WOLF CREEK
NUCLEAR OPERATING CORPORATION

February 23, 2016

Jaime H. McCoy
Vice President Engineering

ET 16-0009

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

References:
1) Letter dated March 12, 2012, from E. J. Leeds and M. R. Johnson, USNRC, to M. W. Sunseri, WCNOC, "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"
2) Letter ET 14-0012, dated March 10, 2014, from J. P. Broschak, WCNOC, to USNRC
3) Letter ET 15-0012, dated May 20, 2015, from J. H. McCoy, WCNOC, to USNRC
4) Electronic Mail dated December 10, 2015, from A. J. Minarik, USNRC, to N. R. Good, WCNOC

Subject: Docket No. 50-482: Response to Request for Additional Information Regarding Flood Hazard Reevaluation Report, Revision 1

Gentlemen:

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued Reference 1 to Wolf Creek Nuclear Operating Corporation (WCNOC). Enclosure 2 of Reference 1 contains specific Requested Actions, Requested Information, and Required Responses associated with Near-Term Task Force Recommendation 2.1, Flooding. The enclosure to Reference 2 provided the WCNOC Flood Hazard Reevaluation Report (FHRR), Revision 0.

Due to significant changes occurring to the site, the FHRR was revised. Reference 3 provided the FHRR, Revision 1. Reference 4 provided a NRC request for additional information related to the FHRR, Revision 1.

A010
NRR

Responses to Reference 4 were provided during a teleconference on December 16, 2016, with A. J. Minarik, USNRC. The attachment to this letter provides written documentation of the verbal responses provided during the discussion on December 16, 2016. The enclosure to this letter provides copies of the native files requested in Reference 4.

This letter contains no commitments. If you have any questions concerning this matter, please contact me at (620) 364-4156, or Cynthia R. Hafenstine (620) 364-4204.

Sincerely,

Jaime H. McCoy

JHM/rlt

Attachment

Enclosure

cc: M. L. Dapas (NRC), w/a, w/e
C. F. Lyon (NRC), w/a, w/e
A. J. Minarik (NRC), w/a, w/e
N. H. Taylor (NRC), w/a, w/e
Senior Resident Inspector (NRC), w/a, w/e

STATE OF KANSAS)
) SS
COUNTY OF COFFEY)

Jaime H. McCoy, of lawful age, being first duly sworn upon oath says that he is Vice President Engineering of Wolf Creek Nuclear Operating Corporation; that he has read the foregoing document and knows the contents thereof; that he has executed the same for and on behalf of said Corporation with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By Jaime H McCoy
Jaime H. McCoy
Vice President Engineering

SUBSCRIBED and sworn to before me this 23rd day of Feb., 2016.

GAYLE SHEPHEARD
My Appointment Expires
July 24, 2019

STATE OF KANSAS NOTARY PUBLIC

Gayle Shepheard
Notary Public

Expiration Date 7/24/2019

Wolf Creek Nuclear Operating Corporation (WCNOC)
RIZZO Input for Responses to NRC's Request for Additional Information / Information Needs dated December 10, 2015

The enclosure of Reference 1 provided the Wolf Creek Nuclear Operating Corporation (WCNOC) Flood Hazard Reevaluation Report (FHRR), Revision (Rev.) 0. Significant changes occurred to the site since the time of the preparation and review of the initial FHRR. Enclosure I of Reference 2 was an update and provided the FHRR, Rev. 1. Reference 3 provided a Nuclear Regulatory Commission (NRC) request for additional information (RAI) regarding the WCNOC FHRR. Provided below are the responses to the questions in the NRC RAI. The specific NRC request is provided in italics.

QUESTION 5 FROM ORIGINAL RAI:

Background: The WCGS FHRR stated that the vehicle barrier system (VBS) used in the reevaluation analysis used the configuration from February 2013 and that changes to site layout had occurred since. Changes in configuration of the VBS could affect the flood analysis. On October 27, 2015, WCNOC submitted a revised FHRR that described several changes to the site layout and how they were incorporated into the LIP flood analysis (FLO-2D model). Changes in the revised FLO-2D analysis include changes in Vehicle Barrier System (VBS) configuration; change in roof configuration to include a 2-in. nailing strip around the edge of certain buildings; changes in roof elevations to allow overflow from one roof to another; addition of new buildings, trailers, and Sea-Vans; and changes in elevation from regrading the ESWS intake area and an area adjacent to the Control Building. These revisions were adequately described in the FHRR and during the November 10, 2015 audit. However, WCNOC's May 20, 2015 response to RAI-5 is now outdated, and several elements of the revised LIP calculation are needed to support the staff's review.

Original Request: Please describe any changes to the VBS since February 2013. Also, provide a technical description of the process followed to incorporate these changes in the LIP flood analysis. Caution: treat appropriately any security-related information in your response.

