branches of Deer Creek and Mill Creek, respectively. The 1982 study lumped these distinct streams into a single watershed and used a single lag time and curve number (CN) as described below.

2. The CN describes the runoff potential of the watershed based on hydrologic soil groups and land use data within watershed area. The 1982 study (NRC, 1982) used a CN of 94 while the reevaluation used a CN of 89.7 (90.4 for Deer Creek with a drainage area of 3.7 sq. mi. and 89.4 for Mill Creek with a drainage area of 10.8 sq. mi.). The 1982 study (NRC, 1982) states that ARCIII antecedent runoff condition was used but does not discuss in detail how the CN of 94 was calculated. The calculated CN for the PMF reevaluation used site specific data and conservative assumptions including:

    a. SCS hydrologic soil group classification for the soils within the delineated subwatersheds obtained from the Natural Resources Conservative Service (NRCS) (NRCS, 2011 and NRCS, 2012). The re-evaluation curve number calculation is presented in Appendix D of the Ginna PMF flow re-evaluation calculation (AREVA, 2013) and indicate the following percentage breakdown of the SCS hydrologic soil groups in the Deer Creek and Mill Creek watersheds:
        i. Deer Creek: 2-percent A; 0-percent B; 9-percent C; and 89-percent D
        ii. Mill Creek: 4-percent A; 16-percent B; 11-percent C; and 69-percent D

        For soil types assigned with a dual-classification (e.g., B/D), the soil group with the higher runoff potential was conservatively used.

    b. Land use/Land cover data for the delineated watersheds obtained from the United States Geological Survey 2006 Land Cover Dataset (USGS, 2011). The

land cover data for the Deer Creek and Mill Creek watersheds shown in Figure 5 and Appendix C of the Ginna PMF flow reevaluation calculation indicate that majority of the land cover types in the two watershed are classified as either "Deciduous Forest" or "Pasture/Hay". For Curve Number categories with multiple hydrologic conditions (good, fair and poor), the most conservative was assigned based on engineering judgment and detailed descriptions of each land use classification.

The representative curve number used for each watershed is an area-weighted value of the curve numbers for each of the four soil types within each watershed.

c. Assumption of wet antecedent runoff conditions (ARC III).

The FHRR evaluation is based on a more precise runoff estimate than in the design basis calculation (by using a more detailed breakdown of soils and land use) and is conservative because of the ARC-III adjustment.

3. Lag Time: The lag time has an effect on the time to peak and peak flowrate from a watershed with shorter lag times usually resulting in higher peak flows. The 1982 study (NRC, 1982) appears to use a simplified method to estimate the lag time, as reproduced below from a preceding study performed in 1981 (NUS, 1981):

The watershed time of concentration, T_C, is given by:(3)

$$T_C = \left[\frac{11.9\ L^3}{H}\right]^{0.385}$$

where:

L = channel length in miles
H = elevation difference in feet.

The time of concentration for the Deer Creek watershed is 4.3 hours. The basin lag is approximately 0.6 T_C, or 2.6 hours.

The simplified method does not use up-to-date methodology. The lag time calculation for the reevaluated PMF was based on the Natural Resource Conservation Service method (NRCS, 2010) for time of concentration, which separately estimates sheet flow, shallow concentrated flow, and channel flow as compared to just the channel flow lag time estimate used in the simplified method. Actual travel path within a watershed covers these steps of sheet flow from the watershed divide, shallow concentrated flow through wooded areas, and channel travel. The segmented approach for calculating the time of concentration is more representative of the watershed and longer than that calculated using the simplified approach in the design basis calculation. Lag time was also estimated as 0.6 times the time of concentration. The reevaluation lag time calculation used watershed-specific data including:

a. Stream flow length based on site/basin orthoimagery
b. Channel slope based on National Elevation Dataset (USGS, 2008)
c. Manning's roughness coefficients based on USGS land cover data (USGS, 2011)
d. Conservative 2-year 24-hour rainfall values from the Northeast Regional Climate Center (NRCC, 2011)

The lag time(s) used in the reevaluation of the PMF is therefore appropriate and conservative.

4. The 1982 study conservatively applied a simplified 10-square-mile PMP value from HMR-52 to the approximately 14-square-mile Deer Creek watershed. The reevaluation used BOSS HMR-52 to more accurately apply the PMP over the actual watershed area. This results in minor differences in the 6-hour PMP value (23.5 inches vs. 21.2 inches).

5. The reevaluation uses the up-to-date HEC-HMS computer program while the older studies used HEC-1 (e.g., the predecessor to HEC-HMS). This could result in minor differences due to the updates in software codes.

The reevaluation uses widely accepted methods (i.e., the NRCS method) that are also discussed in NUREG/CR-7046 Section 3.3 and Appendix C. Conservative assumptions are used, including:

- Use of wet antecedent runoff conditions (ARCIII);
- Non-linearity adjustments of lag time and unit hydrograph peak flow for PMF conditions;
- Use of HMR-51 and HMR-52 in lieu of performance of a site-specific PMP study.

The reevaluation approach is consistent with the Hierarchical Hazard Assessment approach outlined in NUREG/CR-7046, which may be considered to refine the results of the older evaluation to develop a conservative and bounding PMF. In general, the 1982 era studies use simplified methods (particularly for application of the PMP and calculation of lag time) which are outdated and/or not as accurate as the methods used in the reevaluation.

References:

AREVA, 2013. AREVA Document No. 32-9190273-000, "Flood Hazard Re-evaluation – Probable Maximum Flood Flow in Streams near R.E. Ginna Nuclear Power Plant", GZA GeoEnvironmental, Inc., Revision 0, 2013.

NRC, 1982. TER-C5257-419. "Ginna Nuclear Power Plant – Final Evaluation of SEP Topics II-3.A, II-3.B, II-3.C, and II-4.D" United States Nuclear Regulatory Commission, May 27, 1982.

NRCC, 2011. Extreme Precipitation in New York and New England (http://precip.eas.cornell.edu\), Version 1.12, by Natural Resources Conservation Services (NRCS) and Northeast Regional Climate Center, revised October 19, 2011, accessed September 5, 2012.

NRCS, 2010. "Chapter 15 Time of Concentration", Part 630 Hydrology, National Engineering Handbook, U.S. Department of Agriculture Natural Resource Conservation Service, May 2010.

NRCS, 2011. Web Soil Survey, U.S. Department of Agriculture Natural Resource Conservation Service (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm), revised December 20, 2011, accessed August 27, 2012. See AREVA, 2013.

NRCS, 2012. Soil Survey Geographic Database for Wayne and Monroe Counties, New York, Natural Resources Conservation Services (http://soils.usda.gov/survey/geography/ ssurgo/), revised December 19, 2011, accessed August 22, 2012. See AREVA, 2013.

NUS, 1981. "Ginna Station Design Basis Flooding Study for Rochester Gas and Electric Corporation," NUS Corporation, August, 1981.

USGS, 2008. The National Map, National Geospatial Program (http://viewer.nationalmap.gov/viewer/), revised April 14, 2008, accessed August 20, 2012.

USGS, 2011. The National Landcover Database 2006 Land Cover (http://www.mrlc.gov/nlcd06_data. php), U.S. Geological Survey, February 2011, Edition 1.0, accessed August 27, 2012.

Information Need 9: Flood Event Duration Parameters

Background: *The March 12, 2012, 50.54(f) letter, Enclosure 2, requests the licensee to perform an Integrated Assessment of the plant's response to the reevaluated hazard if the reevaluated flood hazard is not bounded by the current design basis. Flood scenario parameters from the flood hazard reevaluation serve as the input to the Integrated Assessment. To support efficient and effective evaluations under the Integrated Assessment, staff will review flood scenario parameters as part of the flood hazard reevaluation and document results of the review as part of the staff assessment of the flood hazard reevaluation. This information is also necessary for conducting the Mitigating Strategies Assessment in accordance with NEI 12-06 App G.*

Request: *Provide the applicable flood event duration parameters (see definition and Figure 6 of the Guidance for Performing an Integrated Assessment, JLD-ISG-2012-05) associated with mechanisms that trigger an Integrated Assessment using the results of the flood hazard reevaluation. This includes (as applicable) the warning time the site will have to prepare for the event (e.g., the time between notification of an impending flood event and arrival of floodwaters on site) and the period of time the site is inundated for the mechanisms that are not bounded by the current design basis. Provide the basis or source of information for the flood event duration, which may include a description of relevant forecasting methods (e.g., products from local, regional, or national weather forecasting centers) and/or timing information derived from the hazard analysis. The FHRR does state a PMF flood duration (6.5 h) but other parameters are lacking.*

In Section 3.3 of the FHRR, LIP, flooding on rivers and streams, and two combined-effects flood scenarios were stated to exceed the current licensing basis (which needs to be evaluated/corrected per Information Need #1). The FHRR did not provide sufficiently clear information on all flood duration parameters.

Response:

Local Intense Precipitation and the combined effect of PMF on Deer Creek, the 25-yr storm surge on Lake Ontario, and 2-yr wind generated waves are the two controlling flood mechanisms determined in the FHRR.

Time series graphs for the LIP flood mechanism at key locations are provided as Figures 9-1 through 9-9. Time series graphs for the combined effect PMF flood mechanism at key locations are provided as Figures 9-10 through 9-19.

The FHRR indicates flood protection measures described in the FSAR trigger on flood levels at Driveway Bridge. Based on detailed time-series data for the combined effect flood scenario (bounding Deer Creek flooding scenario), there is a 35+ hour delay between the triggering flood levels at Driveway Bridge and flood levels above grade near plant structures.

Detailed evaluation of timing required for potential flood mitigation strategies will be addressed as part of the Integrated Assessment phase of work.

Figure 9-1: LIP Time Series Plot for Grid Element 6193 – East of Reactor Containment

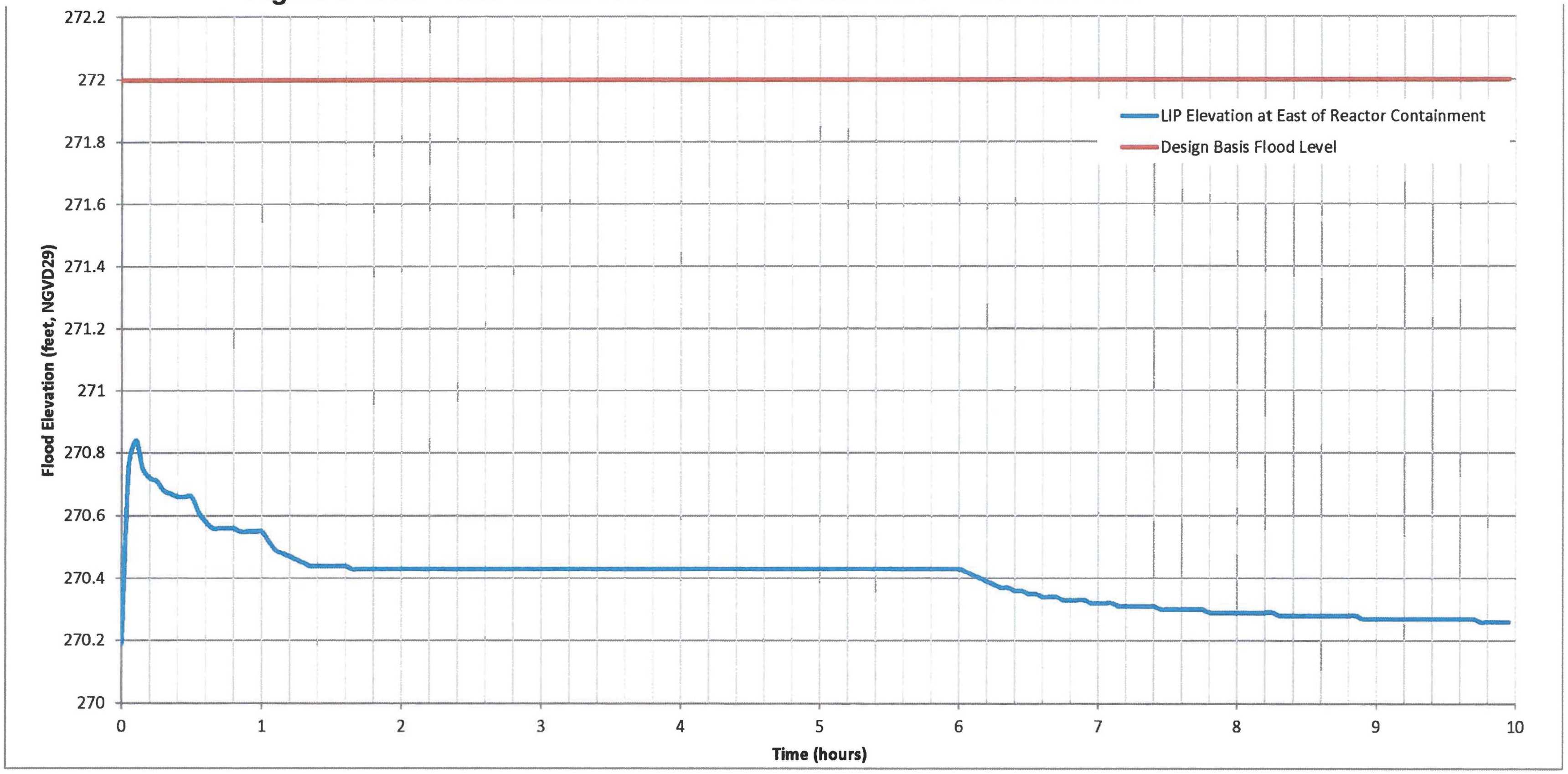


Figure 9-2: LIP Time Series Plot for Grid Element 6651 – East of Auxiliary Building

