Exelon Generation.

10 CFR 50.54(f)

RS-15-001

January 13, 2015

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

Quad Cities Nuclear Power Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-29 and DPR-30
NRC Docket Nos. 50-254 and 50-265

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

References:

1. Exelon Generation Company, LLC Letter to USNRC, Response to March 12, 2012 Request for Information Enclosure 2, Recommendation 2.1, Flooding, Required Response 2, Flooding Hazard Reevaluation Report, dated March 12, 2013 (RS-13-047)
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
3. NRC Email Request for Additional Information Regarding Fukushima Lessons Learned - Flood Hazard Reevaluation Report, dated October 17, 2014
4. Exelon Generation Company, LLC Letter to USNRC, Updated Supplemental Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Flooding Aspects of Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated June 4, 2014 (RS-14-133)

In Reference 1, Exelon Generation Company, LLC (EGC) provided the Quad Cities Nuclear Power Station, Units 1 and 2, Flooding Hazard Reevaluation Report in response to the March 12, 2012 Request for Information Enclosure 2, Recommendation 2.1, Flooding, Required Response 2, (Reference 2).

The purpose of this letter is to provide the response to the NRC request for additional information (RAI) (Reference 3) regarding the Quad Cities Nuclear Power Station, Units 1 and 2 Flooding Hazard Reevaluation Report. Enclosure 1 provides the response to each NRC RAI. The Quad Cities Nuclear Power Station, Units 1 and 2 Local Intense Precipitation (LIP) Evaluation, initially

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provided in Reference 1, has been revised to incorporate new site-specific LIP information. Enclosure 2 provides the updated LIP evaluation report. Enclosure 3 provides the updated LIP model input and output electronic files. The updated evaluation resulted in maximum water surface elevation increases between 0.06 and 0.29 foot at main door locations (a comparison between Table 4 of Reference 1, Enclosure 1, and Table 4-2 of Enclosure 2).

The results of the updated evaluation have been reviewed and the newly installed LIP barriers will protect the plant from the increased water elevation. No new or revised interim action commitments are required based on the results of the revised LIP evaluation.

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 13th day of January 2015.

Respectfully submitted,

Glen T. Kaegi
Director - Licensing & Regulatory Affairs
Exelon Generation Company, LLC

Enclosures:

1. Quad Cities Nuclear Power Station, Units 1 and 2 - Response to Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report
2. Quad Cities Nuclear Power Station, Units 1 and 2 – Local Intense Precipitation Evaluation Report, Revision 8
3. DVD labeled: Quad Cities Nuclear Power Station, Units 1 and 2, Enclosure 3 of RS-15-001, FLO-2D Model Input and Output Files, Revision 1

   Document Components:

   QDC4-0FINAL folder containing FLO-2D *.DAT and *.OUT files

cc: Director, Office of Nuclear Reactor Regulation
NRC Regional Administrator - Region III
NRC Senior Resident Inspector – Quad Cities Nuclear Power Station, Units 1 and 2 (w/o Enclosure 3)
NRC Project Manager, NRR – Quad Cities Nuclear Power Station, Units 1 and 2 (w/o Enclosure 3)
Mr. Robert F. Kuntz, NRR/JLD/JHMB, NRC
Mr. Victor Hall, NRR/JLD/JHMB, NRC
Illinois Emergency Management Agency - Division of Nuclear Safety (w/o Enclosure 3)

bcc: Site Vice President – Quad Cities Nuclear Power Station, Units 1 and 2 (w/o Enclosure 3)
Vice President Operations Support (w/o Enclosure 3)
Site Engineering Director – Quad Cities Nuclear Power Station, Units 1 and 2 (w/o Enclosure 3)
Regulatory Affairs Manager (w/o Enclosure 3)
Regulatory Assurance Manager – Quad Cities Nuclear Power Station, Units 1 and 2 (w/o Enclosure 3)
Severe Accident Management Director (w/o Enclosure 3)
Site Operations Director –Quad Cities Nuclear Power Station, Units 1 and 2 (w/o Enclosure 3)
Corporate Licensing Manager – West (w/o Enclosure 3)
Corporate Licensing Director – West (w/o Enclosure 3)
Exelon Records Management (w/o Enclosure 3)
Commitment Tracking Coordinator – East (w/o Enclosure 3)
Vinod Aggarwal (w/o Enclosure 3)
Joseph Bellini (w/o Enclosure 3)
Dustin Damhoff (w/o Enclosure 3)

Enclosure 1

Quad Cities Nuclear Power Station, Units 1 and 2

Response to Request for Additional Information

Regarding Fukushima Lessons Learned - Flood Hazard Reevaluation Report

(5 pages)

RAI-7a: Local Intense Precipitation – Precipitation onto Buildings

Background: On page 6 of Enclosure 1 of the FHRR, the licensee notes that all active and passive drainage system components are considered blocked during the LIP event, in order to arrive at a conservative estimate of flooding. The staff agrees that the assumption that surface drains are blocked, allowing water to flow to the ground, provides a conservative flooding estimate. However, the assumption that roof drains are blocked, such that water is stored on parapet roofs, is not conservative with regards to flooding.

In its RAI response, the licensee states that "water was allowed to pond on building roofs due to roof parapets, which assumes any roof drains are completely blocked." A significant portion of the land cover within the concrete security barriers is comprised of buildings. Water ponded on the roofs could represent a substantial decrease in the overall water volume on the site. While staff concurs that this methodology is conservative for evaluating the static loads on the building structures, this is not conservative for LIP flooding, since the runoff could flow to the ground.

Request:

1. Provide a building list and/or map denoting each building's drainage system design in terms of whether the roof:
    a. Drains to the site surface;
    b. Drains to the underground drainage system, or;
    c. Precludes drainage and acts as storage.
2. Describe the methodology used in the FLO-2D model to account for buildings that drain water from the roof to the site.
3. Provide an analysis that shows the effect of allowing water falling on the roofs to drain to the site ground (i.e., without assuming water is stored on roofs).

Response:

During a conference call on September 12, 2014, NRC staff provided Exelon with two options in responding to RAI 7a:

1. Provide information requested in items 1 and 2 above (i.e., additional information on the roof structure and drainage system) supporting the modeling approach in the original (March 12, 2013) submittal, which assumed roofs retain or bypass some of the LIP volume; or

2. Provide information requested in item 3. That is, revise the LIP calculation that shows the effect of allowing water falling on the roofs to drain to the site ground (i.e., without assuming water is stored on roofs).

Exelon decided to prepare the response using Option 2 by revising the LIP calculation (Reference 1) based on the conservative assumption that all roof runoff is conveyed directly to adjacent site grade, without taking credit for roof retention and/or drainage bypass. Therefore, information requested in items 1 and 2 are not included in the response. The revised calculation uses site-specific Probable Maximum Precipitation (PMP) data for the 1-hour/1-square-mile storm (Reference 2); a change from original input which was obtained from the NWS Hydrometeorological Report (HMR) No. 52.