Revised Request: *Provide an updated response to RAI-5 that describes the changes in the site layout and LIP flood analysis as presented in the revised FHRR. Please provide the FLO-2D model input and output files for the revised LIP analysis, as well as publication-quality files (≥300 dpi, jpg or png format) of Figures 2-1 and 2-2 from Calculation No. 14-5262-F-02. Caution: treat appropriately any security-related information in your response. Please include the following items in the description:*

- *changes in the FLO-2D grid cell size (if any)*
- *differences in elevation in regraded areas*
- *relative elevations of buildings in the powerblock area that allow overflow from one roof to another*
- *whether there are potential gaps within the nailer strips along certain roof edges, and whether any walkdown was conducted to verify the condition of the nailer strips*
- *differences in predicted water-surface elevations in the regraded areas and their effects on safety-related SSCs.*
- *Changes in the VBS.*

Response: FLO-2D input and output files for the revised LIP analysis were provided to the NRC previously (ML16042A211). The requested publication-quality files of Figures 2-1 and 2-2 from Calculation No. 14-5262-F-02 are provided on the enclosed CD-ROM.

- *Changes in the FLO-2D grid cell size (if any)* – The FLO-2D grid cell size in the updated model is 15 feet (ft) by 15 ft, which is the same grid size used for the more refined simulations reported in the enclosure of Reference 1.

- *Differences in elevation in regraded areas* – Additional topographic data was collected by WCNOC in two areas of the plant where regrading occurred subsequent to the LIP analysis performed for the enclosure of Reference 1. These areas are illustrated in Figure 2-2 of enclosure I of Reference 2, and summarized as follows:

  - West of the Control Building: the topography adjacent (to the west) of the Control Building was raised by 6 inches to 1 foot in some areas with the largest increase immediately adjacent to the Control Building and a gentle slope of approximately 1-percent directed away from the building.

  - Near the Emergency Service Water System (ESWS) Pumphouse: The topography in this area was disrupted during construction activities. Localized changes in elevation are up to ±1 foot or more in a few places, but the overall slope and drainage patterns were not changed by the regrading.

- *Relative elevations of buildings in the powerblock area that allow overflow from one roof to another* – The grid cells used to represent the roofs of buildings in the powerblock were not raised to the full height of the buildings (to avoid potential model instabilities). Rather, these cells were assigned nominal elevations of approximately 2 ft higher than the surrounding grade. This ensures that the natural course of drainage is enforced (i.e., no water flows onto a building roof from the surrounding grade). Plant drawings were consulted to determine the relative elevations of adjacent buildings, and the roofs of higher buildings were raised higher (e.g., 6 inches higher) than the roofs of lower buildings. This serves as a simple way of directing roof drainage.

- *Whether there are potential gaps within the nailer strips along certain roof edges, and whether any walkdown was conducted to verify the condition of the nailer strips* – The nailer strips as designed and installed do not have any gaps, and are well secured. Engineering walked down the roofs of the Control Building, portions of the Communications Corridor, Diesel, and Auxiliary Buildings to check the nailer strips and found no issues. Buildings in the structural monitoring program are formally inspected, including the roofs, once every 5 years. The building roofs within the power block are also periodically walked down for other purposes. Currently, a nailer strip on the Rad Waste Building has been identified as damaged and will be reworked under Work Order 14-392486-000.

- *Differences in predicted water-surface elevations in the regraded areas and their effects on safety-related SSCs* – The effect of the regraded areas on local water levels can be summarized as follows:

- Near the Control Building: The regraded area near the Control Building caused a localized increase in water levels. For example, the ground elevation adjacent to the Control Building Pressure Door (Door No. 7 of FHRR Rev. 1 Table 3-2) increased by approximately 6 inches due to the regrading. This resulted in a 2 inch increase in the maximum water surface elevation at this location. The regrading also appears to cause a slight increase (approximately 0.03 ft) in water levels at the Communication Corridor doors to the north of this area.

- Near the ESWS Pumphouse: The regraded area near the ESWS Pumphouse caused an increase in water levels at the ESWS Pumphouse Marine Pressure Doors. However, the water levels remain more than 2 inches below the door thresholds. The topographic changes also caused an increase in water level at the ESWS Manholes MHE5A and MHE5B (Items 15 and 16 in FHRR Rev. 1 Table 3-3) of approximately 2 inches.

- Changes in the VBS – This bulleted topic was not included on the RAI sent to WCNOC by the NRC, it was added to the RAI response by WCNOC. This topic was part of the RAI discussion on December 16, 2015 between the NRC and WCNOC. Changes to the Vehicle Barrier System (VBS) subsequent to the Local Intense Precipitation (LIP) analysis performed for the FHRR, Rev. 0 are documented in Reference 4, and incorporated in the LIP analysis performed for the FHRR, Rev. 1.