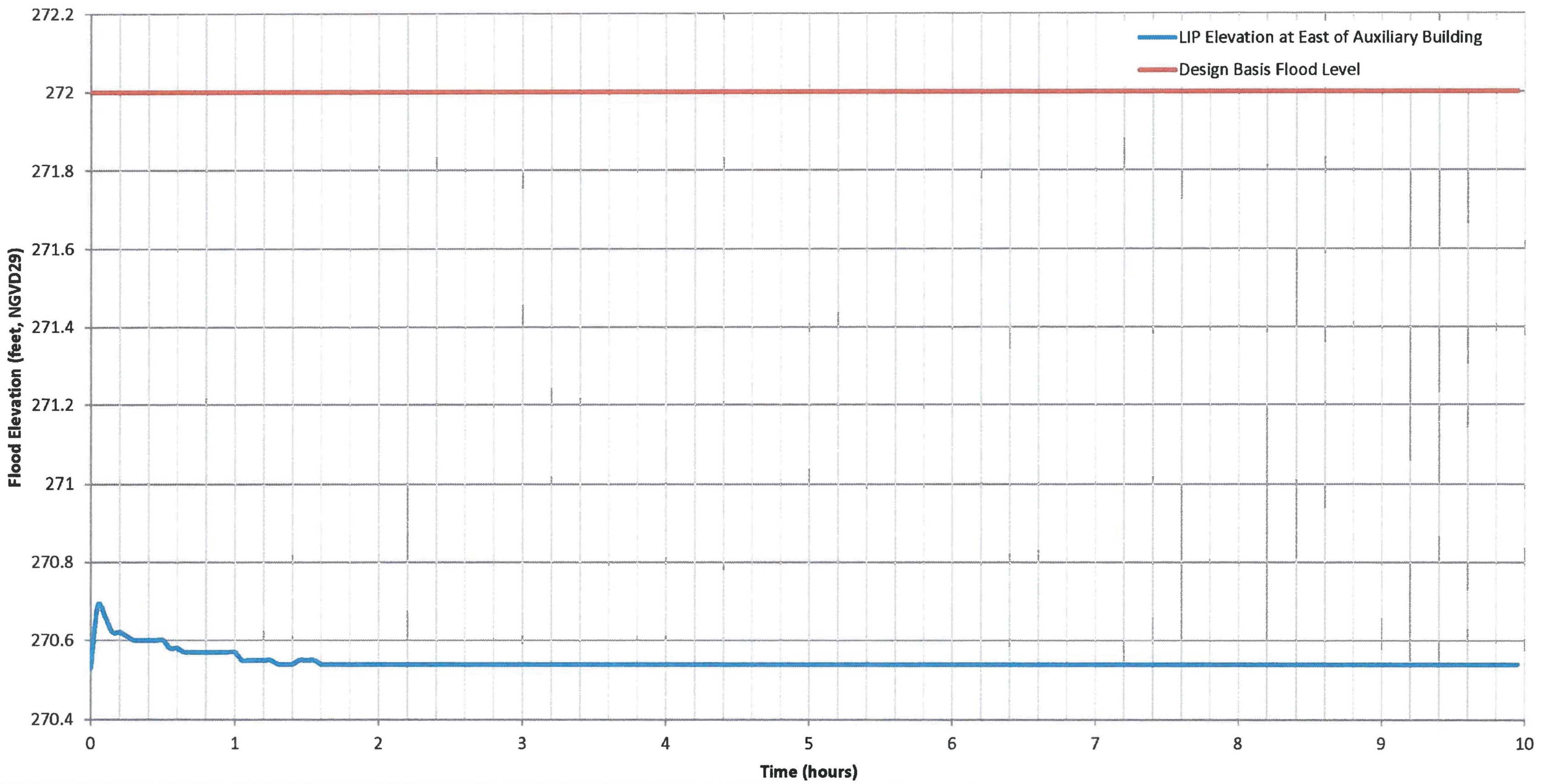


Figure 9-3: LIP Time Series Plot for Grid Element 4364 – North of Turbine Building

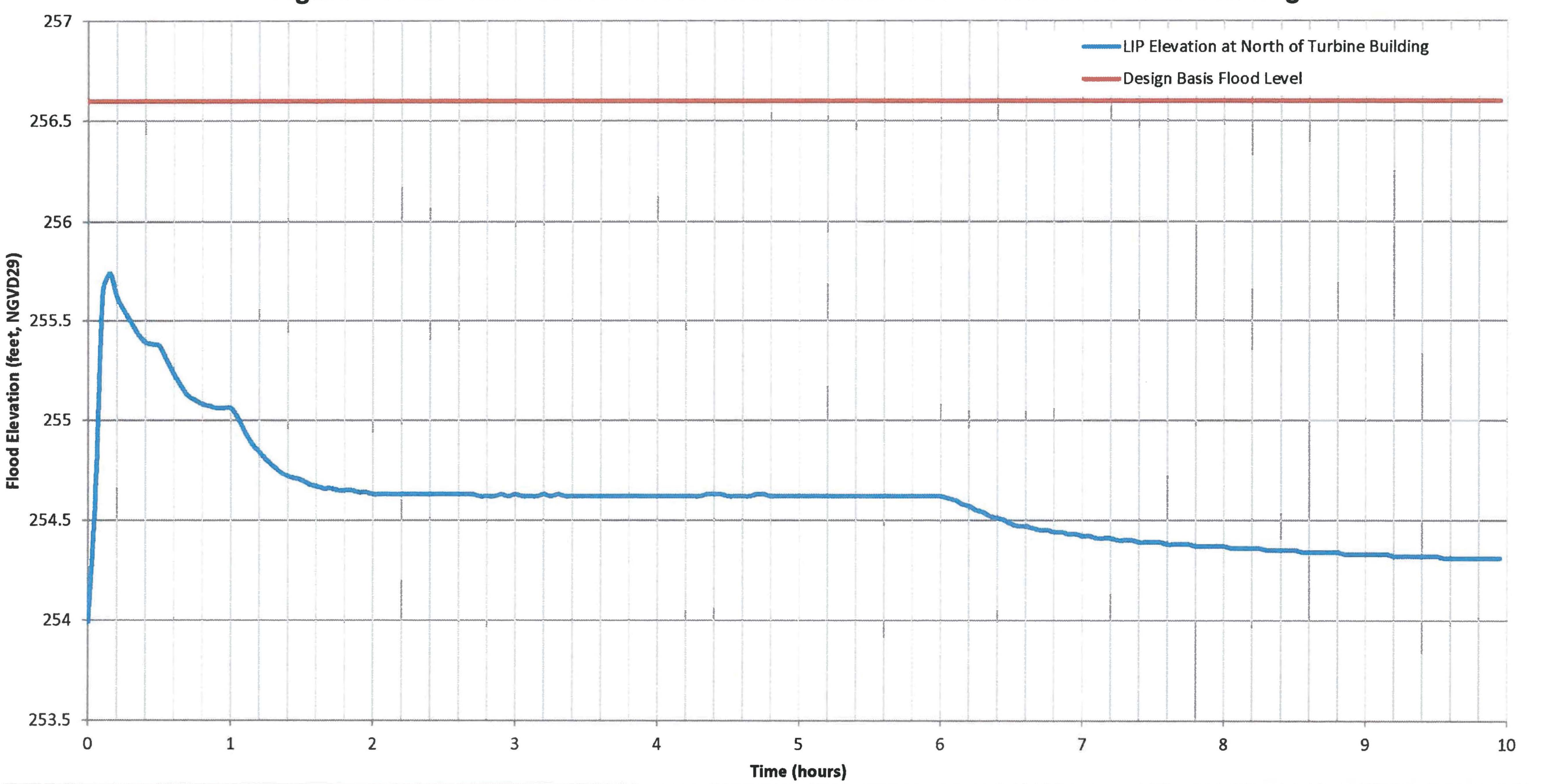


Figure 9-4: LIP Time Series Plot for Grid Element 5740 – South of Control Building

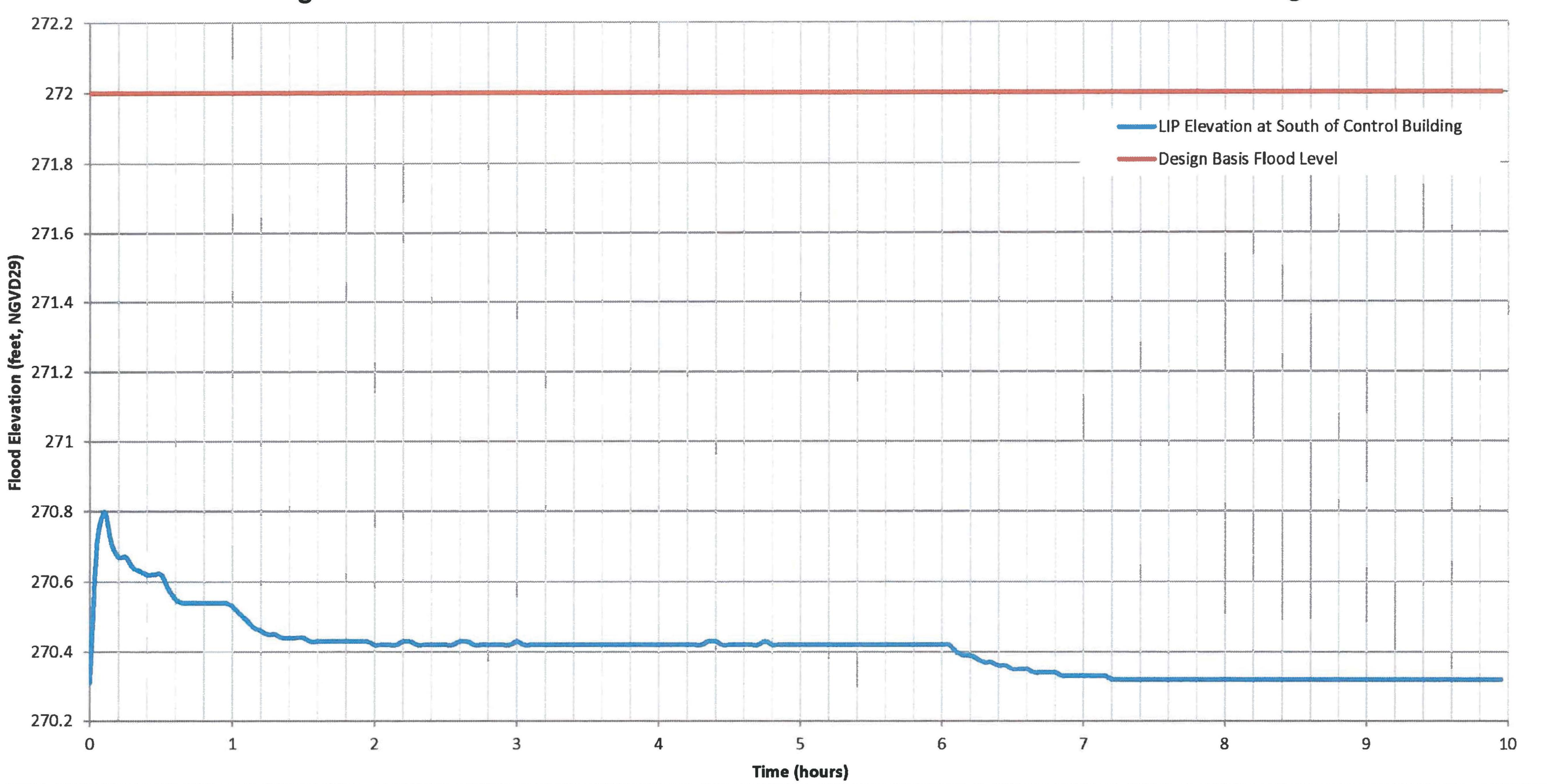


Figure 9-5: LIP Time Series Plot for Grid Element 5286 – East of All-Volatile-Treatment Building

