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Arkansas Department of Health, Arkansas Game and Fish Commission, Delta Council, Delta FARM, Delta Sustainable Water Resources Task Force, Delta Wildlife HydroGeophysics Group, Aarhus University, Mississippi Department of Environmental Quality, Mississippi State University, Missouri Department of Natural Resources, The Nature Conservancy, U.S. Army Corps of Engineers, U.S. Department of Agriculture-Agricultural Research Service, University of Arkansas, University of Mississippi, Yazoo Mississippi Delta Joint Water Management District

Scientific Investigations Map 3500
Sheet 2 of 2

Figure Annotations

These extended notes provide greater detail about specific aspects of the figures. Each note is numbered, and those numbers have been placed in large white font on the figures to emphasize specific features. In italics after the note number are figure numbers that the extended caption references

[1] *In figure 2*. The Tallahatchie River begins at the discharge of three flood-control reservoirs in Mississippi: Arkabutla (not shown), Enid, and Sardis Lakes (fig. 1). The combined discharge from these three lakes comes together just north of the surveyed reaches (figs. 1 and 2), and from here the Tallahatchie flows south predominantly over coarse-grained point-bar and abandoned-course deposits (figs. 2 and 4).

[2] *In figures 2, 3, and 4B*. High-resistivity sediments (100 to 200 ohm-meters) at the streambed (fig. 2) continue into the near surface to a depth of at least 4 meters (fig. 3). Based on the depth of incision, these high-resistivity sediments indicate that the Tallahatchie River is hydraulically connected to the aquifer, particularly along the southernmost portion of its extent near Money, Mississippi (figs. 4 and 7).

[3] *In figures 2, 3, and 8*. The high resistivity of the streambed and near-surface sediments (figs. 2 and 3) and the high potentiometric surface of the groundwater (figs. 3 and 8) near the Tallahatchie River suggest that the Tallahatchie River corridor recharges groundwater in this area.

[4] *In figures 2 and 4B*. Near Greenwood, Mississippi, the Tallahatchie and Yalobusha Rivers combine to form the Yazoo River (fig. 1). The Yazoo flows south from Greenwood over point-bar and abandoned-course deposits (figs. 2 and 4A), following the path of the ancestral Mississippi River.

[5A–C] *In figure 4B.* The resistivity profiles underlying the Yazoo River can be divided into three parts: (5A) from Greenwood south to the beginning of the abandoned-channel deposits (fig. 4*A*, in blue) north of Belzoni, (5B) the abandoned-channel and backswamp deposits around Belzoni (fig. 4*A*, in blue and green), and (5C) the abandoned-course deposits near Yazoo City (fig. 4*A*, in yellow). The aquifer recharge contributions of the Yazoo River likely are controlled by a low-resistivity unit about 2–3 meters beneath the streambed. The presence of the low-resistivity confining unit in the shallow subsurface over the majority of its length indicates that the Yazoo River may have limited interaction with the alluvial aquifer.

[5A] *In figure 4B*. In the upper third of the Yazoo River near Greenwood, the low-resistivity unit is discontinuous, and potential surface-water recharge to the aquifer is variable, with higher potential recharge located where the river overlies abandoned-course deposits (fig. 4*A*, in yellow).

[5B] *In figure 4B*. In the middle third of the Yazoo River near Belzoni, the low-resistivity sediments near 5A are absent where the Yazoo crosses several belts of abandoned channel deposits (figs. 2 and 4*A*, blue) and backswamp deposits (fig. 4*A*, green). In this middle reach, the surficial geology has more typical electrical resistivity than the formations in the other two reaches. Greater electrical resistivity (100–150 ohm-meters, implying greater groundwater/surface-water exchange) was measured near coarse-grained point-bar deposits, and lower electrical resistivity (25–50 ohm-meters, implying less groundwater/surface-water exchange) was measured near fine-grained abandoned-channel and backswamp deposits.