Grid elements in FLO-2D (version 2009) that represent building roofs were raised above the maximum flooding elevation to simulate the effect of buildings blocking flow and to conservatively transfer all roof runoff directly to adjacent site grade. The use of the 2009 version of FLO-2D (same version used in the original LIP calculation) and the above method for conservatively simulating roof runoff should address NRC concerns in using FLO-2D for roof runoff modeling. Exelon understands these industry-wide concerns are associated with the 2013 version of FLO-2D and use of area reduction factors when conservatively modeling roof runoff as being entirely transferred directly to site grade.

The updated evaluation resulted in maximum water surface elevation increases between 0.06 and 0.29 foot at main door locations. The results of the updated evaluation have been reviewed and the newly installed LIP barriers will protect the plant from the increased water elevation.

Note that the site is modifying the roof parapets for critical buildings to provide load relief during a heavy rainfall event. The roof parapet modification process will evaluate the localized effects of water released through the modified parapets to ensure that critical areas will remain protected during the LIP event.

References

1. AMEC Calculation Package LIP-QDC-001, Rev 4, 2014. *Quad Cities Local Intense Precipitation Evaluation.*

2. Exelon Nuclear (2014). Beyond Design Basis Site-Specific Local Intense Precipitation Analysis (Fukushima) for Exelon's IL Sites, including Quad Cities, Analysis No. QDC-0000-S-2131, Rev. 0.

<u>RAI-9a: Local Intense Precipitation – Modeling of Concrete Security Barriers</u>

<u>Background:</u> In its RAI response, the licensee stated that "the use of the levee feature allowed for modeling of the gaps between the security barriers to accurately represent potential flow paths around and over the structures." Figure 1 shows several openings in the VBS. However, the modeled levee feature does not appear to account for the numerous openings present along the VBS, especially along the East end of the site. Additionally, based on discussions with the licensee, the staff understood that the water does not discharge past the barriers until the water surface exceeds the barrier height at which point water overtops and flows over the barrier, but not around the barrier. Figure 1 shows multiple other VBS features that represent more sizeable openings that were not identified in the FLO-2D model. The lack of VBS openings could create an artificial backwater effect in the model, which could reduce the volume of water conveyed within the VBS and reduce maximum flow depths.

Additionally, staff identified width reduction factors (WRFs) of 0.1914, which were included along the FLO-2D levees (see the green lines surrounding the red levee lines in Figure 2). Based on discussions with licensee, the staff understood that the WRFs are used to account for the actual length of the barrier, as the modeled length within the cells is larger than the actual barrier. However, there is no mechanism to account for flow in the gap areas (~3-4 ft. openings in Figure 1) between the barriers.

Request: The staff requests that the licensee quantify and account for discharge passing through the gaps in the VBS. The example gaps shown in Figure 1 are representative of similar gaps in other sections of the VBS. The staff also requests that the licensee analyze the effect of water flowing through these gaps in the numerical model. These gaps are denoted in green, adjacent to the red VBS, in Figure 2. The licensee response should describe effects associated with discharge passing through the larger, vehicle-sized, gates and the smaller 3-4 foot gaps in the VBS.

Response:

The FLO-2D model was revised to enhance representation of flow through openings in the Vehicle Barrier System (VBS), particularly on the east side of the plant. Field measurements indicate that the width of the openings in the VBS vary between 1 foot and 2 feet each. Due to the size of the grid elements (set at 20 feet by 20 feet to provide sufficient detail while maintaining reasonable computational time), openings in the VBS were represented by creating 20-foot openings to conservatively represent the cumulative effects of multiple 2-foot openings. The openings in the FLO-2D levee feature were placed toward the low point in the FLO-2D grid surface to maximize the cumulative flow at these locations. The ratio of the total number of actual 1 to 2-foot openings to the total number of representative 20-foot openings in the model is just under 5. That is, on average, each 20-foot opening in the model is conservatively representing less than 10 feet of actual openings along the VBS. The FLO-2D model also includes individual openings in the levee feature at personal and vehicle gates. Figure A-15 of Reference 1 shows the locations of representative and individual openings in the FLO-2D levee feature.

The model is intended to accurately characterize conditions near plant structures during a LIP flood. However, the model configuration for the VBS is conservative because the 20-foot openings in the FLO-2D levee feature pass flow at a higher rate than in reality, decreasing storage and attenuation on the east side of the VBS.

The revised calculation uses site-specific Probable Maximum Precipitation (PMP) data for the 1-hour/1-square-mile storm (Reference 2); a change from original input which was obtained from the NWS Hydrometeorological Report (HMR) No. 52.

The updated evaluation resulted in maximum water surface elevation increases between 0.06 and 0.29 foot at main door locations. The results of the updated evaluation have been reviewed and the newly installed LIP barriers will protect the plant from the increased water elevation.

References

1. AMEC Calculation Package LIP-QDC-001, Rev 4, 2014. *Quad Cities Local Intense Precipitation Evaluation.*

2. Exelon Nuclear (2014). Beyond Design Basis Site-Specific Local Intense Precipitation Analysis (Fukushima) for Exelon's IL Sites, including Quad Cities, Analysis No. QDC-0000-S-2131, Rev. 0.

