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GPR and Resistivity to Determine Depth to Bedrock at the Roaring River Trout Hatchery

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16. Abstract

The spillway and dam at Roaring River Trout Hatchery were built in the 1930's, and now leak to the point where sufficient waters to support a full-capacity hatchery operation cannot be retained over extended periods. The Missouri Department of Conservation requires information about the depth to bedrock so that mitigation efforts can be planned.

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Interpretation of
Resistivity and Ground Penetrating Data:
Roaring River State Park

Summary: Two resistivity profiles (Figures 1 and 2) and seven ground penetrating radar (GPR) profiles (Figures 3 to 9) were acquired at Roaring River State Park (Figures 10-14) for the Missouri Department of Conservation. On the basis of the interpretation of these geophysical data, we estimate that soil thicknesses at the toe of the dam/spillway complex (at a distance of about 3 feet from the toe of dam/spillway) range from five (5) to seven (7) feet. Interpreted soil thicknesses in the center of the pond (immediately north of the dam/spillway) range from four (4) to six (6) feet in thickness.

Resistivity Control: Two resistivity profiles were acquired at the Roaring River study site (Figures 1 and 2). Both resistivity profiles were acquired in the grass median along the concrete walkway immediately to the west of the dam/spillway. (The western edge of the dam/spillway is at distance "0".) The resistivity profile (southern) depicted as Figure 1 was acquired along a traverse about 3 feet from the exposed rock face. The resistivity profile (northern) depicted as Figure 2 was acquired along a traverse about 13 feet from the rock face. The interpretation of the resistivity data indicates that bedrock (immediately to the west of the dam/spillway; lateral distances <25 feet), is at a depth of 10-12 feet (relative to elevation of concrete walkway).

Ground Penetrating Radar (GPR) Control: Seven GPR profiles were acquired in the pond immediately to the north of the dam/spillway complex. (A 200 MHz antenna was placed in a small boat, which was then towed along pre-determined traverses.)

One GPR profile was acquired parallel to the toe of the dam/spillway complex (Figure 3). (The distance between the parallel GPR traverse and the dam/spillway was a fairly uniform 8 feet.) This GPR profile is presented as both a time-section (3a) and a depth section (3b) in Figure 3. The reflection from the water bottom is clearly visible on Figures 3a and 3b. The reflection from bedrock (as per our interpretation) is also highlighted on the GPR profiles. Soil thicknesses (water bottom to bedrock) can be estimated at any location by merely multiplying the estimated "water bottom to bedrock" thicknesses (as per Figures 3b) by a factor of 1.8. This conversion factor is necessary because the GPR depth profiles were generated using the velocity of EM energy in water only (limitation of conversion software).

Mark #1 (Figure 3) represents the tie point between this parallel GPR profile and perpendicular GPR profile #1, etc. The W-E parallel profile of Figure 3 extends from a marker (Mark #1) approximately 20 feet from the western edge of the dam/spillway complex to a marker (Mark #6) immediately to the west of the small pump house (?).

GPR profiles #1 through #6 were acquired along traverses oriented perpendicular to the dam/spillway complex. All of the profiles are oriented S-N (left-right). Western-most

Profile #1 (Figure 4) ties the parallel profile (Figure 3) at Mark #1. Tie points for GPR profiles #2 to #6 are depicted similarly.

The reflection from the water bottom is clearly visible on all six perpendicular GPR profiles. The time-depth of this reflector is shown on Figures 3a-9a. The estimated depth to the water bottom is shown on Figures 3b-9b.

The reflection from bedrock (as per our interpretation) is also highlighted on all of the GPR profiles. Soil thicknesses (water bottom to bedrock) can be estimated at any location by merely multiplying the estimated "water bottom to bedrock" thicknesses (as per Figures 3b-9b) by a factor of 1.8. This conversion factor is necessary because the depth profiles were generated using the velocity of EM energy in water only (limitation of conversion software).

Interpretation: On the basis of the interpreted resistivity and GPR profiles, we conclude that soil thicknesses at a distance of about 3 feet from (to the north of) the toe of the dam/spillway complex range from five (5) to seven (7) feet. Soil thicknesses in the center of the pond (immediately north of dam/spillway) are estimated to range from four (4) to six (6) feet.

Level of Confidence: The interpretation of geophysical data is inherently ambiguous. The absence of "ground truth" control makes this statement particularly applicable to the Roaring River study area. We strongly encourage the Missouri Department of Conservation to acquire control in the pond or immediately adjacent to the dam/spillway to verify/validate geophysical interpretation. (If our estimated depth to bedrock is accurate at one test location – it is probably accurate at all other locations.)