QUESTION 6 FROM ORIGINAL RAI:

Background: The WGGS FHRR did not describe how precipitation runoff from building roofs was configured in the FLO-2D model. The NRC staff's review of the licensee's calculation packages in the e-documents library provided some FLO-2D model implementation details. The staff confirmed that the licensee's FLO-2D model files are consistent with the description in the calculation packages. The staff noted that American National Standards Institute/American Nuclear Society (ANSI/ANS)-2.8-1992, Section 11.4 recommends that building runoff used in the LIP flood assessment allow evaluation of worst-case roof drainage. This evaluation includes analysis of alternative points of roof drainage to maximize flood elevation adjacent to points of access and egress at safety- related structures, systems, and components. The revised FHRR describes several changes to how runoff from building roofs was configured in the FLO-2D model.

Original Request: Please describe how drainage from facility roofs as represented in FLO-2D analyses is consistent with the recommendations of ANSI/ANS-2.8-1992, Section 11.4.

Revised Request: *Provide an updated response to RAI-6 that addresses the revisions to the LIP analysis.*

Response: The following text supersedes the original response to RAI 6 with updates to reflect the LIP analysis performed for the FHRR, Rev. 1. Note that the overall content and conclusion of the response to RAI 6 remain unchanged from the original response.

To evaluate worst-case roof drainage effects, American National Standards Institute/American Nuclear Society (ANSI/ANS)-2.8-1992, Section 11.4 requires consideration of the following:

"Roof drainage contributions to the surface runoff during the PMP event shall be evaluated to determine the worst case for site surface drainage effects. Blockage of roof drains and the resulting release of flow from the roof at alternative points shall be evaluated."

In accordance with this guidance, it was assumed that all roof drainage systems were blocked (i.e., flow through downspouts was not credited), as documented in Section 3.3.1.2 of the FHRR, Rev. 1.

By blocking the roof drainage systems, water is forced to discharge to the surrounding ground at "alternative points" (i.e., discharging over the edges of the buildings). The FLO-2D model was developed with consideration for the Wolf Creek Generating Station (WCGS) roof configurations, which do not include parapet walls or scuppers. The safety-related buildings in the powerblock have two-inch high nailing strips (nailers) along the roof perimeters. The nailers provide a storage volume on the roof, which was credited in the FLO-2D analysis for the FHRR, Rev. 1. In addition to the storage volume introduced by the nailing strips, there is some storage volume on the roof due to the grading of the roof with slopes toward roof drain locations (generally away from roof edges). This additional storage volume was not credited, which is a conservative approach, because this volume could attenuate peak discharges.

In summary, the roof drainage analysis for the FHRR, Rev. 1 meets the requirements of ANSI/ANS-2.8-1992 Section 11.4, because it simulates the discharge of water from "alternate roof locations" (i.e., assuming that the roof drainage systems are blocked). The FLO-2D analysis for the FHRR, Rev. 1 does take credit for some of the storage capacity of the roof that is created by the installed roof configuration (i.e., the nailing strips); however, this refined modeling approach still meets the guidance set forth in Section 11.4 of ANSI/ANS-2.8-1992.

QUESTION 7 FROM ORIGINAL RAI:

Background: The values of Manning's roughness coefficients chosen to represent surface characteristics can significantly affect flow depths. The licensee used the lower end of the range of Manning's roughness coefficient values in the FLO-2D analyses. The revised FHRR describes changes in land use associated with changes in the site layout. For example, several grassy areas were converted to gravel, which would have a different range of Manning's roughness coefficient values.

Original Request: Please provide justification for choosing Manning's roughness coefficient values at the lower end of the range which can result in lower flood water surface elevations

Revised Request: *Provide an updated response to RAI-7 that describes any change to the selection of Manning's roughness coefficient values related to the land use changes described in the revised FHRR. Provide a publication quality file (≥300 dpi, jpg or png format) of Figure 4-1 from Calculation No. 14-5262-F-02.*

Response: The Manning's roughness coefficients assigned to each land use category were the same for both revisions of the FHRR. The land use map was updated for the revised FLO-2D analysis used as input to the FHRR, Rev. 1 to reflect changes to the site configuration, and roughness coefficients in the model were updated to reflect the new land use map. A high-resolution version of the updated land use map (Figure 4-1 of Calculation 14-5262 F-02) is provided in its native file format on the CD-ROM enclosed.

Since the Manning's roughness coefficients assigned to each land use category were not changed, the discussion in the original response to RAI 7 (Reference 4) remains valid and sufficient for justifying the coefficients chosen. The text of the previous RAI response will not be repeated here. Note, however, that the last paragraph of the original RAI response (Reference 4) is no longer applicable for the FHRR, Rev. 1. The new Case 7 in the FHRR, Rev. 1 supersedes both Cases 5 and 6, which were used together for identifying potentially affected plant entrances in the FHRR, Rev. 0.

QUESTION 8 FROM ORIGINAL RAI:

Background: The infiltration rates used during a precipitation event can significantly reduce the amount of runoff and therefore result in reduced flow depths. The FHRR used the Soil Conservation Service (SGS) Curve Number method to estimate infiltration losses for the FLO-2D analyses. The revised FHRR describes changes in land use associated with changes in the site layout. For example, several grassy areas were converted to gravel, which could have an effect on infiltration losses.