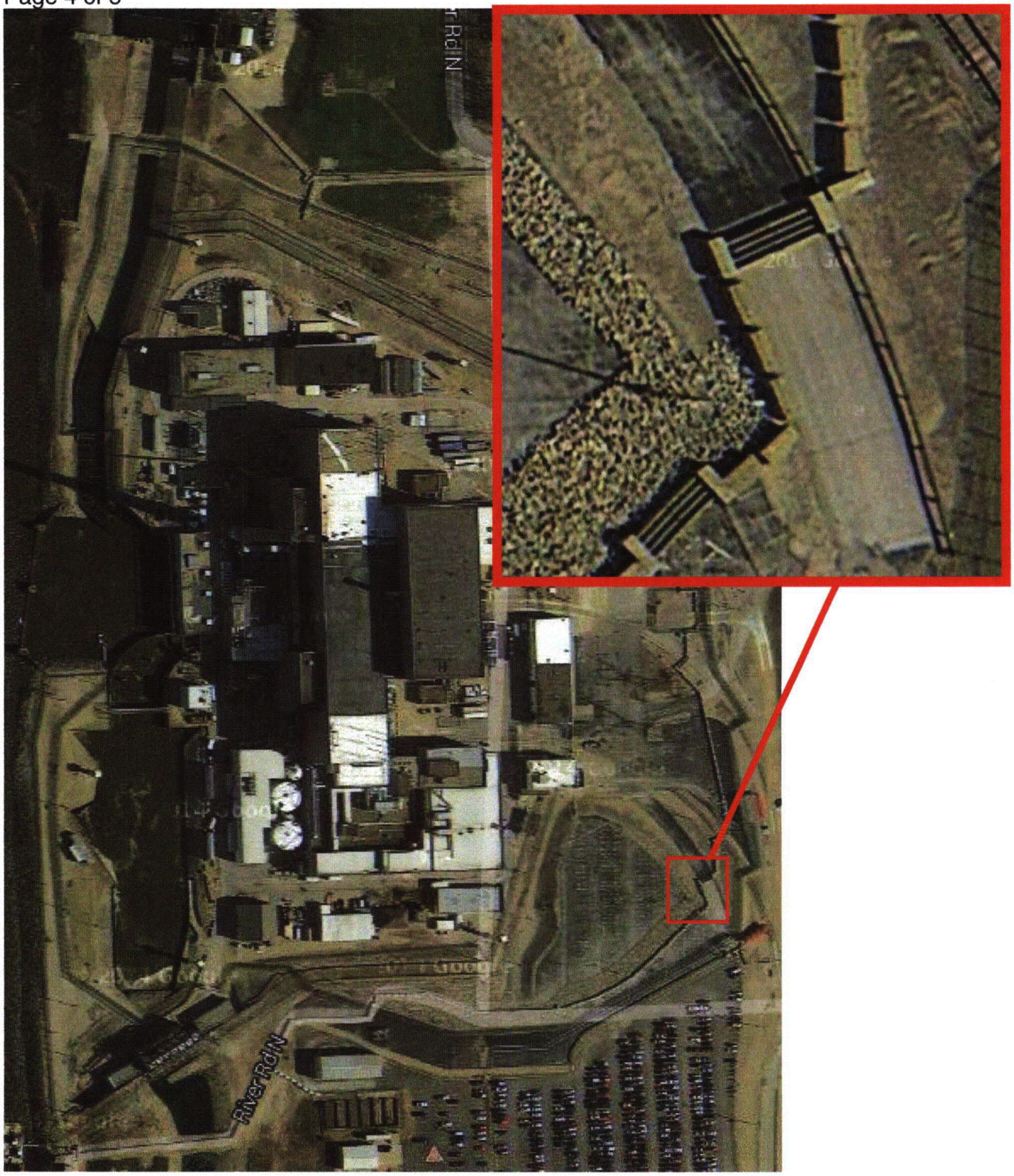

Figure 1 - Image of the Quad Cities site, with an example of the unmodeled VBS openings shown. Additionally, an example of the ~3-4 ft openings can be seen in the top right portion of the zoomed image. (from the NRC's Request for Additional Information)

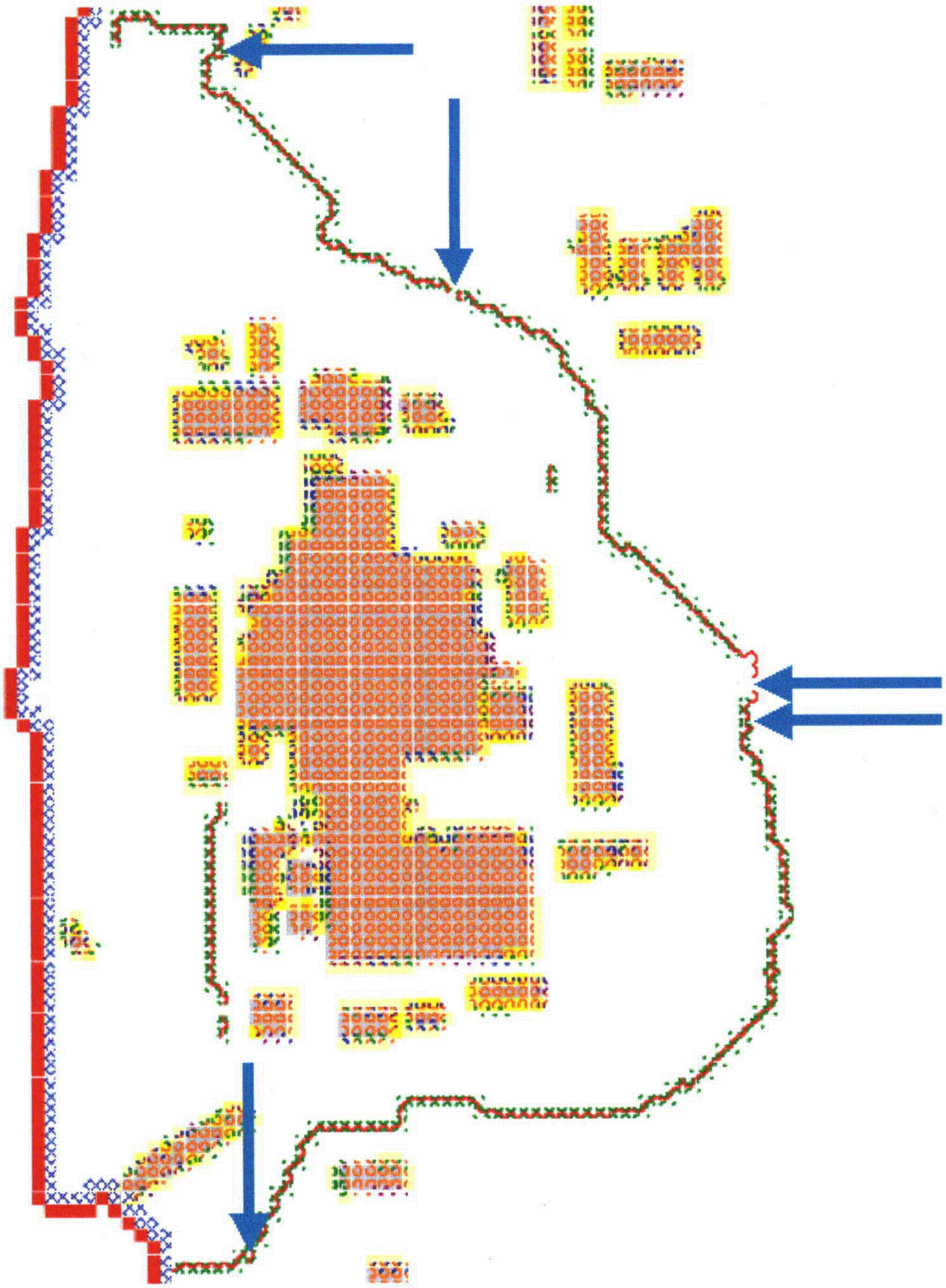

Figure 2 - FLO-2D model including VBS. Blue arrows indicate locations of VBS openings that were identified (from the NRC's Request for Additional Information)

Enclosure 2

Quad Cities Nuclear Power Station, Units 1 and 2

Local Intense Precipitation Evaluation Report

Revision 8

(13 Pages)

LOCAL INTENSE PRECIPITATION EVALUATION REPORT, Rev. 8

for the

QUAD CITIES NUCLEAR POWER STATION 22710 206th Avenue, Cordova, IL 61242

Exelon Generation Company, LLC (Exelon)
P.O. Box 805387
Chicago, Illinois 60680-5387