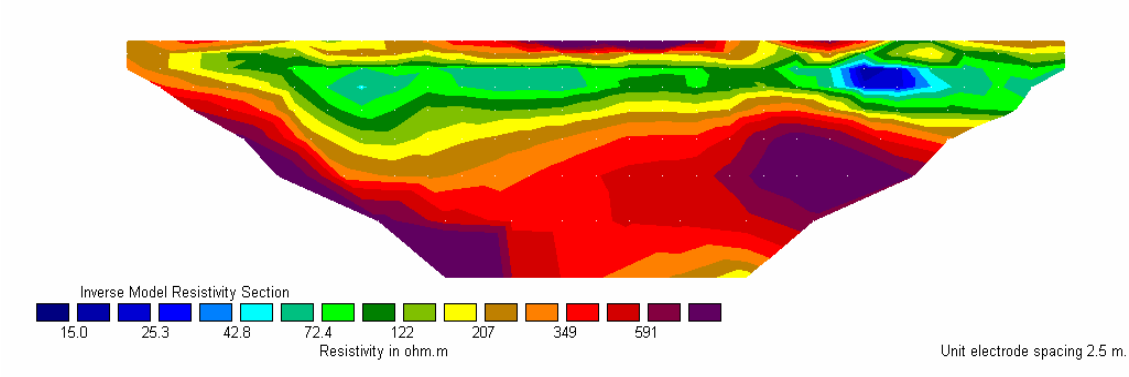

Figure 1: Resistivity Profile 1.

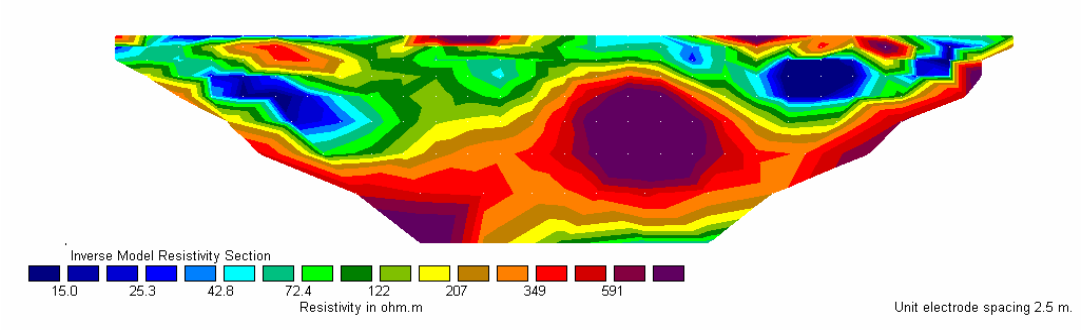

Figure 3: Resistivity Profile 2.

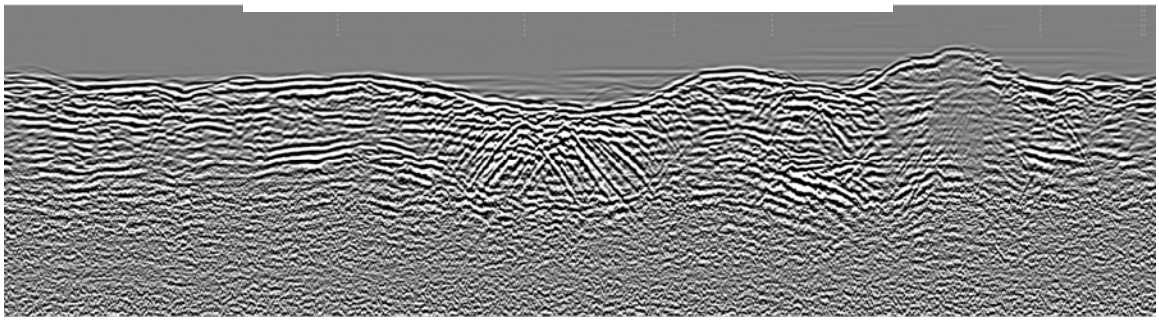

Figure 4: GPR Profile 1.

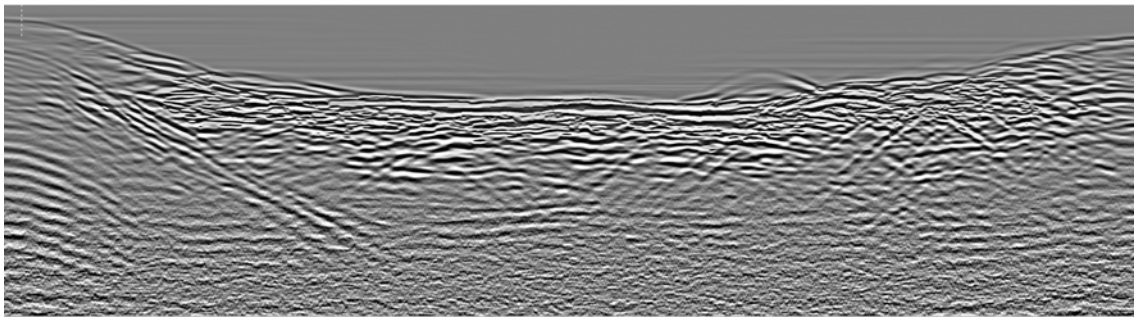

Figure 1: GPR Profile 2.

