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Geophysical Characterization of Soil and Bedrock, Monroe City Bridge

by

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
UTC R187			

4. Title and Subtitle	5. Report Date
Geophysical Characterization of Soil and Bedrock, Monroe City Bridge	April 2008
	6. Performing Organization Code
7. Author/s Neil Anderson	8. Performing Organization Report No. 00015324
9. Performing Organization Name and Address Center for Infrastructure Engineering Studies/UTC program Missouri University of Science & Technology 223 Engineering Research Lab Rolla, MO 65409	10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTRS98-G-0021
12. Sponsoring Organization Name and Address U.S. Department of Transportation Research and Special Programs Administration 400 7th Street, SW Washington, DC 20590-0001	13. Type of Report and Period Covered Final 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

MST proposes to acquire echo sounding and marine seismic profiling data at a MoDOT bridge site, south of Monroe City. These geophysical data will be processed, analyzed and interpreted with the objective of mapping and characterizing sub-bottom sediment and bedrock at this construction site. The main project deliverables will be maps showing the location and estimated water depths and depth to bedrock at the construction site.

17. Key Words	18. Distribution Statement
Non-destructive imaging, non-invasive imaging, technology transfer, education, echo sounding, sub-bottom profiling	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. Of Pages	22. Price
unclassified	unclassified	5	

Form DOT F 1700.7 (8-72)

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Executive Summary:

Echo sounding data and sub-bottom profiling data were acquired on the water surface in proximity to bridge bents 4-8 (Mark Twain Bridge A-3798, MoDOT Route 107). The echo sounding data imaged the lake bottom and were used to generate contoured maps showing variable depth to the lake bottom. The sub-bottom profiling data imaged the lake bottom but did not image the underlying soil or rock. This is because the talus or alluvium deposits are absent in places and/or heterogeneous and relatively dense.

Two-dimensional (plan view) and three-dimensional images of the lake bottom (Figures 1, 2 and 3) are presented herein as the deliverables.

Summary of Field Work:

Echo sounding data and sub-bottom profiling data were acquired on the water surface in proximity to bridge bents 4-8, using a boat equipped with a GPS antenna.

The echo sounding tool emits a very high frequency pulse of acoustic energy at predetermined time intervals as it is towed along the surface of the water. Some of this acoustic energy is reflected (as an echo) from the lake bottom and returned to the echo sounding tool. Because it emits a high frequency pulse of acoustic energy, the echo sounding tool is <u>not</u> capable of penetrating and/or imaging dense soils or underlying bedrock. At the Mark Twain bridge site it provided accurate water depths only.

The echo sounding tool records the time it takes the acoustic pulse to travel to/from the lake bottom (travel time; **T**). The water depth (depth; **D**) is accurately estimated by dividing the travel time (**T**) by a factor 2 and then multiplying it by the acoustic velocity of water (**V**).

$$\mathbf{D} = \mathbf{Tw}/2 \times \mathbf{V}$$

Two-dimensional and three-dimensional images of the lake bottom were generated on the basis of echo sounding depth estimates. These are presented as Figures 1 and 2, respectively.

The sub-bottom profiling tool emits a much lower frequency pulse of acoustic energy at predetermined time intervals as it is towed along the water surface. Some of this acoustic energy is reflected (as an echo) from the lake bottom. Reflected energy from bedrock will also be recorded if the sub-bottom material is comprised of thin (typically < 30 ft), low-density, fairly uniform soils. If bedrock is imaged, soil thicknesses (**Ds**) can be estimated at each observation location by calculating the two-way travel time though the soil (**Ts**), dividing the resultant by a factor 2, and then multiplying the output by the acoustic velocity of the soil (**Vs**).

$$\mathbf{Ds} = \mathbf{Ts}/2 \times \mathbf{Vs}$$

The reflection from the lake bottom was clearly identified on the sub-bottom profiling data acquired at the Mark Twain bridge site. Unfortunately, we were unable to identify a second reflection from underlying bedrock. There are two most-probable explanations. The first explanation is that bedrock, in many places, is not overlain by soil. The second explanation is that the talus or alluvium, where present, is dense and heterogeneous, and has acoustic properties similar to those of the underlying bedrock.