Prepared by:
AMEC Environment & Infrastructure, Inc.
751 Arbor Way, Suite 180, Blue Bell, PA 19422

Revision 8, Submittal Date: 12/19/2014

	Printed Name	Affiliation	Signature	Date
Originator:	James Barbis	AMEC	james.barbis 2014.12.18 13:55:46 -05'00'	12/18/2014
Verifier:	Matthew Lehrer	AMEC	matthew.lehrer 2014.12.18 14:10:34 -05'00'	12/18/2014
Approver:	Jeffrey Mann	AMEC	jeffrey.mann Digitally signed by jeffrey.mann DN: cn=jeffrey.mann Date: 2014.12.18 16:11:56 -05'00'	12/18/2014
Lead Responsible Engineer:	DUSTIN DAMHOFF	Exelon		1/7/15
Branch Manager	Douglas F Collins	Exelon		01/08/15
Senior Manager Design Engineering:	BRIAN L. STEDMAN	Exelon		1/9/15
Corporate Acceptance:	Joseph V. Bellini	Exelon		1/7/2015

Contents

Figures

Tables

1. List of Acronyms

ASME	American Society of Mechanical Engineers
CLB	Current Licensing Basis
DEM	Digital Elevation Model
ft	Foot
fps	Feet per second
GIS	Geographic Information System
lb	Pound-force
LiDAR	Light Detection and Ranging
LIP	Local Intense Precipitation
NAVD-88	North American Vertical Datum of 1988
NRC	Nuclear Regulatory Commission
PMP	Probable Maximum Precipitation
psf	Pounds per Square Foot
SEP	Systematic Evaluation Program
sq mi	Square Miles
VBS	Vehicle Barrier System
WSE	Water Surface Elevation

2. PURPOSE

a. Background

AMEC Environment & Infrastructure, Inc. (AMEC) on behalf of Exelon Corporation (Exelon) performed an evaluation of site runoff generated from a Local Intense Precipitation (LIP) event to supplement the ongoing flooding studies at Quad Cities Nuclear Power Station (Quad Cities Station). AMEC performed this work under a Quality Assurance (QA) Program that conforms to the requirements of ASME NQA-1 and 10 CFR 50 Appendix B. The LIP evaluation was performed in accordance with the Nuclear Regulatory Commission's (NRC's) "Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America," dated November 2011 (NUREG/CR-7046) (Reference 7).

NUREG/CR-7046 (Reference 7) identifies the LIP under causative mechanisms for design based floods and states that these mechanisms or causes be investigated to estimate the design-basis flood for nuclear power plant sites. Local flooding is associated with inundation caused by localized, short-duration, intense rainfall events. The focus of this study was to evaluate the adequacy of the site's grading, drainage, and runoff carrying capacity. It was conservatively assumed for this analysis that all active and passive drainage system components (e.g., pumps, gravity storm drain systems, small culverts, inlets, etc.) are non-functional during the local intense rainfall event, per Case 3 in NUREG/CR-7046 (Reference 7). As such, only overland flow and open channel systems were modeled and considered in the local flooding analysis.

Per NUREG/CR-7046 (Reference 7), the LIP event is defined as a 1-hour/1-square-mile Probable Maximum Precipitation (PMP). The PMP is the greatest depth of precipitation, for a given duration, that is theoretically possible for a particular area and geographic location (Reference 7). The PMP is derived by transposing and maximizing extreme rainfall events in the region, rather than from a statistical analysis of annual rain gage records. The 1-hour/1-square-mile PMP depth and temporal distribution used in the analysis was based on a beyond design basis site-specific LIP analysis for Exelon's nuclear stations in Illinois (Reference 3).

b. Site Description

Quad Cities Station is located approximately three miles north of the Village of Cordova, Illinois. The plant is located on the Mississippi River at its confluence with Wapsipinicon River at Mile Mark 506.8. The contributing drainage area to the Mississippi River, upstream of the cooling water intake, is approximately 88,000 square miles (Reference 9). There are no structural external flood protection systems in place for Quad Cities Station; it relies almost exclusively on flood emergency procedures to mitigate the effects of the probable maximum flood (PMF) along the Mississippi River (Reference 6).

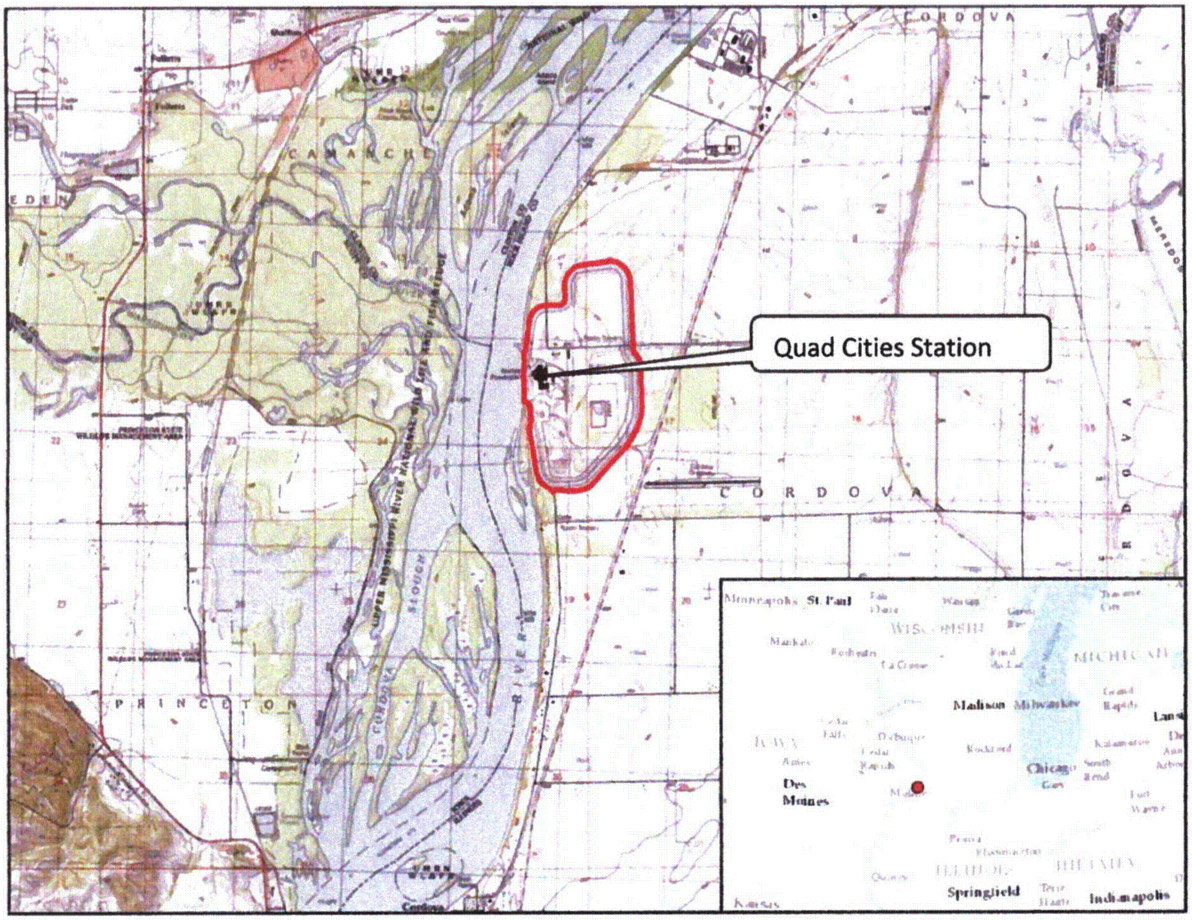

Figure 2-1: Quad Cities Station Location Map (Reference 10)

