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August 16, 2011

Mr. Chris Gaskins, P.E., P.G.
SCDOT
955 Park Street
Columbia, South Carolina 29202

Re.: Geophysical Investigation Report
SC 41 Replacement Bridge over Wando River
Charleston/Berkeley County, South Carolina
SCDOT File No. 8.158B/10.032102; PIN: 32099
F&ME Project No. G4067.01

Dear Chris:

Submitted herein is the report from the performed geophysical investigation for the above referenced bridge project. Included is a summary of the field investigation, our analysis of the subsurface findings, and our conclusions for the proposed bridge system.

It has been a pleasure working with you on this project and we appreciate the opportunity to be of service. Please notify us if there are any questions.

Sincerely,

F&ME CONSULTANTS

James R. Wessinger
James R. Wessinger, P.G.
Project Geologist

John F. Hamilton, E.I.T.
Staff Engineer

attachments (CD)

JRW/jfh

GEOPHYSICAL INVESTIGATION

F&ME performed a geophysical investigation on November 10, 2004 at select locations within the Wando River to supplement our geotechnical investigation. The geophysical investigation was accomplished through two-dimensional Electrical Resistivity (ER) imaging. The main objective of our geophysical investigation was to provide a continuous indication of subsurface conditions to interpolate between widely spaced test borings. The borings and soundings from the geotechnical exploration were used to proof the geophysical data allowing additional refinement and interpretation.

(i) General Information

F&ME utilized the SuperSting Earth Resistivity System manufactured by Advanced Geosciences, Inc. (AGI). The system consists of the SuperSting 8-channel resistivity meter and a multi-electrode cable with 42 electrodes at nine (9) foot spacing and an automatic switching unit. The eight channels allow for eight resistivity measurements to be taken simultaneously. The electrodes are 'grounded' at the desired design electrode spacing utilizing steel spring clips and stakes pushed into the ground.

ER imaging is based on the principle that materials have unique physical characteristics, which determine how well, or poorly, the material can conduct an electrical current. The current is injected at two points and then measured at other pre-determined points depending upon the electrode arrangement for the selected in-situ measurement methodology. Analysis of the potential electrical current drops between electrodes using a finite difference algorithm that allows a determination of the resistance of the subsurface material (expressed as ohms/meter).

Resistivity values of soil and rock are affected by mineral composition, porosity, moisture, dissolved electrolytes, and temperature. Soils generally have low resistivity values, whereas rock has a relativity high resistivity value. A soil or rock resistivity can vary greatly depending on whether it is wet or dry. Because of overlap in the range of resistivity for various materials, this method is used in conjunction with other geotechnical methods to verify data interpretation.

The 'resolution' that the ER equipment can detect is a function of the electrode probe spacing. In general, objects and soil strata which are smaller or thinner than one-half the individual electrode probe spacing may not be easily discernable. The depth of investigation that ER data acquisition is capable is a function of the total survey line length. Therefore, the depth that can be interpreted with a reasonable resolution is approximately one-fourth to one-fifth of the total survey line length.

Points to remember when reviewing the data collected from resistivity surveys are as follows:

1. The resistivity imaging technique is 'side-looking'. This results in the fact that while the ER profiles depict a vertical slice, roughly perpendicular to ground surface, the indicated anomalies may be located to either side of the survey line;
2. The resistivity image may be distorted by unknown formations;
3. Constructed objects at ground surface (e.g. metallic fencing, power lines, grounding systems, etc.) and below ground (e.g. metallic pipe lines, bridge steel piling, foundation reinforcing steel, etc.) will provide 'artificial' high conductivity values;
4. Clay layers at ground surface or below grade with relatively high electro-chemical conductivities can 'mask' deeper soil and rock strata;

5. The resistivity image is a picture in terms of electrical resistivity and not a true picture of subsurface strata as we are accustomed to visualizing (i.e. pseudo-section); and,
6. The electrical resistivity of the strata will slightly change depending on the electrode signal configuration.

(ii) Field Work

A continuous marine survey was performed at the bridge site on November 10, 2004. A special marine electrode cable was towed behind a boat at 2 to 3 knots and the data gathered includes: resistivity, location (GPS), temperature (affects resistivity), and depth. The electrode spacing used here was five (5) meters. By knowing the boat location, the GPS unit can calculate the position of each electrode at any given moment. The continuous survey allows survey lines to be 1000 feet or more and consist of thousands of data points. The data is then converted to a "straight line" and then analyzed through the inversion process. This gives a two-dimensional picture of the river bottom which shows apparent resistivity, depth, temperature, and beginning/ending latitude and longitude. In addition, an image is created that shows the actual plan view of the ER survey line.

Due to the current in the river, it was necessary to perform the survey at low tide. This minimized the current affecting the cable and the boat. Several survey lines had to be terminated due to the current moving the boat off course.

Nine (9) successful survey lines were performed at the site. Three (3) survey lines were located to the southeast of the existing bridge, and they were in the approximate footprint of the proposed new bridge. The other six (6) survey lines were run perpendicular to the bridge, between the following bents (numbered from the north end of the existing bridge); 4 and 5, 8 and 9, 13 and 14, 19 and 20, 25 and 26 and the south side of the swing gate bridge. No survey was performed near the southern end of the existing bridge due to the shipyard structures on the southwest side of the bridge.

AREA GEOLOGY

The bridge site is located within the Lower Coastal Plain Physiological Province of South Carolina. The Coastal Plain consists of a wedge of sedimentary deposits which overlie basement rocks beginning at the Fall Line and increase in thickness moving seaward. In the Charleston area this sediment wedge is on the order of 2500 feet thick. The surface deposits of this physiological province were formed during the Pleistocene epoch of the Quaternary period and generally consist of sand and clay layers with varying amounts of shells and occasional organics. Underlying the surface deposits (about 17 feet on the north side of the river to about 22 feet on the south side of the river) is the stiff fine grained soils of the Cooper Marl Formation.

The Cooper Marl Formation varies in composition depending upon depositional environments and was formed in the Upper Cretaceous age. For engineering purposes, Cooper Marl is classified as silt, clay, or silty sand. The formation is over-consolidated with plasticity ranging from low to high. Properties of Cooper Marl are well documented in Charleston in that it is the predominant support formation for most major structures.

ER SURVEY RESULTS

The ER survey of the river bottom shows that the Wando River has cut into the Cooper Marl in the main river channel and there appear to be remnants of previous main channel locations. In the channel (high flow zone), there appears to be little sediment on top of the Cooper Marl. In low flow zones, there is approximately 8 to 10 feet of sediment, which is predominantly coarse grained material.

We have provided the results from the performed ER survey on the disc submitted with this report.

LIMITATIONS OF REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to the referenced bridge project. The conclusions and recommendations contained herein are based upon the provided test borings and testing results contained within, and applicable standards in this geographic area at the time this report was prepared. No other warranty, expressed or implied, is made.

In the event that any changes in nature, design, or location of the structure and/or foundation elements are planned, the recommendations contained in this report will not be considered valid unless the changes are reviewed and verified in writing.