PMHarrisCOL PEmails

From: Kenneth See
Sent: Monday, August 18, 2008 9:05 AM
To: Daniel Barnhurst; Henry Jones
Cc: HarrisCOL Resource
Subject: FW: Harris files
Attachments: Trip Report Harris COLA Hydrology Site Audit_SKE.doc; Harris_Safety_Info_Needs-Hydrology final_SKE.doc

Guys,

Attached is the info needs table after some PNNL editorial work.

Ken

From: Vail, Lance W [mailto:lance.vail@pnl.gov]
Sent: Thursday, August 07, 2008 8:27 PM
To: Kenneth See; Williams, Mark D; Wigmosta, Mark S
Subject: FW: Harris files

From: Ennor, Susan K
Sent: Thursday, August 07, 2008 4:00 PM
To: Vail, Lance W
Subject: Harris files

<<Trip Report Harris COLA Hydrology Site Audit_SKE.doc>> <<Harris_Safety_Info_Needs-Hydrology final_SKE.doc>>
Mostly minor tweaks. Have at it!

Susan K. Ennor

Technical Communications Specialist

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Hearing Identifier: ShearonHarris_COL_Public
Email Number: 125

Mail Envelope Properties (C4A4C9A16294FB4CBA5A36312D05FFAC0ABA5739F8)

Subject: FW: Harris files
Sent Date: 8/18/2008 9:04:46 AM
Received Date: 8/18/2008 9:04:49 AM
From: Kenneth See

Created By: Kenneth.See@nrc.gov

Recipients:
"HarrisCOL Resource" <HarrisCOL.Resource@nrc.gov>
Tracking Status: None
"Daniel Barnhurst" <Daniel.Barnhurst@nrc.gov>
Tracking Status: None
"Henry Jones" <Henry.Jones@nrc.gov>
Tracking Status: None

Post Office: HQCLSTR02.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	909	8/18/2008 9:04:49 AM
Trip Report Harris COLA Hydrology Site Audit_SKE.doc	24642	
Harris_Safety_Info_Needs-Hydrology final_SKE.doc	342082	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Trip Report for Harris COLA Hydrology Site Audit – August 4-6, 2008

From August 4-6, 2008, NRC visited ~~to~~ Raleigh, North Carolina, to review PSC's application for a COLA at the Harris site. ~~The day of~~ On August 4, ~~2008~~ the staff met with the applicant at the PSC offices in downtown Raleigh. On the morning of August 5, ~~2008,~~ PSE provided a tour of the site of the existing HNP Unit 1 and the proposed HAR Units 3 and 4. Key hydrologic features ~~of~~ observed during the site audit included ~~:~~ the Main Reservoir~~,~~ and the Auxiliary Reservoir~~;~~, exposures of the subsurface stratigraphy at the intake and discharge of the existing unit~~,~~, and a tour of the terrain around the area of the existing Fire Pond. The staff returned to the downtown Raleigh offices to resume meetings from the afternoon of August 5 through ~~to~~ the close of business on~~COB~~ August 7~~, 2008~~. The complete set of 29 ~~Information~~ information ~~Needs~~ needs was discussed. After the audit, all but 5 of the 29 ~~Information~~ information ~~Needs~~ needs were RESOLVED. Each UNRESOLVED ~~Information~~ tnformation ~~Need~~ need will result in one or more RAIs.

The individuals who ~~participating~~ participated in the various meetings are listed in Attachment 1. In Attachment 2, the list of Information Needs provided by the staff to the applicant prior to the audit is presented and augmented with a summary of the information provided by applicant and the associated disposition of each topic.

Comment [ske1]: spell out? Combine operating License Agreement…

Comment [ske2]: I changed the "traveled to" wording before remembering to track changes; verify.

Comment [ske3]: Spell out?

Comment [ske4]: Site of the Harris Nuclear Plant?

Comment [ske5]: PSC or another term to introduce?

Comment [ske6]: In the area of?

Comment [ske7]: Meaning resolved or unresolved?

Serial #	FSAR Section	Discipline	Information Needs	Reviewer
1	2.4.2.3 and 2.4.3	Surface Hydrology	**Provide a subject matter expert (SME) to describe sub-basin and runoff zone delineation.** **Applicant Response:** The subbasin and runoff zone delineation as provided in HAR FSAR Subsection 2.4.2.3 was described. Supporting information: HAR FSAR Figure 2.4.2-205 – "Local PMP Site Drainage Map with HAR 2 and HAR 3" Figures: Conceptual Grading and Drainage Plans HAG-0000-XG-001 through -013 Report No. HAG-0000-XGR-001, Rev. 2 – "Conceptual Grading and Drainage" HAG-0000-X7C-034, Rev. 0 – "Probable Maximum Precipitation Estimate for One Square Mile Area" HAG -0000-X7C-035, Rev 1 – "Evaluation of Local Probable Maximum Precipitation (PMP)" Source: National Elevation Dataset (NED) 1/3 Arc Second **NRC Comments:** The Buckhorn Creek Basin draining into Harris Reservoir and the associated sub-basins used the ~~the~~ applicant's HEC-HMS were delineated based on 10-m digital elevation obtained from USGS. The sub-basin was determined to be consistent with the USGS HUC-12 basin. The staff understands the DEM was obtained from the National Elevation Dataset (NED) 1/3 Arc Second. See ~~section~~ Section 2.4.2.3, page 2.4-15 and Figure 2.4.2-205 for local PMP control structure (railroad). UNRESOLVED information need: The staff will prepare an RAI asking the applicant to better explain the conservatism in lag time response with regard to the residual area around the lake.	M Wigmosta

Comment [ske1]: Purposeful difference in use of spacing following headings and difference in fonts? Or can I insert a space here, too?

Comment [ske2]: As the new kid on the block, I want to see all abbreviations spelled out upon first use. Also USGS, HUC, PMP, RAI, etc.

This sentence doesn't read right – sot of like two thoughts being merged with a disconnect in the middle; lost something in translation along the way, perhaps?

Comment [ske3]: Is this clearly understood (in this case) to mean the following item is unresolved, hence the need for the follow-up staff request of the applicant? Does the introduction to this table/report indicate this for uniform understanding by all readers?

2	2.4.2.3	Surface Hydrology	**Provide a SME to describe technical basis to determine runoff depths.** **Applicant Response:** The technical basis to determine runoff depths as provided in HAR FSAR Subsection 2.4.2.3 was described. Supporting information: HAR FSAR Figure 2.4.2-205 – "Local PMP Site Drainage Map with HAR 2 and HAR 3" Figures: Conceptual Grading and Drainage Plans HAG-0000-XG-001 through -013 Report No. HAG-0000-XGR-001, Rev. 2 – "Conceptual Grading and Drainage" Calculation HAG-0000-X7C-034, Rev. 0 – "Probable Maximum Precipitation Estimate for One Square Mile Area" HAG -0000-X7C-035, Rev 1 – "Evaluation of Local Probable Maximum Precipitation (PMP)" 1. During periods of high water level in the Main Reservoir including PMF, the broad crested weir will not be submerged as the weir crest elevation is above the reservoir water level. Therefore, the estimated water levels discussed in Section 2.4.2.3 will not be affected by water level in the Main Reservoir. 2. Section 2.4.2.3 conservatively estimates the maximum water levels for different zones of the plant area. During final design of the site grading, local roads and grade elevations and any local obstructions are not expected to adversely affect the maximum water levels near the power block and hence the safety-related facilities will not be affected by local PMP. **NRC Comments:** Linked to 1 Information needs RESOLVED based on discussions and information presented at the site audit.	M Wig

Comment [ske4]: …the technical basis for determining…?

