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by Paul E. Albertson and Maureen K. Corcoran
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WES

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Prepared for U.S. Army Engineer District, Vicksburg

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Final report

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Preface

The U.S. Army Corps of Engineers, Waterways Experiment Station (WES), was authorized by the U.S. Army Engineer District, Vicksburg (CELMK), to conduct geomorphic investigation of Red River, Fulton Arkansas to Arkansas-Louisiana state line authorized under MIPR CELMK-PD-Q-94-5990 dated 10 August 1994. Mr. Erwin Roemer (CELMK-PD-Q) was the program manager for this study.

This report was prepared by Mr. Paul E. Albertson and Ms. Maureen K. Corcoran, Engineering Geology Branch (EGB), Earthquake Engineering and Geosciences Division (EEGD), Geotechnical Laboratory (GL), WES. Mr. Robert Larson is Chief, Geological Environments Analysis Section (GEAS), EGB.

Geomorphic mapping was conducted by Dr. Whitney Autin and Mr. John Kruger of Louisiana State University and revised by Mr. Albertson and Ms. Corcoran.

Ms. Theresa Foster, a contract student at San Diego State, San Diego, California, assisted with compilation of the geographic information system and report revisions.

This investigation was completed under the supervision of Dr. Lillian D. Wakeley, Chief, EGB, Dr. Arley G. Franklin, Chief EEGD, and Dr. William F. Marcuson III, Director, GL.

At the time of publication of this report, Director of the WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

1 Introduction

Background and Study Area

The U.S. Army Engineer District, Vicksburg (CELMK) is conducting feasibility studies to rehabilitate the levees along the Red River from Fulton, Arkansas, to the Arkansas-Louisiana State Line. The proposed project is designed to raise and strengthen the existing levee system along the Red River below Denison Dam. Rehabilitation between Fulton, Arkansas and the Louisiana state line consists of separate items representing reaches of levee. The geomorphology of the Red River Valley Great Bend Region will be discussed in general while the site-specific detail can be extracted from the geomorphic maps and cross-sections. Figure 1 shows the location of the quadrangles mapped in the Great Bend Region by this study.

Purpose and Scope

The purpose of this investigation is to provide a geomorphic framework for cultural resources research in the project area. There are three specific objectives of this investigation, as follows. (1) Identify and map geomorphic features or landforms in the study area on 1:24,000 scale base maps. (2) Define geomorphic processes that are active in the study area. (3) Reconstruct to the extent possible the geomorphic development of the study area and determine the significance of geomorphic features in terms of locating previously unknown archaeological sites and the potential for discovering buried sites.

Previous Investigations

Several studies relate either directly or indirectly to the project area. The Red River has attracted exploration since early European expansion into North America. Desoto's second expedition may have wandered through the valley in 1542. Documentation is inadequate because the expedition was a disaster and Desoto never returned (Tyson 1981). La Salle camped upstream of the

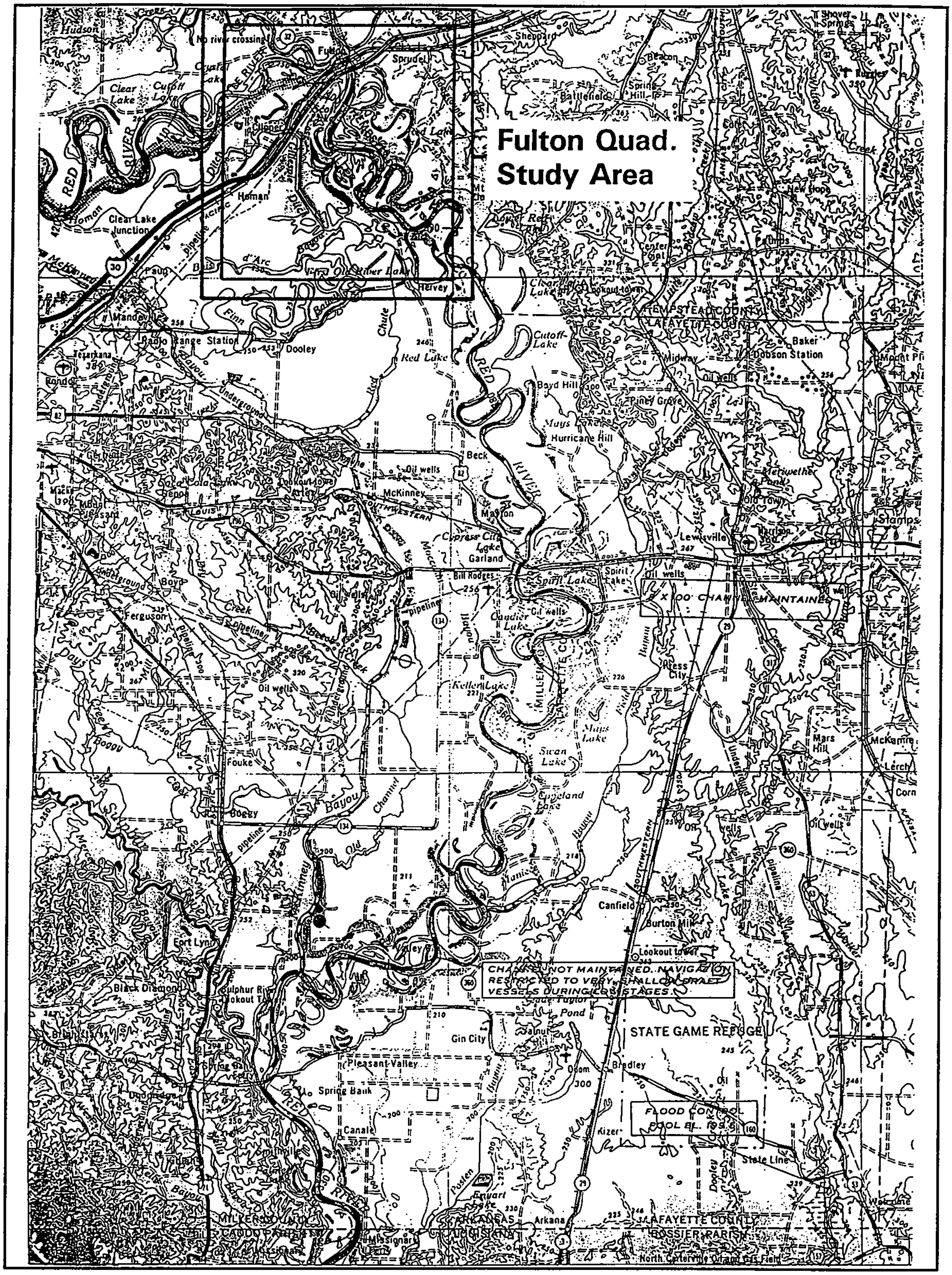

Figure 1. Levee project map from Fulton, Arkansas, to Arkansas-Louisiana State Line with Fulton Quadrangle study area

Great Bend on the Red River in 1687 (Santeford 1994). St. Denis, the French explorer and entrepreneur, established the trading post of Natchitoches in 1714 at the toe of the Great Raft (Guardia 1933). In 1719, La Harpe, another French explorer, traveled further up the Red River to the confluence of the Sulphur River and established a trading post in the region from 1719 to 1778 (Santeford 1994).

"Historically, the amount of interest in the ... Red River is directly related to the perceived value of land in question" (Jacobs 1985). The land area later to become Miller Co., Arkansas, became part of United States territory in 1803 with the Louisiana Purchase. *Documents Related to the Purchase and Exploration of Louisiana* (Dunbar 1804) is a fine example of our great scientific president Thomas Jefferson's interest in the newly acquired territory. In 1806, Jefferson sent Freeman and Curtis to further explore the Red River Valley but the Spanish repulsed the expedition. Details of the expedition with description of the Miller Co. area of the Red River are found in Flores (1984). Other early 19th century accounts (Stoddard 1812, Darby 1816, and Flint 1833) described the anastomosing flow of the Red River due to the affects of the log jams known as the Great Raft. Captain Henry Shreve removed the raft as far as Coats Bluff (later named Shreveport) in the 1830's. The Corps of Engineers completed removal of the log jam rafts to the Arkansas-Louisiana state line in 1873. Lt. Woodruff's (U.S. Army Corps of Engineers (USACE) reports 1873) report to Congress gives a photographic record of river conditions in the region.

The period of modern investigation may be said to begin with the work of Veatch (Schultz and Krinitzsky 1951). Veatch's (1906) report about the *Geology and Groundwater Resources of Northern Louisiana and Southern Arkansas* described the geological history of the region and focused on raft process and response. Some of the classical geological investigations of the Red River Valley were conducted downstream of the levee rehabilitation reach. Fisk's (1938) *The Geology of Grant and La Salle Parishes* introduced the fundamentals of differentiating the Holocene alluvium into depositional environments and the Pleistocene into a four terrace sequence. Fisk's concepts were extended up the river in Schultz and Krinitzsky (1951) *The Geology of Lower Red River* which included the alluvial geology, geological history and their geological engineering significance. Harms et al (1963) studied the stratification and sedimentary structure of point bars in the Shreveport, Louisiana, vicinity.

Abington (1973) described and analyzed the Red River's changing meandering morphology. Abington's process-response model concluded that the Red River meandering is reducing its sinuosity and is in transition to braided regime. Smith and Russ (1974) provided geological maps and cross-sections at a scale of 1:62,500 which provides the most complete geological mapping of the study area until the present geomorphic investigation. Russ's (1975) dissertation is essentially the accompanying text to the Smith and Russ (1974) mapping. Russ (1975) offered a chronology for 5 meander belts in the lower Red River Valley with the youngest belt being less than 600 years B.P.

Smith (1982) extrapolated Russ's framework to describe the geomorphic development of Bayou Bodcau and its significance to locating archeological sites. Pearson (1982) offered a working hypothesis of the meander belts of the Red River in the great Bend region to archeological site potential and preservation proposing the idea of the modern, intermediate and older meander belts. The *Depositional and Quaternary History of the Red River in Northeast Texas* was studied by Jacobs (1981 and 1985). He differentiated five terraces and related archeological potential of each surface. The soils of Miller Co., Arkansas were mapped in 1984 and in adjacent Hempstead Co. in 1979. Harvey et al. (1987) conducted a geomorphic and hydraulic analysis of the Red River above Shreveport. Saucier and Snead's (1989) synoptic 1:1,100,000 scale *Quaternary Geology of The Lower Mississippi Valley Map* depicts the latest two meander belts in the Great Bend region, i.e., Hrm1 and Hrm2. Earlier, Saucier (1974) stated that "... the chronology of the meander belts for this stream is quite tentative."

Albertson (1992) conducted engineering geology mapping south of the project area for sources of construction material and to provide foundation data for engineering structures associated with the proposed Shreveport to Daingerfield navigation project. Albertson and Dunbar (1993) conducted detailed geomorphic mapping for the proposed navigation project and related it to the archaeological significance of the area. Recent work by Heinrich (1993) and Guccione (1994) describe geomorphology and sedimentation rates in other parts of the river system.

2 Procedure

Approach

The geomorphic evaluation of the Red River Great Bend study area was approached by:

a. Review of previous literature, including geological and soil maps.

b. Aerial photographic geomorphic interpretation.

c. Conducting field reconnaissance and shallow auger borings.

d. Compiling existing subsurface boring data which includes Corps of Engineers revetments and levee studies, Arkansas Department of Transportation (DOT) borings, and water wells.

e. Construction of geomorphic cross-sections.

f. Synthesizing the data into soil geomorphic maps with inferred age relationship.

g. Inclusion of pertinent data into a geographic information system (GIS).

h. Comparison of temporal landforms to the known archeological record.

The study was conducted in several phases. Following the literature review, a preliminary investigation involved geomorphic mapping based on a field reconnaissance of the project area. Building upon the first three steps of the geomorphic evaluation, site specific stratigraphic and chronological characteristics about the different depositional environments within the study area were determined in steps a, e, and f. Essential information, i.e., soil, geology, and archeological site data, was entered in a GIS database to better maintain and interpret the data. The GIS serves as an analytical tool to examine soil-geomorphic and archeological relationships. The GIS is a dynamic document, that is, it will change with time as additional data are incorporated into it and new attributes are defined. Once a GIS structure is established, it can be modified to meet many purposes of land-use planning and resource management. The GIS as originally created is described in Chapter 6 of this report, and its use for relating geomorphic landforms and processes to known and potential cultural resources is explained.

Geomorphic Mapping

The first objective of this study was to map the geomorphic features within the study area. Mapping was done at a scale of 1:24,000 using a quadrangle as a base map. Delineation and definition of the geomorphic features were accomplished primarily by analysis of topographic data, soil survey information, and aerial photography (i.e., black and white photography flown in 1959, 1983, 1989, and 1990). Some information sources such as historic maps were examined but not rigorously analyzed. In addition to these data, the geomorphic mapping was based and guided by previous studies conducted by the U.S. Army Engineer Waterways Experiment Station (WES). (Smith and Russ 1974, Smith 1982, Saucier and Snead 1989, Albertson 1992, and Albertson and Dunbar 1993). These studies served as the foundation for the aerial photographic interpretation. The results of the geomorphic mapping are presented as maps in the back of the report.

Field Studies

Objectives and approach

The purpose of the field studies was to evaluate the results of the geomorphic mapping and conduct soil sampling of selected geomorphic environments. Soil samples were described to determine specific stratigraphic and chronological properties about the study area. Two separate visits were made to the project area as part of the field work. A general reconnaissance was conducted during this first phase to evaluate the results of previous geomorphic mapping. During the field investigation, auger soil sampling was conducted of selected geomorphic environments to determine general soil properties associated with various geomorphic environments. Soils data were used to define sedimentological characteristics of different geomorphic environments to aid in reconstructing the evolution of the study area. Soil samples were visually inspected and logged on-site. Additional soils information was obtained from boring data and published literature. Boring data included existing CELMK borings and borings drilled during the levee rehabilitation project (see Appendix A for reference table). Published soil data consisted of county soil survey bulletins from the Soils Conservation Service (1979 and 1984).

Boring logs

Logs of auger borings drilled during this study are presented in Appendix B. Boring logs in Appendix B contain descriptions of soil type, color (Munsell), texture, soil structure, consistency, and stratigraphic thickness. Boring locations are identified on the logs in Appendix B and are shown on the geomorphic maps in the back of the report.

3 Geology and Geomorphology

Geologic Setting

The Red River headwaters are in the arid High Plains of eastern New Mexico in an area named the Llano Estacado. The Red River flows east and forms the Texas-Oklahoma border. In Arkansas, the river turns south at Fulton and forms the Great Bend. Geomorphic development of the Red River Great Bend Region is the result of geologic processes operating during the last 65 million years. Surface deposits in the study area are Tertiary (2 to 65 million years) to Quaternary (2 million years to present) in age. Tertiary sediments were deposited by fluvial-deltaic processes similar to processes active in present day Louisiana. These sediments were incised by numerous Pleistocene and younger fluvial systems such as Red River meander belts. This study focuses on the geomorphic processes that have been active during the past 10,000 years.

Geomorphic Surfaces and Environments

Introduction

Gross geomorphic evaluation identified three major geomorphic surfaces within the study area. These surfaces are differentiated according to their physical characteristics, their apparent age, and by the types of processes that are active on each of these surfaces. These surfaces are identified in Table 1 as the floodplain, terraces, and bluffs. These three surfaces are further subdivided into depositional environments and/or geologic formations as shown by Table 1 and Figure 2. The approximate age of each surface and the types of geomorphic processes that are active are identified in Table 1.

Table 1
Geomorphology of the Project Area

Surface	Landform-Formation	Age	Geomorphic Processes
Floodplain	Point Bar	H	LA
	Backswamp (Hb)	H	VA-BT-SF
	Abandoned Course	H	LA-VA
	Abandoned Channel	H	LA-VA
	Natural Levee	H	VA-SF
Terrace	Abandoned Flood Plain (Pi)	P	E-SF
	Deweyville Terrace (Pd)	P	VA-BT-SF
	Prairie Terrace (Pp)	P	E-SF
	Montgomery Terrace (Pi)	P	E-SF
Bluffs	Claiborne Group (Tc)	T	E-SF
	Wilcox Group (Tw)	T	E-SF
	Midway Group (Tm)	T	E-SF

AGE: H = Holocene, P = Pleistocene, T = Tertiary
PROCESS: VA = Vertical accretion, LA = Lateral accretion, BT = Bioturbation, SF = Soil Forming Processes, E = Erosion

Bluff slopes and tertiary sediments

Surface outcrops of Tertiary sediments in the study area are restricted to the bluff slopes and summits. Tertiary sediments forming the bluff summit and slopes were defined by a sharp break in the topography between the floodplain surface and the bluff slopes. Boundaries separating the Tertiary units are based on Smith and Russ (1974). These Tertiary formations are fluvial-deltaic, near shore, and marine sedimentary sequences. Geologic formations that make up the valley slopes are identified on the geomorphic maps and in Table 1. The Tertiary Claiborne, Wilcox and Midway groups consist of interbedded deposits of sand, clays, lignitic silts, and lignite. Overlying the Tertiary units in the valleys are Pleistocene and Holocene fluvial sediments.

Terrace (Pi)

A *terrace* is an abandoned floodplain surface that is elevated above the present river's floodplain. A terrace consists of a relatively flat or gently inclined surface that is bounded on one edge by a steeper descending slope and on the other edge by a steeper ascending slope (Bates and Jackson 1980).

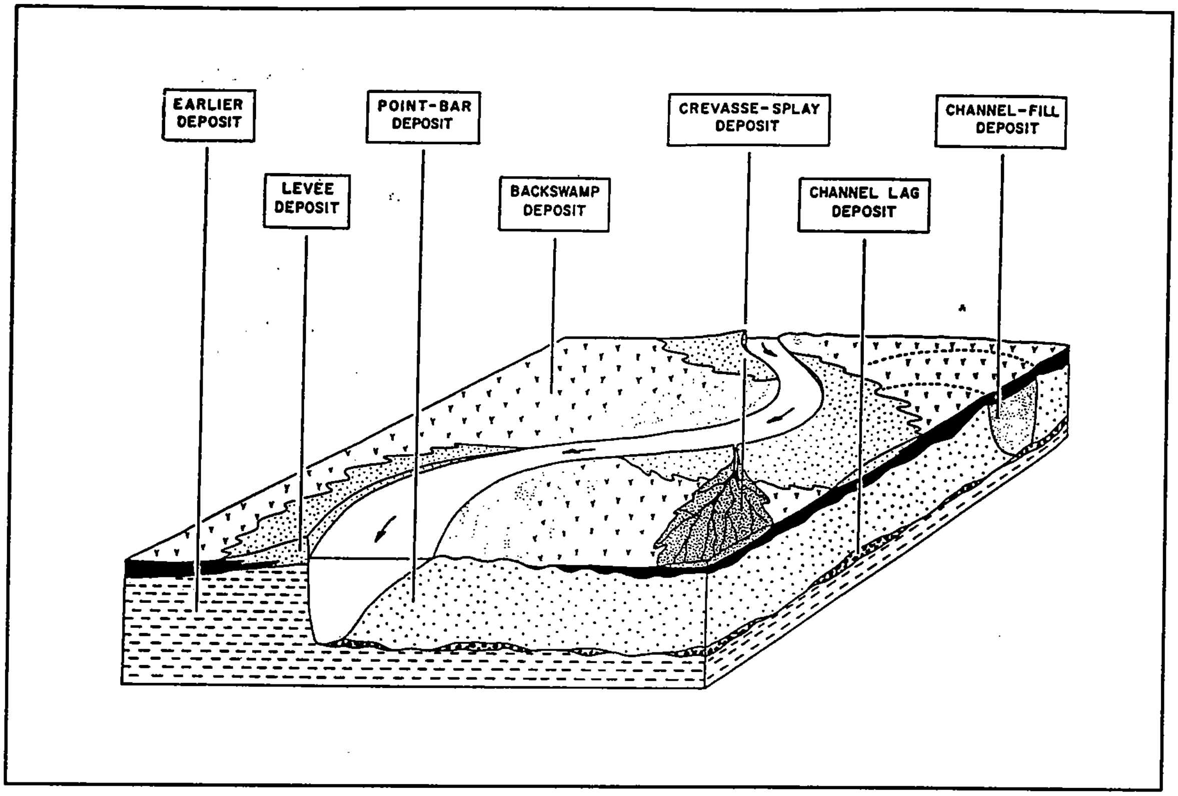

Figure 2. Depositional environments of a meandering river

Terraces generally border the present floodplain or may be preserved as topographic islands or remnants within the present floodplain. Terraces are differentiated on previous geomorphic maps (Smith and Russ 1974).

In the Red River Valley five terraces have been differentiated in Texas (Jacobs 1981) and six in Louisiana (Russ 1975). The recognized terraces from Louisiana (Russ 1975 and Smith and Russ 1974) nomenclature are: (from oldest to youngest) Williana or Citronelle Formation, Bentley, Montgomery, Prairie-upper, Prairie-lower and Deweyville. Pleistocene terraces in the study area were identified as Qtm or Montgomery by Smith and Russ (1974). However, this report uses the revised nomenclature developed by Saucier and Snead (1989), and identified the terraces as Pleistocene intermediate (Pi) terraces. Refer to Table 2 for a Pleistocene Terrace Correlation chart.

Terraces mapped in the study area are flat or gently inclined surfaces which occur adjacent to the floodplain. Mapped terraces on the geomorphic maps are interpreted to be depositional terraces. In general, the boundary between the terrace and the floodplain was mapped by noting the sharp scarp between the two surfaces. This boundary was then further refined by incorporating soils data from the available county soil survey bulletins, land use interpreted from aerial photography, and from site investigations conducted in the field. The Pd surface is at about the same level or buried by the Holocene

Table 2
Pleistocene Terrace Correlation Chart

Fisk (1938)	Russ (1975) Smith and Russ (1974)	Jacobs (1981)	Used in this Report Saucier and Snead (1989)
		T1	
	Deweyville (Qtd)		Deweyville Complex (Pd)
Prairie	Prairie-Lower Surface (Qtp2)	T2	Prairie Complex (Pp)
	Prairie-Upper Surface (Qtp1)		
Montgomery	Montgomery (Qtm)	T3	Intermediate Complex (Pi)
Bentley	Bentley	T4	Upland Complex (Pu)
Williana	Williana (Citronelle)	T5	

floodplain. The Pp terrace stands approximately 20 ft (6 m) above the floodplain. The Pi terrace surface stands approximately 40 ft (12 m) above the floodplain.

Floodplain Geomorphic Environments

General

The following paragraphs describe the physical appearance and processes that form individual types of geomorphic features encountered in the study area. This is a summary of information published in textbooks of geomorphology (i.e. Chorley, Schumm, and Sugden 1984), and is included here to make this report more useful to non-geologists.

Point bar (PB)

Point bar deposits are lateral accretion deposits formed as a river migrates across its floodplain. River channels migrate across their floodplain by eroding the outside or concave bank and depositing a sand bar on the inside or convex bank (Figure 2 and 3). With time, the convex bar grows in size and the point bar is developed. Associated with the point bar are a series of arcuate ridges and swales. The ridges are formed by lateral channel movement and are relic sandy lateral bars separated by low-lying swales. The swales are locations where fine-grained sediments accumulate.

Point bar deposits are as thick as the total depth of the river that formed them. These deposits fine upward from the maximum size of the river's bed load (coarse sand and/or fine gravel) to fine-grained soils (clay) at the surface.

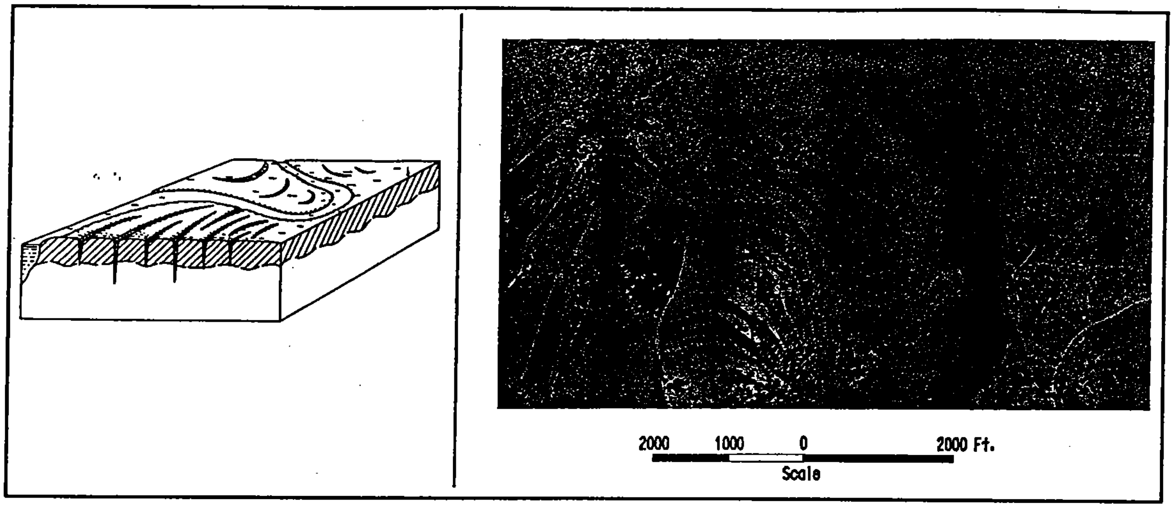

Figure 3. Schematic and aerial photograph of a typical point bar depositional environment

The basal or coarse-grained portion of the point bar sequence (i.e. point bar substratum) is deposited primarily by lateral accretion while the fine-gained or upper portion of the point bar sequence (i.e., point bar topstratum) is deposited by overbank vertical accretion.

Point bar deposits in the Red River Valley are the dominant and the most dynamic environment within the project area. Point bar limits were defined primarily from interpretation of the photography, boring and topographic data. Older point bar deposits are removed from the zone of active lateral accretion and are receiving sediment primarily by vertical accretion.

Primary characteristics of the active point environment are the well developed ridge and swale topography and its proximity to the main channel. In the Red River Valley, ridge and swale topography is especially well developed. Another primary characteristic of the point bar environment is the prominent sandy point bars along the main channel. Sandy point bars are easily recognized on aerial photography and on topographic maps.

Sediment types defined by borings identify a typical point bar sequence as grading upward from poorly graded, or uniform sands at the base, to silty sands, silts, and clays near ground surface. These deposits are usually variable horizontally, especially where ridge and swale topography is well developed or relic chutes (high water channel across the point bar neck) are present. Older Red River point bar deposits contain a much thicker and finer topstratum.

Boring data indicates that point bar deposits are separated into two distinct units based on sediment types; a thin predominantly fine-grained upper unit or *point bar topstratum* (silt and clay) deposited by vertical accretion, and a thick coarse-gained lower unit or *point bar substratum* (silty sand and sand) deposited by lateral accretion. Point bar topstratum deposits are approximately 15 to 20 ft (5.0 to 7.0 m) thick. The substratum, in comparison to the topstratum, is much thicker, (forming almost the entire thickness for this environment.

Natural levee

Natural levee deposits form by vertical accretion when the river overtops its banks during flood stage and sediment suspended in the flood flow is deposited immediately adjacent to the channel. The resulting landform is a low, wedge-shaped ridge with the greatest thickness adjacent to the river (Figure 2 and 4). Natural levee thickness decreases away from the river until it eventually merges with other floodplain deposits.

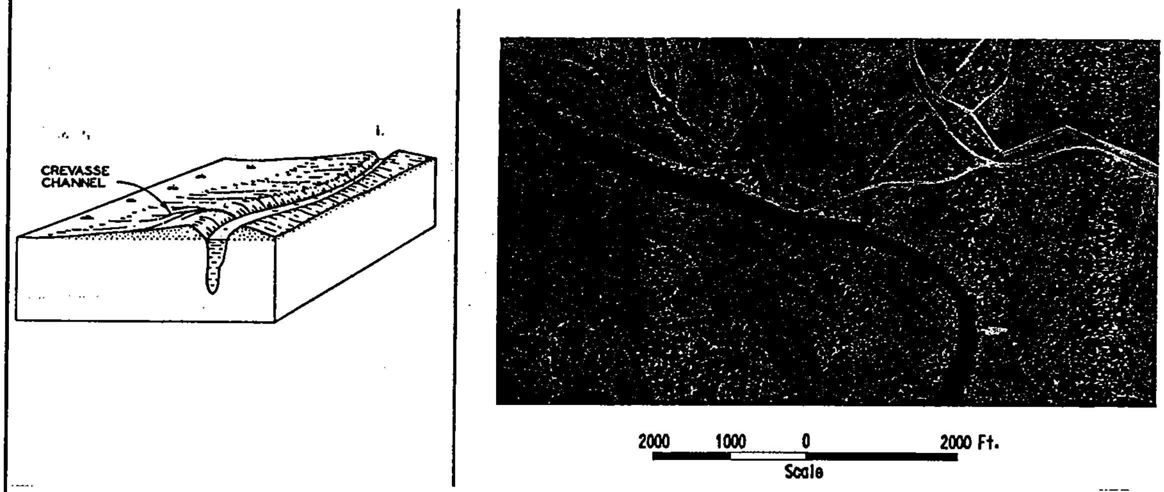

Figure 4. Schematic and aerial photograph of a typical natural levee depositional environment

Natural levee deposits in the project area are approximately 5 to 20 ft (2 to 6 m) thick and along the Red River may range several miles in width. A reconnaissance investigation identified silt and sand as the predominant soil types associated with natural levee deposits.

Natural levee deposits generally contain a low organic content because oxidation has reduced organic materials to a highly decomposed state. Soils are typically brown to reddish brown. Small calcareous nodules are frequently associated with these deposits as a result of groundwater movement through the permeable levee soils. Natural levee soils are generally well drained, have low water contents, and a stiff to very stiff consistency.

Natural levee deposits were mapped as a separate environment on the geomorphic maps because this environment is present throughout the floodplain to some extent. Natural levee deposits are an important geomorphic process in the study area, especially as a foci for cultural resources. Knowledge about topstratum thickness is helpful in understanding and evaluating buried archaeological sites.

Abandoned course

An *abandoned course* is a river channel that is abandoned in favor of a more efficient course (Figure 5). A course must contain a minimum of two meander loops for the channel to be classified as an abandoned course on the geomorphic maps. Abandoned courses are abundant throughout the project area. An abandoned course forms when the river's flow path is diverted to a new position on the river's floodplain. This event usually is a gradual process and begins by a break or a "crevasse" in the river's natural levee during flood stage. The crevasse forms a temporary or crevasse channel that may, over time, develop into a more permanent channel. Eventually, the new channel diverts the majority of flow and the old channel progressively fills. Final abandonment begins as coarse sediment fills the abandoned channel segment immediately down stream from the point of diversion. Complete filling of the abandoned course is a slow process that occurs first by lateral accretion and then later by overbank deposition and vertical accretion. The complete filling process may take several hundred to several thousand years to complete. In some instances, complete filling may not occur as relict and upland drainage preserves partial stream flow through the course.

Abandoned courses and associated abandoned channels collectively form a meander belt on the floodplain of the river. Meander belt deposits consist of a several mile wide, massive point bar sequence, divided by various abandoned channels and courses which collectively form the meander belt. The frequency and location of the meander belt segments are useful for determining the Holocene chronology of floodplain development which will be discussed later.

Abandoned channel

Abandoned channels are relict channel loops that are abandoned when the river cuts across its point bar (Figure 2 and 6). The cutoff produces an oxbow lake. The process by which the river abandons the loop occurs either gradually as a neck cutoff or during a single flood event as a chute cutoff. A chute is a high water channel across the point bar of the channel. Abandoned channels mapped by this study may be either well defined classic "oxbow"

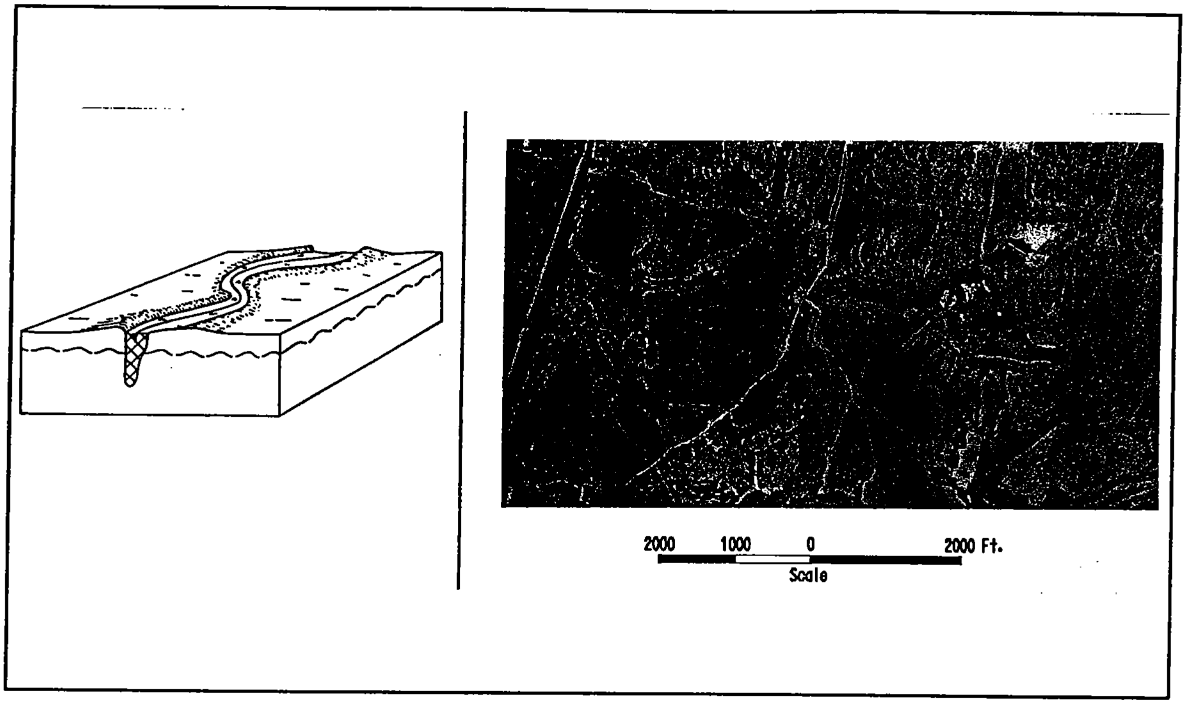

Figure 5. Schematic and aerial photograph of a typical abandoned course depositional environment

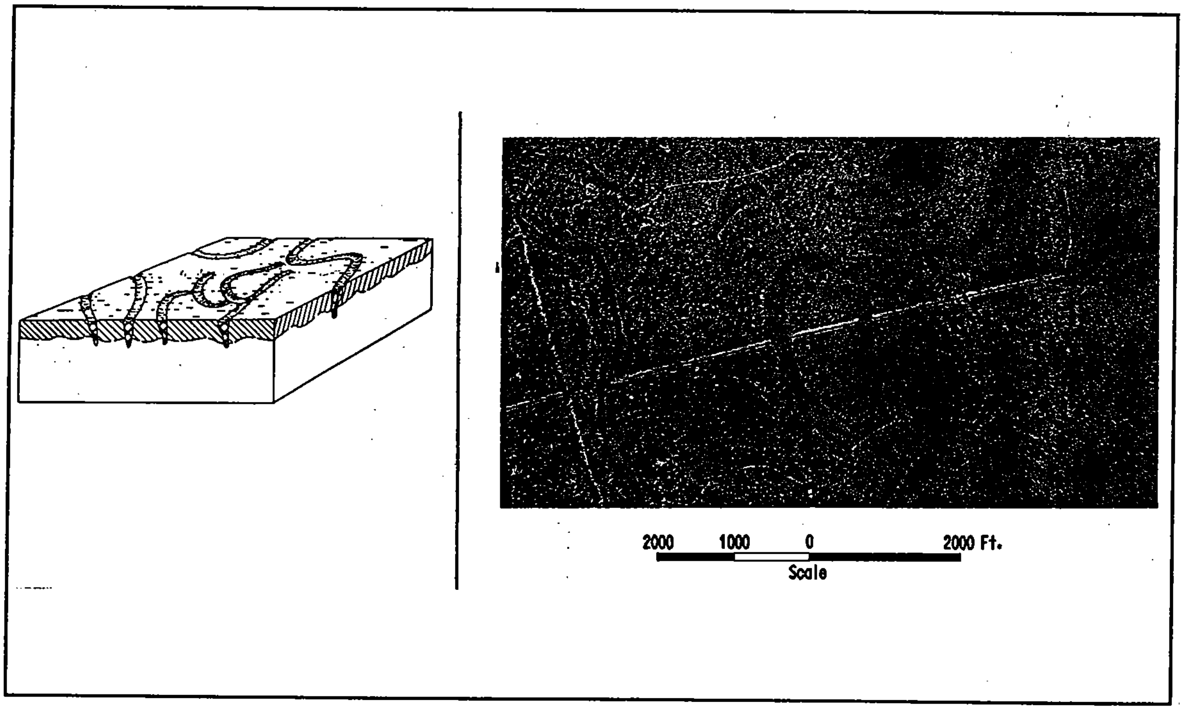

Figure 6. Schematic and aerial photograph of a typical abandoned channel depositional environment

loops or loop segments. Abandoned channels are abundant throughout the project area.

Channel filling is a gradual process. It occurs initially by lateral accretion, when the channel is still connected to the main course. After the main channel has migrated away from the abandoned segment, then vertical accretion dominates. During times of high water flow, suspended sediment is transported to the abandoned channel. Abandoned channels associated with the present meander belt are generally hydraulically connected to the main channel and are still in the process of filling. In contrast, abandoned channels on the older surfaces are filled or almost completely filled. Thickness of channel fills range from 25 to 30 ft (8 to 10 m). Abandoned channels that are not filled continue to receive sediment by overbank deposition during the peak flood season which may occur for only a brief time each year.