[5C] *In figure 4B*. In the lower third of the Yazoo River near Yazoo City, the low-resistivity confining unit is continuous and likely limits the potential groundwater/surface-water exchange along most of this reach (fig. 4*B).*

[6] *In figure 5*. The Big Sunflower River (fig. 5) flows south from its headwaters north of Clarksdale predominantly over point-bar deposits before joining the Yazoo River northwest of Redwood, Mississippi. These deposits exhibit low to moderate resistivities except for a highly heterogenous section of the river near Sunflower, Mississippi, where large variations in resistivity are observed as the Big Sunflower River meanders among several geologic units. This river was surveyed in four parts and at different times; the variations in water depth and water-column resistivity are not necessarily comparable along the length of the river.

[7] *In figure 5*. Near the town of Sunflower, Mississippi, the Big Sunflower River follows an eccentric course (figs. 5*B* and 5*C*) that appears to be a result of the relative stability of the different surficial geologic units in the area. The sediments beneath the Big Sunflower River are highly resistive where it traverses the backswamp deposits and highly conductive where it crosses the abandoned-channel deposits. These changes give the river profile for this area a distinct striped appearance with alternating bands of high and low-resistivity units (fig. 5*C*).

[8] *In figures 5D and 8*. The section of the Big Sunflower River described in annotation 7 is located near the center of the cone of depression in water levels in the alluvial aquifer (McGuire and others, 2019) (fig. 8). The high hydraulic conductivity in portions of the Big Sunflower River streambed in this reach (fig. 8, red circles) indicates an area for groundwater/surface-water exchange (fig. 5*D*). Because these higher streambed hydraulic conductivities occur where the surficial geology indicates limited areal recharge, this section of the Big Sunflower River is likely one of few contributors of water to the aquifer in this area with depressed groundwater levels.

[9] *In figure 6C*. The Bogue Phalia (figs. 6*A* and *C*) flows south from its headwaters near Gunnison, Mississippi, over point-bar and valley-train deposits before turning sharply east and joining the Big Sunflower River east of Arcola, Mississippi (figs. 1 and 2). Two major changes in elevation along the river profile are caused by weirs constructed west of Shaw, Mississippi, and northeast of Hollandale, Mississippi (fig. 6*C*).

[10A and 10B] *In figure 6C*. The Bogue Phalia is unique in this study because it flows over the braided-stream deposits in the western part of the study area. A paleochannel of one of these braided streams can be seen as an area of high resistivity (pink, green, and yellow) in the electrical resistivity section (10A on fig. 6*C*). The paleochannel is absent as the Bogue Phalia passes near Leland, Mississippi, and is visible again in the southern portion of the profile (green and yellow, 10B on fig. 6*C*).

[11] *In figure 6D*. The Quiver River flows south through the heart of the Delta region mostly over fine-grained backswamp deposits (fig. 2) before joining the Big Sunflower River south of Indianola, Mississippi (fig. 1). Because this river was surveyed in two parts and at different times, there are areas of missing data as well as discontinuities in water depth and water-column resistivity in the section (fig. 6*D*).

[12] *In figure 6D*. The Quiver River watershed is associated with the lowest groundwater elevations in the region (fig. 8, red circles). The clay backswamp deposits that underlie most of the watershed are very thin (less than 1 m in some cases) beneath the Quiver River, but the river has not incised to the high-resistivity sediments beneath those deposits (fig. 6*D*). This combination of recharge inhibiting surficial geology and readily available shallow aquifer material for irrigation could be contributing to the severely depressed groundwater levels in the area.