A map showing variations in soil thickness and/or soil characteristics could not be generated on the basis of the interpretation of the sub-bottom profiling data.

Sub-bottom Features of Significance:

Contoured lake bottom elevations are displayed on Figure 3.

Two significant sub-bottom features are observed on the contoured base map (Figure 3):

1. Bent 4 is located on a steeply dipping (~35 ft drop in elevation over a lateral distance of ~60 ft) sub-bottom surface.

2. The old channel of the North Fork of the Salt River is imaged on the contour map immediately to the south of bent 8.

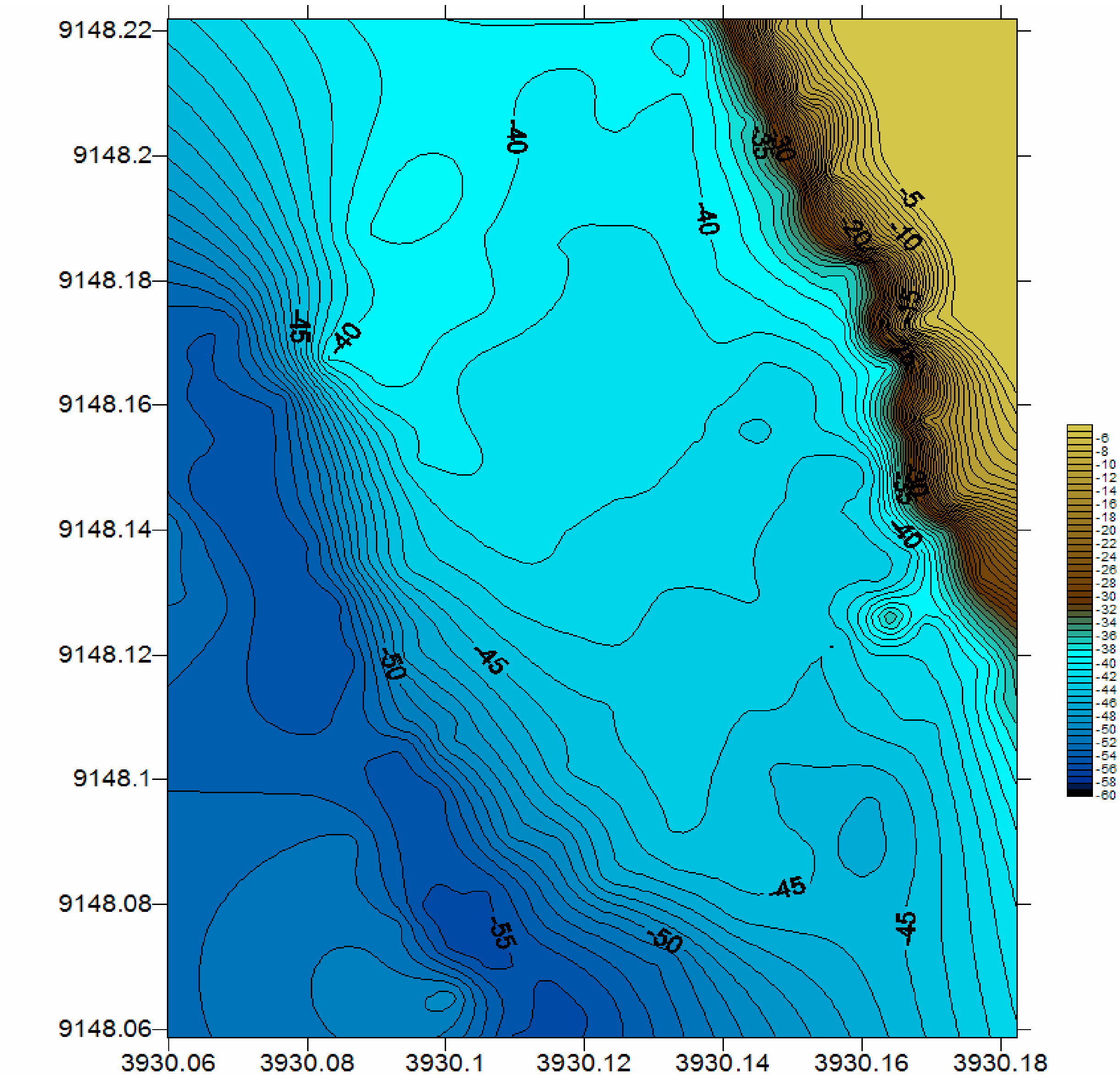

Figure 1: Partial plan view map of the study area showing variable water depths (in feet). Depths were relative to the 601.9 ft water surface elevation recorded on 10/18/06. This contoured map is based on the interpretation of the acquired echo sounding data.

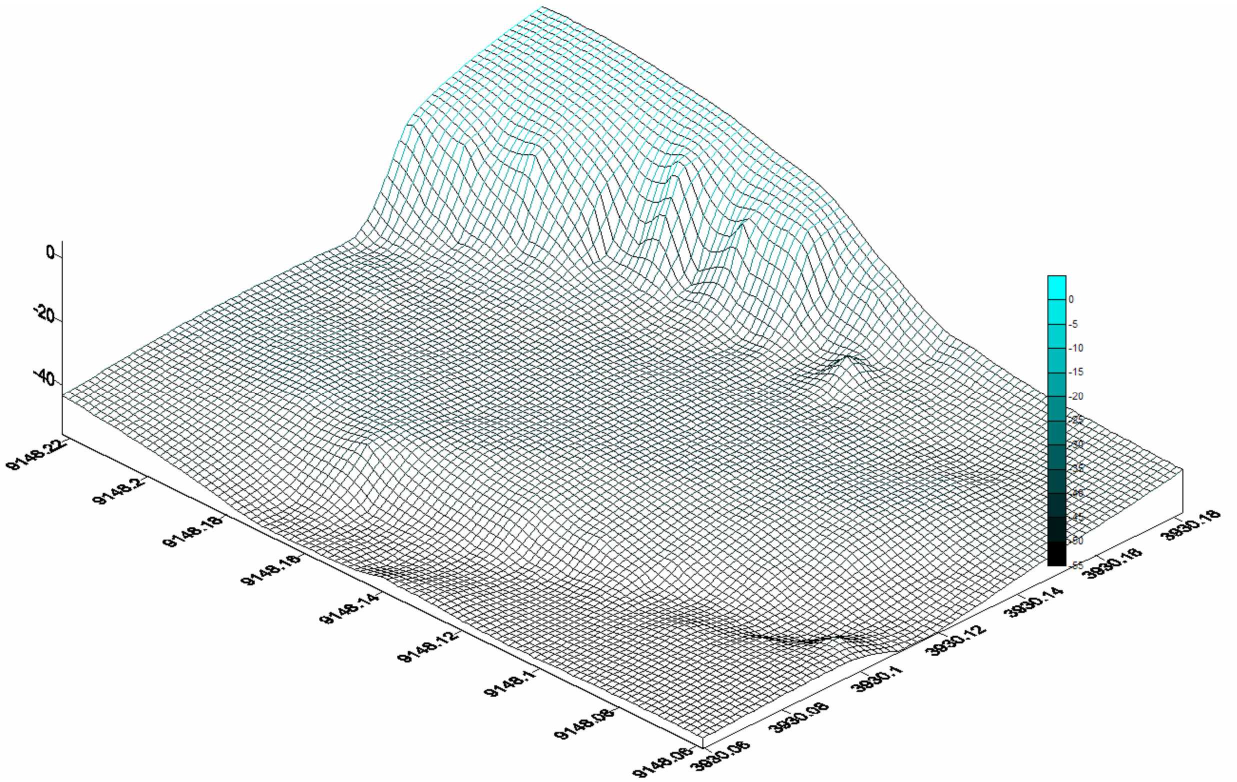

Figure 2: 3-D presentation of Figure 1. Water depths (in feet) are relative to the 601.9 ft water surface elevation recorded on 10/18/06. This contoured map is based on the interpretation of the acquired echo sounding data.