Backswamp (BS)

Backswamp deposits form by periodic flooding and vertical accretion of new sediment. The primary geomorphic process occurring in this environment are vertical accretion of new sediment by annual flooding, pedogenisis, and bioturbation. These processes combine to form a characteristic soil profile and lithology. In general, soil types are predominantly gray to dark red gray clay interbedded with silt and decayed roots and wood fragments. Backswamp deposits are 20 to 30 ft (6 to 10 m) thick.

Backswamp deposits in the project area are located in poorly drained forested areas bordering the point bar environments (Figure 2 and 7). This environment is approximately 25 percent of the study area. Backswamps are common in the Red River valley and have been covered with lacustrine deposits.

Alluvial architecture

The previous sections described the landscape components or geomorphic depositional environments. This section will portray the landform relationship in the subsurface. Twelve cross-sections (Plates 1-12) were compiled with available boring data (located at the back of the report). The source of the boring data is presented by number in Appendix B. Location of the cross-section is shown on the geomorphic maps. The horizontal distance in feet represents running distance along the cross-section and not levee stationing. Examination of sections reveal the alluvial sediment incised the Tertiary Sediments (Tu). Abandoned channels and point bars are seen in the sections. Backswamps are located away from the active and abandoned channels. Natural levee deposits drape most of the floodplain. Beneath and within the natural levee deposits is an inferred paleo surface. The paleosurface is a suggested level to explore for covered archeological sites.

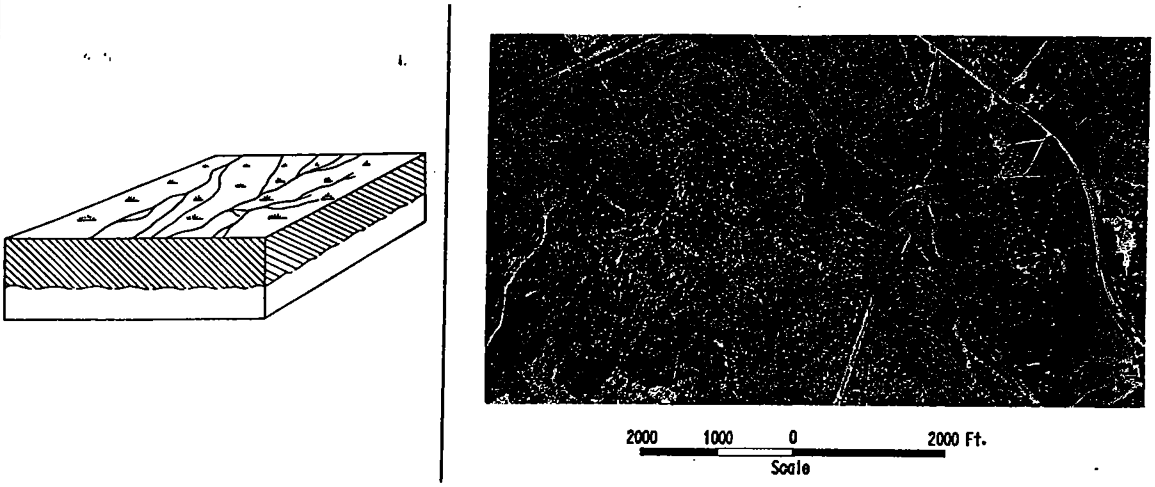

Figure 7. Schematic and aerial photograph of a typical backswamp environment

4 Soil Geomorphology

Introduction

An important characteristic that distinguishes landforms is the development of a mature soil profile(s) by pedogenic processes. The presence or absence of a soil profile reflects the types of geomorphic processes that are active in the area and the age of the soil sequence (Birkeland 1984). A definite relationship was established during the study between geomorphic surfaces and soil materials. The understanding of the relationship increases the ability to predict location and probability of archaeological sites and pattern of soil genesis on a given surface. Landscape stability is evident by a well defined soil imprint. Soil data from the soil surveys (SCS 1979 and 1984) were used to infer the degree of stability in Red River landforms. Since burial of sites is important to archeological surveys the recognition of buried soil horizons and surfaces needs to be considered.

Soil-Forming Processes

Soil-forming processes are governed by the physical properties of the soils, the environmental influences of the geomorphic system, and the duration of the geomorphic processes. Soil genesis on each surface "can be viewed as consisting of two steps: (1) the accumulation of parent materials, and (2) the differentiation of horizons in the profile" (Simonson 1959). The primary parent material in this study is alluvium with colluvium and hillslope sediments being secondary sources. Horizon differentiation in the parent material is a result of four basic kinds of changes occurring throughout the system. These are additions, removals, transfers and transformation (Simonson 1959). Physical properties of the underlying soils and the soil profile are variable because of differences in (a) topography and slope, (b) the types of vegetation which are growing on the surface, (c) the land use characteristics of the area (i.e. crop land versus timber), (d) variations in climate, (e) composition of the underlying parent materials, and (f) the time involved in which the soil has formed. These variations control the different types of geomorphic and pedogenic processes that are involved in soil formation, and they govern the soil profile that will be developed. Changes are brought about by the effects of the soil-forming factors.

Soil-Forming Factors

The five soil-forming factors have been studied and have been put forth in equation form by Hans Jenny (1941). His equation has the form:

$$s = f\,(cl,\ o,\ r,\ p,\ t..)$$

where s denotes any soil property. The soil-forming factors in parentheses, mostly groups of factors, are defined as follows:

cl = climate change
o = organisms and their frequencies
r = relief or topography
p = parent material, defined as state of soil at soil formation time zero
t = age of soil, absolute period of soil formation
... = additional, unspecified factors (Jenny 1961)

Discussion of the factors independently follows.

Climate

The climatic factor is considered by many to be the most important factor in the development of soil characteristics. It accounts for the present and historical effects of rainfall, temperature and wind on soil features. A significant point in considering the effect of climate is its cyclic nature, and variance in time and amounts of inputs.

Organisms

The organism factor is comprised of the fauna and flora of the region. As with climate both the past and present influences of plants and animals is visible in the present soil. Plants are involved in the initial development of soils through mechanical and chemical weathering. Throughout the succession of a soil the properties of organic carbon, nitrogen, pH, bulk density, color, and structure are effected by plants. The influence of animal populations can be seen by the mixing brought about by the activities of burrowing species. Grazing species and even man impacts the soil to an extent through cultivation and compaction.

Topography

Topography refers to the surface shape of a landform. It includes the gradient, length and width, slope orientation, and convexity or concavity. It effects soil hydrology, runoff or run-on, erosion or deposition and in conjunction with climate, vegetation. These attributes govern soil properties such as clay distribution, depth of weathering, profile development and organic matter and chemical variance.

Parent material

Parent material refers to unconsolidated organic and mineral materials in which soils form (Soil Survey Manual 1993). It is the material present when soil genesis is initiated. The nature and original properties of the parent material are important to the development of soil properties. It determines many of the chemical, mineralogical and physical limits of a soil. It influences types of clay developed, structure, texture, color and natural fertility. These properties in turn create variability in drainage, available moisture and vegetation.

Time

"Time here refers to passage of time...and in itself has no influence on the landscape; rather it records the accomplishments of the system" (Schumm 1977). Time in the above context is important only to help establish a starting and stopping point and to compute process rate (Daniels and Hammer 1992). Weathering of the parent material and development of soil features are aligned with time. Diverse parent materials will vary in the amount of time needed to produce soil material. Soil features will vary in the amount of time needed for development. Determining these times for a given parent material or feature can in some cases assist in ascertaining relative age. For example, the absence of a soil profile indicates a soil that has been recently deposited and has not had sufficient time to develop a profile.

Soil Geomorphology

The soil series will be discussed in terms of the geomorphic position and geoarcheological significance. Each of these different soil series has a unique soil profile characterized by diagnostic physical or chemical properties. The diversity of the soil series for different landforms reflects, in part, differences in mapping conventions between the various counties and differences in soil type due to geography and variations associated with the soil forming variables (i.e. time, parent material, climate, biological activity, etc.). Because of the great variety of soil series associated with the different landforms, specific or exact relationships between soil series and landform type are not possible.

Rather, general soil properties and characteristics can be differentiated for the various landforms.

The study area consists of soil classes, ultisols, alfisols, vertisols, mollisols, inceptisols, and entisols. The Tertiary bluff and slopes consist of ultisols such as the Bowie, Briley and Sacul series and alfisols such as the McKamie and Muskogee. These soils reflect long term pedogenesis and thus stability. Numerous Archaic sites have been located on Buzzard Bluff. However, the fact that ultisols are poor agriculture soils may explain the lack of Caddo sites.

Other Alfisols are the Rilla which are associated with natural levee deposits of former Red River channels. The Rilla reflects natural levee deposition along portions of Finn Bayou and Red Chute. The soil profile in a typical Rilla silt loam an argillic horizon at 1.2 ft (0.35 m).

Vertisols such as the Billyhaw series are developed on backswamp surfaces. Another clay soil associated with backswamps is the Perry. The Perry clay is an inceptisol reflecting some weak soil profile development. The profile of Perry clay reveals a buried B horizon at 1.75 ft (0.5 m). The Billyhaw and Perry clay are associated with the Finn Bayou Meander belt (Heinrich 1994). The clay veneer masked the meander belt features and probably buried site associated with settlement along the Finn Bayou course.

Other soils have mollic epidons and are classified as mollisols, such as the Latanier and Caspiana. Discussions with Louisiana SCS staff suggest that the organic enrichment of these mollisols is possibly associated with the Great Raft which accelerated organic and overbank deposition in the Red River Valley. The Caspiana is found on the flanks or distal portions of natural levees. The soil profile of the Caspiana shows a discontinuity at 2.2 ft (0.66 m). The Latanier contains a contrasting texture at approximately 3.3 ft (1 m).

Entisols exhibit the least amount of soil development and are, therefore, considered the most recent in age. Included in the entisol class are the Severn silt loam, Kiomatia loamy fine sand, and Oklared fine sandy loam. The Severn is associated with natural levee while the Kiomatia and Oklared series seem associated with historic and modern meander point bars. The Severn's profile reflects cumulative sedimentation which outfaced pedogenisis. Lithologic and color discontinuities at approximately 0.75 ft (0.25 m) indicate a possible buried surface in the Severn. The Kiomatia also reflects a change in deposition but deeper at 4 ft (1.3 m). The Oklared's profile reveals a depositional break at 3.8 ft (1.2 m). Considering the lack of soil development and thus relative recent age of these soils only historic and proto-historic sites are possible.

Soil Summary

The principal soil geomorphic processes are vertical accretion of new sediment from annual flooding, pedogenesis (soil formation), and bioturbation.

These processes combine to produce a characteristic soil profile and lithology in each landform. In general, soil profiles are better developed in older deposits than in the active point bar setting. Classification of soils by the SCS indicates inceptisols, mollisols and alfisols are the major soil groups for the older surface, while entisols are associated with the younger environment. The geomorphic importance associated with argillic and mollic soil horizons in the Finn Bayou area is that these soil horizons represent a stable surface and require a certain amount of time to develop. Exactly how much time is needed to develop either of these characteristics is unknown as it relates to the complex interchange between the different soil forming variables. Geomorphic significance of soil horizons in terms of this study is that the Finn Bayou surfaces have been stable long enough for pedogenic processes to imprint and alter the underlying fluvial deposits.

5 Geomorphic Chronology

Introduction

Another objective of this study was to define the geomorphic chronology of the project area to the extent possible with the known data. The chronology is based on the available soils and geological data, results of the geomorphic mapping and boring and radiometric age data (Appendix C) from this study, and comparison of archeological site records. The geomorphic history of the area is defined by the distribution and extent of the underlying geologic units, the floodplain sediments which overlie these formations, and the soils that have formed and modified these different landscape elements.

Pleistocene

The Red River was not directly affected by continental glaciation during the Pleistocene. Therefore, the fluvial system did not directly receive glacial meltwater or related sediments. Instead, geomorphic processes operating in the study area were controlled by climatic variations associated with Pleistocene glaciation. Climatic changes influenced the base level on the Red River and its tributaries. Since the outlet for the Red River during the latter part of the Pleistocene was by way of the Mississippi River Valley, indirect effects of glaciation (i.e. glacial melt water, glacial sediment, and sea level changes) would have influenced the Red River's discharge to the Mississippi River and its link to the Gulf of Mexico. The end result of this complex interchange between Pleistocene climate changes and associated base level response has been the creation and incision of a well-defined drainage basin into the underlying Tertiary sediments. At the beginning of the Holocene, the Red River alluvial valley and its larger tributaries had developed a series of descending stepped terraces, formed as a result of aggrading and degrading fluvial cycles, and a well-defined flood plain with associated environments of deposition. Within the boundaries of the study area, the mapped terraces are the Pleistocene Deweyville (Pd), Praire (Pp), and Montgomery (Pm) Intermediate (Pi) (Saucier and Snead 1989).

Holocene

During the Holocene, the Mississippi River built five meander belt courses in its alluvial valley (Saucier 1974 and Saucier and Snead 1989). In the Red River valley, six remanent meander belts are preserved (Smith and Russ 1974, Russ 1975, Saucier 1974, Saucier and Snead 1989). The most recent Red River course to the Mississippi River may have formed some time between 500 and 1,000 years BP through Moncla Gap (Russ 1975). Pearson (1986) suggests this change may have occurred even earlier, perhaps as early as 1,800 years BP based on archaeological data. Hall (1990) indicates that approximately 1,000 years BP, a regional climate change occurred from moist to dry in the southern Great Plains. The response by the Red River to this climate change may have led to channel incision which helped to promote increased bank erosion. Floodplain incision, bank erosion, and valley-wide lateral migration may have introduced a large influx of sediment and trees into the lower Red River Valley to form the Red River Raft.

Saucier and Snead (1989) compiled previous mapping of the Lower Mississippi Valley and its tributaries. This synoptic view of the region indicates two meander belt deposits, i.e., Hrm1 and Hrm2. These meander belts are the youngest two of the six recognized belts (Saucier and Snead 1989). A preliminary geomorphic study relating the distribution of prehistory archaeological record was conducted by Pearson (1982). The work is part of a multi-hypothesis in the valley's evolution and prehistoric landscape adaption. Pearson infers three meander belts, i.e., modern, intermediate age and older belts.

Older Meander Belt (Hrm2)

Saucier and Snead (1989) mapped the Finn Bayou abandoned channels and course as Hrm2. The age of the Finn Bayou meander belt (Pearson 1982) is tentative but is associated with his older meander projected to be older than 3,000 years BP. A radiometric date of 4610 ± 60 years BP was recorded from an Hrm2 over bank deposit (Appendix C). Archaeological data indicate Late Archaic (5,000-2,500 BP) and Fourche Maline (2,500 - 1,000 BP) sites adjacent to Finn Bayou. Based on Jacobs (1981) work Heinrich (1994) suggested that Hrm2 could have flowed from 4,000 to 6,000 years BP. Until additional investigations produce radiometric dates, the presumed dates are plausible. The geomorphic features along Hrm2 are mashed with overbank clay deposits. It is inferred that the affect of the Great Raft added additional vertical accretion deposits. Archeological sites are expected to be buried along this meander belt.

Intermediate Meander Belt (Hrm1.1 and 1.2)

Pearson's (1982) intermediate belt is part of Saucier and Snead's Hrm1. Geomorphic analysis during this study concurs that based on oxbow filling the Hrm1 can be differentiated into Hrm1.1 and Hrm1.2. Pearson's (1982) chronology suggests that the intermediate belt was formed 200 to 2,000 years BP. Additional data for this study suggest that the age of Hrm1.2 is 4,000 to 1,200 years B.P. Hrm1.1 is tentatively estimated at 1,200 to 200 years B.P. Hrm1.2 oxbows are recognized by their partial filling. The Hrm1.2 abandoned channels usually are flooded part of year and contain cypress swamps. Pearson (1982) included Red Lake on the eastern valley wall as part of the intermediate belt. An alternative hypothesis is that Red Lake and other eastern wall abandoned channels could be remnants of a Little River meander flowing during the time of Hrm2 deposition.

Modern Meander Belt (Hrm1.0)

The modern meander belt has been active for the last 200 years (Pearson 1982). Review of historic maps show the present meander belt to be very active. For example, Old River Lake, Adam's Cut-off and First Old River Lake were part of the channel in the 1840s. Willow Lake and Scott Lake were abandoned before 1840. The oxbow lakes or abandoned channels in Hrm1.0 are open with only partial filling. Examination of the Fulton Quadrangle topographic map also reveals the active meandering of the Red River. For example, the Miller-Hempstead Co. line represents the 1876 channel. Even comparison of the 1951 quad to the photo-revised 1970 and 1975 maps show areas of 2,000 ft migration in approximately 20 years. Thus, the modern meander belt is not likely to contain prehistoric sites.

Historic

The southern portion of the study area was affected by the Red River Raft. By the early 1800's, the lower Red River was blocked by a series of log-jams known as the "Great Raft." The Red River Raft was a series of log jams nearly 100 miles long which had accumulated on the point bars of the river and formed numerous interconnected river channels in the upper Red River Valley (Figure 8). An account of rafting described by Timothy Flint (1833) is presented in Smith (1982).

The Red River Raft led to the formation of numerous valley margin lakes within the Red River Valley and alluvial valleys of its tributaries (Flint 1833). The raft was an important mechanism for the formation of the large lakes that covered the southern part of the study area during historic time. This study will not examine in detail the history of the raft other than its significance to lake formation as it is beyond the scope of this investigation. Further information about the raft is available from numerous historic accounts and papers (Darby 1816, Flint 1833, Veatch 1906, Caldwell 1941, and Mills 1978).

Poston Lake covered much of the lower study area by the early 1800's as shown by Figure 9 (from Veatch 1906). It is judged that the maximum lake limits for Poston Lake were established during historic time, near the levels indicated by Figure 9. Beneath the limits of raft lakes, lacustrine deposits

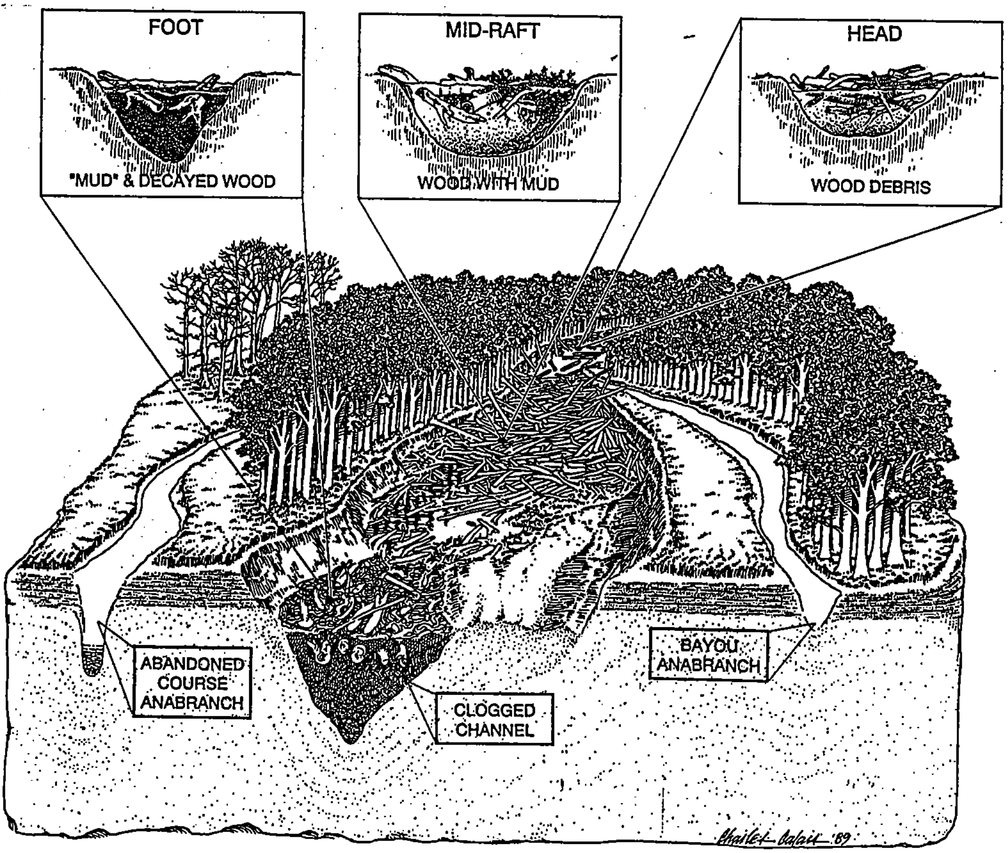

Figure 8. An artist conception of the Great Raft. Note, the overflow anabranch and distributary channels

buried the former floodplain of the Red River. The thickness of these lacustrine sediments was identified about 3.2 ft (0.98 m) (Albertson and Dunbar 1993). Lacustrine deposits may be even thicker, depending on distance from sediment source areas.

After 40 years of intermittent action, removal of the Great Raft was completed in 1873 by the USACE, to make the Red River navigable. Removal of the Great Raft caused the Red River to degrade its channel headward and drained the large lakes such as Poston Lake that had formed behind the raft (Figure 9).

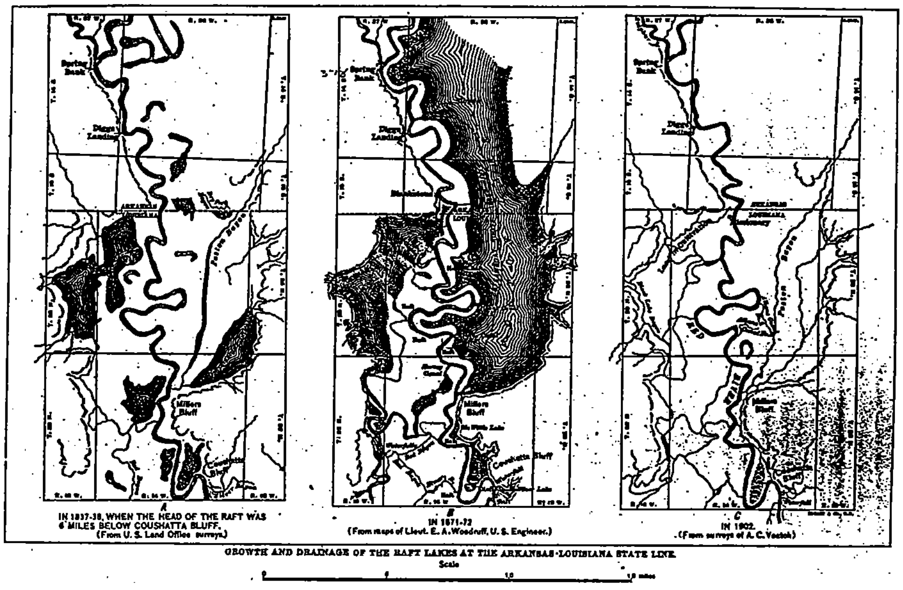

Figure 9. Location and limits of Raft Lake (Veatch 1906)

Formation of raft lakes would have flooded the existing floodplain. The Hrm2 former floodplain with its abandoned courses and channels would have been buried and masked with a veneer of lacustrine sediments. Therefore, this study suggests that existing archaeological sites would have been buried by lake formation, where they are present.

Geomorphic Mapping and Chronology

A geomorphic map (back of the report) was prepared to reflect the geomorphic chronology. The Holocene map units follow the general designations of Saucier and Snead (1989) and Pearson (1982) with addition of detail appropriate to 1:24,000 flood plain mapping for geoarchaeological site prediction. The Holocene flood plain consists of Red River meander belts (Hrm), natural levees (Hrl), and backswamps (Hb). Two meander belts Hrm1 and Hrm2 are identified (Saucier and Snead 1989). Modifying Pearson's (1982) model subunits of Hrm1 are delineated as Hrm1.0, Hrm1.1, and 1.2. The abandoned Hrm2 has surficial expression, but is covered by a mappable thickness of abandonment phase backswamp clay. The Little River has also produced two meander belts (Hlm) and associated natural levees (Hll). Pleistocene deposits Pm (Pd, Pp and Pi) and Tertiary Groups (Tc, Tw and Tm) are delineated but not investigated during this project.

Geomorphic mapping units

HRm. Present and former channel and point bar deposits of Red River meander belts. Surficial deposits range from fine sand to silt loam to clay depending on landscape position in the meander belt topography. Meander belt deposits may be veneered by fine-grained overbank deposits of natural levee, channel fill, swale fill, and backswamp origin. Multiple meander belts are identified. Meander belt 1 has discrete subunits 1.0, 1.1 and 1.2, with locally mappable cross-cutting or accretionary phases. Hrm2 is covered by backswamp clay.

HRl. Natural levee deposits of the Red River associated with overbank deposition near channels. Local crevasse splay and crevasse channel deposits are included within the unit. Sediment textures range from sandy and silty adjacent to channels and grade to silty and clayey in distal areas. Individual natural levees are locally associated with meander belt 1 subunits.

Hb. Backswamp sediments deposited in distal areas of the Red River flood plain. Sediments range from clay to silty clay loam.

HRcc. Crevasse channels deposit of major premonient flood basin channels. Sediment texture ranges from sandy to silty.

HRcl. Natural levee associated with crevasse channels (Hcc). Sediment texture are silty to clayey.

Haf. Alluvial fans associated with small tributaries along the valley wall. Sediment texture varys with sediment supply of the tributary basin.

HLm. Present and former meander belt deposits of the Little River.

HSm. Present and former meander belt deposits of the Sulphur River.

Hu. Undifferentiated alluvium of small streams.

HLm. Present and former meander belt deposits of the Little River. Surficial deposits range from fine sand to silt loam to clay depending on landscape position in the meander belt topography. Meander belt deposits may be veneered by fine-grained overbank deposits. Two meander belts are identified.

Pm. Pleistocene Montgomery Terrace.

Pd. Pleistocene Deweyville Complex.

Pp. Pleistocene Prairie Complex.

Pi. Pleistocene Intermediate Complex.

Tc. Tertiary Claiborne Group.

Tw. Tertiary Wilcox Group.

Tm. Tertiary Midway Group.

6 Significance of Geomorphology to Cultural Resources

Introduction

Objectives

The most important objective of this study was to determine the archaeological significance of the geomorphic features, especially in terms of locating previously undiscovered sites. The major goals of this objective are as follows: identify and define the principal archaeological site/landform associations and classify the landforms according to their site potential; provide guidance for locating sites that are of specific ages or cultural components; and identify areas that have high potential for site destruction or preservation by natural geomorphic processes.

The approach that was used to define the relationships between known archaeological sites and geomorphic features involved identifying the known archaeological sites, evaluating geomorphic site data from the recorded sites, and identifying important characteristics that relate the archaeological sites to geomorphic features. These characteristics were then evaluated to predict locations of undiscovered sites according to their geomorphic context.

It is important to emphasize that the primary purpose of this analysis is to show general relationships between the various landforms that comprise the study area and archaeological sites contained within this area. This study is **not** meant to be an archaeological analysis, but rather to reveal trends of geoarcheologic preservation.

Procedure

Archaeological site data were obtained from the Environmental Resources Branch (PD-Q), CELMK, Coastal Environments Inc., and published reports for Arkansas Archeological Survey. There are 324 known archaeological sites in the Great Bend region. The database of all known sites includes characteristics that were compiled from the geomorphic maps and site descriptions. These characteristics are site number, site name, quadrangle map, cultural components, diagnostic artifacts, site description type (i.e. surface scatter, ceramics, historic debris, etc.), and size. Because of their sensitivity, the locations for the known archeological sites are not individually identified on the geomorphic maps. The sites locations along with the previous characteristics were entered into the GIS database for analysis. Using overlay comparisons, relationship of sites to landforms and meander belts were analyzed spatially and temporally by cultural component. The GIS analysis treats sites which occur on two or more landforms as two or more sites.

Use of geographic information system in cultural resource assessment

A geographic information system (GIS) is a powerful tool used to manage and manipulate geographically referenced data and information. Software and hardware GIS packages vary in analytical capabilities and database structure. The decision of which one to use is based on the type and amount of data, the desired product, and the GIS format. To construct the Red River GIS and database, ARC/INFO 7.0.2 was used. The interchangeable format between ARC/INFO Unix and ARC/INFO PC was considered essential in view of the fact that the GIS will be used as a management tool.

The framework for the GIS consists of various coverages that can best supply answers to proposed queries. Coverages refer to a GIS map and represent only one of them. Each theme must be assigned attributes or information that pertain to a particular feature. For example, an archeological site is digitized into the database as a polygon. Attributes, such as cultural affiliation, occupation, and chronology, can then be assigned to form a data structure. Until this information is added, the coverage has little value in the GIS.

The intent of the GIS is to provide support both in interpretation and maintenance of pertinent data concerning cultural resource assessment. The major analysis technique will be the combination or linkage of data layers to analyze or display spatial queries. For example, archeological sites, elevation, and geomorphology may be combined to locate sites situated on a selected landform occurring at a determined elevation. Predictive modeling based on established facts can then aid in future cultural resource investigations and management. By understanding the environment, i.e. geology, geomorphology, and soils, of known sites, the GIS is able to locate potential areas containing these same parameters.

Data in the GIS exists in either raster or vector format. Raster data is a cellular data structure composed of rows and columns whereas vector data is a coordinate-based data structure used to represent linear map features (ESRI 1994). In raster data, attributes are associated with each grid cell but in vector data, attributes are assigned to each feature. Both played an important role in construction of the Red River GIS.

The following is a list of digital databases assembled for the project:

a. Raster maps.

  (1) Topography.

  (2) Aerial photography.

b. Vector maps.

  (1) Geomorphology.

  (2) Geology.

  (3) Soils.

  (4) Elevation.

  (5) Levees.

  (6) Archeological sites.

  (7) Geochronology.

  (8) Borings.

  (9) Surface water.

The GIS can be queried based only on attributes assigned to the above coverages and linkage between the coverages. When planning a GIS, the purpose of the project supports the queries and is considered when constructing a GIS. It is possible, however, that future projects may require additional information to support different objectives. Additional attributes for existing coverages can be added or new links between coverages can be established. New coverages can also be added if needed. The following questions are just a few examples the Red River GIS is capable of answering at this time:

a. On what type of landform is a particular archeological site situated?

b. What is the minimum and maximum elevation of an archeological site?

c. What is the lithology of a particular geologic formation?

d. What is the chronology and area of a particular archeological site?

e. What percentage of archeological sites are situated a given distance from a levee?

Data requirements for cultural resource assessment

Many factors contribute to preservation or destruction of archeological sites and each must be considered for proper management of these resources. Fortunately, the scope of the project included field interpretation as well as analyses from available data. An initial reconnaissance of the study area determined that the management system needed to be based on geomorphology, geology, soils, elevation, levees, and mapped archeological sites. Interpretation of aerial photography and further field investigations provided verification of previous data. In the following paragraphs, these data are discussed in terms of their source and characteristics.

Geomorphology. Field investigations and aerial photography provided the interpretation for the geomorphology theme. A soil auger was used to retrieve samples at various depths throughout the study area. Sampling locations were chosen to confirm previous interpretations and to clarify conflicting analyses. A boring log was then constructed from soil sample descriptions. Each feature was digitized as a separate polygon and then assigned attributes. Previous geomorphological mapping by Smith and Russ (1974) and existing boring data were considered in this interpretation. Geomorphologic interpretation was discussed in Chapter 3.

Geology. This data coverage consists of the geology. The 1:62,500 scale map was scanned using a Tangent Drum Scanner to ensure a more accurate digitization of features. Geologic age, formation name, and feature type were included in the data structure.

Soils. Soil information was taken directly from existing 1:20,000 county soil maps generated by the U.S.D.A. Soil Conservation Service (1984 and 1979) for Miller and Hempstead Counties. In order to provide an accurate overlay of this map to other coverages, the soil information was referenced using the Red River course from the topographic map discussed below.

Elevation. Elevation was digitized from the 7.5 min (1:24,000) USGS topographic quadrangles. The area covered by the terrace (Pi) was not considered essential in the interpretations and, therefore, was not included in the data.

Levees. The levees were included in the database as a significant feature. In addition, a buffer reflecting the right-a-way was included. In this way, project specific queries relating to engineering impacts can be made.

Archeological sites. Coastal Environments Inc. provided location and descriptive data on archeological sites in the southern portion of the quadrangle. Additional locations can be added to the database as they are acquired.

Archaeological site definition

An *archaeological site* was defined as a location where artifacts have been found. This definition of a site does not differentiate sites of settlements. That is, a site can be a location where settlement has occurred, or it can be a location that was occupied only once and artifacts were left. This nonrestrictive definition is used because of the nature of archaeological site data. For some sites, exact locations or other important information in the site descriptions are missing or the data are wrong. In addition, it is possible for a single large site to be represented in the record as multiple sites that were recorded at different times by different individuals or organizations.

The primary objective of using the archaeological site data is to show the general relationships between the prehistoric sites and the landforms. It will be left to the archaeologists to interpret information about the site beyond its geomorphic characteristics. It is important to emphasize that the site catalogue has not been field checked. Basic trends are defined about the landforms by the archaeological site data in this section of the report.

Characteristics of an archaeological site

Artifacts that make up the archaeological site have by their distribution and position within the site certain temporal and spatial qualities. These qualities are defined by geographic, stratigraphic, and ethnographic characteristics of the artifacts (Gould 1987).

The stratigraphic and geographic characteristics describe physical qualities about the site itself. Geographic characteristics describe the spatial context between artifacts and their relationships to other artifacts and their environment. Stratigraphic characteristics define the temporal or chronological order of the artifacts and relate these characteristics to the site occupation. Defining the geomorphic setting of the site is an important first step in evaluating geographic and stratigraphic characteristics of the site.

This study describes mainly the geographic (environmental or geomorphic) characteristics of the known archaeological sites. The identification of the site geomorphology is important to understanding the overall site archaeology, since the different landforms are dominated by certain types of geomorphic processes. These different kinds of processes will affect or control the distribution of the archaeological sites and the associated artifacts.

Stratigraphic or chronological characteristics of individual archaeological sites are not fully addressed by this study. The geomorphic analysis provided by this investigation will provide a general stratigraphic or chronological framework to evaluate the individual sites. A more detailed evaluation of individual sites will require the acquisition and analysis of further soil borings from the landforms on which individual sites are located. Soil borings will identify important sedimentological and soil forming characteristics and may provide datable materials for further determining chronological boundaries.

The last major criteria of an archaeological site are the ethnographic characteristics. These characteristics are determined by the archaeologist. The ethnographic characteristics of the artifacts and the site are concerned with human qualities of the site. Ethnographic characteristics relate human occupation to their associated activities and to the different types of cultures. However, before ethnographic characteristics can be fully understood, the geographic and stratigraphic characteristics must be fully defined and evaluated.

Distribution of Known Archaeological Sites

Landforms

The distribution of prehistoric sites as a function of the different landforms in the study area on which the sites are located is presented in Figure10. Approximately 6 percent of the known archeological sites are located above the floodplain on valley slopes or bluffs. The remaining 94 percent of the sites are associated with the floodplain of the various fluvial components which form the study area. Many (46 percent) of floodplain sites are located adjacent to crevasse channels. Other known archaeological sites are primarily located upon natural levee or point bars adjacent to the Hrm1.1 and Hrm1.2 channels or on the Hrm2 surface. Additional sites on the Hrm2 surface in this river reach may be buried by vertical accretion of sediment.

Distribution of cultural components

Available archaeological site data for the purpose of this study were divided into cultural component types: Paleo, Archaic, Fourche Maline, and Caddo. Figure 10 displays the distribution of the culture component across the landscape. Historic sites were not evaluated in this study as prehistoric sites are the primary focus of this investigation and because other factors may govern the distribution and occurrence of historic sites. Historic sites are best defined and evaluated by conducting a detailed historic assessment and inventory of the study area. The Caddo culture ranges from approximately 1,000 to 150 years BP. Fourche Maline culture ranged from 2,500 to 1,000 years BP. Archaic sites in the southeastern United States generally range from approximately 9,000 to 2,500 years BP. Paleo Indian sites are older than 9,000 years BP. The table in Appendix B indicates that some sites contain multiple occupations. Sites that are identified as multiple occupations (i.e. Paleo, Archaic, Fourche Maine and/or a Caddo) are located along Finn Bayou and Red Chute (Hrm2).

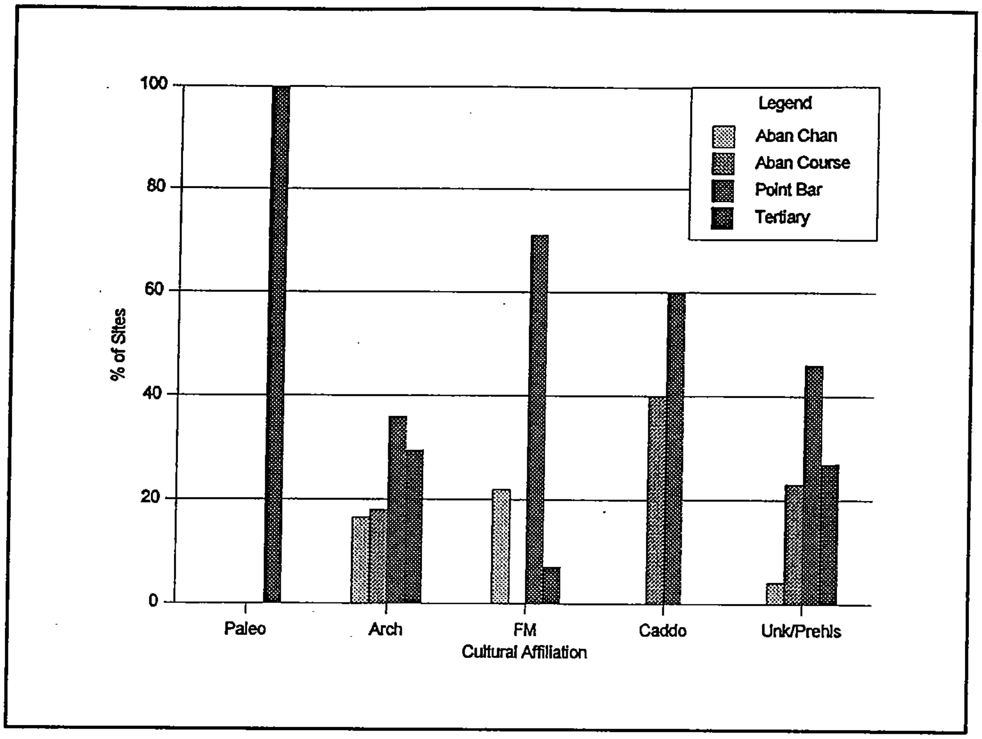

Figure 10. Distribution of archaeological sites by landform

Paleo sites

Four sites contain Paleoindian artifacts. These sites are located primarily on Buzzard Bluff (Tw). Three PaleoIndian sites are located on Tertiary deposits (Figure 10), and the other is located along a crevasse channel.

