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U.S. Nuclear Regulatory Commission
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Subject: Duke Energy Carolinas, LLC
William States Lee III Nuclear Station - Docket Nos. 52-018 and 52-019
AP1000 Combined License Application for the
William States Lee III Nuclear Station Units 1 and 2
Response to Request for Additional Information
(RAI No. 2685)
Ltr# WLG2009.07-09

Reference: Letter from Brian Hughes (NRC) to Peter Hastings (Duke Energy), Request for Additional Information Letter No. 070 Related to SRP 02.04.12 - Groundwater for the William States Lee III Units 1 and 2 Combined License Application, dated June 17, 2009

This letter provides the Duke Energy response to the Nuclear Regulatory Commission's requests for additional information (RAIs) included in the referenced letter.

The response to the NRC information requests described in the referenced letter are addressed in separate enclosures, which also identify associated changes, when appropriate, that will be made in a future revision of the Final Safety Analysis Report for the Lee Nuclear Station.

If you have any questions or need any additional information, please contact Peter S. Hastings, Nuclear Plant Development Licensing Manager, at 980-373-7820.

Bryan J. Dolan
Vice President
Nuclear Plant Development

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NRO

Enclosures:

1) Duke Energy Response to Request for Additional Information Letter 070, RAI 02.04.12-015
2) Duke Energy Response to Request for Additional Information Letter 070, RAI 02.04.12-016
3) Duke Energy Response to Request for Additional Information Letter 070, RAI 02.04.12-017
4) Duke Energy Response to Request for Additional Information Letter 070, RAI 02.04.12-018

AFFIDAVIT OF BRYAN J. DOLAN

Bryan J. Dolan, being duly sworn, states that he is Vice President, Nuclear Plant Development, Duke Energy Carolinas, LLC, that he is authorized on the part of said Company to sign and file with the U. S. Nuclear Regulatory Commission this supplement to the combined license application for the William States Lee III Nuclear Station and that all the matter and facts set forth herein are true and correct to the best of his knowledge.

Bryan J. Dolan

Subscribed and sworn to me on July 31, 2009

Phoebe P. Elliott

Notary Public

My commission expires: June 26, 2011

SEAL

xc (w/o enclosures):

Loren Plisco, Deputy Regional Administrator, Region II
Stephanie Coffin, Branch Chief, DNRL

xc (w/ enclosures):

Brian Hughes, Senior Project Manager, DNRL

Lee Nuclear Station Response to Request for Additional Information (RAI)

RAI Letter No. 070

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.12-015

NRC RAI:

In its independent review of the geologic information, the staff determined that there was uncertainty in the geologic materials that are present along each plausible groundwater pathway. The staff also determined that the major materials – the soil, saprolite, and PWR – were all exposed in the existing excavation and that a postulated leak could enter any of these materials. Because the exact geologic structure of the Lee Nuclear site is uncertain, the applicant should assume the presence of the PWR material (the most highly conductive of the three materials) for all pathways, or justify why the materials assumed present along each pathway in the FSAR analysis are conservative.

Duke Energy Response:

Groundwater exists at the Lee Site as a single undifferentiated aquifer, comprised of soils, saprolite, partially weathered bedrock (PWR), and competent bedrock. Typical of Piedmont terrain, the relative thicknesses and characteristics of each of these zones vary across the site. All of these materials are exposed in the existing excavation. Duke has thoroughly characterized the site through an extensive program of borings, wells, test pits, geophysical testing, *in situ* and laboratory testing and analyses of soil and geologic materials. This work has shown that the aquifer is principally comprised of saprolite and PWR zones. Site-specific hydraulic conductivity test results and available literature from hydrogeological studies conducted in similar Piedmont soil and rock environments (References 1 and 2) demonstrate that transport characteristics of the PWR, where such conditions occur, can produce groundwater flow velocities higher than for the saprolite zone. Although the aquifer has been shown to be comprised of a mixture of weathered materials, Duke acknowledges that a conservative approach to the calculation of potential contaminant transport velocities is to use the somewhat higher hydraulic conductivity and effective porosity values of PWR for all evaluated release scenarios.

As discussed in FSAR Subsection 2.4.12.3.2, groundwater velocities have been determined for five distinct postulated flow-paths, each from one of the reactor buildings to a downgradient receptor. Although the aquifer is comprised of primarily saprolite and PWR, use of the PWR values for hydraulic conductivity and effective porosity provides a conservative estimate of time of travel for each of the five groundwater pathways. Based on revised calculations, the limiting groundwater pathway for the evaluated postulated release is Pathway 1, from the Unit 2 Radwaste Storage Tank to Hold-Up Pond A. Using the hydraulic conductivity and effective porosity of PWR, and currently known design features, groundwater is estimated to reach this postulated receptor in approximately 1.35 years.

FSAR Subsection 2.4.12.3.2 will be revised to reflect the re-evaluation of flow pathways assuming conductivities and effective porosities consistent with PWR characteristics. FSAR

Figure 2.4.12-205 will be revised to reflect the limiting pathway discussed above, as well as other changes discussed in the response to RAI 2.4.12-016 (this letter). FSAR Table 2.4.12-204 will be revised to reflect this RAI response more clearly. The revisions to FSAR Table 2.4.12-204 are included as an attachment to the response to RAI 02.04.12-016 (this letter). Additional revisions to FSAR Subsection 2.4.12.3.3 and 2.4.12.5 will be made, unrelated to this RAI, to correct the discussion regarding the lateral area of influence of the excavation and hydrostatic loading. These changes will be reflected in a future revision to the FSAR.

References:

1) Daniel, C. C. III et al., "Ground Water in the Piedmont, Proceedings of a Conference on Ground Water in the Piedmont of the Eastern United States," Clemson University, October 1989.

2) Schaffer, M. F., "Hydraulic conductivity of Carolina Piedmont soil and rock: Is a transition zone present between the regolith and bedrock?," 17th Annual Hydrogeology Symposium, Clemson, April 2009.

Associated Revisions to the Lee Nuclear Station Final Safety Analysis Report:

FSAR Subsection 2.4.12.3.2

FSAR Subsection 2.4.12.3.3

FSAR Subsection 2.4.12.5

FSAR Figure 2.4.12-205, Sheets 2, 3 and 4

Attachments:

1) Revision to FSAR Subsection 2.4.12.3.2
2) Revision to FSAR Subsection 2.4.12.3.3
3) Revision to FSAR Subsection 2.4.12.5
4) Revision to FSAR Figure 2.4.12-205, Sheets 2, 3 and 4

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 1 to RAI 02.04.12-015

Revision to FSAR Subsection 2.4.12.3.2

COLA Part 2, FSAR Chapter 2, Subsection 2.4.12.3.2, 2nd, 3rd and 4th paragraphs, will be revised, as follows:

After construction dewatering and the return to static conditions, the potentiometric surface beneath in the area of the reactor buildings is expected to rebound to a maximum elevation of approximately 584 ft. above msl. These conditions reflect the maximum anticipated groundwater level during operations. Based on the preceding discussion of hydraulic conductivity (Subsection 2.4.12.2.4.2), effective porosity (Subsection 2.4.12.2.4.1) and hydraulic gradients (derived from Figure 2.4.12-204, Sheet 8), groundwater velocities were determined for multiple flow paths. For example, one projected groundwater flow path (Pathway 1) is to the north from the Unit 2 reactor building to Hold-Up Pond A, with an average projected gradient of approximately 0.040 ft/ft and a distance to a potential exposure point of 1250 ft., which is the shortest of the flow paths evaluated. Another flow path (Pathway 2) from the Unit 2 reactor building to the Broad River, through partially weathered rock, had a faster travel time to the point of exposure because of greater hydraulic conductivity, even though it has a greater distance of 1935 ft. These two pathways are shown in Table 2.4.12-204.

Three additional pathways were evaluatedTravel distances for contaminants from postulated release points at the reactors to downgradient receptors were to determine the most conservative travel pathway from potential points of release to exposure points, based on hydrogeologic conditions. The distances through the various aquifer materials in which groundwater movement occurs were estimated from site information from cross-sections for each of five possible flow-paths. , allowing travel times for each alternative flow path to be determined. In summary Although the aquifer is comprised principally of saprolite and PWR, the more conservative PWR values for hydraulic conductivity and effective porosity- were used in the analysis of groundwater velocities. , the eEstimated travel times for the alternative five groundwater pathways flow paths are as follows:

- Pathway 1: Groundwater travels from Unit 2 to Hold-Up Pond A in approximately 7.21.35 years.
- Pathway 2: From Unit 2 to the Broad River in approximately 2.835 years.
- Pathway 3: From Unit 2 to Make-Up Pond A in approximately 23 4.04 years.
- Pathway 4: From Unit 1 to the non-jurisdictional wetland area in approximately 53 4.86 years.
- Pathway 5: From Unit 1 to Make-Up Pond B in approximately 9.85.06 years.

These pathways flow paths are represented on Figure 2.4.12-208. The results of theThis -analysis identified indicates the conservative limiting flow path for the evaluateda postulated release to be from the Unit 2 radwaste storage tank to Hold-Up Pond A the Broad River (Pathway 21, Figure 2.4.12--205, Sheet 3).