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Comment [ske5]: Should this be in the other font (Arial) to match the rest of the applicant's section?

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Comment [ske6]: Linked to 1 understood? Serial number in this list or NRC comment numbers?

3	2.4.3.1.3	Surface Hydrology	**Provide a SME to discuss maximization of precipitation volume.** **Applicant Response:** In order to maximize precipitation volume, the probable maximum storm (PMS) needs to be determined. We have used HMR-52 step-by-step instructions for configuring a PMS using PMP estimates from HMR-51. The PMS has a specific storm-area size that yields the maximum precipitation volume for a given drainage basin. Step-C of HMR-52 (page 102 through 106) provides a step-by-step procedure to determine the storm-area size for the Buckhorn Creek watershed. Based on the calculations presented in HAR FSAR Tables 2.4.3-207, 2.4.3-208, and 2.4.3-209, the pattern area size that maximizes the volume of precipitation for the three largest 6-hour incremental periods was found to be 259 km2 (100 sq. mi). For further detail please see Figure 1 of Appendix H3 and Calculation HAG-0000-X7C-031, Rev. 1 (Probable Maximum Precipitation). **NRC Comments:** Information needs RESOLVED based on discussions and review of calculation packages at the site audit.	M Wigmosta

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4	2.4.3.2	Surface Hydrology	**Provide a~~n~~ SME to discuss constant loss rates and impact of impervious surfaces.** **Applicant Response:** The impervious surface is about 1.84 % (NOT in FSAR) of the watershed area. The FSAR analysis is based on 30% impervious and is conservative. See FSAR Table 2.4.3-217. Further, the constant loss rates were assumed to be the lowest value of the of the minimum infiltration range corresponding to the saturated conditions without accounting the vegetation effects which can greatly increase the rate of infiltration: 1) ~~1.~~ A high percentage of plant cover and large amounts of root biomass generally increase the infiltration rate. 2) ~~2.~~ Organic matter and soil biota.—Increased plant material, dead or alive, generally improves infiltration. As organic matter is broken down by soil organisms, it binds soil particles into stable aggregates that enhance pore space and infiltration. 3) ~~3.~~ Vegetation hold water in place, buffer the release of water to the ground surface. 4) ~~4.~~ Vegetation shields the soil surface from compaction effects of rainfall. See FSAR Table 2.4.3-217. The applicant expects very little additional development affecting runoff from impervious areas. **NRC Comments:** ~~Development~~ The effects of development on infiltration and runoff and shallow soils saturation resulting in impervious behavior was adequately explained. UNRESOLVED information need: The staff will prepare an RAI asking the applicant to justify the constant loss rate of 0.05 in./hr used in their PMF analysis.	M Wigmosta

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Comment [ske7]: Use Arial font to match above?

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Comment [ske8]: Spell out upon first use?

5	2.4.3.3.1	Surface Hydrology	**Provide a~~n~~ SME to discuss unit hydrograph application.** **Applicant Response:** This is an un-gauged basin for which unit hydrographs were developed synthetically for various sub-basins using previously (SHNPP FSAR) determined parameters of Snyder's synthetic unit hydrograph as described in HAR FSAR section 2.4.3.3.1. HAR FSAR Table 2.4.3-219 lists Unit Hydrograph Characteristics for various sub-basins of the Buckhorn Creek watershed. All the developed unit hydrographs were checked for volume = 1 –inch. Further, it was ensured that the computation interval < 0.29*lag time. HAR FSAR Figure 2.4.3-209 presents the developed unit hydrographs for various sub-basins of the Buckhorn Creek watershed. For further details, see HAG-0000-X7C-003, Rev. 1 (Probable Maximum Flood). **NRC Comments:** The staff understands the unit hydrographs were developed from ~~site~~ site-specific information. UNRESOLVED information need: The staff will prepare an RAI asking the applicant to justify the conservatism in ~~their~~ its unit hydrographs, including the hydrograph used for the water surface.	M Wigmosta

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6	2.4.3.3.2	Surface Hydrology	**Provide a~~n~~ SME to discuss reservoir stage-discharge calculations included spillway pier dimensions and choice of contraction coefficients.** **Applicant Response:** Where crest piers and abutments are shaped to cause side contractions of the outflow, the effective length, L, is less than the net length of the crest. The effect of the end contraction may be taken into account by reducing the net crest length according to the following equation (Design of Small Dams, USBR Publication 1987): $L = L' - 2(NK_p + K_a)H_e$ where H_e = actual head on crest L' is the net length of the spillway, N is the number of piers, and K_P and K_a are pier and abutment contraction coefficients, respectively. In the present study, the piers are of round-noised for which Kp = 0.01 (Design of Small Dams, USBR Publication 1987). K_a = 0.01 was assumed, however, K_a = 0 for $\frac{r}{H_d}$ >0.5 (Design of Small Dams, USBR Publication 1987), where H_d is the design head. This assumption is further strengthened due to decrease in H_d by increasing the crest level by 20 ft. It should be noted, K_P =0.01 and K_a = 0 was used during the design and K_P= K_a= 0.01 was used in SHNPP FSAR. **NRC Comments:** Information needs RESOLVED based on discussions ~~at~~ during the site audit.	M Wig

Comment [ske9]: Meaning calculations, including…?

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7	2.4.3.3.2	Surface Hydrology	**Provide a~~n~~ SME to provide a technical basis for kinematic wave routing in tributaries and the Main Reservoir.** **Applicant Response:** The use of kinematic wave routing approximations to the full equations for unsteady flow can be justified when specific terms in the momentum equation are small in comparison to the bed slope. In the present case we are interested in the most conservative results rather than very accurate results. Therefore, the use of the kinematic routing is conservative as it does not allow attenuation of flood peaks and account natural storage of expanding tributaries. Following are the points that were considered while selecting the routing method: 1) ~~1.~~ Kinematic wave routing was used in tributaries only and not in the Main Reservoir. 2) ~~2.~~ This method models flow with translation and no attenuation by computing flow depth and channel parameters. 3) ~~3.~~ Simple and easy to use. Parameters can be estimated from field observations. 4) ~~4.~~ Does not account for over-bank or other storage effects well in broad, flat channels. Thus, it is conservative as in our case the tributaries are expanding and have natural storage. 5) ~~5.~~ In the current study we are dealing with very fast rising hydrograph in which the flow increased from 100 to 100,000 cfs and decreased again to 10,000 cfs within 4-6 hours. In such a situation the contribution of neglected terms in the dynamic equation will be insignificant. **NRC Comments:** Linked to 5, 8, and 9. Information needs RESOLVED based on discussions and information presented ~~at~~ during the site audit.	M Wigmosta

