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April 2, 2008

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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Subject: Duke Energy Carolinas, LLC (Duke)
William States Lee III Nuclear Station
AP1000 Combined License Application - Docket Nos. 52-018 and 52-019
Transmittal of Concrete Basemat Evaluation

The purpose of this letter is to transmit a summary report describing the concrete basemat testing performed on the reactor building foundation of the former Cherokee Nuclear Station (Cherokee) Unit 1. This foundation will remain in place as concrete fill for the proposed William States Lee III Nuclear Station (WLS) Unit 1.

This evaluation reflects the conditions of the existing basemat (structural) concrete, concrete fill, and foundation rock prior to the demolition of the partially constructed Cherokee Unit 1 reactor building. The purpose of basemat concrete testing was to characterize the properties of the existing basemat (structural) concrete, concrete fill, and foundation rock beneath the accessible areas of the partially constructed Cherokee Unit 1 reactor building structure. Additional post-demolition testing will be performed to confirm the pre-demolition test results to verify that demolition activities did not impair the structural integrity of the existing foundation. A summary of the post-demolition test results will be provided to the Nuclear Regulatory Commission in a future submittal.

Based on field and laboratory data collected as part of this evaluation, foundation materials at the WLS site have been determined to be in good condition and of acceptable quality and strength. The concrete-rock interface is well bonded with no significant zones of weakness or weathering observed. Recovered rock core is consistent with observations from WLS site characterization activities in support of the WLS combined license application and historic records, developed originally for the Cherokee site.

The results of the Cherokee Unit 1 pre-demolition evaluation validate the assumptions and bounding values for structural concrete, fill concrete, and rock materials described in the FSAR. Static and dynamic material properties as well as foundation support

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considerations relative to existing structural and fill concrete are described in FSAR 2.5.4.2.4, "Material Properties;" FSAR 2.5.4.3, "Foundation Interfaces;" FSAR 2.5.4.5, "Excavations and Backfill;" FSAR 2.5.4.7, "Response to Soil and Rock to Dynamic Loading;" and FSAR 2.5.4.10, "Static Stability."

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

Bryan J. Dolan
Vice President
Nuclear Plant Development

Enclosure:
1. *Summary of Pre-demolition Field and Laboratory Basemat Test Results, Unit 1 Concrete Basemat Evaluation*, Revision 0

xc (w/out enclosure):
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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

Bryan J. Dolan

Subscribed and sworn to me: April 2, 2008
Date

Phoebe P. Elliott
Notary Public

My Commission Expires: June 26, 2011

SEAL

ENCLOSURE NO. 1

SUMMARY OF PRE-DEMOLITION FIELD AND LABORATORY

BASEMAT TEST RESULTS, UNIT 1

CONCRETE BASEMAT EVALUATION

FOR

WILLIAM STATES LEE III NUCLEAR STATION

COMBINED CONSTRUCTION PERMIT AND OPERATING LICENSE COL PROJECT

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1.0 INTRODUCTION

This project report summarizes the field and laboratory test results on existing concrete and underlying rock materials collected at the former Cherokee Nuclear Station (CNS) Unit 1 reactor building foundation. Field work was performed by William Lettis & Associates, Inc. (WLA) and MACTEC Consulting and Engineering, Inc. (MACTEC) personnel and qualified subcontractors as part of site investigations for the proposed Duke Energy William States Lee III Nuclear Station (WLS). The field and laboratory testing program was based on site observations and discussions developed during the December 19, 2006 walk around that involved personnel from Duke Energy, ENERCON Services Inc., WLA, MACTEC, Shaw, Stone & Webster, Inc., Westinghouse Electric Company (Vendor) and Paul C. Rizzo Associates, Inc. (consultant to Westinghouse).

The results described in this project report represent a summary of the field and laboratory sampling and test procedures with reported test results. These evaluations are presented in detailed reports developed as part of the WLS Combined Construction Permit and Operating License (COL) field investigations performed for Unit 1. The field-testing program also relied on evaluations of historic field explorations and records developed during CNS studies.

This technical memorandum is organized into the following ten sections:

1.0 Introduction
2.0 Background
3.0 Evaluation Objectives
4.0 Field Exploration, Laboratory Testing, and Methodology
5.0 Summary of Results
6.0 Conclusions
7.0 Quality Assurance
8.0 Post-Demolition Test Plan
9.0 References
10.0 Tables and Figures

Copies of basemat testing boring logs are included as Appendix A.

All work was performed under an approved Quality Assurance Program meeting 10 CFR 50, Appendix B.

2.0 BACKGROUND

As proposed, the WLS will consist of twin AP1000 power plants located at the site of the former partially constructed CNS in Gaffney, South Carolina. The new AP1000 Unit 1 will reoccupy the former Unit 1 footprint and is planned to overlie portions of the existing structure and foundation; the new AP1000 Unit 2 will occupy the former CNS Unit 3 footprint area. Both plants under this configuration are located within the existing CNS excavation and some minor additional excavation will be required (Figure 1).

Construction at the CNS site was initiated in the mid-1970s and was halted in the early 1980s with the former CNS Units 1 and 2 excavations completed to foundation grade (continuous rock, defined as rock with a minimum RQD of 65) and the former CNS Unit 3 area partially excavated to top of rock. As a result of project cancellation, the CNS excavation including Unit 1 basemat structures below about elevation 579±5 ft were submerged until WLS site investigation preparation in early 2006. The excavation is currently dewatered to maintain accessibility, post-

construction dewatering will not be required as the foundation basemat and below grade walls will be waterproofed during construction and are designed for hydrostatic pressure. Approximately 40% of the existing CNS Unit 1 reactor building and adjacent structures, including the reactor building basemat and lower structural walls, was completed prior to project termination. Demolition of all or parts of the partially completed former CNS Unit 1 structures is in progress with demolition including removal of the concrete superstructure and portions of the auxiliary building basemat foundation. The existing CNS Unit 1 basemat foundation and portions of the reactor building walls are planned to remain following completion of demolition activities at CNS Unit 1.

The existing concrete foundation for the former CNS Unit 1 reactor building structure is a circular mat of diameter 214 feet (ft) and with nominal top elevation 545 ft, which corresponds to CNS plant elevation of 55+0, and whose structural mat is approximately 4 ft thick. The existing mat is underlain by fill concrete of variable thickness which in turn is underlain by continuous (sound) rock as defined in the Cherokee Preliminary Safety Analysis Report (PSAR) (Duke Power Company, 1974) and confirmed by the WLS COL investigation coring through the existing mats and fill concrete and into the rock. The foundation for the new Unit 1 Nuclear Island, with its structural mat bottom elevation at 550.5 ft, which corresponds to CNS and WLS plant elevation of 60+6 ft, will be underlain by varying thickness of existing CNS concrete and new WLS fill concrete as required to support the entire new WLS nuclear island for Unit 1 on the underlying rock.

3.0 EVALUATION OBJECTIVES

The purpose of the concrete basemat testing program was to collect sufficient representative samples to characterize the pre-demolition properties of the existing basemat (structural) concrete, concrete fill, and underlying foundation rock beneath the accessible areas within the partially constructed CNS Unit 1 reactor building structure.

Field and laboratory evaluations were completed on rock and the two types of existing concrete that serve as the foundation; surface leveling slab referred to as "fill concrete" and overlying steel reinforced foundation slab referred to as "structural concrete". Structural concrete represents existing CNS concrete with steel reinforcement (structural foundation). Whereas, fill concrete is similar to existing CNS structural concrete but lacks steel reinforcement that was used to extend from the bottom of the CNS structural foundation mat down to the rock foundation support.

The concrete and rock were cored, logged, and selected for in-depth analysis and field and laboratory testing (Table 1). The laboratory and in situ characteristics of the cored samples were determined from representative samples obtained from within the existing CNS Unit 1 reactor building structure, in which, the WLS Unit 1 nuclear island will overlay (Figure 2). Additional sources of information include the existing CNS PSAR, construction-derived data, and published literature.

Field activities including sample collection and testing at WLS Unit 1 were initiated on February 5, 2007 and continued through March 25, 2007. Detailed discussions on the field and laboratory testing program, technical procedures, and results are presented in the reports listed below.

- MACTEC Data Report Attachment K, Concrete Basemat Testing – Concrete Core Logs and Laboratory Physical and Chemical Testing of Cores, Lee Nuclear Station, prepared by CTL Group, Revision 0 (2008a).
- MACTEC Data Report Attachment L, Field Seismic Testing of Existing Basemat Concrete and Rock at the Former Cherokee Nuclear Island Station Unit 1 Reactor Building, Lee Nuclear Station, Revision 1, prepared by University of Texas at Austin (2008b)
- MACTEC Data Report, Attachment M, Dynamic Laboratory Tests on Intact Concrete Specimens, Revision 0, prepared by University of Texas at Austin (2008c).

As described in the WLS Final Safety Analysis Report (FSAR Subsection 2.5.4.2.4.2, Static Properties of Geotechnical Materials), additional post demolition tests are planned to confirm the pre-demolition tests results and verify that demolition activities did not impair the structural integrity of the CNS Unit 1 foundation. The testing program and requirements are described in the FSAR.

4.0 FIELD EXPLORATION, LABORATORY TESTING, AND METHEDOLOGY

As previously described, the field and laboratory-testing program was based on consultations with Duke and consultant team personnel. The confined access field conditions including, but not limited to, restrictions on overhead clearance coupled with narrow hallways and entry points, inside the CNS reactor building structure limited drilling and sampling equipment options. Access was hindered further due to thick mud and debris accumulations that infilled the entire formally submerged portion of the structure. These conditions combined with areas of protruding steel rebar, and floor and wall penetrations limited testing to safety-cleared specific test locations. Power supplies to support temporary lighting and field testing were positioned outside the building structure. Selected test areas were distributed throughout the reactor building structure, were cleaned by hand and small power equipment, and determined to be safe before testing proceeded. All sampling and testing equipment was disassembled at the surface, carried by hand to the test locations, and then reassembled to perform testing. A minimum of two borings were drilled within each of the reactor building foundation quadrants. Additional sample and test locations were positioned in the southeast reactor building quadrant. The distribution of borings across the reactor building basemat slab defines the range of expected conditions and material properties. Selected sample and test locations correspond to CNS plant elevation 55+0 (CNS reactor building main floor) and 37+0 (CNS reactor building lower room), corresponding to elevations 545 ft and 527 ft, respectively.

The exploration points for completed test locations are shown in Figure 2. The site exploration and testing program schedule is summarized in Table 1. The number and type of tests performed at each location including depth and thickness of concrete materials and rock are summarized in Table 2.

4.1 Test Methods

The procedures and testing methods utilized to attain the data within this report used guidance provided in Regulatory Guide 1.132 - "Site Investigations for Foundations of Nuclear Power Plants". Concrete and rock borings completed for this study utilized the drilling procedures, sampling techniques, and core storage and transport techniques in accordance with the project approved quality assurance plan.

4.1.1 Drilling Methods
Sixteen borings were drilled into the existing CNS Unit 1 basemat and underlying rock materials. Electrically and hydraulically operated concrete coring equipment was used during this work (Figure 3). Each core hole was advanced using a 6-inch diameter single tube core barrel system as shown in Figure 3.

4.1.2 Boring Logs
Continuous concrete and rock core was collected and logged by a rig geologist or site coordinator (Figure 4). The concrete core logs identify concrete as either "fill" or "structural" and are associated with construction of the former CNS Unit 1 foundation. Fill concrete was placed over continuous rock during construction to provide a level surface for construction of the structural foundation slab, and lacks steel reinforcement. The structural concrete is similar to the fill concrete, but it included steel reinforcement bars. The structural concrete overlay the fill concrete and is 4 ft thick. Selected structural and fill concrete core samples were tested to characterize the physical and chemical durability/strength of the pre-existing concrete. The rock was identified and examined for strength and weathering properties with particular emphasis focused on the concrete and rock interface. All recovered core samples were logged, transported to and stored in the on-site sample storage facility, and selected samples were then packaged and shipped to the testing laboratory.

4.2 Static Laboratory Testing
Selected core samples were prepared for testing to identify physical and chemical properties and characteristics (Table 3). Sample preparation and testing was completed according to the procedures and guidelines for each test type (Table 1). The following analyses and characterizations were carried out on core samples:

4.2.1 Physical & Mechanical Tests
Visual Examination of Cores - The cores were photographed and visually inspected for the following characteristics (Figure 4):

- Maximum size aggregate
- Gradation of aggregates
- Condition of paste (characterization of surface defects~scaling)
- Presence of reinforcing steel
- Measurement of the length and diameter of the cores

Laboratory testing to evaluate physical and strength properties was performed in accordance with the standard procedures listed below.

- Density, Absorption, and Voids in Hardened Concrete, ASTM C642
- Compressive Strength of Concrete Cores, ASTM C42
- Modulus of Elasticity of Concrete Cores, ASTM C469
- Splitting Tensile Strength of Concrete Cores, ASTM C496
- Petrographic Examination of Hardened Concrete, ASTM C856

Additional testing was performed to evaluate mix durability and the current condition of concrete. The test purpose and applicable standard method is described below.

4.2.2 Mix Durability Tests
The following two test procedures were used to evaluate concrete mix durability.

- Permeability of concrete using Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration, ASTM C1202. Determination of the rapid chloride permeability, was performed using a two-inch thick section of four-inch diameter core placed into a chamber with a sodium chloride solution on one side and a sodium hydroxide solution on the other side. Sixty volts is placed across the concrete specimen. The current passed across the specimen is measured over six hours. The result of the testing provides an indication of the overall durability of the mix.

- Petrographic Examination of multiple thin sections were prepared according to ASTM C856 to determine the following:
    - Performance of aggregates including types of aggregates, and presence of alkali-silica reactions.
    - Cementitious matrix including estimation of water/cement ratio, presence of pozzolans, microcracking, and degree of hydration.

4.2.3 Current Condition of Concrete Tests

The following test procedures were used to evaluate current concrete condition:

- Chloride Content using Standard Test Method for Water-Soluble Chloride in Mortar and Concrete, ASTM C1218. Testing for chloride content was performed at both the exterior and interior (middle point) locations. Small sections of core were pulverized to pass a #50 sieve and then digested in acid to dissolve cement paste.

- Alkali-Silica Reactivity (ASR) using ASTM C856. In the Strategic Highway Research Program, uranyl acetate test, concrete is treated with a uranyl acetate solution, which is then rinsed off. This process leaves uranyl (UO_2^{+2}) absorbed to the negatively charge ASR gel which fluoresces with yellow-green glow under UV light. It is this glow that is attributed to the presence of ASR gel. The presence of gel is an indication of possible expansion products produced by highly reactive aggregate.

- Carbonation Depth Measurements, ASTM C856. Depth of carbonation was determined by an application of Rainbow Indicator (manufactured by Germann Instruments) on freshly cut cross sections of concrete core samples. The result of test provides an overall indication of the current condition of concrete.

4.3 Dynamic Laboratory Testing, Unconfined, Free-Free, Resonant Column (URC)

A total of 12 intact concrete cores (six cores each for structural and fill concrete) from the existing CNS Unit 1 basemat materials were tested. All cores were recovered from six different boreholes: C-1, C-3, C-4, C-11, C-16 and C-9A over the depth range from about 0.45 to 5.63 ft as listed in Table 4. Two samples, representing structural and fill concrete material, were obtained at different depths from each borehole were shipped to University Texas at Austin (UT) for testing. The concrete cores were tested in the unconfined, free-free, resonant column (URC) set-up (Figure 5). All of the concrete cores had a cylindrical shape with uniform dimensions (about 5.7 in) in diameter and 12 in. in length. Therefore, all cores were tested in the as-shipped condition without performing any cutting or trimming processes at UT.

The objective of this work was to measure the small-strain dynamic properties of a total of 12 intact concrete cores that were recovered from the CNS Unit 1 reactor building foundation (Table 4). All measurements were performed in the Soil and Rock Dynamics Laboratory at UT. An unconfined, free-free, resonant column (URC) test set-up was used to perform the measurements. Technique and calibrations procedures were developed and documented by

University of Texas at Austin and results were compared with industry standard published values (Table 5). A procedure developed by UT was used for the unconfined, free-free, resonant column testing.

4.4 Field Geophysical Methods

Two types of geophysical investigations were completed in the field, crosshole seismic testing and Spectral Analysis of Surface Waves (SASW) testing. Crosshole testing included both inclined and horizontal data collection. These analyses were completed on borings C-1 through C-5, the standard field set up is shown in Figures 6a and 6b.

4.4.1 Crosshole Seismic Testing – Horizontal and Inclined Travel Paths

Crosshole testing was performed in the basemat structural concrete, fill concrete, and underlying rock. Two sets of crosshole tests, positioned orthogonally to form an 'L' pattern were preformed with borings C-1, C-2 and C-3 as one leg and C-1, C-4 and C-5 the second leg of the "L" pattern. Each set involved three boreholes with C-1 representing the common source location for each survey direction (Table 2). The three boreholes were composed of one source borehole and two receiver boreholes. The boreholes were arranged in a linear array (Figure 7). The center-to-center spacing between the boreholes was measured on the floor surface just before testing (Figure 7).

The same basic field procedure was used to obtain horizontal and inclined travel path measurements between each set of three boreholes (Figures 8 and 9). The procedure involved starting seismic testing at the shallowest depth (1 ft) and progressing in 1-ft depth intervals to the final depth (17 ft). Crosshole seismic analyses were performed in accordance with ASTM D 4428, "Standard Test Methods for Crosshole Seismic Testing", with an exception as discussed below.

Due to limitations associated with testing inside the reactor building structure, overhead clearance and magnetic interferences, it was not reasonably feasible to obtain verticality measurements for the boreholes (Figures 3 and 6). For this study, it was assumed that the boreholes were essentially vertical over the testing depth of 17 ft. This assumption was proved valid as the compression wave forward and reverse travel times for the horizontal and inclined travel paths measured between source and receiver boreholes demonstrate fundamentally equivalent time records and no adjustments to average compression and shear wave velocities are necessary.

Crosshole Data Processing

Statistical analyses of the measured wave velocities and resulting Poisson's ratio were performed to calculate average values of P-Wave (V_p), S-Wave (V_s), and Poisson's Ratio for structural concrete, fill concrete, and rock materials. In these analyses, only measurements along horizontal travel paths were used. Also, only independent measurements were used; that is, measurements along the C-1 through C-2 and C-2 through C-3 travel paths were used between Boreholes C-1, C-2 and C-3 because the C-1 through C-3 travel path represents an averaging of the other two travel paths. Likewise, only the C-1 through C-4 and C-4 through C-5 travel paths were used between Boreholes C-1, C-4 and C-5.