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 2 to RAI 02.04.12-015

Revision to FSAR Subsection 2.4.12.3.3

COLA Part 2, FSAR. Chapter 2, Subsection 2.4.12.3.3, second paragraph, will be revised, as follows:

~~Though m~~Most domestic wells in the vicinity of the Lee Nuclear Site are completed as either shallow bored wells, or deeper drilled wells. ~~to depths less than 150 ft. below ground surface~~Shallow bored wells are usually completed in the saprolite zone, typically no deeper than 75 ft. Deeper drilled wells are installed in the PWR and fractured bedrock zones. Both types of wells generally have yields of 5-10 gpm, or less. Using these conditions~~, this depth~~ provides a conservative estimate of the potential reach of a typical domestic well producing at full capacity. Assuming the hydraulic conductivities are consistent with partially weathered rock, as listed in Table 2.4.12-204, the radius of influence is ~~less than~~approximately 1700 ft. (0.32 mi.) from these wells. The ~~maximum radius~~lateral area of influence of the dewatered excavation is ~~less than~~approximately ~~1~~500 ft. (0.095~~28~~ mi.). ~~The calculated radius of influence is consistent with historical drawdown observations.~~

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 3 to RAI 02.04.12-015

Revision to FSAR Subsection 2.4.12.5

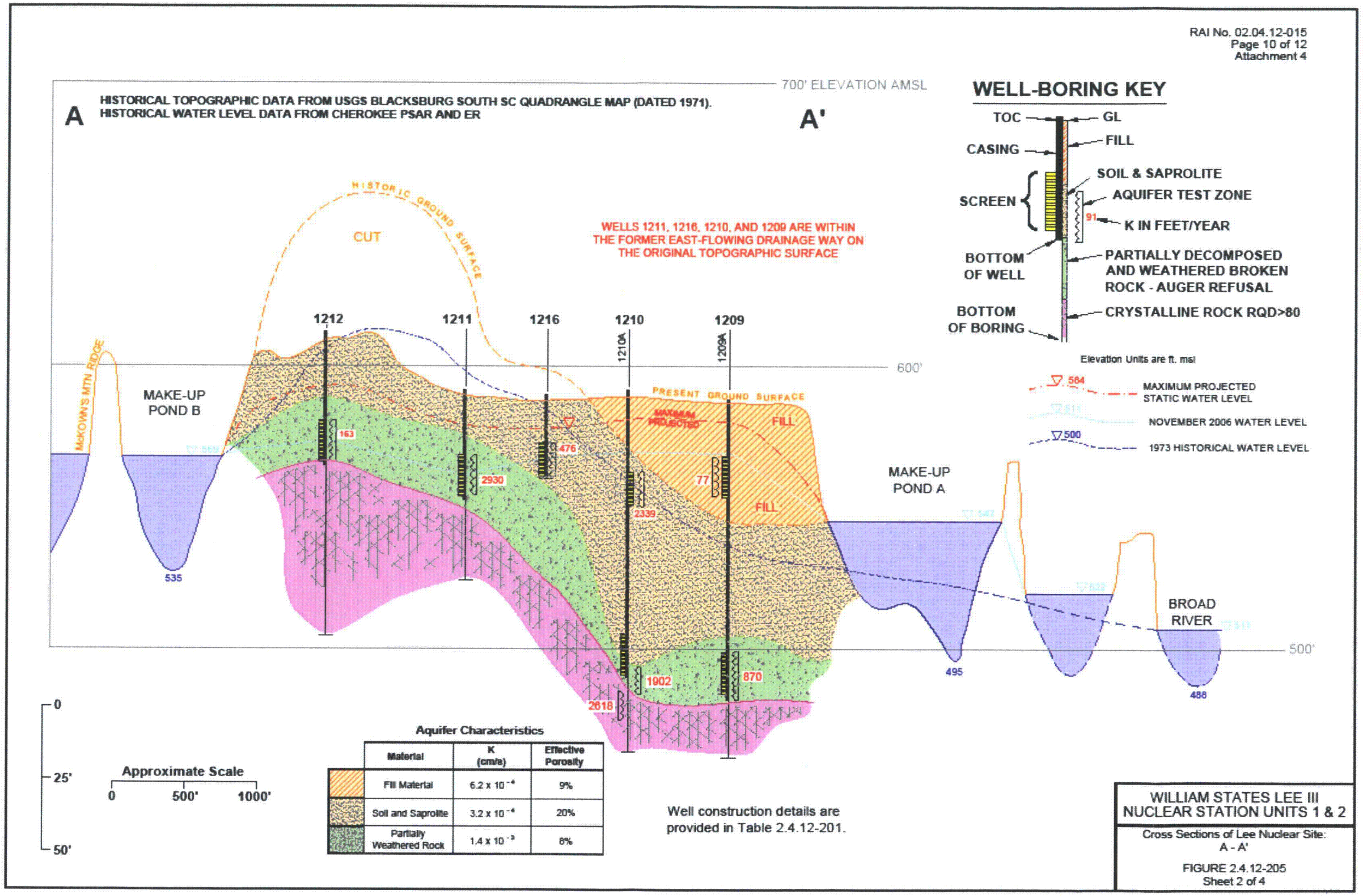
COLA Part 2, FSAR. Chapter 2, Subsection 2.4.12.5, first paragraph, will be revised, as follows:

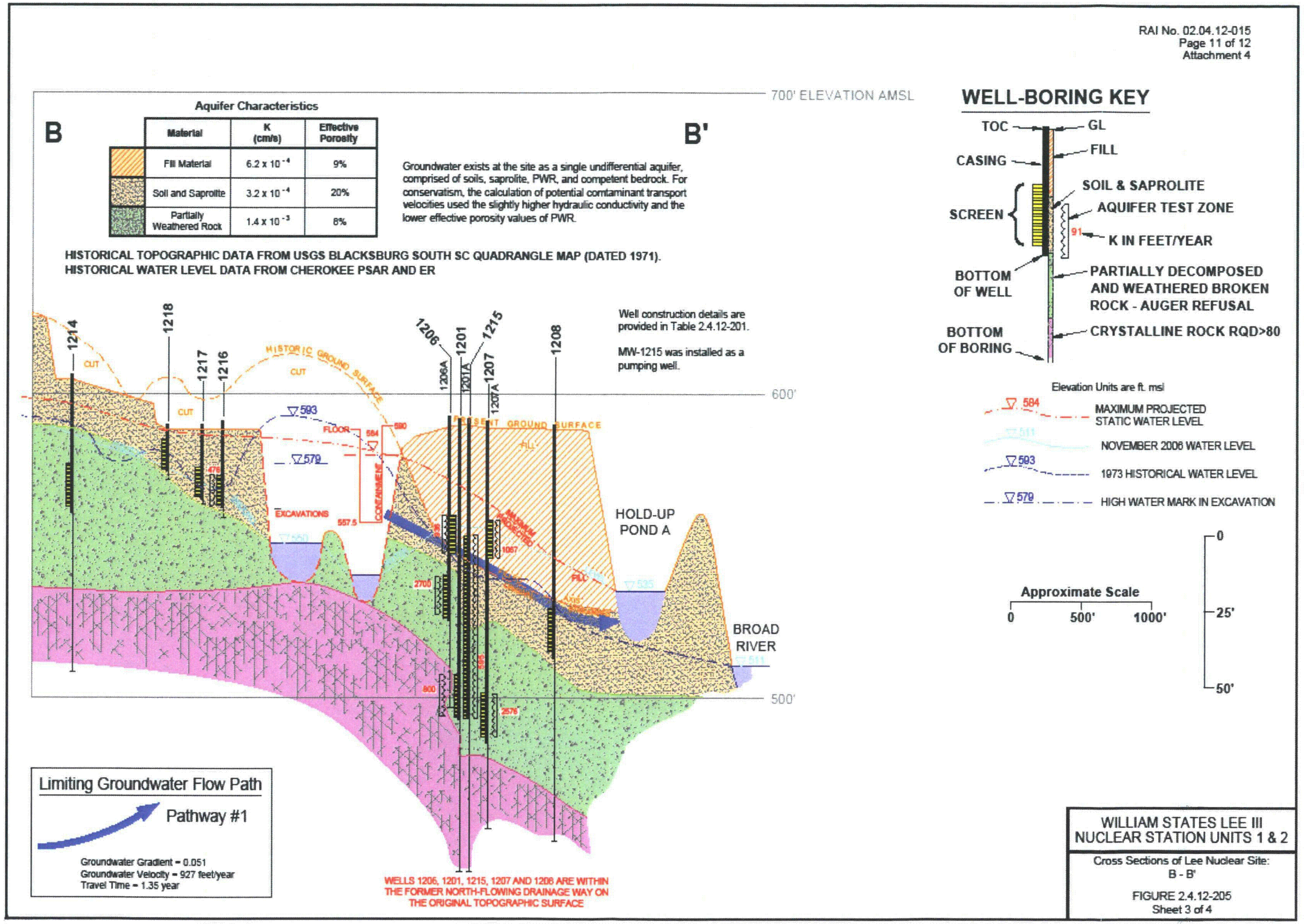
According to the AP1000 Design Control Document (DCD), the design maximum groundwater elevation is 2 ft. below yard grade elevation. The Lee Nuclear Station plant elevation is 590.0 ft. above msl and the yard grade is 589.5 ft. above msl, therefore, the design maximum groundwater elevation is 587.5 ft. above msl. The maximum static groundwater level anticipated in the vicinity of Units 1 and 2 power blocks during operations is expected to be ~~around~~ a maximum of 584 ft. ~~above~~ msl. (Figure 2.4.12-204, Sheet 8). The hydrostatic loading is not expected to exceed design criteria. An unsaturated zone of ~~since~~ at least 5 ft. below grade level will be maintained during operations. ~~of unsaturated interval are expected below the design basis groundwater elevation.~~ The installation and operation of a permanent dewatering system is not a facility design requirement. ~~expected.~~