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8	2.4.3.3.2	Surface Hydrology	**Provide ~~an~~ a SME to provide a technical basis for HEC-HMS model application as presented in Figure 2.4.3-210.** **Applicant Response:** HAR FSAR Figure 2.4.3-210 is the schematic of HEC-HMS basin model representing the physical watershed as given in HAR FSAR Figure 2.4.3-201. The basin model was developed by adding and connecting hydrologic components such as drainage sub-basins, reaches, junctions, reservoirs, meteorological models, etc. These hydrologic components are mathematical models that are used to simulate the hydrologic response of a drainage basin to given rainfall event defined in the meteorological model. HAR FSAR Table 2.4.3-219 lists various watershed parameters, along with the Snyder hydrograph parameters that were used in the HEC-HMS model. HAR FSAR Table 2.4.3-220 tabulates the parameters that were used for reach routing. HAR FSAR Figures 2.4.1-206 and 2.4.1-207 present the stage-storage-area curves for the Main Reservoir and the Auxiliary Reservoir, respectively. Similarly, HAR FSAR Figures 2.4.3-211 and 2.4.3-212 show the rating curves developed for both spillways of the Main Dam and the Auxiliary Dam. Using these components along with unit hydrographs developed for each sub-basin (see response to Appendix H5), a HEC-HMS model was developed to simulate the hydrologic response of the Buckhorn Creek drainage basin to the PMP event. For further details, see Appendix H-8 and HAG-0000-X7C-003, Rev. 1 (Probable Maximum Flood). **NRC Comments:** Linked to 5, 7, and 9 Information needs RESOLVED based on discussions and review of calculation package ~~at~~ during the site audit.	M Wigmosta

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9	2.4.3.4.2	Surface Hydrology	**Provide a~~n~~ SME to provide a technical basis for approach used to calculate reservoir water levels.** **Applicant Response:** Using the HEC-HMS model (discussed in H-8), hydrologic response from each sub-basin was routed through the Auxiliary and Main reservoirs using the Modified Puls reservoir routing. The modified Puls reservoir routing employs the use of the continuity equation. All these calculations were accomplished using the HEC-HMS model described in H-8. As described in HAR FSAR Subsection 2.4.3.4.1, to determine the PMF inflow and outflow hydrographs, two cases were considered: • Case 1: Using the PMP corresponding to the entire basin (i.e., the PMP storm given on HAR FSAR Figure 2.4.3-206 for the entire basin). • Case 2: Using two different PMP storms. HAR FSAR Figure 2.4.3-206 was used as the PMP for the Main Dam watershed and HAR FSAR Figure 2.4.3-208 was used as the PMP for the Auxiliary Dam watershed [Note: the PMP for the Auxiliary Dam watershed is more severe as its intensity relates to a drainage area of 7.8 km^2 (3.0 $mi.^2$)]. HAR FSAR Figures 2.4.3-215 and 2.4.3-216 present the inflow and outflow hydrographs for the Main Reservoir corresponding to Cases 1 and 2, respectively. A detail description of the approach is given in Appendix H-9 and HAG-0000-X7C-003, Rev. 1 (Probable Maximum Flood). **NRC Comments:** Linked to 5, 7, and 8 Information needs RESOLVED based on discussions and review of calculation package ~~at~~ during the site audit.	M Wigmosta

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10	2.4.3.6	Surface Hydrology	**Provide ~~an~~ a SME to provide a technical basis for use of Reference 2.4-231 rather than USACE Coastal Engineering Manual for wind-wave activity.** **Applicant Response:** USACE Coastal Engineering Manual (EM 1110-2-1100) describes methods for simplified wave predictions in open waters such as oceans, the Great Lakes, or other large open water bodies. Reference 2.4-231 (ETL1110-2-221) was specifically written for determining wave run-up and wind setup on reservoir embankments. This is best described on Page 11 of ETL1110-2-221, which states “The generally narrow irregular shoreline of inland reservoirs will have lower waves than an open coast because there is less water surface for the wind to act on. The method to compensate for the reduced water surface for an enclosed body of water is computation of an “Effective Fetch”. Since Harris Lake is a small narrow body of water that is irregularly shaped (consisting of 6 substantial branches), the methods described in ETL1110-2-221 are most applicable to determine wind-wave activity. It is also noted that Section 2.4.3 of Standard Review Plan (NUREG-0800) references the publication ETL1110-2-221 as given below. The SRP does not reference EM 1110-2-1100 19. ETL 1110-2-221, "Wave Runup and Wind Setup on Reservoir Embankments," U.S. Army Corps of Engineers, November 1976. ETL1110-2-221 was utilized to determine wind-wave activity rather than USACE Coastal Engineering Manual since it is appropriately applicable manual when applied to the geometry of Harris Lake. **NRC Comments:** NRC ~~to~~ will consult with the US Army Corps of Engineers regarding the acceptability of the applicant’s chosen methodology. Information needs RESOLVED based on information presented during the site audit.	M Wig

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Comment [ske11]: Hurray! I’d use during globally in place of at, but restrained myself in “hands-off” copy editing mode. Will change them now.

11	2.4.3.6.2	Surface Hydrology	**Provide a~~n~~ SME to provide a technical basis for use of Reference 2.4-231 for wind-velocity calculations rather than PMH.** **Applicant Response:** Please see response to H-10. The HAR site is at least 140 miles away from the coastal area, thus it is not subjected to a hurricane in coincident with a PMP event. Therefore, PMH hasn't been considered for coincident wind-wave activity. The PMH derived wind-velocity calculations have been discussed under HAR FSAR Subsection 2.4.5 rather in coincident with PMF. Further, according to "ANSI-2.8-1992 Section 5.7 Coincident Wind-Wave Activity": coincident effects of wind-generated setup and runup should be superimposed on flood crest. Normal pool elevation was assumed for PMH event. **NRC Comments:** Water surface elevation for PMH event. The staff ~~to~~ will review ANSI 2.8 and the applicability for Alternative 4. Linked to 10, 12, and 14. Information needs RESOLVED based on the information presented during site audit.	M Wig
12	2.4.3.6.4	Surface Hydrology	**Provide ~~an~~ a SME to discuss wave runup calculations.** **Applicant Response:** We have used the procedure given in Reference 2.4-231 wave runup calculations. A detailed calculation has been presented in the calculation package HAG-0000-X7C-003, Rev. 1 (Probable Maximum Flood). **NRC Comments:** Linked to 10, 11, 14 Information needs RESOLVED based on discussions and review of calculation packages.	M Wig

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Comment [ske13]: Incomplete sentence could be interpreted a number of ways, or not at all.

Comment [ske14]: Of what? Do you mean…ANSI 2.8 and its applicability…?

Comment [ske15]: Do you want to use bulleted list format where there are more than one NRC comment? Is the "Linked to" information a comment for the applicant or a flag for NRC staff?

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13	2.4.5.1	Surface Hydrology	**Provide a~~n~~ SME to provide technical basis for neglecting the adjustment for asymmetry due to storm forward speed.** **Applicant Response:** The maximum gradient wind was used to calculate the wave generating wind activity at the HAR site. According to "U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Weather Service, Meteorological Criteria for Standard Project Hurricane and Probable Maximum Hurricane Windfields, Gulf and East Coasts of the United States. Climate Wind Data for the United States, NOAA Technical Report NWS 23. September 1979, Washington, D.C." the gradient wind is defined as a wind blowing under conditions of circular motion, parallel to isobars, in which the centripetal and coriolis accelerations together exactly balance the horizontal pressure gradient forces. Thus asymmetry was accounted indirectly in the calculations. For the sake of accounting the adjustment for asymmetry due to storm forward speed, one has to determine the wind velocity in a stationary hurricane. Such a wind velocity is adjusted for asymmetry using the following equation: $V_x = 0.95\ V_{gx} + 1.5\ (T^{0.63})\ (T_o^{0.37})\ \cos \beta$ Using the above procedure, wind-wave activity at the HAR site were determined and compared with the numbers presented in the FSAR. It can be noted that elevation difference is not significant. Item | Location point # 1 | Location point # 2 | Location point # 3 | Location point # 4 | Location point # 5 | Location point # 6 | Location point # 7 *adjustment for asymmetry* | 248.43 | 257.75 | 249.37 | 255.98 | 243.41 | 256.17 | 243.20 Max. Water Level (ft) | 248.40 | 257.73 | 249.33 | 255.97 | 243.40 | 256.15 | 243.19 Difference | 0.03 | 0.02 | 0.03 | 0.01 | 0.01 | 0.02 | 0.01 Wind velocity adjusted for asymmetry = 124.9 mph; wind velocity used in FSAR = 124.5 mph. Here, it is worth to mention that the above numbers are very conservative due the following alternate calculation. According to this calculation wind velocity = 96 mph.	M Wigmosta

13 cont'd | 2.4.5.1 | Surface Hydrology

Kaplan, J. and Demaria, M., (2000). "On the Decay of Tropical Cyclone Winds after Landfall in the New England Area," Journal of Applied Meteorology, Vol. 40, pp 280.