4.4.2 SASW Testing

One SASW test array was performed within the existing CNS Unit 1 reactor building. Two receivers were used at each source/receiver set-up shown in Figure 10. Receiver #1 was located at or near the centerline of the test array shown in Figure 11. When different spacings were used, receivers #2 and the source were moved. For source-to-receiver spacings from 1

and 8 ft, tests were performed in both the forward and reverse directions using a sledgehammer for an impact source. Reverse-direction testing for the 12-ft spacing was not performed due to the limited test space as shown by the room walls in Figure 11. Six receiver spacings ranging from 1 to 12 ft were used. Regardless of the spacing between receivers, at no point in the data analysis were wavelengths considered that were longer than twice the distance between the source and first receiver in the receiver pair. This array geometry results in minimizing near-field effects while simultaneously recording long wavelengths. The largest receiver spacing was based on the space available for testing. This number and progression of receiver spacings resulted in significant overlapping of the individual dispersion curves used to develop the composite field curve, thereby enhancing the test reliability and confirming global lateral uniformity over the test array. A proprietary procedure developed by the University of Texas at Austin was used for the SASW field-testing.

The SASW test method is a nondestructive and non-intrusive seismic method. The method utilizes the dispersive nature of Rayleigh-type surface waves propagating through a layered material to determine the shear wave velocity profile of the material (Figure 12). The goal of the part of the seismic investigation was to characterize the shear wave velocity (V_s) of the existing concrete and underlying rock at the existing CNS Unit 1 reactor building structure. This goal was accomplished by: (1) developing V_s profiles to a depth of about 7.5 feet, and (2) comparing the V_s profile from SASW test with the profiles from crosshole tests (Figures 13).

SASW Data Processing

Once the composite field dispersion curve is generated for the site, an iterative forward modeling procedure is used to create a theoretical dispersion curve to match the experimental curve (Table 6). The theoretical dispersion curve is calculated (actual receiver spacing is not used) assuming that the receivers are located 2λ and 4λ (λ is wavelength) from the source. Past research has shown that this assumption does not greatly affect the final V_s velocity profile determined at most sites. It is important to understand that as the wavelength used in SASW testing increases, and hence the depth of penetration increases, the surface wave propagates through a greater material volume. The SASW resolution is best near the surface and decreases at greater depths in the profile. For these analyses, the V_s velocity profiles are presented to a maximum depth of approximately 0.5 times the longest wavelength recorded in the field (λ_{max}=15 ft). The maximum profile depth is based on the fact that most of the surface wave particle motion is occurring at depths less than 0.5 times the longest wavelength. The step-wise V_s model used in the SASW analysis reflects the general trend in the V_s velocity profile to this depth (0.5 times the longest wavelength).

The stiffness profile that provides the best match to the experimental dispersion curve is presented as the V_s velocity profile at the site. Comparisons between rock V_s profiles measured by SASW testing during this study and by independent crosshole and downhole seismic tests performed during WLS COL investigations exhibit good correlation across the site. A proprietary procedure developed by UT was used for the SASW survey.

5.0 SUMMARY OF RESULTS

Qualitative descriptions of the weathering and rock strength characteristics for recovered rock materials are according to ASTM standards as summarized in Table 8. The rock is described as meta-granodiorite, strong to very strong (R4 to R5) and fresh/unweathered. The rock strength and weathering is consistent at the interface with fill concrete and at depth with the following exceptions. In Borings C-1, C-20, and C-21 the contact zone is slightly weaker and in

Borings C-2 and C-3 the contact rock shows some evidence of slight weathering. Copies of boring logs are included as Appendix A.

No significant surface cracking of the structural slab was noted during pre-demolition testing. The results for analyses performed on the concrete samples are presented in Tables 3 through 8 and are summarized below.

5.1 Static Laboratory Testing

5.1.1 Unit Weight, Density, Absorption, and Voids in Hardened Concrete

The structural concrete ranges in unit weight/density from 151.2 to 144.6 pounds per cubic foot (pcf), with volume of permeable pore space between 14 to 10.6 % (Figure 14a). The fill concrete ranges in unit weight /density from 149.3 to 143.4 pcf, with a volume of permeable pore space between 16.8 to 12 % (Figure 14b)(Table 7).

5.1.2 Compressive Strength of Drilled Concrete Cores

Unconfined compressive strength of the structural concrete ranged from 10,550 to 6,310 pounds per square inch (psi) and the fill concrete ranges from 7,750 to 4,120 psi (Table 7).

5.1.3 Static Elastic Modulus and Poisson's Ratio

The elastic modulus of the structural concrete ranges between 4,350- 3,170 thousand pounds per square inch (ksi) with a Poisson's ratio between 0.21 and 0.17. The fill concrete elastic modulus ranges between 3,710 to 2,010 ksi with a Poisson's ratio between 0.24 and 0.15 (Table 7).

5.1.4 Splitting Tensile Strength of Cylindrical Concrete Specimens

Splitting tensile strength of the structural concrete ranged from 700 to 400 psi and the fill concrete ranges from 580 to 390 psi (Table 7).

5.1.5 Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

The potential for rapid "Chloride Penetrability" was found to be "high" to "moderate" in the structural concrete and "high" in the fill concrete (Table 7). "High" indicates a passed charge greater than 4000 Coulombs and "moderate" ranges from 2,000 to 4,000 Coulombs (designations by ASTM C1202-05).

5.1.6 Petrographic Examination

Observations made during petrographic examination indicated the concrete represented by both the structural segments and the fill segments is judged to be of good condition. This conclusion was based on; the composition, paste properties, chemical reactivity and physical condition, all of which indicated the concrete was stable and of good quality.

Both the structural and the fill concrete consist of siliceous coarse and fine aggregates distributed in a hardened Portland cement paste (Figure 15). Nominal aggregate top size is one inch. Paste properties vary somewhat among the structural segments compared to the fill segments. Overall, paste properties are somewhat better in the structural segments compared to the fill segments (Figure 16). The concrete exhibits an advanced degree of cement hydration and secondary deposits are abundant. These observations are consistent with the age of the structure and the submerged condition reported.

Cracking observed on the top of the surface of the structural core segments is attributed to the insertion of anchors into the core top structure (presumably to aid in core extraction) and do not

appear to represent wider-scale stress or deterioration of the concrete. No other significant cracking was observed within the structural or fill core segments.

5.1.7 Water Soluble Chloride Analysis

The weight percent of concrete (fill and structural) considered soluble was generally low. Chloride content within the structural concrete (Figure 17a) was consistently 0.002% by weight of the samples (14 tests), the fill concrete (Figure 17b) was on average 0.001% with a high of 0.002% weight by of samples (13 tests) (Table 7).

5.1.8 Alkali-Silica Reaction Analysis

Evidence of alkali-silica reaction (ASR) is observed in each of the core segments examined. ASR is occurring in chert fine aggregate particles that comprise a very small proportion of the total aggregate. Likely due to the small size of the reacting particles, and their relative scarcity within the concrete, no significant deterioration associated with the ASR is observed. Further, considering the age and previous exposure conditions of the concrete, it is likely that no additional ASR will occur in the future.

5.1.9 Carbonation Depth Analysis

Paste was not carbonated along the top surfaces of the structural concrete segments. The fill segments exhibited paste carbonation ranging from 0.1 to 0.2 inches in depth, with few cores exhibiting carbonation as deep as 0.3 inches. The extent of carbonation was also confirmed during petrographic examination (Figure 18).

5.2 Dynamic URC Free-Free Analysis

The URC Free-Free testing of the 12 concrete cores was performed without difficulties. The dynamic response curves and waveforms that were measured were typical of competent, intact concrete. The values of total unit weight, wave velocities moduli and Poisson's ratios of the cores equaled or exceeded values reported in the literature for 11 of the 12 cores. Values of the twelfth core (specimen FrF6) were near or less than values reported in the literature, as described below.

The measured values of total unit weight, wave velocities, moduli and Poisson's ratio of the 12 cores were compared to values reported in the literature for concrete. The values of these properties that are reported in two references in the literature are listed in Table 5. Literature reported ranges of total unit weights for plain, lightweight, and reinforced concrete and typical values of Young's modulus (E) and Poisson's ratio (v) for concrete with medium to high strength. The Table 5 values of Unconstrained Compression Wave Velocity (V_C) were calculated based on the E using an average total unit weight of plain concrete (145 lb/ft3). Furthermore, the values of Shear Wave Velocity (V_S), Constrained Compression Wave Velocity or P-Wave (V_P), Shear Modulus (G_{max}) and Constrained Compression Modulus (M_{max}) were calculated from the values of E_{max} and v of concrete with high strength. The second literature data set has a typical range of V_p for normal weight concrete with a total unit weight of 143.5 lb/ft^3 (Table 5). The range of v the authors reported is between 0.1 to 0.3, as shown in Table 5. The range of the constrained modulus M_{max} is calculated based on the ranges of V_p and v. In addition, the values of V_c, V_s, E_{max} and G_{max} are calculated from the average values of V_p and v for normal weight concrete in Table 4.

By comparing the average measured values of the 12 concrete cores with values presented in Table 4, the following is found:

- The total unit weight of all cores except sample from Boring C-4 Fill concrete (specimen

FrF6) is within the range reported in the literature. Specimen FrF6 exhibits a unit weight that is about 3% lower than the others.

- The wave velocities and moduli of all cores except specimen FrF6 exceed values reported for normal weight concrete. The values of specimen FrF6 are near or slightly below the lower values reported in the literature.
- The Poisson's ratios of all cores are close to the ones in the literature.
- The material damping ratios in shear and unconstrained compression are in the range of 0.31 to 0.40%, which, are typical of competent concrete.

5.3 Evaluation of Concrete-Rock Interface

The concrete-rock interface was evaluated using multiple methods including visual inspection of recovered core samples and velocity measurements obtained using crosshole and SASW testing methods.

5.3.1 Visual-Logging

Visual descriptions of the rock and concrete indicated both were of good quality. The concrete is described in more detail in subsections 5.1 through 5.2. The rock's visual analysis identified the weathering stage and strength characteristics. In general, the rock is described as meta-granodiorite, strong to very strong and fresh/unweathered. The rock strength and weathering is consistent at the interface with fill concrete and at depth with the following exceptions. In Borings C-1, C-20, and C-21 the contact zone is slightly weaker and in Borings C-2 and C-3 the contact rock shows some evidence of slight weathering (Table 8).

5.3.2 Crosshole

The average wave velocities determined from crosshole analysis are presented in Table 5 for the P-wave (V_p) and S-wave (V_s) velocities, respectively, measured between Boreholes C-1, C-2 and C-3. The V_p and V_s velocities, respectively, measured between Boreholes C-1, C-4 and C-5 gave average values and standard deviations (σ) of the V_p and V_s velocities and Poisson's ratios for the structural concrete, fill concrete and rock are summarized in Table 5.

Structural Concrete:

In the case of the structural concrete, only measurements between Boreholes C-1, C-2 and C-3 were used since very few values were determined from Boreholes C-1, C-4 and C-5 and the average V_p velocity from the second set of boreholes was essentially the same. Recorded data and selection of first arrivals from Boreholes C-1, C-4, and C-5 was impaired by interference from vertical concrete walls associated with a lower room within the reactor building. The structural concrete is very stiff as shown by the average velocities.

Fill Concrete:

In the case of the fill concrete, the average velocities are slightly higher (about 8%) between Boreholes C-1, C-2 and C-3 than measured between Boreholes C-1, C-4 and C-5. However, all values show the fill concrete to be less stiff than the structural concrete. The stiffness of fill concrete is considered to represent very good concrete as shown by the average wave velocities.

Rock:

The rock is stiffer between Boreholes C-1, C-2 and C-3 than between Boreholes C-1, C-4 and C-5. In each case, the V_p values of the rock are above the structural and fill concretes while the shear wave velocities range from about the V_s velocities in the concretes to about 25% less. In any case, the underlying rock is stiff as shown by the average wave velocities. The variation in rock velocities is attributed to the presence of natural discontinuities and man-made

discontinuities associated with standard excavation methods (e.g. blasting) used to reach suitable CNS foundation subgrade. The concrete thickness and the concrete-rock interface transition are illustrated in Figure 8. Figure 8a shows relatively uniform concrete thick and depth to rock interface along the C-1 through C-3 direction. Figure 8b shows a relatively steep fill concrete-rock interface along the C-1 through C-5 direction. This condition results from the proximity of boring C-5 to the wall for the lower room 18 ft below the basemat slab grade (CNS plant elevation 37+0).

The values of Poisson's ratio (v) for the rock are somewhat above the typical range for many types of rock (0.25 to 0.35). The reason or reasons are unknown but anisotropy in the rock due to cracks and fractures (both natural and blasting-derived) could be a contributor.

5.3.3 SASW

Comparison of V_s profiles in the structural and fill concrete from the crosshole and SASW Measurements: The V_s profiles determined independently from the crosshole and SASW measurements are shown in Figure 13. As seen in the figure, the SASW results essentially represent average V_s velocities in each layer of the structural and fill concrete. The SASW profile also exhibits V_s values slightly lower than the test results from the concrete cores.

Comparison of V_s profiles in the rock measured by crosshole testing at the WLS site and measured by SASW testing on the exposed rock: SASW testing on an exposed rock area near the existing substructure was performed for MACTEC (2007). The values from analysis completed for this study correspond well to the values measured in local rock outcrops within the existing excavation.

The SASW profiles fall within the range of V_s values measured between Boreholes C-1, C-2 and C-3 and above the values measured between Boreholes C-1, C-4 and C-5.

6.0 CONCLUSIONS

Based on field and laboratory data collected as part of the pre-demolition evaluation on existing CNS Unit 1 concrete and rock materials, the WLS Site is determined to be in good condition, of acceptable quality and strength. The concrete-rock interface is bonded with no significant zones of weakness or weathering observed. Recovered rock core is consistent with observations from WLS COL and historic CNS investigations.

Concrete represented by both the structural and fill segments is judged to be of good quality and is in good condition. The concrete exhibits an advanced degree of cement hydration and secondary deposits are abundant. These observations are consistent with the age of the structure and the submerged conditions of the basemat materials. Considering the age and previous exposure conditions of the concrete it is likely that no additional alkali-silica reactions will occur.

Field and laboratory seismic velocity measurements are consistent with the values published in the Final Safety Analysis Report (FSAR) and used to calculate WLS Unit 1 foundation input response spectra (FIRS) ground motion calculations.

The results of the CNS Unit 1 pre-demolition evaluation validates the assumptions and provisional values for structural and fill concrete and rock materials described in the FSAR. Static and dynamic material properties as well as foundation support considerations relative to existing CNS structural and fill concrete are described in the following FSAR Subsections

2.5.4.2.4 Material Properties, 2.5.4.3 Foundation Interfaces, 2.5.4.5 Excavations and Backfills, 2.5.4.7 Response to Soil and Rock to Dynamic Loading, and 2.5.4.10 Static Stability. Pre-demolition testing indicates that existing CNS concrete conforms to the requirements for plain structural concrete in DCD Subsection 2.5.4.6.3.

7.0 QUALITY ASSURANCE

Quality related activities performed by MACTEC, WLA and their subcontractor organizations that provided equipment and personnel during the completion of this COL project were in accordance with the project approved Quality Assurance (QA) program. The project approved QA program complies with the requirements of 10 CFR 50 Appendix B.

8.0 POST-DEMOLITION TESTING PROGRAM

The post-demolition test program is described in FSAR Subsection 2.5.4.5.3.1 Nuclear Island Foundation Materials. The pre-demolition test results were not available for use in the FSAR. Hence, the post-demolition program described in the FSAR considers a large-scale testing program configured similarly to the pre-demolition program described and summarized in this document. As a result, the post-demolition testing program is modified slightly based on the pre-demolition findings. The objectives of the post-demolition program include the following goals: 1) to confirm that demolition activities did not substantially impair the structural qualities of basemat concrete material properties obtained during WLS COLA investigations, and 2) evaluate anomalous pre-demolition test results. The post-demolition test program is described below.

The post-demolition testing program will include coring, collection of representative concrete and rock material samples, and field and laboratory testing at between six to eight locations across the CNS basemat slab at elevation 545 ft (CNS Plant elevation of 55+0). Confirmatory testing will include discrete test locations within each of the reactor building foundation quadrants (four to six locations) with additional testing planned at pre-demolition test locations to evaluate anomalous test results, such as C-4 and C-15 (two locations).

The program to evaluate concrete, rock and the concrete-rock interface is described below.

Concrete testing program

- Visual inspection of basemat slab for evidence of significant surface cracking attributed to demolition.
- Coring of the structural and fill concrete materials for visual observation of the concrete condition, using double and/or triple-tube diamond coring methods.
- Field compression and shear wave velocity measurements at location of pre-demolition test location (e.g. vicinity of C1 through C-5) using downhole and SASW test methods.
- Laboratory compression and shear wave velocity measurements on selected structural and fill concrete materials using unconfined, free-free, resonant column method.
- Laboratory testing of the concrete materials to include strength, compression and petrographic analysis, and degradation due to chloride or sulfate reaction.

Rock testing program

- Coring through the concrete into rock for visual observation of the rock and the condition of the rock materials below the concrete fill or concrete slab. Coring will extend into rock up to 50 ft to obtain borehole geophysical measurements.
- Field compression and shear wave velocity measurements using downhole and P-S suspension test methods.

Concrete-rock interface testing program
The concrete and rock interface will be observed and logged using recovered core and downhole logged using either a televiewer or an impression packer device.

The results of the post-demolition testing will be presented in a data summary report that will include boring logs, summary of field and laboratory test results and comparisons to the pre-demolition results. This comparison report will provide commentary regarding CNS concrete materials uniformity and conformance to the requirements for plain concrete in DCD Subsection 2.5.4.6.3.

9.0 REFERENCES

ASTM C 42, 2004; "Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete".

ASTM C 469, 2002; "Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression".

ASTM C 496, 2004; "Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens".

ASTM C 642, 2006; "Standard Test Method for Density, Adsorption, and Voids in Hardened Concrete".

ASTM C 856, 2004; "Standard Practice for Petrographic Examination of Hardened Concrete".

ASTM C1202-05; "Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration".

ASTM C 1218, "Standard Test Method for Water-Soluble Chloride in Mortar and Concrete".

ASTM D 4428, 2000, "Standard Test Methods for Crosshole Seismic Testing".

Duke Power Company, 1974, "Preliminary Safety Analysis Report", Project 81, Cherokee Nuclear Station.

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MACTEC, (2008a), Attachment K, Concrete Basemat Testing – Concrete Core Logs and Laboratory Physical and Chemical Testing of Cores, Lee Nuclear Station, prepared by CTL Group, Revision 0, February, 1, 2008.

MACTEC (2008b), Geotechnical Data Report, Attachment L, Field Seismic Testing of Existing Basemat Concrete and Rock at the Former Cherokee Nuclear Island Station Unit 1 Reactor Building, Lee Nuclear Station, Revision 1, prepared by University of Texas at Austin, January 30, 2008.

MACTEC (2008c), Attachment M, Dynamic Laboratory Tests on Intact Concrete Specimens, Revision 0, dated February 4, 2008.

Regulatory Guide 1.132, "Site Investigation for Foundations of Nuclear Power Plants." Rev 2.October, 2003.