c. Summary of Current Licensing Basis Flood Hazards

A review of the Quad Cities Station UFSAR (Reference 6), particularly Sections: 2.3, Meteorology; 2.4, Hydrologic Engineering; and 3.4, Water Level (Flood) Design, identified that the LIP flood evaluation is a beyond design basis event, which was not required under the CLB, and therefore LIP has not been previously addressed.

It should be noted that, per Section 3.4 of the UFSAR, there would be adequate time for a safe shutdown of the plant prior to a flood from the Mississippi River reaching the plant grade. If a riverine flood did exceed plant grade, independently powered portable pumping equipment would be deployed, above the projected flood elevation, to supply the make-up water required in the storage pools and reactor vessels due to the evaporative cooling losses.

Topographic relief at the site is low compared to the land surrounding the plant and relatively flat. The site generally slopes to the west toward the Mississippi River. Areas just upslope of the station to the east partially drain through the site to the west and drain toward the manmade channel to the east (Reference 6). The man-made channel (Spray Canal) runs along the north, east, and south sides of the station. The channel intake and outfall are located along the Mississippi River. Berms run along both sides of the manmade channel.

3. METHODOLOGY

a. Modeling Approach

A two-dimensional (2D) hydrodynamic model, FLO-2D, was used to evaluate the flow characteristics of the runoff caused by a LIP event. The model was created with boundaries along the east bank of the Mississippi River and the top of berm along the east bank of the man-made spray channel. The spray canal geometry is included in the FLO-2D model as part of the gridded digital elevation model (DEM) surface based on publically available LiDAR survey data (Reference 1). The LiDAR survey coverage of the spray canal reflects the side slopes and water surface elevation in the canal at the time of the LiDAR survey. The LiDAR survey did not penetrate the water surface in the spray canal to capture bathymetry and, therefore, the spray canal bottom elevation in the DEM is represented by the water surface elevation at the time of the LiDAR survey. This method of depicting the spray canal is conservative since it does not treat the spray canal as a flow element and reflects the NUREG/CR-7046 Case 3 scenario for the LIP analysis (all drainage canals blocked). Figure 3-1 shows the exterior boundary of the FLO-2D model and landmarks referenced in this document.

The FLO-2D model consists of 48,608 grid elements that are each 20-ft by 20-ft in size. The 20-ft by 20-ft grid size was chosen to provide an adequate level of detail to reflect the hydrodynamic effects at the site, while requiring a reasonable amount of computational resources. Smaller grid size would result in a model containing over 60,000 grid elements, which according to Table 1.1 of the FLO-2D Data Input Manual would result in a "slow" model simulation speed (Reference 5).

The FLO-2D model required the following inputs to evaluate LIP:

- Topography to characterize grading, slopes, drainage divides, and low areas of the site;
- Manning's Roughness Coefficients (n-values) to characterize the land cover of the site and its effects on flow depths and velocities; and
- 1-hour site-specific PMP event to characterize the LIP event (volume, distribution, and duration).

The model was run with the above inputs to evaluate the adequacy of the site grading and runoff carrying capacity during the LIP event. The model provides the following outputs:

- Predicted duration of flooding conditions;
- Predicted maximum velocities;

- Predicted maximum resultant static loads; and
- Predicted maximum resultant impact loads.

All active and passive drainage system components (e.g., pumps, roof drains, gravity storm drain systems, small culverts, inlets, etc.) were considered non-functional or blocked during the LIP event, per Case 3 in NUREG/CR-7046 (Reference 7). NUREG/CR-7046 discusses that it is extremely rare that the passive site drainage network would remain completely unblocked during the LIP event. This is a reasonable, yet conservative assumption to consider potential conditions of a storm sewer system during a LIP event, such as buildup of debris, reduced conveyance capacity due to deformation in pipes, or the system being surcharged due to the limited capacity. Additionally, NUREG/CR-7046 requires the utility to provide justification for crediting partial or full conveyance from drainage structures (Reference 7). Conservatively, roof parapets were not represented in the model and runoff from building roofs was conveyed to adjacent ground areas without crediting roof storage or drainage.

The Vehicle Barrier System (VBS) along the east side of the plant has small gaps that varies between 1 and 2 feet wide. Due to the size of the grid elements, gaps in the VBS located along the eastern side of the plant were represented by placing a 20-foot gap (equal to the width of one 20 foot grid element), which conservatively represents the cumulative effects of ten 2-foot gaps. The gaps in the FLO-2D levee representing small openings in the VBS were placed toward the low point in the FLO-2D grid surface elevation along the sections of the VBS containing the small openings in order to maximize the cumulative model flow at these locations. This modeling configuration provides a conservative representation of the 2-foot gaps allowing more flow to pass through the representative 20-ft openings in the FLO-2D model than would through the actual 2-ft openings distributed along the VBS system on the eastern side of the plant.

The LIP evaluation was conducted independently of external high-water events. That is, the LIP event was assumed to have occurred non-coincidental to a river flood. Therefore, backwater or tailwater was not considered.

As shown in Table 3-1, the Quad Cities Station's land cover is predominantly grass and shrubs, which could potentially allow for runoff infiltration losses in these areas. However, NUREG/CR-7046 requires that runoff infiltration losses be ignored to maximize the runoff from the event. While this assumption could possibly produce conservative estimates of calculated water surface elevations, NUREG/CR-7046 does not provide a LIP discussion or scenario where infiltration losses are considered. If infiltration losses are to be considered in a LIP evaluation, NUREG/CR-7046 requires justification (Reference 7). Only overland flow and open channel systems were modeled and considered in the LIP flooding analysis.