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 4 to RAI 2.4.12-015

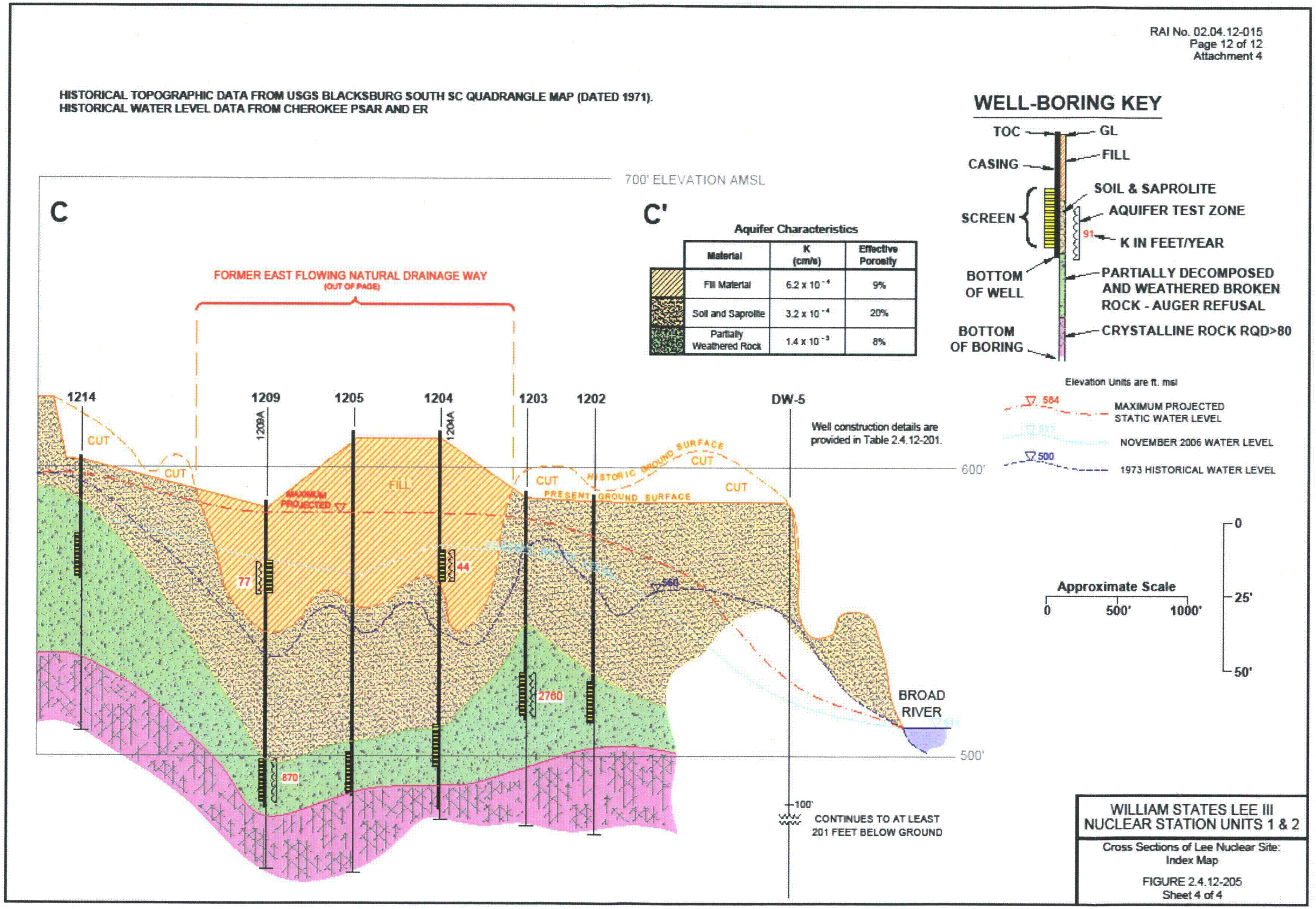
Revision to FSAR Figure 2.4.12-205 (Sheets 2, 3 and 4)


RAI No. 02.04.12-015
Page 10 of 12
Attachment 4
A
A'
700' ELEVATION AMSL
HISTORICAL TOPOGRAPHIC DATA FROM USGS BLACKSBURG SOUTH SC QUADRANGLE MAP (DATED 1971).
HISTORICAL WATER LEVEL DATA FROM CHEROKEE PSAR AND ER
HISTORIC GROUND SURFACE
CUT
WELLS 1211, 1216, 1210, AND 1209 ARE WITHIN THE FORMER EAST-FLOWING DRAINAGE WAY ON THE ORIGINAL TOPOGRAPHIC SURFACE
1212
1211
1216
1210
1209
1210A
1209A
600'
500'
PRESENT GROUND SURFACE
MAXIMUM PROJECTED
FILL
MCKOWN'S MTN RIDGE
MAKE-UP POND B
MAKE-UP POND A
BROAD RIVER
535
495
488
163
476
2930
2339
77
1902
870
2618
WELL-BORING KEY
TOC
GL
FILL
CASING
SOIL & SAPROLITE
SCREEN
AQUIFER TEST ZONE
K IN FEET/YEAR
BOTTOM OF WELL
PARTIALLY DECOMPOSED AND WEATHERED BROKEN ROCK - AUGER REFUSAL
BOTTOM OF BORING
CRYSTALLINE ROCK RQD>80
Elevation Units are ft. msl
MAXIMUM PROJECTED STATIC WATER LEVEL
NOVEMBER 2006 WATER LEVEL
1973 HISTORICAL WATER LEVEL
0
25'
50'
Approximate Scale
0
500'
1000'
Aquifer Characteristics
Material | K (cm/s) | Effective Porosity
Fill Material | 6.2 x 10⁻⁴ | 9%
Soil and Saprolite | 3.2 x 10⁻⁴ | 20%
Partially Weathered Rock | 1.4 x 10⁻³ | 8%
Well construction details are provided in Table 2.4.12-201.
WILLIAM STATES LEE III NUCLEAR STATION UNITS 1 & 2
Cross Sections of Lee Nuclear Site: A - A'
FIGURE 2.4.12-205
Sheet 2 of 4



Aquifer Characteristics

Material	K (cm/s)	Effective Porosity
Fill Material	6.2×10^{-4}	9%
Soil and Saprolite	3.2×10^{-4}	20%
Partially Weathered Rock	1.4×10^{-3}	8%



Aquifer Characteristics

Material	K (cm/s)	Effective Porosity
Fill Material	6.2×10^{-4}	9%
Soil and Saprolite	3.2×10^{-4}	20%
Partially Weathered Rock	1.4×10^{-3}	8%

Lee Nuclear Station Response to Request for Additional Information (RAI)

RAI Letter No. 070

NRC Technical Review Branch: Hydrologic Engineering

Reference NRC RAI Number(s): 02.04.12-016

NRC RAI:

In its independent review of the hydraulic conductivity data, the staff determined that the unconsolidated material had the highest measured hydraulic conductivity, but this material did not show up in the three cross-sections provided in the applicant's FSAR. Because the value was higher than the conductivity for PWR and could, if used, yield a shorter and more conservative groundwater travel time, the applicant should identify the lateral and vertical extent of the unconsolidated material and re-evaluate the pathway analysis, or justify why the unconsolidated material is not relevant to any of the plausible groundwater pathways.

Duke Energy Response:

During the Cherokee-era site investigations, observation wells were installed so that the screened zone bracketed the entire saturated interval of the aquifer, to depths of up to 100 ft. While these wells recognize one undifferentiated aquifer zone, measurements of aquifer characteristics from these wells cannot distinguish the respective hydraulic properties of the saprolite and partially-weathered rock (PWR) portions of the aquifer system. As a result, the hydraulic conductivities calculated during these aquifer tests were listed in the FSAR as representing "unconsolidated" material. The term "unconsolidated," relative to the Piedmont, refers to the regolith, or those components of the weathered geologic profile situated above the hard, competent and consolidated bedrock (References 1 and 2). In 2006, the Lee Site investigation further characterized specific zones of the Piedmont aquifer. The geologic logs from both the Cherokee-era investigations, as well as the 2006 investigations, were used to develop geologic cross-sections presenting actual site conditions. Three cross-sections (FSAR Figure 2.4.12-205, Sheets 2, 3 and 4) present Duke's interpretation of site soil and geologic conditions and differentiate between the distinct geologic materials present at the site.

The well and aquifer testing conducted at the Lee Site in 2006 indicate that the PWR zone generally has higher hydraulic conductivity values than the saprolite zone. Based on extensive review of well and aquifer testing, and screening and analysis of conductivity results, a scientifically sound and defensible data set was evaluated to determine a conservative hydraulic conductivity (K) value for the PWR zone (1.4×10^{-3} cm/s). This value is consistent with the results of the 2006 aquifer test and reflects wells designed specifically to evaluate the PWR portion of the aquifer. For purposes of comparison to the entire population of PWR hydraulic conductivity values derived from the Cherokee- and Lee-era studies, the representative value of 1.4×10^{-3} cm/s is approximately 9.1 times greater than the median value of 1.54×10^{-4} cm/s.