Shaw, Stone & Webster, Inc., 2007, AP1000 Site and Facility Layout, 124029-CVL-SP.dwg, September, 2007.

10.0 TABLES AND FIGURES

Tables

Laboratory and Field Testing: Types and Methods	Laboratory and Field Testing Quantities
Concrete and Rock Borings, Rock Coring	16
Static Modulus of Elasticity and Poisson's Ratio for Concrete in Compression, ASTM C469	two (core samples) from 6 Borings
Compressive Strength of Drilled Concrete Cores ASTM C42	two (core samples) from 16 borings
Splitting Tensile Strength of Cylindrical Concrete Specimens, ASTM C469	two (core samples) from 16 borings
Density, Absorption, and Voids in Hardened Concrete, ASTM C642	two (core samples) from 16 borings
Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration, ASTM C1202	two (core samples) from 16 borings
Petrographic Examination of Hardened Concrete, ASTM C856	two (core samples) from 16 borings
Water-Soluble Chloride Analysis, ASTM C1218	two (core samples) from 16 borings
Unconfined, Free-Free, Resonant Column Test, Proprietary Procedure - University of Texas at Austin	two (core samples) from 16 borings
Crosshole Seismic Analysis, ASTM D4428	5 (borings), in two sets of three
Spectral Analysis of Surface Waves (SASW) Survey, Proprietary Procedure - University of Texas at Austin	SASW Tests Coincide with Crosshole Survey

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Summary of Geotechnical Exploration Field and Laboratory Testing Program

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Table 1

Facility	CNS Basemat Slab Plant Elevation (ft)	Boring Number	Elevation (ft MSL)	Depth into Rock Below Existing Basemat/Fill Concrete (ft)	Material Type and Max. Depth (Measured from top of slab)			Material Type Elevation				Physical & Chemical Concrete Static Tests							Field and Laboratory DynamicTesting			
					Structural Concrete	Fill Concrete	Rock	Top Structural Concrete	Top Fill Concrete	Top of Rock	Bottom of Hole	Static Modulus	Poisson's Ratio	UCS	Tensile strength	Petro-graphy	Unit Weight	Chloride Penetrability	Crosshole Inclined	Crosshole horizontal	SASW	Unconfined Free-Free Resonant Column
WLS Unit 1 (Basemat Elevation 550.5 ft MSL)	55+0	C-1	545	10.0	4.0	8.8	18.9	545	541.0	536.2	526.2	X	X	X	X	X	X	X	X	X	X	X
	55+0	C-2	545	10.0	3.9	8.4	18.4	545	541.1	536.6	526.6	X	X	X	X	X	X	X	X	X	X	--
	55+0	C-3	545	10.2	3.8	7.8	18.0	545	541.2	537.2	527.1	X	X	X	X	X	X	X	X	X	X	X
	55+0	C-4	545	7.2	4.0	11.0	18.2	545	541.0	534.0	526.8	X	X	X	X	X	X	X	X	X	X	X
	55+0	C-5*	545	6.3	4.0	26.0	32.3	545	541.0	519.0	512.7	X	X	X	X	X	X	X	X	X	X	--
	55+0	C-9**	545	--	4.0	--	--	545	541.0	--	--	X	X	X	X	X	X	X	--	--	--	--
	55+0	C-9A*^	545	4.6	4.0	7.9	12.5	545	541.0	537.1	532.5	X	X	X	X	X	X	X	--	--	--	X
	55+0	C-11	545	3.1	3.9	9.9	13.0	545	541.1	535.1	532.0	X	X	X	X	X	X	X	--	--	--	X
	55+0	C-12	545	3.2	4.0	12.9	16.0	545	541.1	532.2	529.0	X	X	X	X	X	X	X	--	--	--	--
	55+0	C-15	545	2.4	4.0	9.3	11.7	545	541.0	535.7	533.3	X	X	X	X	X	X	X	--	--	--	--
	55+0	C-16	545	3.5	4.0	6.4	9.6	545	541.0	538.6	535.4	X	X	X	X	X	X	X	--	--	--	X
	55+0	C-18	545	3.6	4.0	7.6	11.3	545	541.0	537.4	533.8	X	X	X	X	X	X	X	--	--	--	--
	55+0	C-19^	545	--	3.9	7.3	--	545	541.1	537.7	--	X	X	X	X	X	X	X	--	--	--	--
	55+0	C-19A*^	545	4.4	3.9	7.0	11.4	545	541.1	538.0	533.6	X	X	X	X	X	X	X	--	--	--	--
	37+0	C-20^^	527	3.1	4.4	6.8	9.9	527	522.6	520.2	517.1	X	X	X	X	X	X	X	--	--	--	--
	37+0	C-21^^	527	0.9	4.5	5.9	6.8	527	522.5	521.1	520.2	X	X	X	X	X	X	X	--	--	--	--

Notes:

1. Sample locations and plant grade elevations based on Duke Power Company Project 81, Auxiliary Building Plan EL 55+0, Reactor Building Plan elevation 55+0, General Arrangment, Drawing No. P81-1040-2; and Longitudinal Section General Arrangement, Drawing No. P81-1040-10.
2. Boreholes C-6, C-7, C-8, C-10, C-13, C-14 and C-17 were removed from the exploration program.
3. Boring notes from field exploration:

--	Indicates no test completed
X	Indicates tested

*Borehole abandoned, core barrel sheared at 32.5 ft., total drilled depth approximatley 35 ft.
**Borehole abandoned due to obstruction
*^Offset boring
^Location abandoned due to obstruction
^^Sample location in lower room, CNS plant elevation 37+0, testing complete in lower room

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Summary of Completed Geotechnical Borings and Tests for Basemat Concrete

WLA William Lettis & Associates, Inc. | Table 2

Core/ Boring ID	Completed Testing and Designated Core Segments (depths in feet)						
	ASTM C856 Petrography	ASTM C1218 Water-soluble Chloride	ASTM C469 Modulus of Elasticity	C42 Compressive Strength	C496 Splitting Tensile Strength	C642 Density, Absorption and Voids	C1202 Rapid Chloride Penetration
C-1	S 0 – 0.4		*S 2.35 – 3.35	S 0.4 – 1.4	S 1.4 – 2.35	S 3.35 – 4.0	
	F 4.0 – 4.5		*F 4.5 – 5.5	F 5.5 – 6.4	F 6.4 – 7.3	F 7.3 – 8.05	
C-2	S 0 – 0.5		S 0.5 – 1.55	S 2.4 – 3.3	S 1.55 – 2.4	S 3.3 – 3.93	
	F 3.93 – 4.43		F 4.43 – 5.43	F 5.43 – 6.33	F 6.33 – 7.23	F 7.23 – 7.78	
C-3	S 0 – 0.45		*S 0.45 – 1.45	S 1.45 – 2.45	S 2.45 – 3.2	S 3.2 – 3.83	
	F 3.83 – 4.4		*F 4.4 – 5.4	F 5.4 – 6.4	F 6.4 – 6.97	F 6.97 – 7.5	
C-4	S 0 – 0.55		*S 0.55 – 1.55	S 1.55 – 2.55	S 2.55 – 3.35	S 3.35 – 3.96	
	F 3.96 – 4.63		*F 4.63 – 5.63	F 5.63 – 6.63	F 6.63 – 7.37	F 7.37 – 7.93	
	-		F 8.93 – 9.93	F 7.93 – 8.93	-	F 9.93 – 10.85	
C-5	S 0 – 1.23		S 1.23 – 2.23	S 2.23 – 3.3	~~S 3.52-4.3 4.6-5.3~~ +	~~S 4.3-5.3 3.52 – 4.3~~ +	
	F/S 22.43 – 22.85		F/S 22.85 – 23.85	F/S 24.85 – 26.0	F/S 24.35 – 24.85	F/S 23.85 – 24.35	
C-9A	S 0 – 0.45		*S 0.45 – 1.47	S 1.47 – 2.5	S 2.5 – 3.25	S 3.25 – 3.94	
	F 3.94 – 4.54		*F 4.54 – 5.54	F 5.54 – 6.54	F 6.54 – 7.45	F 7.45 – 7.91	
C-11	S 0 – 0. 5		*S 0. 5 – 1. 5	S 2.3 – 3.3	-	S 3.3 – 3.94	
	F 3.94 – 4.55		*F 4.55 – 5.55	F 5.55 – 6.55	F 6.94 – 7.95	F 7.95 – 8.5	
C-12	S 0 – 0.6		S 0.6 – 1.6	S 2.5 – 3.35	S 1.6 – 2.5	S 3.35 – 3.95	
	F 3.95 – 4.55		F 4.55 – 5.55	F 5.55 – 6.6	F 6.6 – 7.6	F 7.6 – 8.2	
C-15	S 0 – 0.5		S 0.5 – 1.5	S 1.5 – 2.5	S 2.5 – 3.35	S 3.35 – 3.97	
	F 3.97 – 4.97		F 4.97 – 5.97	F 5.97 – 6.97	F 6.97 – 7.97	F 7.97 – 9.27	
C-16	S 0 – 0.5		*S 1.6 – 2.6	S 2.6 – 3.42	S 0.5 – 1.2	S 3.42 – 3.96	
	F 5.4 – 5.8		*F 3.96 – 4.75	F 4.9 – 5.4	-	F 6.0 – 6.36	F 5.8 – 6.0
C-18	S 0 – 0.65		S 0.65 – 1.65	S 1.65 – 2.65	S 2.65 – 3.28	S 3.28 – 3.96	
	F 3.96 – 4.47		F 4.47 – 5.47	F 5.47 – 6.47	F 6.47 – 7.15	F 7.15 – 7.55	
C-19A	S 0 – 0.45		S 0.45 – 1.45	S 1.45 – 2.45	S 2.45 – 3.37	S 3.37 – 3.9	
	F 3.9 – 4.37		F 4.37 – 5.37	F 5.37 – 6.13	F 6.13 – 6.63	F 6.63 – 7.02	
C-20	S 0 – 0.55		S 1.55 – 2.55	S 2.55 – 3.57	S 0.55 – 1.55	S 3.57 – 4.13	
	F 4.43 – 4.85		-	-	-	F 6.1 – 6.78	~~F 6.1 – 6.78~~ 5.93 – 6.1 †
C-21	S 0 – 0.6		S 2.52 – 3.5	S 1.4 – 2.52	S 0.6 – 1.4	S 3.5 – 4.25	-
			F 4.5 – 5.5	-	-	-	-

Notes:

S Designates structural slab (concrete with reinforcement), followed by core segment depth range.

F Designates fill concrete (concrete lacking rebar reinforcement), followed by core segment depth range.

F/S Dual symbol identifying the condition at boring C-5 in which a layer of steel reinforcement was encountered at approximately 21.5 ft. depth, but below approximately 17.5 ft. of fill concrete.

* Indicates core segments shipped by University of Texas at Austin

\+ Core C-5 S 3.52–4.3', intended for C496, was mis-cut by CTLGroup. Segment S 4.3–5.3', intended for C642 and C1202, was substituted, however steel bar was present at depth of 4.3–4.6', therefore segment S 4.6–5.3' tested for C496. Mis-cut segment S 3.52–4.3' was substituted for C642 and C1202.

† Due to a longitudinal crack through the Fill segment of Core C-20, there was insufficient cross-sectional area to drill a 4-in. diameter disk from segment F 6.1–6.78' for ASTM C1202. The segment 5.93 –6.1' did provide the necessary area and this segment was substituted for the C1202 testing.

\- No Tests designated

Source: MACTEC Data Report Attachment K, Appendix K2, MACTEC, 2008a.

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Summary of Completed Physical and Chemical Tests for Concrete

WLA William Lettis & Associates, Inc.

Table 3

UTEXAS Free-Free Specimen No.	Core/ Borehole ID	Concrete Type	Depth (ft)	Total Unit Weight (pcf)	V_c (fps)	E_{max} (psf)	Dc (%)	V_s (fps)	G_{max} (psf)	D_s (%)	V_p (fps)	M_{max} (psf)	Poisson's Ratio v (MG)(1)	(ME)(2)	(EG)(3)
FrF1	C-1	Structural	2.4 - 3.4	142.8	**13,229**	7.76E+08	0.37	**8,394**	3.12E+08	0.36	**14,054**	8.76E+08	**0.22**	**0.21**	**0.24**
FrF3	C-3	Structural	0.5 - 1.5	141.4	**13,059**	7.49E+08	0.32	**8,275**	3.01E+08	0.33	**14,045**	8.66E+08	**0.23**	**0.23**	**0.25**
FrF5	C-4	Structural	0.6 - 1.6	140.3	**13,087**	7.46E+08	0.38	**8,208**	2.94E+08	0.38	**13,999**	8.54E+08	**0.24**	**0.22**	**0.27**
FrF7	C-11	Structural	0.5 - 1.5	142.8	**13,100**	7.61E+08	0.34	**8,291**	3.05E+08	0.34	**13,740**	8.37E+08	**0.21**	**0.19**	**0.25**
FrF9	C-16	Structural	1.6 - 2.6	142.5	**13,002**	7.48E+08	0.4	**8,291**	3.04E+08	0.38	**13,796**	8.42E+08	**0.22**	**0.21**	**0.23**
FrF11	C-9A	Structural	0.5 - 1.5	142.4	**13,210**	7.72E+08	0.33	**8,423**	3.14E+08	0.31	**14,118**	8.81E+08	**0.22**	**0.22**	**0.23**
FrF2	C-1	Fill	4.5 - 5.5	140.9	**13,046**	7.45E+08	0.34	**8,239**	2.97E+08	0.34	**13,786**	8.32E+08	**0.22**	**0.2**	**0.25**
FrF4	C-3	Fill	4.4 - 5.4	140.8	**12,844**	7.21E+08	0.34	**8,159**	2.91E+08	0.32	**13,657**	8.16E+08	**0.22**	**0.21**	**0.24**
FrF6	C-4	Fill	4.6 - 5.6	135.9	**11,491**	5.57E+08	0.34	**7,311**	2.26E+08	0.34	**12,413**	6.50E+08	**0.23**	**0.23**	**0.23**
FrF8	C-11	Fill	4.6 - 5.6	140.5	**12,880**	7.24E+08	0.38	**8,196**	2.93E+08	0.36	**13,390**	7.82E+08	**0.2**	**0.18**	**0.23**
FrF10	C-16	Fill	4 - 4.8	141.5	**12,997**	7.43E+08	0.36	**8,224**	2.97E+08	0.34	**13,860**	8.44E+08	**0.23**	**0.22**	**0.25**
FrF12	C-9A	Fill	4.5 - 5.5	141.3	**13,033**	7.45E+08	0.34	**8,275**	3.01E+08	0.31	**13,569**	8.08E+08	**0.2**	**0.18**	**0.24**

Notes:

V_c Unconstrained Compression Wave Velocity
E_{max} Young's Modulus
Dc Material Damping Ratio in Compression
V_s Shear Wave Velocity
G_{max} Shear Modulus
D_s Material Damping Ratio in Shear
V_p Constrained Compression Wave Velocity
M_{max} Constrained Compression Modulus

1) Poisson's Ratio derived from: $\nu_{MG} = \frac{M_{max} - 2G_{max}}{2(M_{max} - G_{max})}$

2) Poisson's Ratio derived from: $\nu_{ME} = \frac{1}{4M_{max}}\left(-M_{max} + E_{max} + \sqrt{9M_{max}^2 - 10M_{max}E_{max} + E_{max}^2}\right)$

3) Poisson's Ratio derived from: $\nu_{EG} = \frac{E_{max} - 2G_{max}}{2G_{max}}$

Testing performed by Dr. Kenneth Stokoe at the University of Texas at Austin (UTEXAS)

Source: MACTEC Data Report Attachment M, MACTEC, 2008c.

WILLIAM STATES LEE III NUCLEAR STATION

Summary of Free-Free Resonant Column and Direct-Arrival Test for Concrete

WLA WILLIAM LETTIS & ASSOCIATES, INC.

Table 4

Data Sources	Concrete Sample Sources	Weight (pcf)	Torsional Resonance V_c (fps)	Torsional Resonance E_{max} (psf)*	Torsional Resonance Dc (%)	Compressional Resonance V_s (fps)	Compressional Resonance G_{max} (psf)*	Compressional Resonance D_s (%)	Direct-Travel-Time V_p (fps)	Direct-Travel-Time M_{max} (psf)*	Poisson's Ratio ν
Literature for Concrete	Craig, 2000 (medium to high strength)	140.0	10729.00	5.22E+08	-	7743.0	2.69E+08	-	12645.0	7.21E+08	0.20
	Craig, 2000 (high strength)	150.0	11996.00	6.47E+08	-	8088.0	2.95E+08	-	12131.0	6.64E+08	0.10
	Malhorta and Carino, 1991	143.5	10604.00	5.01E+08	-	6576.0	1.92E+08	-	12303.0	7.03E+08	0.30
	Malhorta and Carino, 1991	143.5	11672.00	6.08E+08	-	7534.0	2.53E+08	-	12303.0	7.03E+08	0.20
UTEXAS Laboratory	Average Unconfined, Free-Free, Resonant Column, [**All Structural** samples (6)]	142.0	13114.5	7.59E+08	0.36	8313.7	3.1E+08	0.35	13958.7	8.59E+08	0.23
	Average Unconfined, Free-Free, Resonant Column, [**All Fll** samples (6)]	140.2	12715.2	7.06E+08	0.35	8067.3	2.8E+08	0.34	13445.8	7.89E+08	0.22
UTEXAS Field	Average Crosshole C1, C2, and C3 **Structural** Concrete	-	-	-	-	7860 (σ 420)	-	-	14950 (σ 730)	-	0.30 (σ 0.04)
	Average Crosshole C1, C2, and C3 **Fill** Concrete	-	-	-	-	7790 (σ 580)	-	-	14730 (σ 510)	-	0.31 (σ 0.04)
	Average Crosshole C1, C4, and C5 **Fill** Concrete	-	-	-	-	7260 (σ 620)	-	-	13430 (σ 350	-	0.31 (σ 0.06)
	Average Crosshole C1, C2, and C3 **Rock**	-	-	-	-	7660 (σ 590)	-	-	19270 (σ 870)	-	0.40 (σ 0.02)
	Average Crosshole C1, C4, and C5 **Rock**	-	-	-	-	5590** (σ 590)	-	-	17450 (σ 700)	-	0.44 (σ 0.01)

Notes:

1) $V_C=\sqrt{E/(\gamma_t/32.2)}$

2) $V_S=\frac{V_C}{\sqrt{2(1+\nu)}}$

3) $G=(\gamma_t/32.2)V_S^2$

4) $V_P=V_C\sqrt{\frac{(1-\nu)}{(1+\nu)(1-2\nu)}}$

5) $M=(\gamma_t/32.2)V_P^2$

6) $V_C=V_P\sqrt{\frac{(1+\nu)(1-2\nu)}{(1-\nu)}}$

7) $E=(\gamma_t/32.2)V_C^2$

8) $V_S=V_P\sqrt{\frac{1-2\nu}{2(1-\nu)}}$

9) $G=(\gamma_t/32.2)V_S^2$

V_c Unconstrained Compression Wave Velocity
E_{max} Young's Modulus
Dc Material Damping Ratio in Compression
V_s Shear Wave Velocity
G_{max} Shear Modulus
D_s Material Damping Ratio in Shear
V_p Constrained Compression Wave Velocity
M_{max} Constrained Compression Modulus
σ Standard deviation (sigma)

* Values from literature were converted from gigapascals to pounds per square foot.