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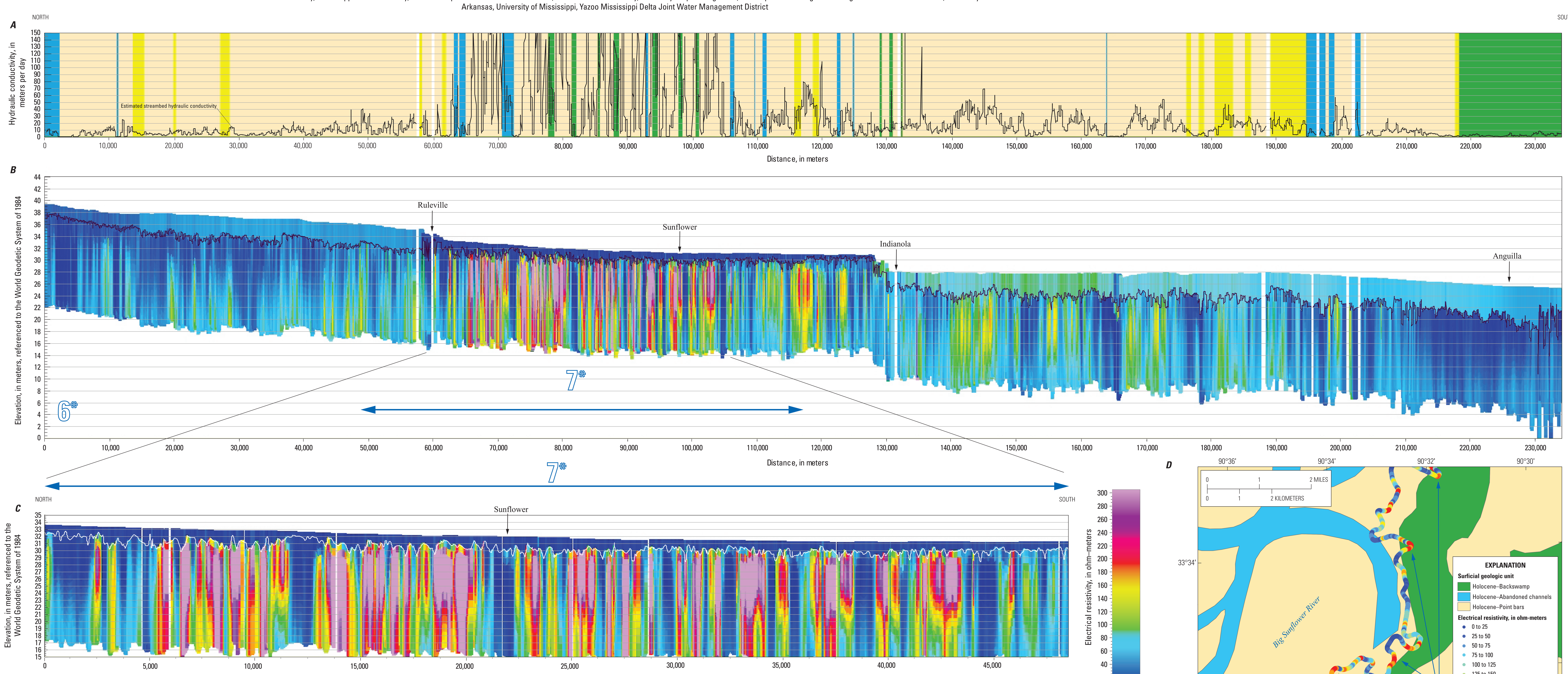
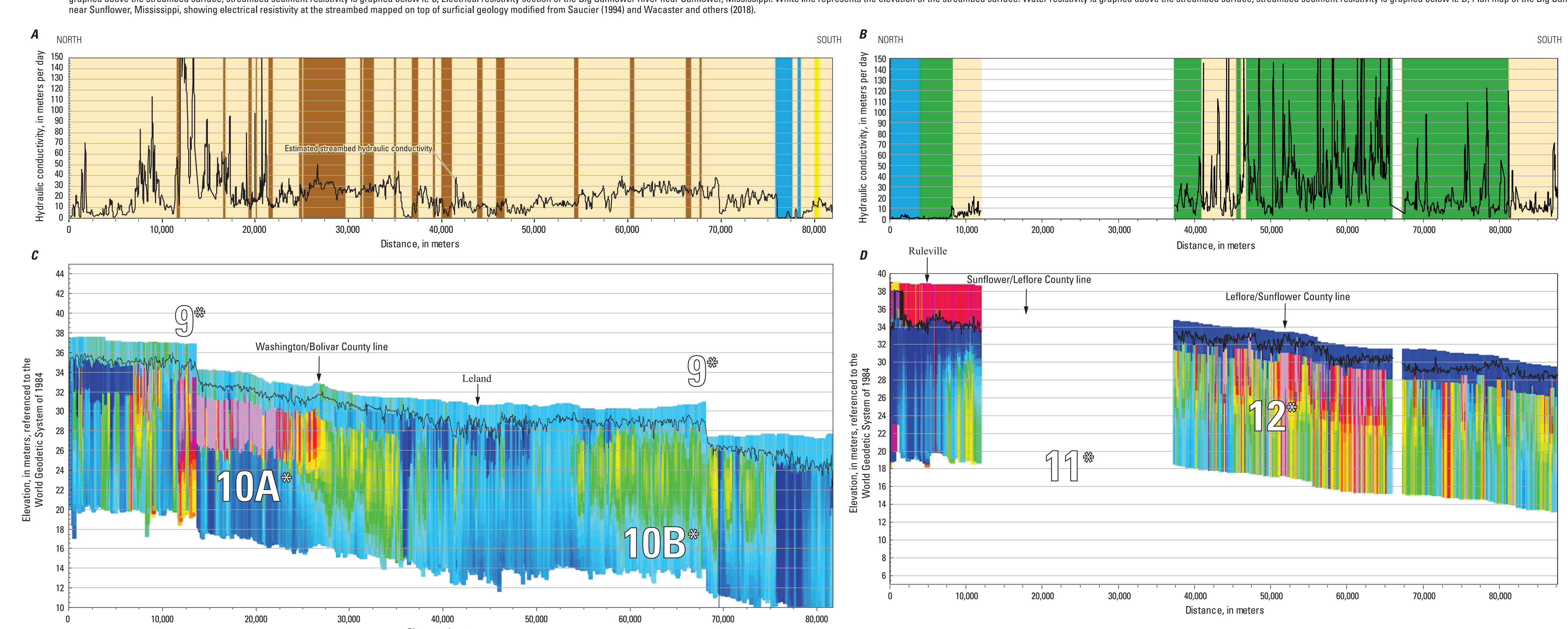


