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Cone Penetration Testing for Seismic Hazards Evaluation in Memphis & Shelby County, Tennessee

External Grants, Earthquake Hazards Program

US Geological Survey

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### **TECHNICAL ABSTRACT**

Cone penetration tests have been advanced at six test sites in the Memphis & Shelby County, TN and nearby New Madrid Seismic region to aid in the mapping of potential seismic ground hazards and to quantify subsurface characteristics at paleoliquefaction sites related to historic earthquakes. The cone penetrometers provide multiple and continuous readings with depth to develop vertical profiles of the soil geostratigraphy, strength, and stiffness parameters. Sites include two reference properties (CERI headquarters, Mud Island) and four paleoliquefaction sites (Wolf River, Hillhouse, Nodina, and Marked Tree) that have been studied by other researchers for USGS and the Center for Earthquake Research & Information (CERI). At many of these sites, a series of soundings of the same type, as well as different types of probings have been conducted to obtain a variety of measurements useful to geologists, seismologists, geophysicists, and geotechnical engineers. Types of tests include piezocone (CPTu<sub>1</sub> and CPTu<sub>2</sub>), seismic piezocone (SCPTu<sub>2</sub>) with downhole shear wave velocity measurements ( $V_S$ ), and resistivity piezocone (RCPTu<sub>1</sub>) with downhole readings of electrical conductivity. The data are utilized to evaluate the occurrence, extent, & susceptibility of liquefiable sands and silty sands, as well as provide supplementary Gmax data needed in ground amplification studies for seismicity hazards determination in the Memphis & Shelby County area. At paleoliquefaction sites, the source sands and clay capping strata are evaluated for resistance to liquefaction, lateral variability issues, and relevance of cyclic stress-based liquefaction procedures in the New Madrid Seismic Zone.

### **NON-TECHNICAL ABSTRACT**

Special series of cone penetration tests (CPT) have been completed at six project sites in the Shelby County, metropolitan Memphis, Tennessee area, and nearby New Madrid Seismic Zone. Cone penetration involves soil exploration without the use of traditional drilling, boring, & sampling. An instrumented electronic steel probe is hydraulically-pushed into the ground vertically to record stress, pressure, friction, conductivity, and/or wave characteristics that are continuously monitored by a

computer. With this tool, we can identify layers of loose sands and silts that may be prone to liquefaction should another large earthquake shock this area of the country. The recovered data are used to determine if the sand is strong enough to resist certain levels of seismic ground shaking as well as help evaluate how high the accelerations will be. This information can be used to forewarn of select sites and local areas that may be problematic for development and/or require rehabilitation for current residents. The CPT instrumentation also permits the forensic study of paleoliquefaction sites that have undergone earthquakes during prior events (900 A.D., 1500 A.D., 1811, 1812) to aid in back-investigative studies on the sources, causes, and magnitudes of this historic occurrences.