Original Request: Please provide a justification for accounting for infiltration losses during a high-intensity, extreme storm.

Revised Request: *Provide an updated response to RAI-8 that describes any change to the selection of infiltration loss rates related to the land use changes described in the revised FHRR.*

Response: The approach for characterizing infiltration losses was the same for the FLO-2D analyses for both revisions of the FHRR. The infiltration parameters assigned were updated only as necessary for the FHRR, Rev. 1 based on changes to the site land use map (refer to the above response to Question 7). Apart from the land use map, the text of the previous RAI response is still valid; refer to the original RAI responses for this discussion.

QUESTION 9 FROM ORIGINAL RAI:

Background: The WCGS FHRR did not provide the locations of openings and penetrations for safety-related buildings and other plant components listed in FHRR Tables 3-1, 3-2, and 3-3. Because flow depths during the LIP event vary across the site, this information is needed to determine whether the reevaluated flood is bounded by the current design basis (CDB) at these locations. Since the LIP analysis was updated in the revised FHRR, the reevaluated flow depths have changed, and the original response to RAI-9 is outdated.

Original Request: Please provide FLO-2D model grid cell identifications from which the model results were extracted and processed to produce Tables 3-1, 3-2, and 3-3 in the FHRR.

Revised Request: *Please provide an updated response to RAI-9 that includes Tables 7-1 and 7-2 from Calculation No. 14-5262-F-02, with additional columns for structure description and grid cell number. For locations that have multiple grid cells associated with them (e.g., item numbers 30-36 in Table 7-2 of Calculation No. 14-5262-F-02), provide all grid cell numbers associated with the location. Provide a publication-quality file (≥300 dpi, jpg or png format) of Figure 4-3 from Calculation No. 14-5262-F-02.*

Response: The following text and tables supersede the previous response to RAI 9.

The requested tables are included below. Note that Table 1 provides updated grid cell numbers for the peak water levels along building walls. Some of these grid cells have changed due to the model updates. All information included in these tables was obtained from Calculation 14-5262 F-02. All elevations reported in these tables and elsewhere in these RAI responses are with reference to Mean Sea Level (MSL) unless otherwise noted.

A high-resolution version of Figure 4-3 of Calculation 14-5262 F-02 is attached in its native file format on the enclosed CD-ROM.

TABLE 1: FLO-2D GRID CELL NUMBERS FOR FHRR, REV. 1 TABLE 3-1
(Extracted from RIZZO Calculation 14-5262 F-02 Table 7-3)

Building	FLO-2D Grid Cell Number
Auxiliary Building	11642
Communications Corridor	10624
Condensate Storage Tank	12239
Control Building	9109
Demineralized Water Storage Tank	12390
Diesel Generator Building	9844
Fuel Building	10736
Hot Machine Shop	10736
Radwaste Building	9083
Reactor Building	11642
Reactor Make-up Water Storage Tank	9837
Refueling Water Storage Tank	10583
Turbine Building	12107

TABLE 2: FLO-2D RESULTS – DOORS TO SEISMIC CATEGORY I BUILDINGS AT ELEVATION 1,100FT[a]
(Expanded Version of RIZZO Calculation 14-5262 F-02 Table 7-1)