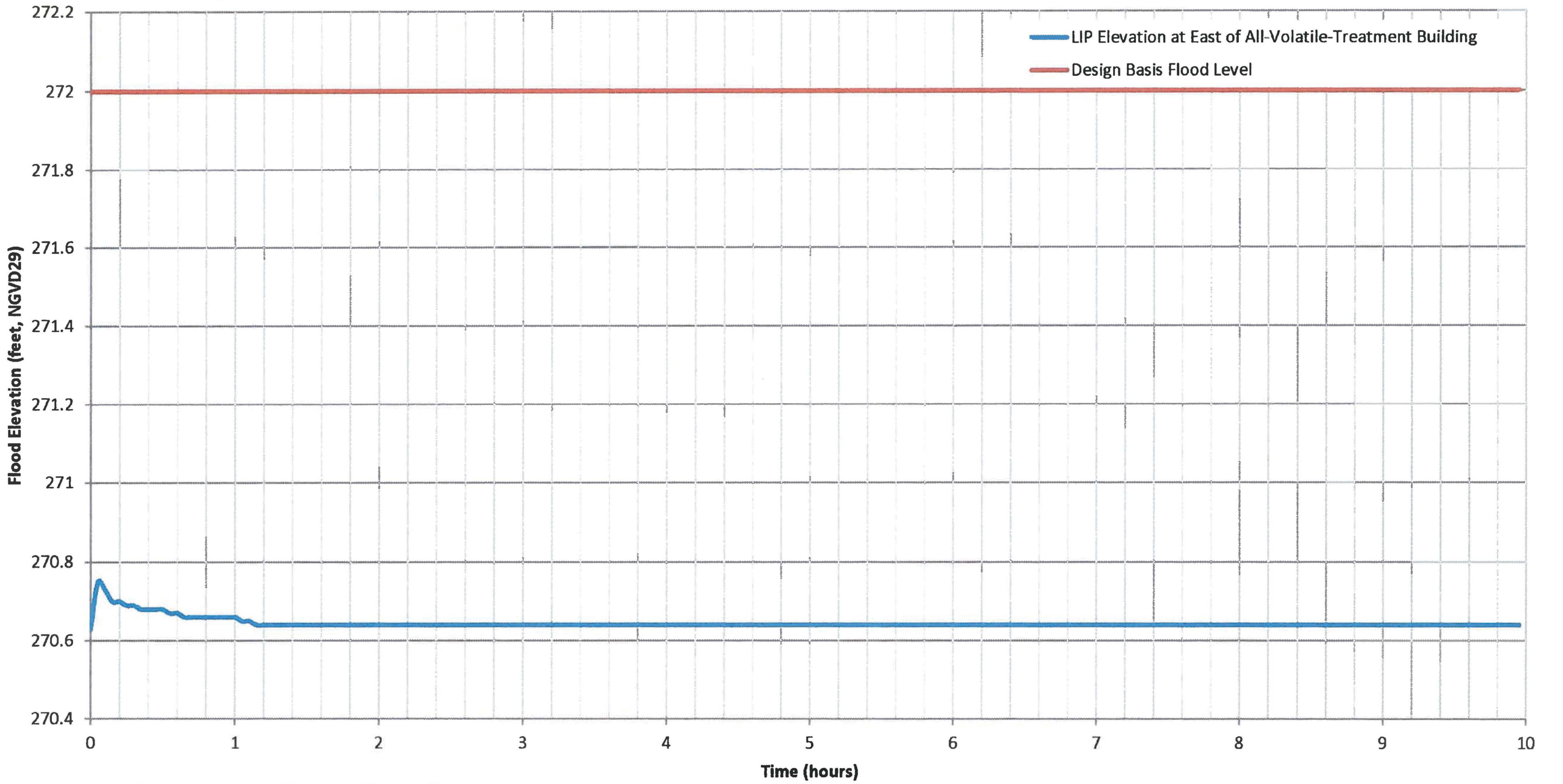


Figure 9-6: LIP Time Series Plot for Grid Element 6879 – East of Standby Auxiliary Feedwater Pump Building

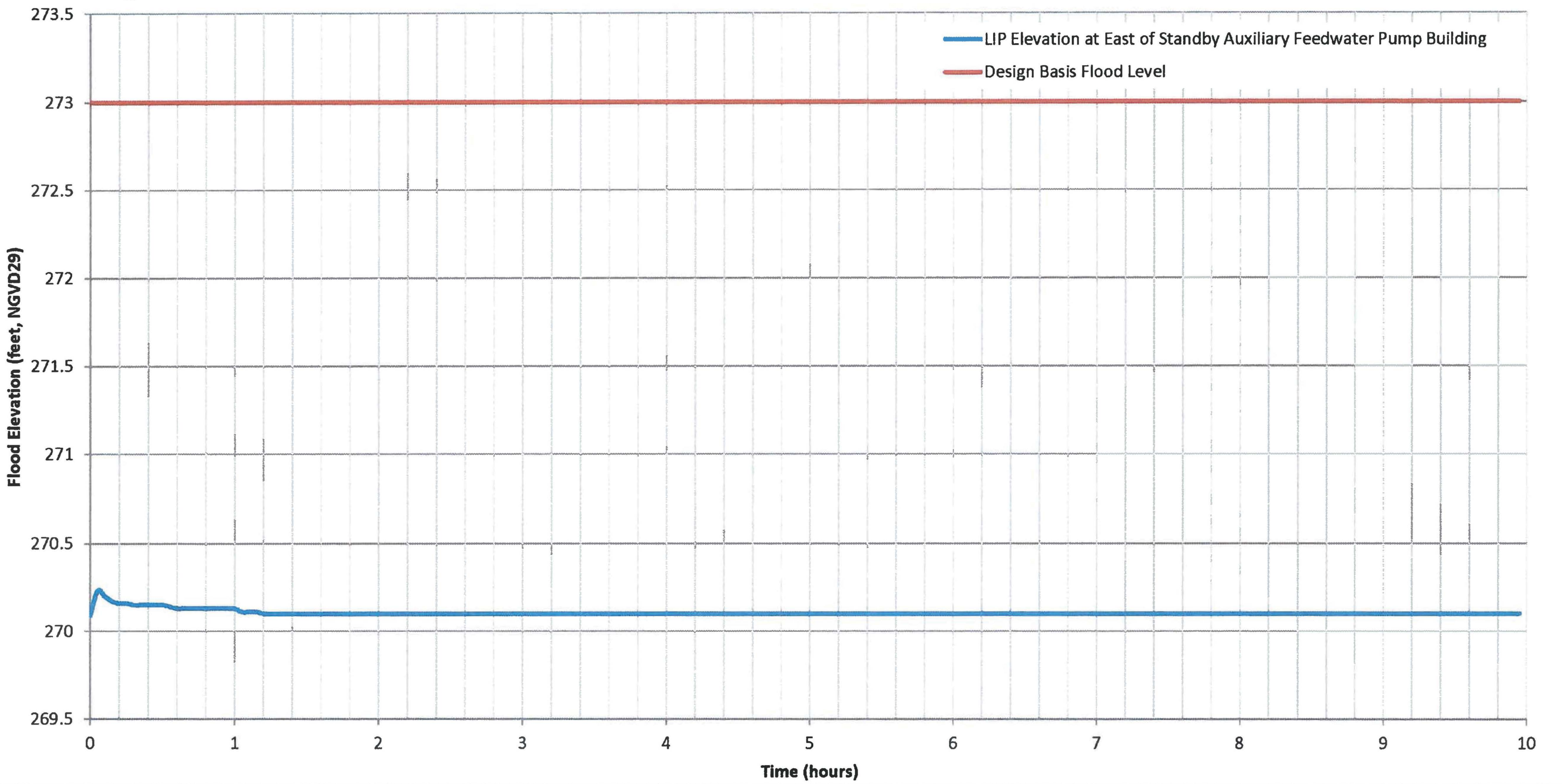


Figure 9-7: LIP Time Series Plot for Grid Element 7105 – East of Proposed Standby Auxiliary Feedwater Pump Building Annex