Archaic sites

One hundred eighty sites or 55 percent (GIS) contained Archaic artifacts. Approximately 8 percent of the known Archaic sites are located upon the summit or slopes (Figure 10). The remaining sites (92 percent) are located on the floodplain. Archaic sites are primarily found on crevasse channels (Hcc) and the Hrm2 meander belt. Apparently, the entire landscape was utilized by the Archaic cultures. Additional archaic sites may be concealed in the older floodplain (Hrm2) due burial by vertical accretion.

Fourche Maline Sites

One hundred fifteen of the known sites or 35 percent (GIS) contained Fourche Maline artifacts. Fourche Maline sites (5 percent) have been located on Tertiary units. The other 95 percent of sites are primarily located on the flood plain. Sixty-six percent are along meander belts; Hrm2 (8 percent), Hrm1.2 (30 percent) and Hrm1.1 (22 percent). Other sites are located along crevasse channels (31 percent) (Figure 10). Fourche Maline culture seems to have habituated across the landscape, using both upland and floodplain sites. The potential of additional sites existing beneath vertical accretion deposits is very real. For example, a Fourche Maline site (3LA25) was buried to 1.5 m (Schambach 1982).

Caddo sites

One hundred twenty-four known sites (Appendix B) or 38 percent (GIS) contain Caddo culture components. The sites located along Hrm1.2 meander belt features comprise 45 percent. Caddo sites are located along Hrm1.2 and comprise 33 percent in the Great Bend region. Late Caddo sites also exist along the modern meander belt Hrm1.0 (Pearson 1982).

Prediction of Site Occurrence

The distribution of the known archaeological sites as identified in the preceding illustrations indicates that sites are not random, but are clearly associated with specific landforms in the project area. Geomorphic relationships identified for the known sites can be used to locate and interpret previously undiscovered sites and guide the subsequent archaeological analysis of the individual sites and the entire study area. Geomorphic relationships identified by this study should help to improve the efficiency of later cultural resource investigations in the project area and maximize the results obtained. In addition to locating undiscovered sites, geomorphic relationships will aid the archaeologist in defining the ethnographic site characteristics. Considering the distribution of known sites, expected site distribution is presented in Table 3.

Artifacts are most likely to be encountered on the natural levees of abandoned channels associated with the Hrm2, Hrm1.2 and Hrm1.1 courses. Artifacts may be located either on these landform surfaces or as part of the sediments that form these landforms. Lack of sites upon the older floodplain surfaces may be due to vertical accretion of sediment. Further investigations on the Hrm2 surface in the Finn Bayou segment is probably needed. Geomorphic data indicates that possible some abandoned channels and courses comprising this surface may possibly have formed during the early Holocene. Archaeological site data may provide additional evidence to the age of the various floodplain components. Backswamp veneers over older meander belts have possible potential for buried sites.

Summits (Tc, Tw and Tm) and terraces (Pp and Pi) have the high potential for surface sites. Because Tertiary summits and slopes, and Pleistocene terraces are stable to erosive landforms, buried sites are not to be expected.

Table 3
Expected Distribution of Cultural Resources by Meander Belts

Map Unit	Surface Culture	Buried Culture, <2m	Buried Culture, >2m
Hrm1.0	No	No	No
Hrm1.1	Yes	Possible	Doubtful
Hrm1.2	Yes	Probable	Possible
Hrm2	Yes	Probable	Possible
Hrl1.1	Yes	Possible	Doubtful
Hrl1.2	Yes	Probable	Possible
Hb	Possible	Doubtful	Doubtful
Hc	Yes	Probable	Possible
Hlm1	Yes	Yes	Possible
Hlm2	Yes	Yes	Possible
Pm, Pd, Pp, Pi	Yes	Doubtful	No
Tc, Tw, Tm	Yes	Doubtful	No

Site Preservation and Destruction

In the project area, a number of processes are or have been at work either preserving or destroying the evidence of prehistoric groups. Most evidence of these processes are the result of historic man, such as cultivation of the soil, timbering, construction of roads, buildings, and levees, and removal of the Red River Raft. However, natural processes have also played a key role in the preservation or destruction of the archeological record. Some geomorphic processes, such as lacustrine sedimentation or fluvial sedimentation, may serve to preserve the record through burial. Erosional processes may destroy sites by redistribution or destruction of the surfaces where sites occur. In the following paragraphs, the archeological significance of several processes is discussed, including fluvial sedimentation, chemical weathering, and fluvial scouring.

Fluvial sedimentation and site preservation

An understanding of fluvial sedimentation rates is important in evaluating artifact decay and preservation characteristics. Knowledge about sedimentation rates is also important in understanding the stratigraphic or chronological significance of the archaeological record. Rapid sedimentation will promote the preservation and superposition of artifacts and features that result from serial occupation of sites (Ferring 1986). In contrast, slow sedimentation rates will result in the accumulation of archaeological debris as mixed assemblages and increase the potential for artifact decay by chemical and physical causes.

It is therefore important to understand, at least in general terms, local sedimentation rates to address the potential for site preservation and the types of sites that will be preserved. Sedimentation rates in the project area were interpreted from geomorphic evidence and are based on field observations and analysis of the available data. Guccione (1994) published sediment rates for the Item 2 and 3 area. She found 3 cm per year in a decade scale for proximal natural levee, 0.3 cm per year on a decade to century scale for distal natural levees, and .003 cm year on a century to millennium scale for backswamp. Careful application of sediment rates requires thinking about both the temporal and spatial location of the site. Sedimentation is a function of distance to the active channel and episodic overbank deposition.

Geomorphic Evidence and Archaeological Significance of Sedimentation Rates

Geomorphic evidence and sedimentation model

Geomorphic mapping and published data were the principal means of determining sedimentation rates in the study area. Types of evidence include sedimentary structure, soil profile development, bioturbation, and fossil preservation. The types of evidence and a general knowledge of the different processes operating within each landform make it possible to estimate sedimentation rates for the landforms identified in Table 3.

Sedimentation rates in the study area must be considered in terms of the present day and when the landform was formed. Erosion and sediment transport are occurring throughout the project area. Sedimentation rates on the Red River floodplain area also considered to be high, estimated at approximately 3 ft (1 m) per 1,000 years (Smith 1982). In addition, sedimentation because of the Red River Raft accelerated the aggrading of the Red River in the southern portion of the project area by adding 3 to 4 ft (0.91 to 1.22 m) of lacustrine sediment during the past 500 years (Albertson and Dunbar 1993). In contrast, the lowest sedimentation rates occur on the terraces and backswamp areas removed from semiannual flooding. Valley slopes and summits are mainly locations of weathering and erosional processes.

The site preservation and destruction characteristics of the different landforms, as a function of sedimentation, are evaluated for different types of archaeological artifacts in Table 3. The artifacts examined in Table 3 are animal bones, shell, charcoal, ceramics, crystalline lithics, and granular lithics. The different landforms were evaluated according to their ability to enhance preservation or accelerate decay. The interpretations made in Table 3 are based on the deterioration of archaeological sites primarily by chemical weathering in a humid environment with the main preservation influence by burial from fluvial sedimentation.

Discussion

Preservation and destruction qualities of landforms are site dependent and are based on a number of interdependent variables. These variable include soil pH, soil moisture, wet aerobic or anaerobic environments, types of microorganisms and macroorganisms present, sediment movement, and soil loading. The relationships between these variables are very complex. They can vary slightly and result in different decay properties for the different artifact types. Hamilton (1987), Steele (1987), Vaughn (1987) and Mathewson and Gonzales (1989), describe the effects that each of these variables has on artifact deterioration in archaeological sites. The majority of artifacts identified in the archaeological site descriptions are lithics. These artifacts are least affected by chemical and physical weathering as shown by Table 4.

Chemical weathering promotes the decay of bone, shell, charcoal, and pottery. Stone artifacts are not affected. With increasing sedimentation and burial, artifact preservation is greatly enhanced as burial reduces the rate at which chemical weathering occurs. Archaeological sites are most threatened on the summits and on the side slopes where sedimentation rates are very low or where erosion is the dominant process.

Archaeological sites are more likely to be protected adjacent to or near the main channel where maximum sedimentation and burial occurs. Sites that are in close proximity to the main channel and not in the direct path of lateral migration by the river are buried by vertical accretion. Other factors to be considered in a discussion of artifact preservation and decay for geomorphic systems include flooding effects, groundwater movements, and fluvial scouring. Flooding can accelerate artifact decay by altering the chemical and physical processes normally operating. Artifacts may be affected by groundwater movements and associated chemical reactions between the groundwater. Terraces are especially affected by groundwater movements as they are composed primarily of unconsolidated sediments and are hydraulically connected to the main channel. Other indirect and potentially adverse effects of flooding on archaeological sites include riverbank caving following a rapid river drawdown.

There are no strict rules governing archaeological site preservation or destruction as a function of the respective landforms and associated geomorphic processes. Various trends or generalizations that have been identified above can be used as guidelines in evaluating the archaeological significance of the different landforms. Specific areas or individual archaeological sites should be examined and evaluated on the merits of each site.

Table 4
Geomorphology of the Red River Levee Rehabilitation Project Area

Surface	Landform - Formation	Age[1]	Geomorphic Process[2]	Rate[3]	Archaeological Artifacts[4]					
					AB	SH	CH	CE	CL	GL
Floodplain	Point bar (Hrm1)	H	LA	M-R	B	B	B	B	N	N
	Point bar (Hrm2)	H	LA-VA-BT-SF	M	B	B	B	B	N	B
	Raft Lake/Backswamp	H	VA	M-R	E	E	A	E	N	N
	Abandoned course	H	LA-VA	M	E	E	A	E	N	N
	Abandoned channel	H	LA-VA	M	E	E	A	E	N	N
	Natural levee (Hrl1)	H	VA	M-R	A	A	A	A	N	N
	Natural levee (Hrl2)	H	VA-BT-SF	M-R	A	A	A	A	N	N
Terrace	Abandoned floodplain (Pi)	P	E-SF	L	A	A	A	A	N	N
Bluffs and slopes	Tertiary geology, (Tw) Wilcox group	T	E-SF	L	A	A	A	A	N	N

[1] Age: H = Holocene, P = Pleistocene, T = Tertiary.

[2] Geomorphic process: VA = Vertical accretion, LA = Lateral accretion, SF = Soil forming processes (Pedogenesis), BT = Bioturbation (organic mixing by vegetation and organisms), E = Erosion.

[3] Rate of deposition: L = Low, M = Medium, R = Rapid.

[4] Archaeological artifact: AB = animal bones, SH = shell, CH = charcoal, CE = ceramics, CL = crystalline lithics, GL = granular lithics, A = accelerates decay, E = enhances preservation, B = both; may accelerate decay or enhance preservation, N = neutral or no effect.

7 Summary and Conclusions

Geomorphology

Geomorphic mapping has identified three primary landform surfaces (i.e. bluffs, terraces, and the floodplain) which are further subdivided according to environments of deposition or underlying parent geology. Bordering the floodplain of the different fluvial systems in the study area are topographically higher Pleistocene terrace and valley slopes composed of Tertiary age sediments. Three Pleistocene age terraces were identified and mapped adjacent to the main Red River Valley. The major floodplain environments of deposition, point bar, abandoned channel, abandoned course, backswamp, and natural levees, were identified or mapped as a separate environments of deposition.

The development of the study area began during the late Tertiary and early Pleistocene. Fluvial downcutting and lateral migration by the various stream courses have created a well-defined alluvial valley and floodplain. Terraces are situated along the valley walls, midway between the Tertiary uplands and the floodplain. Geomorphic data and published works (Russ 1975, Pearson 1982, and Saucier and Snead 1989) indicate two to three meander belts in the study area. The older meander belt Hrm2 surface may extend in age from approximately 4,000 years BP to possibly the middle Holocene. The intermediate meanders (Pearson 1982), designated Hrm1.2 in this report, are possible 4,000 to 1,200 years BP. Meander belt Hrm1.1 is estimated to represent 1,200 to 200 years BP. The modern meander belt (Hrm1.0) is approximately 200 years BP to present.

Formation of the Red River Raft during the late prehistoric and early historic time blocked channel flow on the Red River and created a series of large lakes. Poston (see on Figure 11) and Swan lakes were formed as a result of the raft. Historic and geomorphic data indicates that the lakes were formed less than 500 years ago.

Archaeological Significance

Historic archaeological sites were not evaluated by this study. The majority of prehistoric archaeological sites are located on terràces and valley slopes and former abandoned channels adjacent to Finn Bayou.

It is probable that sites may be buried beneath vertical accretion. Vertical accretion processes operation throughout the Holocene could have buried site to 10 ft (3.05 m) based on similar sites reported for the Red River Valley (Smith 1982).

Caddo sites generally correlate with natural levee deposits associated with the meander belts. These sites are located upon natural levees of abandoned channels and courses connected to the Hrm1.1 and Hrm2 meander belts.

Archaic sites are concentrated mainly along crevasse channels and the Finn Bayou course. Additional Archaic sites within the floodplain may be buried by vertical accretion of sediment and/or the landforms which comprise the floodplain may be younger at some locations. The potential for archaeological sites at the surface and in the subsurface in the Finn Bayou area is considered to be very favorable. Surface and buried sites are highly probable for Hrm2 and Hrm1.2 surfaces. Other locations occur in close proximity to crevasse channels.

Existing data suggest that the different floodplain components may extend into the late Holocene. Exact chronological boundaries are not possible with the limited data presently available. The archaeological record may provide additional evidence to determine more specific chronological boundaries and ages for the various floodplain features.

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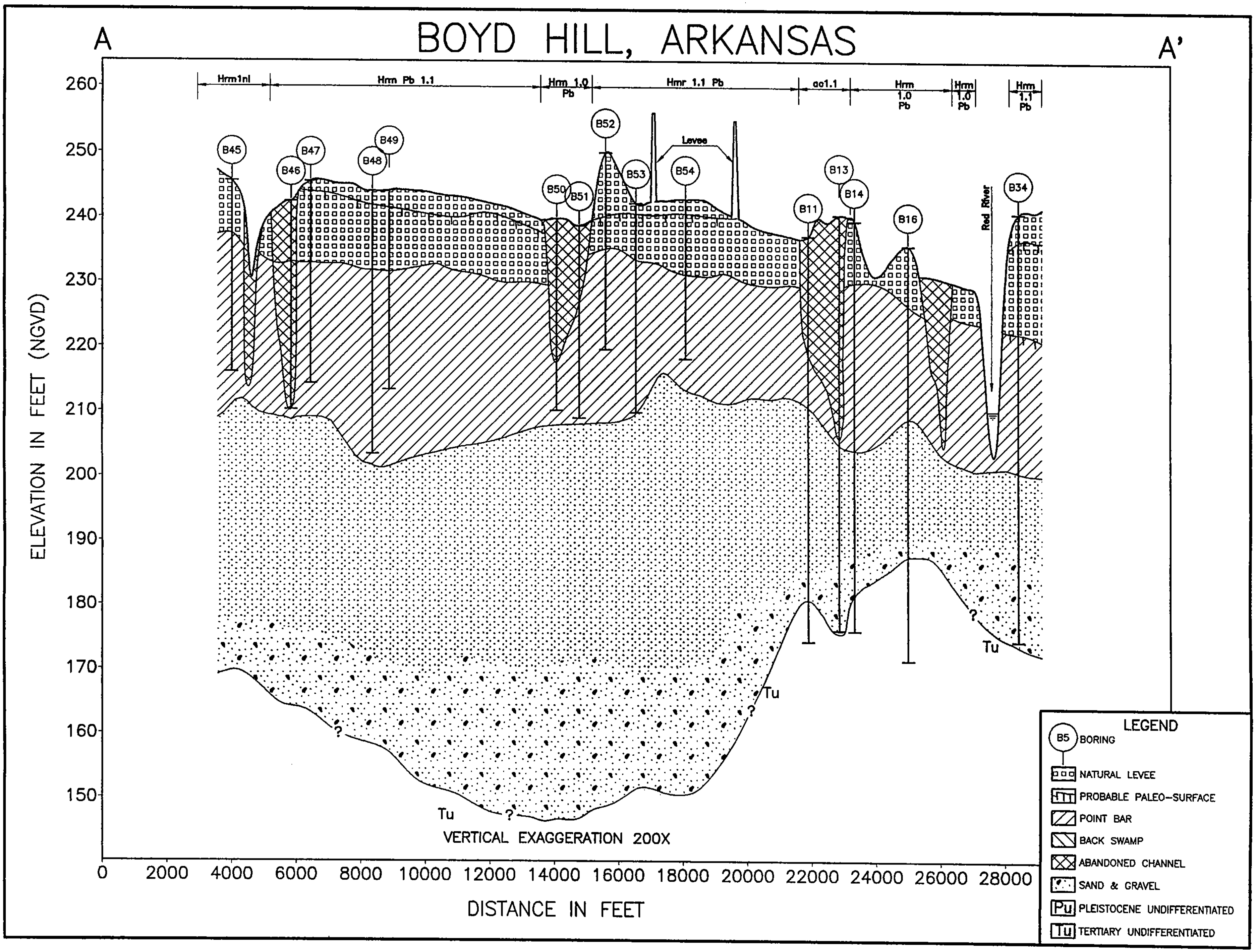

BOYD HILL, ARKANSAS
A
A'
Hrm1nl
Hrm Pb 1.1
Hrm 1.0 Pb
Hmr 1.1 Pb
ao1.1
Hrm 1.0 Pb
Hrm 1.0 Pb
Hrm 1.1 Pb
Levee
Red River
B45
B46
B47
B48
B49
B50
B51
B52
B53
B54
B11
B13
B14
B16
B34
Tu
?
VERTICAL EXAGGERATION 200X
ELEVATION IN FEET (NGVD)
260
250
240
230
220
210
200
190
180
170
160
150
DISTANCE IN FEET
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
22000
24000
26000
28000
LEGEND
B5 BORING
NATURAL LEVEE
PROBABLE PALEO-SURFACE
POINT BAR
BACK SWAMP
ABANDONED CHANNEL
SAND & GRAVEL
Pu PLEISTOCENE UNDIFFERENTIATED
Tu TERTIARY UNDIFFERENTIATED

Plate 1

BOYD HILL, ARKANSAS

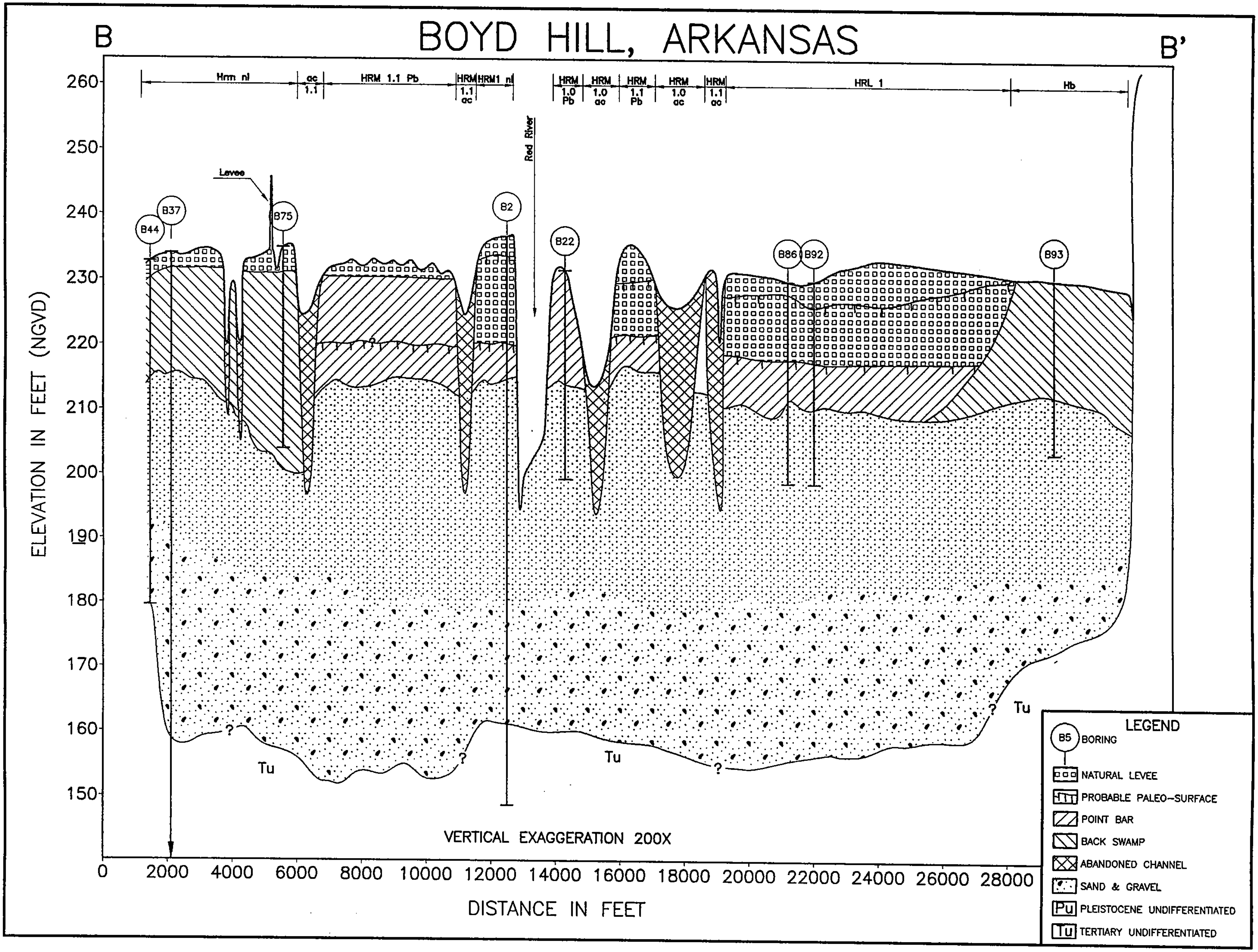
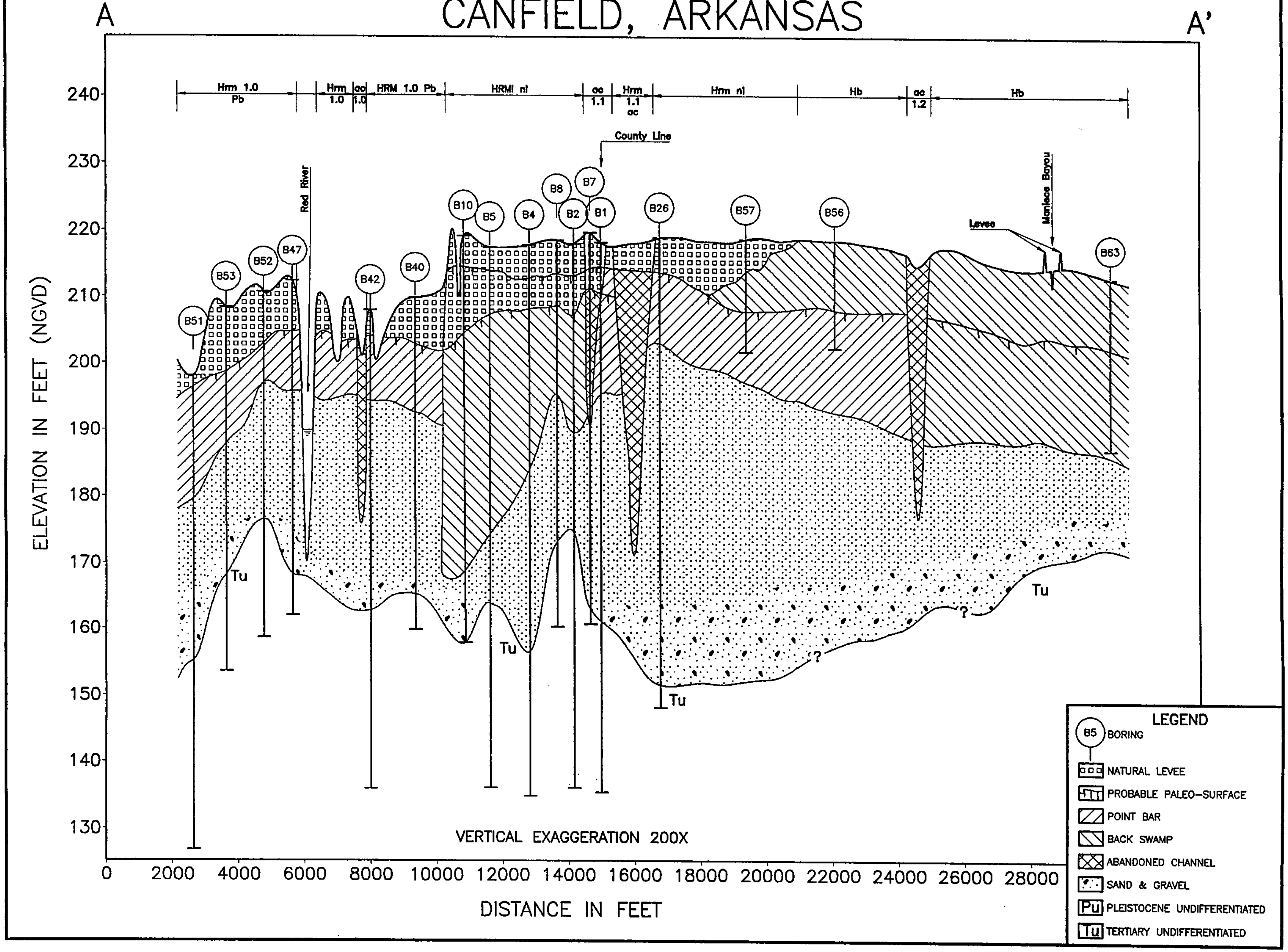


Plate 2

CANFIELD, ARKANSAS



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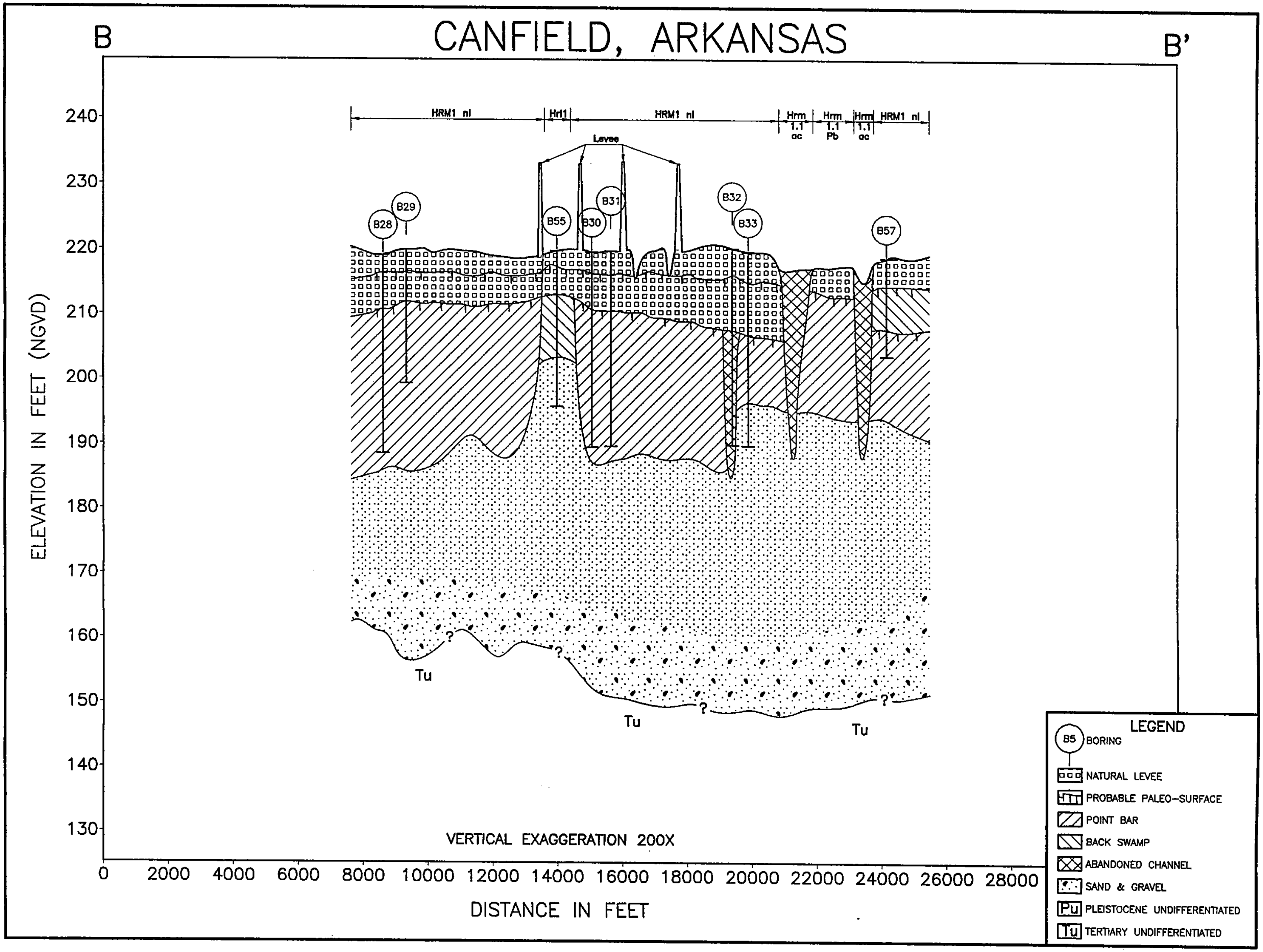
B
CANFIELD, ARKANSAS
B'
HRM1 nl
Hrl1
HRM1 nl
Hrm 1.1 ac
Hrm 1.1 Pb
Hrm 1.1 ac
HRM1 nl
Levee
B28
B29
B55
B30
B31
B32
B33
B57
Tu
Tu
Tu
ELEVATION IN FEET (NGVD)
240
230
220
210
200
190
180
170
160
150
140
130
VERTICAL EXAGGERATION 200X
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2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
22000
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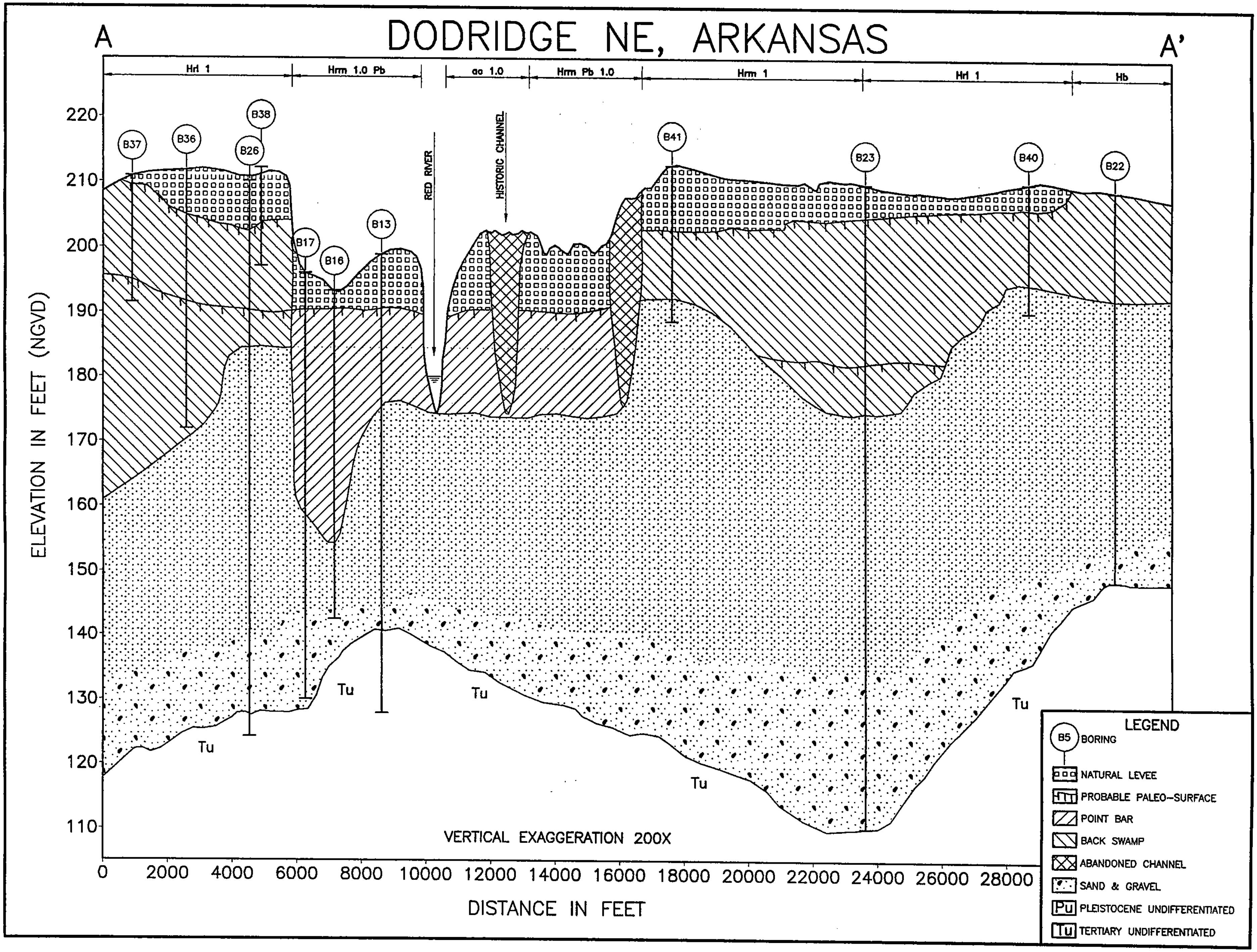
26000
28000
DISTANCE IN FEET
LEGEND
B5 BORING
NATURAL LEVEE
PROBABLE PALEO-SURFACE
POINT BAR
BACK SWAMP
ABANDONED CHANNEL
SAND & GRAVEL
Pu PLEISTOCENE UNDIFFERENTIATED
Tu TERTIARY UNDIFFERENTIATED

Plate 4

DODRIDGE NE, ARKANSAS



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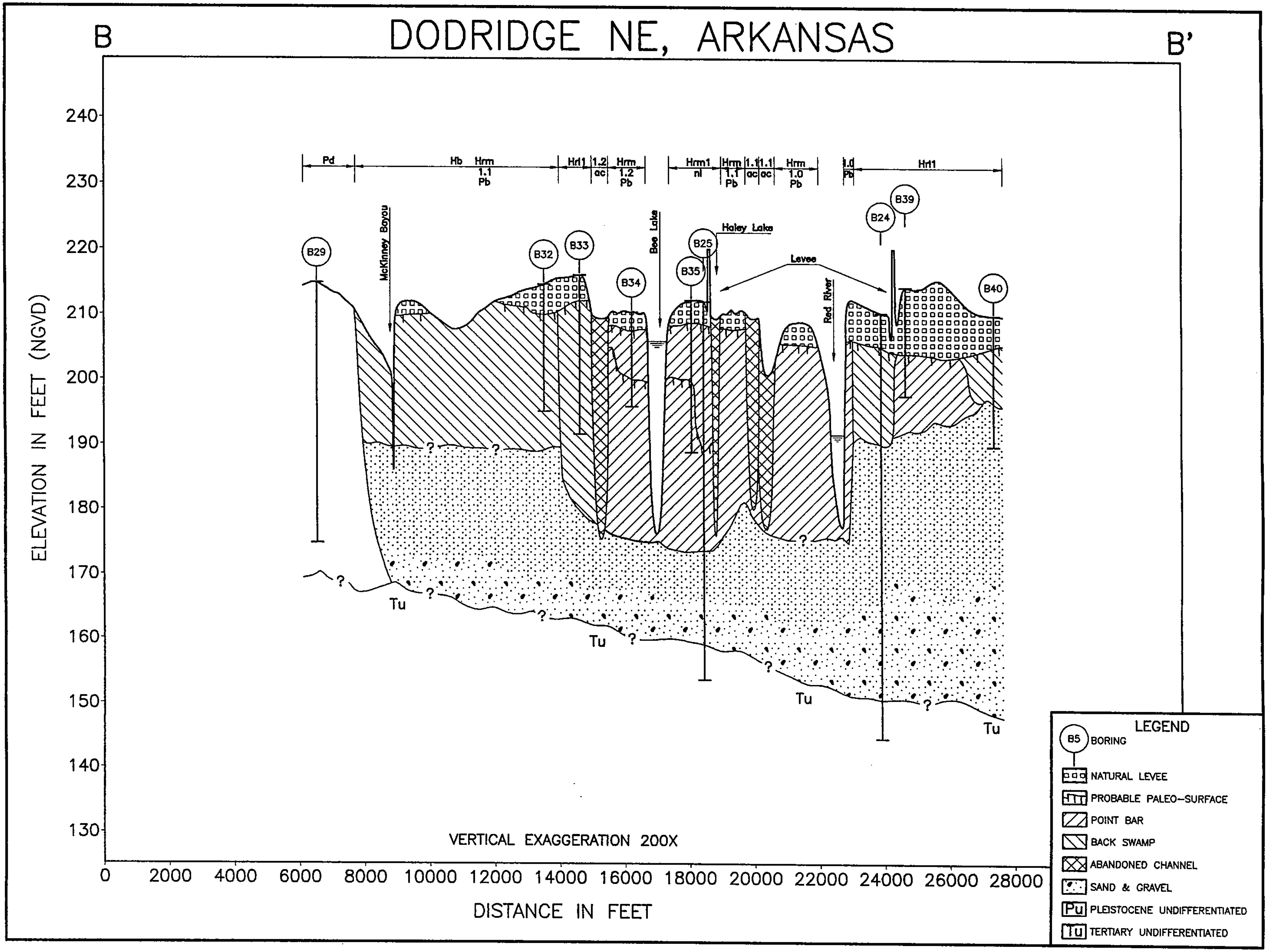
DODRIDGE NE, ARKANSAS