Door[b]	Structure Description	Ground Elevation[c] (ft)	FLO-2D Grid Cell Elevation (ft)	FLO-2D Grid Cell Number	Threshold Elevation (ft)	Maximum Flood Elevation[d] (ft)	Maximum Depth (ft)	Duration of Inundation[e] (hr)	Maximum Velocity (ft/s)	Maximum Hydrostatic Force (lb/ft)	Maximum Hydrodynamic Force (lb/ft)
1	Auxiliary Building Door (Pressure Door/Alcove Door)	1,099.33	1,099.34	10736	1,100.00	1,100.35	1.01	0.5	1.2	32	3
2	Auxiliary Building Door (Missile Door)	1,099.40	1,099.44	9991	1,100.00	1,099.96	0.52	<0.05	1.5	8	3
3	Auxiliary Building Door (Pressure Door/Alcove Door)	1,099.44	1,099.43	9844	1,100.00	1,100.03	0.60	0.2	2.6	11	10
4	Communication Corridor (Double Door/Hollow Core Door)	1,098.98	1,099.16	9413	1,100.00	1,100.05	0.89	1.0	0.7	25	1
5	Communication Corridor (Roll Up Door)	1,099.34	1,099.28	9860	1,100.00	1,100.07	0.79	0.7	0.7	19	1
6	Communication Corridor (Hollow Core Door)	1,099.30	1,099.23	10158	1,100.00	1,100.08	0.85	0.9	0.9	22	1
7	Control Building (Pressure Door/Alcove Door)	1,099.60	1,099.68	9106	1,100.00	1,100.04	0.36	0.0	1.8	4	3
8	Diesel Generator Building (Missile Door)	1,099.35	1,099.33	9397	1,100.00	1,099.90	0.57	0.1	2.8	10	10
9	Diesel Generator Building (Missile Door)	1,099.17	1,099.31	9695	1,100.00	1,099.95	0.64	0.5	1.6	13	4
10	Fuel Building (Hollow Core Door)	1,099.07	1,099.11	11027	1,100.00	1,099.81	0.70	1.0	1.7	15	5
11	Fuel Building (Hollow Core Door)	1,099.36	1,099.36	11773	1,100.00	1,099.86	0.50	0.1	1.2	8	2
12	Fuel Building (Roll Up Door)	1,099.58	1,099.64	11774	1,100.00	1,100.05	0.41	0.0	0.9	5	1
13	Hot Machine Shop (Hollow Core Door)	1,099.30	1,099.27	10734	1,100.00	1,100.18	0.91	0.6	2.3	26	11
14	Hot Machine Shop (Hollow Core Door)	1,099.29	1,099.31	9989	1,100.00	1,099.92	0.61	0.4	0.9	12	1
15	Hot Machine Shop (Roll Up Door)	1,099.32	1,099.33	9990	1,100.00	1,099.94	0.61	0.1	1.2	12	2
16	Stair T-2 (Hollow Core Door)	1,099.35	1,099.39	10311	1,100.00	1,100.09	0.70	0.5	1.0	15	1
17	Stair T-3 (Hollow Core Door)	1,099.35	1,099.38	10318	1,100.00	1,100.10	0.72	0.5	1.0	16	1

NOTES:
[a] Not including the ESWS Pumphouse and miscellaneous yard buildings, which are included in Table 3, below.
[b] Door numbers correspond to the numbering in RIZZO Calculation 14-5262 F-02 Figure 4-2.
[c] Topographic elevations are nominal values taken near each door. These values are similar to (but not identically equal to) the associated FLO-2D grid cell elevations. Thus, adding the "Ground Elevation" to the "Maximum Depth" may result in a value slightly different than the "Maximum Flood Elevation". These differences are due to the topographic averaging within the model.
[d] Grayed values indicate a potential flooding hazard (i.e., the flood elevation is greater than the inlet elevation for the associated door).
[e] Duration of flooding is calculated based on the threshold depth parameter (DEPTHDUR), which is specified in the *CONT.DAT* file. A DEPTHDUR value of 0.5 ft is used for this analysis (i.e., the nominal difference between the plant grade elevation of 1,099.5 ft and the plant floor elevation of 1,100.0 ft). The time-history figures in Appendix B of RIZZO Calculation 14-5262 F-02 can be used to determine the duration of inundation with respect to other threshold levels.

TABLE 3: FLO-2D RESULTS – OTHER POTENTIAL FLOODING PATHWAYS TO SAFETY-RELATED SSCs
(Expanded Version of RIZZO Calculation 14-5262 F-02 Table 7-2)

Item[a]	Structure Description	Topographic Elevation[b] (ft)	FLO-2D Grid Cell Elevation (ft)	FLO-2D Grid Cell Number(s)	Threshold Elevation (ft)	Maximum Flood Elevation[c] (ft)	Maximum Depth (ft)	Duration of Inundation[d] (hr)	Maximum Velocity (ft/s)	Maximum Hydrostatic Force (lb/ft)	Maximum Hydrodynamic Force (lb/ft)
1	Condensate Storage Tank Pipe House Door (91011)	1,099.31	1,099.31	12239	1,100.00	1,100.37	1.06	1.8	1.0	35	1
2	Emergency Fuel Oil Tanks and Access Vaults (Z055)	1,099.51	1,099.47	9392	1,099.75	1,099.78	0.31	0.0	0.5	3	<1
7	ESWS Manhole MHE1A	1,099.53	1,099.45	8512	1,099.50	1,099.92	0.47	0.0	0.5	7	<1
8	ESWS Manhole MHE1B	1,099.57	1,099.58	8661	1,099.50	1,099.93	0.35	0.0	0.5	4	<1
9	ESWS Manhole MHE2A	1,097.51	1,097.51	8466	1,098.00	1,097.73	0.22	0.0	0.7	1	<1
10	ESWS Manhole MHE2B	1,097.80	1,097.65	8615	1,098.00	1,097.78	0.13	0.0	0.3	<1	<1
11	ESWS Manhole MHE3A	1,097.03	1,097.32	15036	1,097.00	1,097.51	0.19	0.0	0.4	1	<1
12	ESWS Manhole MHE3B	1,097.11	1,097.32	15036	1,097.00	1,097.51	0.19	0.0	0.4	1	<1
13	ESWS Manhole MHE4A	1,096.79	1,096.90	22334	1,097.00	1,097.73	0.83	1.4	2.2	22	9
14	ESWS Manhole MHE4B	1,096.89	1,096.90	22334	1,097.00	1,097.73	0.83	1.4	2.2	22	9
15	ESWS Manhole MHE5A	1,097.23	1,097.86	29285	1,097.75	1,098.29	1.43	10.0	0.6	64	<1
16	ESWS Manhole MHE5B	1,097.29	1,097.86	29285	1,097.75	1,098.29	1.43	10.0	0.6	64	<1
17	ESWS Pumphouse Marine Door A (K1051)	1,099.34	1,099.18	30552	1,100.00	1,099.49	0.11	0.0	0.8	<1	<1
18	ESWS Pumphouse Marine Door B (K1041)	1,099.54	1,099.62	30553	1,100.00	1,099.79	0.17	0.0	0.4	<1	<1
21	Reactor Building Tendon Gallery Access Shaft	1,099.22	1,099.14	11931	1,100.27	1,100.23	1.09	6.4	0.7	37	<1
22	Reactor Make-up Water Storage Tank Valve House Door (91031)	1,099.34	1,099.33	9985	1,100.00	1,099.86	0.53	<0.05	1.7	9	3
23	Refueling Water Storage Tank Valve House Door (91021)	1,099.18	1,099.19	10434	1,100.00	1,099.93	0.74	0.9	3.4	17	20
24	FLEX Building No. 1: East Personnel Door	1,099.10	1,099.14	24204	1,099.75	1,099.41	0.27	0.0	0.5	2	<1
25	FLEX Building No. 1: West Personnel Door	1,098.86	1,098.92	22840	1,099.75	1,099.36	0.44	0.0	0.6	6	<1
26	FLEX Building No. 2: North Personnel Door	1,097.62	1,097.84	4214	1,099.44	1,099.26	1.42	9.7	1.8	63	8
27	FLEX Building No. 2: South Personnel Door	1,097.38	1,097.38	4649	1,099.44	1,099.25	1.87	9.9	3.3	109	15