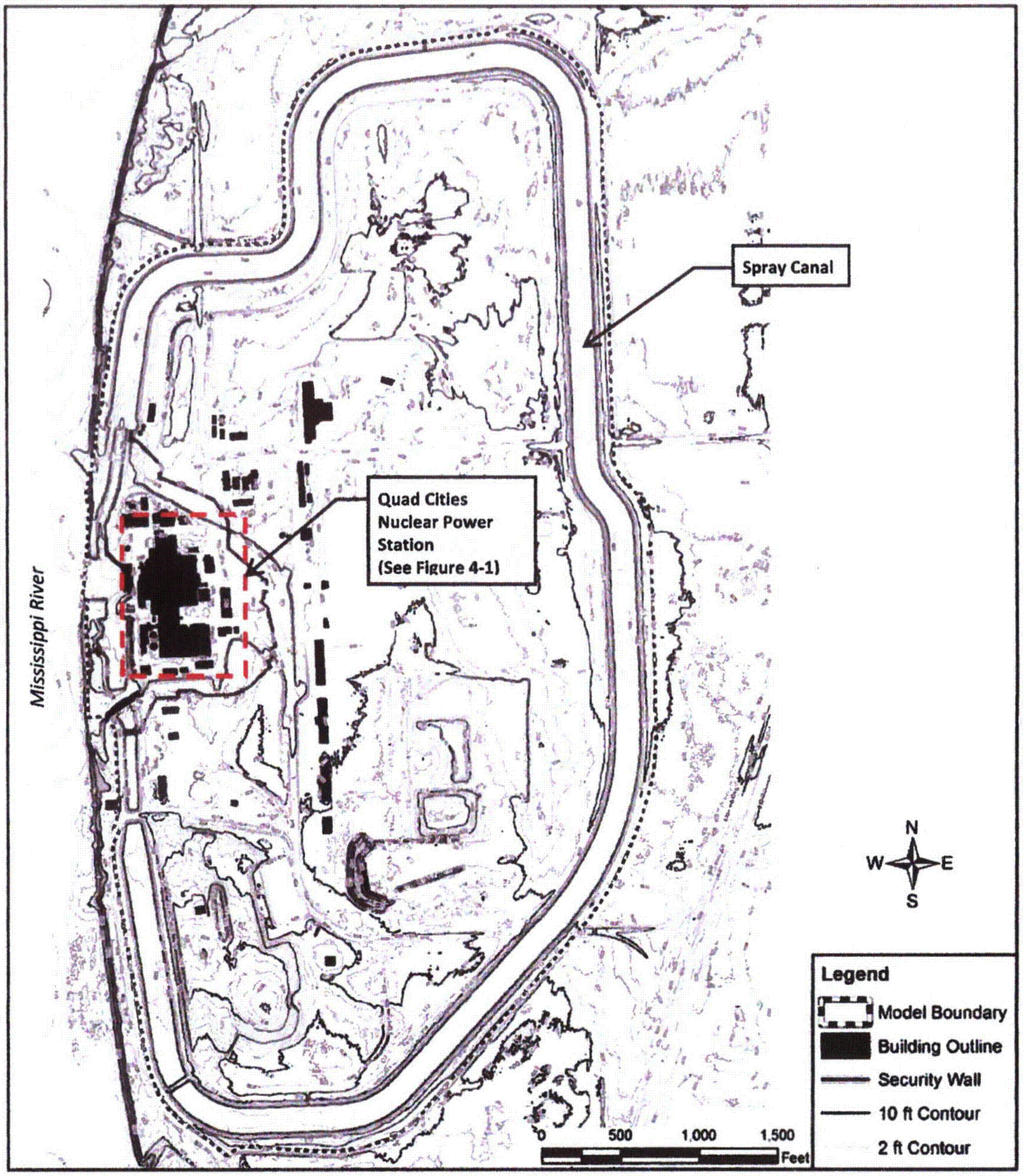

Figure 3-1: FLO-2D Model Boundary

b. Topography

The FLO-2D model was developed using a Digital Elevation Model (DEM) produced from available LiDAR data and supplemental field survey to characterize grading, slopes, drainage divides, and low areas of the site. Site drawings were used to define roof elevations and general slopes for the Reactor and Turbine Buildings (Reference 2).

Publically available LiDAR data was collected in 2009. According to the January 5, 2010 Aero-Metric Vertical Accuracy Assessment Report for Rock Island County, Illinois (Reference 1), the data has a vertical accuracy of ± 6 inches, and was accompanied with digital orthoimagery. AMEC validated the LiDAR data through a commercial grade dedication process under AMEC's 10 CFR 50 Appendix B Quality Assurance Program.

AMEC considered the available LiDAR data sufficient as a baseline for the LIP evaluation. However, supplemental field survey of the site allowed for the incorporation of site features that were not identified by the LiDAR survey. The features included depressions/low points, isolated concrete barriers/blocks, concrete pads, and sill elevations. The field survey was performed in July of 2012 by a Professional Land Surveyor licensed in the State of Illinois.

The supplemental field survey data was incorporated into the LiDAR data using AutoCAD Civil 3D software to produce the DEM. The DEM was clipped to match the FLO-2D model limits shown in Figure 3-1 above.

All LiDAR and survey inputs were provided in North American Vertical Datum of 1988 (NAVD-88) and, therefore, all model result elevations in the LIP evaluation are reported in NAVD-88.

c. Land Cover

The FLO-2D model uses Manning's Roughness Coefficients (n-values) to characterize the site's surface roughness and calculate effects on flow depths and velocities. Land cover for the site was evaluated using interpretation of orthoimagery that was verified in the field by AMEC during subsequent visits to the site to support the surveying and LiDAR validation efforts. Manning's n-values were assigned to each land cover type and were based on ranges described on page 22 of the FLO-2D Reference Manual (Reference 4). The assigned n-values are provided in Table 3-1 below.

Table 3-1: Assigned Manning's Roughness Coefficients (n-values)

Land Cover Surfaces of Quad Cities Station	Recommended Range of n-values	Assigned n-value	% Coverage
Bermuda and dense grass, dense vegetation	0.17 - 0.48	0.32	39
Shrubs and forest litter, pasture	0.30 - 0.40	0.40	26
Asphalt, concrete, buildings	0.02 - 0.05	0.035	14
Gravel	-	0.05	9
Water surface (Primarily due to spray canal)	-	0.02	12

The Manning's n-values for gravel and water land cover surfaces were assigned values from the recommended range for asphalt/concrete to reflect their surface roughness. Gravel was assigned the upper end of the range to consider typical irregularities in the gravel surface. The Manning's n-value for water was assigned the lower end of this range as it was considered a near smooth surface. Shrubs and forest litter were assigned a Manning's n-value at the upper end of the recommended range to reflect the dense brush surface observed on site. The remaining land cover surface categories were assigned the middle of their respective recommended ranges.