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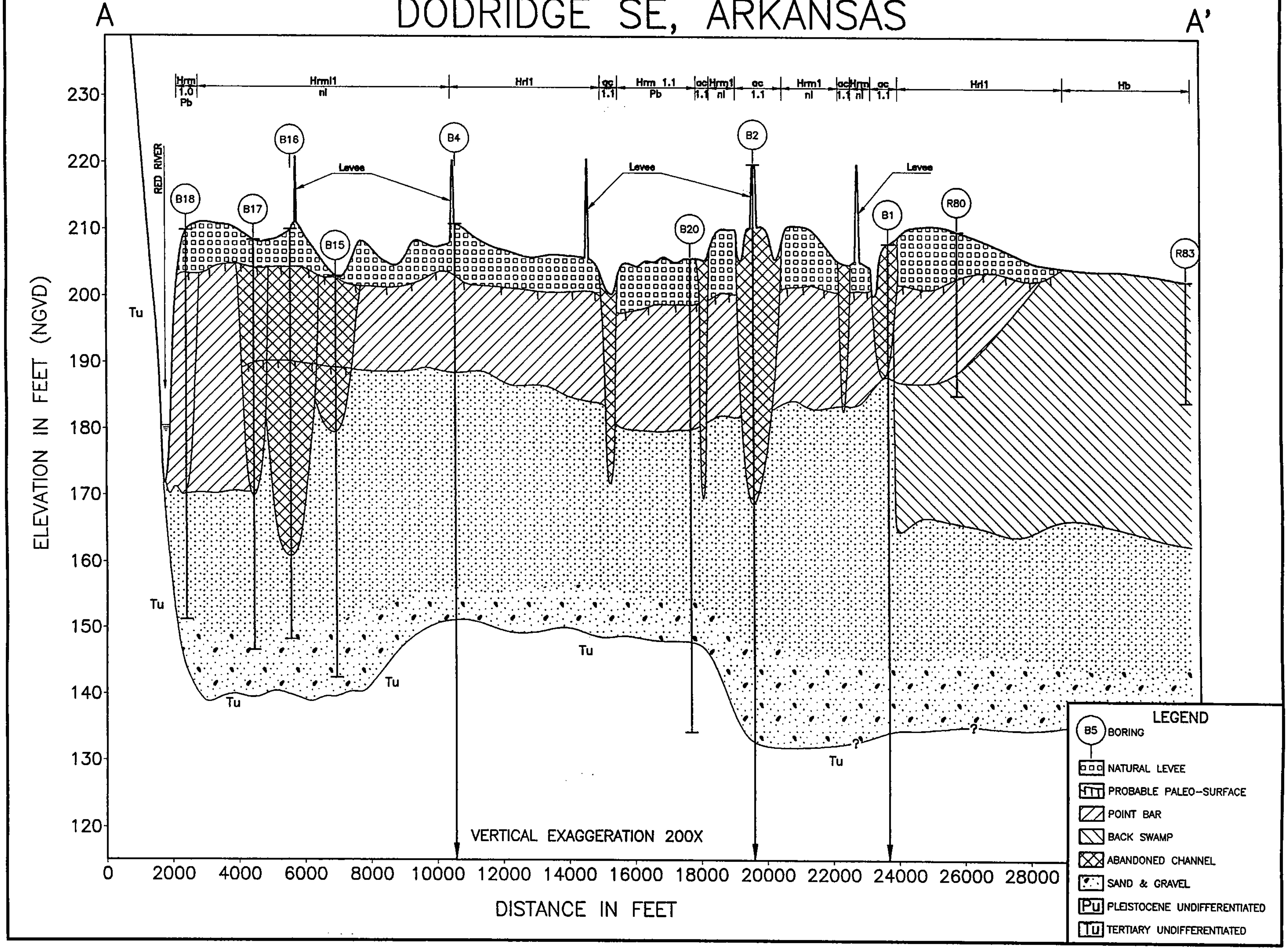

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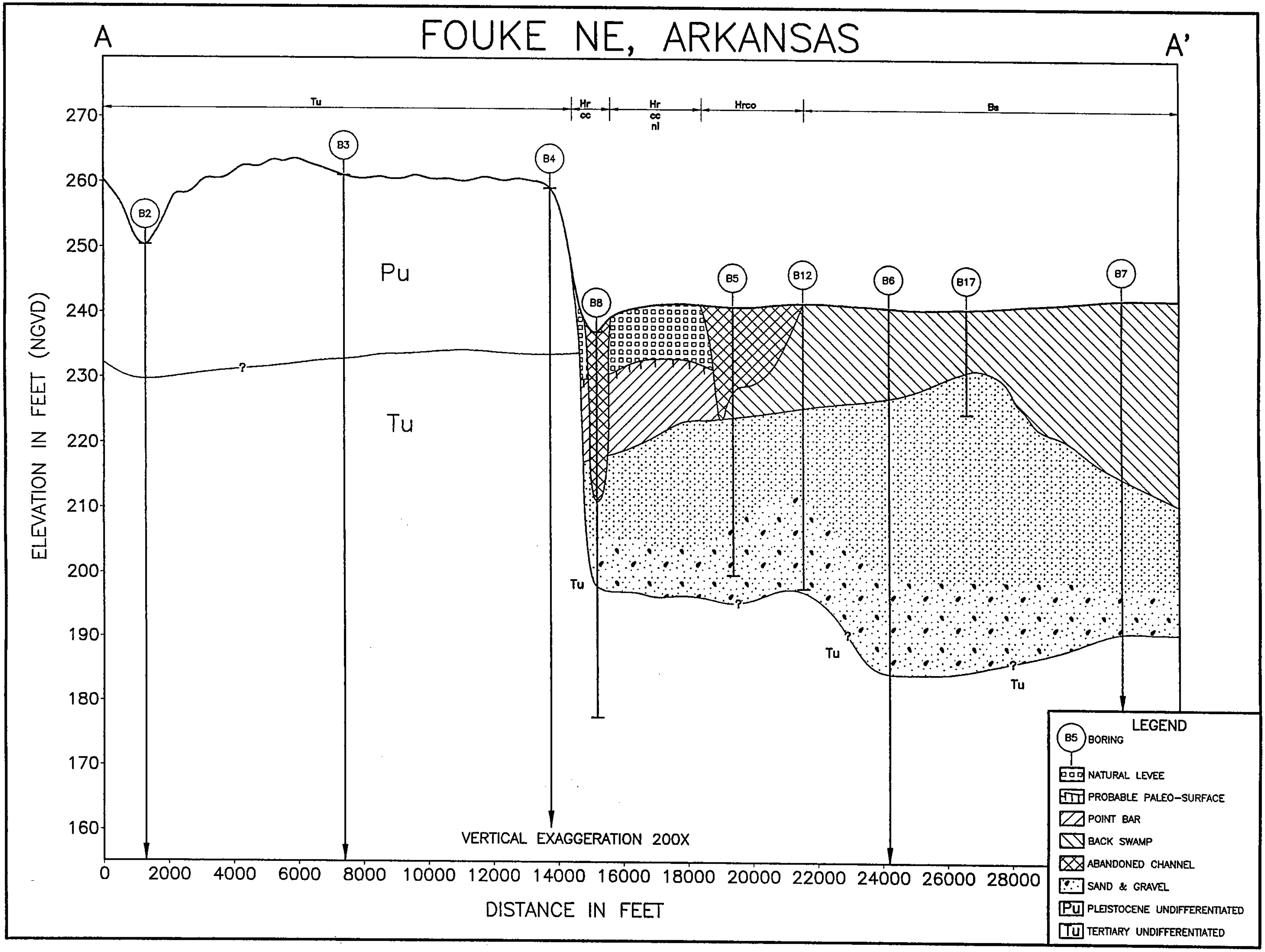
FOUKE NE, ARKANSAS



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FULTON, ARKANSAS

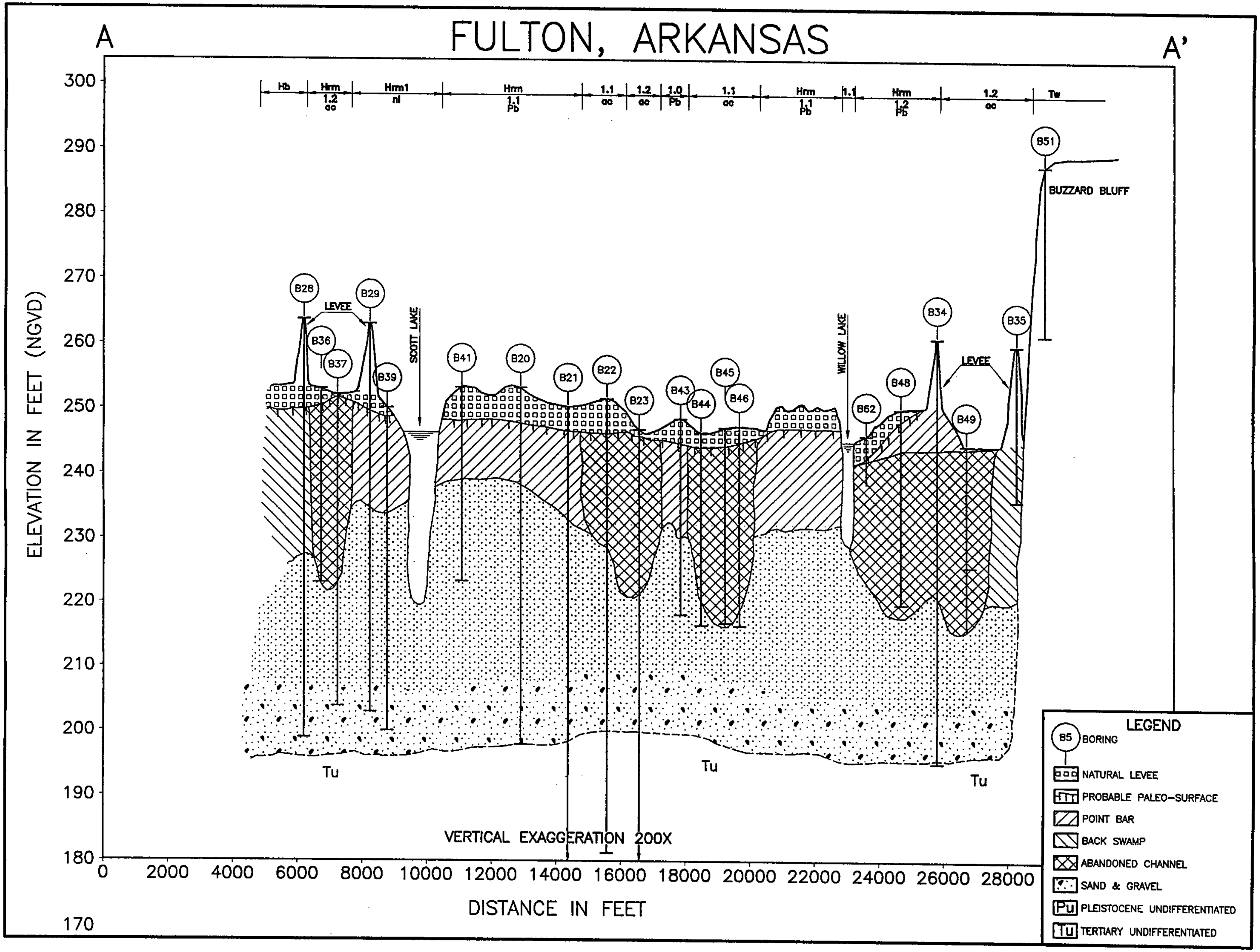
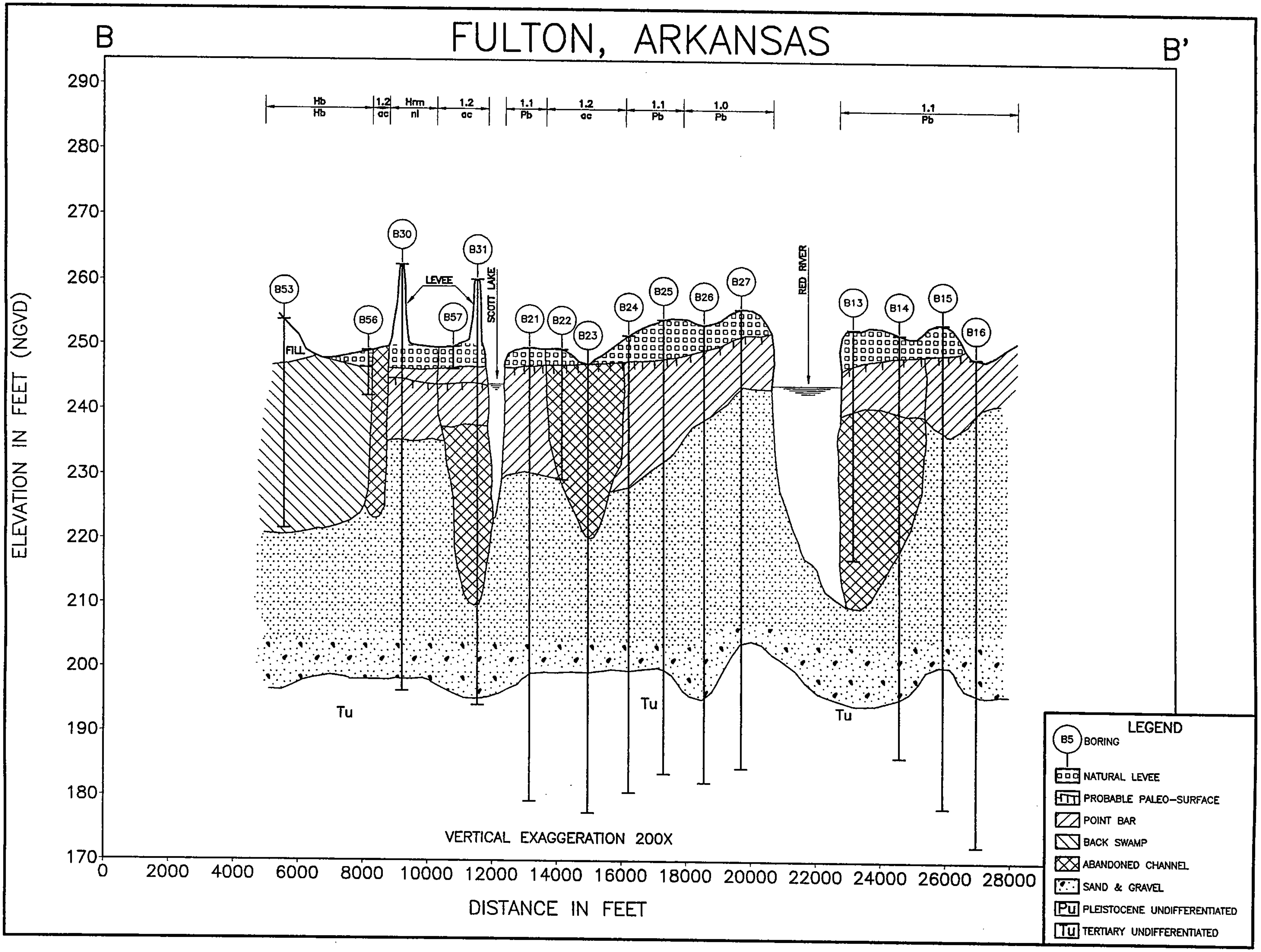


Plate 9


B
FULTON, ARKANSAS
B'
Hb
Hb
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ac
Hrm
nl
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ac
1.1
Pb
1.2
ac
1.1
Pb
1.0
Pb
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Pb
B53
FILL
B56
B30
LEVEE
B57
B31
SCOTT LAKE
B21
B22
B23
B24
B25
B26
B27
RED RIVER
B13
B14
B15
B16
Tu
Tu
Tu
VERTICAL EXAGGERATION 200X
ELEVATION IN FEET (NGVD)
290
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200
190
180
170
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2000
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8000
10000
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DISTANCE IN FEET
LEGEND
B5 BORING
NATURAL LEVEE
PROBABLE PALEO-SURFACE
POINT BAR
BACK SWAMP
ABANDONED CHANNEL
SAND & GRAVEL
Pu PLEISTOCENE UNDIFFERENTIATED
Tu TERTIARY UNDIFFERENTIATED

Plate 10

GARLAND, ARKANSAS

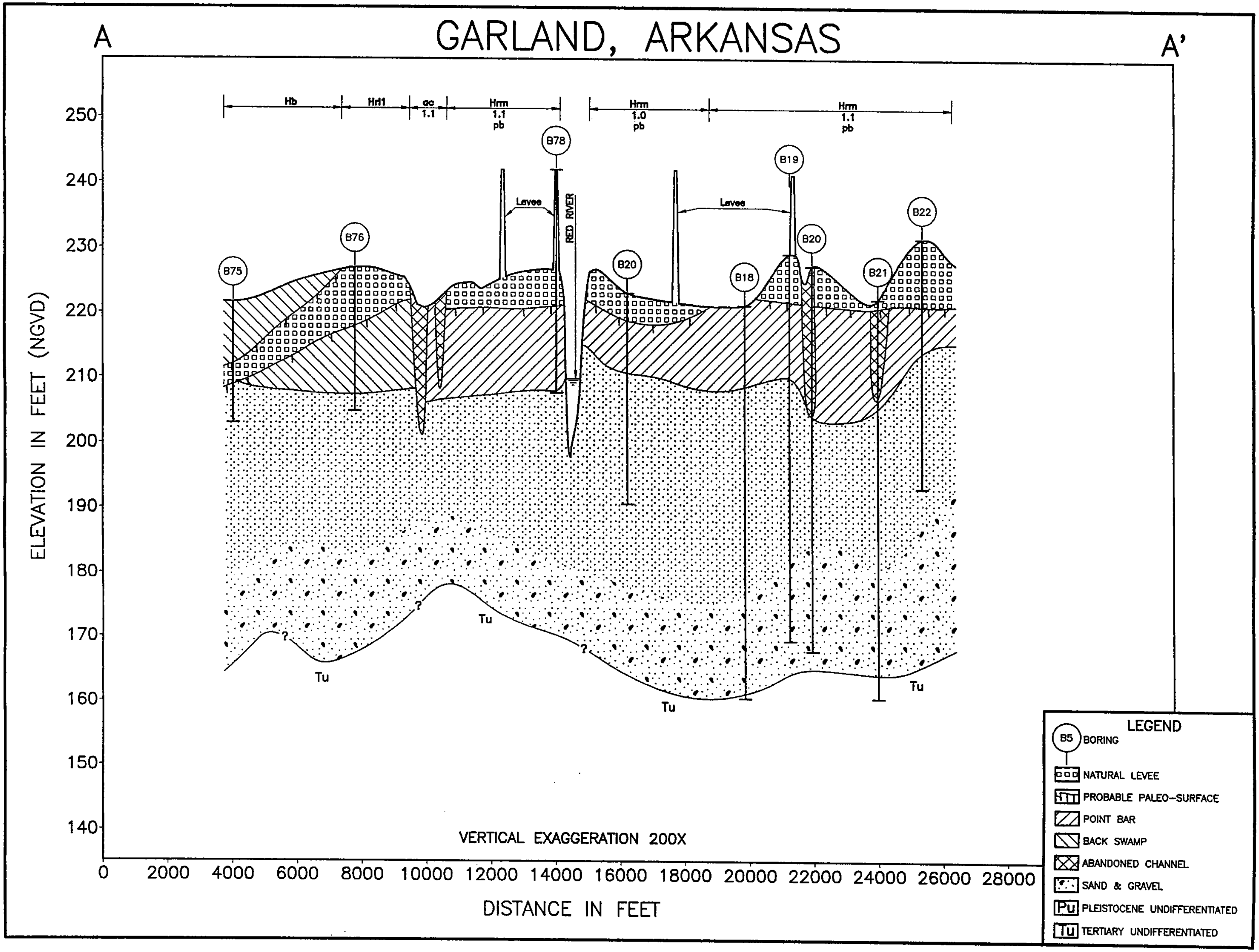

Plate 11

GARLAND, ARKANSAS

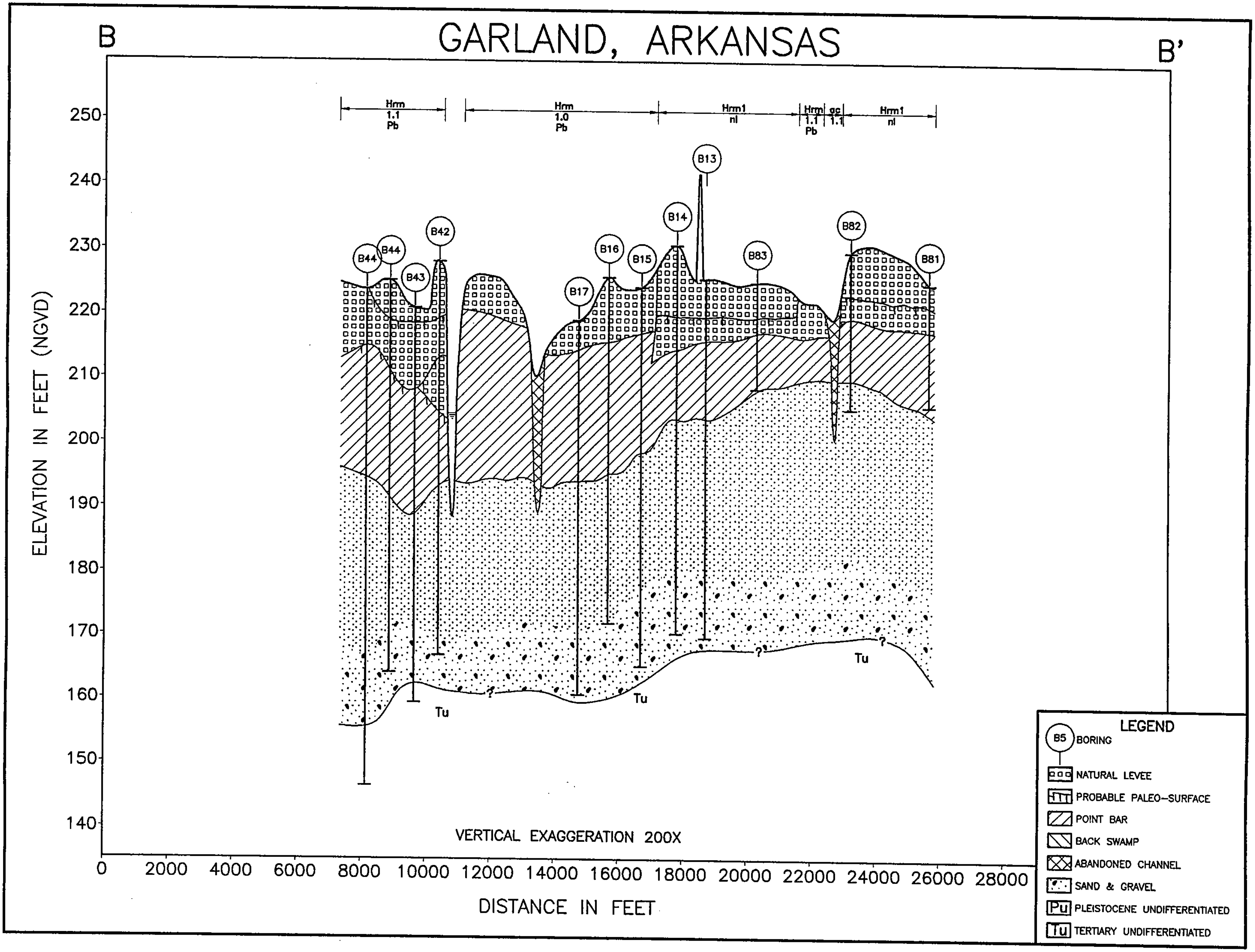

Plate 12

Appendix A
Red River Boring Log Reference Table

Red River Boring Reference Logs Table of Contents

Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
1	374 L-5	Kenny Revetment	374	Boyd Hill
2	374 L-6	Corps of Engineers New Orleans	374	Boyd Hill
3	374 L-7	Corps of Engineers New Orleans	374	Boyd Hill
4	374 L-8	Corps of Engineers New Orleans	374	Boyd Hill
5	374 L-9	Corps of Engineers New Orleans	374	Boyd Hill
6	374 L-10	Corps of Engineers New Orleans	374	Boyd Hill
7	380 R-1	Mays Lake Realinement	381.5-377.	Boyd Hill
8	380 R-2	Corps of Engineers New Orleans	381.5-377.	Boyd Hill
9	380 R-3	Corps of Engineers New Orleans	381.5-377.	Boyd Hill
10	380 R-4	Corps of Engineers New Orleans	381.5-377.	Boyd Hill
11	384 R-1	Red Lake Revetment	384	Boyd Hill
12	384 R-1U	Corps of Engineers New Orleans	384	Boyd Hill
13	384 R-2	Corps of Engineers New Orleans	384	Boyd Hill
14	384 R-3	Corps of Engineers New Orleans	384	Boyd Hill
15	384 R-2U	Corps of Engineers New Orleans	384	Boyd Hill
16	384 R-4	Corps of Engineers New Orleans	384	Boyd Hill
17	373 R-3	Kenny Revetment	374	Boyd Hill
18	373 R-4	Corps of Engineers New Orleans	374	Boyd Hill
19	373 R-5	Corps of Engineers New Orleans	374	Boyd Hill
20	373 R-6	Corps of Engineers New Orleans	374	Boyd Hill
21	373 R-7	Corps of Engineers New Orleans	374	Boyd Hill
22	373 R-8	Corps of Engineers New Orleans	374	Boyd Hill
23	380 R-2	Beck Revetment	380	Boyd Hill
24	380 R-3	Corps of Engineers New Orleans	380	Boyd Hill
25	380 R-4	Corps of Engineers New Orleans	380	Boyd Hill
26	380 R-5	Corps of Engineers New Orleans	380	Boyd Hill
27	380 R-6	Corps of Engineers New Orleans	380	Boyd Hill
28	380 R-7	Corps of Engineers New Orleans	380	Boyd Hill
29	380 R-8	Corps of Engineers New Orleans	380	Boyd Hill
30	380 R-9	Corps of Engineers New Orleans	380	Boyd Hill
31	383 L-1	Boyd Revetment	383.1	Boyd Hill

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Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
32	383 L-2	Corps of Engineers New Orleans	383.1	Boyd Hill
33	383 L-3	Corps of Engineers New Orleans	383.1	Boyd Hill
34	383 L-4	Corps of Engineers New Orleans	383.1	Boyd Hill
35	383 L-5	Corps of Engineers New Orleans	383.1	Boyd Hill
36	383 L-6	Corps of Engineers New Orleans	383.1	Boyd Hill
37	708	Arkansas Lignite Investigations	I-82	Boyd Hill
38	709	Info. Cir. 28-C 1985	I-82	Boyd Hill
39	258	Info. Cir. 28-C 1985	Rt. 29	Boyd Hill
40	257	Info. Cir. 28-C 1985	Rt. 29	Boyd Hill
41	Bridge No. 5617	Arkansas State Highway Commission	Rt. 29	Boyd Hill
42	W-7	Geological Investigation Map	n/a	Boyd Hill
43	W-8	USGS 1:62500 Lewisville	n/a	Boyd Hill
44	W-18	USGS 1:62500 Lewisville	n/a	Boyd Hill
45	B5	Item 5	n/a	Boyd Hill
46	B9	Item 5	n/a	Boyd Hill
47	B10	Item 5	n/a	Boyd Hill
48	B11	Item 5	n/a	Boyd Hill
49	B12	Item 5	n/a	Boyd Hill
50	B13	Item 5	n/a	Boyd Hill
51	B14	Item 5	n/a	Boyd Hill
52	B15	Item 5	n/a	Boyd Hill
53	B16	Item 5	n/a	Boyd Hill
54	B17	Item 5	n/a	Boyd Hill
55	B18	Item 5	n/a	Boyd Hill
56	B19	Item 5	n/a	Boyd Hill
57	B20	Item 5	n/a	Boyd Hill
58	B21	Item 5	n/a	Boyd Hill
59	B22	Item 5	n/a	Boyd Hill
60	B23	Item 5	n/a	Boyd Hill
61	B24	Item 5	n/a	Boyd Hill
62	B25	Item 5	n/a	Boyd Hill

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Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
63	B26	Item 5	n/a	Boyd Hill
64	B27	Item 5	n/a	Boyd Hill
65	B28	Item 5	n/a	Boyd Hill
66	B29	Item 5	n/a	Boyd Hill
67	B30	Item 5	n/a	Boyd Hill
68	B31	Item 5	n/a	Boyd Hill
69	B32	Item 5	n/a	Boyd Hill
70	B33	Item 5	n/a	Boyd Hill
71	B34	Item 5	n/a	Boyd Hill
72	B35	Item 5	n/a	Boyd Hill
73	B36	Item 5	n/a	Boyd Hill
74	B37	Item 5	n/a	Boyd Hill
75	B38	Item 5	n/a	Boyd Hill
76	B39	Item 5	n/a	Boyd Hill
77	B40	Item 5	n/a	Boyd Hill
78	B1	Item 9 Below Dension Dam	n/a	Boyd Hill
79	B2	Item 9 Below Dension Dam	n/a	Boyd Hill
80	B3	Item 9 Below Dension Dam	n/a	Boyd Hill
81	B4	Item 9 Below Dension Dam	n/a	Boyd Hill
82	B5	Item 9 Below Dension Dam	n/a	Boyd Hill
83	B6	Item 9 Below Dension Dam	n/a	Boyd Hill
84	B7	Item 9 Below Dension Dam	n/a	Boyd Hill
85	B8	Item 9 Below Dension Dam	n/a	Boyd Hill
86	B9	Item 9 Below Dension Dam	n/a	Boyd Hill
87	B10	Item 9 Below Dension Dam	n/a	Boyd Hill
88	R23	Whitney Autin Soil Borings	n/a	Boyd Hill
89	R44	Louisiana State University	n/a	Boyd Hill
90	R33	Louisiana State University	n/a	Boyd Hill
91	R32	Louisiana State University	n/a	Boyd Hill
92	R36	Louisiana State University	n/a	Boyd Hill
93	R37	Louisiana State University	n/a	Boyd Hill

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Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
94	R40	Louisiana State University	n/a	Boyd Hill
95	R38	Louisiana State University	n/a	Boyd Hill
96	R46	Louisiana State University	n/a	Boyd Hill
97	R47	Louisiana State University	n/a	Boyd Hill
98	R45	Louisiana State University	n/a	Boyd Hill
99	R41	Louisiana State University	n/a	Boyd Hill
100	R43	Louisiana State University	n/a	Boyd Hill
101	R39	Louisiana State University	n/a	Boyd Hill
102	R42	Louisiana State University	n/a	Boyd Hill
1	352 L-1	Maniece Bayou Revetment	352.5	Canfield
2	352 L-2	Corps of Engineers New Orleans	352.5	Canfield
3	352 L-3	Corps of Engineers New Orleans	352.5	Canfield
4	352 L-4	Corps of Engineers New Orleans	352.5	Canfield
5	352 L-5	Corps of Engineers New Orleans	352.5	Canfield
6	352 L-6	Corps of Engineers New Orleans	352.5	Canfield
7	350 R-4	Corps of Engineers New Orleans	350	Canfield
8	350 R-5	Corps of Engineers New Orleans	350	Canfield
9	350 R-6	Corps of Engineers New Orleans	350	Canfield
10	350 R-7	Corps of Engineers New Orleans	350	Canfield
11	350 R-8	Corps of Engineers New Orleans	350	Canfield
12	350 R-9	Corps of Engineers New Orleans	350	Canfield
13	350 R-100	Corps of Engineers New Orleans	350	Canfield
14	350 R-11	Corps of Engineers New Orleans	350	Canfield
15	Bridge No. 2450	Arkansas Highway Comm.-Dooley Creek	Rt.29	Canfield
16	355.5 L-1	Swan Lake Revetment	355.5	Canfield
17	355.5 L-2	Corps of Engineers New Orleans	355.5	Canfield
18	355.5 L-3	Corps of Engineers New Orleans	355.5	Canfield
19	355.5 L-4	Corps of Engineers New Orleans	355.5	Canfield
20	SL-1-83U	Corps of Engineers New Orleans	355.5	Canfield
21	SL-2-83U	Corps of Engineers New Orleans	355.5	Canfield
22	788	Arkansas Lignite Investigation	n/a	Canfield

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Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
23	787	Info. Cir. 28-C 1985	n/a	Canfield
24	786/1154	Info. Cir. 28-C 1985	n/a	Canfield
25	W-13	Geological Investigation Map	n/a	Canfield
26	W-4	USGS 1:62500 Bradley	n/a	Canfield
27	W-8	USGS 1:62500 Bradley	n/a	Canfield
28	B35	Item 9 Below Dension Dam	n/a	Canfield
29	B36	Item 9 Below Dension Dam	n/a	Canfield
30	B37	Item 9 Below Dension Dam	n/a	Canfield
31	B38	Item 9 Below Dension Dam	n/a	Canfield
32	B39	Item 9 Below Dension Dam	n/a	Canfield
33	B40	Item 9 Below Dension Dam	n/a	Canfield
38	GL-10-84	Goose Lake Realignment	348	Canfield
39	GL-1-84U	Corps of Engineers New Orleans	348	Canfield
40	GL-11-84	Corps of Engineers New Orleans	348	Canfield
41	GL-2-84U	Corps of Engineers New Orleans	348	Canfield
42	GL-3-84U	Corps of Engineers New Orleans	348	Canfield
43	GL-12-84	Corps of Engineers New Orleans	348	Canfield
44	GL-4-84U	Corps of Engineers New Orleans	348	Canfield
45	GL-13-84	Corps of Engineers New Orleans	348	Canfield
46	GL-5-84U	Corps of Engineers New Orleans	348	Canfield
47	GL-14-84U	Corps of Engineers New Orleans	348	Canfield
48	GL-6-84U	Corps of Engineers New Orleans	348	Canfield
49	GL-7-84U	Corps of Engineers New Orleans	348	Canfield
50	GL-8-84U	Corps of Engineers New Orleans	348	Canfield
51	GL-9-84U	Corps of Engineers New Orleans	348	Canfield
52	GL-15-84	Corps of Engineers New Orleans	348	Canfield
53	GL-16-84	Corps of Engineers New Orleans	348	Canfield
54	GL-117-84	Corps of Engineers New Orleans	348	Canfield
55	R69	Whitney Autin Soil Boring	348	Canfield
56	R70	Louisiana State University	348	Canfield
57	R71	Louisiana State University	348	Canfield

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Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
58	R72	Louisiana State University	348	Canfield
59	R73	Louisiana State University	348	Canfield
60	R74	Louisiana State University	348	Canfield
61	R75	Louisiana State University	348	Canfield
62	R76	Louisiana State University	348	Canfield
63	R85	Louisiana State University	348	Canfield
1	DR-1-94U	Dickson Revetment	343-346	Doddridge NE
2	DR-2-94U	Corps of Engineers Vicksburg	343-346	Doddridge NE
3	DR-3-94U	Corps of Engineers Vicksburg	343-346	Doddridge NE
4	DR-4-94U	Corps of Engineers Vicksburg	343-346	Doddridge NE
4	DR-5-94U	Corps of Engineers Vicksburg	343-346	Doddridge NE
6	DR-6-94U	Corps of Engineers Vicksburg	343-346	Doddridge NE
7	DR-7-94U	Corps of Engineers Vicksburg	343-346	Doddridge NE
8	DR-8-94U	Corps of Engineers Vicksburg	343-346	Doddridge NE
9	DR-9-94fU	Corps of Engineers Vicksburg	343-346	Doddridge NE
10	DR-10-94U	Corps of Engineers Vicksburg	343-346	Doddridge NE
11	DR-11-94U	Corps of Engineers Vicksburg	343-346	Doddridge NE
12	BBR-1-88	Brown Bend Realignment	339-342	Doddridge NE
13	BBR-2-88	Brown Bend Realignment	339-342	Doddridge NE
14	BBR-3-88	Brown Bend Realignment	339-342	Doddridge NE
15	BBR-4-88	Brown Bend Realignment	339-342	Doddridge NE
16	BBR-5-88	Brown Bend Realignment	339-342	Doddridge NE
17	BBR-6-88	Brown Bend Realignment	339-342	Doddridge NE
18	OR-1-85	Oak Revetment Extention	348-346	Doddridge NE
19	OR-2-85	Corps of Engineers Vicksburg	348-346	Doddridge NE
20	OR-3-85	Corps of Engineers Vicksburg	348-346	Doddridge NE
21	OR-4-85	Corps of Engineers Vicksburg	348-346	Doddridge NE
22	803	Arkansas Lignite Investigations	n/a	Doddridge NE
23	804	Info. Cir. 28C 1985	n/a	Doddridge NE
24	W-1	Geological Investigation Map	n/a	Doddridge NE
25	W-9	USGS 1:62500-Doddridge	n/a	Doddridge NE