FSAR Subsections 2.4.12.2.4.1 and 2.4.12.2.4.2, FSAR Tables 2.4.12-203 and 2.4.12-204 and FSAR Figure 2.4.12-205 (Sheets 2, 3 and 4) will be revised, changing the term "unconsolidated" to "undifferentiated" or removing the term, as appropriate. Additional revisions to FSAR Subsection 2.4.12.2.4.1 and FSAR Table 2.4.12-203 will include reporting the corrected soil and rock characteristics. An additional resource cited in the text edit to Section 2.4.12.2.4.1 will also be added to Section 2.4.16. The revisions to FSAR Figure 2.4.12-205 (Sheets 2, 3 and 4) are included as an attachment to the response to RAI 02.04.12-015 (this letter). The identified changes will be incorporated in a future revision of the Final Safety Analysis Report.

References:

1) U.S. Geological Survey, HA 730-G Piedmont and Blue Ridge aquifers text, http://capp.water.usgs.gov/gwa/ch_g/G-text8.html, accessed November 30, 2007.
2) LeGrand, Harry E. Sr., *A Master Conceptual Model for Hydrogeological Site Characterization in the Piedmont and Mountain Region of North Carolina,* North Carolina Department of Environment and Natural Resources, Division of Water Quality, Groundwater Section, 2004.

Associated Revisions to the Lee Nuclear Station Final Safety Analysis Report:

FSAR Subsection 2.4.12.4.1

FSAR Subsection 2.4.12.2.4.2

FSAR Subsection 2.4.16

FSAR Table 2.4.12-203

FSAR Table 2.4.12-204

FSAR Figure 2.4.12-205 (Sheets 2, 3 and 4)

Attachments:

1) Revision to FSAR Subsection 2.4.12.2.4.1
2) Revision to FSAR Subsection 2.4.12.2.4.2
3) Revision to FSAR Table 2.4.12-204
4) Revision to FSAR Subsection 2.4.16
5) Revision to FSAR Table 2.4.12-203

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 1 to RAI 2.4.12-016

Revision to FSAR Subsection 2.4.12.2.4.1

COLA Part 2, FSAR Chapter 2, Subsection 2.4.12.2.4.1, will be revised as follows:

Site-specific ~~soils~~ subsurface materials in the area surrounding the power block include fill, ~~residuum~~ residual soil, ~~and~~ saprolite, and partially weathered rock. ~~Fill materials are located in former drainage ways, which have been built up to existing elevation.~~ Based on the results of the geotechnical investigation~~analyses of saturated and unsaturated (vadose zone) materials~~, ~~average~~ representative engineering properties of the soils~~soil characteristics~~ were determined according to methods described in Subsection 2.5.4.2. Characterization of porosity and effective porosity were made using the data provided in Table 2.5.4-211.

~~For fill material, a mean total porosity of 41 percent with a range from 33 percent to 55 percent, was calculated (Table 2.4.12-203). Based on the difference between total porosity and residual water content, the effective porosity was estimated to be 31 percent.~~ Fill materials are located in former drainage ways, which were built up to existing elevations during Cherokee construction. Based on the specific gravity (particle density, 2.71 grams per cubic centimeter, g/cc) and dry unit weight (101 pounds per cubic foot, pcf) provided for fill material, a mean total porosity of 40 percent was determined (Table 2.4.12-203). The effective porosity is assumed to be equivalent to specific yield, and was estimated using grain size distribution described within Water Supply Paper 1662-D (Reference 299). This technique indicates effective porosity was estimated to be 9 percent. Fill materials have been ~~borrowed~~cut from other areas of the site, and they are typically comprised of ~~unconsolidated~~undifferentiated materials (residual soils, saprolite and/or PWR) similar to native ~~soil~~materials. ~~However, because of disturbance during transport, they may display different hydrogeological characteristics.~~

The residual soils have undergone relatively complete weathering and lack the relict features found in the saprolite zone. Saprolite is the isovolumetrically weathered zone which does not reflect the characteristics of surficial soil development processes, but does reflect some of the physical properties of the underlying parent rock from which it was formed. ~~Based on data available from~~ According to the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), ~~residuum~~surficial soils in the vicinity of the power block area ~~consists~~ consisted predominantly of Tatum silty clay loam and Tatum very fine sandy loam with variable slope and erosion (Figure 2.4.12-206). Tatum soils are well-drained (not seasonally saturated) and are typically derived from sericite schist, phyllite, and/or other related metamorphic rocks of the Piedmont. Tatum soils are typically composed of a surficial 0 - 8 in. ~~of~~ silty clay loam or very fine sandy loam (CL, CL- ML, ML). These soil horizons grade subsoils of ~~overlying~~ clay, silty clay, and/or silty clay loam (CH, MH) ~~overlying shallow, weathered bedrock or silt loam~~. Clay content in the subsoil stratum of Tatum soils ranges from 12 to 60 percent. Tatum soils transition at depths of 45-60 inches to saprolite materials reflecting the characteristics of the underlying parent rock. ~~Moist bulk densities were reported between 1.30 and 1.60 grams per cubic centimeter (g/cc).~~ The saturated hydraulic conductivity of Tatum soils is reported by the NRCS to be moderately permeable: 4 to 14 micrometers per second (μ~~m~~m/s) (4 to 14 x 10~~-4~~$^{-4}$ centimeters per second [cm/s]). Tatum soils are not prone to flooding and exhibit erosion factors (Kf) that range from 0.32 to 0.43. The soils are highly corrosive to both concrete and steel (Reference 278). Based on geotechnical analyses of both the ~~residuum~~residual soil and saprolite, a mean total porosity of 45~~8~~ percent ~~with a range from 46 percent to 51 percent~~ was ~~determined~~ estimated for these materials.

The effective porosity was estimated to be approximately 2017 percent. The native soils in the immediate area of the power block were essentially completely removed or mixed with deeper saprolite materials to become site fill materials during Cherokee-era activities. Regardless, knowledge of the natural properties of these surface soil materials is useful in understanding characteristics of site soils, and conditions in the undisturbed portions of the site.

~~The mean total porosity measured in saprolite was 44 percent. A range from 30 percent to 54 percent was determined for these materials. Based on geotechnical analyses, the effective porosity was conservatively estimated to be 22 percent.~~ Partially weathered rock (PWR) is a transitional weathering zone between the saprolite and the hard, competent, underlying bedrock. The PWR materials are similar to the overlying saprolite zone, but include more fragments of less weathered and less porous rock. Partially weathered rock was conservatively estimated to have an effective porosity of 188 percent. This value is based on the free drainage (specific yield) represented by the difference between saturated unit weight (140 pcf) and the wet unit weight (135 pcf) . The total porosity of partially weathered rock, based on saturated unit weight, is estimated to be 27 percent.

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 2 to RAI 2.4.12-016

Revision to FSAR Subsection 2.4.12.2.4.2

COLA Part 2, FSAR Chapter 2, Subsection 2.4.12.2.4.2, third paragraph, fourth bullet, will be revised as follows:

Values of ~~Reported~~ hydraulic ~~conductivities~~ conductivity reported in the Cherokee-era studies representing the upper 100 ft. of the ~~unconsolidated~~ saturated interval. This undifferentiated aquifer zone is~~,~~ comprised of residual soil, saprolite, and partially weathered rock. The resultant hydraulic conductivity values range from 2.21 x 10^{-4} cm/s to 3.90 x 10^{-3} cm/s ~~with a median hydraulic conductivity for the unconsolidated material of 4.10 x 10^{-4} cm/s. For samples exceeding the median hydraulic conductivity of the data set, the geometric mean (2.6 x 10^{-3} cm/s) represents a conservative hydraulic conductivity value for the unconsolidated materials~~. These results are consistent with and support the recent findings of the Lee-era site investigation. These more recent studies determined the hydraulic conductivity of PWR, the most hydraulically conductive aquifer material, to be 1.4 x 10^{-3} cm/s.

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 3 to RAI 2.4.12-016

Revision to FSAR Table 2.4.12-204

COLA Part 2, FSAR Chapter 2, Table 2.4.12-204 will be revised as follows:

COL 2.4-4

TABLE 2.4.12-204
AQUIFER CHARACTERISTICS

Material	Hydraulic Conductivity (K) Minimum	Median	Conservative Estimate	Maximum	Source
Saprolite/Soil K_v	2.45×10^{-8}	2.10×10^{-6}	4.4×10^{-5}	2.55×10^{-4}	1973 investigation laboratory analyses.
Saprolite/Soil K_h	9.67×10^{-7}	6.38×10^{-6}	3.2×10^{-4}	2.26×10^{-3}	1973 investigation field tests and 2006 slug tests.
Bedrock - PWR K_h	9.67×10^{-7}	1.54×10^{-4}	1.4×10^{-3}	9.89×10^{-3}	1973 investigation packer tests and 2006 slug, aquifer, and packer tests.
~~Unconsolidated~~ Undifferentiated-Material	2.21×10^{-4}	4.10×10^{-4}	2.6×10^{-3}	3.90×10^{-3}	1973 aquifer tests ~~and 2006 pumping well~~.
Fill Material	4.22×10^{-5}	1.81×10^{-4}	6.2×10^{-4}	1.03×10^{-3}	2006 slug tests.

Units are in centimeters per second (cm/sec).
PWR – Partially weathered rock.
K_v - Vertical hydraulic conductivity.
K_h - Horizontal hydraulic conductivity.

Conservative Estimate - The geometric mean of samples exceeding the median
Conservative Estimate for Bedrock K_h was obtained from results of 2006 pump test.
Conservative Estimates were used to calculate the groundwater velocity
~~Unconsolidated~~ Undifferentiated Material –identification used for 1973 data where well screens bracketed the entire saturated zone, and did not differentiate between the fill material, soil, saprolite, or or partially weathered rock.