A sensitivity analysis was performed on the Manning's n-values to evaluate the effect this parameter has on the maximum water surface elevation. As part of the analysis, the upper and lower ranges of the Manning's n-values presented in Table 3-1 were evaluated. The results indicate that the difference in water surface

elevations between the upper and lower range of the Manning's n-values presented in Table 1 are within ± 0.10 ft.

d. Probable Maximum Precipitation

Per NUREG/CR-7046, the LIP event is defined as a 1-hour/1-square-mile PMP event. The PMP is the greatest depth of precipitation, for a given duration, that is theoretically possible for a particular area and geographic location. The site-specific 1-hour/1-square-mile PMP distribution was based on a site-specific LIP analysis performed for Exelon's nuclear stations in Illinois (Reference 3) and is provided in Table 3-2 and Figure 3-2 below. The 1-hour/1-sq-mi PMP event was run in the FLO-2D model to calculate the subsequent site flooding.

Table 3-2: Site-specific 1-hr/1-sq-mi PMP Distribution

Time	Cumulative Depth	Percent Total PMP
(minutes)	(inches)	(%)
0	0.0	0.0%
5	4.6	33.7%
15	7.2	53.1%
30	10.4	76.2%
60	13.6	100%

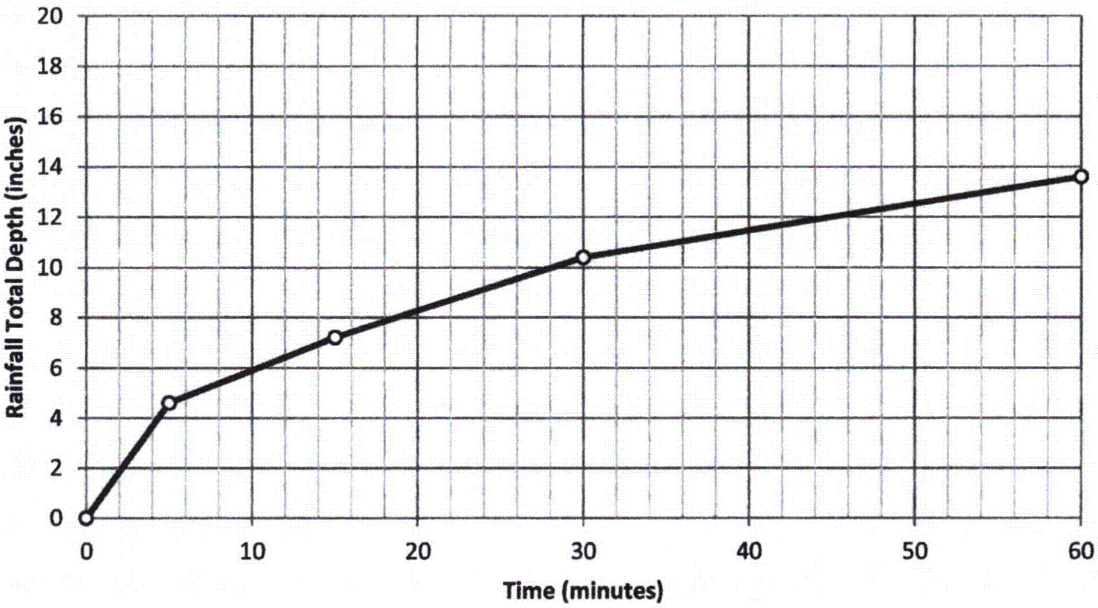

Figure 3-2: Site-specific 1-hr/1-sq-mi PMP Distribution

4. RESULTS

The LIP flooding evaluation, as per the Case 3 assumptions of NUREG/CR-7046, Section 3.2 (Reference 7) predicted the maximum flooding depths, water surface elevation, velocities, predicted resultant static loads, and resultant impact loads that could be expected for an LIP event at the site. The maximum resultant impact load and maximum resultant static load are expressed as pounds per unit width. Multiplying these loads by the horizontal width of the structure within the grid element will provide the magnitude of the resultant force. Detailed calculations, results, and figures are presented in the Quad Cities LIP Evaluation Calculation Package LIP-QDC-001 (Reference 2).

The maximum results of the LIP evaluation are presented in Table 4-1. Results provided in this report are direct outputs from the FLO-2D model. The FLO-2D model reports results to the hundredth of a foot. However, based on the sensitivity analysis of grid size and Manning's n-values, an accuracy of ± 0.1 foot should be taken into consideration when evaluating the reported results.

Table 4-1: LIP Predicted Flooding Results

Building Name[1]	Max. Water Surface	Max. Flooding Depth[2]	Max. Velocity	Max. Resultant Impact Load	Max. Resultant Static Load
	ft (NAVD-88)	ft	ft/sec.	lb/ft	lb/ft
OGFB	594.95 - 595.62	0.83 - 2.03	0.66 - 3.66	0.92 - 46.81	21.50 - 128.23
Fab Shop	595.60 - 596.07	1.42 - 1.95	0.56 - 3.21	0.92 - 37.81	62.55 - 118.87
Outage Support Building	594.49 - 596.06	0.28 - 2.18	0.62 - 3.79	0.27 - 76.54	2.51 - 147.99
IRSF	595.97 - 597.15	1.78 - 3.70	0.68 - 6.40	1.04 - 257.63	99.05 - 428.27
IDNS	594.95 - 595.61	0.79 - 1.94	1.35 - 3.53	3.74 - 48.96	19.49 - 117.66
Cribhouse	576.03 – 595.48	0.36 - 2.57	0.52 – 7.32	0.45 – 86.06	4.06 - 205.65
Chimney House	595.38 - 595.58	0.82 - 2.30	0.66 - 2.47	1.89 - 31.88	20.83 - 164.46
Radwaste	593.79 - 595.35	0.38 - 2.11	1.27 - 4.59	5.69 - 50.71	4.55 - 139.35
Boiler House	594.15 - 595.05	0.61 - 0.77	0.82 - 2.55	1.06 - 10.35	11.52 - 18.35
Turbine Building	594.47 - 597.68	0.14 - 3.57	0.31 - 6.69	0.03 - 279.67	0.61 - 396.69
U-2 HRSS	597.27 - 597.49	3.01 - 3.61	0.95 - 2.41	1.69 - 46.79	282.70 - 405.63
Design Engineering Building	597.45 - 597.75	2.92 - 3.44	0.93 - 2.75	3.29 - 61.13	265.15 - 369.50
Reactor Building	597.28 - 597.71	2.76 - 4.06	0.34 - 2.38	0.27 - 40.70	238.18 - 513.30
SBO	597.66 - 597.71	2.96 - 4.06	0.38 - 1.11	0.24 - 3.30	273.54 - 513.30
Admin.	597.65 - 597.92	2.60- 6.09	0.40 - 2.65	0.09 - 50.85	211.19 – 1158.93
U-1 HRSS	597.65 - 597.66	2.96 - 3.87	0.34 - 0.90	0.12 - 1.85	273.54 - 467.87
FL Drain Surge Tank	593.69 - 594.40	0.06 - 0.77	0.67 - 2.89	0.06 - 5.44	0.11 - 18.35
LTD BLDG.	594.63 - 595.70	0.14 - 2.74	0.26 - 3.71	0.02 - 59.96	0.62 - 233.83
Service Building	595.70 - 597.66	1.05 - 3.58	0.43 - 5.08	0.16 - 175.68	34.31 - 399.41
Security Building	597.46 - 597.90	2.62 - 3.63	0.53 - 3.96	1.26 - 128.5	214.00 - 410.25
Weld Shop	592.17 - 595.78	0.20 - 1.80	0.91 - 4.97	0.71 - 55.37	1.26 - 100.65
Mausoleum	595.85 - 596.53	0.92 - 1.80	1.01 - 2.53	1.27 - 25.75	26.27 - 100.93
TSC	596.43 - 597.29	2.06 - 3.58	1.09 - 5.08	6.86 - 175.68	132.38 - 399.41

[1] Figure 4-1
[2]Max Flooding Depth is based on the ground surface, which varies in elevation depending on location.