** The values of Poisson's ratio for the rock are somewhat above the typical range for many types of rock (0.25 to 0.35). The reason or reasons are unknown but anisotropy in the rock due to cracks and fractures could be a contributor.

Literature sources as cited in MACTEC Data Reports L and M

Roy R. Craig, Mechanics of Material, John Wiley & Sons, Inc., New York, NY, 2000

V.M. Malhotra and N.J. Carino, Handbook on Nondestructive Testing of Concrete, CRC Press, Inc., Boca Raton, Florida, 1991

Source: MACTEC Data Reports Attachment L, Vol. 1, MACTEC, 2008b and Attachment M, MACTEC, 2008c Laboratory and field testing performed by Dr. Kenneth Stokoe at the Univeristy of Texas at Austin (UTEXAS).

WILLIAM STATES LEE III NUCLEAR STATION

Summary of Laboratory and Field Average Dynamic Analysis Results Compared to Published Values

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Table 5

SASW Testing on Basemat Slab (CNS Plant Elevation 55+0)

Layer No.	Thikness, ft	Depth to Top of Layer, ft	P- Wave Velocity, ft/s	S- Wave Velocity, ft/s	Assumed Poisson's Ratio	Assumed Total Unit Weigth, pcf
1	0.3	0	15341	8200	0.3	142
2	0.7	0.3	14967	8000	0.3	142
3	3	1	14031	7500	0.3	142
4	2	4	13376	7150	0.3	140
5	2	6	13189	7050	0.3	140
6	15*	8	14988	7200	0.35	135
7	Half Space*	23	15613	7500	0.35	135

* Layer below maximum depth of the V_S Profile

Source: MACTEC Data Report Attachment L, Vol 1, MACTEC, 2008b.

WILLIAM STATES LEE III NUCLEAR STATION

Summary of Profile Parameters for the Theoretical Dispersion Curve - SASW

WLA WILLIAM LETTIS & ASSOCIATES, INC. Table 6

Concrete Type and Core/ Boring ID	Test Type and Method					
	ASTM C469		ASTM C42	ASTM C496	ASTM C642	ASTM C1202
	Modulus of Elasticity (ksi)	Poisson's Ratio	Compressive Strength (psi)	Tensile Strength (psi)	Unit Weight (pcf)	Chloride Penetrability [1]
Structural						
C-1	4,060	0.19	7,700	620	148.7	high
C-2	3,570	0.18	8,960	650	147.8	moderate
C-3	3,870	0.2	9,320	600	147	moderate
C-4	3,790	0.19	9,870	630	146.3	high
C-5	3,500	0.18	8,720	690	149.1	high
C-9A	3,970	0.19	9,060	400 [2]	146.8	high
C-11	3,650	0.18	6,310	—	147.7	high
C-12	3,170	0.17	6,950	520	145.8	high
C-15	3,900	0.2	8,690	620	147.1	moderate
C-16	3,820	0.18	9,230	590	144.6	moderate
C-18	4,350	0.19	10,000	630	151.2	high
C-19A	4,070	0.21	10,030	650 [3]	149	high
C-20	3,510	0.19	10,550	610 [3]	149.9	high
C-21	3,200	0.18	10,330	700	144.8	high
Fill						
C-1	3,590	0.17	7,520	580	146.2	high
C-2	3,370	0.18	7,250	560	147.1	high
C-3	3,510	0.19	7,360	540	146.7	high
C-4	2,410	0.15	4,130	390	144.2	high
	2,010	0.22	4,120	—	143.4	high
C-5	2,550	0.22	6,760	480	143.8	high
C-9A	3,710	0.17	7,750	580	149.3	high
C-11	3,600	0.16	5,480	560	147.3	high
C-12	3,260	0.18	6,410	570	147.2	high
C-15	2,720	0.17	4,060	460 [3]	144.4	high
C-16	3,330	0.16	7,240	—	148.5	high
C-18	3,420	0.16	6,650	580	146.3	high
C-19A	3,620	0.19	6,900	510	147.7	high
C-20	—	—	—	—	146.8	high
C-21	2,430	0.24	—	—	—	—

Notes:

'—' Indicates that no segment was tested.

1 Rating per Table 1 in ASTM C1202-05.

2 Core segment tested exhibited a longitudinal crack, likely pre-existing.

3 Core segment tested was cracked transversely, either during sampling or during transport to the laboratory.

Source: MACTEC Data Report Attachment K, Appendix A in Data Report Attachment K Appendix K2, MACTEC, 2008a.

WILLIAM STATES LEE III NUCLEAR STATION

Summary of Physical and Chemical Tests and Results for Concrete

WLA WILLIAM LETTIS & ASSOCIATES, INC. Table 7

	Rock at Fill Concrete Interface			Rock Below Contact with Fill Concrete		
Boring	**Weathering**	**Strength**	**Notes**	**Weathering**	**Strength**	**Notes**
C1	Fresh	R3-R4 Medium Strong - Strong	-	Fresh	R4 - Strong	Fractured
C2	Slightly Weathered (SW)	R4 - Strong	-	Fresh	R4 - Strong	-
C3	SW- Fresh	R4 - Strong	Shear fabric present	Fresh	R4 - Strong	-
C4	Fresh	R4 - Strong	-	Fresh	R4 - Strong	-
C5	Fresh	R4 - Strong	-	Fresh	R4 - Strong	-
C9	NE	NE	NE	NE	NE	NE
C9A	Fresh	R4 - Strong	Fractured	Fresh	R4 - Strong	Shear fabric present
C11	Fresh	R5 - Very Strong	-	Fresh	R5 - Very Strong	-
C12	Fresh	R5 - Very Strong	-	Fresh	R5 - Very Strong	-
C15	Fresh	R5 - Very Strong	-	Fresh	R5 - Very Strong	-
C16	Fresh	R5 - Very Strong	-	Fresh	R5 - Very Strong	-
C18	Fresh	R5 - Very Strong	-	Fresh	R5 - Very Strong	-
C19	NE	NE	NE	NE	NE	NE
C19A	Fresh	R4 - Strong	-	Fresh	R4 - Strong	-
C20	Fresh	R2 - Weak	Healed Joints	Fresh	R2-R3 Weak-Medium Strong	-
C21	Fresh	R3-R4 Medium Strong - Strong	Shear fabric present	NE	NE	NE

NE= Not Encountered, test location terminated; refer to Table 2.

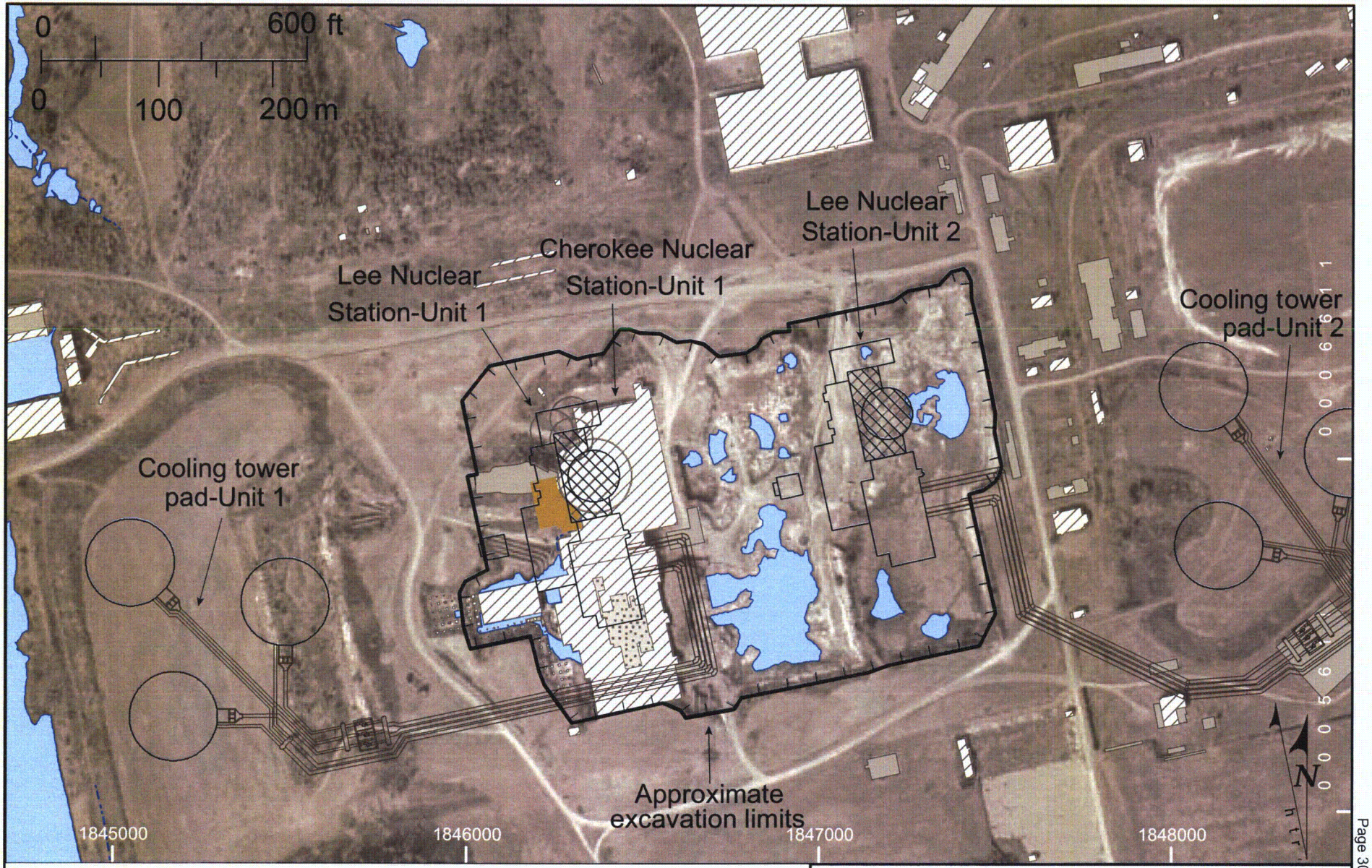
Source: MACTEC Data Report Attachment K, Appendix K1, MACTEC, 2008a.

WILLIAM STATES LEE III NUCLEAR STATION

Summary of Visual Observations from Boring Logs

WLA WILLIAM LETTIS & ASSOCIATES, INC. Table 8

Figures

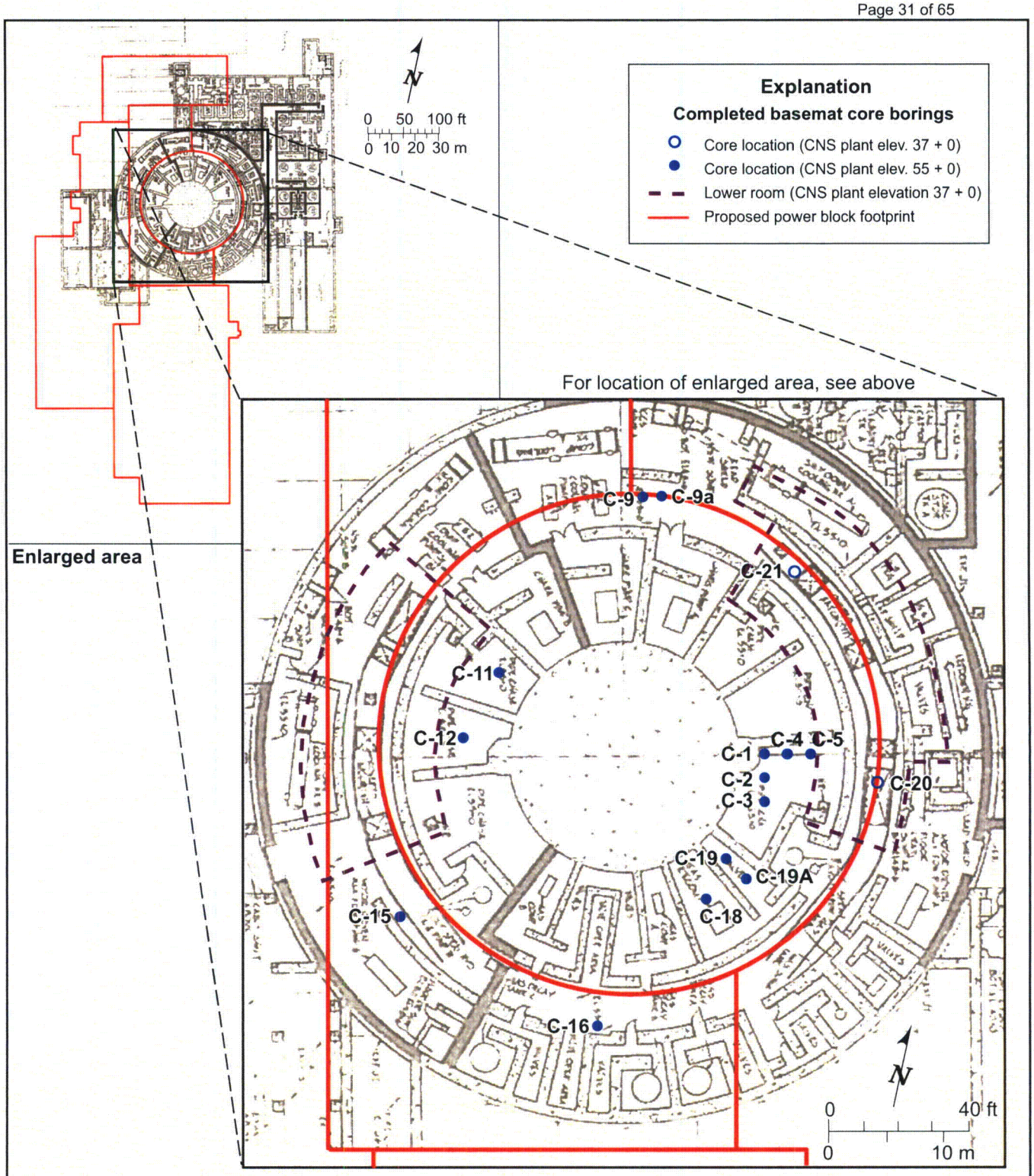


WILLIAM STATES LEE III NUCLEAR STATION

Site Features of WLS Nuclear Station Units 1 & 2 Area

WLA William Lettis & Associates, Inc.

Figure 1



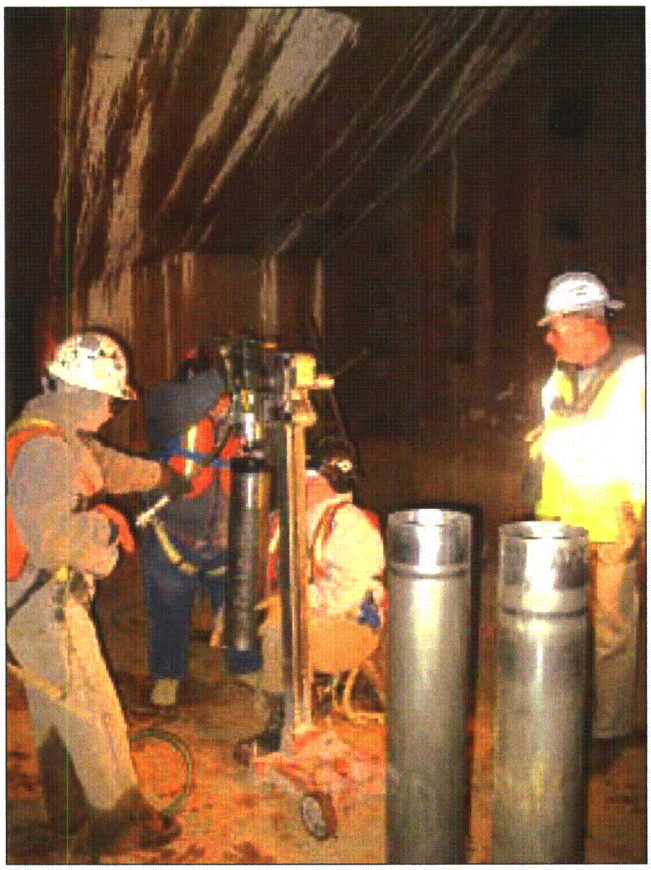
Sources: 1. PSAR Figure 2.4.13-1, Reactor and Auxiliary Buildings, Ground Water Control, Cherokee Nuclear Station, Duke Power Company, 1974.
2. AP1000 Site and Facility Layout, 124029-CVL-SP.dwg, Shaw Stone & Webster, Inc., September, 2007.

WILLIAM STATES LEE III NUCLEAR STATION

Completed Test Locations Unit 1 Concrete Basemat Evaluation Cherokee Nuclear Station

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 2

A) Single Barrel Drill utilized and set up for core extraction.

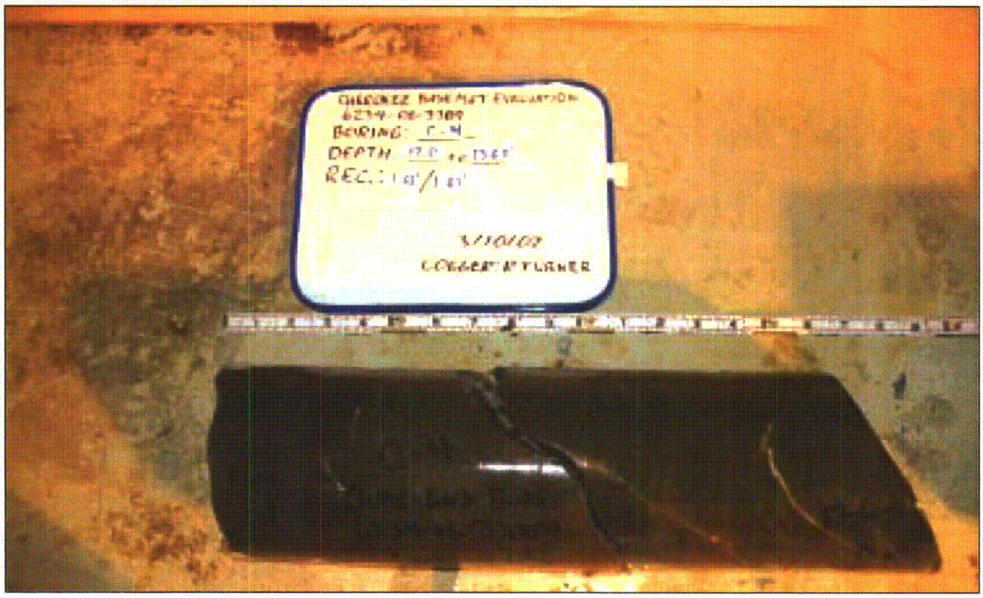


B) Extraction of 6-inch diameter core samples.