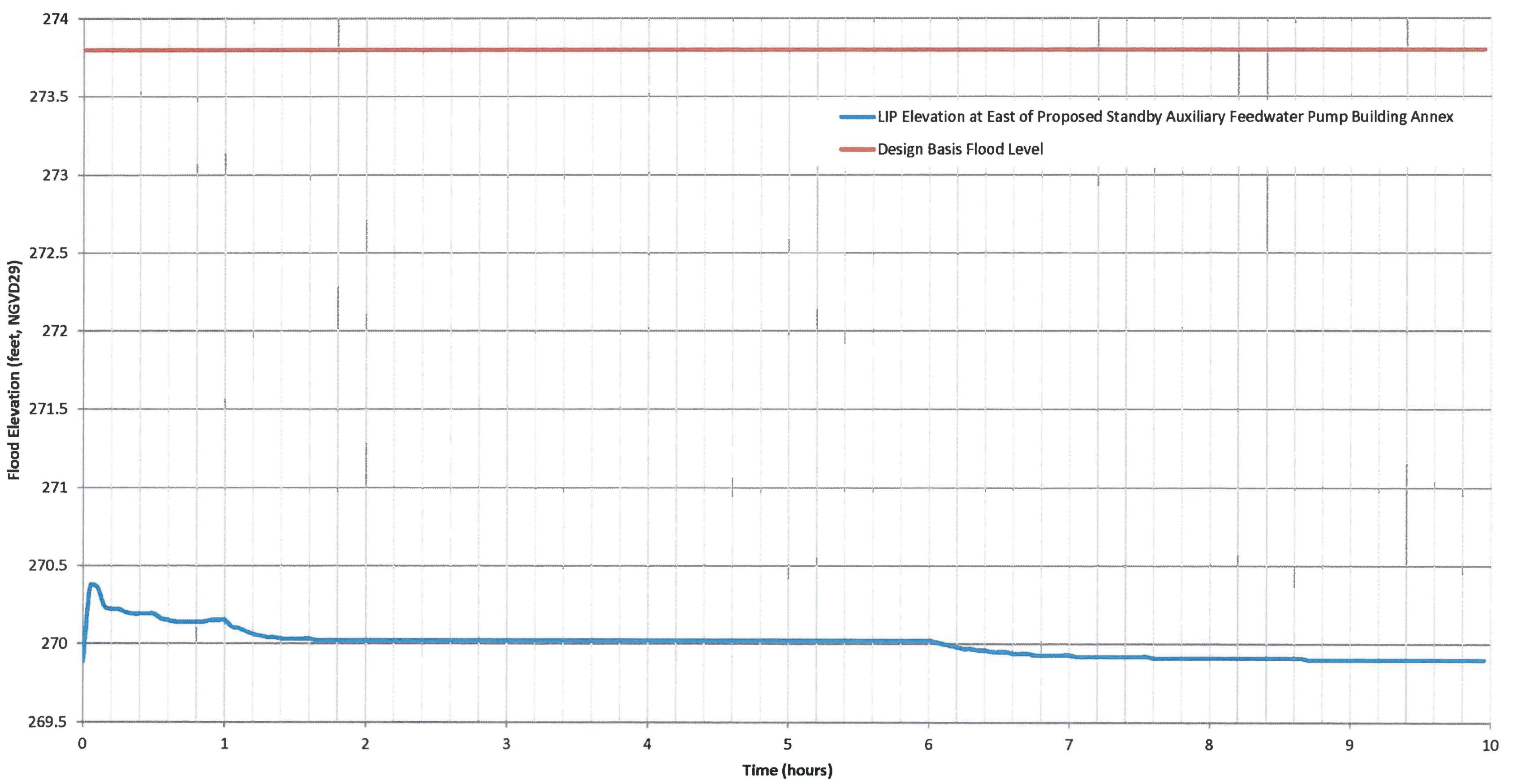


Figure 9-8: LIP Time Series Plot for Grid Element 3840 – South of Screen House

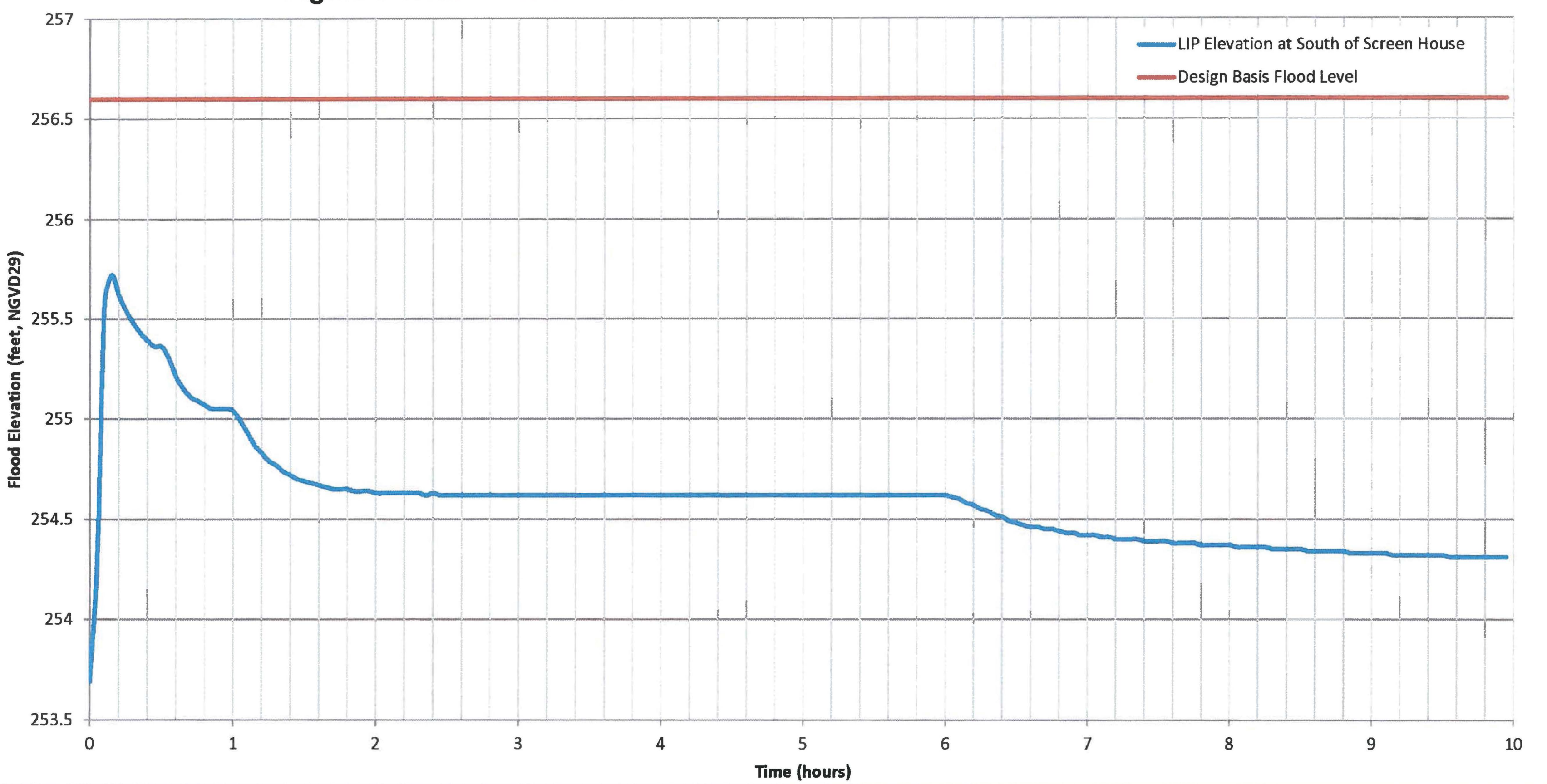


Figure 9-9: LIP Time Series Plot for Grid Element 4014 – North of Diesel Generator Building

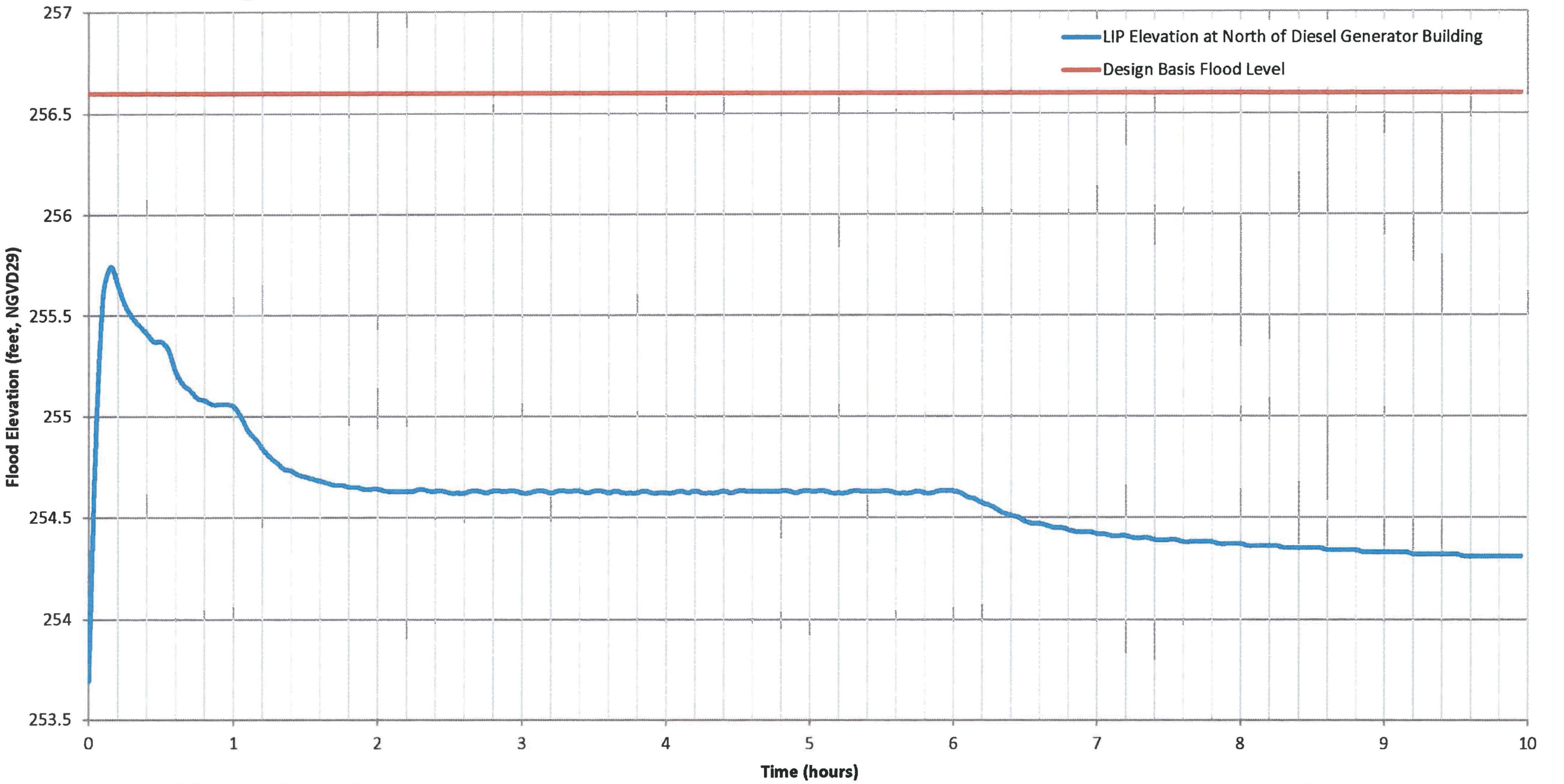


Figure 9-10: Combined Effect PMF Time Series Plot for Grid Element 6193 – East of Reactor Containment

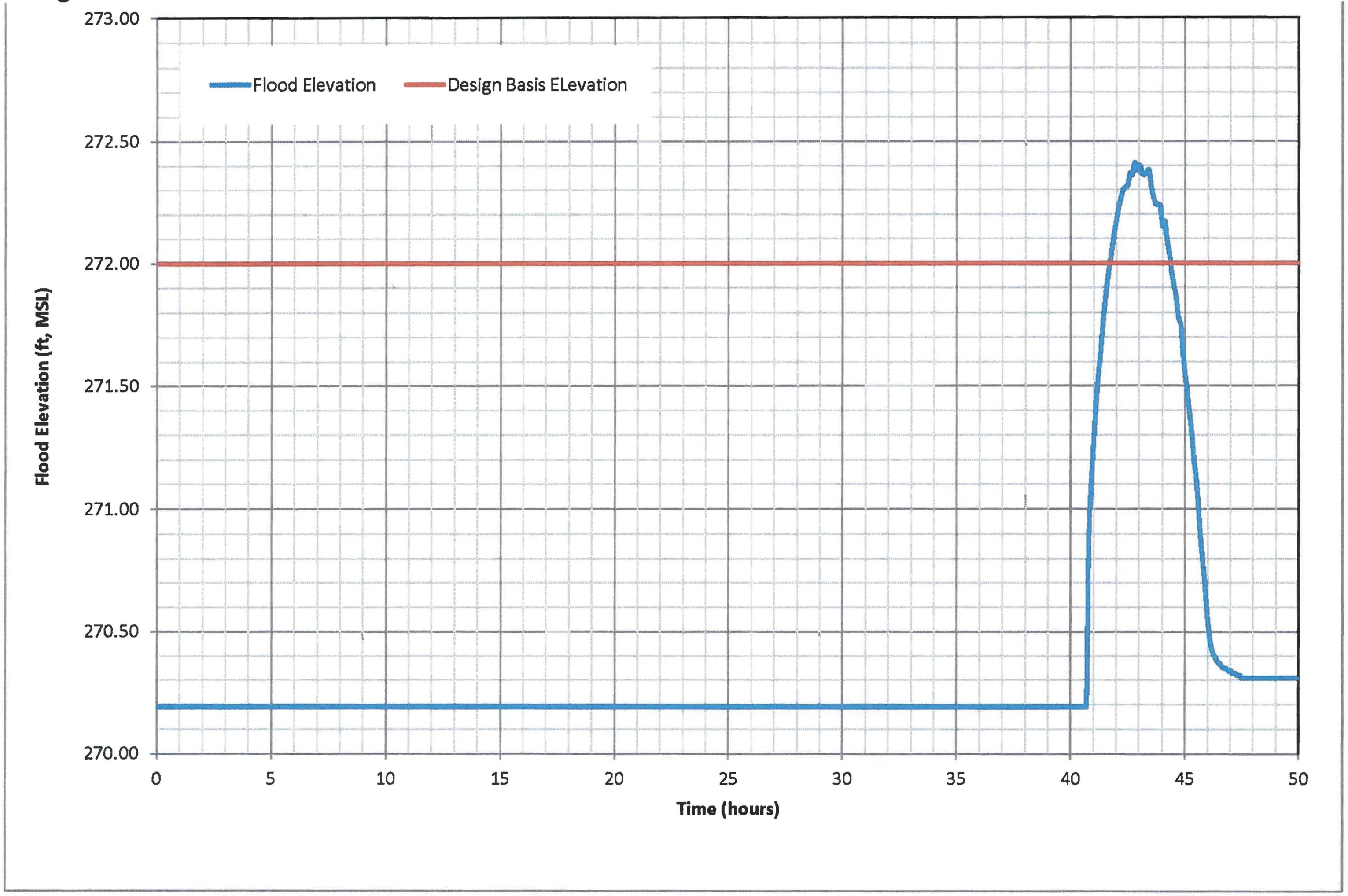


Figure 9-11: Combined Effect PMF Time Series Plot for Grid Element 6651 – East of Auxiliary Building