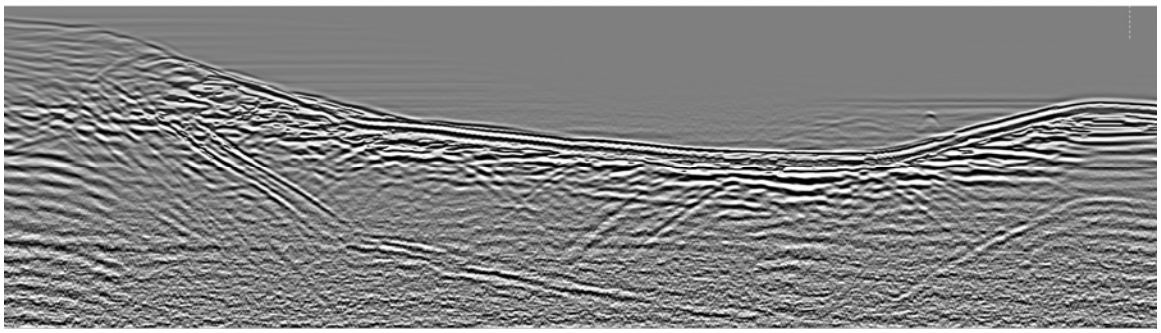

Figure 5: GPR Profile 3.

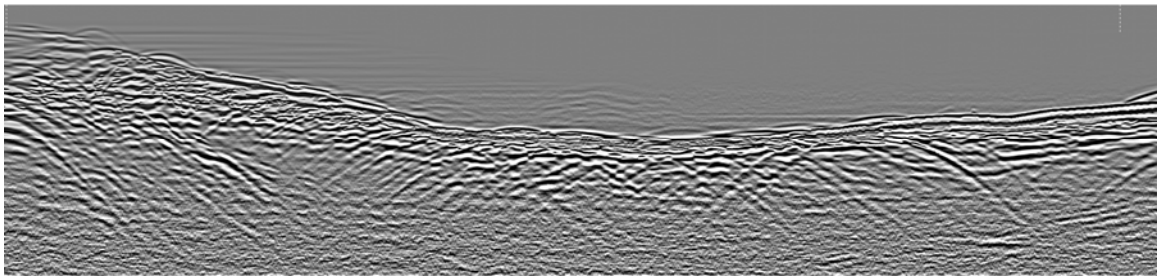

Figure 6: GPR Profile 4.

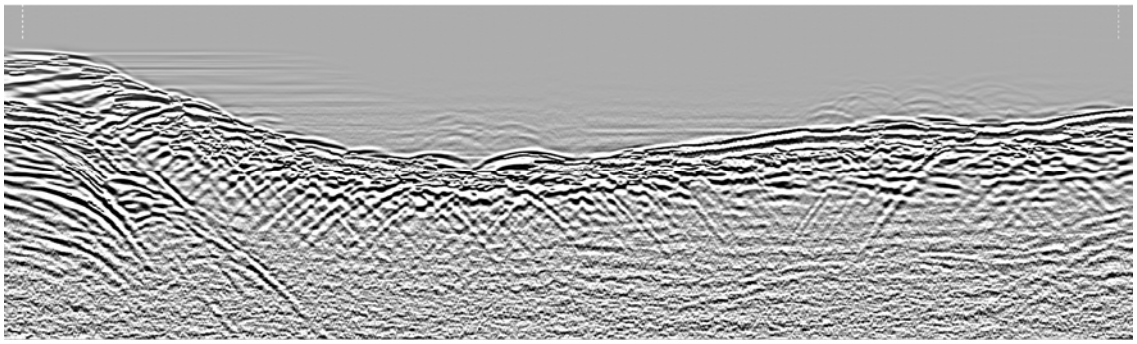

Figure 7: GPR Profile 5.