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Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
26	W-10	USGS 1:62500-Doddridge	n/a	Doddridge NE
27	W-13	USGS 1:62500-Doddridge	n/a	Doddridge NE
28	W-8	USGS 1:62500-Doddridge	n/a	Doddridge NE
29	W-6	USGS 1:62500-Doddridge	n/a	Doddridge NE
30	R54	Whitney Autin Soil Borings	n/a	Doddridge NE
31	R55	Louisiana State University	n/a	Doddridge NE
32	R56	Louisiana State University	n/a	Doddridge NE
33	R57	Louisiana State University	n/a	Doddridge NE
34	R58	Louisiana State University	n/a	Doddridge NE
35	R59	Louisiana State University	n/a	Doddridge NE
36	R60	Louisiana State University	n/a	Doddridge NE
37	R61	Louisiana State University	n/a	Doddridge NE
38	R62	Louisiana State University	n/a	Doddridge NE
39	R77	Louisiana State University	n/a	Doddridge NE
40	R78	Louisiana State University	n/a	Doddridge NE
41	R79	Louisiana State University	n/a	Doddridge NE
1	805	Arkansas Lignite Investigation	n/a	Doddridge SE
2	1164	Info. Cir. 28-C 1985	n/a	Doddridge SE
3	806	Info. Cir. 28-C 1985	n/a	Doddridge SE
4	807	Info. Cir. 28-C 1985	n/a	Doddridge SE
5	225A	Info. Cir 28-C 1985	n/a	Doddridge SE
6	328 R-7	Missionary Revetment	326.4	Doddridge SE
7	328 R-8	Corps of Engineers New Orleans	326.4	Doddridge SE
8	328 R-9	October 1977	326.4	Doddridge SE
9	328 R-10	October 1977	326.4	Doddridge SE
10	328 R-11	October 1977	326.4	Doddridge SE
11	328 R-1	Halfmoon Revetment	329-325	Doddridge SE
12	328 R-2	Corps of Engineers New Orleans	329-325	Doddridge SE
13	328 R-3	Corps of Engineers New Orleans	329-325	Doddridge SE
14	328 R-4	Corps of Engineers New Orleans	329-325	Doddridge SE
15	335 R-5	Spring Bank Revetment	335.5	Doddridge SE

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Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
16	335 R-6	Corps of Engineers New Orleans	335.5	Doddridge SE
17	335 R-7	August 1979	335.5	Doddridge SE
18	335 R-8	August 1979	335.5	Doddridge SE
19	W-3	Geological Investigation Map	n/a	Doddridge SE
20	W-2	USGS 1:62500 Doddridge	n/a	Doddridge SE
1	701	Arkansas Lignite Investigation	n/a	Fouke NE
2	702	Info. Cir. 28-C 1985	n/a	Fouke NE
3	703	Info. Cir. 28-C 1985	n/a	Fouke NE
4	704	Info. Cir. 28-C 1985	n/a	Fouke NE
5	705	Info. Cir. 28-C 1985	n/a	Fouke NE
6	706	Info. Cir. 28-C 1985	n/a	Fouke NE
7	707	Info. Cir. 28-C 1985	n/a	Fouke NE
8	Bridge No. 3860	Arkansas Highway Comm.-Mckinney Bay	Rt. 82	Fouke NE
9	R25	Whitney Autin Soil Borings	n/a	Fouke NE
10	R26	Louisiana State University	n/a	Fouke NE
11	W-6	Geological Investigation Map USGS 1:62500 Fouke	n/a	Fouke NE
12	W-3	Geological Investigation Map USGS 1:62500 Fouke	n/a	Fouke NE
13	W-4	Geological Investigation Map USGS 1:62500 Fouke	n/a	Fouke NE
14	W-9	Geological Investigation Map USGS 1:62500 Fouke	n/a	Fouke NE
15	R28	Whitney Autin Soil Borings	n/a	Fouke NE
16	R27	Louisiana State University	n/a	Fouke NE
17	R34	Louisiana State University	n/a	Fouke NE
18	R35	Louisiana State University	n/a	Fouke NE
1	FR-1	RR Waterway - Fulton Revetment	401.7-402.3	Fulton
2	FR-2	Corps of Engineers - April 1987	401.7-402.3	Fulton
3	OR-1	RR Waterway-Mo Pac 30 Revetment	403	Fulton
4	OR-2	Corps of Engineers Soils Report	403	Fulton
5	OR-3	August 1983	403	Fulton
6	OR-4	August 1983	403	Fulton

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Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
7	OR-5	August 1983	403	Fulton
8	OR-6	August 1983	403	Fulton
9	OR-7	August 1983	403	Fulton
10	OR-8	August 1983	403	Fulton
11	397L-1	RR Waterway - Bushy Revetment	397	Fulton
12	397L-2	Corps of Engineers Soils Report	397	Fulton
13	397L-3	November 1978	397	Fulton
14	397L-4	November 1978	397	Fulton
15	397L-5	November 1978	397	Fulton
16	397L-6	November 1978	397	Fulton
17	397L-7	November 1978	397	Fulton
18	397L-8	November 1978	397	Fulton
19	398.2 R-1	RR Waterway - Kuykendall Revetment	397 to 399	Fulton
20	398.2 R-2	Corps of Engineers Soils Report	397 to 399	Fulton
21	398.2 R-3	July 1983	397 to 399	Fulton
22	398.2 R-4	July 1983	397 to 399	Fulton
23	398.2 R-5	July 1983	397 to 399	Fulton
24	398.2 R-6	July 1983	397 to 399	Fulton
25	398.2 R-7	July 1983	397 to 399	Fulton
26	398.2 R-8	July 1983	397 to 399	Fulton
27	398.2 R-9	July 1983	397 to 399	Fulton
28	BDD4-1-94U	RR Below Dension Dam	n/a	Fulton
29	BDD4-2-94U	Corps or Engineers Vicksburg	n/a	Fulton
30	BDD4-3-94U	Maps and Boring Logs November 1994	n/a	Fulton
31	BDD4-4-94U	Maps and Boring Logs November 1994	n/a	Fulton
32	BDD4-5-94U	Maps and Boring Logs November 1994	n/a	Fulton
33	BDD4-6-94U	Maps and Boring Logs November 1994	n/a	Fulton
34	BDD4-7-94U	Maps and Boring Logs November 1994	n/a	Fulton
35	BDD4-8-94U	Maps and Boring Logs November 1994	n/a	Fulton
36	BDD4-1-94B	Maps and Boring Logs November 1994	n/a	Fulton
37	BDD4-2-94B	Maps and Boring Logs November 1994	n/a	Fulton

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Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
38	BDD4-3-94B	Maps and Boring Logs November 1994	n/a	Fulton
39	BDD4-4-94B	Maps and Boring Logs November 1994	n/a	Fulton
40	BDD4-5-94B	Maps and Boring Logs November 1994	n/a	Fulton
41	BDD4-6-94B	Maps and Boring Logs November 1994	n/a	Fulton
42	BDD4-6A-94B	Maps and Boring Logs November 1994	n/a	Fulton
43	BDD4-7-94B	Maps and Boring Logs November 1994	n/a	Fulton
44	BDD4-8-94B	Maps and Boring Logs November 1994	n/a	Fulton
45	BDD4-9-94B	Maps and Boring Logs November 1994	n/a	Fulton
46	BDD4-10-94B	Maps and Boring Logs November 1994	n/a	Fulton
47	BDD4-11-94B	Maps and Boring Logs November 1994	n/a	Fulton
48	BDD4-12-94B	Maps and Boring Logs November 1994	n/a	Fulton
49	BDD4-13-94B	Maps and Boring Logs November 1994	n/a	Fulton
50	BDD4-14-94B	Maps and Boring Logs November 1994	n/a	Fulton
51	BDD4-15-94B	Maps and Boring Logs November 1994	n/a	Fulton
52	BR3797A	Arkansas State Highway Int. 30	I-30	Fulton
53	BR3797B	pp 122-123, 8-27-63	Gill. Ditch	Fulton
54	R-1	Whitney Autin - Soil Borings	n/a	Fulton
55	R-2	Louisiana State University	n/a	Fulton
56	R-3	Louisiana State University	n/a	Fulton
57	R-4	Louisiana State University	n/a	Fulton
58	R-5	Louisiana State University	n/a	Fulton
59	R-6	Louisiana State University	n/a	Fulton
60	R-7	Louisiana State University	n/a	Fulton
61	R-8	Louisiana State University	n/a	Fulton
62	R-9	Louisiana State University	n/a	Fulton
63	R-10	Louisiana State University	n/a	Fulton
64	R-11	Louisiana State University	n/a	Fulton
65	R-12	Louisiana State University	n/a	Fulton
66	R-13	Louisiana State University	n/a	Fulton
67	R-14	Louisiana State University	n/a	Fulton
68	R-15	Louisiana State University	n/a	Fulton

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Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
69	R-16	Louisiana State University	n/a	Fulton
70	R-17	Louisiana State University	n/a	Fulton
71	R-18	Louisiana State University	n/a	Fulton
72	R-19	Louisiana State University	n/a	Fulton
73	R-20	Louisiana State University	n/a	Fulton
74	R-21	Louisiana State University	n/a	Fulton
75	R-22	Louisiana State University	n/a	Fulton
76	AH-2	Geological Investigation Map	n/a	Fulton
77	AH-4	USGS Scale 1 = 62500	n/a	Fulton
78	AH-5	USGS Scale 1 = 62500	n/a	Fulton
79	GS-8	USGS Scale 1 = 62500	n/a	Fulton
80	BDD5-1-95G	RR Waterway Below Dension	n/a	Fulton
81	BDD5-2-95G	Dam - Item 5	n/a	Fulton
82	BDD5-3-95G	Corps of Engineers Soils Report	n/a	Fulton
83	BDD5-4-95G	March 8, 1995	n/a	Fulton
84	BDD5-5-95G	March 8, 1995	n/a	Fulton
85	BDD5-6-95G	March 8, 1995	n/a	Fulton
86	BDD5-7-95G	March 8, 1995	n/a	Fulton
87	BDD5-8-95G	March 8, 1995	n/a	Fulton
88	BDD3-5-94U	RR Waterway Below Dension	n/a	Fulton
89	BDD3-6-94U	Dam - Item 3	n/a	Fulton
90	BDD3-7-94U	Corps of Engineers Soils Report	n/a	Fulton
91	BDD3-14-94B	October 1994	n/a	Fulton
92	BDD3-15-94B	October 1994	n/a	Fulton
93	BDD3-16-94B	October 1994	n/a	Fulton
94	BDD3-17-94B	October 1994	n/a	Fulton
95	BDD3-18-94B	October 1994	n/a	Fulton
96	BDD3-19-94B	October 1994	n/a	Fulton
97	BDD3-20-94B	October 1994	n/a	Fulton
98	BDD3-21-94B	October 1994	n/a	Fulton
99	BDD3-22-94B	October 1994	n/a	Fulton

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Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
100	R30	Whitney Autin - Soil Borings	n/a	Fulton
101	R31	Louisiana State University	n/a	Fulton
102	R29	Louisiana State University	n/a	Fulton
103	R86	Louisiana State University	n/a	Fulton
104	R87	Louisiana State University	n/a	Fulton
42	CL-1-87U	Candler Lake Revetment Extension	365-364	Garland
43	CL-2-87U	Corps of Engineers Vicksburg	365-364	Garland
44	CL-3-87U	Corps of Engineers Vicksburg	365-364	Garland
45	CL-4-87U	Corps of Engineers Vicksburg	365-364	Garland
46	B41	Item 5	n/a	Garland
47	B42	Item 5	n/a	Garland
48	B43	Item 5	n/a	Garland
49	B44	Item 5	n/a	Garland
50	B45	Item 5	n/a	Garland
51	B11	Item 9 Below Dension Dam	n/a	Garland
52	B12	Item 9 Below Dension Dam	n/a	Garland
53	B13	Item 9 Below Dension Dam	n/a	Garland
54	B14	Item 9 Below Dension Dam	n/a	Garland
55		Item 9 Below Dension Dam	n/a	Garland
56	B15	Item 9 Below Dension Dam	n/a	Garland
57	B16	Item 9 Below Dension Dam	n/a	Garland
58	B17	Item 9 Below Dension Dam	n/a	Garland
59	B18	Item 9 Below Dension Dam	n/a	Garland
60	B19	Item 9 Below Dension Dam	n/a	Garland
61	B20	Item 9 Below Dension Dam	n/a	Garland
62	B21	Item 9 Below Dension Dam	n/a	Garland
63	B22	Item 9 Below Dension Dam	n/a	Garland
64	B23	Item 9 Below Dension Dam	n/a	Garland
65	B24	Item 9 Below Dension Dam	n/a	Garland
66	B25	Item 9 Below Dension Dam	n/a	Garland
67	B26	Item 9 Below Dension Dam	n/a	Garland

(Sheet 12 of 13)

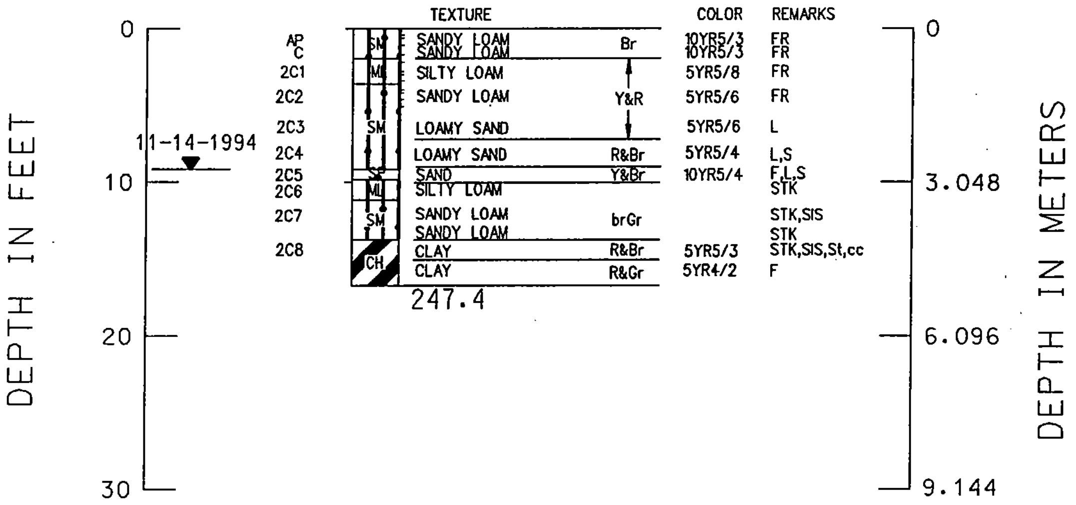
Usage Boring No.	Reference Boring No.	Report Name	Mile No.	Quadrangle
68	B27	Item 9 Below Dension Dam	n/a	Garland
69	B28	Item 9 Below Dension Dam	n/a	Garland
70	B29	Item 9 Below Dension Dam	n/a	Garland
71	B30	Item 9 Below Dension Dam	n/a	Garland
72	B31	Item 9 Below Dension Dam	n/a	Garland
73	B32	Item 9 Below Dension Dam	n/a	Garland
74	B34	Item 9 Below Dension Dam	n/a	Garland
75	R48	Whitney Autin LSU Soil Borings	n/a	Garland
76	R49	Whitney Autin LSU Soil Borings	n/a	Garland
77	R50	Whitney Autin LSU Soil Borings	n/a	Garland
78	R51	Whitney Autin LSU Soil Borings	n/a	Garland
79	R52	Whitney Autin LSU Soil Borings	n/a	Garland
80	R53	Whitney Autin LSU Soil Borings	n/a	Garland
81	R63	Whitney Autin LSU Soil Borings	n/a	Garland
82	R64	Whitney Autin LSU Soil Borings	n/a	Garland
83	R65	Whitney Autin LSU Soil Borings	n/a	Garland
84	R66	Whitney Autin LSU Soil Borings	n/a	Garland
84	R67	Whitney Autin LSU Soil Borings	n/a	Garland
86	R68	Whitney Autin LSU Soil Borings	n/a	Garland
1	252	Arkansas Lignite Investigation	n/a	Spring Hill
2	1168	Info. Cir. 28-C 1985	n/a	Spring Hill
3	251	Info. Cir. 28-C 1985	n/a	Spring Hill
4	250	Info. Cir. 28-C 1985	n/a	Spring Hill
5	249	Info. Cir. 28-C 1985	n/a	Spring Hill
6	248	Info. Cir. 28-C 1985	n/a	Spring Hill
7	SA-1	Geological Investigation Map-Hop	n/a	Spring Hill
8	390 R-3	Hervey Revetment	389.2	Spring Hill
9	390 R-4	Corps of Engineers New Orleans	389.2	Spring Hill
10	390 R-5	March 1977	389.2	Spring Hill
11	Bridge No. 6127	Arkansas State Highway Comm.-Goss Creek	Rt. 174	Spring Hill

(Sheet 13 of 13)

Appendix B
Soil Borings

R-01

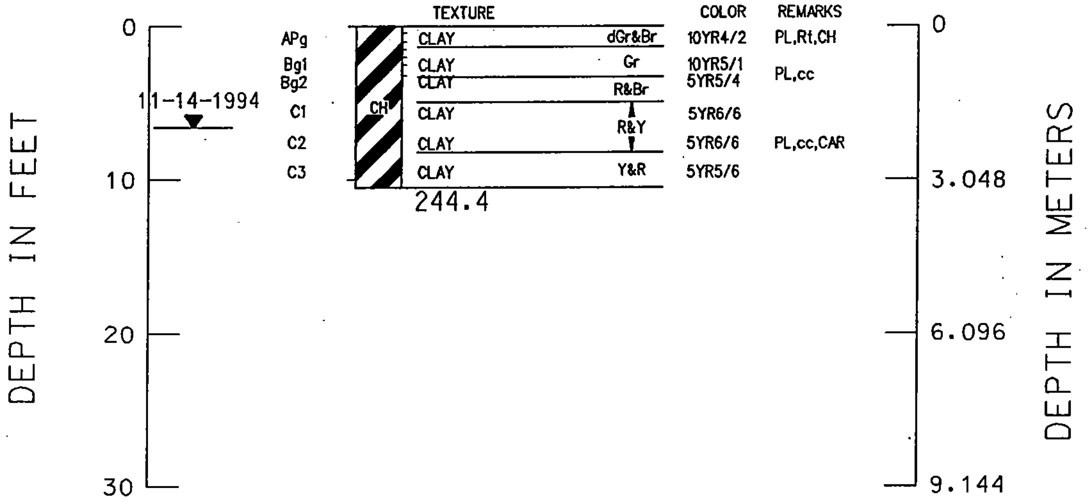
Sec 2 T14S R27W
Fulton
11-14-1994
G.S.E. 264.1



RED RIVER FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-02

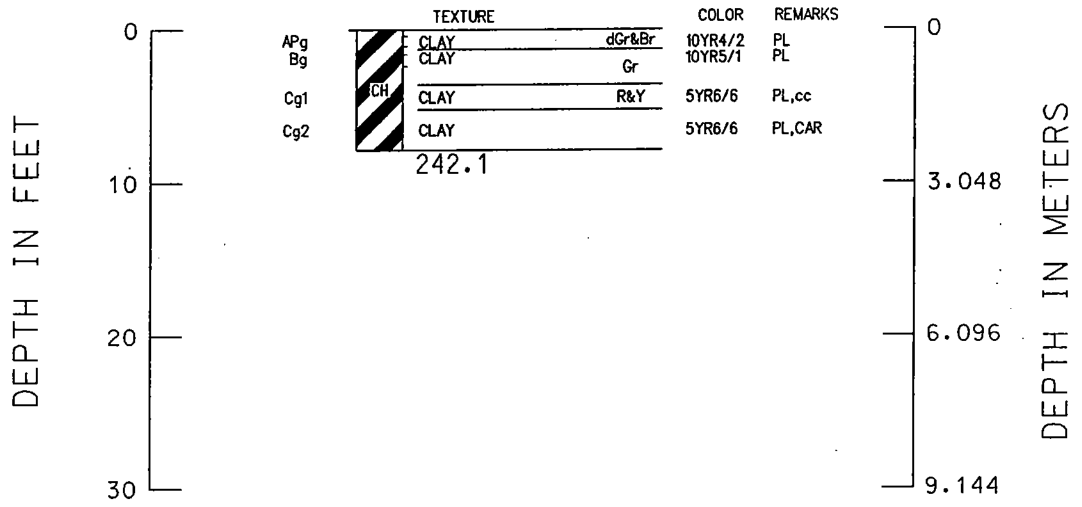
Sec1 T14S R27W
Fulton
11-14-1994
G.S.E. 254.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-03

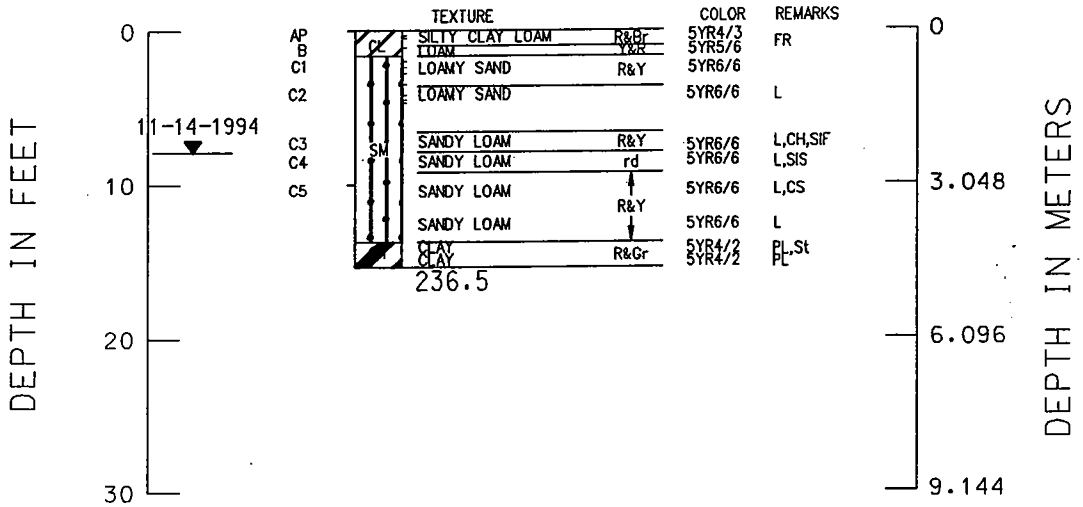
Sec36 T13S R27W
Fulton
11-14-1994
G.S.E. 250.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-04

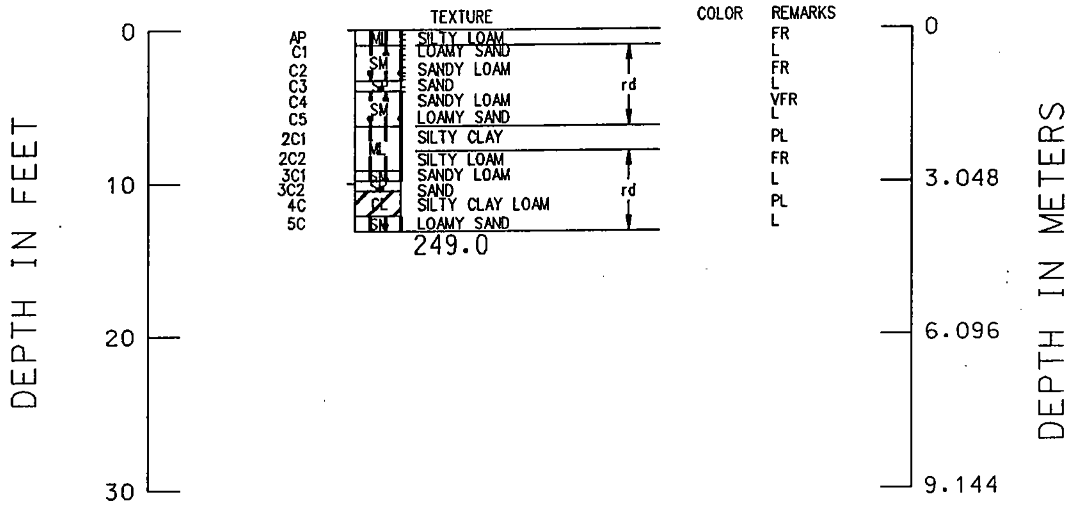
Sec6 T14S R26W
Fulton
11-14-1994
G.S.E. 252.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-05

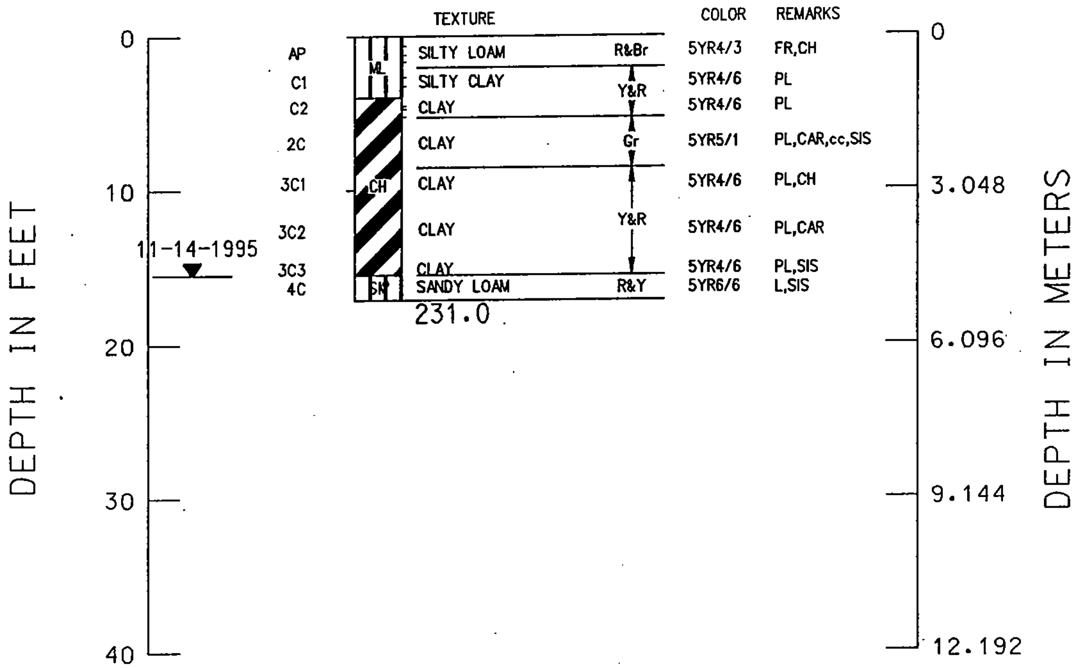
Sec26 T13S R27W
Fulton
11-14-1994
G.S.E. 262.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-06

Sec11 T14S R26W
Fulton
11-14-1994
G.S.E. 248.0

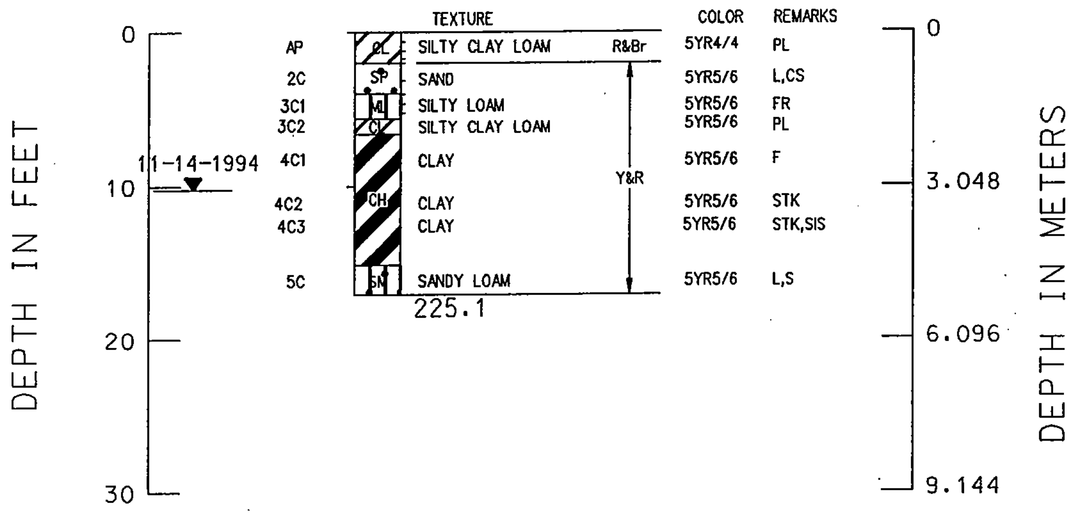


	TEXTURE		COLOR	REMARKS
AP	SILTY LOAM	R&Br	5YR4/3	FR,CH
C1	SILTY CLAY	Y&R	5YR4/6	PL
C2	CLAY		5YR4/6	PL
2C	CLAY	Gr	5YR5/1	PL,CAR,cc,SIS
3C1	CLAY	Y&R	5YR4/6	PL,CH
3C2	CLAY		5YR4/6	PL,CAR
3C3	CLAY		5YR4/6	PL,SIS
4C	SANDY LOAM	R&Y	5YR6/6	L,SIS

RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-07

Sec14 T14S R26W
Fulton
11-14-1994
G.S.E. 242.1

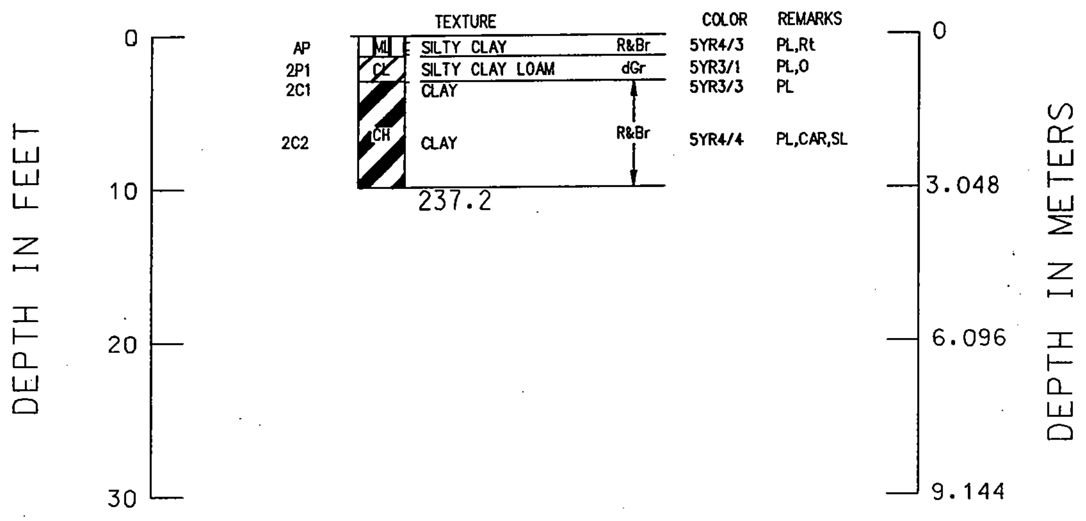


		TEXTURE		COLOR	REMARKS
AP	CL	SILTY CLAY LOAM	R&Br	5YR4/4	PL
2C	SP	SAND	Y&R	5YR5/6	L,CS
3C1	ML	SILTY LOAM		5YR5/6	FR
3C2	CL	SILTY CLAY LOAM		5YR5/6	PL
4C1		CLAY		5YR5/6	F
4C2	CH	CLAY		5YR5/6	STK
4C3		CLAY		5YR5/6	STK,SIS
5C	SM	SANDY LOAM		5YR5/6	L,S

RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-08

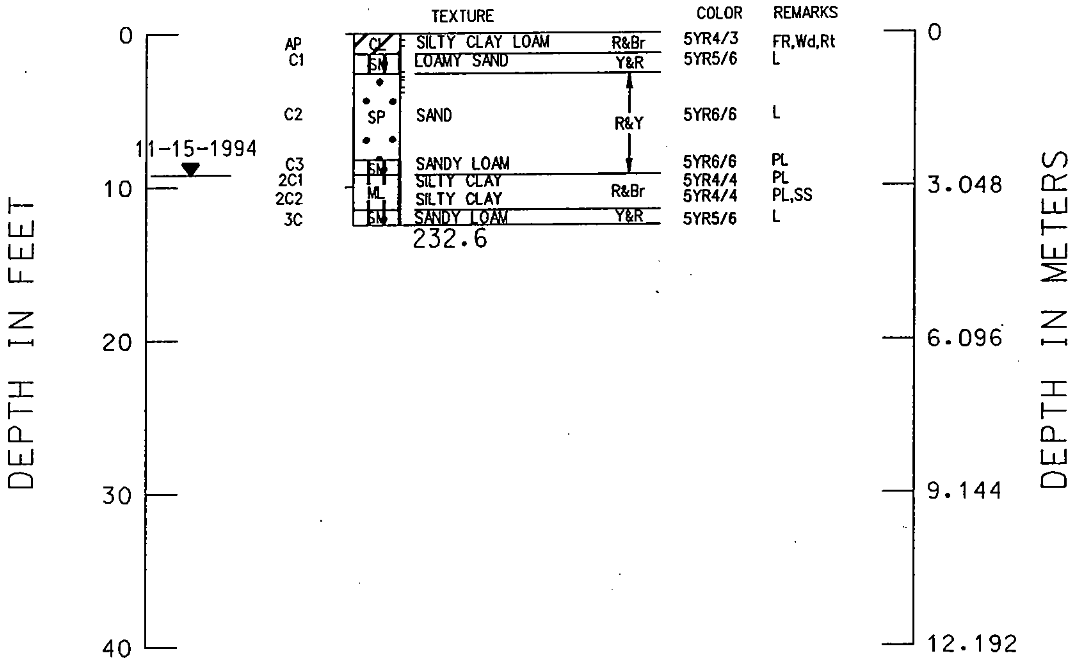
Sec7 T14S R26W
Fulton
11-15-1994
G.S.E. 247.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-09

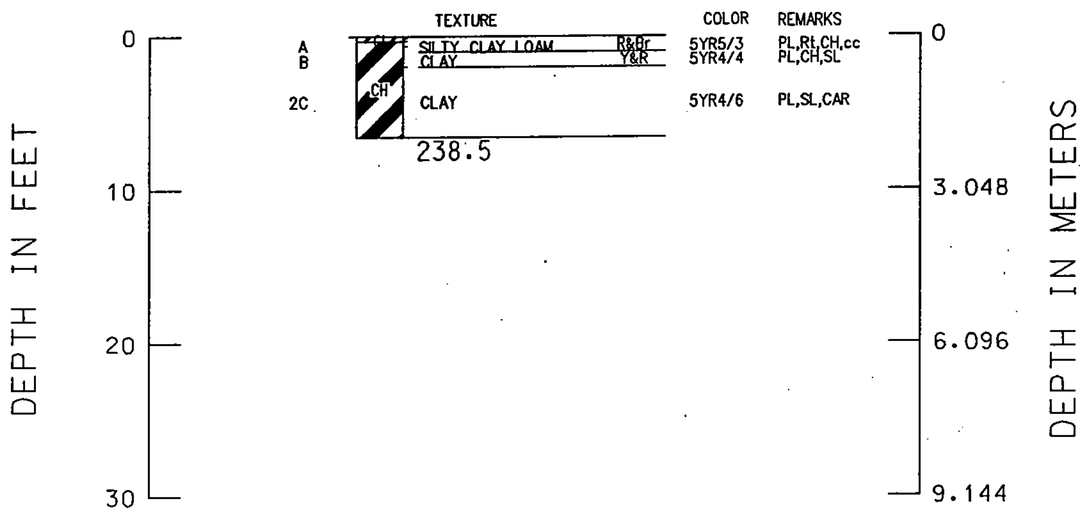
Sec8 T14S R26W
Fulton
11-15-1994
G.S.E. 245.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-10

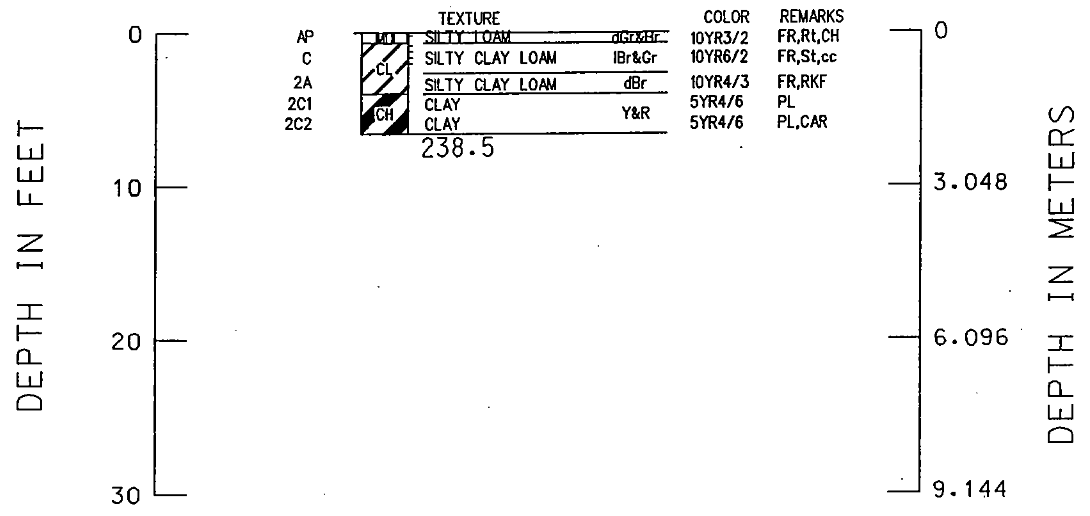
Sec12 T14S R26W
Fulton
11-15-1994
G.S.E. 245.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-11