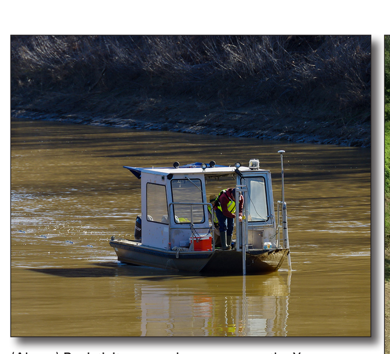
Notes: Blank spaces indicate no data; see sheet 2 for figure annotations.

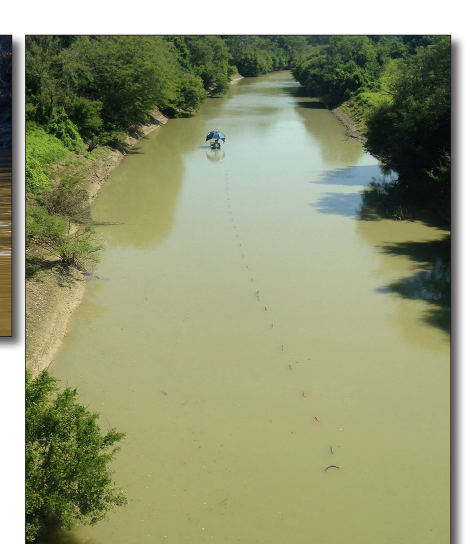
Figure 5. Streambed hydraulic conductivity, surficial geology, and electrical resistivity section, Big Sunflower River. *A*, Estimated streambed hydraulic conductivity (black line) and surficial geology (colored areas, same symbology as used for surficial geology in figure 2). *B*, Electrical resistivity section. Black line represents the elevation of the streambed surface. Water resistivity is graphed above the streambed surface; streambed sediment resistivity is graphed below it. *C*, Electrical resistivity section of the Big Sunflower River near Sunflower, Mississippi. White line represents the elevation of the streambed surface. Water resistivity is graphed above the streambed surface; streambed sediment resistivity is graphed below it. *D*, Plan map of the Big Sunflower River near Sunflower, Mississippi, showing electrical resistivity at the streambed mapped on top of surficial geology modified from Saucier (1994) and Wacaster and others (2018).



Notes: Blank spaces indicate no data; see sheet 2 for figure annotations.

Figure 6. Streambed hydraulic conductivity, surficial geology, and electrical resistivity section, Bogue Phalia and Quiver River. *A*, *B*, Estimated streambed hydraulic conductivity (black line) and surficial geology (colored areas, same symbology as used for surficial geology in figure 2) for the *A*, Bogue Phalia and *B*, Quiver River. *C*, *D*, Electrical resistivity section for the *C*, Bogue Phalia and *D*, Quiver River. Black line represents the elevation of the streambed surface. Water resistivity is graphed above the streambed surface; streambed sediment resistivity is graphed below it.