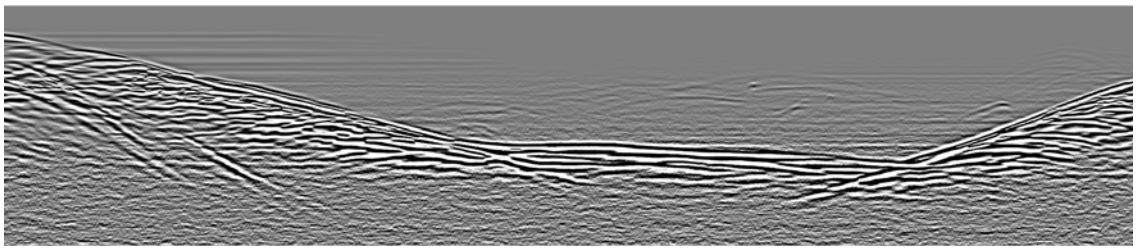

Figure 8: GPR Profile 6.

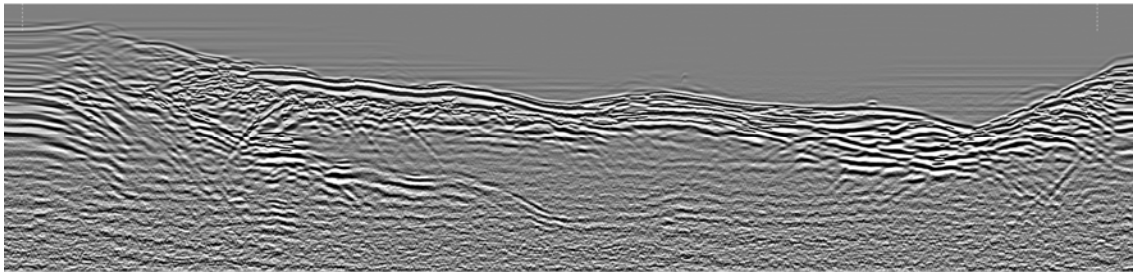

Figure 9: GPR Profile 7.

Figure 10: Hatchery view from outlook.

Figure 11: Old photograph of raceway.

Figure 12: Interior erosion near double spillway.

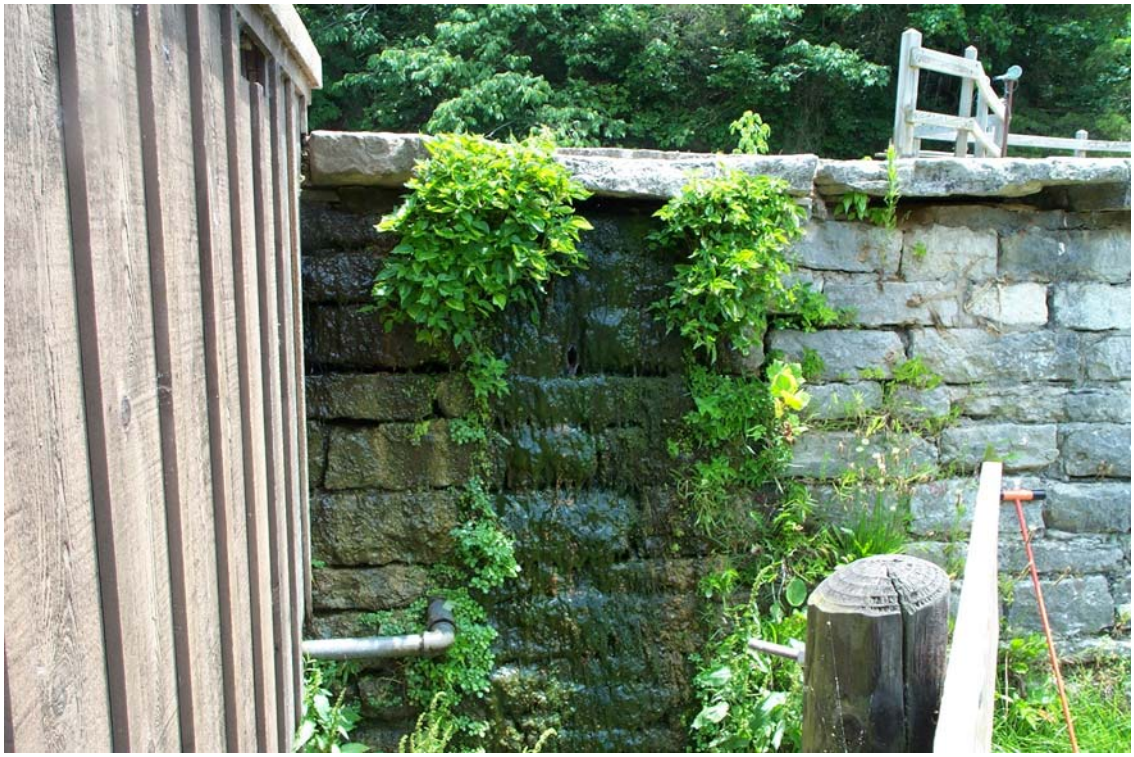

Figure 13: Seepage through Dam near toe.

Figure 14: Toe of Dam near Double spillway.