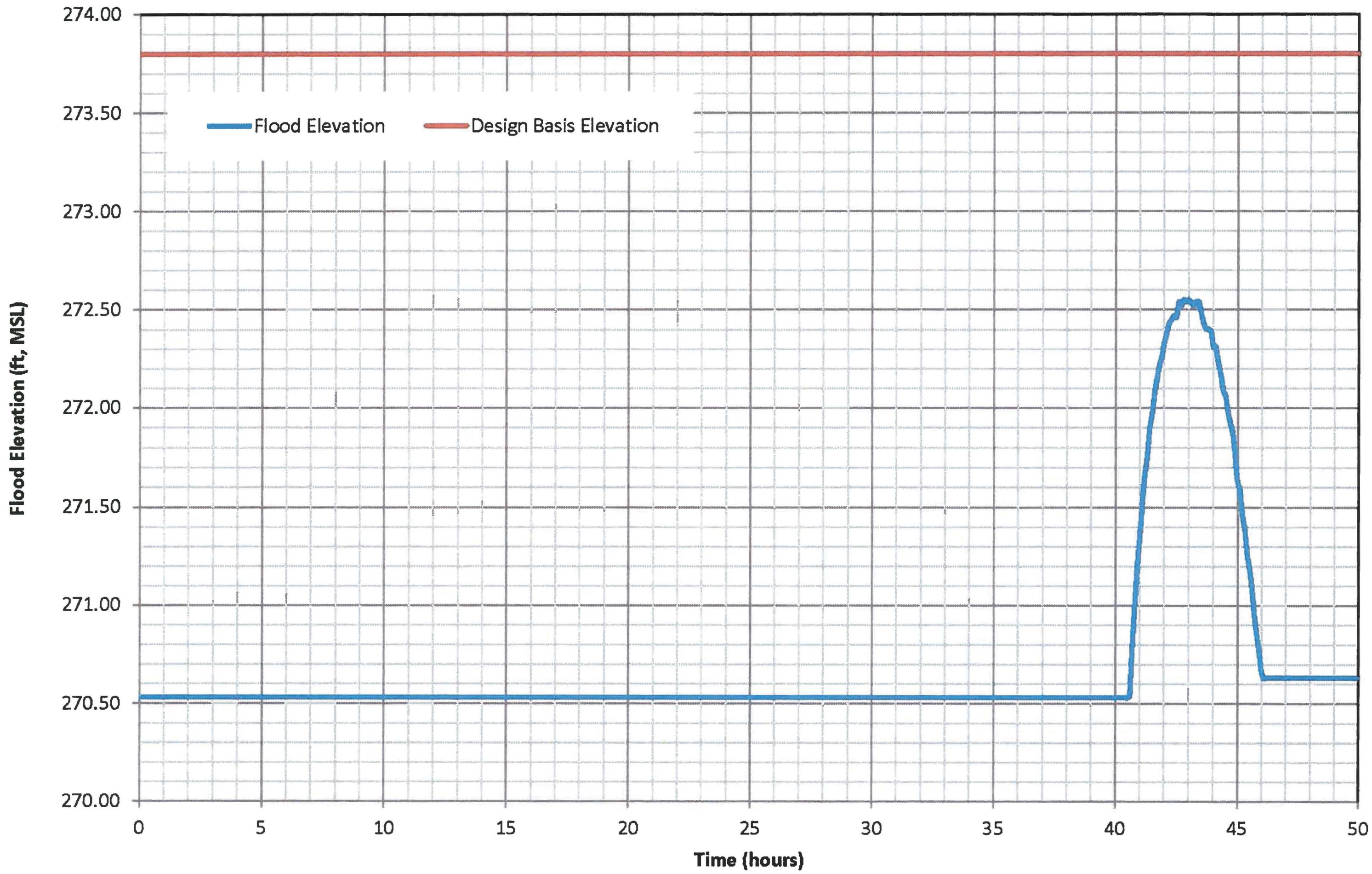


Figure 9-12: Combined Effect PMF Time Series Plot for Grid Element 4364 – North of Turbine Building

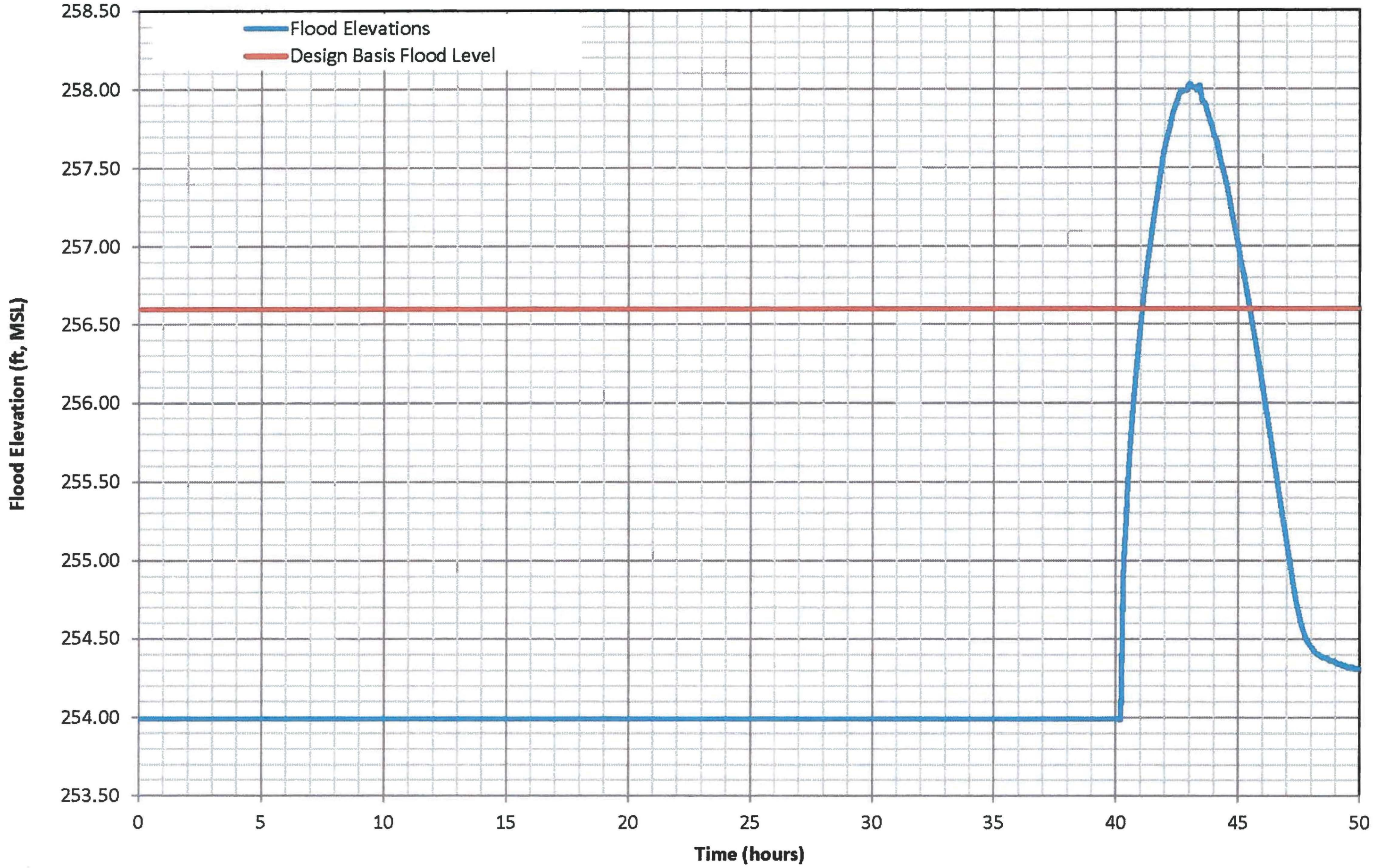


Figure 9-13: Combined Effect PMF Time Series Plot for Grid Element 5740 – East of Control Building

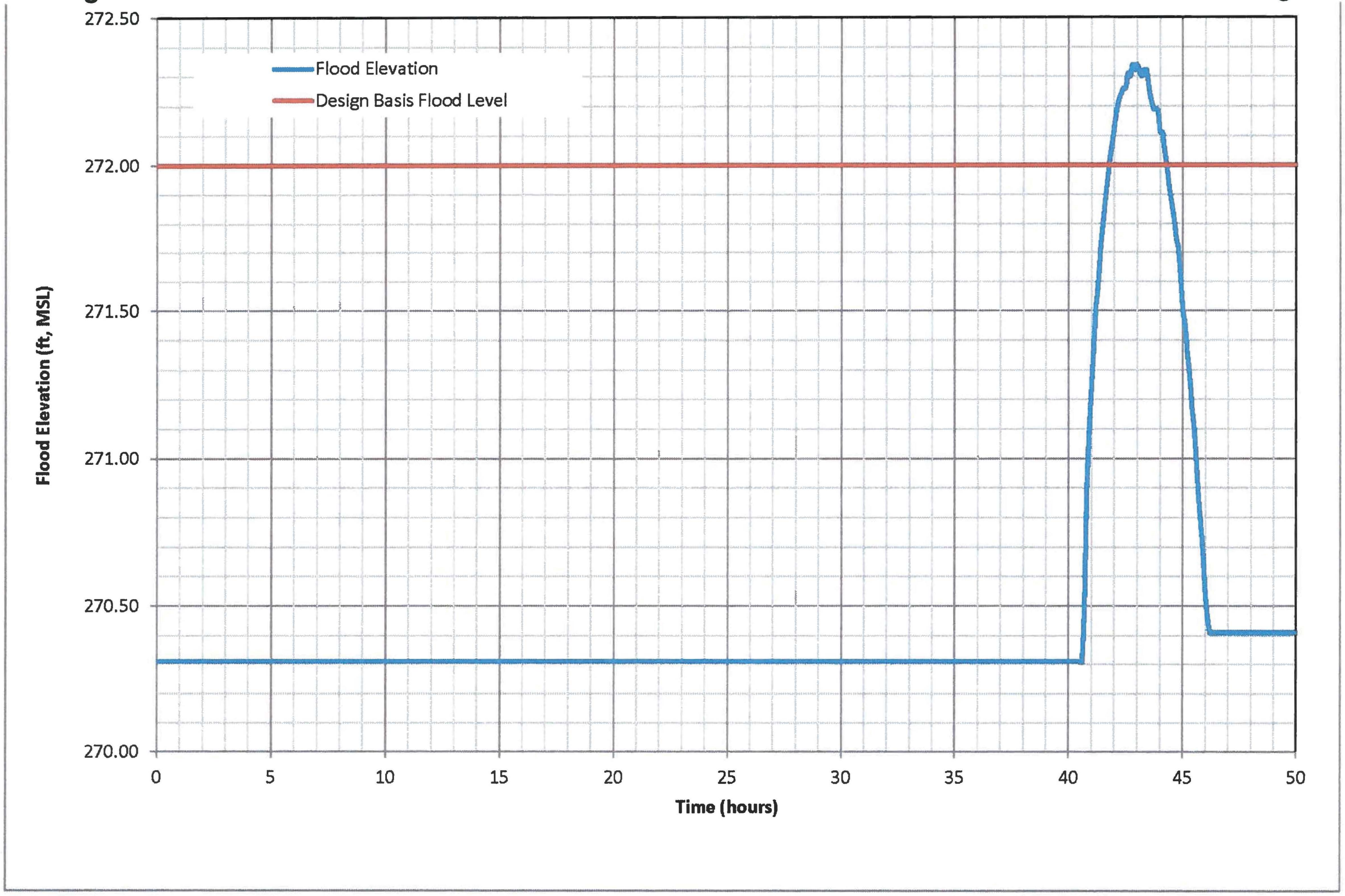


Figure 9-14: Combined Effect PMF Time Series Plot for Grid Element 5286 – All-Volatile-Treatment Building