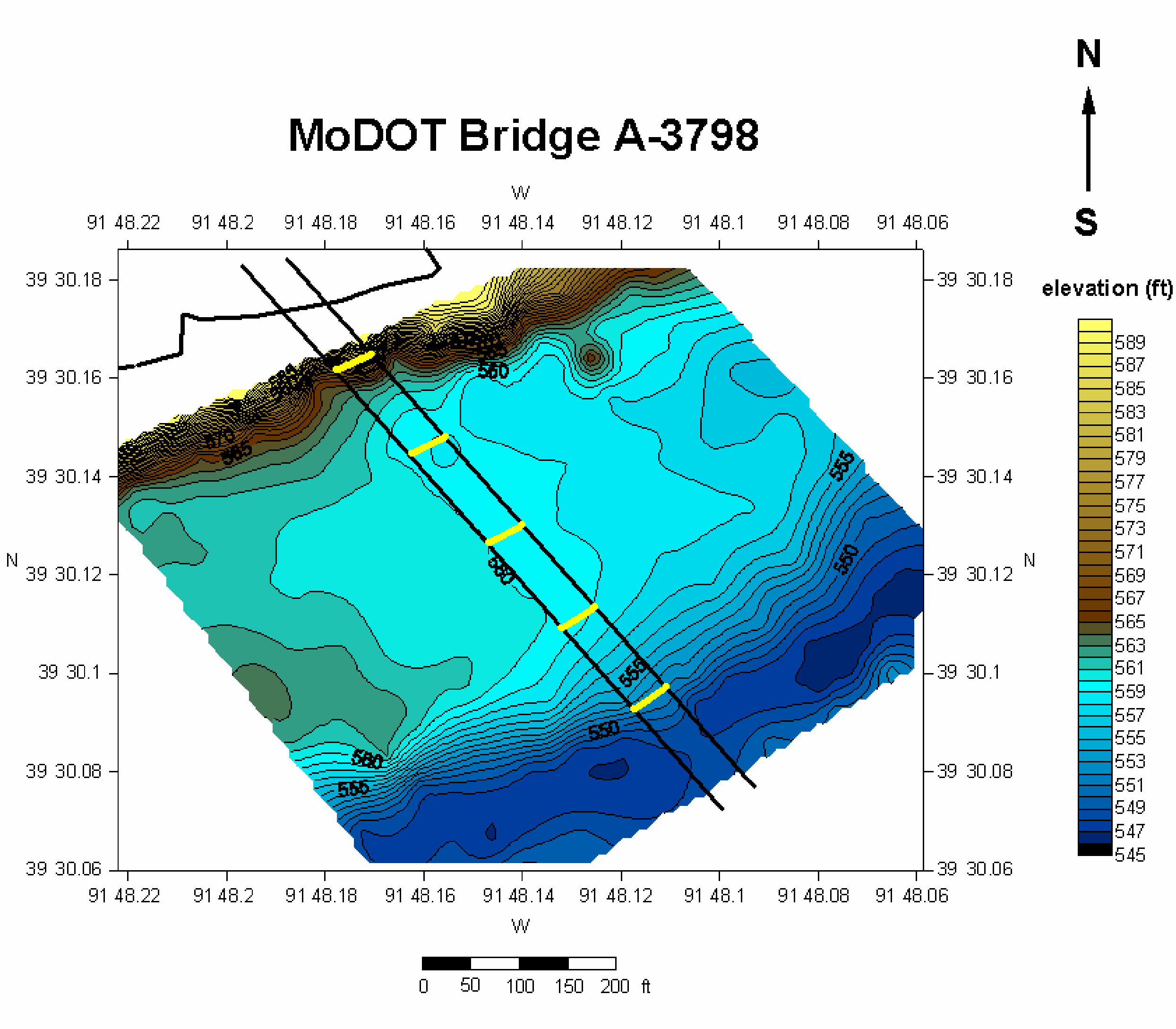

Figure 3: Plan view map of the study area showing elevation of the lake bottom (in feet). This contoured map is based on the interpretation of the acquired echo sounding data.