Parameter	Value	Unit		Parameter	Value	Unit	
R =	1			R =	0.9		
Vb =	26.7	KT		Vb =	29.6	KT	
alpha =	0.095	1/hr		alpha =	0.187	1/hr	
Landfall Velocity, V0 =	136.400	KT					

Southern Model			Northern Model			
Time (hr)	Maximum Surface Wind Velocity (KT)	Maximum Surface Wind Velocity (mph)	Maximum Surface Wind Velocity (KT)	Maximum Surface Wind Velocity (mph)	Maximum Velocity (mph)	30-ft, 30-Min Wind Velocity (mph)
1.0	114	131	107	122.98	131	121.45
2.0	106	122	94	107.82	122	113.02
3.0	99	114	83	95.24	114	105.35
4.0	92	106	74	84.81	106	98.38
5.0	86	99	66	76.15	99	92.04
5.5	84	96	63	72.39	96	**89.09**

NRC Comments:

Information needs RESOLVED based on discussions and information presented ~~at~~ during the site audit.

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14 | 2.4.5.1 | Surface Hydrology | M Wig

Provide a~~n~~ SME to discuss wave action calculations.

Applicant Response:

We have used the procedure given in Reference 2.4-231 wave action calculations. A detailed calculation has been presented in the calculation package HAG-0000-X7C-003, Rev. 1 (Probable Maximum Flood).

NRC Comments:

Linked to 10, 11, and 12

Information needs RESOLVED based on discussions and review of calculation packages.

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15	2.4.12	Groundwater Hydrology	**Provide a~~n~~ SME to describe subsurface conceptual model used to estimate changes in water table elevation due to increase in Harris Reservoir, site grading, drainage ditches, and hydraulic properties of backfill after construction.** **Applicant Response:** To explain the groundwater conceptual model, multiple details concerning the site needs to be understood. These include: **<u>Topography of the Site</u>** <u>Figure not in FSAR</u> – "Buckhorn Creek Topography" <u>HAR Figure 2.4.1-204</u> – "Site Drainage Map of Existing Conditions" <u>HAR Figure 2.4.1-205</u> – "Site Drainage Map With HAR2 and HAR3" **<u>Lithology</u>** <u>HAR FSAR Subsection 2.4.12.1.2.1</u> describes site soils. Additional information is included in: <u>HAR Figure 2.4.12-201</u> – "HAR Site Soil Classification Map" <u>HAR Table 2.4.12-201</u> – "U.S. Department of Agriculture (USDA) Soil Summary" Several HAR FSAR figures show subsurface cross-sections and topography of bedrock: <u>HAR FSAR Figure 2.5.4-202</u> - "Borehole Locations Near AP1000 Structures" <u>HAR FSAR Figure 2.5.4-204A & 204B</u> - "Stratigraphic Cross Section at HAR 2" - Plant N-S and E-W <u>HAR FSAR Figure 2.5.4-205A & 205B</u> - "Stratigraphic Cross Section at HAR 3" - Plant N-S and E-W <u>HAR FSAR Figure 2.5.4-206A & 206B</u> - "Elevation of Top of Sound Rock" at HAR 2 and HAR 3 <u>HAR FSAR Subsection 2.5.4.1.1</u> provides a description of soil and rock subsurface conditions encountered in the HAR 2 and HAR 3 boreholes (a few pages). A detailed description of the site geologic setting (based on literature sources and field reconnaissance by Geomatrix) is presented in <u>HAR FSAR Subsection 2.5.1.2</u>.	M Wil

Comment [ske16]: Clear intended meaning? Size, pool, volume, footprint,…?

15 cont'd	2.4.12	Groundwater Hydrology	**Groundwater** HAR FSAR Subsection 2.4.12.1 provides a description of the regional and HAR site groundwater systems (includes descriptions of the regolith and bedrock). HAR FSAR Subsection 2.4.12.2.2 provides a description of the groundwater levels and movement at the HAR site. HAR FSAR Subsection 2.4.12.2.3 provides descriptions of site hydrogeological characteristics. HAR FSAR Figures 2.4.12-203 through 2.4.12-210 show the locations of the monitoring wells associated with the HAR and HNP site and groundwater elevations for each of the quarterly gauging events. HAR Table 2.4.12-208 – "Slug Test Results Data Reduction" HAR Table 2.4.12-209 – "Groundwater Linear Flow Velocity" Additional information: HAG-0000-X3C-001, Rev. 0 – "HAR Potentiometric Maps" HAG-0000-X7C-001, Rev. 1 – "Calculation for Groundwater Slug Tests" HAG-0000-X7C-002, Rev. 0 – "Groundwater Velocity and Flux Calculations" HAG-0000-X7C-019, Rev. 0 – "Groundwater Vertical Gradients" HAG-0000-X7C-022, Rev. 1 – "Water Level Measurement within the Vicinity of HAR 2 and HAR 3" **NRC Comments:** UNRESOLVED information needs: The staff will prepare RAIs asking the applicant to describe the following: 1) Process ~~employed~~ used for the site maximum groundwater elevation assessment is the most conservative plausible conceptual model. 2) Changes in the piezometric heads between current conditions and post-construction environment. 3) Recharge in the post-construction environment for non-impervious surfaces. ~~4)~~ Rationale for assuming that the 2006-2007 water level observations are representative of the normal water table. ~~5)~~4)	

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16	2.4.12	Groundwater Hydrology	**Provide for staff review: photos from excavation of Unit 1 to provide understanding of subsurface environment~~,~~ and well test data packages.** **Applicant Response:** Progress Energy presented photos of the excavation for HNP 1. The original well test data packages for the HNP "24-hour driller's test" could not be located. This information was consistent with the HAR site analysis and not the basis for HAR calculations or conclusions. However, results for the down-hole pressure tests in boreholes were found. HNP FSAR Subsection 2.4.13.2.3 describes aquifer characteristics at the HNP site. HNP FSAR Table 2.4.13-7 – "Permeability of Plant Site Materials Based on Down-hole Pressure Tests*" HNP FSAR Subsection 2.5.1.2.5 provides details concerning the down-hole pressure tests conducted for HNP 1. HNP FSAR Figure 2.5.1-14 shows locations of the borings within the immediate vicinity of HNP 1. HNP Appendix 2.5A contains the results from the down-hole pressure tests for boreholes associated with HNP 1. **NRC Comments:** Information needs RESOLVED based on discussions and review of information presented by the applicant ~~a~~ during~~t~~ the site audit.	M Williams