28	SBO Diesel Generator Building – West Personnel Door	1,097.84	1,097.84	5693	1,100.00	1,099.38	1.54	9.8	1.0	74	2
29	SBO Diesel Generator Building – East Personnel Door	1,098.61	1,098.56	6731	1,100.00	1,099.46	0.90	1.5	1.0	26	2
30	SBO Diesel Generator Vault	1,098.51	N/A[e]	6578, 6577, 6726, 6727	1,100.00	1,099.42	0.95	1.4	2.7	28	10
31	ESW Vertical Loop Chase	1,099.58	N/A[e]	9112, 8963, 8962, 8961, 9110	1,100.50	1,100.29	0.94	1.1	0.8	28	<1
32	ESW Access Vault AV1	1,098.59	N/A[e]	6721, 6720, 6719, 6868, 7017, 7166, 7315, 7316, 7317, 7168, 7019, 6870	1,100.00	1,099.39	1.00	5.8	1.3	31	2
33	ESW Access Vault AV2	1,096.62	N/A[e]	27152, 27151, 27150, 27293, 27294, 27295	1,098.00	1,097.34	0.65	1.1	4.0	13	25
34	ESW Access Vault AV3	1,098.87	N/A[e]	29153, 29292, 29432, 29572, 29712, 29713, 29573, 29434, 29294, 29154	1,099.50	1,099.55	0.44	0.0	1.2	6	1
35	ESW Access Vault AV4	1,097.86	N/A[e]	29418, 29558, 29559, 29699, 29700, 29840, 29841, 29701, 29702, 29562, 29561, 29421, 29420, 29280, 29279	1,098.50	1,098.28	0.73	1.9	2.5	17	8
36	ESW Access Vault AV5	1,098.09	N/A[e]	29432, 29292, 29291, 29431, 29571, 29572	1,098.50	1,099.19	0.44	0.0	1.2	6	1

NOTES:

[a] Item numbers correspond to the numbering in Figure 4-3 of RIZZO Calculation 14-5262 F-02.

[b] Topographic elevations are nominal values taken near each potential pathway. For the larger access vaults, the elevations represent an average of the topography around the vault. Thus, adding the "Ground Elevation" to the "Maximum Depth" may result in a value slightly different than the "Maximum Flood Elevation."

[c] Grayed values indicate a potential flooding hazard (i.e., the flood elevation is greater than the associated critical threshold).

[d] Duration of flooding is calculated based on the threshold depth parameter (DEPTHDUR), which is specified in the *CONT.DAT* file. A DEPTHDUR value of 0.5 ft is used for this analysis (i.e., the nominal difference between the plant grade elevation of 1,099.5 ft and the plant floor elevation of 1,100.0 ft). The time-history figures in Appendix B of RIZZO Calculation 14-5262 F-02 can be used to determine the duration of inundation with respect to other threshold levels.

[e] N/A = "Not Applicable." Several of the penetrations are larger than a single grid cell (e.g., the large ESW Access Vaults). In these cases, no single grid cell represents the ground adjacent to the penetration, and the "FLO-2D Grid Cell Elevation" is set to "N/A."