The maximum predicted LIP flooding results are also provided at the critical entrances to the site buildings. Table 4-2 provides detailed LIP flooding results at main building doors.

Table 4-2: LIP Predicted Flooding Results at the Main Doors and Bays of the Site Buildings

Door/Building	Reference Grid Element No.	Max. Water Surface	Max. Flooding Depth[1]	Max. Velocity	Max. Resultant Impact Load	Max. Resultant Static Load
		ft (NAVD-88)	ft	ft/sec	lb/ft	lb/ft
Door 1 Reactor Building	8129	597.69	3.27	0.72	3.43	334.21
Door 2 Reactor Building	5649	597.28	3.28	0.58	0.73	336.18
Door 3 Turbine Building	5384	597.19	2.91	2.62	47.93	263.67
Door 4 Turbine Building	3527	595.81	1.96	2.02	19.43	120.19
Door 5 Reactor Building	7573	597.65	3.20	1.50	14.78	320.44
Door 6 Turbine Building	5628	597.66	3.06	0.75	0.70	291.24
Door 7 Reactor Building	5905	597.66	3.32	0.81	1.62	344.93

[1] Max Flooding Depth is based on the ground surface, which varies in elevation depending on location.

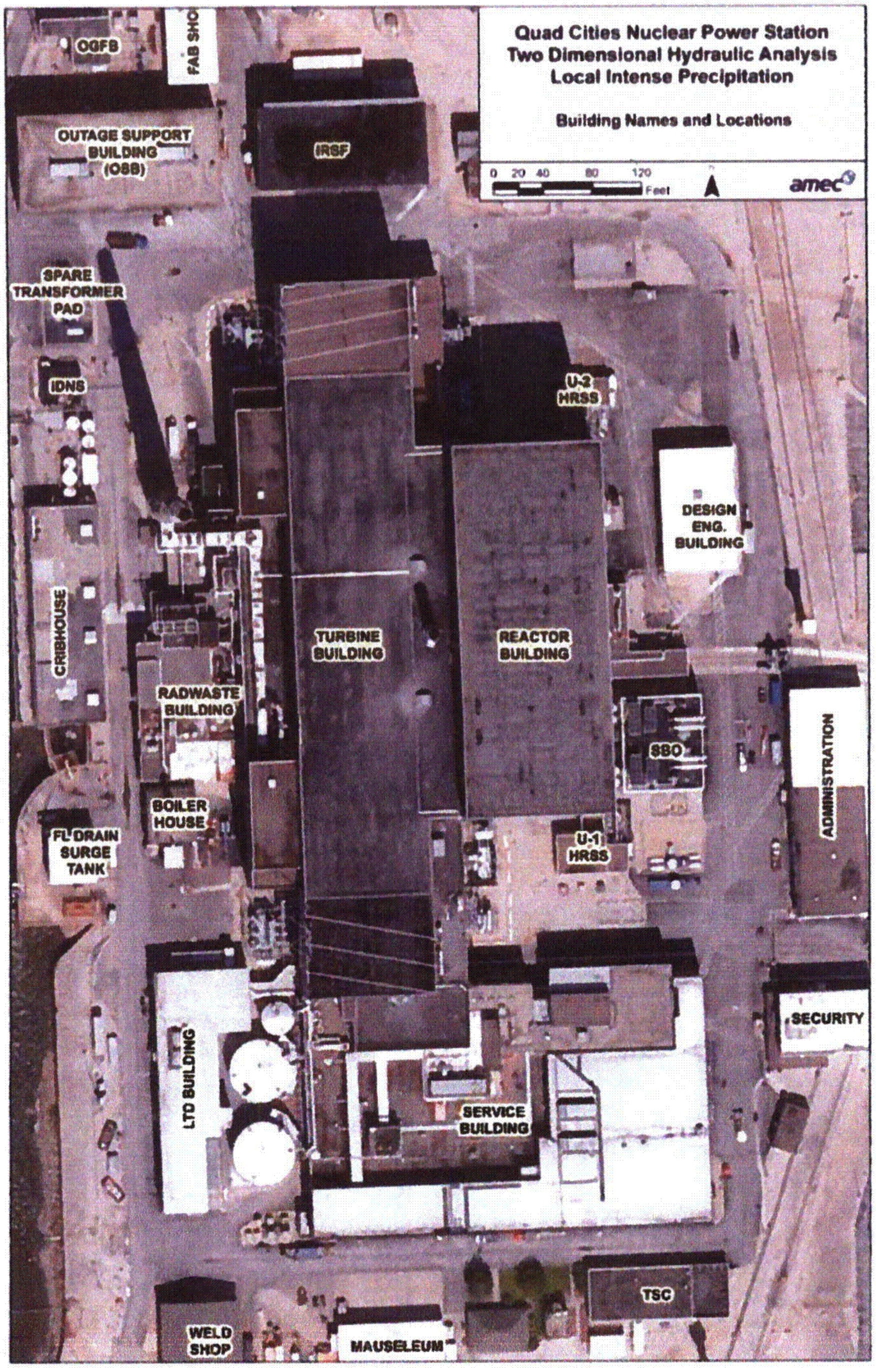

Figure 4-1: Building Names and Locations

5. CONCLUSIONS

The Quad Cities Station CLB does not address a LIP flood, and although it is a beyond design basis event, additional interim actions have been evaluated to mitigate risk to the site from a LIP event.

The results of the analysis show that the predicted maximum LIP flooding water surface elevations at the main doors and bays of the site buildings range between 595.81 feet NAVD-88 to 597.69 feet NAVD-88. However, based on the performed sensitivity analysis of grid size and Manning's n-values, an accuracy of ± 0.1 foot should be taken into consideration when evaluating the reported results.

6. REFERENCES

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Enclosure 3

Quad Cities Nuclear Power Station, Units 1 and 2

DVD labeled: Quad Cities Nuclear Power Station, Units 1 and 2

Enclosure 3 of RS-15-001, FLO-2D Model Input and Output Files

Revision 1