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17	2.4.13	Groundwater Hydrology	**Provide a~~n~~ SME to describe hydraulic properties of soil mixture after construction particularly in areas of Unit 3 containment where some filling will be required.** **Applicant Response:** <u>HAR FSAR Subsection 2.4.12.1.2.1</u> states, “While constructing the HNP, the existing regolith was removed and stockpiled during site grading activities and used as fill for areas below the HNP nominal plant grade elevation of 79.2 m (260 ft.) NGVD29. No fill soil was required from outside locations that might have consisted of different soil types. During construction of the HAR, the same procedures are assumed for site preparation. Therefore, the existing and future regolith for HNP and HAR sites will consist of a mixture of native soil types. Figure 2.4.12-201 shows the NRCS’s classification of soils at the HAR site as the White Store–Creedmoor–Mayodan type (Reference 2.4-207). Table 2.4.12-201 summarizes physical soil and engineering properties by soil type. Characteristics of the White Store–Creedmoor–Mayodan soil types indicate a high percentage of fine soil textures with relatively high porosity but low saturated hydraulic conductivity. These soil characteristics are indicative of relatively impervious surfaces with limited infiltration and percolation.” The composition of the soil will remain the same after constructions activities in the area of HAR3. The properties of the soil will potentially be affected by compaction activities and thus decrease the infiltration and percolation rates. This effect will potentially attenuate surficial groundwater recharge and increase surface runoff. The surficial material in areas east of HAR-2 containment is backfill material from HNP construction. Additional information includes: <u>HAR Figure 2.4.12-201</u> – “HAR Site Soil Classification Map” <u>HAR Table 2.4.12-201</u> – “U.S. Department of Agriculture (USDA) Soil Summary” <u>HAR FSAR Subsection 2.4.13.1.1</u> states: “The release migrates eastward 365.8 m (1200 ft.) in the direction of decreasing hydraulic head to the Thomas Creek branch of the Main Reservoir.” A shorter distance between Unit 3 and the Thomas Creek branch of the Main Reservoir is used to conservatively allow for unanticipated variations in backfill around safety-related structures. The WLS effluent tanks are located in the lowest level of the auxiliary building, a safety-related structure. The distance is ~1500 feet from Thomas Creek. The 1200-foot distance used in the evaluation corresponds to the end of the turbine building nearest the Thomas Creek branch.	M Williams

17 cont'd	2.4.13	Groundwater Hydrology	Additional information includes: HAR FSAR Figure 2.4.12-203 – "Potentiometric Surface map of Surficial/Overburden Aquifer, August 28, 2006" shows the relative locations of Unit 2 and 3 to the Main Reservoir including Thomas Creek branch. HAG-0000-GLC-001, sheet 4. Identifies that a conservative distance is used in the analysis. HAG-0000-GLC-001, ref. Burkingstock, Key 2. This figure shows clearly the distance from Unit 3 to Thomas Creek branch of the Main Reservoir. HAG-0000-X3C-001, Rev. 0 – "HAR Potentiometric Maps" HAG-0000-X7C-001, Rev. 1 – "Calculation for Groundwater Slug Tests" HAG-0000-X7C-002, Rev. 0 – "Groundwater Velocity and Flux Calculations" HAG-0000-X7C-019, Rev. 0 – "Groundwater Vertical Gradients" HAG-0000-X7C-022, Rev. 1 – "Water Level Measurement within the Vicinity of HAR 2 and HAR 3" HAG-0000-XSR-001, Rev. 2 – "Review of the Road Crossings across Harris Lake at the Power Block" Compaction curves for native soils used as fill for the SHNPP Unit 1 are included in SHNPP FSAR figures 2.5.4-106 through 2.5.4-110. Soil classification data at the HAR sites (Atterberg limits, gradation, moisture content, density, etc.) is available in HNP FSAR Table 2.5.4-208. This provides data on potential fill materials at the site. **NRC Comments:** Information needs RESOLVED based on discussions and review of information presented ~~at~~ during the site audit.	

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18	2.4.13	Groundwater Hydrology	**Provide a~~n~~ SME to describe the process that the conceptual model of the transport processes is the most conservative plausible conceptual model.** **Applicant Response:** HAR FSAR .Subsections 2.4.13.1.1 and 2.4.13.1.3 describe the surficial aquifer model used to analyze releases reaching the main reservoir. This model includes no hold-up in building; direct input to aquifer; eastward flow based on hydraulic head; shortest path to Thomas Creek branch of the Main Reservoir; all transported nuclides end up in the Main Reservoir; no communication to bedrock aquifer; dilution only by reservoir flow (no volume). HAR FSAR Subsections 2.4.13.1.2 and 2.4.13.1.3 describes the bedrock aquifer model used for assessment of wells. Wells are sunk and cased to bedrock. This model takes entire release at top of bedrock aquifer; eastward flow based on gradient; CL flow path to well; aquifer productive region only; no dilution at well location. HAR FSAR Subsection 2.4.13.1.3 shows that both models are use time-independent, maximum nuclide concentrations when comparing to 10 CFR 20, Appendix B, Table 2 ECLs. In other words, only maximum concentrations are used even though the maximums do not at the same time. HAR FSAR Subsection 2.4.13.1.4 describes selection of K_d for Cs and Sr based on soil and bedrock properties. Tritium's distribution is taken as zero, hence no retardation, and becomes the dominant concentration. HAR FSAR Subsection 2.4.13.1.5 shows that tritium is the dominant dose contributor for the WLS tank failure. HAR FSAR Figure 1.1-201 "Site Layout" shows proximity to Thomas Creek branch of the Main Reservoir. HAR FSAR Figure 2.4.1-208 "Buckhorn Creek Drainage Basin" shows relationship of Thomas Creek to the Main Reservoir. HAR FSAR Figure 2.4.1-209 "Cape Fear River Drainage Basin" shows relationship between Main Reservoir and Lillington. HAR FSAR Tables 2.4.12-201, -208, -209 are the bases for soil and hydraulic parameters in Table 2.4.13-202. HAR Tables 2.4.12-202 "Nearest Residences Relative to HAR Site" identifies private wells. HAR Table 2.4.12 -203 "Public Water Users within 5 Miles of HAR Site" identifies public wells.	M Williams

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18 cont'd	2.4.13	Groundwater Hydrology	HAR Table 2.4.13-202 "Groundwater Parameters" identifies parameters used in the models. HAR Table 2.4.13-203 "Main Reservoir … Comparisons to 10 CFR 20 ECLs". This table also gives the relative overall ECL at Lillington with consideration of dilution from cape fear River. HAR Table 2.4.13-204 "Main Reservoir at Thomas Creek … Comparisons to 10 CFR 20 ECLs" HAR Table 2.4.13-205 "Groundwater Transport … to Public Use Well with Comparisons to 10 CFR 20 ECLs. Additional information includes: HAG-0000-GLC-001, ref. Burkingstock, Key 2, shows distances used for Units 2 and 3 to Thomas Creek branch of the Main Reservoir. HAG-0000-GLC-001, sheet 29, shows H-3 time concentrations. HAG-0000-X3C-001, Rev. 0 – "HAR Potentiometric Maps" HAG-0000-X7C-001, Rev. 1 – "Calculation for Groundwater Slug Tests" HAG-0000-X7C-002, Rev. 0 – "Groundwater Velocity and Flux Calculations" HAG-0000-X7C-019, Rev. 0 – "Groundwater Vertical Gradients" HAG-0000-X7C-022, Rev. 1 – "Water Level Measurement within the Vicinity of HAR 2 and HAR 3" HAG-0000-XSR-001, Rev. 2 – "Review of the Road Crossings across Harris Lake at the Power Block" **NRC Comments:** • Need more discussion on the development of alternative conceptual models. The • ~~Discussion~~ discussion can be ~~in~~ added to Section 2.4.12. • Need additional details (may be in the calculations package) • Kd values not site specific, but taken from literature. UNRESOLVED information needs: The staff will prepare RAIs asking the applicant to explain the following: 1) Process ~~employed~~ used for the site subsurface tank release assessment is the most conservative plausible conceptual model. 2) Need for site specific Kd values for Cs-/-Sr ~~3)~~Explain how effective porosity values used in the scenarios are representative of the fractured bedrock conditions at the site with implications for contaminant transport. ~~4)~~3)	