WILLIAM STATES LEE III
NUCLEAR STATION

Typical Concrete Basemat Drilling Set-Up and Core Extraction

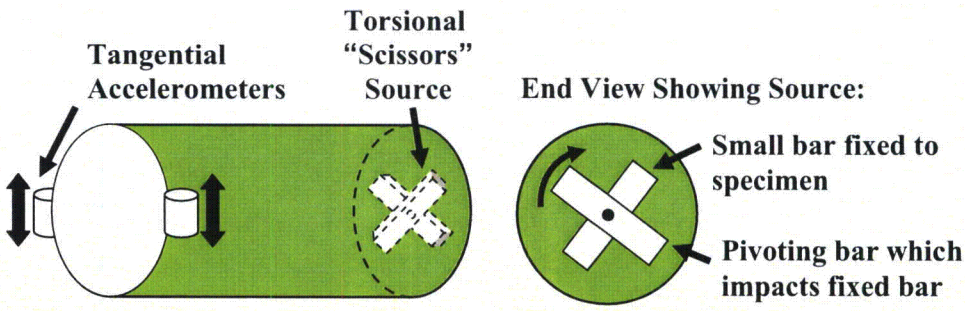
WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 3



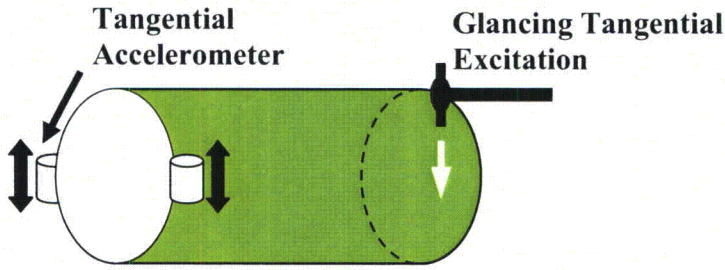
A) Typical Rock Core, Boring C-4.

B) Typical Concrete Core, Boring C-2.

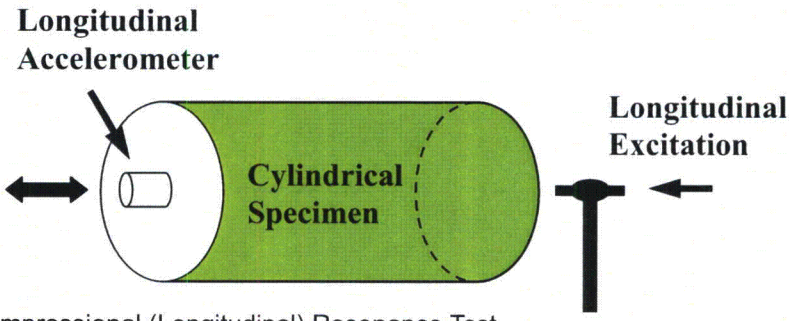
WILLIAM STATES LEE III NUCLEAR STATION	
Typical Concrete Basemat and and Rock Core Samples	
WLA WILLIAM LETTIS & ASSOCIATES, INC.	Figure 4



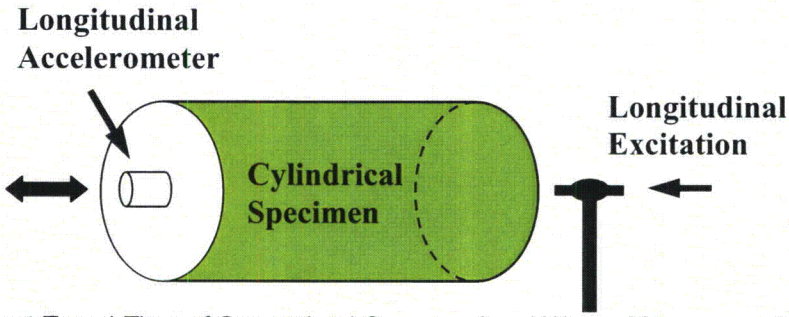
A) Torsional Resonance Test with a "Scissors" Source



B). Torsional Resonance Test with a Tangential Impact



C) Compressional (Longitudinal) Resonance Test



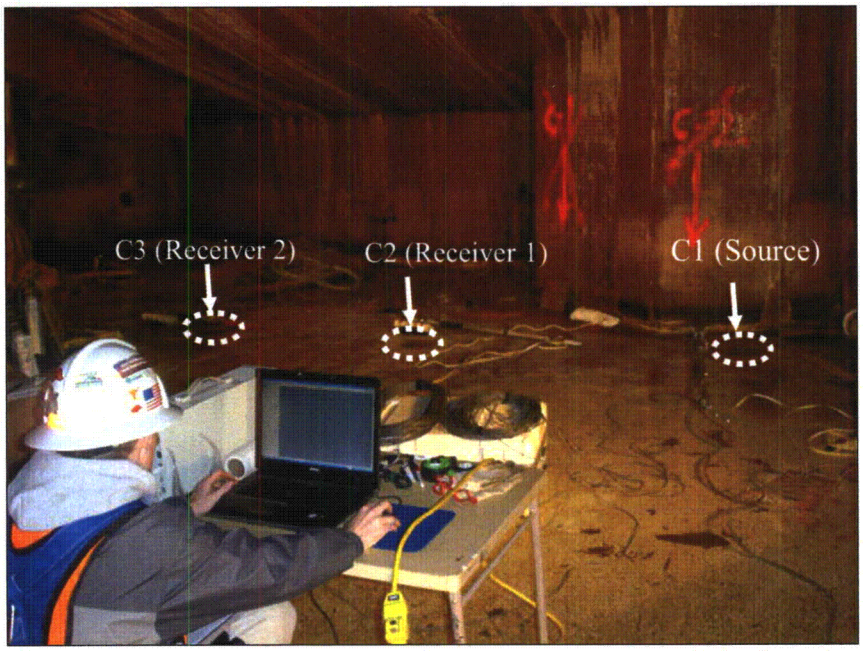
D) Direct-Travel-Time of Constrained Compressional Waves Measurement

Source: MACTEC Data Report Attachment M, MACTEC, 2008c.

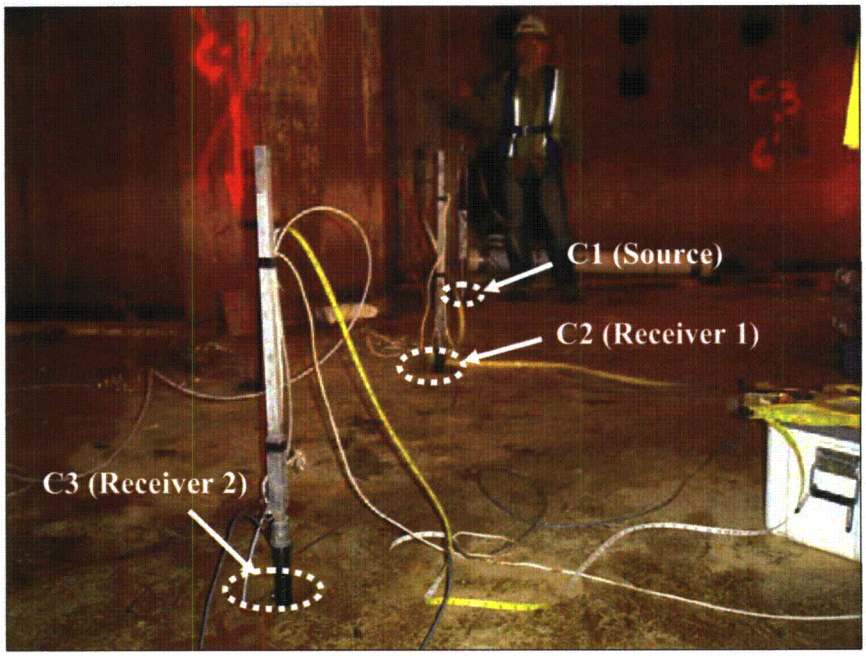
WILLIAM STATES LEE III NUCLEAR STATION

General Test Set-Up Configuration for Unconfined, Free-Free, Resonant Column

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 5



A) Preparing Dynamic Signal Analyzer for Crosshole Testing in Boreholes C1, C2, and C3.



B) Source and 3-D Geophones Placed in Boreholes C1, C2, and C3 at a Depth of 1 ft.

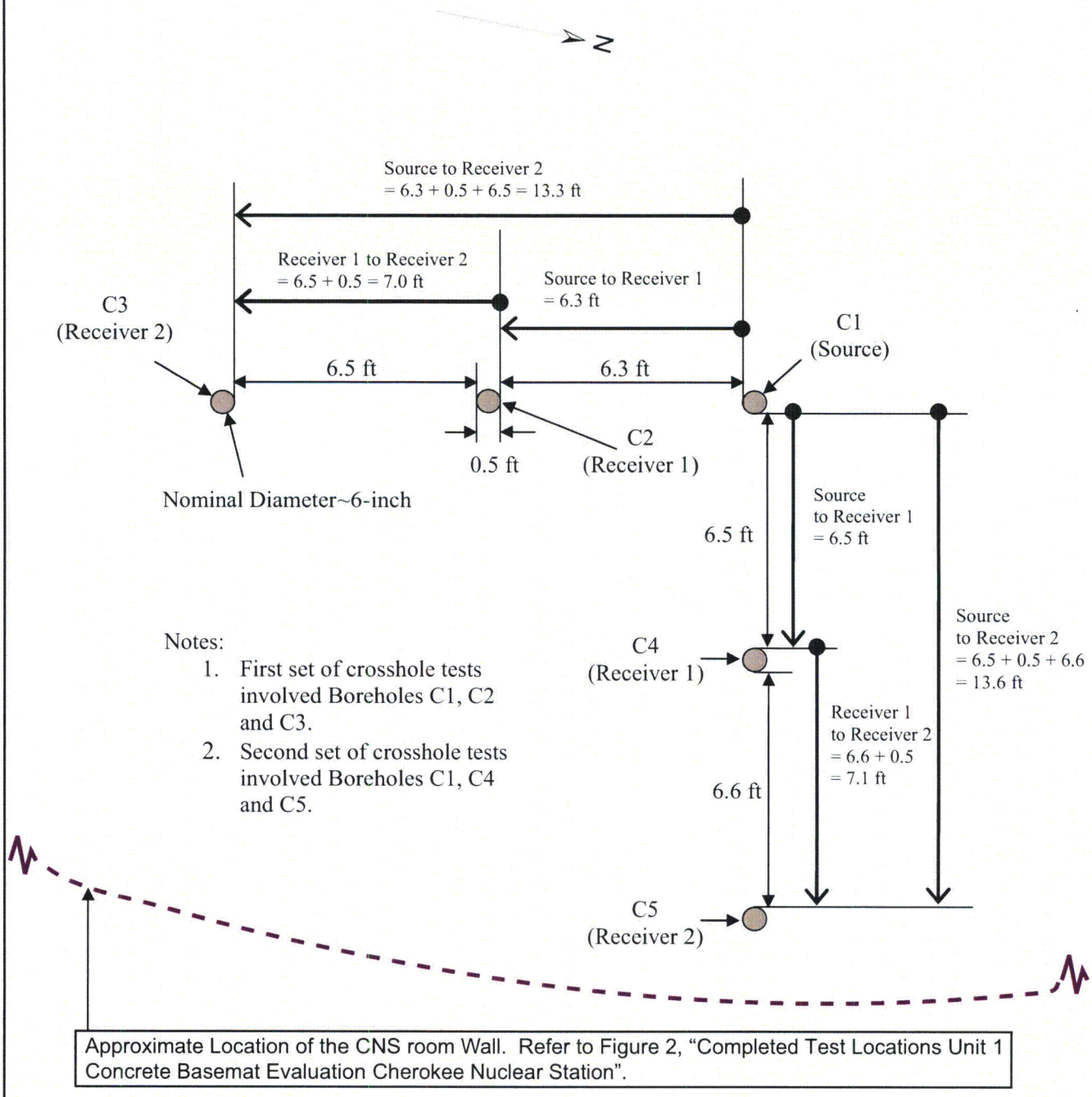
Source: MACTEC Data Report Attachment L, Volume One, MACTEC, 2008b.

WILLIAM STATES LEE III NUCLEAR STATION

Preparing for Crosshole Testing in Boreholes C1, C2, and C3

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 6

Drawing Not To Scale



Notes:

1. First set of crosshole tests involved Boreholes C1, C2 and C3.
2. Second set of crosshole tests involved Boreholes C1, C4 and C5.

Approximate Location of the CNS room Wall. Refer to Figure 2, "Completed Test Locations Unit 1 Concrete Basemat Evaluation Cherokee Nuclear Station".

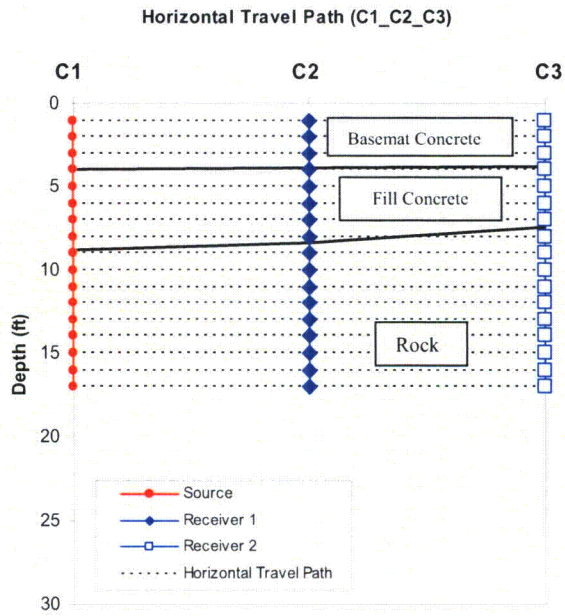
Source: MACTEC Data Report Attachment L, Volume One, MACTEC, 2008b.

WILLIAM STATES LEE III NUCLEAR STATION

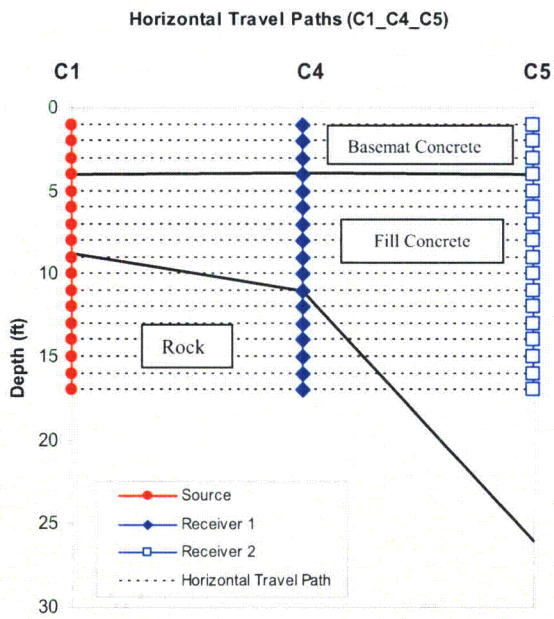
Arrangement of Boreholes Used in Crosshole Testing: Source C1 and Receivers C2, C3, C4, and C5

WLA WILLIAM LETTIS & ASSOCIATES, INC.

Figure 7



A) All Horizontal Travel Paths used in Crosshole Testing between Boreholes C1, C2, and C3.



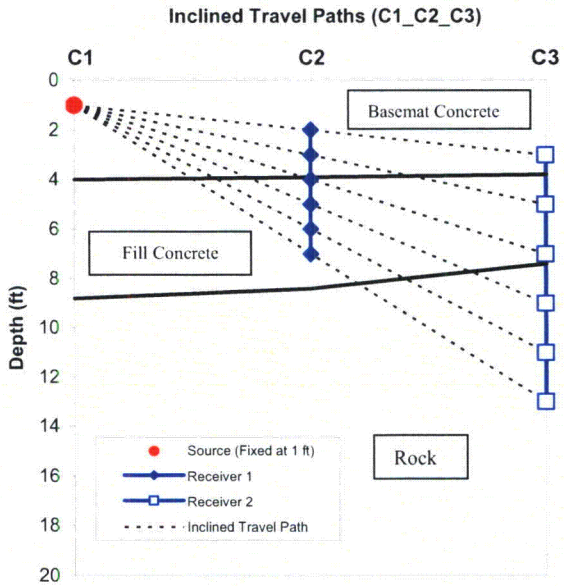
B) All Horizontal Travel Paths used in Crosshole testing between Boreholes C1, C4, and C5.

Source: MACTEC Data Report Attachment L, Volume One, MACTEC, 2008b.

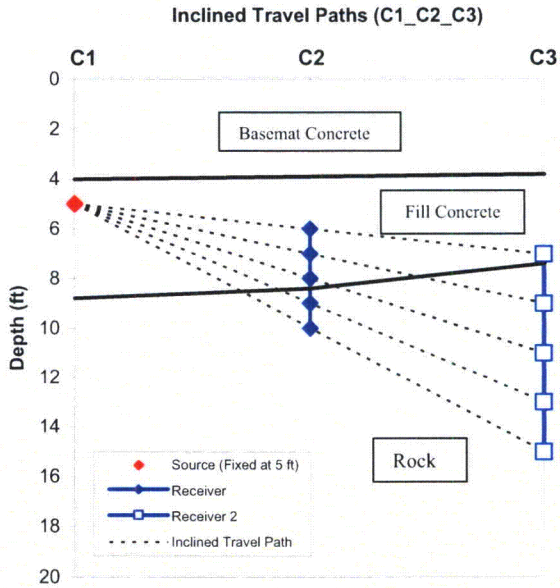
WILLIAM STATES LEE III NUCLEAR STATION

Horizontal Travel Paths Used in Crosshole Testing Between Boreholes C1 through C5

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 8



A) Inclined Travel paths used in Crosshole testing between Boreholes C1, C2, and C3: Source Fixed at a Depth of 1 foot in Borehole C1; Receiver 1 at Depths from 2 to 7 feet in Borehole C2 and Receiver 2 at Depths from 3 to 13 feet in Borehole C3.