<u>QUESTION 10 FROM ORIGINAL RAI:</u>

<u>Revised Background:</u> COMSECY-15-0019 requests the licensee to perform an additional assessment(s) 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 additional assessment(s). To support efficient and effective evaluations for the additional assessment(s), 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.

<u>Revised Request:</u> Please provide an updated response to RAI/Information Need 10 since the original RAI response is based on the LIP FLO-2D simulation results which were subsequently updated as stated in the revised FHRR. *The licensee is requested to 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 additional 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. The licensee is also requested to 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.*

Response: The following text supersedes the previous response to RAI 10. The overall content/conclusion of the response remains unchanged. Figure 4-1 of the FHRR, Rev. 1 illustrates the flooding event duration parameters for LIP at WCGS and is analogous to Figure 6 of the Guidance for Performing an Integrated Assessment, JLD-ISG-2012-05. The duration parameters are based on the LIP FLO-2D simulation prepared for the FHRR, Rev. 1. Specifically, Figures B-1-1 through B-1-17 in Appendix B of RIZZO Calculation 14-5262 F-02 provide time-history profiles for flooding at the plant grade doors to Seismic Category I buildings. These 17 figures were used as an ensemble as the basis for FHRR, Rev. 1 Figure 4-1.

Note that Figure 4-1 did not change between the two revisions of the FHRR because the bounding duration of flooding results at plant grade doors did not change for the updated analysis.

Presently, no credit is taken for meteorological warning systems or weather forecasts. If in the process of completing the Mitigating Strategies Assessment or the Focused LIP Evaluation it is determined that crediting weather forecasts is both necessary and defensible, justification for any credit taken will be supplied to the NRC as part of the associated evaluation.

<u>QUESTION 11 FROM ORIGINAL RAI:</u>

<u>Revised Background:</u> *COMSECY-15-0019 requests the licensee to perform an additional assessment(s) 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 additional assessment(s). To support efficient and effective evaluations for the additional assessment(s), 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.*

***<u>Revised Request</u>*: Please provide an updated response to RAI/Information Need 11, since the original RAI response is based on the LIP FLO-2D simulation results which were subsequently updated as stated in the revised FHRR.** *The licensee is requested to provide the flood height and associated effects (as defined in Section 9 of JLD-ISG-2012-05) that are not described in the flood hazard reevaluation report for mechanisms that trigger an additional assessment. This includes the following quantified information for each mechanism (as applicable):*

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

Response: This response supersedes the previous response to RAI 11. The FHRR, Rev. 1 indicates that LIP is the only flood hazard that is not bounded by the WCGS design basis. The flooding effects identified by the NRC are discussed as follows:

- **Wind waves and run-up effects:** Section 3.3.1.4 of the FHRR, Rev. 1 explains the reasoning and process used to evaluate the potential effects of wind waves coincident with a LIP event. Wind waves coincident with a LIP event were screened out as a potential hazard at the WCGS site based on the following factors: the shallow water depths near buildings, the direction of the flow velocities (away from buildings), and the height of the buildings in the powerblock that would tend to block wind. Wind wave effects will be considered in the Focused LIP Evaluation to the extent that they are necessary in support of the Focused LIP Evaluation approach for the WCGS site.

- **Hydrodynamic loading, including debris:** The FHRR treats hydrodynamic forces as distinct from debris impact forces. Potential hydrodynamic forces are quantified and reported in Tables 2 and 3 above (and also in Tables 3-2 and 3-3 of the FHRR, Rev. 1). Section 3.3.1.3 of the FHRR, Rev. 1 explains that debris impact loading was screened out as a potential hazard to the WCGS site during a LIP event. This screening was based on the shallow flow depths, relatively slow flow velocities, and the flow directions (i.e., away from safety-related System, Structure or Component (SSCs)).

- **The effects caused by sediment deposition and erosion:** Section 3.3.1.3 of the FHRR, Rev. 1 explains that sedimentation due to a LIP event (i.e., deposition and erosion of sediment) was screened out as a potential hazard for the WCGS site.

- **Concurrent site conditions, including adverse weather conditions:** As noted above, the potential for coincident wind waves caused by adverse weather conditions was considered and screened out. Site conditions other than flooding and high winds are not considered in the FHRR, which is only concerned with establishing flood hazards. Other effects will be considered in the Focused LIP Evaluation to the extent that they are necessary in support of the Focused LIP Evaluation approach for the WCGS site.

- **Groundwater ingress:** It is expected that the potential for groundwater ingress will be evaluated as part of the Focused LIP Evaluation (exact scope of the Focused LIP Evaluation to be determined after issuance of NRC guidance). No new groundwater study was performed for the FHRR. Section 2.4.13.5.1 of the Wolf Creek Updated

Safety Analysis Report (USAR) indicates that normal groundwater levels are 5 ft below grade with levels reaching grade during intense precipitation and snowmelt. The potential for groundwater ingress was evaluated during the Recommendation 2.3 walkdowns. The walkdown report (Reference 5) discussed that "A [Corrective Action Plan] CAP plan is in progress to implement a modification that will relieve groundwater pressure from Power Block structures. Penetrations with a history of leakage will then be reworked or repaired." These activities are being tracked under Condition Report (CR) 70319 "Site Wide Dewatering Work," which currently has a due date of November 10, 2016.