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19	2.4.13	Groundwater Hydrology	**Provide for staff's review all calculation packages associated with assessment in 2.4.13 of FSAR.** **Applicant Response:** HAG-0000-GLC-001 "Evaluation of Liquid Radwaste Tank Failure (COL Item 15.7-1)" performs the assessment in Section 2.4.13. This calculation and reference file are available from PE. HAG-0000-GLC-001 uses input from other site data calculations for FSAR Section 2.4.12. These calculations are available from PE. Excerpts are included in the HAG-0000-GLC-001 calculation reference file. Additional information includes: HAG-0000-X3C-001, Rev. 0 – "HAR Potentiometric Maps" HAG-0000-X7C-001, Rev. 1 – "Calculation for Groundwater Slug Tests" HAG-0000-X7C-002, Rev. 0 – "Groundwater Velocity and Flux Calculations" HAG-0000-X7C-019, Rev. 0 – "Groundwater Vertical Gradients" HAG-0000-X7C-022, Rev. 1 – "Water Level Measurement within the Vicinity of HAR 2 and HAR 3" HAG-0000-XSR-001, Rev. 2 – "Review of the Road Crossings across Harris Lake at the Power Block" **NRC Comments:** Information needs RESOLVED based on review of calculation packages ~~at~~ during the site audit.	M Williams

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20	2.4.12	Groundwater Hydrology	**Provide a~~n~~ SME to discuss ~~site~~ site-specific features (fractures, joints, bedding planes, diabase dikes) ~~which~~ that create secondary porosity including: 1) ~~site~~ site-specific characterization of physical nature of features (i.e. location, orientation, aperture), 2) impact on current understanding of groundwater flow directions/rates, and 3) implications on recharge and contaminant transport.** **Applicant Response:** **Lithology/Stratigraphy/Structure** Several HAR FSAR figures show subsurface cross-sections and topography of bedrock: HAR FSAR Figure 2.5.4-202 - "Borehole Locations Near AP1000 Structures" HAR FSAR Figure 2.5.4-204A & 204B - "Stratigraphic Cross Section at HAR 2" - Plant N-S and E-W HAR FSAR Figure 2.5.4-205A & 205B - "Stratigraphic Cross Section at HAR 3" - Plant N-S and E-W HAR FSAR Figure 2.5.4-206A & 206B - "Elevation of Top of Sound Rock" at HAR 2 and HAR 3 HAR FSAR Figures 2.5.4-202, 2.5.4-213, 2.5.1-231, 2.5.1-232, and 2.5.1-235 provide the locations of diabase dikes within the HAR site. HAR FSAR Subsection 2.5.4.1.1 provides a description of soil and rock subsurface conditions encountered in the HAR 2 and HAR 3 boreholes (a few pages). A detailed description of the site geologic setting (based on literature sources and field reconnaissance by Geomatrix) is presented in HAR FSAR Subsection 2.5.1.2. This section includes descriptions of site area joint sets identified during field reconnaissance surveys. The following additional documents provide information on discontinuity on fractures, joints, and bedding planes: HAR FSAR Figures 2.5.4-216A & 216B – "Stereonet Plot of Acoustic Log Bedding Planes and Fractures" – at HAR 2 and HAR 3. These figures indicate dip and direction of discontinuity features at each HAR site, based on acoustic logging at three deep boreholes per HAR site. HAR FSAR Appendix 2BB – "Borehole Logs" – Inspection of borehole logs indicates that full recovery was predominantly obtained in the rock cores. Where full recovery was obtained, this indicates that discontinuities are either closed or have very small opening apertures. Thin clay seams were observed in isolated intervals below top of sound rock at most boreholes. In the few locations where less than full recover was observed, the missing recovery may be interpreted as an opening, a washed-out clay interval, or rock broken off the core and not recovered.	D. Barnhurst

20 cont'd	2.4.12	Groundwater Hydrology	The GeoVision acoustic televiewer logs (in FSAR References 2.5.4-226 and 2.5.4-227 [338884-EDF-003, Rev. D]) provide oriented, scaled 360-degree pseudo-color images of the rock core walls at three deep boreholes per HAR site. A few thin voids were identified on these logs, typically oriented with bedding planes, which may be interpreted either as true openings or as washed-out clay seams. These logs also indicate that the high-angle fractures, where encountered, are typically tight with no to very small apparent aperture. **Groundwater** HAR FSAR Subsection 2.4.12.1 provides a description of the regional and HAR site groundwater systems (includes descriptions of the regolith and bedrock). HAR FSAR Subsection 2.4.12.2.2 provides a description of the groundwater levels and movement at the HAR site. HAR FSAR Subsection 2.4.12.2.3 provides descriptions of site hydrogeological characteristics. HAR FSAR Figures 2.4.12-203 through 2.4.12-210 show the locations of the monitoring wells associated with the HAR and HNP site and groundwater elevations for each of the quarterly gauging events. HAR Table 2.4.12-208 – "Slug Test Results Data Reduction" HAR Table 2.4.12-209 – "Groundwater Linear Flow Velocity" **NRC Comments:** Linked to 15 and 18 Information needs RESOLVED based on discussions and review of ~~presented~~ information presented during the site audit.	

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21	2.4.12	Groundwater Hydrology	**Provide a SME to discuss results of the pump test described in Section 2.4.12.2.3.** **Applicant Response:** The original well test data packages for the HNP "24-hour driller's test" could not be located. This information was consistent with the HAR site analysis and not the basis for HAR calculations or conclusions. However, results for the down-hole pressure tests in boreholes were found. HNP FSAR Subsection 2.4.13.2.3 describes aquifer characteristics at the HNP site. HNP FSAR Table 2.4.13-7 – "Permeability of Plant Site Materials Based on Down-hole Pressure Tests*" HNP FSAR Subsection 2.5.1.2.5 provides details concerning the down-hole pressure tests conducted for HNP 1. HNP FSAR Figure 2.5.1-14 shows locations of the borings within the immediate vicinity of HNP 1. HNP Appendix 2.5A contains the results from the down-hole pressure tests for boreholes associated with HNP 1. HAG-0000-X7C-001, Rev. 1 – "Calculation for Groundwater Slug Tests" **NRC ~~comments~~Comments:** Information needs RESOLVED based on discussion and material presented ~~at~~ during the site audit.	D. Barnhurst