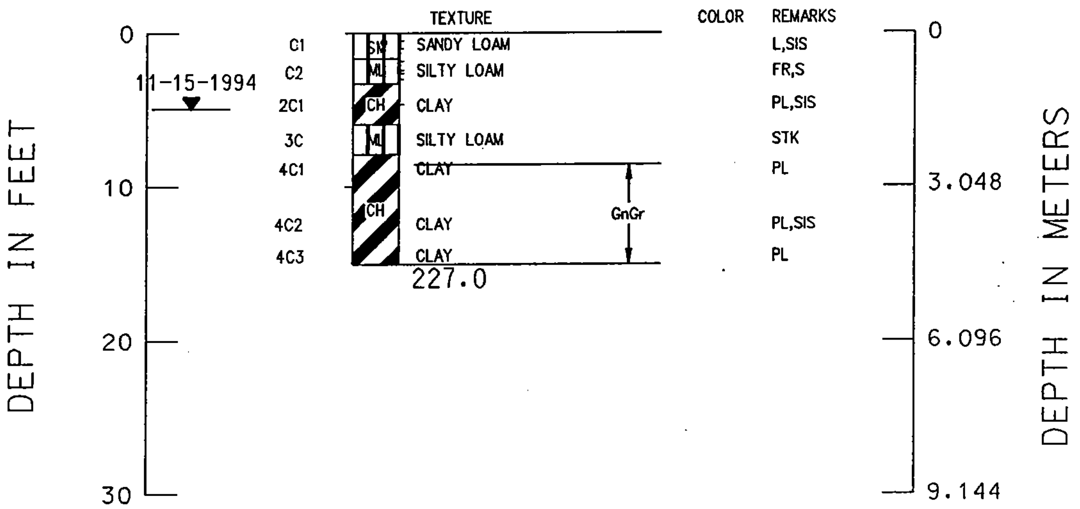
Sec12 T14S R26W
Fulton
11-15-1994
G.S.E. 245.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-12

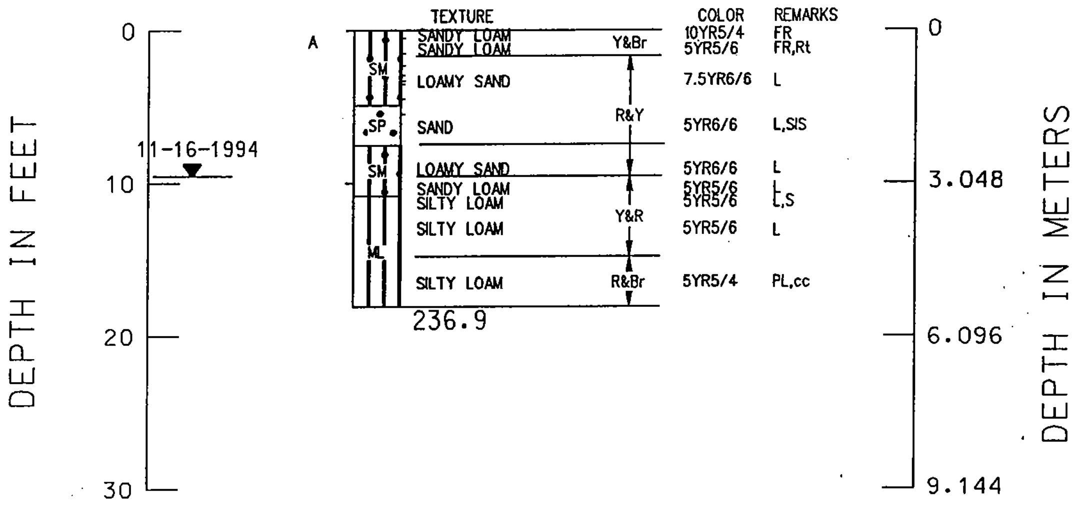
Sec11 T14S R26W
Fulton
11-15-1994
G.S.E. 242.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-13

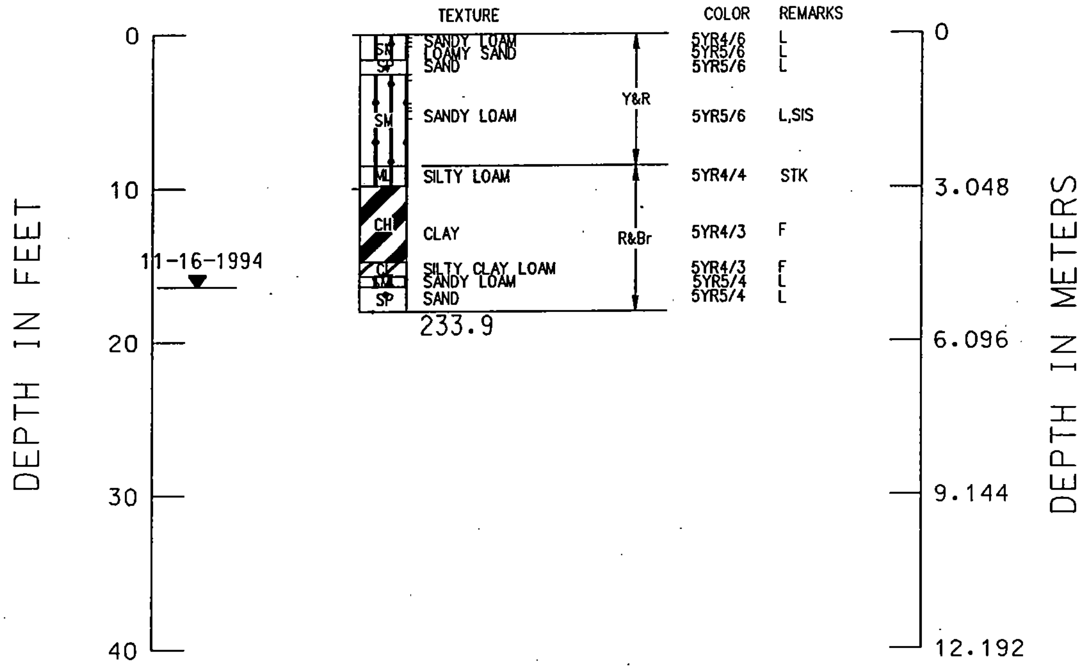
Sec32 T13S R26W
Fulton
11-16-1994
G.S.E. 254.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-14

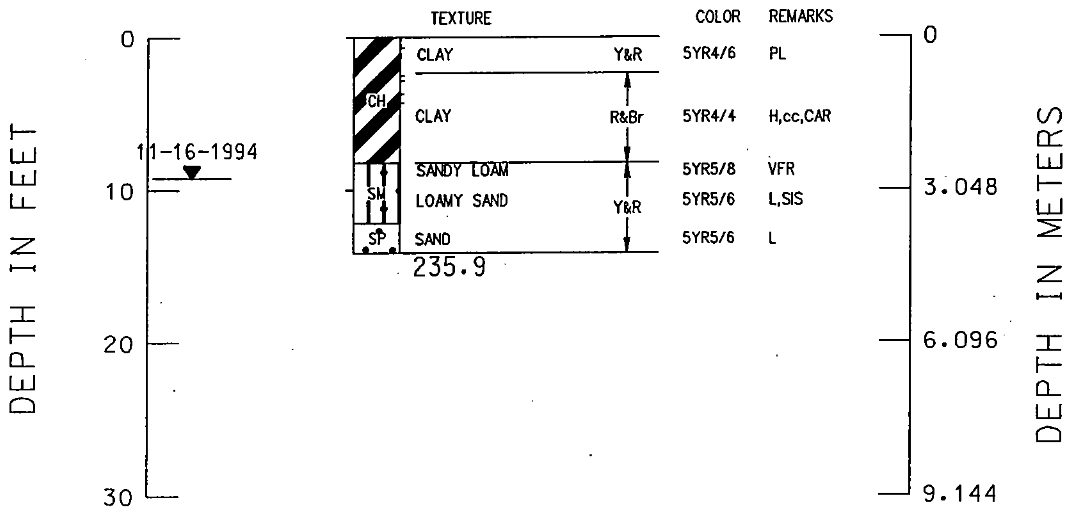
Sec4 T14S R26W
Fulton
11-16-1994
G.S.E. 252.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-15

Sec4 T14S R26W
Fulton
11-16-1994
G.S.E. 250.0

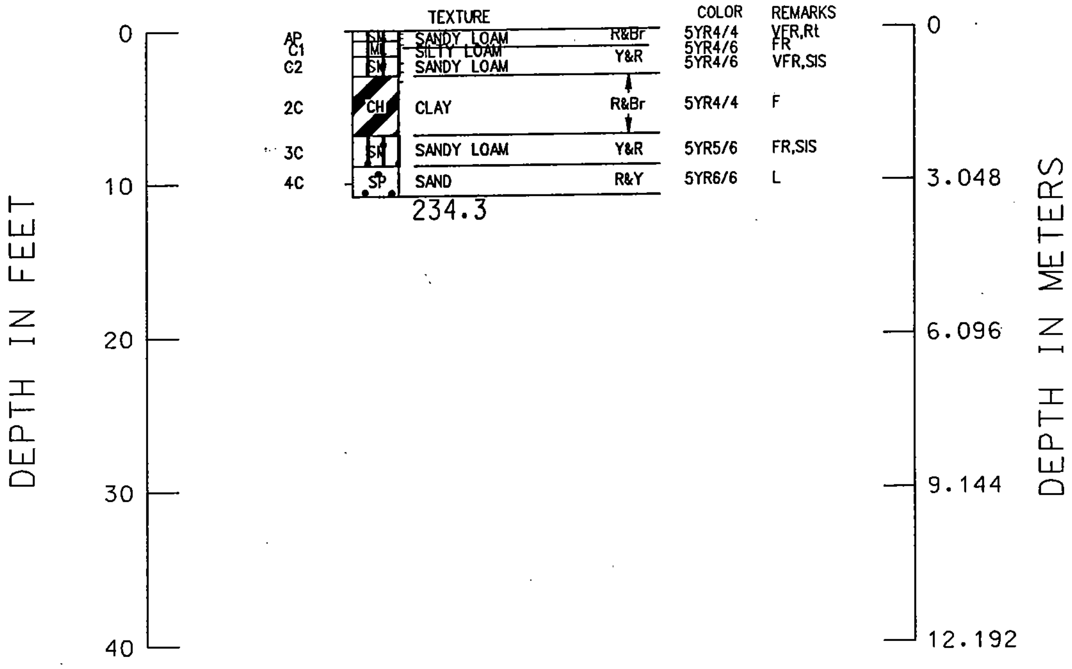


	TEXTURE		COLOR	REMARKS
CH	CLAY	Y&R	5YR4/6	PL
	CLAY	R&Br	5YR4/4	H,cc,CAR
SM	SANDY LOAM	Y&R	5YR5/8	VFR
	LOAMY SAND		5YR5/6	L,SIS
SP	SAND		5YR5/6	L

RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-16

Sec15 T14S R26W
Fulton
11-16-1994
G.S.E. 245.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

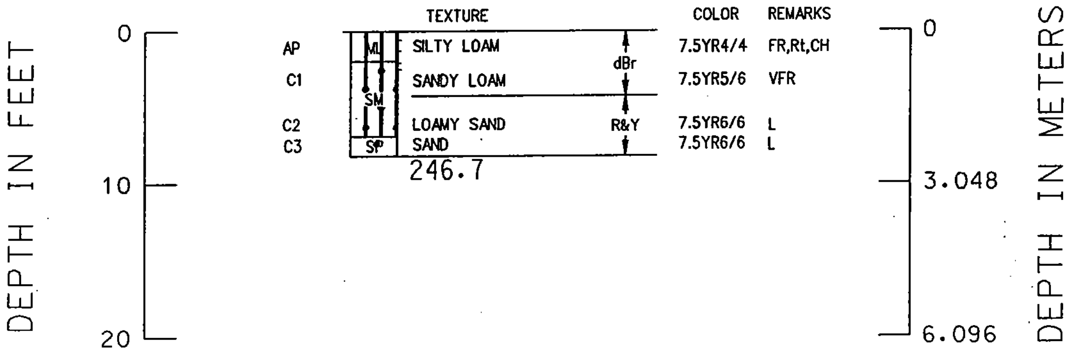
R-17

Sec -- T--N R--W

Fulton

11-16-1994

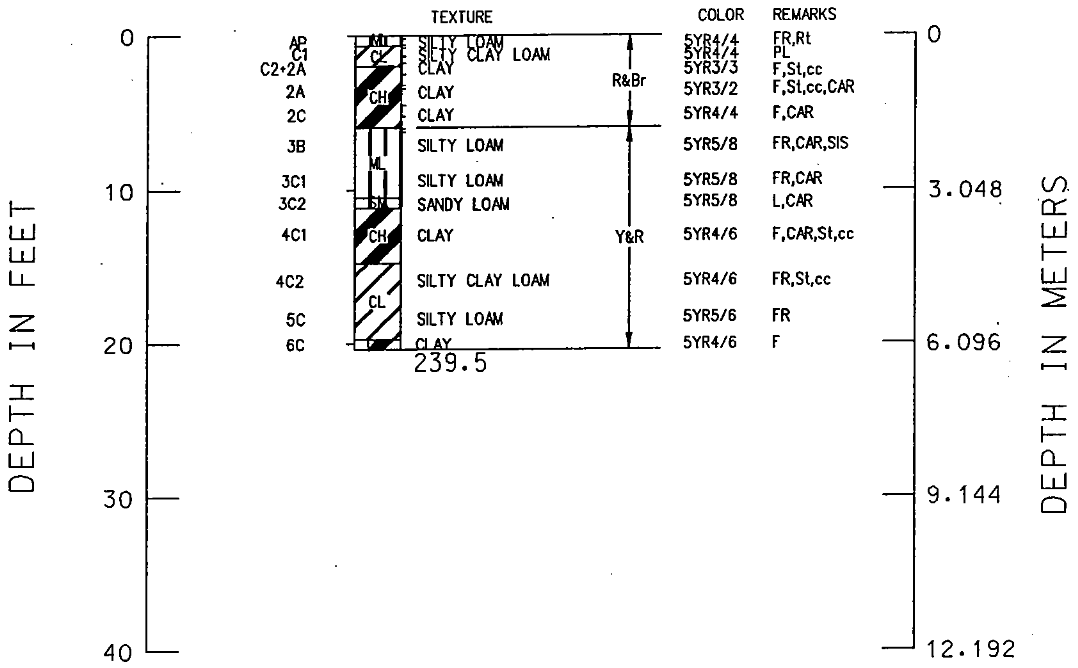
G.S.E. 254.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-18

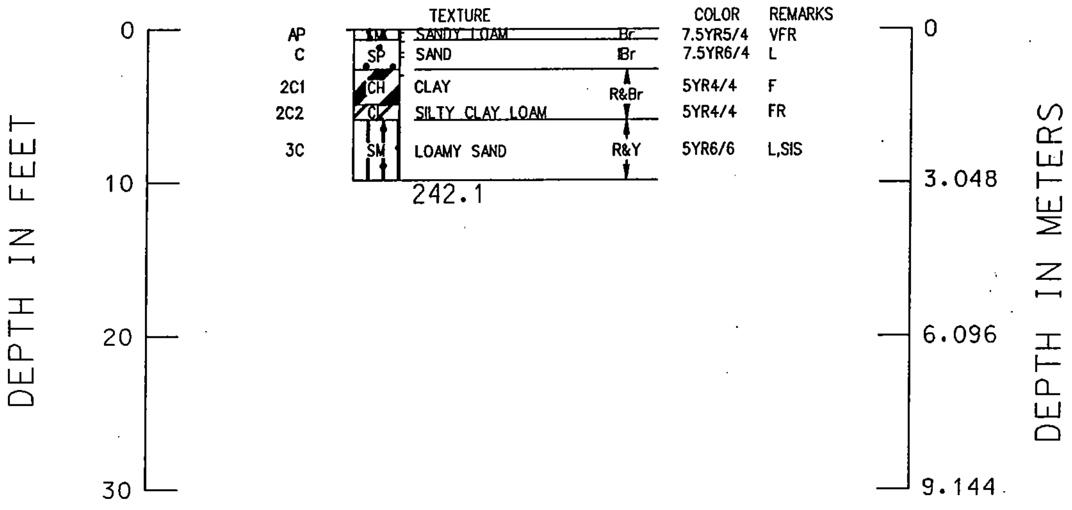
Sec14 T13S R27W
Fulton
11-16-1994
G.S.E. 259.8



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-19

Sec19 T--N R--W
Fulton
11-16-1994
G.S.E. 252.0



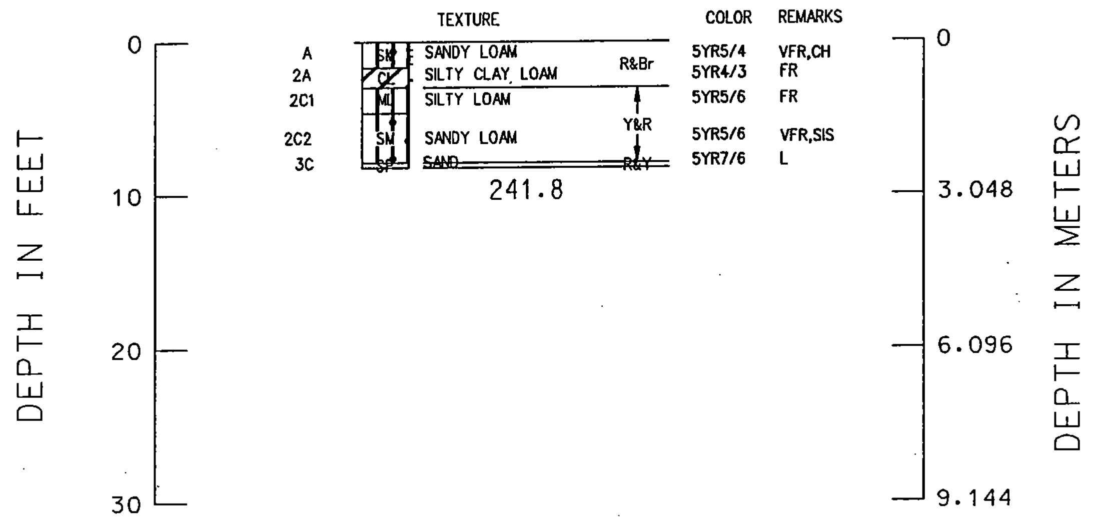
RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-20

Sec27 T14S R26W
Fulton

11-17-1994

G.S.E. 250.0

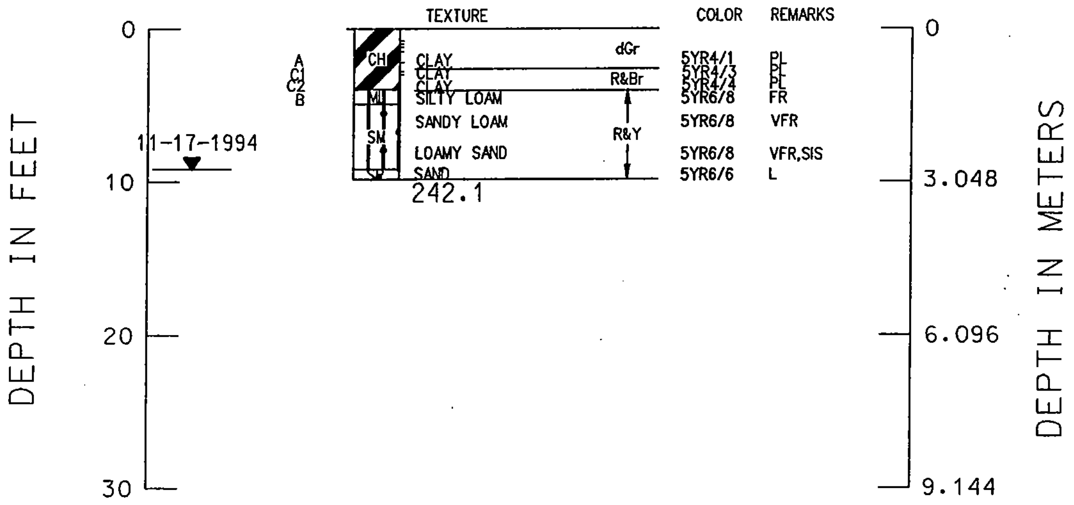


RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-21

Sec29 T14S R26W
Fulton
11-17-1994

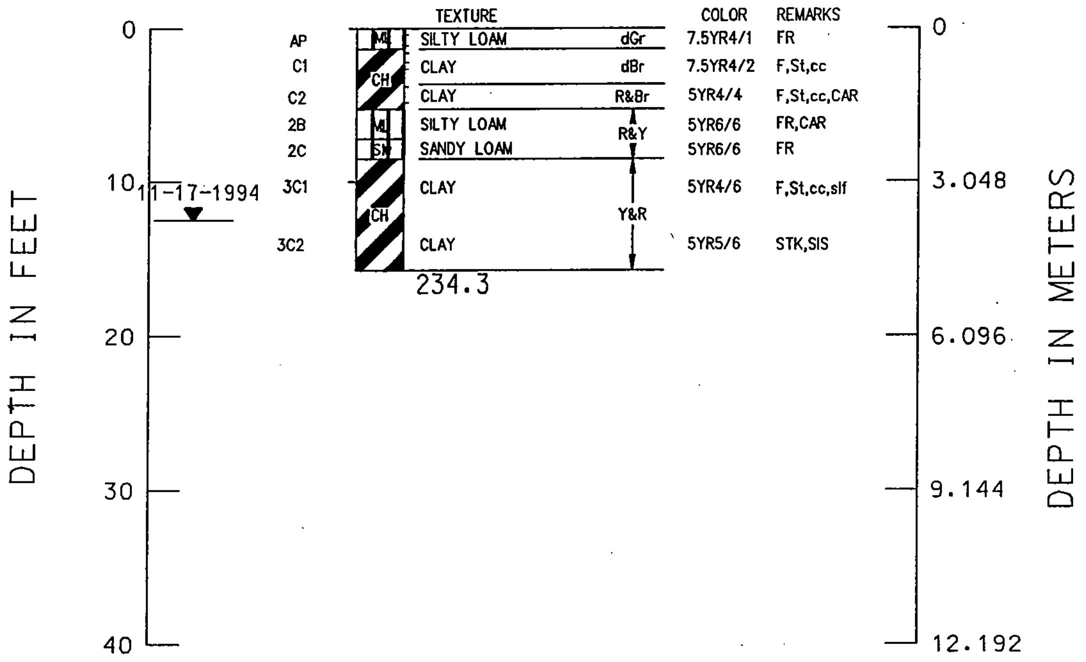
G.S.E. 252.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-22

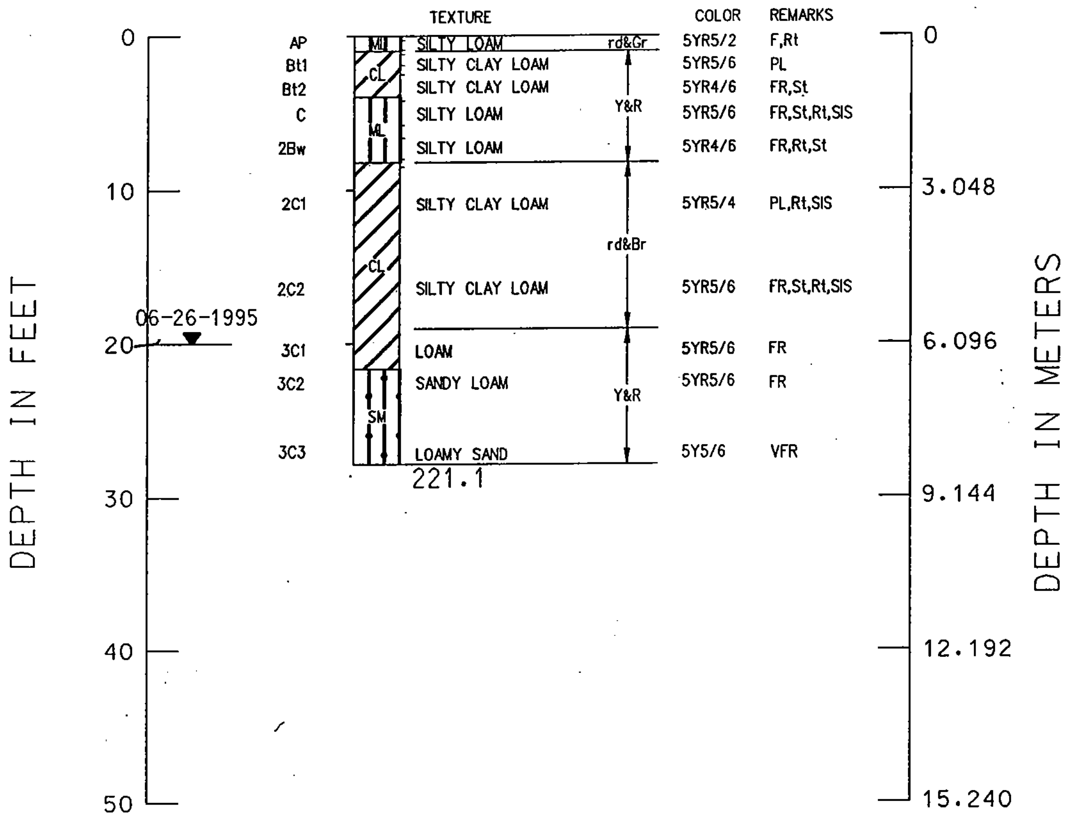
Sec25 T14S R27W
Fulton
11-17-1994
G.S.E. 250.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-24

Sec28 T14S R26W
Fulton
06-26-1995
G.S.E. 249.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

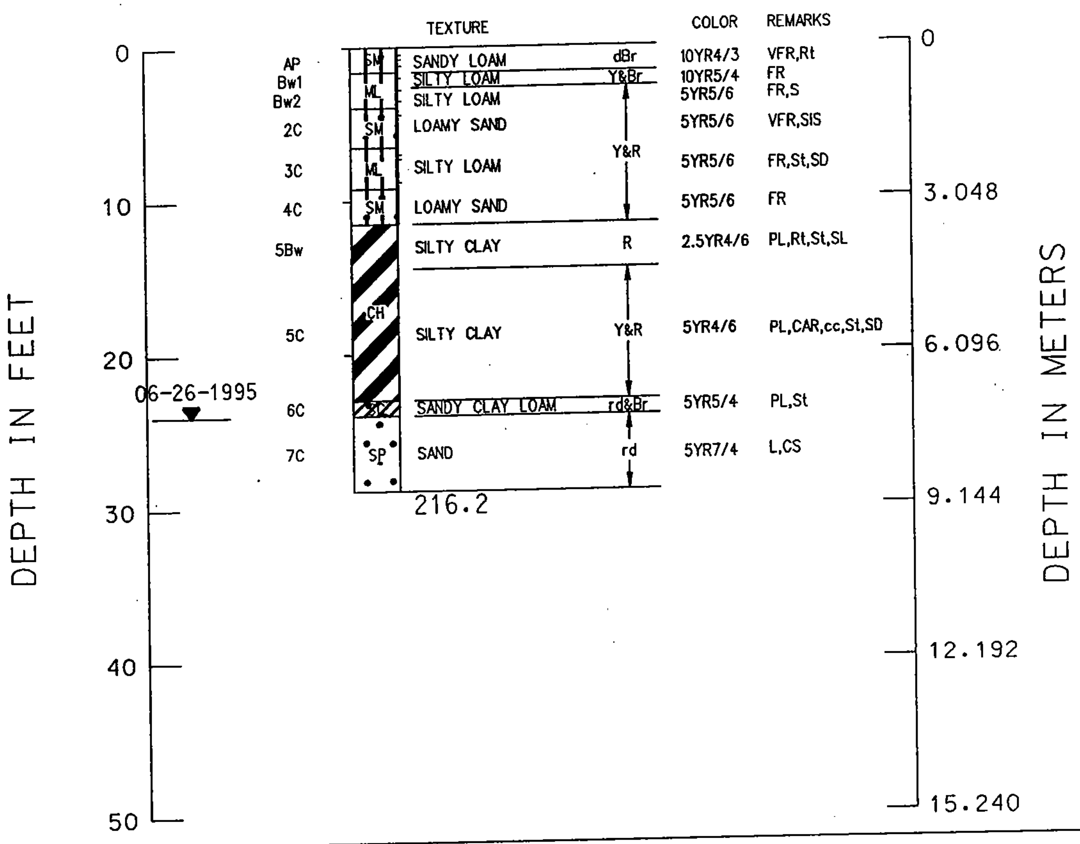
R-25

Sec2 T14S R26W

Fouke NE

06-26-1995

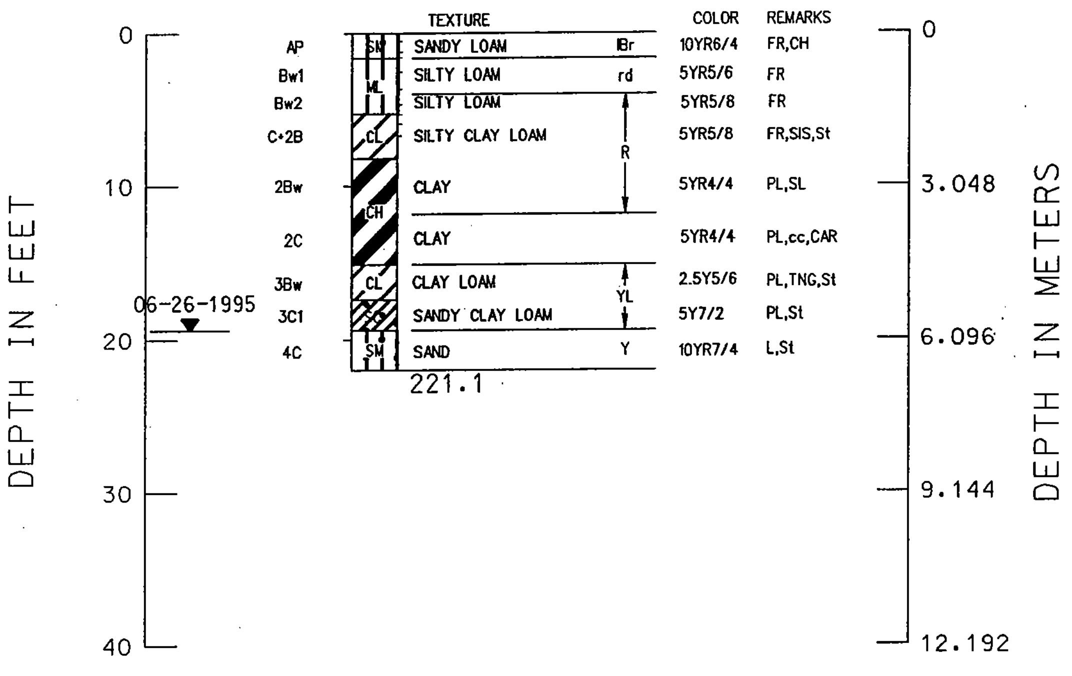
G.S.E. 245.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-26

Sec 3 T14S R26W
Fouke NW
06-26-1995
G.S.E. 243.1

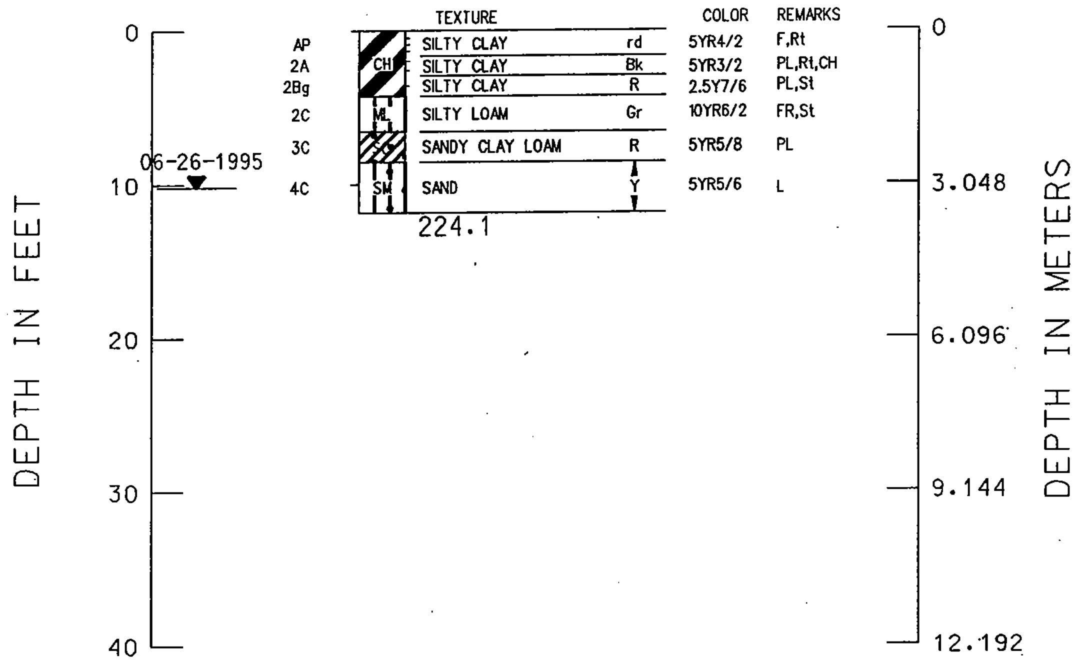


	TEXTURE		COLOR	REMARKS
AP	SANDY LOAM	lBr	10YR6/4	FR,CH
Bw1	SILTY LOAM	rd	5YR5/6	FR
Bw2	SILTY LOAM	R	5YR5/8	FR
C+2B	SILTY CLAY LOAM		5YR5/8	FR,SIS,St
2Bw	CLAY		5YR4/4	PL,SL
2C	CLAY		5YR4/4	PL,cc,CAR
3Bw	CLAY LOAM	YL	2.5Y5/6	PL,TNG,St
3C1	SANDY CLAY LOAM		5Y7/2	PL,St
4C	SAND	Y	10YR7/4	L,St

RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-27

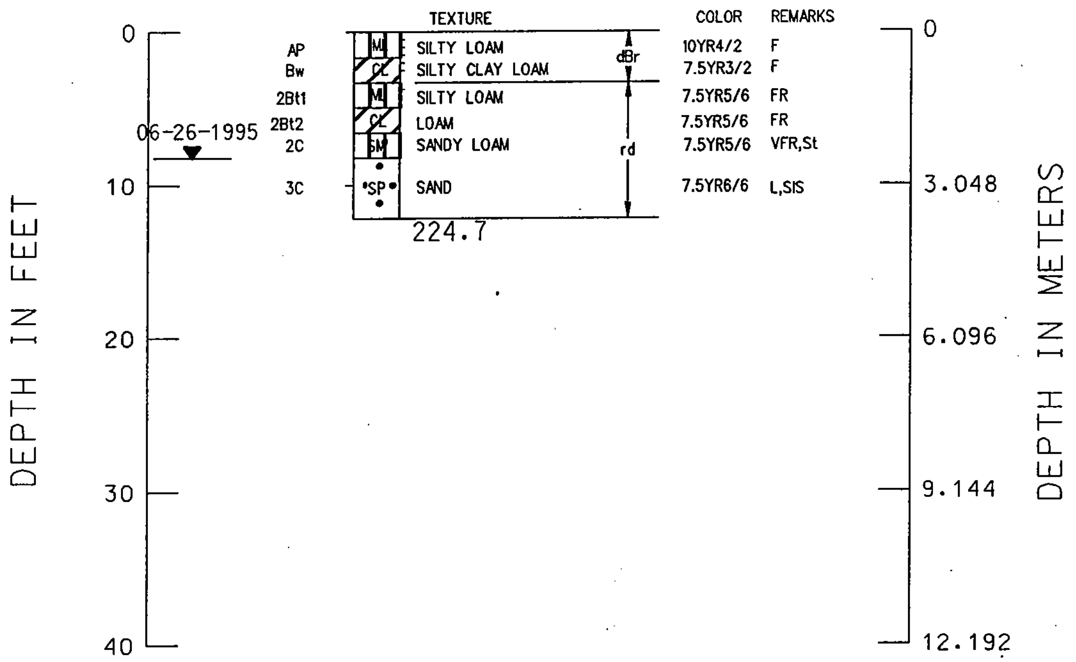
Sec 3 T15S R26W
Fouke NE
06-26-1995
G.S.E. 235.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-28

Sec 8 T15S R26W
Fulton
06-26-1995
G.S.E. 236.9

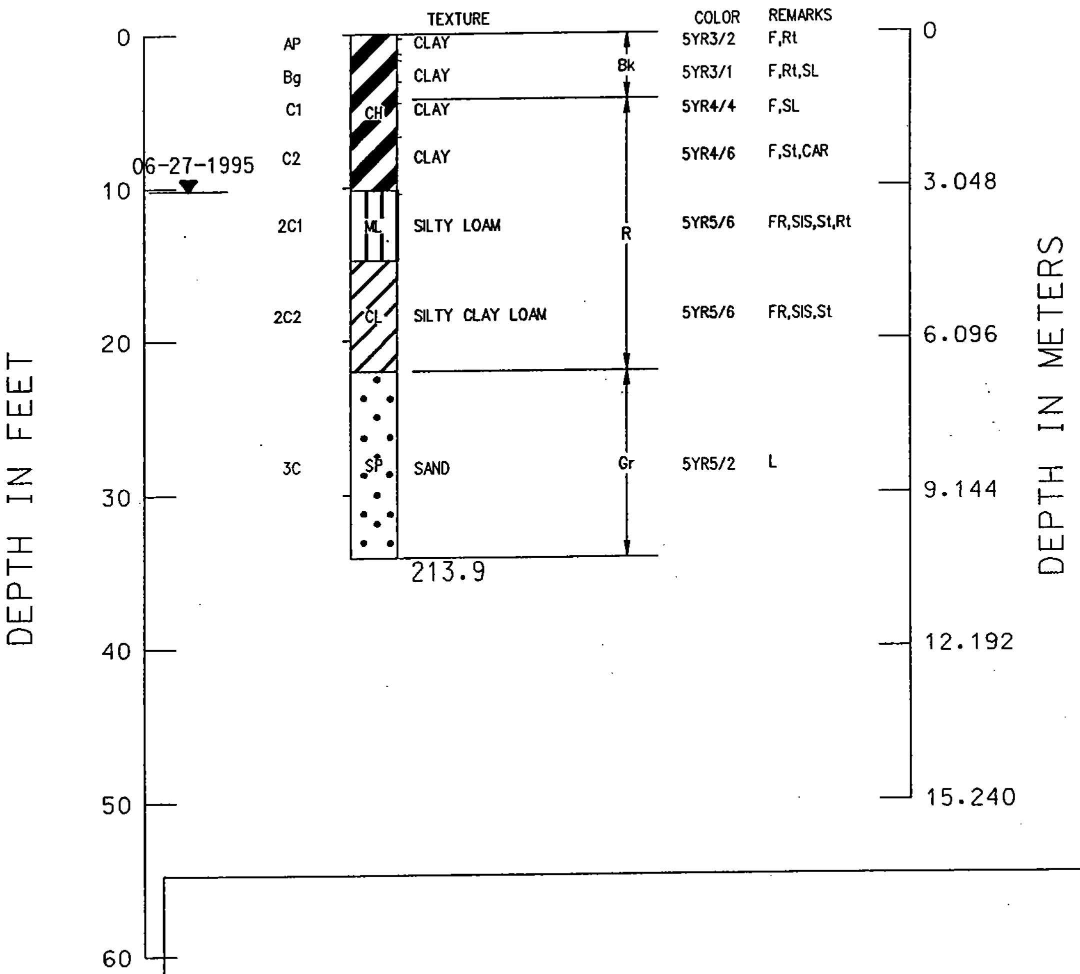


	TEXTURE	COLOR	REMARKS
AP	SILTY LOAM	10YR4/2	F
Bw	SILTY CLAY LOAM	7.5YR3/2	F
2Bt1	SILTY LOAM	7.5YR5/6	FR
2Bt2	LOAM	7.5YR5/6	FR
2C	SANDY LOAM	7.5YR5/6	VFR,St
3C	SAND	7.5YR6/6	L,SIS

RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-29

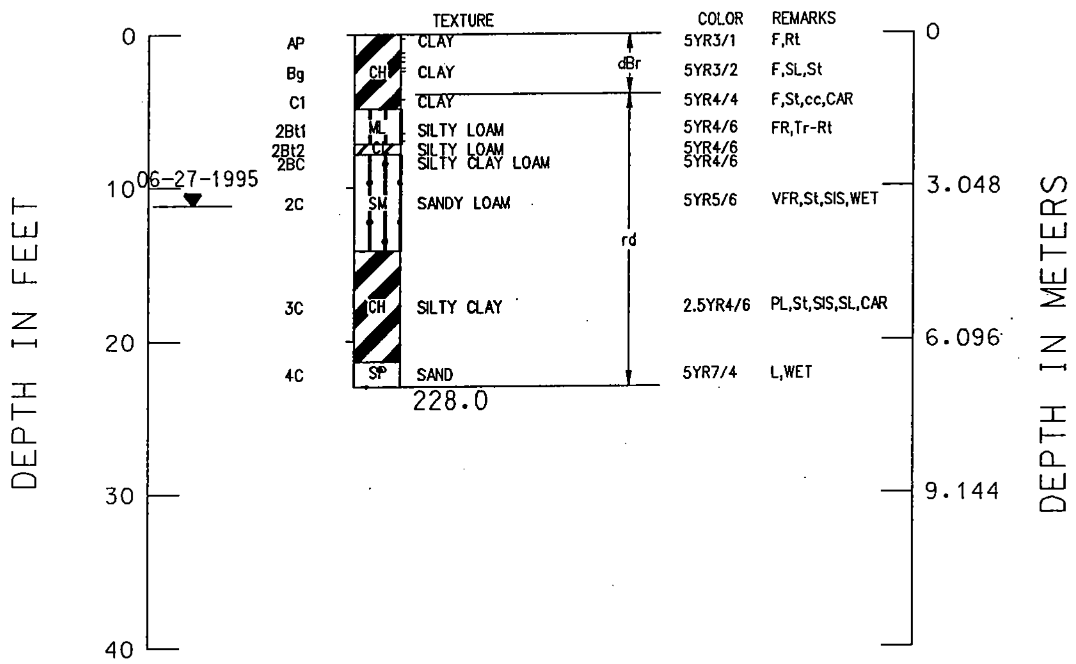
Sec 20 T14S R26W
Fulton
06-27-1995
G.S.E. 248.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-30

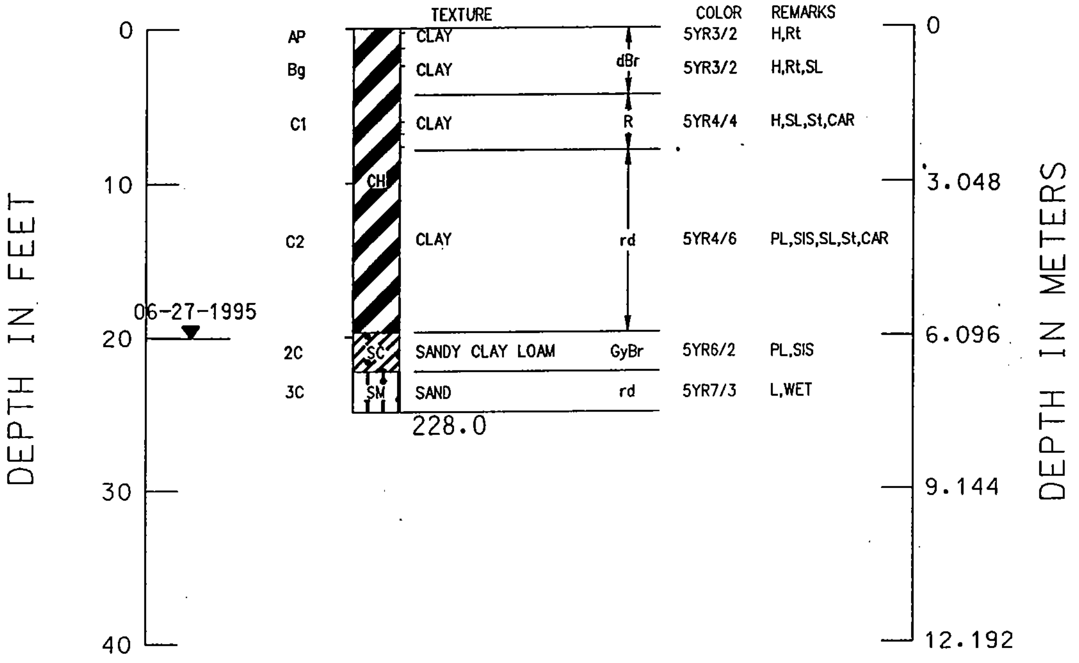
Sec24 T14S R27W
Fulton
06-27-1995
G.S.E. 251.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-31

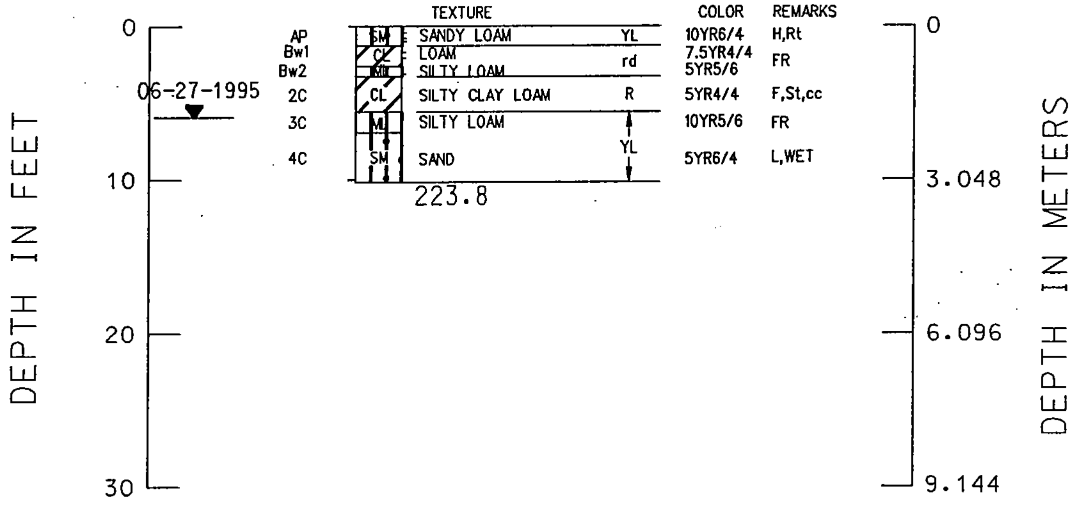
Sec23 T14N R27W
Fulton
06-27-1995
G.S.E. 253.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-32

Sec31 +15S R25W
Boyd Hill
06-27-1995
G.S.E. 233.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

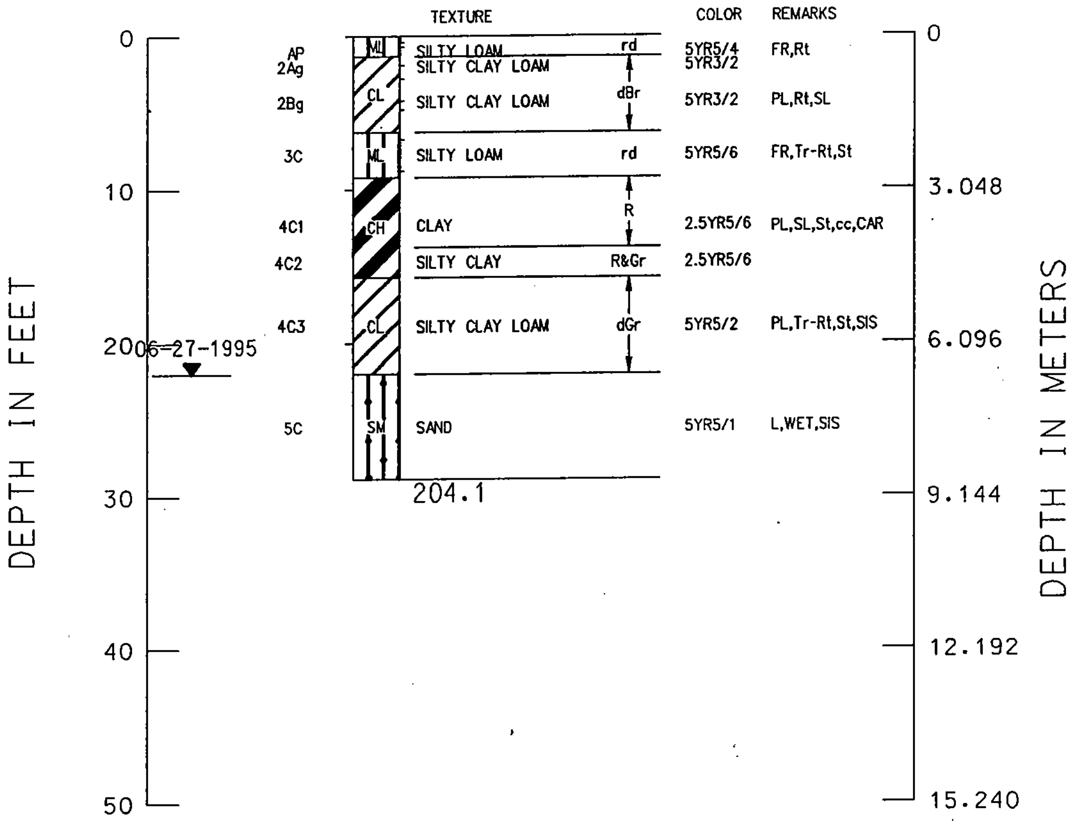
R-33

Sec36 T15S R26W

Boyd Hill

06-27-1995

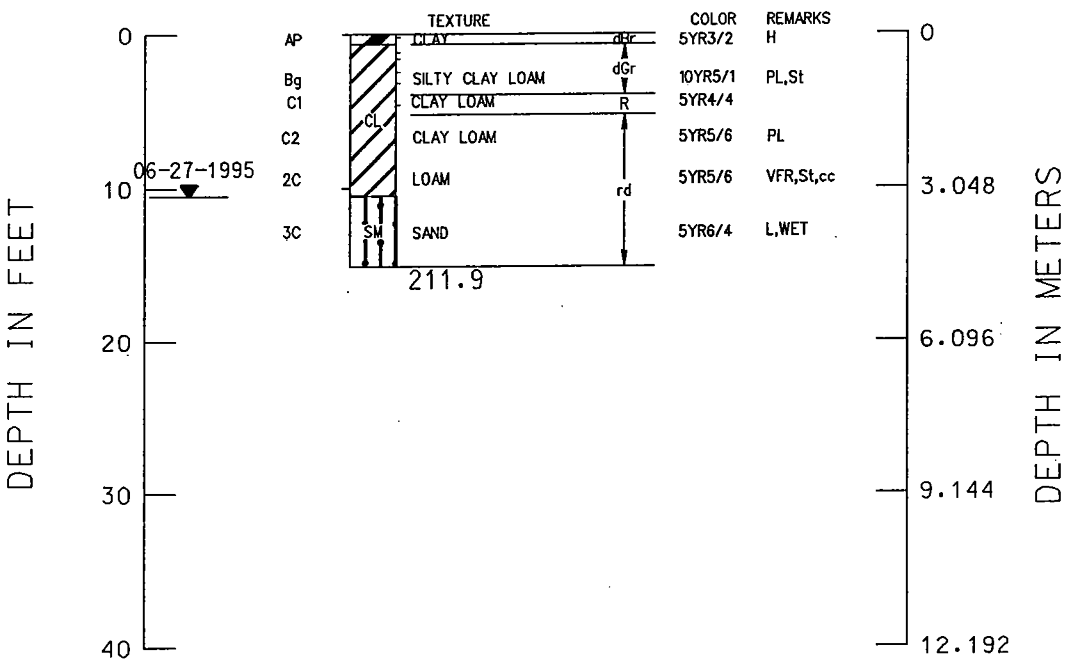
G.S.E. 232.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-34

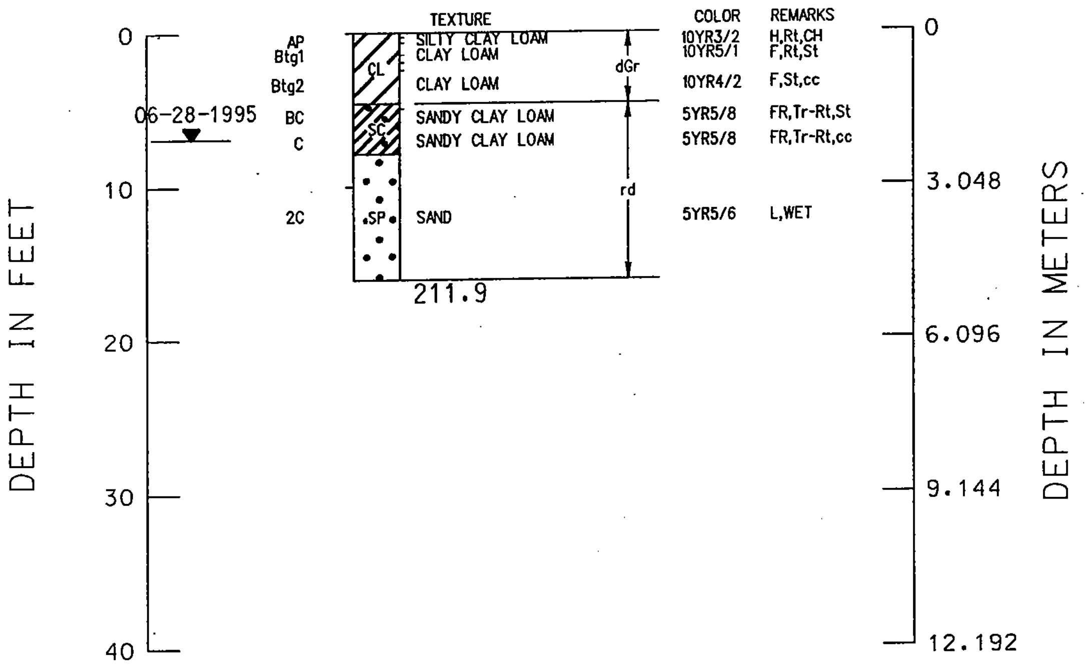
Sec34 T15S R26W
Fouke NE
06-27-1995
G.S.E. 227.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-35

Sec33 T15S R26W
Fouke NE
06-28-1995
G.S.E. 228.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

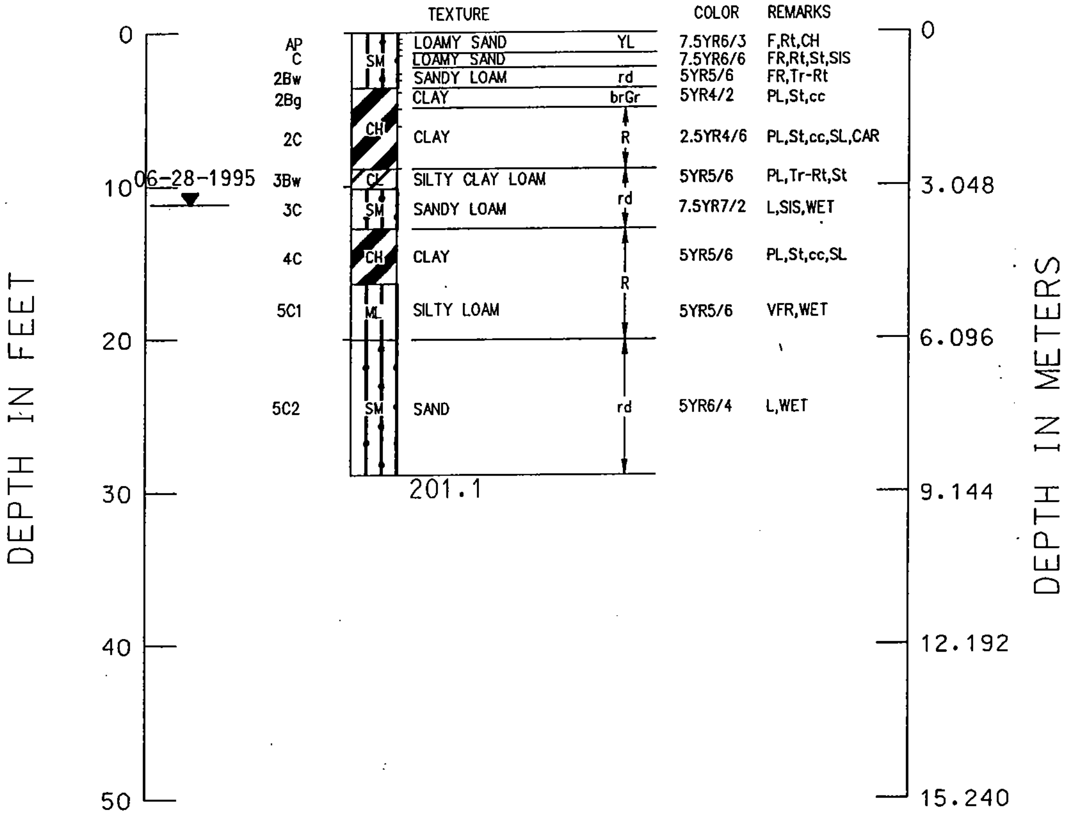
R-36

Sec3 T16S R25W

Boyd Hill

06-28-1995

G.S.E. 230.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

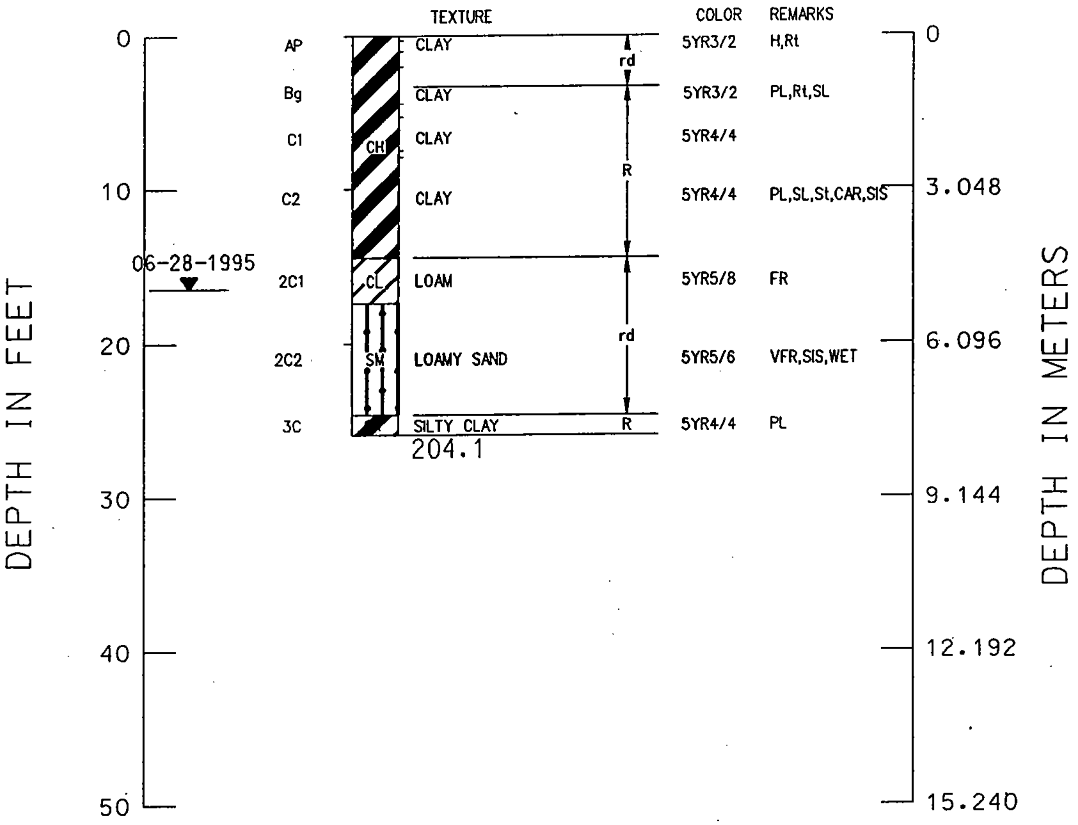
R-37

Sec36 T15S R25W

Boyd Hill

06-28-1995

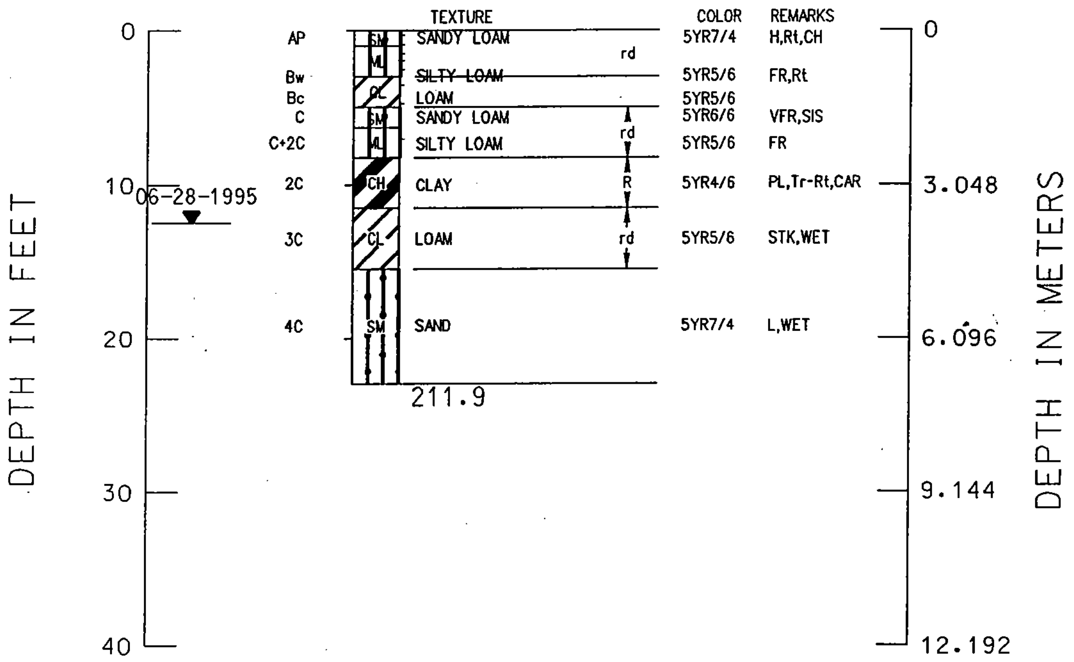
G.S.E. 230.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-38

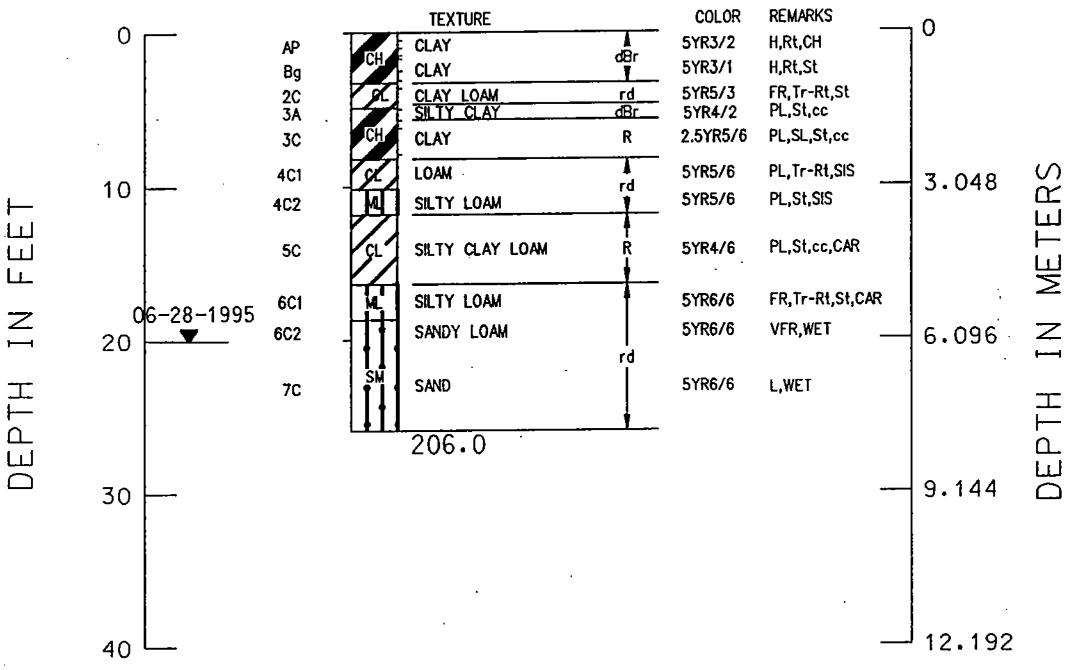
Sec26 T15N R25W
Boyd Hill
06-28-1995
G.S.E. 234.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-39

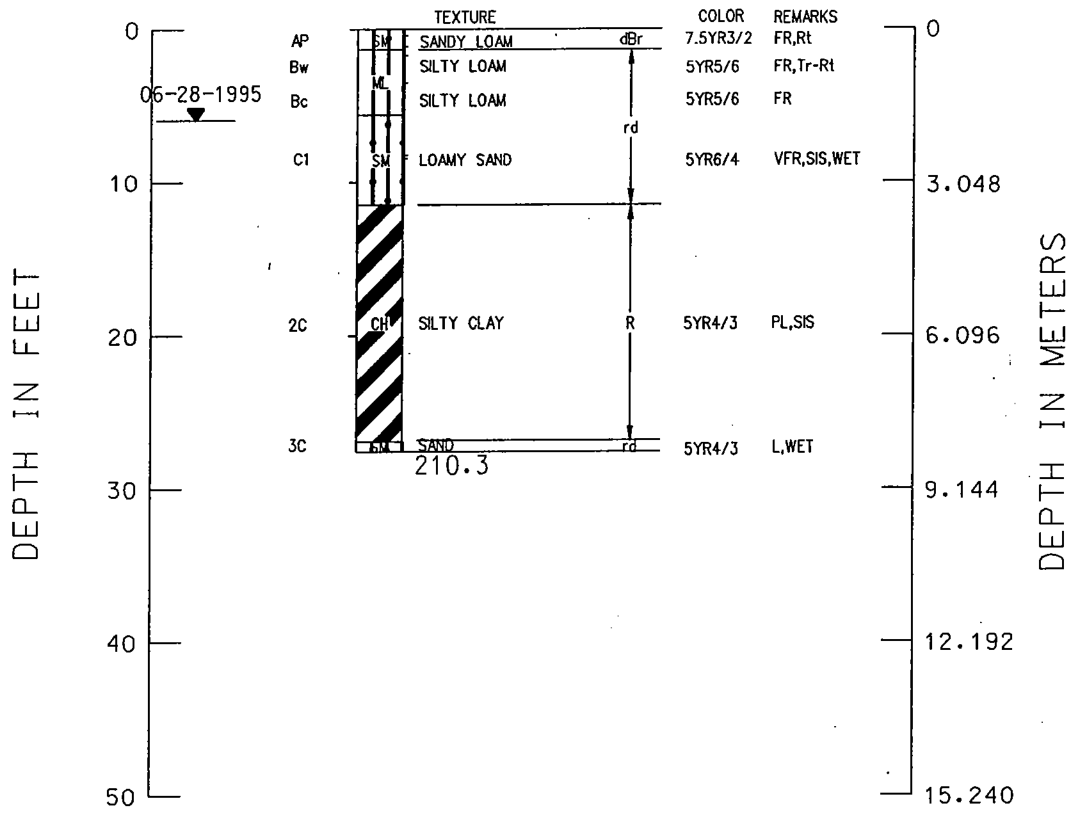
Sec24 T15S R25W
Boyd Hill
06-28-1995
G.S.E. 232.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-40

Sec27 T15S R25W
Boyd Hill
06-28-1995
G.S.E. 237.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

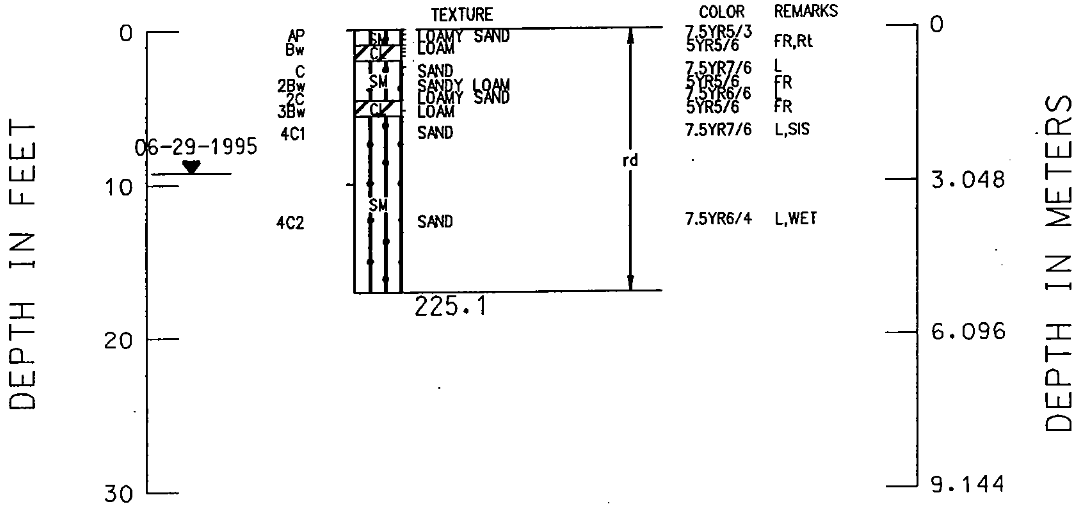
R-41

Sec9 T15S R25W

Boyd Hill

06-29-1995

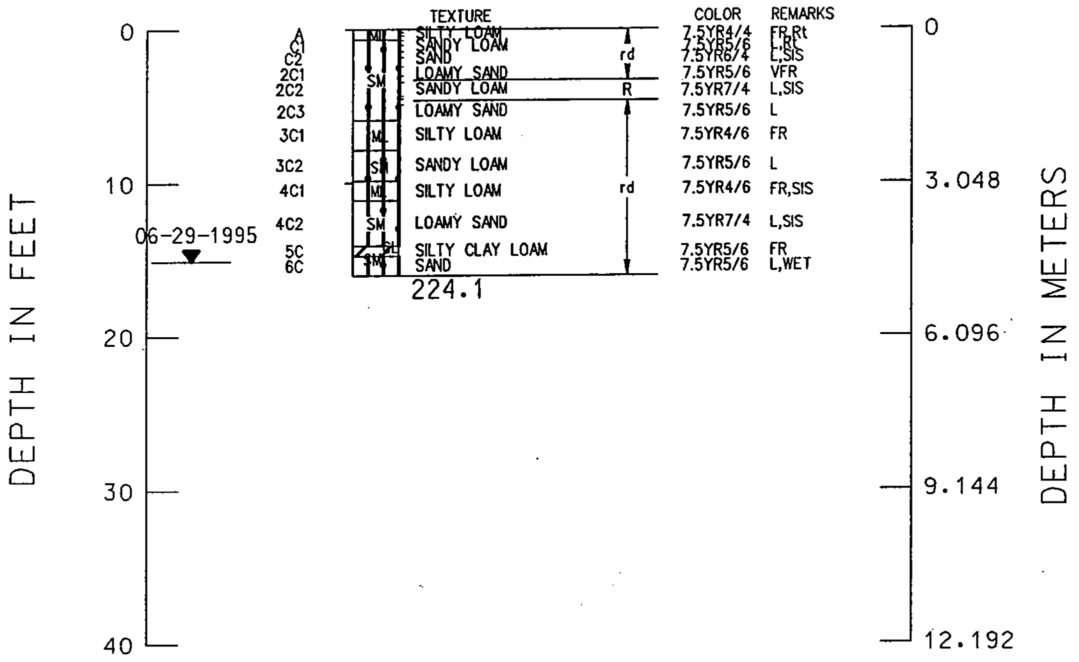
G.S.E. 242.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-42

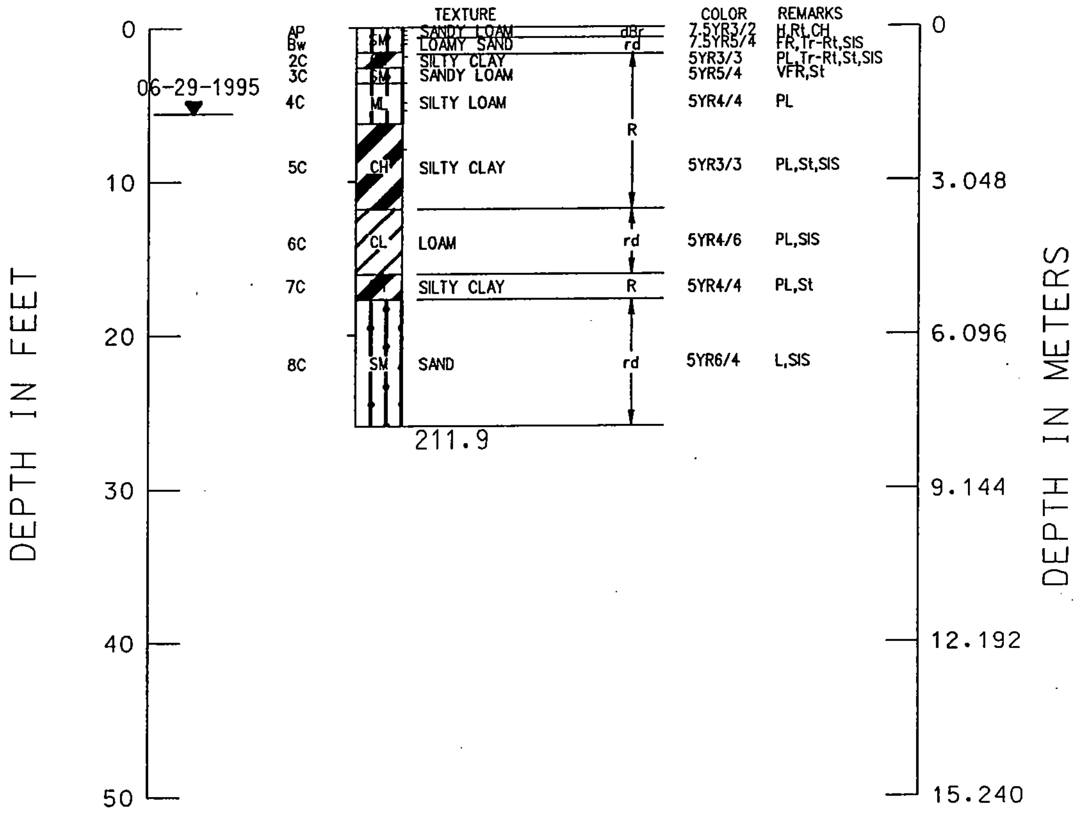
Sec8 T15S R25W
Boyd Hill
06-29-1995
G.S.E. 240.2