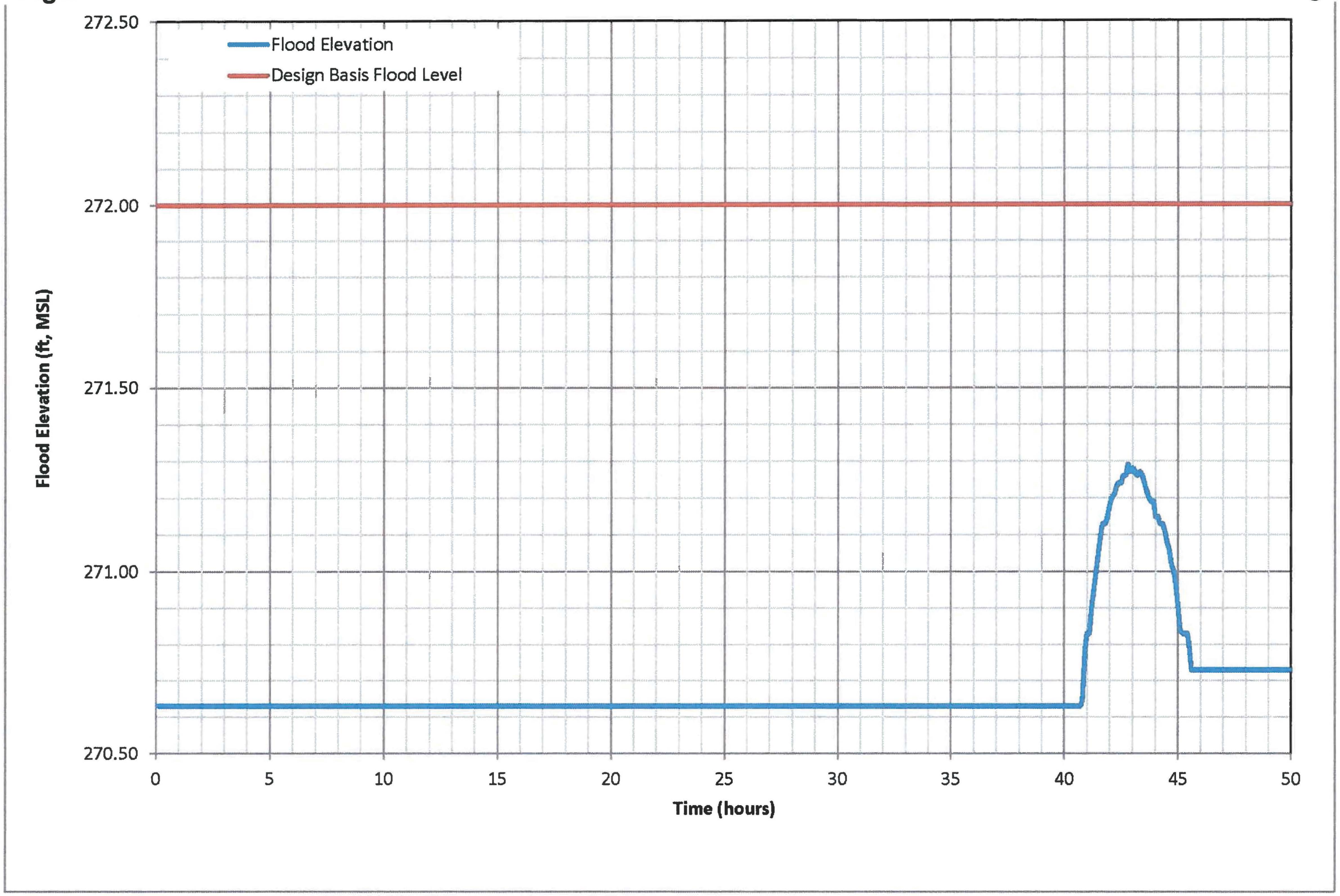


Figure 9-15: Combined Effect PMF Time Series Plot for Grid Element 6879 – West of Standby Auxiliary Feedwater Pump Building

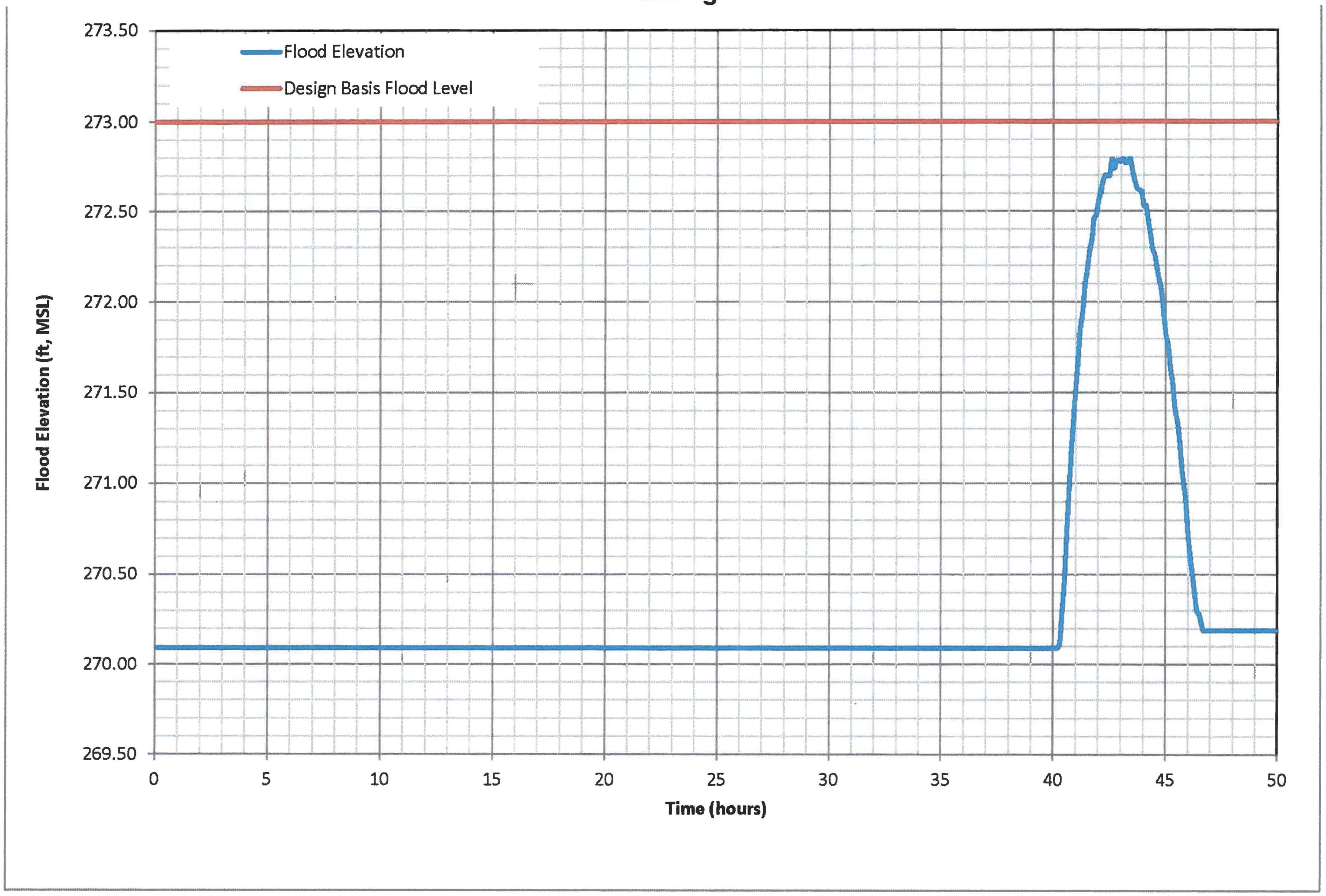


Figure 9-16: Combined Effect PMF Time Series Plot for Grid Element 7105 – Proposed Standby Auxiliary Feedwater Pump Building Annex

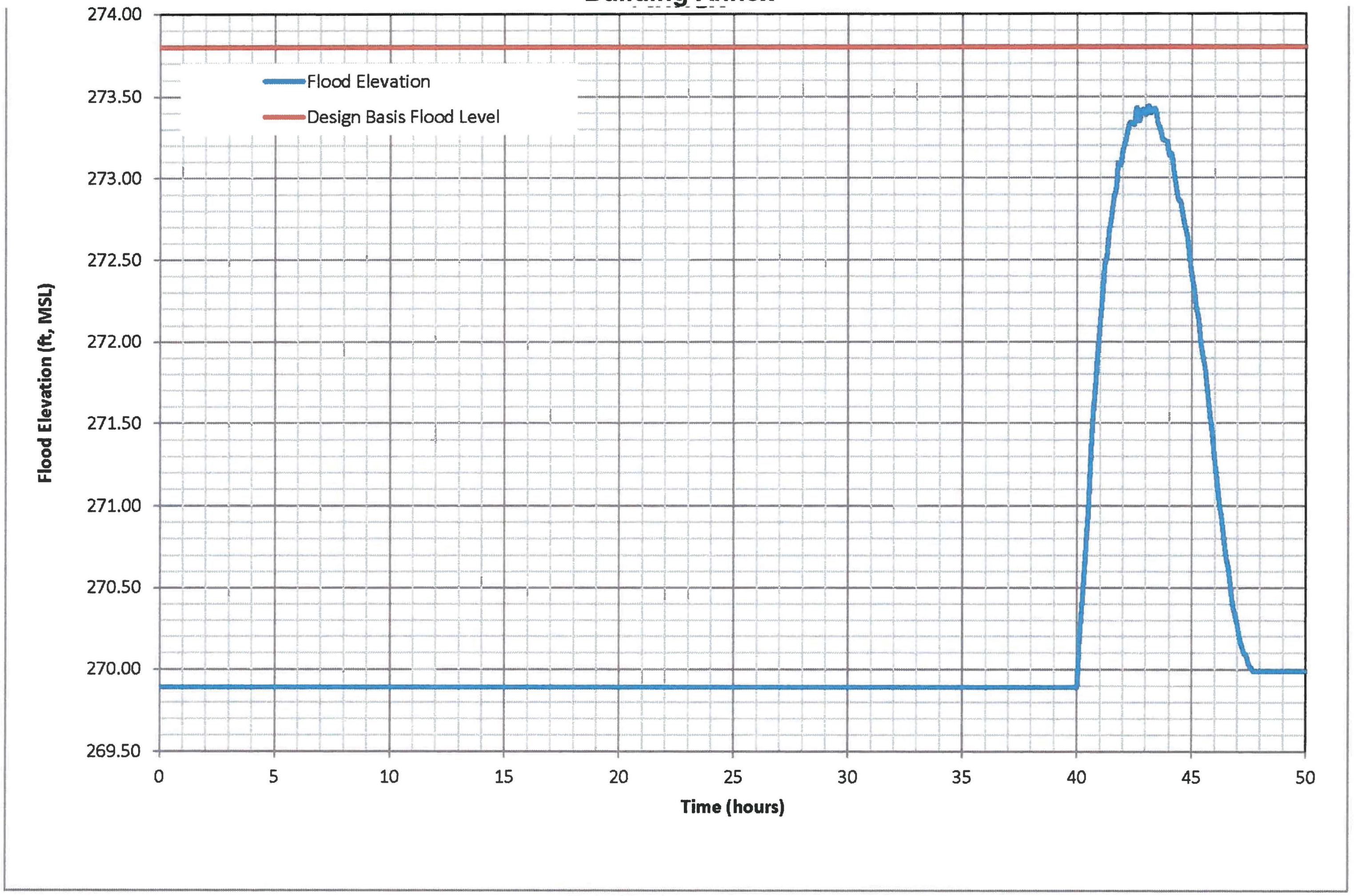


Figure 9-17: Combined Effect PMF Time Series Plot for Grid Element 3840 – South of Screen House