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22	2.4.12	Groundwater Hydrology	**Provide a SME to discuss differences in well yields for wells installed in Triassic Formations as described in Sections 2.4.12.1.1 and 2.4.12.2.3.** **Applicant Response:** Multiple references explain the most important factor pertaining to well yields within the Triassic Basin is the location of the well(s). Fractures within the parent material caused by the intrusion of diabase dikes provide the most available groundwater. Therefore, wells installed near or adjacent to a diabase dike normally will have higher well yields. HAR FSAR Subsection 2.4.12.1.1 – "Maximum well yields in the Triassic age sedimentary rocks are typically less than 94.6 l/min (25 gpm), with average yields less than 37.9 l/min (10 gpm) (Reference 2.4-239)." 2.4-239 *CDM – Wake County, North Carolina, "Comprehensive Groundwater Investigation, Final Report," June 2003.* HAR FSAR Subsection 2.4.12.2.3 – "Yields from known wells in the area generally range up to 75.7 l/min (20 gpm), but average only about 18.9 l/min (5 gpm) or about 0.03 gallons per minute per foot (gpm/ft) of well. Of 57 wells with an average depth of 48.2 m (158 ft.) constructed in the Triassic formation in western Wake County, 16 percent yield less than 3.8 l/min (1 gpm) (Reference 2.4-240)." 2.4-240 *North Carolina Department of Water Resources (NCDWR), Division of Ground Water, "Geology and Ground-water Resources in the Raleigh Area, North Carolina," Ground Water Bulletin No. 15, 1968.* "Generally, the principal areas of groundwater storage in the Triassic basin are found near diabase dikes that have intruded the Triassic sediments. During construction of the HNP, 20 water wells were installed near the diabase dikes to provide water for use during construction activities. These water wells were abandoned or removed from service during HNP's operational status. Based on a total capacity of 757 l/min (200 gpm) for seven wells completed in 1973 and a total capacity of 946 l/min (250 gpm) for eight wells completed over the 1977 to 1979 period, the average discharge rate for the 15 wells was approximately 113.6 l/min (30 gpm)." Source: HNP FSAR HAR FSAR Reference 2.4-236 explains diabase dikes in more detail. **NRC Comments:** Information needs RESOLVED based on discussions and information presented ~~at~~ during the site audit.	D. Barnhurst

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23	2.4.12	Groundwater Hydrology	**Provide a SME to discuss impact of fill to be used at HAR 2/3 on groundwater flow fields.** **Applicant Response:** The proposed nominal plant grade elevation for the HAR site is 261 ft. NGVD29. During construction of HAR 2 and HAR 3, the regolith and upper portions of the bedrock will be excavated and removed from areas above design elevations and transported to areas with elevations below the nominal plant grade. Most of the "filling" will occur in the HAR 3 area. Since no outside fill is assumed to be used, the composition of the soil will remain the same after construction activities in the area of HAR 3 are complete. The properties of the soil will potentially be affected by compaction activities and thus decrease the infiltration and percolation rates. This effect will potentially attenuate surficial groundwater recharge and increase surface runoff. The composition of the native soil is predominately clay and silt with some sand. These characteristics based on the USDA soil summary table produce soils that have a natural hydraulic conductivity estimates ranging from E-03 to E-06 cm/sec. After construction activities, hydraulic conductivities are assumed to stay the same or possibly decrease by a magnitude; thus, possibly creating more restrictive conditions and slightly slower groundwater velocities. The fact that groundwater velocity will go from slow to slower is a minor issue. With this stated, slug tests conducted in the area of HAR 2, which contains disturbed native soils from the construction of HNP 1, estimated hydraulic conductivities within the surficial aquifer ranging from E-03 to E-05 cm/sec. Surficial aquifer wells MWA-7S and MWA-10S are located in an undisturbed portion of the site near HAR 3 and have hydraulic conductivity estimates of 5.2E-04 and 1.3E-03 cm/sec, respectively. Changes to hydraulic conductivity due to construction activities appear to be minor based on site specific data. The biggest change to the future groundwater flow fields based on native fill will be the removal of the fire protection ponds located north of HAR 3. Currently, these ponds help control groundwater potentiometric lines in this area. Once the ponds are removed and filled with native soil, potentiometric lines in this area are assumed to straighten and mirror the shoreline of the Main Reservoir. Based on site specific data and properties of the existing soil, the impact of the fill to be used at HAR 2/3 is assumed to have minor effects on future groundwater flow fields.	D. Barr

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23 cont'd	2.4.12	Groundwater Hydrology	Additional information includes: HAR Figure 2.4.12-201 – "HAR Site Soil Classification Map" HAR Table 2.4.12-201 – "U.S. Department of Agriculture (USDA) Soil Summary" HAR Table 2.4.12-208 – "Slug Test Results Data Reduction" HAR Table 2.4.12-209 – "Groundwater Linear Flow Velocity" HAR FSAR Figures 2.4.12-203 through 2.4.12-210 show the locations of the monitoring wells associated with the HAR and HNP site and groundwater elevations for each of the quarterly gauging events. **NRC ~~comments~~Comments:** Linked to 15 and 17 Information needs RESOLVED based on discussions and review of information presented ~~at~~ during the site audit.	

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24	2.4.12	Groundwater Hydrology	**Provide a SME to discuss the locations of permanent drainage ditches to be installed as part of HAR2/3 construction and analyses of impact to water table elevations and flow directions.** **Applicant Response:** The first step to understanding the impacts of the permanent drainage ditches to water table elevations and flow directions is reviewing the site conceptual model as discussed in *Information Need #15*. The key components for discussing this information need include understanding the topography, surficial potentiometric surface, and lithology associated with the northern area of the site. HAR FSAR Subsection 2.4.12.5 states, “Final grading of the plant site will result in a hydrologic alteration, including the permanent change in groundwater levels within the plant site from site grading and a series of stormwater drainage ditches. North of the plant site, the area is characterized as a topographic high (maximum ground surface elevation of approximately 91.4 m [300 ft.] NGVD29). As specified in Subsection 2.4.12.2.2, the water table in the vicinity of the HAR site is directly influenced by this topographic high and occurs as a ridge-like mound northwest of HAR 3. The position of the groundwater ridge marks a natural recharge area from which groundwater flows west toward the Auxiliary Reservoir, south toward the Emergency Service Water Discharge Channel, and east toward the Thomas Creek Branch of the Main Reservoir. After site grading, a series of stormwater drainage ditches will be constructed around and within the site to direct stormwater and intercepted groundwater away from HAR facilities. Stormwater drainage ditches installed approximately 182.9 m (600 ft.) and farther north of HAR 3 will have bottom elevations ranging from approximately 80.5 m (264 ft.) NGVD29 or lower, while drainage ditches as close as approximately 61.0 m (200 ft.) north of HAR 3 will have bottom elevations ranging from approximately 78.0 m (256 ft.) NGVD29 or lower (Figure 2.4.1-205). This network of stormwater drainage ditches will intersect the water table based on known groundwater elevations and effectively lower the existing water table within the vicinity of the HAR facilities.	D. Barnhurst

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24 cont'd	2.4.12	Groundwater Hydrology	The series of drainage ditches surrounding the plant construction areas and the HAR facilities will form a collective barrier for the flow of groundwater into and out of the HAR facility. Groundwater will migrate to the lower open elevations in the ditch bottoms, resulting in a final water table at or slightly higher than the ditch bottom elevations. The ditches encompass the plant facilities where the final grade elevations outside of the facility limits are higher than the final plant grade of 79.6 m (261 ft.) NGVD29. They will also intercept flow in the surficial aquifer towards HAR 2 and HAR 3. These ditches will act as a natural barrier to the groundwater flow, preventing it from passing into the plant area and raising the groundwater level above the ditch bottom elevations. The groundwater levels may rise during periods of intense precipitation, but these elevated levels will be temporary. Groundwater flow within the surficial material will be redirected towards these ditches and will ultimately discharge into the Main Reservoir. Groundwater elevations at HAR 3, which are expected to decrease to 78.0 m (256 ft.) NGVD29 or lower, meet the requirements for the AP1000 design as provided in the DCD. No dynamic water forces associated with normal groundwater levels will occur because of a higher finished plant grade." Additional information includes: Figures: Conceptual Grading and Drainage Plans HAG-0000-XG-001 through -013 **NRC ~~comments~~Comments:** Linked to 15 Information needs RESOLVED based on discussions and review of information presented ~~at~~ during the site audit.	