Delete Sheet 2 of 2.

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 4 to RAI 2.4.12-016

Revision to FSAR Subsection 2.4.16

COLA Part 2, FSAR Chapter 2, Subsection 2.4.16, will be revised to add a new reference as follows:

299. U.S. Department of Interior, Johnson A.I., "Specific Yield – Compilation of Specific Yields for Various Materials", Geological Survey Water Supply Paper 166-D, prepared in accordance with California Department of Water Resources, 1967, Table 1.

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 5 to RAI 2.4.12-016

Revision to FSAR Table 2.4.12-203

TABLE 2.4.12-203

SOIL CHARACTERISTICS AT THE LEE NUCLEAR

(Reported values are mean ± one standard deviation)

		All Fill Samples(a)			Test Fill Only	Remolded Fill(b)	Residual Soil			Saprolite			PWR
		N60 ≤ 10 (N ≤ 8)(c)	11 < N60 ≤ 30 (8 < N ≤ 23)(c)	31 < N60 ≤ 100 (23 < N ≤ 75)(c)	10 < N60 ≤ 30 (8 < N ≤ 23)(c)	N/A (N/A)	N60 ≤ 10 (N ≤ 8)(c)	11 < N60 ≤ 30 (8 < N ≤ 23)(c)	31 < N60 ≤ 100 (23 < N ≤ 75)(c)	N60 ≤ 10 (N ≤ 8)(c)	11 < N60 ≤ 30 (8 < N ≤ 23)(c)	31 < N60 ≤ 100 (23 < N ≤ 75)(c)	N60 > 100 (N > 75)(c)
Percent gravel(d)	%	0(e) [1]	4 ± 6 [36]	6 ± 8 [6]	10 ± 7 [6]	3 ± 7 [9]	0 [1]	0 [4]	0 [1]	3 ± 3 [8]	3 ± 7 [20	1 ± 1 [11]	9 ± 14 [8]
Percent sand(d)	%	42(e) [1]	34 ± 8 [36]	47 ± 19 [6]	33 ± 11 [6]	34 ± 12 [9]	57(e) [1]	46 ± 15 [4]	40(e) [1]	44 ± 11 [8]	52 ± 12 [20]	52 ± 13 [11]	55 ± 19 [8]
Percent fines (<#200 sieve)(d)	%	58(e)[1]	62 ± 11 [36]	47 ± 21 [6]	57 ± 15 [6]	64 ± 12 [9]	43(e) [1]	54 ± 14 [4]	60(e) [1]	54 ± 13 [8]	46 ± 15 [20]	47 ± 13 [11]	36 ± 22 [8]
Percent silt	%	-	41 ± 9 [13]	42(e) [1]	37 ± 8 [6]	-	-	55(e) [1]	56(e) [1]	53(e) [2]	41 ± 10 [3]	34(e) [1]	-
Percent clay (<5μm)	%	-	18 ± 9 [13]	19(e) [1]	20 ± 11 [6]	-	-	19(e) [1]	4(e) [1]	6(e) [2]	5 ± 2 [3]	8(e) [1]	-
Specific gravity, Gs		-	2.71 ± .06 [20]	2.68(e) [1]	2.72 ± .09 [6]	2.72 ± 0.02 [9]	-	2.72(e) [2]	2.70(e) [1]	2.72 ± 0.04 [6]	2.71 ± .04 [11]	2.69 ± .04 [4]	-
Dry unit weight γ_{dry}	pcf	-	101 ± 8 [13]	-	101 ± 2 [6]	90 ± 5 [5]	-	88(e) [2]	-	93 ± 11 [4]	94 ± 15 [8]	93(e) [2]	123 (j)
Wet unit weight γ_t	pcf	-	122 ± 5 [13]	-	122 ± 3 [6]	110 ± 3 [5]	-	113(e) [2]	-	116 ± 11 [4]	117 ± 7 [8]	114(e) [2]	135(f)
Saturated unit weight, γ_{sat}	pcf	-	125 ± 5 [13]	-	126 ± 2 [6]	119 ± 3 [5]	-	118(e) [2]	-	121 ± 7 [4]	124 ± 7 [7]	121(e) [2]	140(f)
Hydraulic conductivity (g), k	ft/yr	-	-	-	-	29 ± 11 [5]	-	-	-	-	-	-	-
Total Porosity	%	-	40	-	40	47	-	48	- -	45	44	45	27 (j)
Effective Porosiy	%	-	9 ± 2 (h)	12 ± 2 (h)	7 ± 2 (h)	-	-	15 ± 6 (h)	19	20 ± 1 (h)	22 ± 1 (h)	18 ± 2 (h)	8 (i)

a) All fill includes samples classified as fill on boring logs, including test fill samples, but does not include remolded fill samples.
b) Remolded soil samples compacted to 95% of Standard Proctor maximum dry density at optimum moisture content.
c) Field SPT-N values to correlate to N60-values are computed using the average energy transfer ratio (ETR) of 80.0%. N=N60(60/80.0).
d) Three samples of alluvium were tested for moisture content and two underwent grain-size analysis; the results are not shown in this table.
e) Insufficient data to determine standard deviation.
f) These values are from PSAR, Table 2D-3 and Table 2A-1 (Reference 201 in the PSAR).
g) 1 ft/year * 9.67 x 10-7 = 1 cm/sec.
h) Range of values.
i) Minimum effective porosity based on estimate from saturated and wet unit weights.
j) Total Porosity and Dry Unit Weight of PWR were calculated based on the PWR saturated unit weight and its assumed particle density equivalent to that of saprolite.
Note: The number in brackets is the count, [Number].
Weighted Average dependent upon the limiting number of samples for each result.
pcf- pounds per cubic foot

Lee Nuclear Station Response to Request for Additional Information (RAI)

RAI Letter No. 070

NRC Technical Review Branch: Hydrologic Engineering

Reference NRC RAI Number(s): 02.04.12-017

NRC RAI:

In its review of FSAR Section 2.4.12, the staff determined that the applicant used the adjective “preferential” to describe groundwater pathway no. 2 in a manner inconsistent with normal usage. The applicant appears to mean that this pathway is believed to be the most likely pathway for contaminant migration. The normal usage of "preferential", however, when describing subsurface features, is to indicate features that have a much larger hydraulic conductivity than the surrounding material. Preferential flow paths might, for example, result from features such as bedding material beneath buried pipes left behind during the Cherokee construction activities. Such features could, where they exist, “short-circuit” the expected groundwater movement. Because the term “preferential” has this specific meaning, the applicant should consider removing the term, or justify why it is appropriate for describing pathway no. 2.

Duke Energy Response:

Duke will revise the term “preferential” to use “limiting” when referring to the most conservative groundwater flow path (shortest time-of-travel). The alternative flow paths from potential points of release to points of exposure were evaluated to determine the pathway with the shortest time-of-travel based on hydrogeologic conditions. Each pathway was evaluated for groundwater velocity, as discussed in the response to RAI 02.02.12-015 (this letter), based on hydraulic conductivity (permeability) (FSAR Subsection 2.4.12.2.4.2), effective porosity (FSAR Subsection 2.4.12.2.4.1) and hydraulic gradients (derived from FSAR Figure 2.4.12-204, Sheet 8), as discussed in FSAR Subsection 2.4.12.3.2. Although site investigation results document that the aquifer is principally comprised of a spatially variable mixture of saprolite and partially-weathered rock (PWR), the more conservative values of hydraulic conductivity and effective porosity characteristic of PWR were used in analysis of groundwater velocities. The flow path with the shortest time-of-travel was observed and is discussed in FSAR Subsection 2.4.12.2.3.

An existing storm drain, originally designed to transfer stormwater from the Cherokee power block area to Hold-Up Pond A, was identified based on review of Cherokee construction plans. Portions of this storm drain pipe appear to be below the projected water table and, if left in place may potentially affect groundwater movement in the immediately surrounding area once groundwater levels stabilize after construction. Duke agrees that this stormwater pipe and associated bedding material may result in a preferential groundwater flow path. The existing drain line and bedding materials will be removed by over-excavation. The remaining void will be backfilled with low-conductivity soil materials and compacted to assure this potential preferential flow path is eliminated.

FSAR Subsections 2.4.12.2.3, 2.4.12.2.4.2, and 2.4.13.1 will be revised to clarify the evaluation of pathways, changing the term “preferential” to “limiting”, as appropriate. The revisions to FSAR Subsection 2.4.12.2.3 are included as an attachment to the response to RAI 2.4.12-018 (this letter). FSAR Subsection 2.4.12.3.1 will be revised to remove the identification of the flow pathway that extends northward from the proposed reactor buildings toward Hold-Up Pond A and the Broad River as “preferential.” The identified changes will be incorporated in a future revision of the Final Safety Analysis Report.

Associated Revisions to the Lee Nuclear Station Final Safety Analysis Report:

FSAR Subsection 2.4.12.2.3

FSAR Subsection 2.4.12.2.4.2

FSAR Subsection 2.4.12.3.1

FSAR Subsection 2.4.13.1

Attachments:

1) Revision to FSAR Subsection 2.4.12.2.4.2
2) Revision to FSAR Subsection 2.4.12.3.1
3) Revision to FSAR Subsection 2.4.13.1

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 1 to RAI 2.4.12-017

Revision to FSAR Subsection 2.4.12.2.4.2

COLA Part 2, FSAR. Chapter 2, Subsection 2.4.12.2.4.2, second paragraph, will be revised as follows:

During the Cherokee investigation in the early 1970's, 135 field and laboratory tests were conducted to characterize soil and rock permeability. Fifty-five packer tests were conducted in soil and rock intervals in 17 soil borings across the site. An additional 42 field and 38 laboratory tests were performed to evaluate soil permeability. The recent investigation supplements the above investigation with the performance of an additional 11 packer tests in bedrock materials, 16 slug-out tests across the site, and one multi-well aquifer pump test performed within the limiting groundwater ~~preferential~~ flow path (i.e. the flow path with the shortest time-of-travel) from the nuclear island area toward the Broad River to the north.