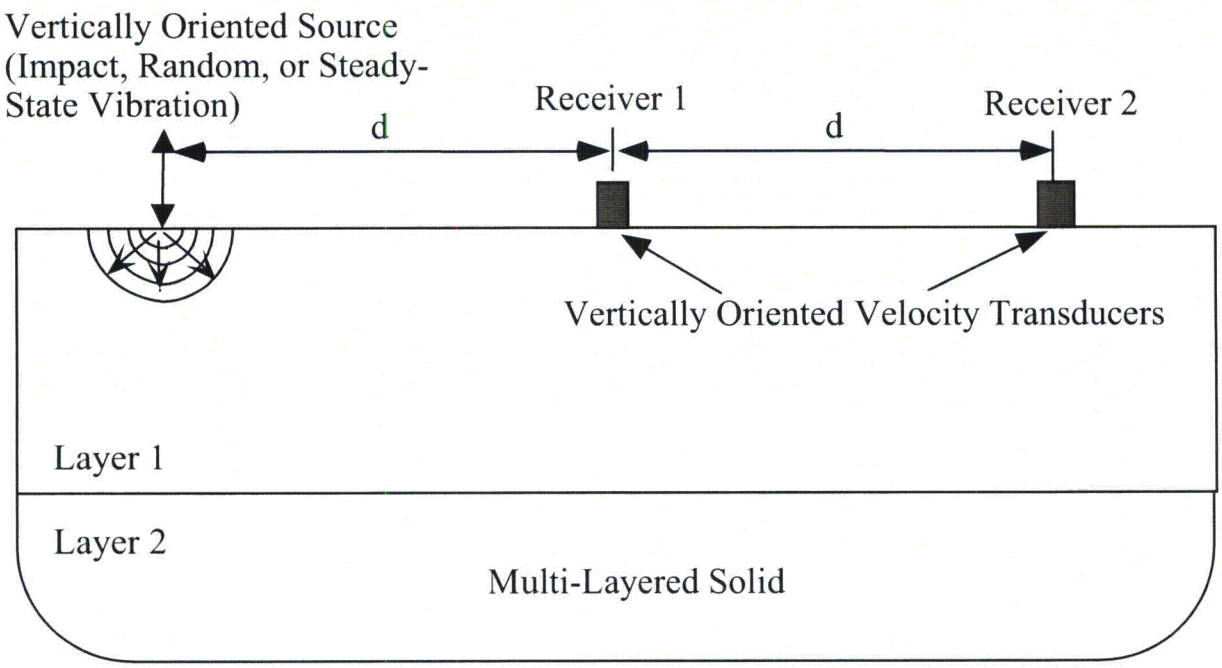
B) Inclined Travel paths used in Crosshole testing between Boreholes C1, C2, and C3: Source Fixed at a Depth of 5 foot in Borehole C1; Receiver 1 at Depths from 6 to 10 feet in Borehole C2 and Receiver 2 at Depths from 7 to 15 feet in Borehole C3.

Source: MACTEC Data Report Attachment L, Volume One, MACTEC, 2008b.

WILLIAM STATES LEE III NUCLEAR STATION

Inclined Travel Paths Used in Crosshole Testing Between Boreholes C1, C2, and C3

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 9



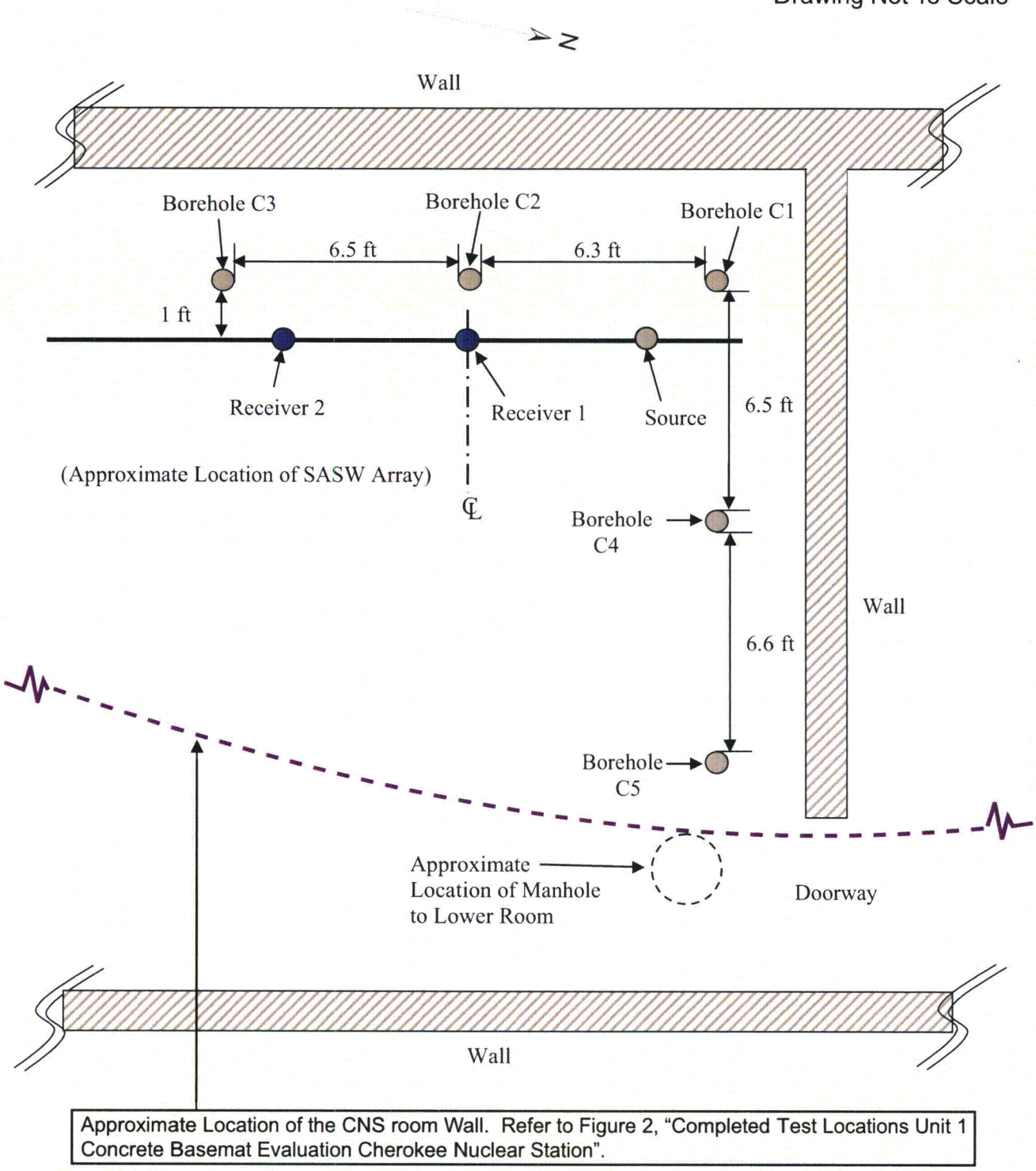
Source: MACTEC Data Report Attachment L, Volume One, MACTEC, 2008b.

WILLIAM STATES LEE III
NUCLEAR STATION

Schematic Diagram of the Equipment Arrangement Used in SASW Testing with Two Sensors (Receiver) Locations

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 10

Drawing Not To Scale



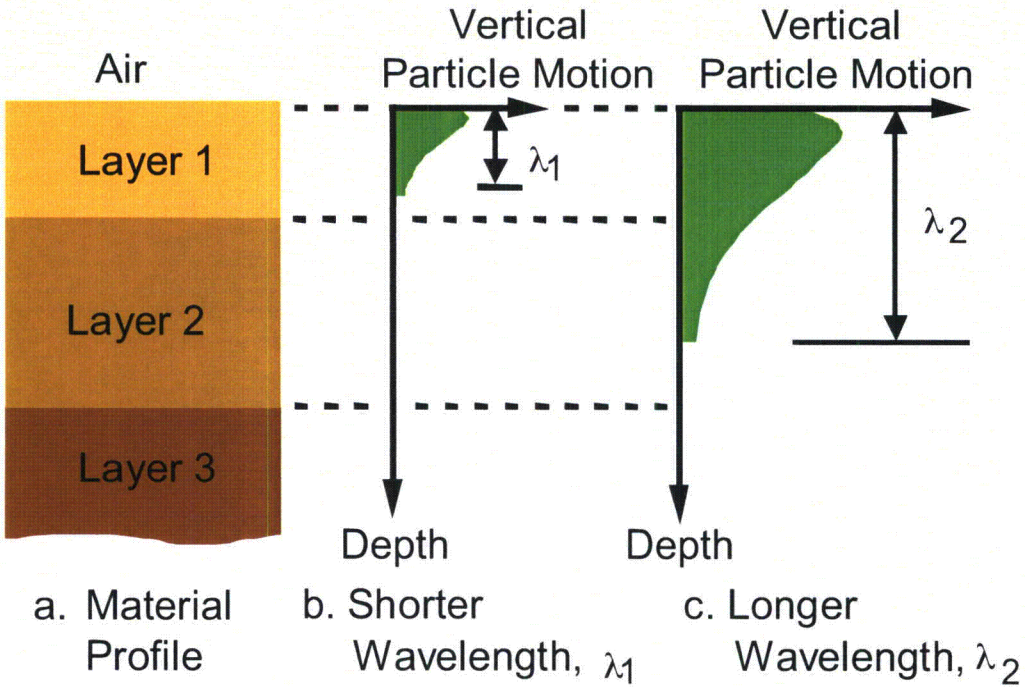
Approximate Location of the CNS room Wall. Refer to Figure 2, "Completed Test Locations Unit 1 Concrete Basemat Evaluation Cherokee Nuclear Station".

Source: MACTEC Data Report Attachment L, Volume One, MACTEC, 2008b.

WILLIAM STATES LEE III NUCLEAR STATION

General Location of Source and Receivers Used in SASW Testing

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 11

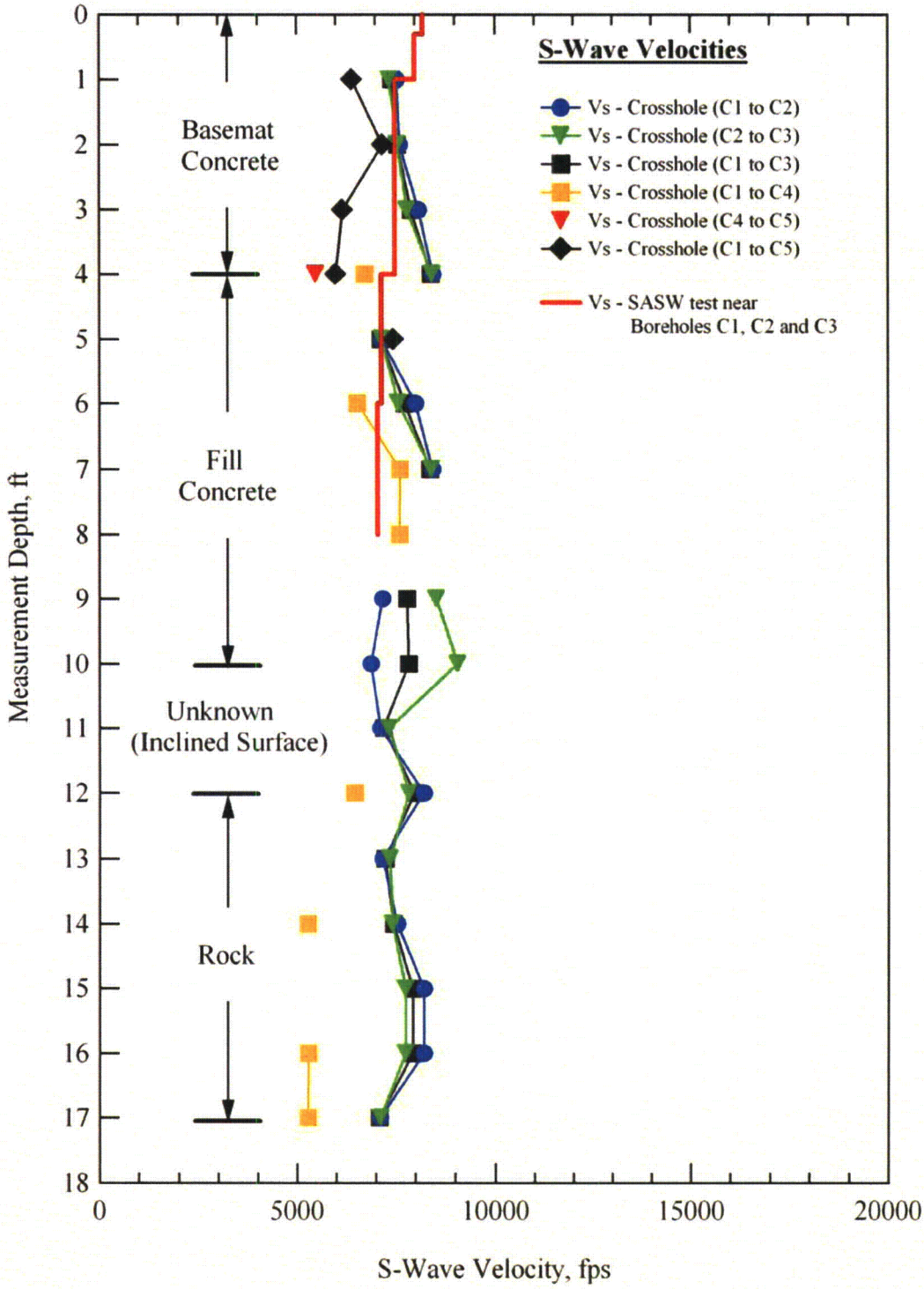


Source: MACTEC Data Report Attachment L, Volume One, MACTEC, 2008b.

WILLIAM STATES LEE III NUCLEAR STATION

Illustration of Surface Waves with Different Wavelengths Sampling Different Materials in a Layered System

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 12

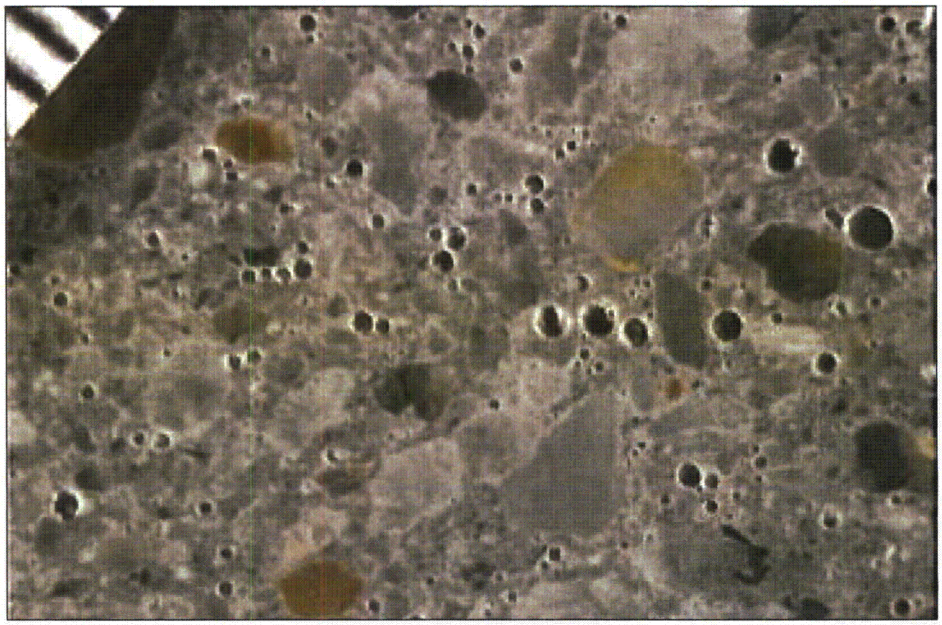


Source: MACTEC Data Report Attachment L, Volume One, MACTE, 2008b.

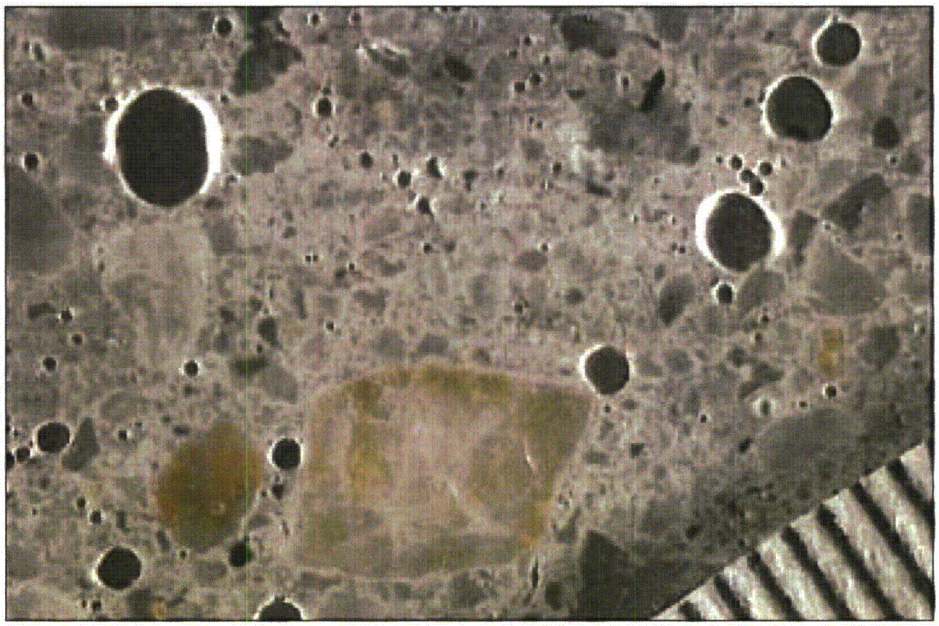
WILLIAM STATES LEE III NUCLEAR STATION

Comparison of S-Wave Velocity Profiles From All Crosshole and SASW Testing for Concrete and Rock

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 13



A) Structural concrete. Stereo-micrograph from boring C-16. Air content in core segment is estimated at 4 to 6%. Scale (upper left) marks represent 0.5 mm (0.02 in.)



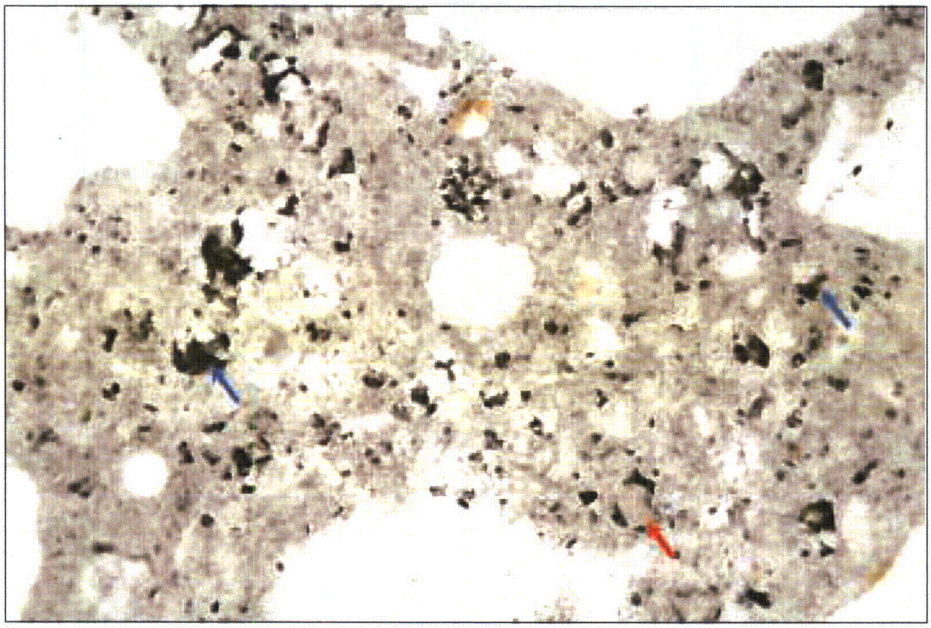
B) Fill concrete. Stereo-micrograph from boring C-11. Air content in core segment is estimated at 2 to 4%. Scale (lower right) marks represent 0.5 mm (0.02 in.)