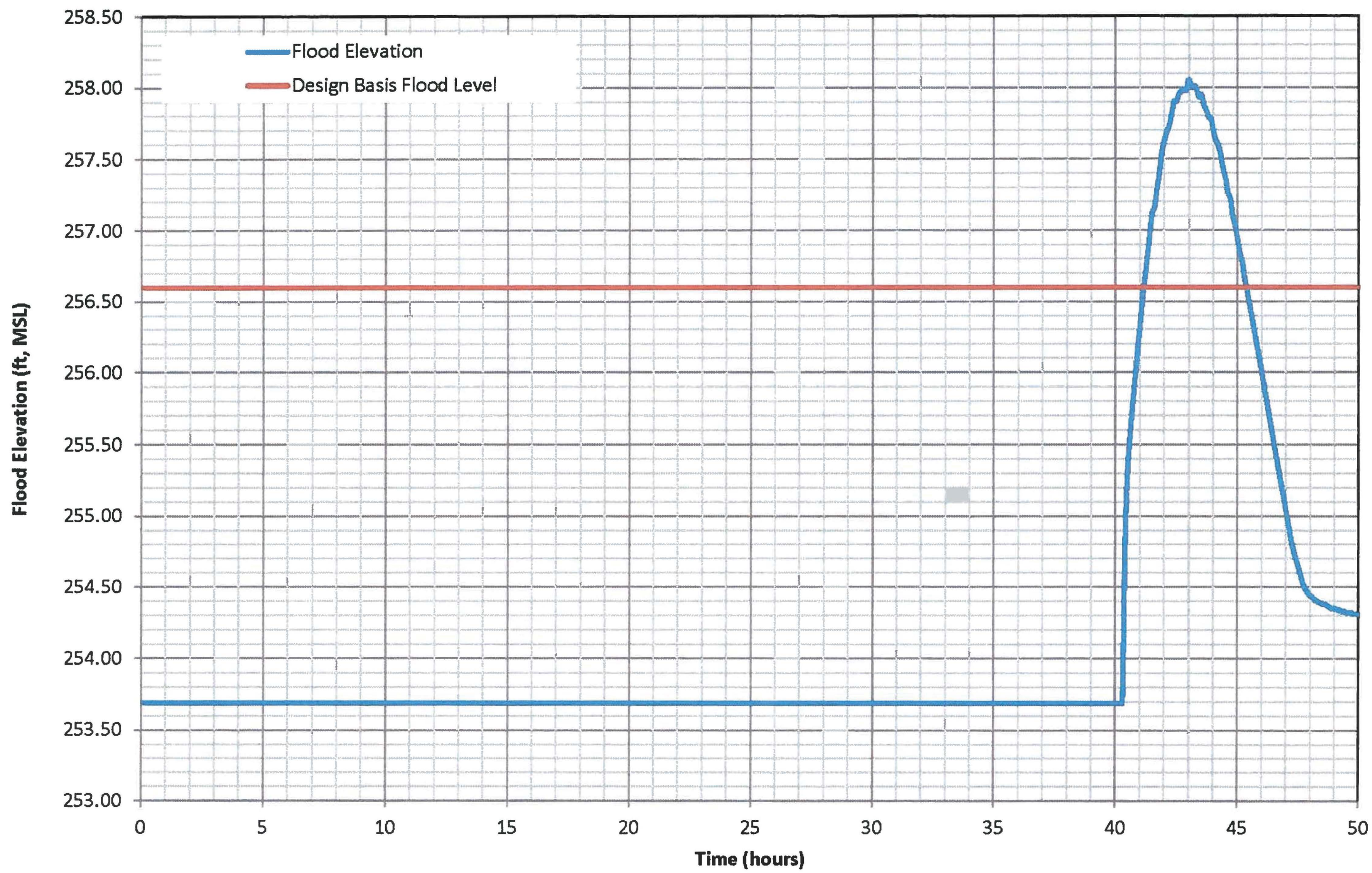


Figure 9-18: Combined Effect PMF Time Series Plot for Grid Element 4014 – North of Diesel Generator Building

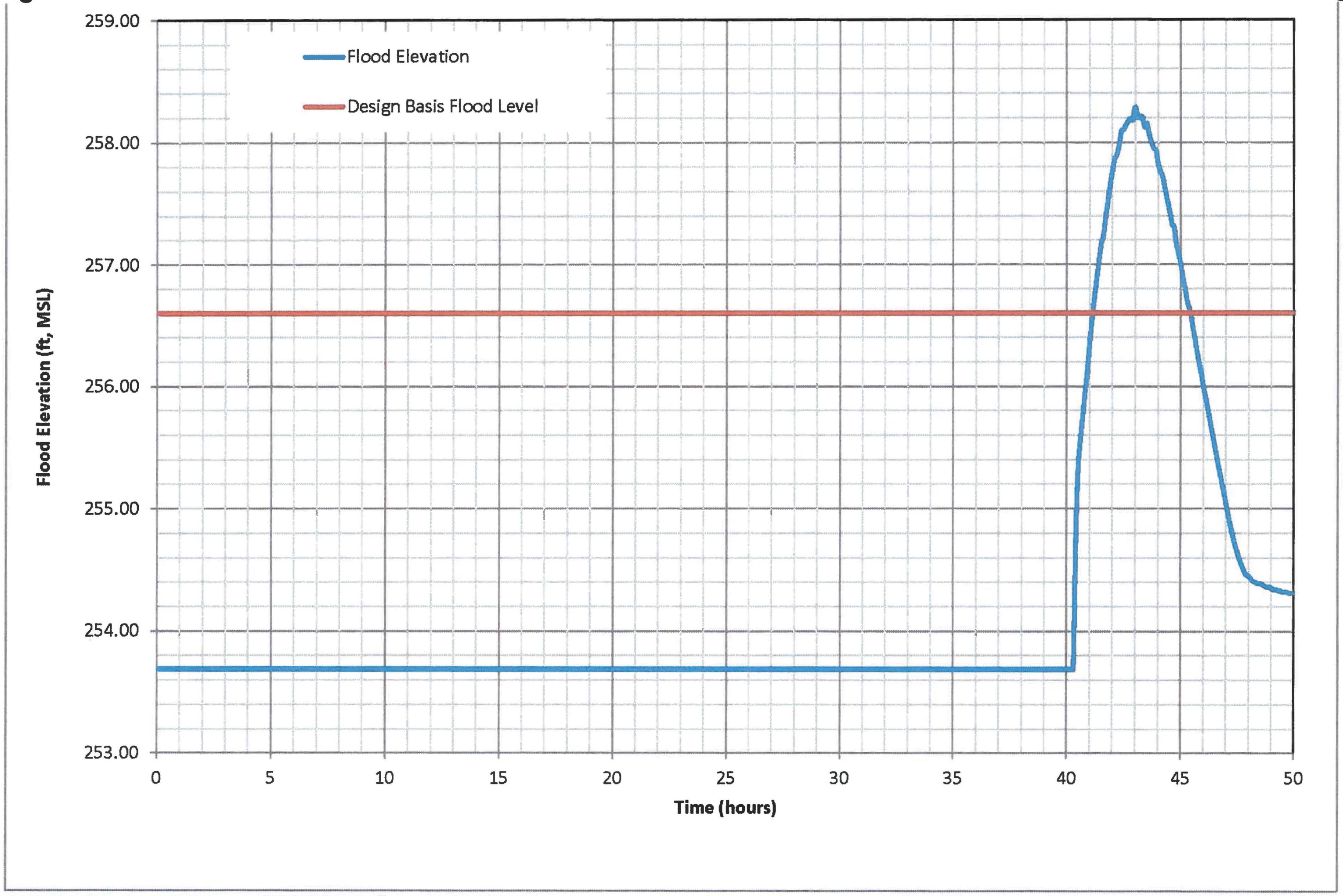
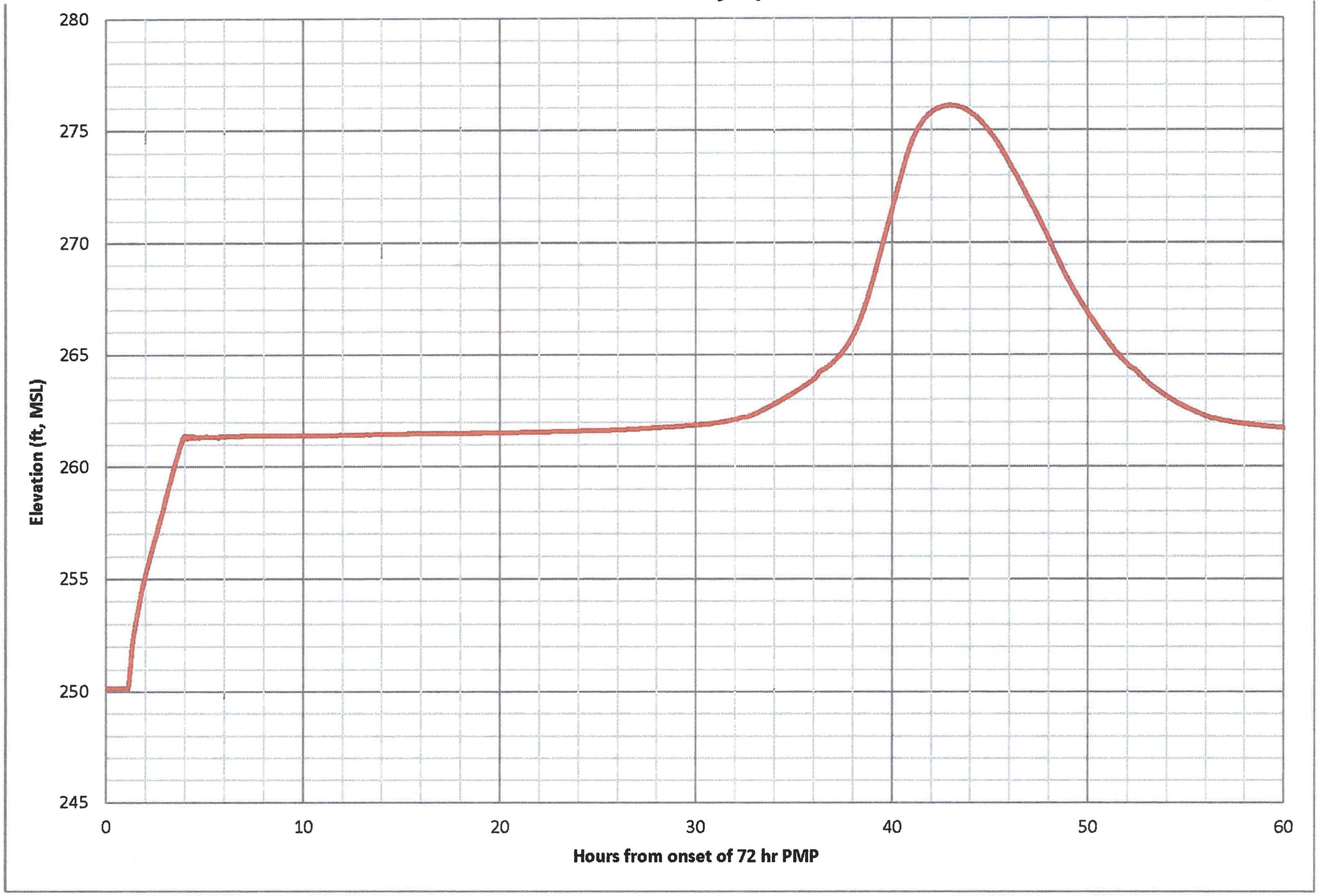


Figure 9-19: Combined Effect PMF Time Series Plot Immediately Upstream of Ginna Access Road at Driveway Bridge



Information Need 10: Flood Height and Associated Effects

Background: *Flood scenario parameters from the flood hazard reevaluation serve as the input to the Integrated Assessment. To support efficient and effective evaluations under the Integrated Assessment, the staff will review flood scenario parameters as part of the 50.54(f) FHHR and document results of the review as part of the staff's assessment. The March 12, 2012, 50.54(f) letter, Enclosure 2, requests that the licensee perform an Integrated Assessment of the plant's response to the reevaluated hazard if the reevaluated flood hazard is not bounded by the current design basis. This information is also necessary for conducting the Mitigating Strategies Assessment in accordance with NEI 12-06 App G.*

Request: *Provide the flood height and associated effects (as defined in Section 9 of JLD-ISG-2012-05) that are not described in the FHRR for mechanisms that trigger an Integrated Assessment. This includes the following quantified information for each mechanism (as applicable):*

- *Wind waves and run up,*
- *Hydrodynamic loading, including debris,*
- *Effects caused by sediment deposition and erosion (e.g., flow velocities, scour),*
- *Concurrent site conditions, including adverse weather,*
- *Groundwater ingress*

The FHRR indicated that the Integrated Assessment will include LIP, flooding on rivers and streams, and two combined-effects flood scenarios. For these mechanisms or their combination not all the associated effects listed above were stated in the FHRR. Provide the analysis used to support the conclusions for each associated effect. Provide analysis of associated effects for these flood causing mechanisms that will be included in the Integrated Assessment or a clear justification of why these effects are excluded.