- **Other pertinent factors**: None.

<u>Information Need #12: Additional Clarifications (NEW)</u>

<u>Request:</u> *The technical reviewers have found some discrepancies in the revised FHRR when compared to the original version. Please verify and clarify the following items:*

a. *For Local Intense Precipitation and Associated Drainage flooding mechanism, Revision 0 of the FHRR indicates that the CDB Stillwater elevation is at 1099.83 ft. The revised FHRR reports this value at 1099.92 ft. Please explain the difference in the reported CDB values.*

b. *Considering the minimal change in the revised LIP flooding water surface elevation, provide and/or confirm the following parameters and explain the changes in these parameters compared to Revision 0 of the FHRR:*

   1) *Time available for preparation for the LIP flood event*
   2) *Duration of the inundation at the site*
   3) *Time for the water to recede from the site*
   4) *Hydrodynamic loading at plant grade*

Response:

Part a. The FHRR, Rev. 0 reports a maximum stillwater elevation of 1099.83 ft based on USAR change request 2013-050. Subsequent to issuance of the FHRR, Rev. 0, the design basis LIP flood level was updated to 1099.92 ft to account for significant site configuration changes, and the new value was incorporated into the USAR, Rev. 28, which is the reference used in the FHRR, Rev. 1. Thus, the two revisions of the FHRR report different design basis values because the design basis level was updated between the respective dates of issuance of the two report revisions.

Part b. As noted by the NRC, the changes to LIP flood elevations are minimal between the two revisions of the FHRR. In a few locations there are changes to the flood levels and/or depths that are caused by regrading (e.g., the berm adjacent to the Control Building) or the refined representation of roof drainage (i.e., crediting some roof storage). Hydrostatic and hydrodynamic loadings are also affected by the model updates in a few areas. The NRC has requested clarification of the changes to the results for the following parameters:

1) **Time available for preparation for the LIP flood event:** As noted above in the response to question 10, presently, no warning time is credited for preparing for the LIP event.

2) **Duration of the inundation at the site:** The summary timeline for LIP flooding at the site is provided in Figure 4-1 of the FHRR, Rev. 1. The results from the updated FLO-2D model did not impact this timeline. Consequently, Figure 4-1 is the same in both revisions of the FHRR.

3) **Time for the water to recede from the site:** The summary timeline for LIP flooding on the site is provided in Figure 4-1 of the FHRR, Rev. 1. The results from the updated FLO-2D model did not impact this timeline. Consequently, Figure 4-1 is the same in both revisions of the FHRR.

4) **Hydrodynamic loading at plant grade:** Hydrodynamic forces are particularly sensitive to changes in flow velocities. The updated FLO-2D model reports a reduction in hydrodynamic force in a few locations due to changes in flow velocities. For example, the Hot Machine Shop Hollow Core Door (Asset Number 13342; Item No. 13 in Table 2, above) reports a reduction of maximum hydrodynamic force from 33 lb/ft to 11 lb/ft between the FHRR, Rev. 0 and the FHRR, Rev. 1, corresponding to a reduction of peak velocity from 4.5 ft/s to 2.3 ft/s. The reduction in velocity is likely due to the location of this door (at the entrance to the alleyway between the Fuel Building and the Hot Machine Shop). By crediting the nailing strips on the roof perimeters, the peak flows through this alleyway are attenuated in the updated model. This results in a corresponding reduction in the flow velocities and hydrodynamic forces.

References:

1. WCNOC Letter ET 14-0012, "Wolf Creek Nuclear Operating Corporation's Flood Hazard Reevaluation Report in Response to NRC Request for Information Regarding Recommendation 2.1, Flooding, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," March 10, 2014. ADAMS Accession No. ML14077A278.

2. WCNOC Letter ET 15-0027, "Wolf Creek Nuclear Operating Corporation's Flood Hazard Reevaluation Report, Revision 1," October 27, 2015.

3. Electronic Mail 16-00140 from A. J. Minarik, USNRC, to N. R. Good, WCNOC, "Wolf Creek Nuclear Operation Corporation (WCNOC) Request for Additional Information / Information Needs," December 10, 2015.

4. WCNOC Letter ET 15-0012, "Response to Request for Additional Information Regarding Flood Hazard Reevaluation Report," May 20, 2015.

5. WCNOC Letter ET 12-0031, "Wolf Creek Nuclear Operating Corporation 180-day Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Recommendation 2.3 (Flooding) of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," November 27, 2012. ADAMS Accession Nos. ML12340A397 and ML12340A398.