COLA Part 2, FSAR. Chapter 2, Subsection 2.4.12.2.4.2, third paragraph, third bullet, will be revised as follows:

Reported hydraulic conductivities measured in the partially weathered rock (PWR), or transition zone, range from approximately 9.67×10^{-7} cm/s to a maximum value of 9.89×10^{-3} cm/s with a median of 1.54×10^{-4} cm/s. For samples exceeding the median hydraulic conductivity of the data set, the geometric mean (1.0×10^{-3} cm/s) represents a conservative hydraulic conductivity value for the PWR transition zone ~~at the top of the weathered rock for samples collected~~ across the site. Based on its thorough review of the properties of the PWR zone Duke asserts that a~~A~~ value of 1.4×10^{-3} cm/s is a scientifically-sound, conservative, and representative hydraulic conductivity value for PWR materials at the Lee site. This is the value~~was~~ obtained from aquifer tests in 2006 for an area believed to best represent the limiting ~~preferential~~ groundwater flow path, and is used ~~for the Kh~~ as the representative value of hydraulic conductivity for PWR. Figure 2.4.12-207 includes three PWR samples that were subsequently excavated in the area of the reactors.

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 2 to RAI 2.4.12-017

Revision to FSAR Subsection 2.4.12.3.1

COLA Part 2, FSAR. Chapter 2, Subsection 2.4.12.3.1, first paragraph, will be revised as follows:

The nature and depth of groundwater circulation in the Piedmont is predictably variable. This variability is a function of the singular aquifer system being comprised of weathered saprolite, partially weathered rock, and fractured bedrock, and the degree of interconnection of pores and fractures between these materials. Typical of the Piedmont, groundwater flow is from topographic positions (recharge areas) to the regional drainage features (discharge areas). Groundwater flow at this site likewise generally mirrors the surface topography, with strong gradients and flow paths from the power block area, northward to the Broad River.~~Within the preferential flow pathway that extends northward from the proposed reactor buildings toward Hold-Up Pond A and the Broad River (Figure 2.4.12-204, Sheet 8), groundwater appears to flow through each of the aquifer materials referenced above. The depth of groundwater circulation in the Piedmont is difficult to define and may be erratic, dependent upon the presence of interconnected rock fractures and gradient. However, based on analysis of groundwater levels at the cluster well locations, vertical gradients are generally in the downward direction, consistent with the topographic slope to the Broad River, indicating that groundwater recharge is occurring and groundwater movement generally parallels topography.~~

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 3 to RAI 2.4.12-017

Revision to FSAR Subsection 2.4.13.1

COLA Part 2, FSAR. Chapter 2, Subsection 2.4.13.1, fourth paragraph, will be revised as follows:

While groundwater functions as the transport media for fugitive radionuclides, interaction of individual radionuclides with the soil matrix can potentially delay their movement. The solid/liquid distribution coefficient, K_d, is, by definition, an equilibrium constant that describes the process wherein a species (e.g., a radionuclide) is partitioned between a solid phase (soil, by adsorption or precipitation) and a liquid phase (groundwater, by dissolution). Soil properties affecting the distribution coefficient include the texture of soils (sand, loam, clay, or organic soils), the organic matter content of the soils, pH values, the soil solution ratio, the solution or pore water concentration, and the presence of competing cations and complexing agents. Because of its dependence on many soil properties, the value of the distribution coefficient for a specific radionuclide in soils can range over several orders of magnitude under different conditions. The measurement of distribution coefficients of radionuclides within the ~~preferential~~ limiting groundwater ~~pathways~~ pathway allows further characterization of the rate of movement of fugitive radionuclides in groundwater.

Lee Nuclear Station Response to Request for Additional Information (RAI)

RAI Letter No. 070

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.12-018

NRC RAI:

In its independent review of the precipitation and groundwater data, the staff determined that precipitation was below normal during the monitoring period such that groundwater responses were potentially smaller than would be expected during wetter years. In addition, currently ongoing excavation dewatering keeps groundwater levels artificially lower than normal such that seasonal variations are muted. Therefore, the range of groundwater variation to be expected could be greater and the estimate of the highest water table level could be higher. The staff also determined that there was insufficient information to determine a) how groundwater levels would respond spatially once groundwater conditions were restored after the cessation of construction dewatering and b) how post-dewatering groundwater conditions would alter the identification of plausible groundwater pathways. Because the groundwater data collected during the monitoring period are insufficient to describe groundwater conditions after the construction dewatering ceases, the applicant should conduct a groundwater flow analysis to provide sufficient support for determining the plausible post-construction groundwater elevations in the vicinity of the nuclear island and for determining the post-construction groundwater pathways for the radionuclide transport analysis in Section 2.4.13 of the FSAR. The analysis should include estimates of post-construction recharge conditions across the Lee Nuclear Site, normal and wetter-than-normal precipitation conditions (to yield maximum water table rise), and plausible pathway properties.

Duke Energy Response:

Duke acknowledges the limitations of data collected in close proximity to the dewatering area as well as data collected during the 2007-2008 drought period. Dewatering activities at the excavation site were initiated in December 2005. To address these data limitations, Duke conducted an analysis of predicted groundwater conditions post-construction, based on conservative estimates of maximum high groundwater elevations under equilibrium conditions. The framework for this analysis utilized data from the period prior to the 2007-2008 drought period and data from prior to the initiation of dewatering.

The South Carolina State Climatology Office has documented the calendar year 2007 as the driest year in Cherokee County history: 24.9 inches annual precipitation, which compares to average annual precipitation of 48.7 inches (Reference 1). Monthly precipitation data from the NOAA-NWSFO Greenville-Spartanburg Airport (GSP) station likewise indicates total annual precipitation of 31.08 inches in 2007, compared to the average annual precipitation (since 1950) of 49.09 inches (Reference 2) (provided previously in the Duke response to RAI 02.04.12-003 (Reference 3)).

Annual precipitation for the GSP station for the three-year period from 2003-2005 was 111.3 percent of normal for this extended period. These above normal precipitation trends continued until the beginning of the 2007-2008 drought in April 2007. Site groundwater elevation data from April 2006, prior to the drought period and when groundwater monitoring was initiated at the Lee Site, through March 2007 is provided for MW-1214 (Attachment 2). This well can be considered a "background" location in that it is approximately 1160 ft upgradient and south of the south wall of the excavation and within the same groundwater flow region of the site as the power block (between the north and south groundwater divides). MW-1214 shows no influence of the dewatering activities and provides a valid reference point for the determination of "natural" upgradient groundwater levels and gradients across the site from south to north. MW-1214 shows springtime peak groundwater elevation of approximately 589-590 ft msl and late fall groundwater elevations of approximately 584 ft msl, a seasonal fluctuation of 5.60 ft. (Attachment 2).

Data from the Cherokee Environmental Report (1974) also support site-specific maximum seasonal groundwater fluctuations of less than 6 ft, with most monitored wells showing typical maximum seasonal fluctuations in the range of 2 to 3 ft (Reference 4).

An indirect method of evaluating seasonal influences of water level fluctuations at Lee Nuclear Site includes the assessment of early 2006 photographs. These photographs (Attachment 3) document observations of water stains on the previously existing Cherokee site structures. The range of water table fluctuation measured in the excavation was established at 574 to 579 ft msl. In addition, aerial imagery documents flooding of the excavation in both 1994 and 2006; therefore, the stains are a result of at least 12 years of seasonal water table fluctuations around an average water level of approximately 576.5 ft msl. During this 12 year period, annual average rainfall was 100.3 percent of normal (49.09 inches for GSP), and varied from 35.04 to 63.11 inches. An additional conservative factor of 5 ft was added to the highest flooding mark observed (579 ft msl) to project the most extreme possible groundwater condition in the power block area. Likewise, maximum drawdown was estimated by subtracting 5 ft from the lowest observed high water mark. Hence, the fluctuation range established for the pit area was conservatively estimated at 569-584 ft msl. Duke finds that these observations present a valid and conservative surrogate for the determination of seasonal groundwater levels in the excavation area over an extended period.

Additionally, photographs taken in early December 2005, prior to dewatering, show that the water level was approximately 1 ft below the historical high water mark elevation of 579 feet (Attachment 4). The four years preceding the December 2005 observation were, according to NOAA, years of higher than normal precipitation (107.9 percent of normal) (Reference 2). The water level observed in relation to the high water level mark at the time of the December 2005 observation indicates that groundwater had generally recovered from the 1998 – 2002 drought.

As a third point of reference, Duke offers that the full-pool elevation of the Ninety-Nine Islands Reservoir, 511 ft msl, presents an accurate downgradient location for assessment of flow across the site for the south to north flow-path. The use of these three points (MW-1214, excavation high water mark and Ninety-Nine Islands Reservoir), all of which were conservatively interpreted to ensure no influence attributable to drought or dewatering, provides a reasonable and conservative groundwater prediction framework.