Source: MACTEC Data Report Attachment K2, MACTEC, 2008a.

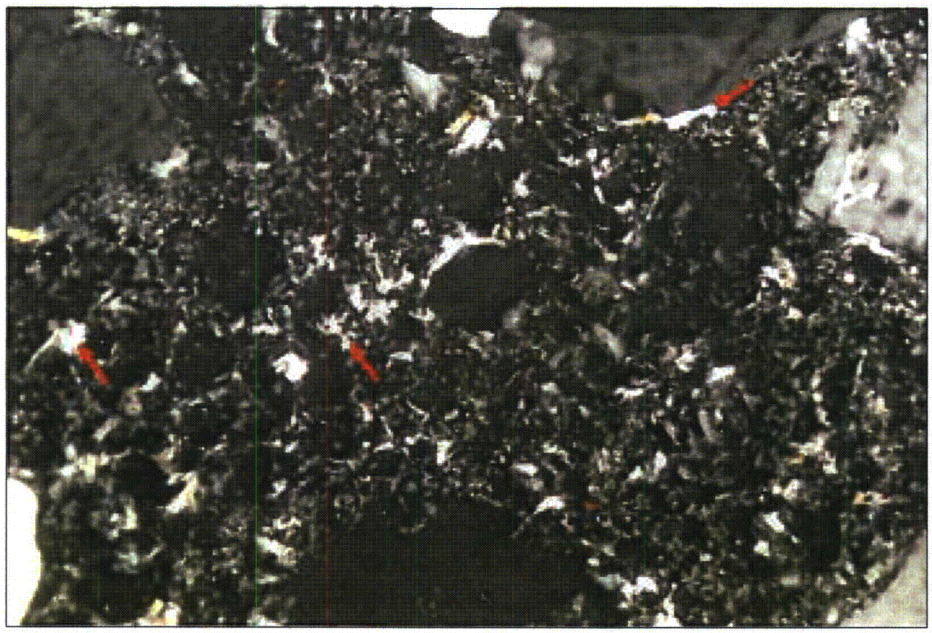
WILLIAM STATES LEE III NUCLEAR STATION

Representative Void Content Identification For Structural and Fill Concrete

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 14



A) Plane polarized light. Red arrow designates unhydrated portland cement clinker particle while blue arrows designate relics of in-situ hydrated clinker. Field of view approximately 0.9 mm (0.035 in.).



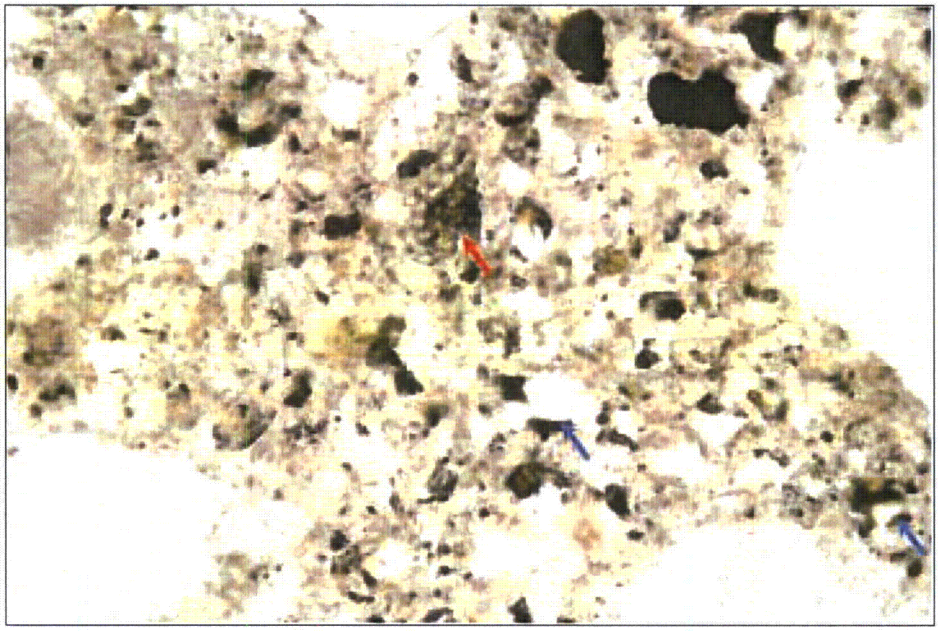
B) Fill concrete cross polarized light boring C-11. Arrows indicate abundant bright calcium hydroxide within paste matrix and along periphery of aggregates. Field of view approximately 0.9 mm (0.035 in.).

Source: MACTEC Data Report Attachment K2, MACTEC. 2008a.

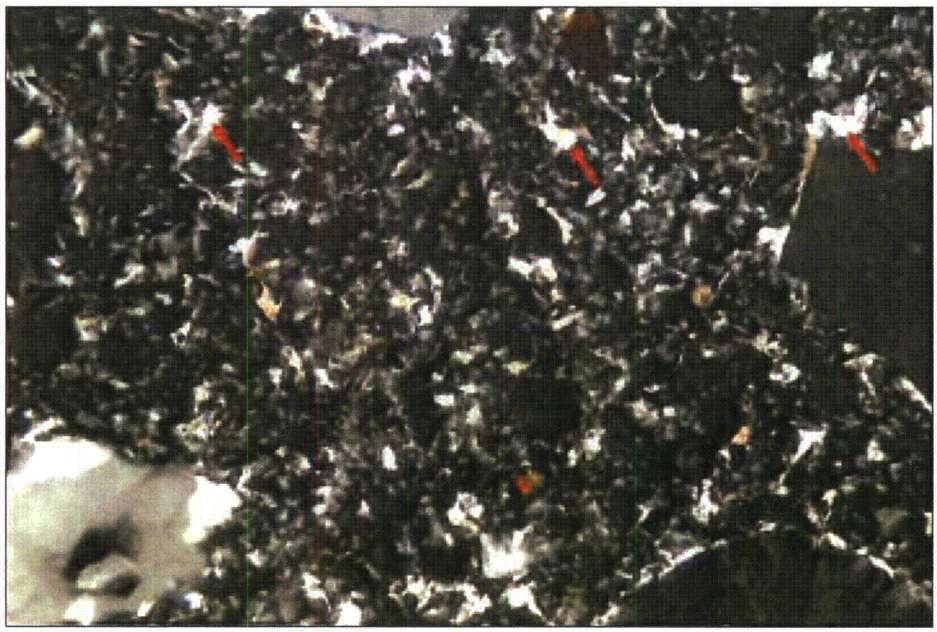
WILLIAM STATES LEE III NUCLEAR STATION

Representative Paste and Core Petrography For Fill Concrete, Boring C-11

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 15



A) Plane polarized light. Red arrow designates unhydrated portland cement clinker particle while blue arrows designate relics of in-situ hydrated clinker. Field of view approximately 0.6 mm (0.023 in.) across.



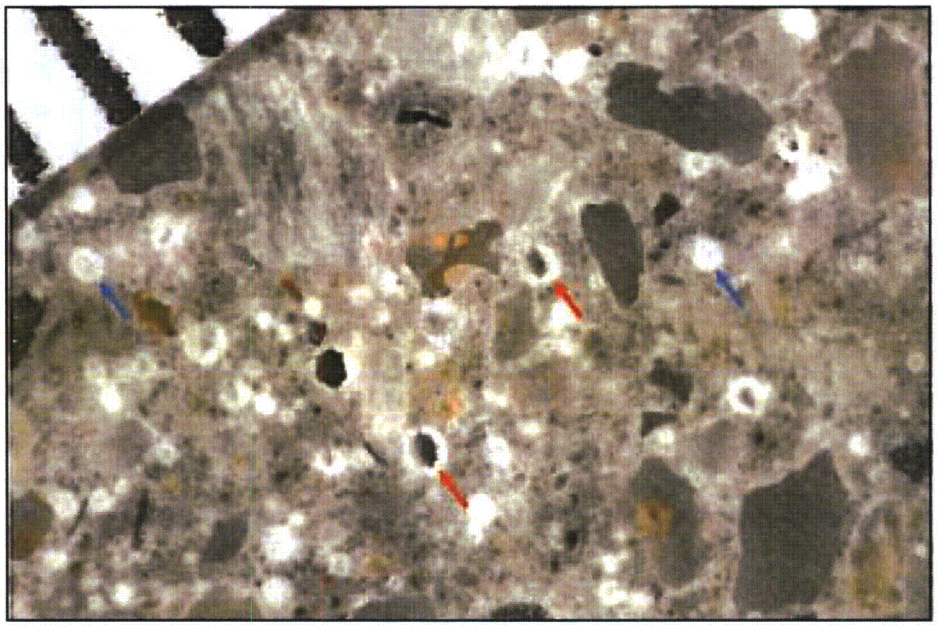
B) Structural concrete cross polarized light boring C-4. Arrows indicate abundant bright calcium hydroxide within paste matrix and along periphery of aggregates. Field of view approximately 0.6 mm (0.023 in.) across.

Source: MACTEC Data Report Attachment K2, MACTEC, 2008a.

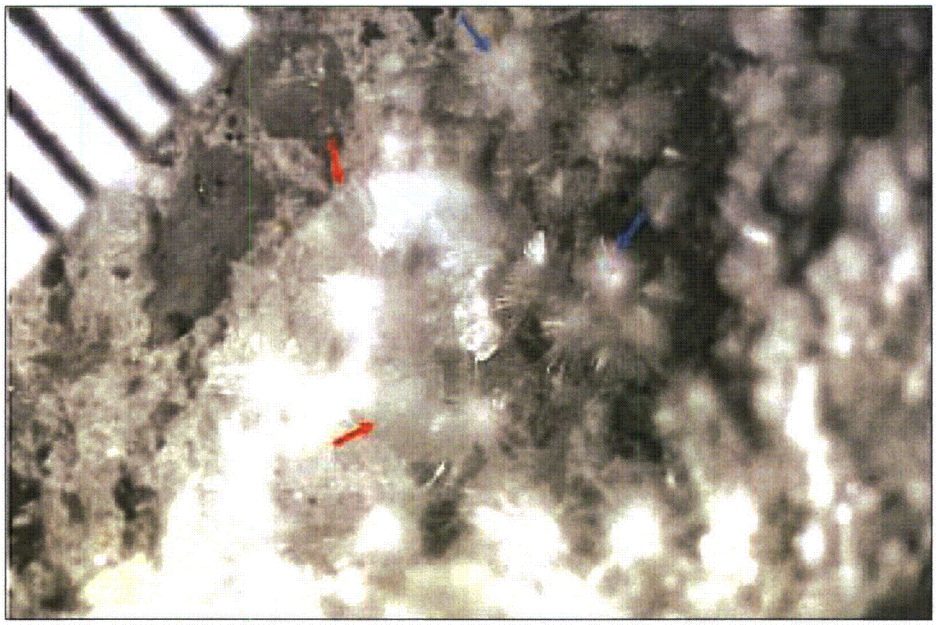
WILLIAM STATES LEE III NUCLEAR STATION

Representative Thin-Section Photomicrographs of Paste and Core Petrography For Structural Concrete, Boring C-4

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 16



A) Stereo-photomicrograph of Core C-4, Structural concrete segment. Note, white deposits lining (red arrows) and completely filling (blue arrows) spherical voids. Scale (upper left) marks represent 0.5 mm (0.02 in.).



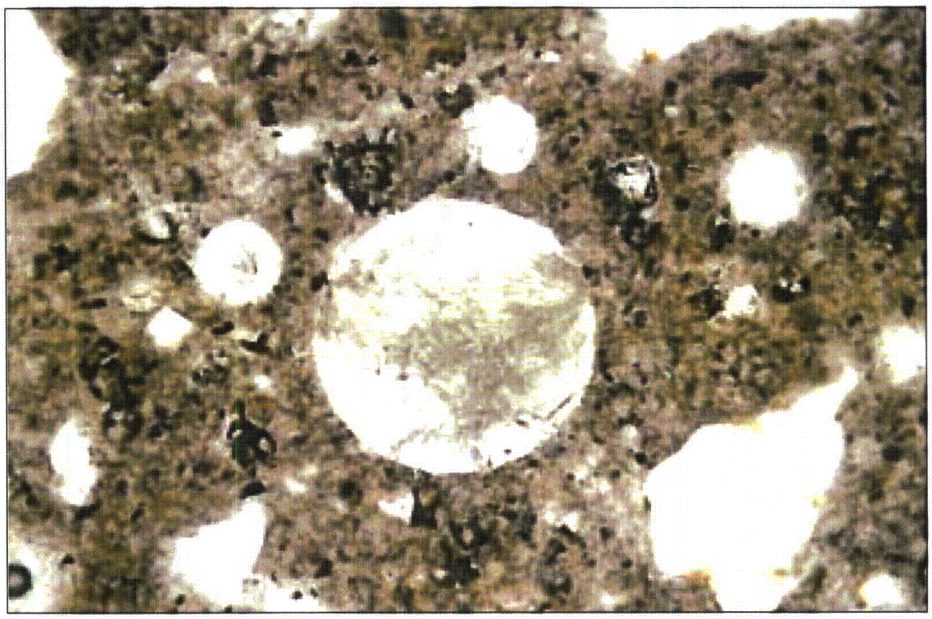
B) Stereo-photomicrograph of Core C-1, Fill concrete segment showing secondary deposits within void. Red arrows indicate translucent and platy Chloride mineral (calcium hydroxide) crystals, blue arrows designate white tufts of needle-like ettringite. Scale (upper left) marks represent 0.5 mm (0.02 in.).

Source: MACTEC Data Report Attachment K2, MACTEC, 2008a.

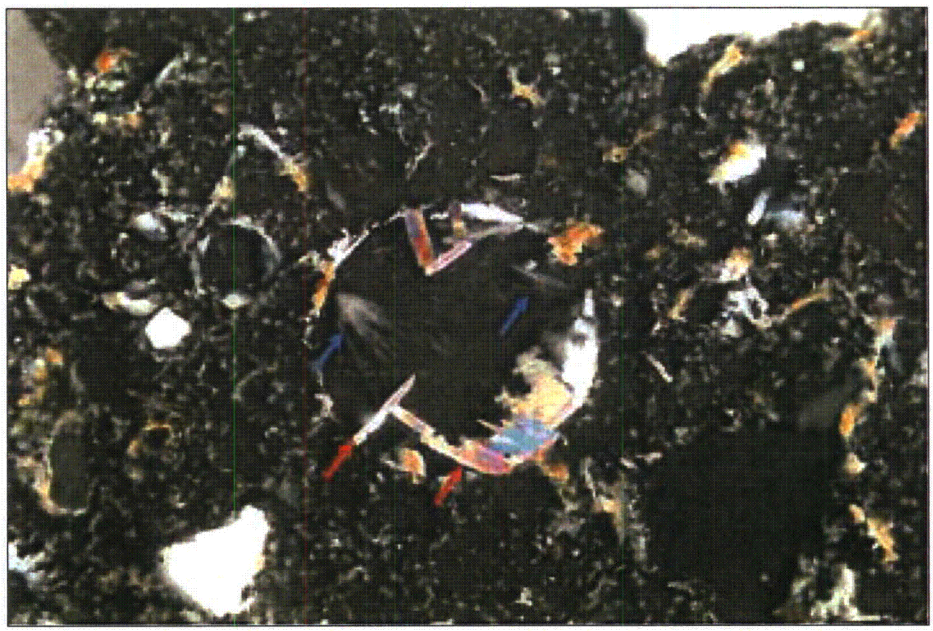
WILLIAM STATES LEE III NUCLEAR STATION

Representative Thin-Section Photomicrographs of Carbonate and Core Petrography For Structural and Fill Concrete

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 17



A) Plane-polarized light (same sample as below). Filed of view approximately 0.9 mm (0.035 in.) across.



B) Cross-polarized light through structural concrete from Core C-19. Red arrows indicate brightly-colored calcium hydroxide crystals, blue arrows designate gray, somewhat feathery ettringite. Filed of view approximately 0.9 mm (0.035 in.) across.

Source: MACTEC Data Report Attachment K2, MACTEC, 2008a.