Response:

Wind waves and run up are addressed in the response to Information Need No. 8, discussed in the NRC audit.

Hydrodynamic loading, including debris loading, is not anticipated to adversely affect Ginna during flood conditions. Hydrodynamic loading is essentially a function of flow velocity acting at structures. The maximum flow velocity at representative grid locations for the plant critical structures is 5.3 feet per second (Table 10-1). This maximum flow velocity is considered relatively low and, in combination with the direction of flow which is typically parallel to or away from important structures, it is expected to generate hydrodynamic loading that is bounded by other CDB loading (i.e., tornado/missile loading). Localized, higher velocities up to a maximum of 9.2 feet per second at the northern end of the All-Volatile-Treatment Building exist during the PMF condition (Figure 10-1). The localized higher velocities are also relatively low and are expected to result in hydrodynamic loads that are bounded by other CDB loading.

Debris loading is not expected to be significant at critical structures due to the resultant shallow maximum flow depths (Table 10-1), limited availability of debris, and distance of the Deer Creek channel to the powerblock area. As shown in Figure 10-1, the predominant flow path of the

PMF is along the Deer Creek channel. Other higher-velocity areas occur along or near site access roads, which have fairly shallow flow depths generally on the order of less than 2 ft (Figure 10-2, reproduced from Figure 2.9-6 of the FHRR). The shallow depths are likely to prevent large debris from being transported to Ginna from the main flow area (i.e., Deer Creek channel).

Areas of localized flow depths greater than 3 feet and higher velocities such as the area at the northern end of the All-Volatile-Treatment Building may experience some loading from localized debris (i.e. cars, trees branches, etc.).

Table 10-1: Peak Water Surface Elevations resulting from the combination of the riverine PMF, 25-year surge with wind-wave activity and maximum controlled water level in Lake Ontario

Structure	Representative Grid Element Number	PMF Peak Elevation (ft, NGVD29)	Maximum Flow Depth (ft)	Maximum Flow Velocity (fps)
Reactor Containment	6193	272.4	2.2	1.1
Auxiliary Building	6651	272.6	2.0	2.8
Turbine Building	4364	258.2	4.2	3.1
Control Building	5740	272.4	2.0	2.1
All-Volatile-Treatment-Building	5286	271.3	0.7	5.3
Standby Auxiliary Feedwater Pump Building	6879	272.8	2.7	4.0
Proposed Standby Auxiliary Feedwater Pump Building Annex	7105	273.5	3.6	2.8
Screen House	3840	258.2	4.5	3.3
Diesel Generator Building	4014	258.4	4.7	4.4

In response to the Information Need request, FLO-2D was used to approximate impact pressure loading as a result of the PMF. The results are provided in Figures 10-3 and 10-4. FLO-2D uses the Deng impact pressure equation, which is a function of maximum velocity (regardless of direction) and the density of water (FLO-2D, 2012). The impact pressure is reported as a force per unit length (impact pressure times flow depth). FLO-2D also reports static pressure based on flow depth and the specific weight of water (FLO-2D, 2012). The results are anticipated to be bounded by existing loading requirements for tornado/missile loading, with the exception of

the Auxiliary Building. Flow velocities in the vicinity of the Auxiliary Building are relatively limited.

Impacts of both hydrodynamic and hydrostatic loading at all critical locations for the site will be addressed during the Integrated Assessment phase of work.

Effects caused by sediment deposition and erosion (e.g., flow velocities, scour)

The maximum flow velocity among the critical structures is 5.3 feet per second (fps), which is not expected to result in erosion at buildings. Well established grass cover has a permissible velocity of about 6 feet per second (USACE, 1984). Higher velocities located away from the buildings are generally in paved areas and do not exceed the permissible velocity for pavement of 12 feet per second (USACE, 1984). Therefore, erosion/scour is not expected to impact Ginna.

Sediment deposition is also not expected to result in significant impacts at Ginna. The PMF combined effect flood reevaulation results already assume blockage of culverts at the Ginna access road (by sediment, debris, or other). The resulting flood travels from the Deer Creek channel overland, past the plant, and eventually into Lake Ontario (Figure 10-1). Velocities are fairly low (less than 10 feet per second) but not stagnant (generally more than 1 foot per second) such that significant sediment deposition leading to higher flood levels is not expected.

Groundwater

The design basis groundwater level was determined using results of monitoring of groundwater levels over a 4-year period from 1983 through 1987, resulting in a groundwater level of 265.0 ft msl. This value was based on a peak recorded groundwater level of 264.69 ft and using a 2% maximum expected error in the recording system. An engineering evaluation was subsequently performed to determine the effects of the design-basis groundwater level on safety related structures below grade. As a conservative approach, the engineering evaluation considered a groundwater level at grade elevation 270.0 ft msl, or 5 ft higher than the design-basis level. The evaluation demonstrated that the below-grade safety-related structures were adequately designed to resist the loads associated with groundwater levels at grade (270.0 ft msl) without requiring strengthening modifications. (Ginna, 2011)

The design-basis groundwater level of 265 ft MSL is well above the regulated maximum Lake Ontario level, and would only be exceeded by surface flooding for relatively short durations during the postulated flood events (PMF on Deer Creek and LIP at the site). As a result, groundwater elevations are not anticipated to be significantly impacted by flood mechanisms detailed in the FHRR. Additionally, the evaluation performed to determine the impacts of groundwater on below-grade safety related structures indicated that no adverse impacts would occur if groundwater levels were at plant grade (270.0 ft MSL).

Figure 10-1: FLO-2D velocity vectors and peak velocity values (in feet per second) for the PMF combined effect flood.

Figure 10-2: Peak flow depths (ft) during the PMF combined effect flood (Figure 2.9-6 of the FHRR)

Figure 10-3: FLO-2D-generated impact forces during the PMF combined effect flood (pounds per foot)

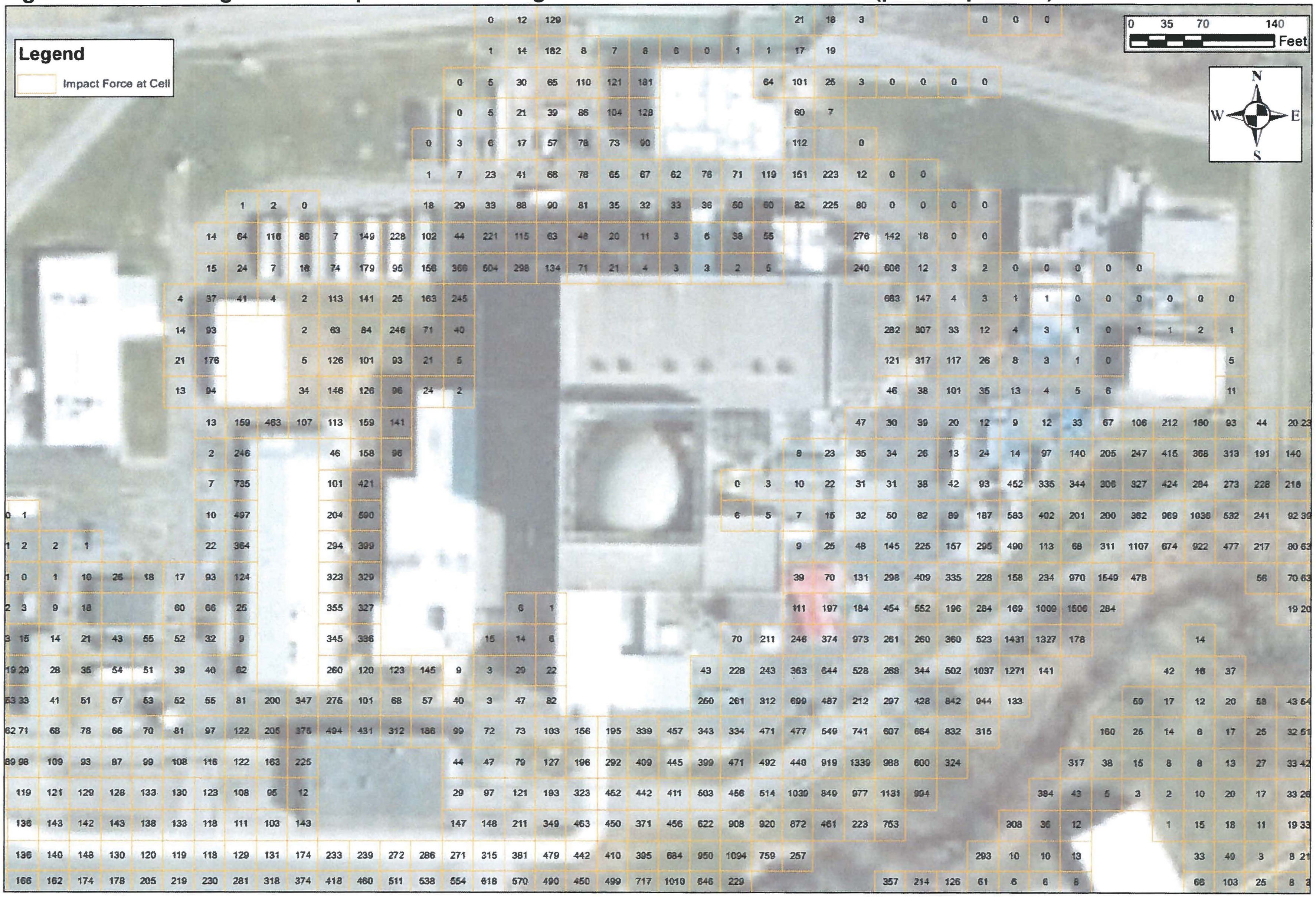


Figure 10-4: FLO-2D-generated static water loads (pounds per foot) during the PMF combined effect flood.

References:

AREVA, 2013. AREVA Document No. 32-9190280-000, "Flood Hazard Re-evaluation – Combined Events Flood Analysis for R.E. Ginna Nuclear Power Plant," GZA GeoEnvironmental, Inc., Revision 0, 2013.

Ginna, 2011. R. E. Ginna Nuclear Power Plant Updated Final Safety Analysis Report (UFSAR) Revision 23, December 6, 2011.

USACE, 1984. "Drainage and Erosion Control Mobilization Construction," U.S. Army Corps of Engineers, EM 1110-3-136, April 1984. See below:

EM 1110-3-136
9 Apr 84

Table 10-1.

Suggested Coefficients of Roughness and Maximum Permissible Mean Velocities for Open Channels

Material	n	Maximum Permissible Mean Velocity Feet per Second
Concrete, with surfaces as indicated:		
Formed, no finish	0.014	---
Trowel finish	0.012	---
Float finish	0.012	---
Gunite, good section	0.016	30
Concrete, bottom float finish, sides as indicated:		
Cement rubble masonry	0.020	20
Cement rubble masonry, plastered	0.018	25
Rubble lined, uniform section	0.030-0.045	7-13
Asphalt:		
Smooth	0.012	15
Rough	0.016	12
Earth, uniform section:		
Sandy silt, weathered	0.020	2.0
Silty clay	0.020	3.5
Soft shale	0.020	3.5
Clay	0.020	6.0
Soft sandstone	0.020	8.0
Gravelly soil, clean	0.025	6.0
Natural earth, with vegetation	0.03-0.150	6.0
Grass swales and ditches[1]		6.0