Duke finds that this analysis, using the observed high and low conditions across the site, confirms that a maximum peak groundwater elevation of 584 ft msl in the area of the excavation is reasonable and conservative, including for high precipitation periods. Furthermore, this value can be considered conservative due to an anticipated decrease in recharge in the area of the plant expected with installation of stormwater controls and the construction of plant facilities and extensive impervious surfaces.

The presence of groundwater divides east and west of the power block, a consistent decrease in groundwater elevation across the site from south to north (towards the Broad River), and a full pond elevation in Make-Up Pond A and Make-Up Pond B consistent with the high level mark in the power block also affirms the assertion that post-construction groundwater conditions in the area of the power block will continue to support consistent groundwater gradients and flow toward the Broad River. Upon cessation of construction dewatering, groundwater is expected to return to hydrostatic equilibrium.

Based on the above analysis, the post-construction groundwater pathways for the radionuclide transport analysis in Subsection 2.4.13 are not affected. FSAR Subsection 2.4.12.2.3 will be revised to reflect the additional assessment of historical precipitation and groundwater elevation data to support a 584 ft msl maximum post-construction groundwater elevation in the area of the power block. Additionally, FSAR Subsection 2.4.13 will be revised to clarify the evaluation of pathways, changing the term "preferential" to "limiting," as appropriate, as discussed in the response to RAI 2.4.12-017 (this letter).

References:

1) South Carolina State Climatology Office Website, accessed 7/16/2009. (http://www.dnr.sc.gov/climate/sco/ClimateData/countyData/county_cherokee.php)
2) NOAA Website (www.erh.noaa.gov/gsp/climate/gsppcp.htm), accessed 8/15/2008.
3) Duke Energy Letter, dated December 11, 2008, from B. J. Dolan to Document Control Desk, U.S. Nuclear Regulatory Commission, Partial Response to Request for Additional Information (RAI No. 826) (ADAMS Accession No. ML083520336).
4) Duke Power Company, Cherokee Nuclear Station – Environmental Report, 1975.

Associated Revision to the Lee Nuclear Station Final Safety Analysis Report:

FSAR Subsection 2.4.12.2.3

Attachments:

1) Revision to FSAR Subsection 2.4.12.2.3
2) Site Specific Groundwater Elevation Data and Hydrographs for MW-1200, MW-1204, MW-1209, MW-1212, and MW-1214 – April 2006 through March 2007
3) Photographs of Site Structures Depicting High Water Mark – Post Dewatering – Early 2006
4) Photographs of Site Structures Depicting High Water Mark – Pre-Dewatering – Early December 2005

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 1 to RAI 02.04.12-018

Revision to FSAR Subsection 2.4.12.2.3

COLA Part 2, FSAR Chapter 2, Subsection 2.4.12.2.3 will be revised as follows:

2.4.12.2.3 Current On-Site Conditions

In March 2006, the current groundwater investigation was initiated as part of the subsurface study to evaluate hydrogeologic conditions for the Lee Nuclear Site. The dewatering of the existing excavation preceded the subsurface investigation, thus returning the site to hydrogeologic conditions similar to those of the previous construction phase. Approximately 740 million gal~~.~~ of water were removed from the excavation from December 19, 2005, through September 7, 2006. Following the initial dewatering, an apparent 5-foot thick interval of staining was observed on the existing Cherokee concrete structures, the top of which was surveyed at an elevation of ~~The apparent high-water-level mark (elev.~~ 578.72 ft~~.~~ msl. Given the range of apparent water table fluctuations as indicated by the concrete staining (574 – 579 ft msl), the hydrostatic equilibrium elevation for the excavation area was estimated to be the midpoint of the range (576.5 ft. msl). A comparison of the apparent water levels in this impoundment, as shown on the February 1994 and February 2005 aerial photographs, with the topographic survey conducted in 2006 indicated a similar range of water levels in the excavation area (574 ft. msl in 1994 to 579 ft. msl in 2005). Precipitation data for the period preceding these observations indicated near normal conditions, confirming the aerial images captured typical impoundment water levels.~~), as indicated by stains observed on the concrete structures, was measured in 2006 following the dewatering of the site. Comparing the apparent water level in this impoundment as shown on the February 1994 and February 2005 aerial photograph with the topographic survey conducted in 2006, indicates that water levels of the impoundment ranged from around 574 ft. msl (1994) to 579 ft. msl (2005). Precipitation data at the time of these photographs did not identify abnormal conditions, suggesting the aerial photographs captured typical impoundment levels. Since no long-term monitoring of the full impoundment was performed, the high-water-level mark observed on the structures appears to be a reasonable estimate of a typical high-water elevation for the impoundment, and a relatively conservative indicator of hydrostatic equilibrium. Currently, groundwater is pumped, as needed, to dewater the excavation for construction of the Lee Nuclear Station. M~~Ongoing maintenance dewatering activities are expected to end following construction activities. ~~Construction dewatering of the excavation is within the capacity of the current on-site pumps.~~

As part of the 2006-2007 ~~current~~ groundwater investigation, fifteen borings were drilled into the crystalline bedrock, and monitoring wells were installed in partially weathered rock intervals. In July 2006, nine additional monitoring wells were installed to evaluate shallow groundwater conditions across the site. Details regarding well construction are presented in Table 2.4.12-201.

Following well development, water levels were measured monthly from April 2006 to April 2007 (Table 2.4.12-202) to characterize seasonal trends in groundwater levels and to identify ~~preferential~~ flow pathways surrounding the Lee Nuclear Site. The hydrograph for this groundwater data is presented on Figure 2.4.12-203. Surface waters at four locations were also gauged as part of the monitoring program. These locations included Make-Up Pond B, a water retention impoundment below Make-Up Pond A, Make-Up Pond A, and Hold-Up Pond A. Based on this year of study, groundwater levels were observed to fluctuate, ~~on average of 4.4 ft.~~ with the highest groundwater elevations observed ~~in wells~~ between January and April 2007 and the lowest groundwater elevations between September and November 2006. This trend ~~appears to~~ correlates with both the river flow and rainfall patterns and confirms ~~indicating~~ that both groundwater levels and river flow are governed by local precipitation ~~volume~~ (Section 2.3). ~~The maximum observed seasonal water level fluctuation was 9 ft. at monitoring well MW-1212, located near the apparent groundwater divide west of the nuclear island.~~

Potentiometric surface maps developed from water level data showed that during the recent construction dewatering and site investigation, groundwater surrounding the excavation is drawn toward the excavation ~~as shown on the potentiometric surface maps~~ (Figure 2.4.12-204, Sheets 1 - 7). During the dewatering activities, continuous decline of water levels in areas downgradient of the excavation was observed, as recharge entering the power block area from the south was intercepted by the excavation and discharged to Make-Up Pond B. Following the completion of construction dewatering, the potentiometric surface beneath the reactor buildings is expected to rebound to equilibrium conditions.

Under natural conditions the topography of the water table within the Piedmont mimics the topography of the land surface, but has less relief. Cross-sections of the Lee Nuclear Site are presented in Figure 2.4.12-205, Sheets 1 - 4. These figures depict the relationship between groundwater beneath the site and the surface water bodies surrounding the site. Groundwater flow in the Piedmont province is typically restricted to the topographic area underlying the slope that extends from a divide to an adjacent stream.

Both regionally and locally, surface topography plays a dominant role in groundwater occurrence. Post-construction topography was observed to affect groundwater conditions such that cuts in topography induce a lowered water table and fill induces a raised water table. Field evidence for this is based on comparison between the Cherokee water table map (Figure 2.4.12-201) and the maps developed from the Lee Nuclear Site investigation (Figure 2.4.12-204, Sheet 1-7). For example, MW-1204, located on the Unit #2 Cooling Tower Pad, is where construction fill was placed during Cherokee construction, resulting in a significantly higher land surface elevation (approximately 610 ft. msl compared to its pre-grading elevation of around 560 ft. msl). Consequently, the water table elevation is higher in MW-1204: groundwater elevation of approximately 570 ft. msl compared with the former groundwater elevation of less than 550 ft. msl. Another example includes MW-1200, located west-northwest of Unit #1, ~~and is~~ where ~~Cherokee~~ construction cuts resulted in a significantly lower land surface elevation (~~:~~ approximately 590 ft. msl compared to its pre-grading elevation of approximately 670 ft. msl). Consequently, the water table elevation has lowered (~~:~~ groundwater elevation of 565 ft. msl compared with the former groundwater elevation of more than 585 ft. msl).

Upon returning to post-dewatering conditions, ~~The topography of~~ the water table ~~during operation, post-dewatering,~~ is expected to mimic land surface, consistent with slope-aquifer conditions of the Piedmont physiographic province. ~~The projected post-dewatering water table conditions are illustrated in Figure 2.4.12-204, Sheet 8. The potentiometric conditions shown in Figure 2.4.12-204, Sheet 8 affect the directions of groundwater flow surrounding the Lee Nuclear Station. Each of the ponds serves as constant head flow boundaries. The crests of the water table undulations serve as groundwater divides within the slope-aquifer system and are expected to contain the movement of groundwater. The low areas between the topographic divides serve as flow~~

compartments that are open-ended down slope, where, ultimately, groundwater is discharged to the Broad River, the groundwater sink for the site and the surrounding area. The potentiometric surface beneath Lee Units 1 and 2 is expected to rebound to an elevation near the apparent hydrostatic equilibrium (576.5 ft. msl). Seasonal water table fluctuations, as observed at the site, do not exceed 5 to 10 ft. A conservative estimate of the post-construction maximum high groundwater elevation in the area of the excavation was established at 584 ft msl.observed pre-dewatering high water level mark. Based on an annual average water level fluctuation observed in monitoring wells outside the apparent dewatering lateral area of influence of 4.5 ft., a maximum high groundwater elevation is not expected to vary more than 5 ft. of that high water mark (i.e., 578.72 + 5 ft. above msl). Therefore, the high groundwater elevation at Lee Nuclear Station is expected to be approximately 584 ft. msl.