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25	2.4.12	Groundwater Hydrology	**Provide a SME to discuss details of monitoring programs described in Section 2.4.12.4 including~~:~~ (1) the well configuration, sampling frequency, sampling length, analytical suite for each monitoring program~~,~~; (~~(~~2) how the monitoring well network will be determined~~,~~; and (3) the limited nature of the operational monitoring program.** **Applicant Response:** Details for the HAR monitoring programs as described in HAR FSAR Subsection 2.4.12.4 are provided in HAR ER Chapter 6. **NRC ~~comments~~Comments:** RESOLVED based on discussions and review of information presented ~~at~~ during the site audit.	D. Barnhurst

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26	2.4.12/13	Groundwater Hydrology	**Provide a SME to discuss development of Alternate Conceptual Models to describe alternate flow and transport scenarios.** **Applicant Response:** The HAR FSAR postulates two groundwater transport paths for evaluation of a radwaste tank failure. Separate conceptual models are used because of differences in the transport flow paths. Both models include the effects of adsorption, dispersion and radiodecay. The first path considers a release to the surficial/overburden aquifer with flow surfacing in the Thomas Creek branch of the Main Reservoir. This is considered the most likely groundwater pathway should radioactive fluids escape from the plant. The model calculates the total amount of nuclides passing through an infinite plane boundary at the nearest location between assumed release point and Thomas Creek reservoir branch. The model includes the effects of dilution and hold-up in the Main Reservoir. Additional dilution from the Cape Fear River is included when assessing concentrations at the surface water user supply at Lillington, NC. The second groundwater path examines the effect of a release to the bedrock formation located below the plant safety-related structures. The bedrock formation is relatively impermeable; however, it is the source of water for residential and public domestic water wells. The transport path is characterized by a network of small cracks and fractures in the bedrock. Concentrations in wells sunk into the bedrock and located about 2 miles east of the site are calculated by this model. No additional dilution is credited. Both models use different parameter sets corresponding to the hydraulic, physical and nuclide absorption properties of the respective aquifer. HAR FSAR Subsections 2.4.13.1.1 and 2.4.13.1.3 describe the surficial aquifer model. HAR FSAR Subsections 2.4.13.1.2 and 2.4.13.1.3 describes the bedrock formation model. **NRC ~~comments~~Comments:** Linked to 15 and 18 Information needs RESOLVED based on discussions and review of information presented ~~at~~ during the site audit.	D. Barn

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27	2.4.12	Groundwater Hydrology	**Provide ~~an~~ a SME to discuss (1) how much groundwater levels in the site are expected to increase when the normal pool elevation of the Main Reservoir is increased from 220 ft to 240 ft, and (2) the methods and data that were used in estimating these increased groundwater levels.** **Applicant Response:** The first step to understanding the impact on groundwater levels from increasing the normal pool elevation from 220 feet NGVD29 to 240 feet NGVD29 is reviewing the site conceptual model as discussed in *Information Need #15*. The key components for discussing this information need include understanding the surficial and bedrock potentiometric surfaces and the lithology associated with the HAR site. HAR FSAR Subsection 2.4.12.2.2 states, "Current groundwater conditions are heavily influenced by surface water pressure from the Main Reservoir and the Auxiliary Reservoir. The HAR site and the HNP are bounded by the Auxiliary Reservoir to the northwest, west, southwest, and south (Emergency Service Water Intake Channel) and the Main Reservoir to the northeast, east, southeast, and south (Cooling Tower Makeup Water Intake Channel). The Emergency Service Water Discharge Channel separates the HAR site from the HNP on the western half of the plant site. The only area not bound by a surface water body is north of the HAR site. This area is characterized as a topographic high (maximum ground surface elevation of approximately 91.4 m [300 ft.] NGVD29). The water table in the vicinity of the HAR site is influenced by the topographic high and occurs as a ridge-like mound northwest of HAR 3. The position of the groundwater ridge marks a recharge area from which groundwater flows west toward the Auxiliary Reservoir, south toward the Emergency Service Water Discharge Channel, and east toward the Thomas Creek Branch of the Main Reservoir. Groundwater south of the Emergency Service Water Discharge Channel, which is influenced by the Auxiliary Reservoir, generally flows to the southeast and east toward the Thomas Creek Branch of the Main Reservoir. The current direction of groundwater flow beneath the site in the surficial/overburden and bedrock aquifers is east in the proposed locations of HAR 2 and HAR 3, and east and southeast at the HNP."	D. Barnhurst/ M McBride

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27 cont'd	2.4.12	Groundwater Hydrology	Based on surface water boundaries associated with the Auxiliary Reservoir (252 feet NGVD29) and the Main Reservoir (240 feet NGVD29), the groundwater ridge to the north of the site, and the lithology of the regolith and bedrock, the potentiometric surface (operational phase) for the HAR site is assumed to retain the same characteristics of the current potentiometric surface. The exceptions to this assumption include the effects associated with the drainage ditches north of HAR 3 and the addition of native fill to the east of HAR 3. Both of these issues are discussed in *Information Needs #24* and *#23*, respectively. Increasing the normal pool elevation in the Main Reservoir will effectively decrease the gradient across the HAR site, but the overall hydraulic heads dictating the direction of flow is assumed to remain constant. **NRC ~~comments~~Comments:** Linked to 15 Information needs RESOLVED based on discussions and review of information presented ~~at~~ during the site audit.	
28	2.4.12	Groundwater Hydrology	**Provide a~~n~~ SME to discuss (1) how groundwater levels in the site will be expected by removal of the hill north of the site and by installation of stormwater ditches, and (2) methods and data used in estimating effects on groundwater levels.** **Applicant Response:** The response for this information need is provided in *Information Need #24*. **NRC ~~comments~~Comments:** Linked to 15 Information needs RESOLVED based on discussions and review of information presented ~~at~~ during the site audit.	D. Barr M McBride

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29	2.4.12	Groundwater Hydrology	**Provide a~~n~~ SME to (1) discuss the basis for the statement that groundwater flow in the proposed locations of HAR 2 and HAR 3 is eastward, and (2) whether southward flow could occur from HAR 2 toward the Emergency Service Water Discharge Canal.** **Applicant Response:** The response for this information need is provided in *Information Need #27*. Further discussion will occur pertaining to the specific direction of groundwater flow for each HAR unit. **NRC ~~comments~~Comments:** : Linked to 15 and 18 Information needs RESOLVED based on discussions and review of information presented ~~at~~ during the site audit.	D. Barnhurst/ M McBride

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