(Above) Resistivity survey in progress on the Yazoo River near Egypt Plantation. Photograph by Shane Stocks, USGS.
(Right) Resistivity survey on Quiver River showing floating resistivity cable and electrodes behind boat. Photograph by Ben Miller, USGS.

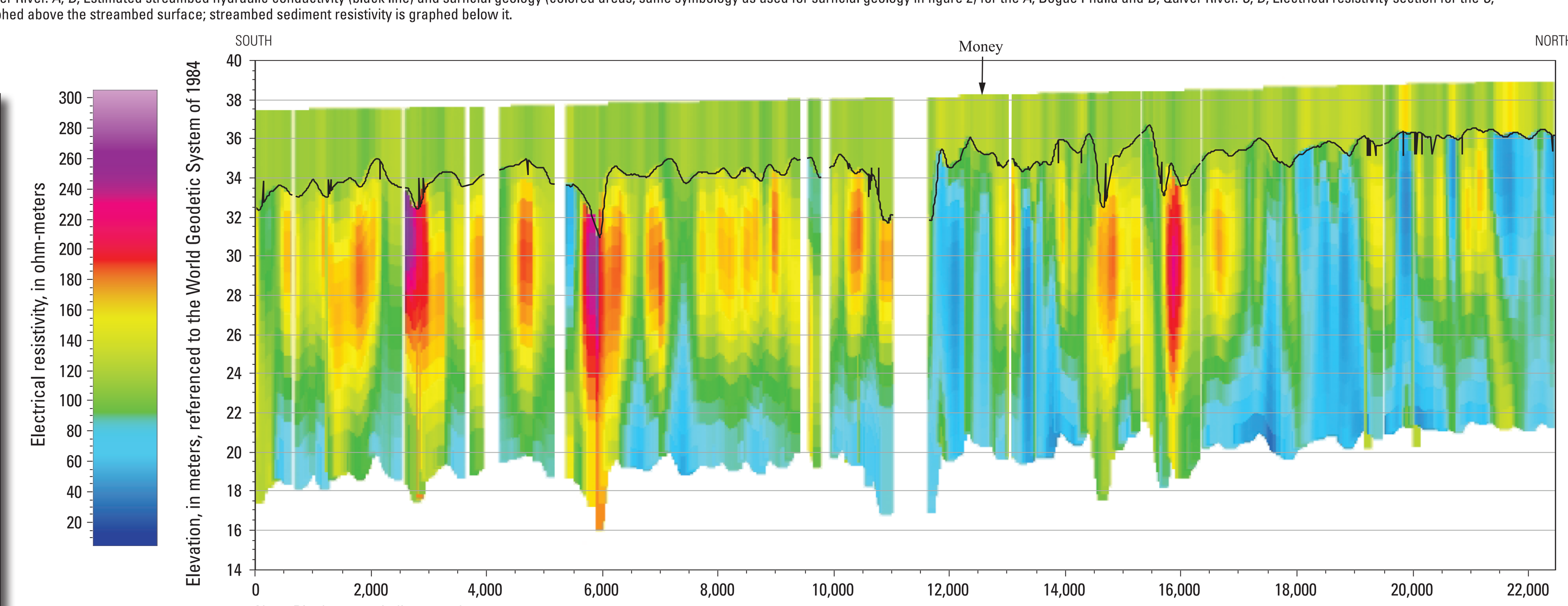


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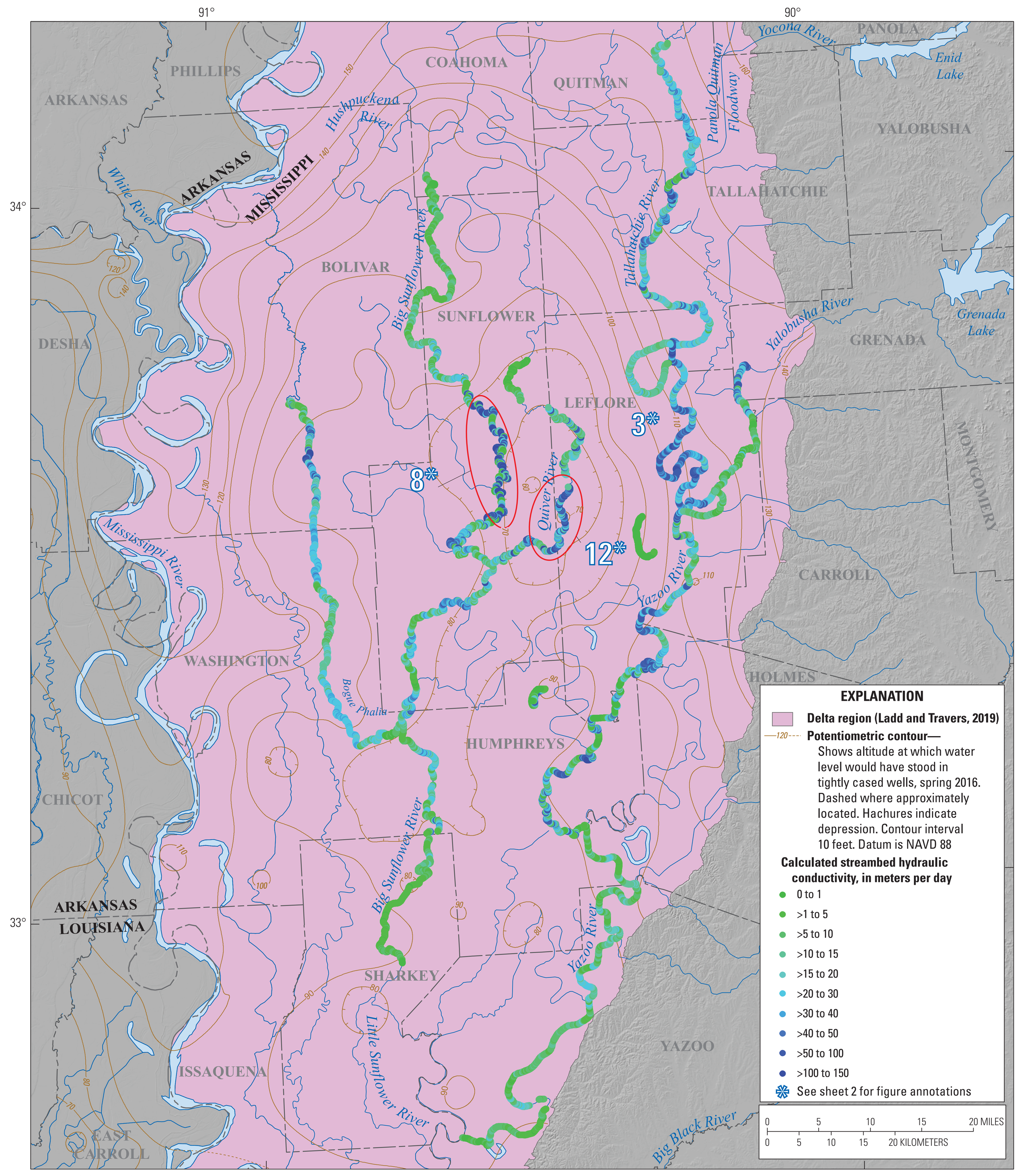
Figure 7. Electrical resistivity section, Tallahatchie River. Black line represents the elevation of the streambed surface. Water resistivity is graphed above the streambed surface; streambed sediment resistivity is graphed below it.



Base from U.S. Geological Survey, The National Map 3D Elevation Program
Albers Equal-Area Conic projection, North American Datum of 1983
Data refreshed July 2018

Figure 8. Calculated hydraulic conductivity for surveyed streambeds in the Delta region (Ladd and Travers, 2019). Potentiometric-surface data from McGuire and others (2019).

Estimating Streambed Hydraulic Conductivity for Selected Streams in the Mississippi Alluvial Plain Using Continuous Resistivity Profiling Methods—Delta Region

By
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2023

Datum

Vertical coordinate information for the electrical resistivity measurements is referenced to the World Geodetic System of 1984 (WGS 84).

Vertical coordinate information for potentiometric-surface data is referenced to the North American Vertical Datum of 1988 (NAVD 88). Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Elevation, as used in this report, refers to distance above the vertical datum.

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