The projected post-dewatering water table conditions are illustrated in Figure 2.4.12-204, Sheet 8. The potentiometric conditions shown in Figure 2.4.12-204, Sheet 8 affect the directions of groundwater flow surrounding the Lee Nuclear Station. Each of the ponds serves as constant head flow boundary. The crests of the water table indicate groundwater divides within the slope-aquifer system. These features indicate distinct compartments of groundwater flow at the site, with the nuclear site area flowing to the north toward the Broad River, the area west of the north divide flowing toward Make-Up Pond B, and the area east of the south divide flowing toward Make-up Pond A. Ultimately all groundwater flow discharge to the Broad River, the groundwater sink for the site and the surrounding area.

Based on site observations, a network of storm drains and buried piping was partially installed during the Cherokee project to manage surface water runoff. While no as-built drawings for the existing storm drain system for the former Cherokee Nuclear Station exist, a review of stormwater plans was conducted to assess the drain system's potential affect on groundwater movement. Storm drains located upgradient (south) of the excavation appear to intercept the water table and allow movement of water toward the make-up ponds. Other storm drains appear to be above the water table and would not affect the movement of groundwater. One exception is a storm drain originally designed to transfer stormwater from the Cherokee power block area to Hold-Up Pond A. The depth of this storm drain pipe appears to be below the projected water table and, thus, if left as is could locally affect groundwater movement when groundwater recovers from the dewatering. The potential effect on groundwater movement can be mitigated by engineering controls or by removal and replacement with less permeable material. The existing storm drain and bedding materials will be removed by over-excavation. The remaining void will then be plugged with low-permeability backfill material, compacted to density sufficient to assure no short-circuiting can occur.

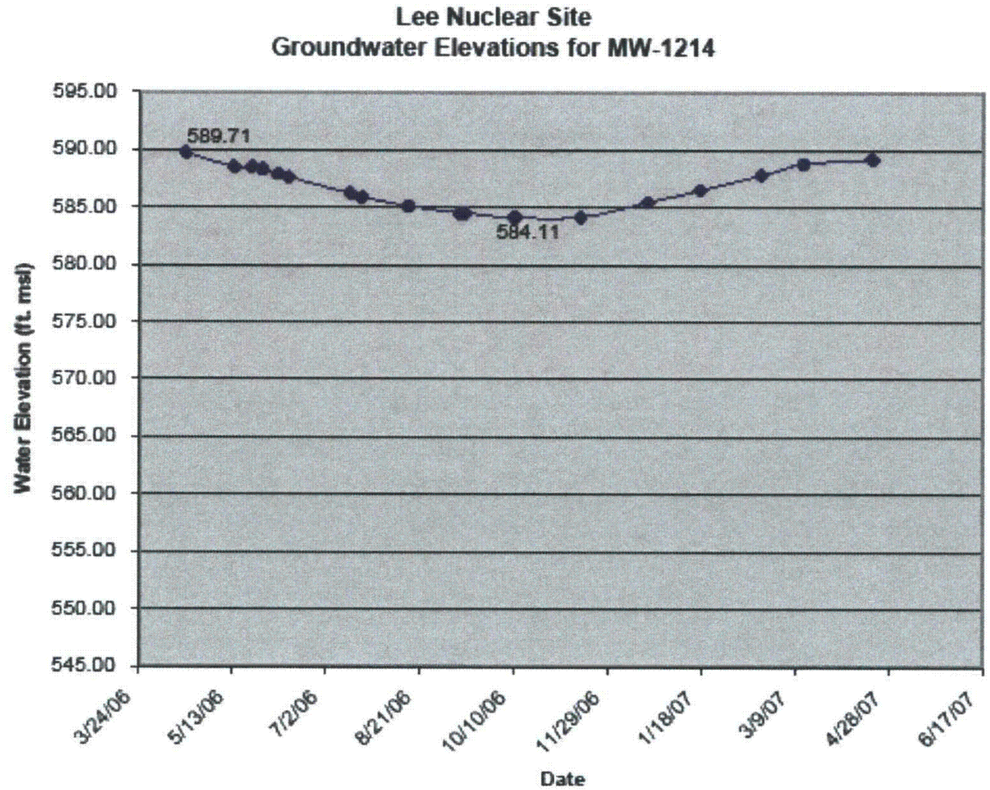
The Lee Nuclear Station stormwater drainage system (DRS) is designed to facilitate and control the runoff of precipitation along surface water flow paths, diverting surface runoff away from the power block area and reducing the potential for flooding. The site grading and drainage plan is shown in Figure 2.4.2-202. The site is relatively flat; however, the site is graded such that overall runoff will drain away from safety-related structures to Make-Up Pond B, Make-Up Pond A, or directly to the Broad River. The DRS is not expected to alter the preferentialdirectly affect groundwater flow system of the limiting groundwater flow pathway.

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 2 to RAI 02.04.12-018

Site Specific Groundwater Elevation Data and Hydrographs for MW-1214 April 2006 through March 2007

Date	Water Elevation (ft. msl)
4/18/2006	589.71
5/14/2006	588.50
5/23/2006	588.50
5/29/2006	588.30
6/6/2006	587.90
6/12/2006	587.60
7/15/2006	586.20
7/21/2006	585.89
8/15/2006	585.10
9/11/2006	584.50
9/14/2006	584.50
10/10/2006	584.11
11/14/2006	584.16
12/20/2006	585.46
1/17/2007	586.50
2/19/2007	587.83
3/13/2007	588.79
4/19/2007	589.19



Max. Elev.	589.71	
Min. Elev.	584.11	
	5.60	Seasonal Groundwater Table Fluctuation (ft)

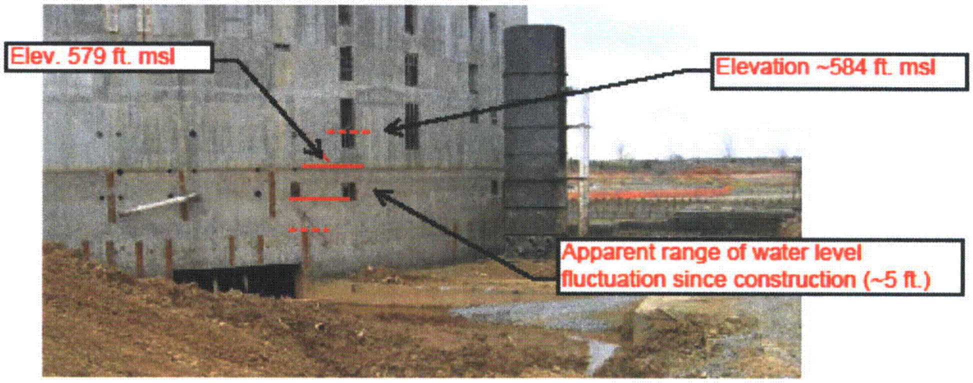
Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 3 to RAI 02.04.12-018

Photographs of Site Structures Depicting High Water Mark – Post Dewatering – Early 2006

Figure 3g

Following dewatering and during the site investigation work, general reconnaissance identified high water marks on site structures. These high water levels were surveyed and measured, identifying an elevation of 578.72 ft. msl.



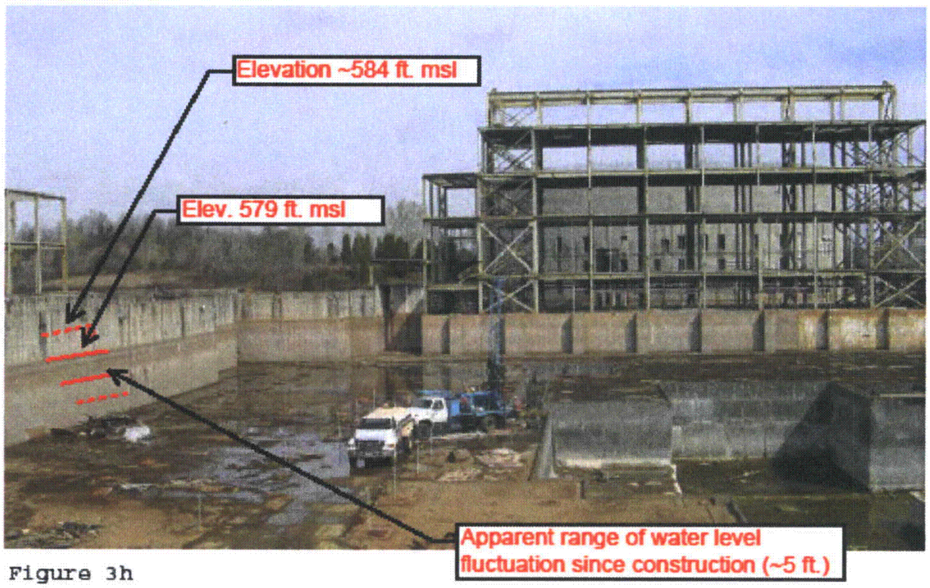


Figure 3h

Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 4 to RAI 02.04.12-018

Photographs of Site Structures Depicting High Water Mark – Pre-Dewatering – Early December 2005

Photographs taken in early December 2005 prior to the start of dewatering.