WILLIAM STATES LEE III NUCLEAR STATION

Representative Thin-Section Photomicrographs of Cementious Paste for Structural Concrete, Boring C- 19

WLA WILLIAM LETTIS & ASSOCIATES, INC. | Figure 18

Appendix A

Boring Logs

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA	CONCRETE LOG - Boring No. C-1	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 18.9 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth 8.5 feet	Depth to Bedrock 8.83 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 8	Date Started 2/6/07
	Borehole Inclination -90	Logged by RP / GD / RT	Date Completed 3/6/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0		1	1.4/1.4					STRUCTURAL CONCRETE Two reinforcing bars at 0.4 to 0.5 inches		545
1										544
2		2	2.6/2.6							543
3								One reinforcing bar at 3.4 to 3.5 ft.		542
4		3	3.3/3.3					FILL CONCRETE		541
5										540
6										539
7										538
8		4	1.5/1.5		F	R3 to R4		Wood fragments from existing drainage system		537
9			1.0/1.0					METAGRANODIORITE; medium dark gray (N3) fine grained, equigranular, some mechanical breaks, quartz veins	Top of rock is an irregular surface	536
10		5	1.2/1.2		F	R3 to R4		SAA with discontinuous infill with quartz; totally healed Quartz veins are < 0.1 ft thick Mechanical breaks abundant in core between 10.5 and 11.1 feet	Drills very slowly in rock	535
11		6	0.2					Highly fractured zone from 11.1 to 11.2 ft		534
		7	0.2/0.8/0.8			R4				
12		8	1.2/1.2		F	R4		METAGRANODIORITE; Gray (N6) matrix with black (N2.5); phenocrysts 15 to 20% hornblende pyroxene, ~10% quartz, 65 to 75% plagioclase, matrix is fine grained, phenocrysts, matrix is fine grained, phenocrysts are medium grained, strong, dry, quartz vein (0.4") cuts through at 65°; 0.3" quartz vein cuts through subvertically		533
13		9	0.8/0.8		F	R4				532
14		10	1.4/1.5		F	R4				531
15								METAGRANODIORITE; Gray (N5) matrix with black (N2.5) phenocrysts; ~15% hornblende and pyroxene, ~20% quartz, ~65% plagioclase, fine grained, strong, dry, fresh		530
16		11	0.7/0.8		F	R4				529
17		12	1.6/1.7		F	R4		Mafic phenocrysts become medium grained by 16.5 feet		528
18		13	0.9/0.9		F	R4				527
19								Total Depth 18.9 ft.		526
20								Groundwater encountered at 8.5 feet		525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA (William Lettis & Associates, Inc)	CONCRETE LOG - Boring No. C-2	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 18.4 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock 8.4 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 10	Date Started 2/15/07
	Borehole Inclination -90	Logged by RP / GD / RT	Date Completed 3/8/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0								STRUCTURAL CONCRETE		545
1								Rebar located at: 0.3' to 0.4', two bars side by side 0.4' to 0.5', two bars side by side 3.4' to 3.5', one single bar Anchor embeded to facilitate extracting operation and core cracked at surface		544
2		1	3.9 / 3.9							543
3										542
4								FILL CONCRETE		541
5										540
6		2	3.9 / 3.9							539
7								Vapor barrier visible at 7.8 feet		538
8		3	0.6 / 0.6					Wood fragments from existing drainage system; top of rock		537
		4	0.4 / 0.4		SW to F	R4		METAGRANODIORITE; bluish gray (Gley 2 6/1), equigranular, massive, with some very thin quartz veins present (<0.1")		
9		5	1.5 / 1.6		F			METAGRANODIORITE; light bluish gray (Gley 2 7/1), fine grained, ~30% mafics, ~15% quartz, ~55% plagioclase, strong, fresh, dry		536
10										535
11										534
12		6	3.9 / 4.0		F					533
13								SAA; color changes to light gray (N7) at 13.3 feet		532
14										531
15								SAA; light to medium gray (N7 to N5), medium grained, ~30% quartz, ~70% meta mafics/plagioclase (Cordierite?) (Andalusite?); fresh, very strong, dry		530
16		7	3.9 / 4.0		F					529
17										528
18										527
19								Total Depth 18.4 ft.		526
20										525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA (William Lettis & Associates, Inc.)	CONCRETE LOG - Boring No. C-3	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 18 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock 7.8 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 9	Date Started 2/19/07
	Borehole Inclination -90	Logged by RP / GD / RT	Date Completed 2/28/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0–4		1	3.8 / 3.8					STRUCTURAL CONCRETE; Rebar located at: 0.2' to 0.3', one single bar 0.4' to 0.5', one single bar 3.2' to 3.3', one single bar		545–542
4–8		2	3.7 / 3.7					FILL CONCRETE		541–538
7.8		3	0.3					Wood fragment from existing drainage system; top of rock		
8		4	0.3		SW to F	R4				537
8		5	0.4 / 0.4		F	R4		METADIORITE; dark bluish gray (Gley 2 4/1), massive, fine grained, some thin (0.1 inch thick) quartz veins present that are vertically oriented; some shear zones (thin), fresh		
9–10		6	0.6 / 0.6 / 1.5 / 1.5		F	R4				536–535
11		7	1.2 / 1.2		F	R4				534
12–15		8	4.2 / 4.2		F	R4		METADIORITE; bluish gray (Gley 2 6/1) to dark bluish gray (Gley 2 4/1), fine grained ~60% hornblende and pyroxene, ~40% plagioclase, fresh, very strong, dry		533–530
16		9	1.0 / 1.0		F	R4				529
17		10	1.3 / 1.4		F	R4				528
18								Total Depth 18 ft.		527
19–20										526–525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA (Williams Lewis & Associates, Inc.)	CONCRETE LOG - Boring No. C-4	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 18.2 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock 11 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 8	Date Started 2/15/07
	Borehole Inclination -90	Logged by RP / GD / RT	Date Completed 3/12/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0								STRUCTURAL CONCRETE		545
1								Rebar located at: 0.4' to 0.5', two bars side by side 3.4' to 3.5', one single bar		544
2		1	4.0/4.0							543
3										542
4								FILL CONCRETE		541
5										540
6		2	4.0/4.0							539
7										538
8										537
9		3	2.9/2.9							536
10										535
11		4	0.2					Wood fragments from existing drainage system; top of rock		534
		5	0.2 1.0 1.0		F	R4		METAGRANODIORITE; bluish gray (Gley 2 6/1), with quartz veins (0.1 to 0.2 inch thick) present throughout, medium grained with variable grain size distribution, fresh		
12										533
13		6	1.7/1.7		F	R4		SAA; bluish gray (Gley 2 6/1), fine to medium grained ~15% quartz, ~15 to 20% hornblende and pyroxene, ~65% plagioclase, fresh, strong, dry, thin (up to 0.2 inch) quartz veins		532
14		7	1.6/1.6		F	R4				531
15										530
16		8	1.1/1.1		F	R4		SAA; medium grained, ~25% quartz, ~40% hornblende, pyroxene, ~35 to 40% plagioclase, strong, dry, some quartz veins 0.4 to 0.8 inch thick		529
17		9	1.9/1.9		F	R4				528
18										527
								Total Depth 18.2 ft.		
19										526
20										525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA (Williams Lewis & Associates, Inc.)	CONCRETE LOG - Boring No. C-5	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 32.3 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock 26 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 13	Date Started 2/12/07
	Borehole Inclination -90	Logged by RP / RT	Date Completed 3/6/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0								STRUCTURAL CONCRETE		545
1		1	3.3/3.3					Rebar located at: 0.3' to 0.4', one single bar 3.3' to 3.4', one single bar 3.4' to 3.5', two bars side by side		544
2										543
3										542
4								FILL CONCRETE		541
5		2	3.2/3.2					1/4 inch diameter welded wire fabric at 4.5 ft		540
6								1/4 inch diameter welded wire fabric at 5.5 ft		539
7										538
8		3	2.5/2.5					1/4 inch diameter welded wire fabric at 7.6 ft.		537
9										536
10		4	2.8/2.8							535
11								1/4 inch diameter welded wire fabric at 10.7 and 11.75 ft		534
12										533
13		5	2.5/2.5							532
14										531
15								1/4 inch diameter welded wire fabric at 14.45 and 16.75 ft. Rebar located at: 17.8' to 17.9', one bar 18.5', one bar		530
16		6	4.2/4.2							529
17										528
18										527
19										526
20			2.9					1.4 inch diameter welded wire fabric at 19.7 and 20.6 ft		525

CONCRETE LOG CHEROKEE_040407.GPJ WLA9-8-06.GDT 1/30/08

Project Name and Job Number
Lee Nuclear Station COL
6234-06-3389

MACTEC WLA

CONCRETE LOG - Boring No. C-5

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
20		7	2.9					Continued from previous page		525
21										524
22		8	0.8 / 0.8					Rebar located at: 21.5' to 21.6', one bar		523
		9	0.3 / 0.3							
23										522
24		10	3.6 / 3.6							521
25										520
26								METAGRANODIORITE; bluish gray (Gley 2 6/1); fine to medium grained ~50% hornblende and pyroxene, ~35% plagioclase, ~15% quartz, fresh, strong, dry, many quartz veins 0.5 to 1.5 inches thick		519
27										518
28		11	4.1 / 4.4	93	F	R4				517
29										516
30										515
31		12	1.9 / 1.9	100	F	R4				514
32										513
								Total Depth 32.3 ft.		
33										512
34										511
35										510
36										509
37										508
38										507
39										506
40										505

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA Williams Lemos & Associates, Inc.	CONCRETE LOG - Boring No. C-9	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 4 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock N/A
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 2	Date Started 2/20/07
	Borehole Inclination -90	Logged by RP	Date Completed 2/21/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0								STRUCTURAL CONCRETE	Boring terminated at 4 feet. Steel pipe hit. Moved to 1 foot south to C-9A.	545
1								Rebar located at: 0.3' to 0.4', two bars side by side 3.6' to 3.4', two bars side by side		544
2		1	4.0/4.0							543
3										542
4								Total Depth 4 ft.		541
5										540
6										539
7										538
8										537
9										536
10										535
11										534
12										533
13										532
14										531
15										530
16										529
17										528
18										527
19										526
20										525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA	CONCRETE LOG - Boring No. C-9A	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 12.5 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock 7.91 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 5	Date Started 2/21/07
	Borehole Inclination -90	Logged by RP / GD	Date Completed 2/22/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0								STRUCTURAL CONCRETE Rebar at: 0.4' to 0.5', one single bar 3.3' to 3.4', one single bar 3.4' to 3.8', one single bar		545
1										544
2		1	3.9/3.9							543
3										542
4								FILL CONCRETE		541
5										540
6		2	4.0/4.0							539
7										538
8		3	1.0/1.0		F	R4		METADIORITE; dark bluish gray (Gley 2 4/1) massive, fine to medium grained, highly fractured zone at 7.9 feet due to drilling; very thin quartz veins found in discontinuities, fresh		537
9		4	0.7/0.7		F	R4				536
10								SAA; shear zones that overprint igneous texture and at ~60° and infilled with quartz vein from 0.1 to 0.6 inch thick		535
11		5	2.9/2.9		F	R4				534
12										533
13								Total Depth 12.5 ft.		532
14										531
15										530
16										529
17										528
18										527
19										526
20										525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA	CONCRETE LOG - Boring No. C-11	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 13 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock 9.94 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 4	Date Started 3/21/07
	Borehole Inclination -90	Logged by RP / RT	Date Completed 3/23/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0								STRUCTURAL CONCRETE Rebar located at: 0.3' to 0.4', one single bar 3.3' to 3.4', one single bar		545
1										544
2		1	3.9/3.9							543
3										542
4								FILL CONCRETE		541
5										540
6		2	3.9/3.9							539
7										538
8										537
9		3	2.1/2.1							536
10								METAGRANODIORITE; light bluish gray (Gley 2 7/1); medium grained, 30% to 35% biotite/hornblende, ~20% plagioclase, ~30% quartz, ~5% K-feldspar, fresh, very strong, dry, 0.6 inch thick quartz vein from 11.4 to 13 feet		535
11		4	3.1/3.1		F	R5				534
12										533
13								Total Depth 13 ft.		532
14										531
15										530
16										529
17										528
18										527
19										526
20										525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA (William Lettis & Associates, Inc.)	CONCRETE LOG - Boring No. C-12	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 16 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock 12.85 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 7	Date Started 3/21/07
	Borehole Inclination -90	Logged by RP / RT	Date Completed 3/23/07

Reviewed by / Date 1/31/08

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Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0								STRUCTURAL CONCRETE Rebar located at: 0.4' to 0.5', one single bar 0.4' to 0.5', one single bar 3.4' to 3.5', one single bar		545
1										544
2		1	3.8/3.8							543
3										542
4								FILL CONCRETE		541
5		2	2.7/2.8							540
6										539
7										538
8		3	2.7/2.7							537
9										536
10										535
11		4	3.6/3.6							534
12										533
13								METADIORITE; dark bluish gray (Gley 2 4/1); fine grained, ~60% mafics, ~40% plagioclase, fresh, very strong, dry, two 0.05 inch to 0.15 inch quartz veins between 13.4 and 14.3 feet		532
14		5	2.8/3.2		F	R5				531
15										530
16								Total Depth 16 ft.		529
17										528
18										527
19										526
20										525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA (William Lettes & Associates, Inc.)	CONCRETE LOG - Boring No. C-15	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 11.7 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock 9.27 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 6	Date Started 3/15/07
	Borehole Inclination -90	Logged by RP / RT	Date Completed 3/20/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0		1	5.0/5.0					STRUCTURAL CONCRETE rebar located at: 0.3' to 0.4', one single bar 0.4' to 0.5', one single bar 2.9' to 3.0', one single bar 3.0' to 3.1', one single bar		545
1										544
2										543
3										542
4								FILL CONCRETE		541
5		2	4.3/4.3							540
6										539
7										538
8										537
9										536
10		3	2.4/2.4		F	R5		METAGRANODIORITE; light bluish gray (Gley 2 7/1); medium grained, ~30% quartz, ~30% biotite/hornblende, ~25% plagioclase, ~15% K-feldspar, fresh, very strong, dry		535
11										534
12								Total Depth 11.7 ft.		533
13										532
14										531
15										530
16										529
17										528
18										527
19										526
20										525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA	CONCRETE LOG - Boring No. C-16	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 9.6 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock 6.36 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 3	Date Started 3/13/07
	Borehole Inclination -90	Logged by RP / RT	Date Completed 3/20/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0		1	4.0/4.0					STRUCTURAL CONCRETE Pipe located at 1.2 to 1.6 feet Rebar located at 3.4 to 3.5 feet, two bars side by side		545
1										544
2										543
3										542
4		2	2.4/2.4					FILL CONCRETE		541
5										540
6										539
7		3	3.2/3.2		F	R5		METADIORITE; medium to dark gray (N5 to N3); medium grained; ~50% mafics, ~40% plagioclase, ~10% quartz (as intrusions), thick (0.7 inch to 2 inch) quartz vein from 6.9 to 8.3 feet, fresh, very strong, dry		538
8										537
9										536
10								Total Depth 9.6 ft.		535
11										534
12										533
13										532
14										531
15										530
16										529
17										528
18										527
19										526
20										525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA (William Lettis & Associates, Inc.)	CONCRETE LOG - Boring No. C-18	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 11.3 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock 7.8 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 4	Date Started 3/12/07
	Borehole Inclination -90	Logged by RP / RT	Date Completed 3/13/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0		1	4.0/4.0					STRUCTURAL CONCRETE Rebar located at 0.4' to 0.5', one single bar 0.5' to 0.6', one single bar 3.5' to 3.6', one single bar 3.6' to 3.7', one single bar		545
1										544
2										543
3										542
4		2	3.8/3.8					FILL CONCRETE		541
5										540
6										539
7										538
8		3	3.5/3.5		F	R5		METADIORITE; bluish gray (Gley 2 7/1 to Gley 2 6/1); ~60% to 65% mafics, ~35 to 40% plagioclase, fine to medium grained, fresh, very strong, dry, very homogeneous, thin (0.1 inch) quartz veins at 9.3 and 11.3 feet		537
9										536
10										535
11										534
12								Total Depth 11.3 ft.		533
13										532
14										531
15										530
16										529
17										528
18										527
19										526
20										525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA (William Lettis & Associates, Inc)	CONCRETE LOG - Boring No. C-19	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 7.3 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock N/A
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 2	Date Started 2/27/07
	Borehole Inclination -90	Logged by RP	Date Completed 2/28/07

Reviewed by / Date 1/31/08

Reviewed by / Date 11/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0								STRUCTURAL CONCRETE rebar located at: 0.4' to 0.5' 3.3' to 3.4', two bars side by side		545
1		1	3.9/3.9							544
2										543
3										542
4								FILL CONCRETE		541
5		2	3.4/3.4							540
6										539
7									Coring was terminated at 7.3 ft due to possible vertical reinforcing steel bar. Moved to C-19A	538
8								Total Depth 7.3 ft.		537
9										536
10										535
11										534
12										533
13										532
14										531
15										530
16										529
17										528
18										527
19										526
20										525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA (William Lettis & Associates, Inc.)	CONCRETE LOG - Boring No. C-19A	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Mat in Reactor Building N E		Total Depth 11.4 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 545 feet MSL	Ground Water Depth N/A	Depth to Bedrock 7.02 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 4	Date Started 2/27/07
	Borehole Inclination -90	Logged by RP / RT	Date Completed 3/5/07

Reviewed by / Date 1/31/08

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Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0–4		1	3.9/3.9					STRUCTURAL CONCRETE rebar located at 0.3' to 0.4', two bars 3.4' to 3.5', two bars		545–542
4–7		2	3.1/3.1					FILL CONCRETE		541–538
7–8		3	0.9/0.9		F	R4		METAGRANODIORITE; bluish gray (Gley 2 6/1); ~30% mafics, ~20% quartz, ~50% plagioclase, medium grained, strong, fresh, dry; 1 inch thick quartz vein near 7 feet		538–537
8–9		4	1.8/1.8		F	R4				537–536
10–11		5	1.8/1.8		F	R4				535–534
11–12								Total Depth 11.4 ft.		534–533
12–20										533–525

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA	CONCRETE LOG - Boring No. C-20	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Pit Slab in Reactor Building N E		Total Depth 9.9 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 527 feet MSL	Ground Water Depth N/A	Depth to Bedrock 6.78 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 3	Date Started 2/8/07
	Borehole Inclination -90	Logged by RP / GD	Date Completed 2/12/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0								STRUCTURAL CONCRETE rebar located at: 0.4' to 0.5', one single bar 3.9' to 4.0', one single bar		527
1		1	4.1 / 4.1							526
2										525
3										524
4		2	0.1 / 0.1					FILL CONCRETE		523
5		3	2.6 / 2.6							522
6										521
7		4	0.4 / 0.4		F	R2		METAGRANODIORITE; medium dark gray (N4), medium grained with thin quartz veins (<0.1 inch thick) discontinuities infilled with quartz, mechanical breaks occur along joints between 8.6 to 9.0 feet, region of more mafic diorite found, diorite dark grey (N3) fine grained		520
		5	0.8 / 0.8		F	R2				
8		6	1.0 / 1.0		F	R2				519
9		7	0.9 / 0.9		F	R2 to R3		METADIORITE; dark gray (N3) fine grained; mafic with small (~ 0.1' x 0.1') inclusion of granodiorite with evidence of contact metamorphic alterations		518
10								Total Depth 9.9 ft.		517
11										516
12										515
13										514
14										513
15										512
16										511
17										510
18										509
19										508
20										507

Project Name and Job Number Lee Nuclear Station COL 6234-06-3389	MACTEC / WLA William Lettis & Associates, Inc.	CONCRETE LOG - Boring No. C-21	
Type and Diameter of Boring Concrete core / 6 inch	Boring Location Pit Slab in Reactor Building N E		Total Depth 6.8 feet
Drilling Contractor and Rig Concrete Coring and Sawing / Concrete Core Rig	Elevation and Datum 527 feet MSL	Ground Water Depth N/A	Depth to Bedrock 5.9 feet
Casing Size and Depth N/A	Length of Core Barrel and Bit 4 feet	No. of Core Boxes 3	Date Started 2/12/07
	Borehole Inclination -90	Logged by RP / GD	Date Completed 2/15/07

Reviewed by / Date 1/31/08

Reviewed by / Date 1/31/08

Depth (feet)	Lithology	Run No.	Recovery / Cut	% RQD	Weathering	Strength	In-Situ Testing	Lithology	Remarks	Elevation (feet)
0								STRUCTURAL CONCRETE rebar located at: 0.4' to 0.5', one single bar 0.5' to 0.6', one single bar		527
1										526
2		1	4.3 / 4.3							525
3										524
4										523
5		2	1.3 / 1.3					FILL CONCRETE		522
		3	0.4 / 0.4							
6		4	0.8 / 0.8		F	R3 to R4		METAQUARTZ GRANODIORITE; gray (N5), medium grained with thin (~0.01inch) parallel and vertical oriented quartz veins, fresh; METAGRANODIORITE; dark gray (N4) some vertical quartz veins from 0.1 inch to 0.6 inches thick. One xenolith granodiorite clast at 6.5 feet that is ~ 0.2' x 0.2' with evidence of contact metamorphic changes, pyrite present, some thin shear zones present		521
7								Total Depth 6.8 ft.		520
8										519
9										518
10										517
11										516
12										515
13										514
14										513
15										512
16										511
17										510
18										509
19										508
20										507