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-43

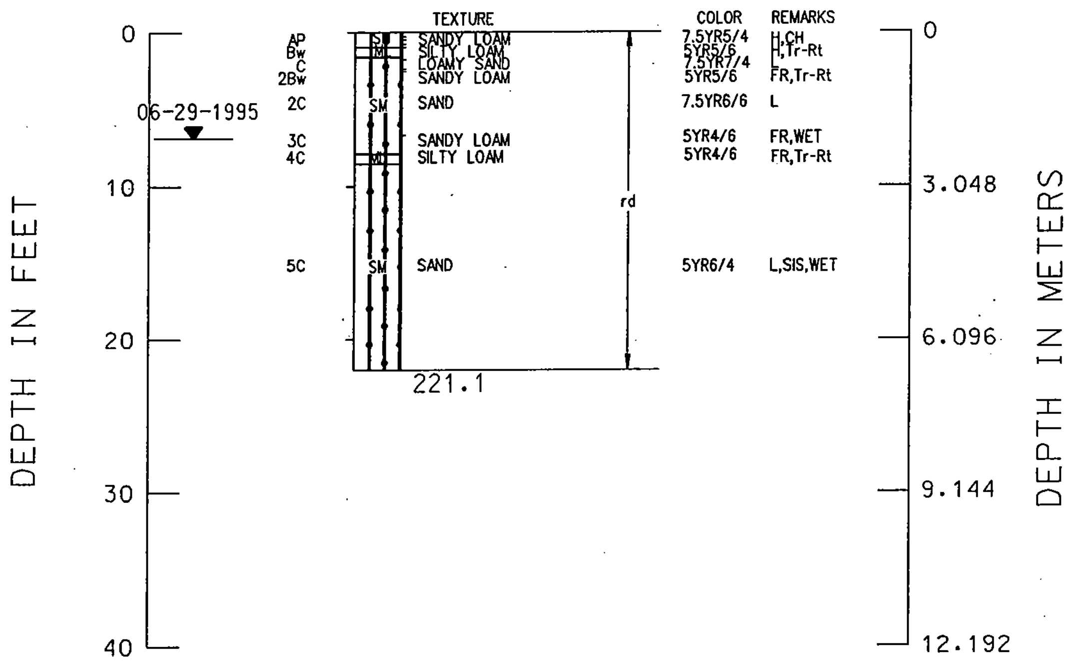
Sec9 T15S R25W
Boyd Hill
06-29-1995
G.S.E. 237.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-44

Sec9 T15S R25W
Boyd Hill
06-29-1995
G.S.E. 243.1



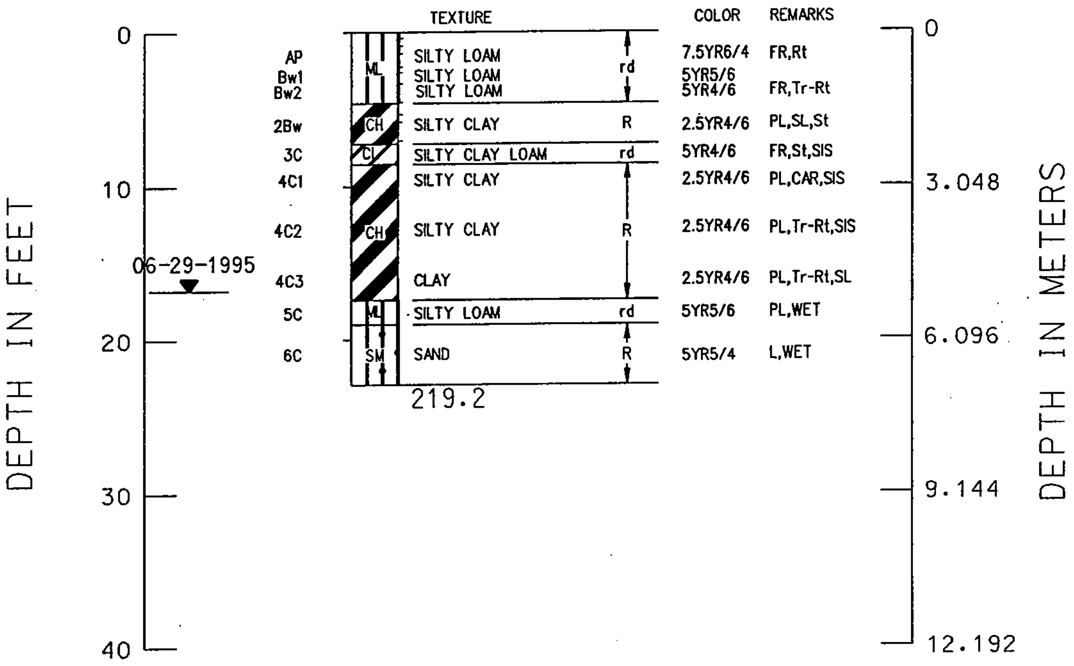
RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-45

Sec40 T15S R25W
Boyd Hill

06-29-1995

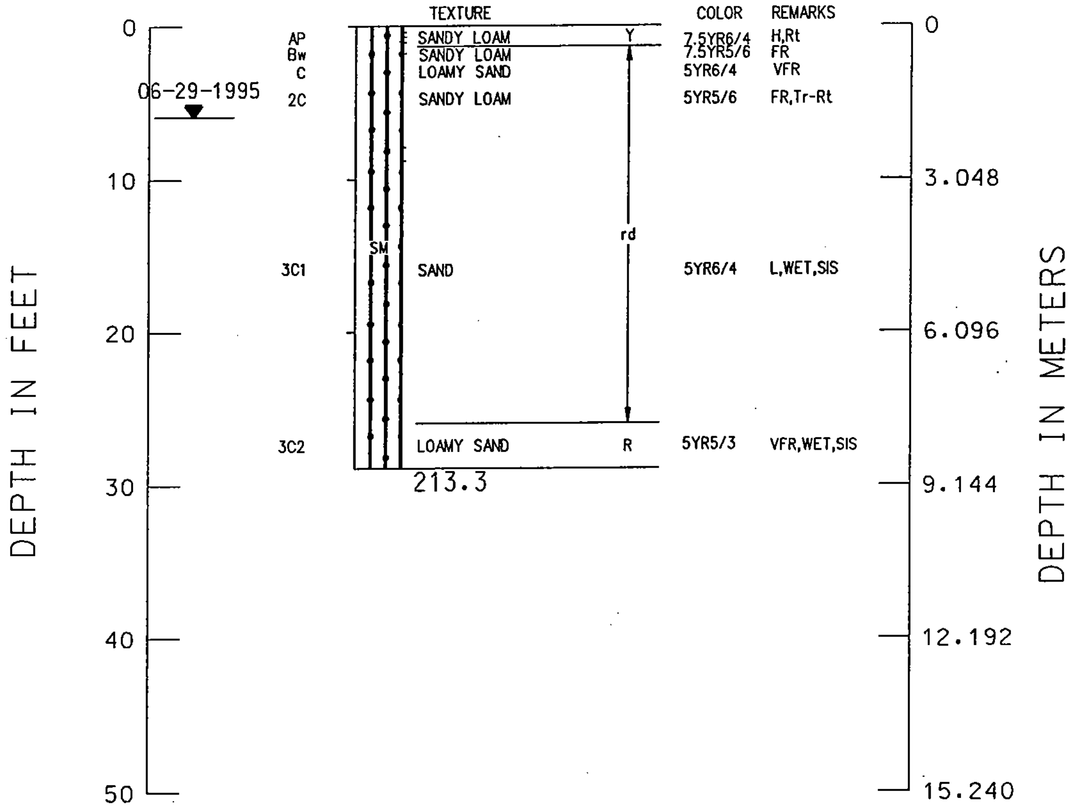
G.S.E. 242.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-46

Sec15 T15S R25W
Boyd Hill
06-29-1995
G.S.E. 242.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

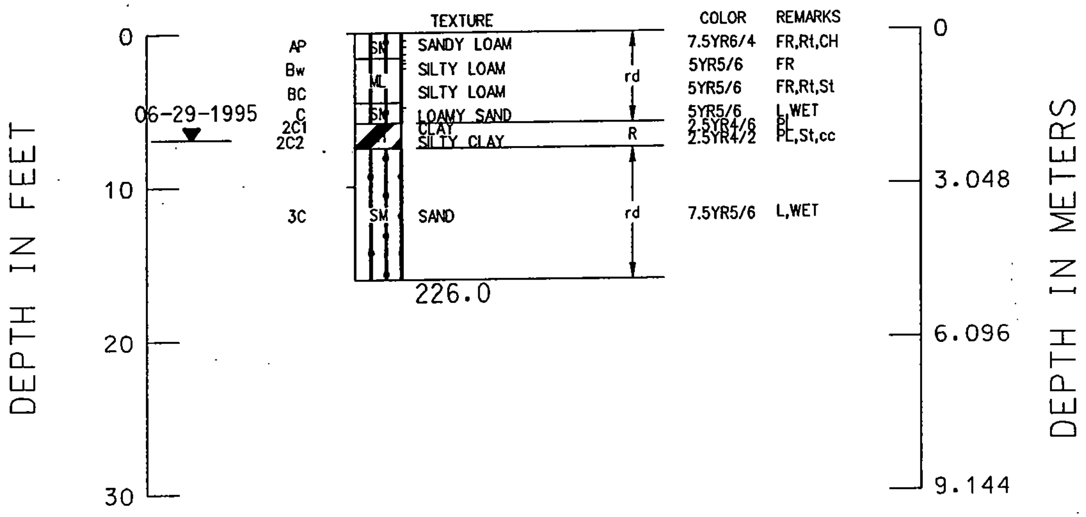
R-47

Sec14 T15S R25W

Boyd Hill

06-29-1995

G.S.E. 242.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

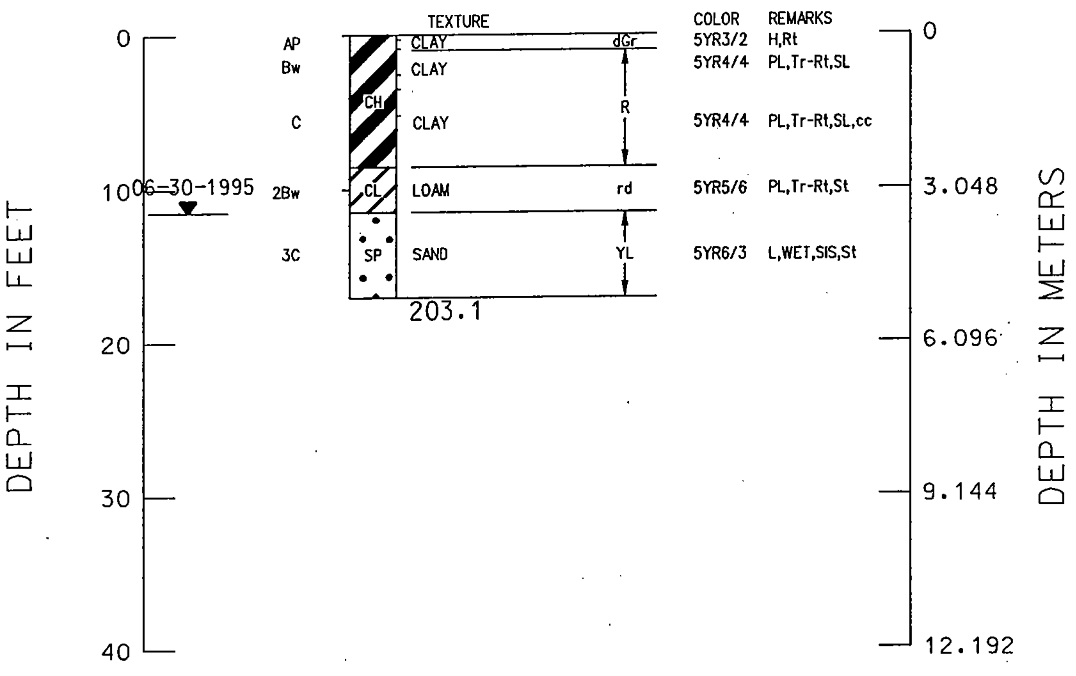
R-48

Sec30 T16S R25W

Garland

06-30-1995

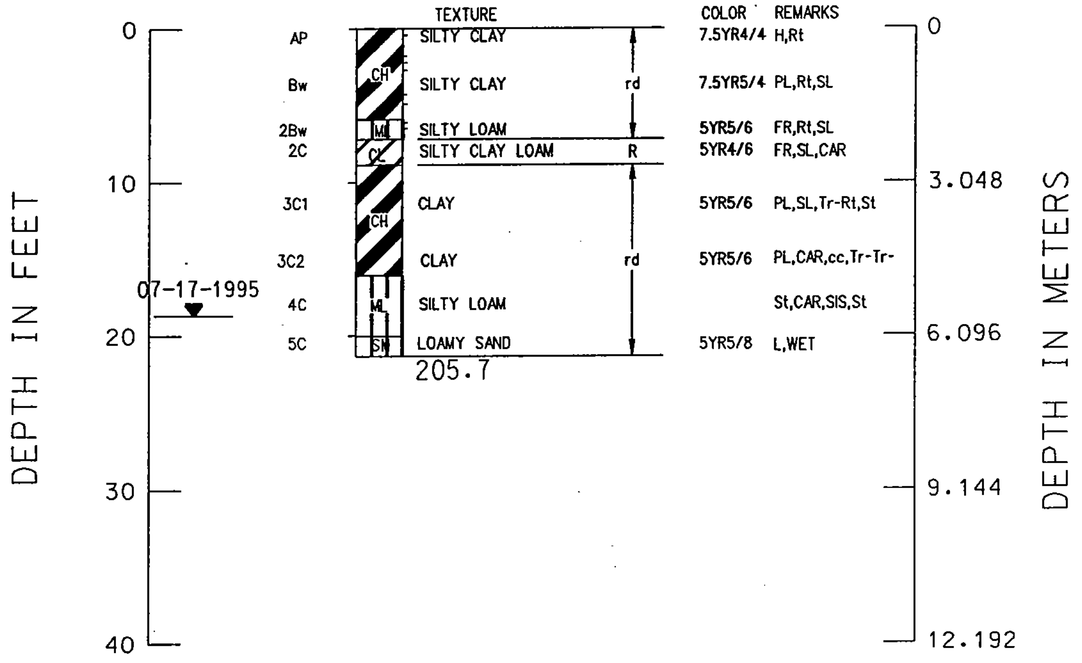
G.S.E. 220.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-49

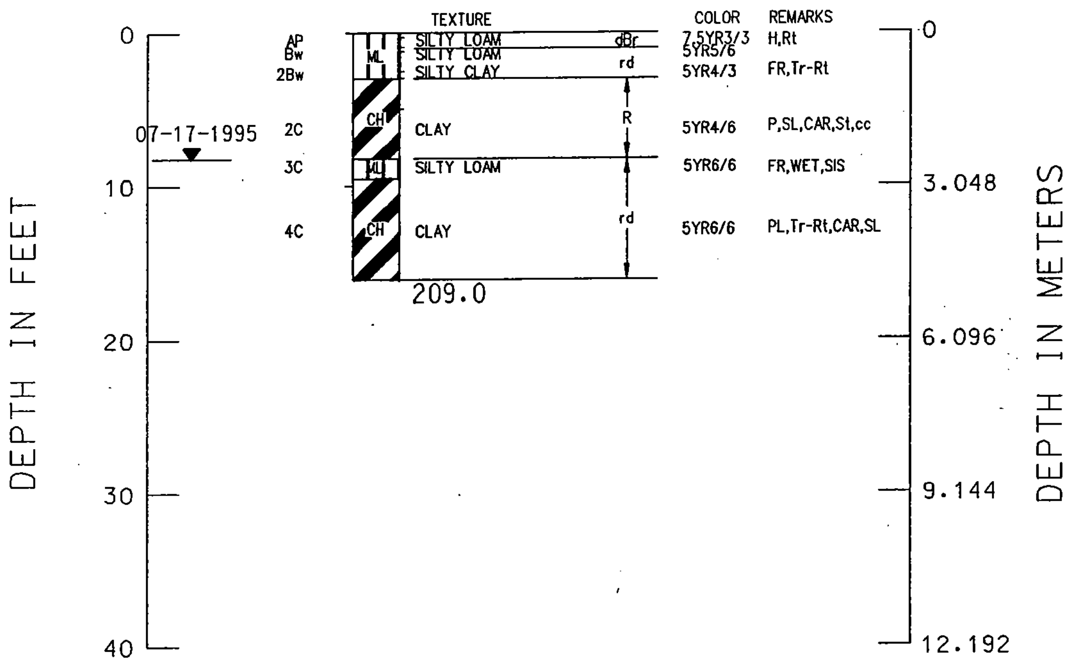
Sec29 T16S R25W
Garland
07-17-1995
G.S.E. 227.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-50

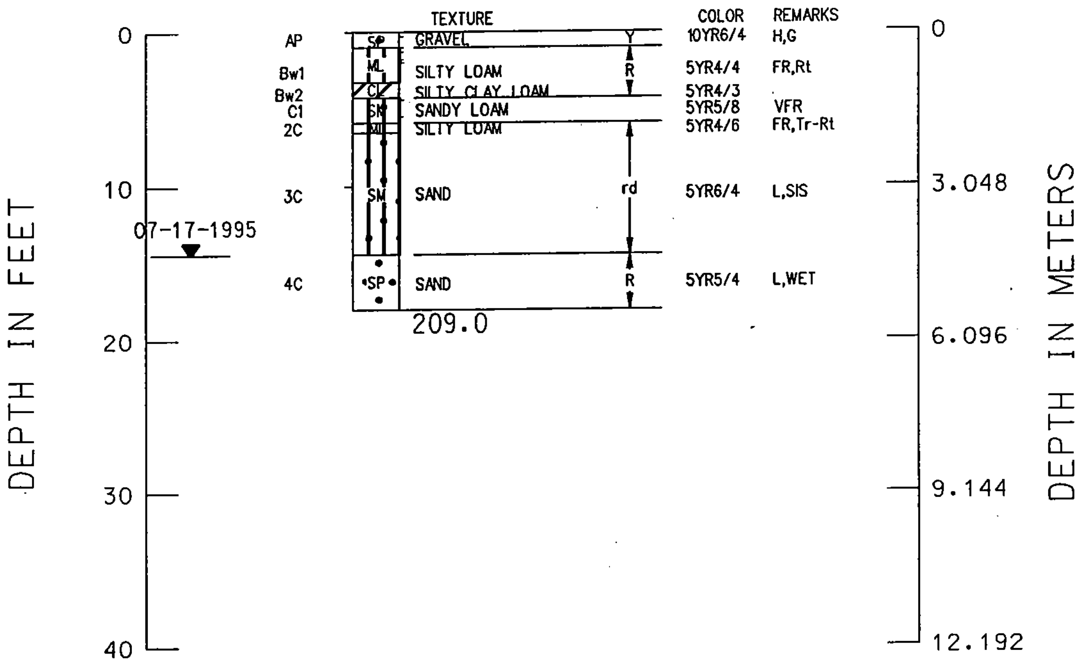
Sec29 T15S R25W
Garland
07-17-1995
G.S.E. 225.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-51

Sec28 T15S R25W
Garland
07-17-1995
G.S.E. 227.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

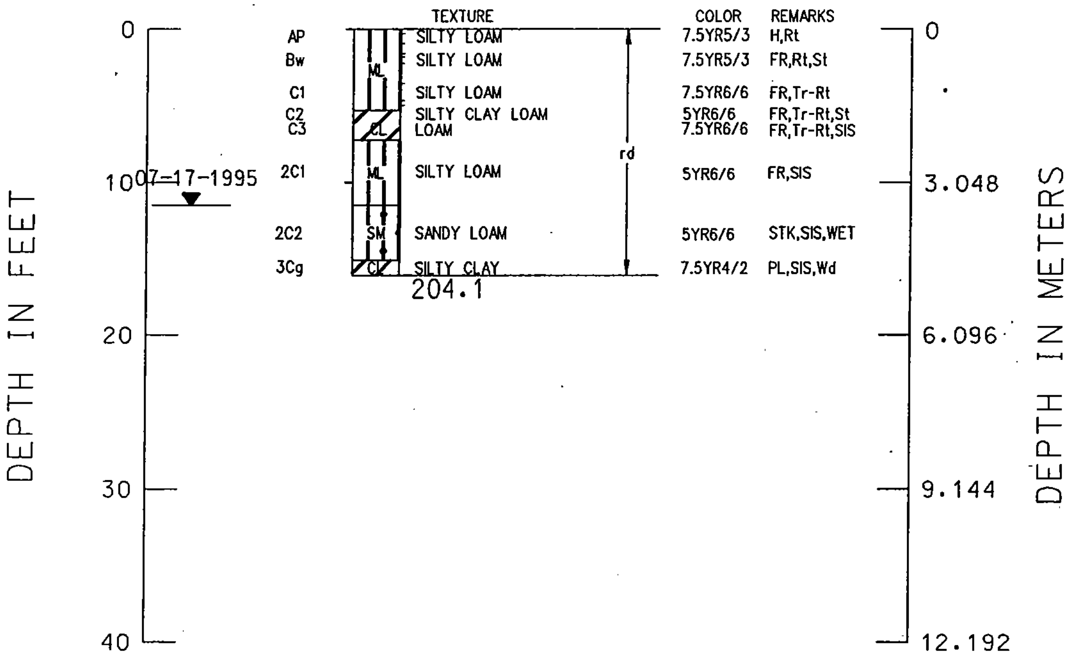
R-52

Sec18 T17N R25W

Garland

07-17-1995

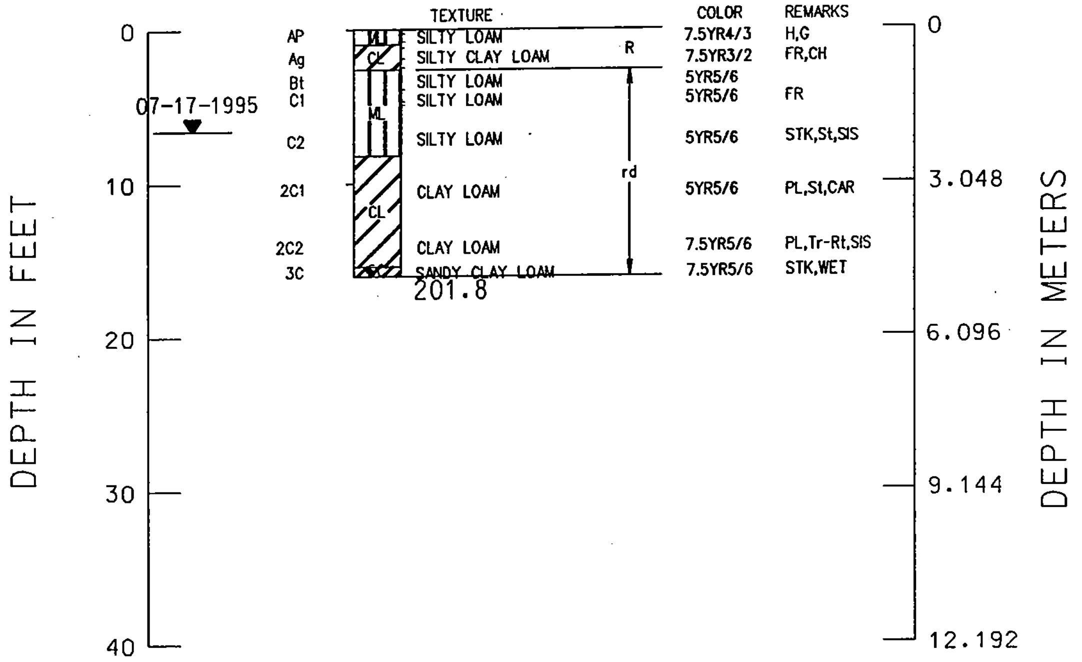
G.S.E. 220.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-53

Sec13 T17N R24W
Garland
07-17-1995
G.S.E. 217.8

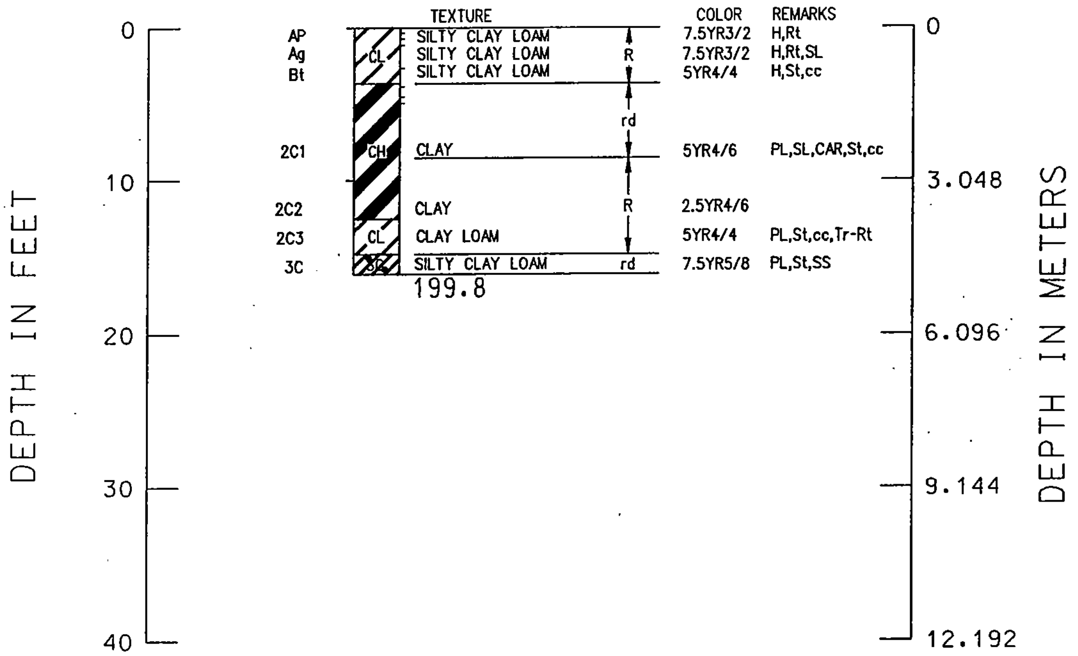


	TEXTURE	COLOR	REMARKS
AP	SILTY LOAM	7.5YR4/3	H,G
Ag	SILTY CLAY LOAM	7.5YR3/2	FR,CH
Bt	SILTY LOAM	5YR5/6	
C1	SILTY LOAM	5YR5/6	FR
C2	SILTY LOAM	5YR5/6	STK,St,SIS
2C1	CLAY LOAM	5YR5/6	PL,St,CAR
2C2	CLAY LOAM	7.5YR5/6	PL,Tr-Rt,SIS
3C	SANDY CLAY LOAM	7.5YR5/6	STK,WET

RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-54

Sec11 T18S R26W
Doddridge NE
07-17-1995
G.S.E. 215.9

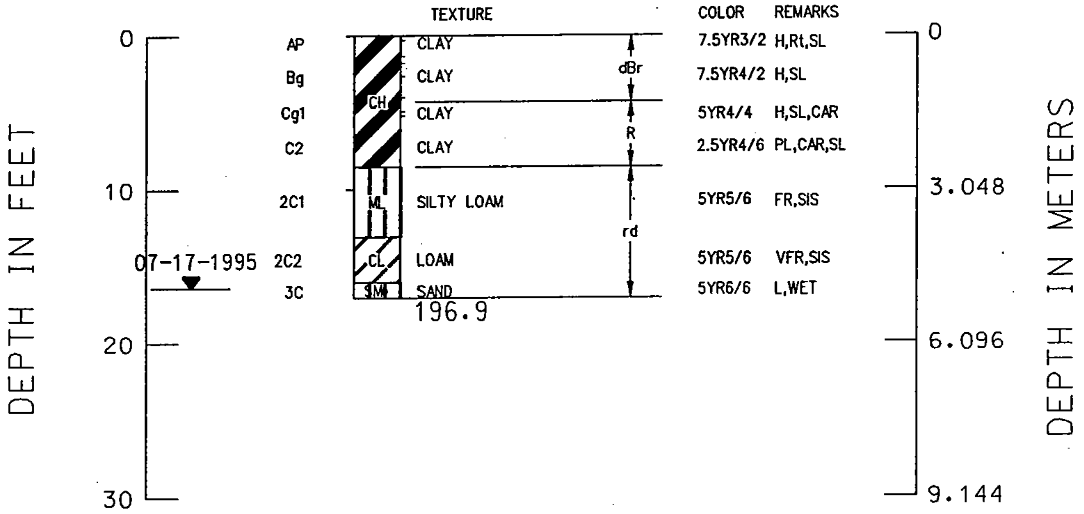


	TEXTURE	COLOR	REMARKS
AP	SILTY CLAY LOAM	7.5YR3/2	H,Rt
Ag	SILTY CLAY LOAM	7.5YR3/2	H,Rt,SL
Bt	SILTY CLAY LOAM	5YR4/4	H,St,cc
2C1	CLAY	5YR4/6	PL,SL,CAR,St,cc
2C2	CLAY	2.5YR4/6	
2C3	CLAY LOAM	5YR4/4	PL,St,cc,Tr-Rt
3C	SILTY CLAY LOAM	7.5YR5/8	PL,St,SS

RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-55

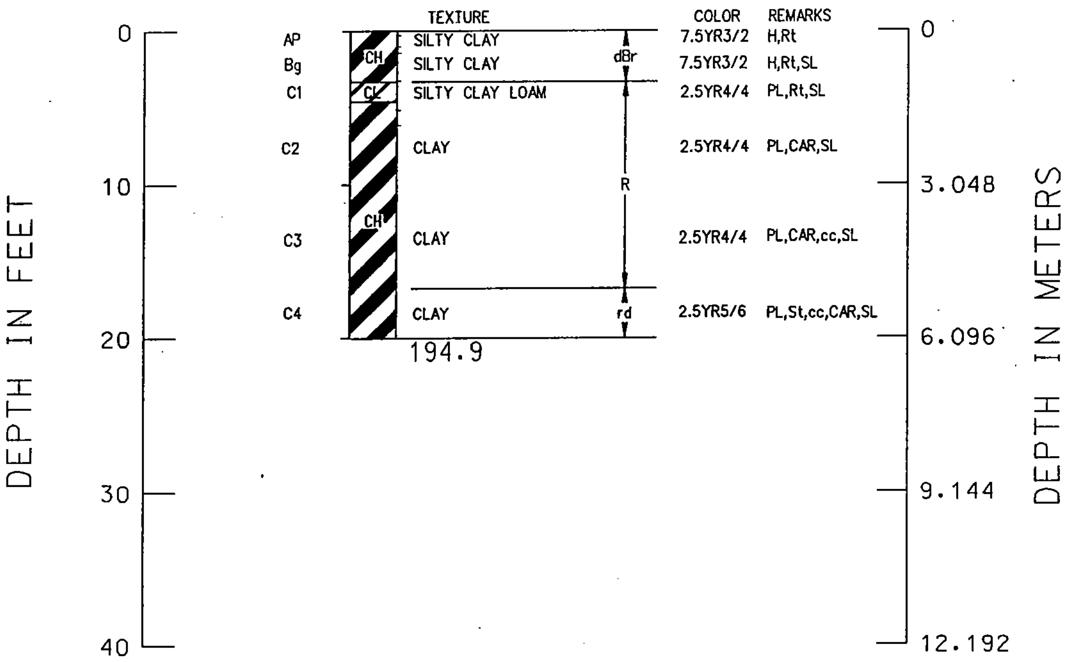
Sec11 T18S R26W
Doddridge NE
07-17-1995
G.S.E. 213.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-56

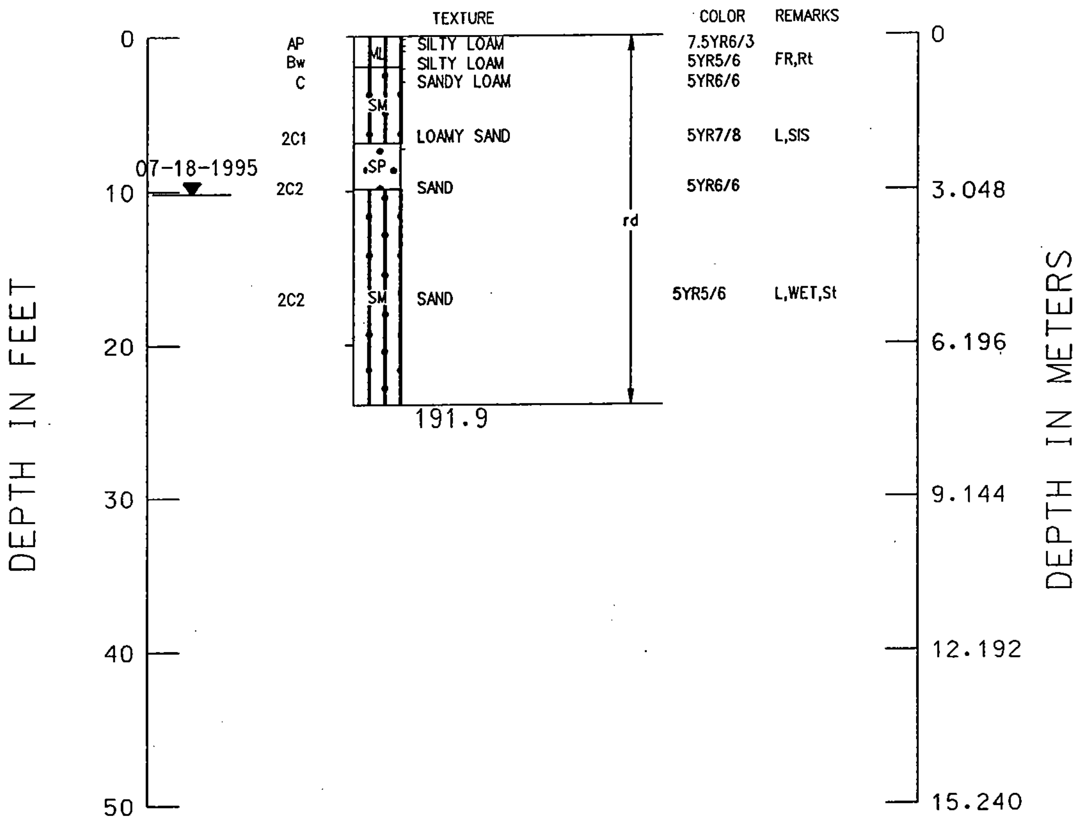
Sec15 T18S R26W
Doddridge NE
07-18-1995
G.S.E. 214.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-57

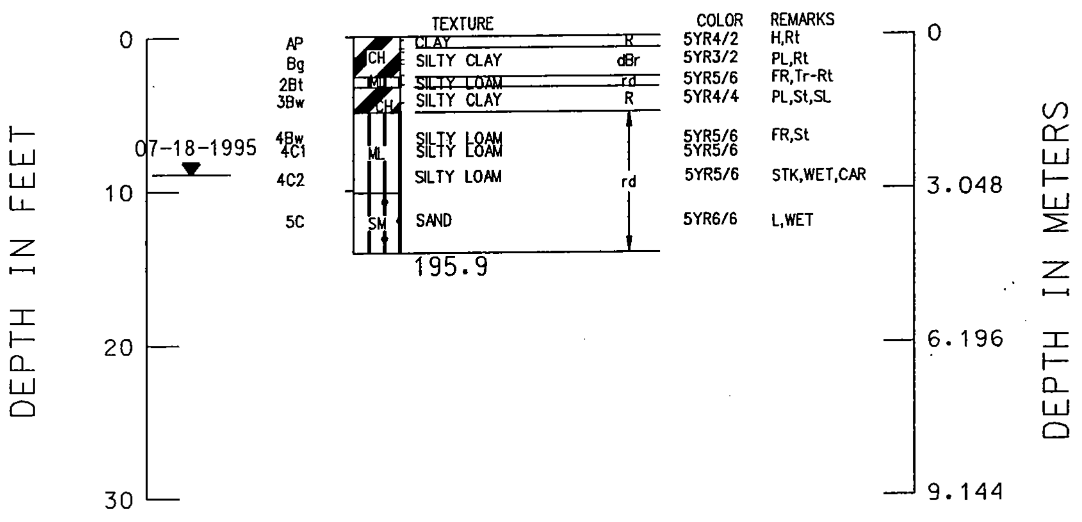
Sec15 T18S R26W
Doddridge NE
07-18-1995
G.S.E. 215.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-58

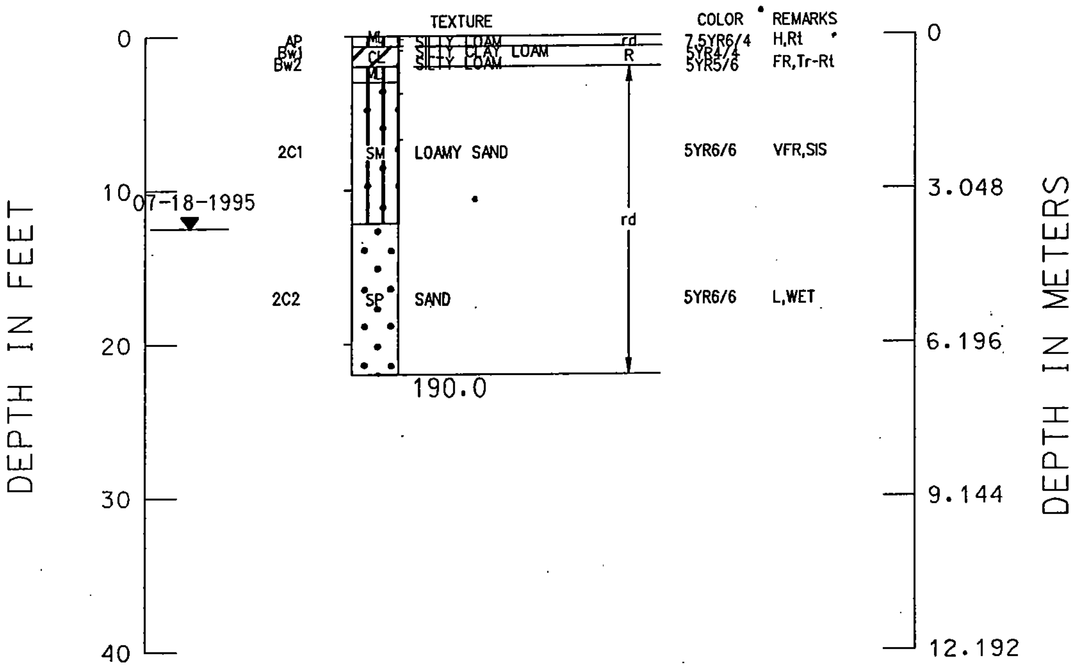
Sec 22 T18N R26W
Doddridge NE
07-18-1995
G.S.E. 210.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-59

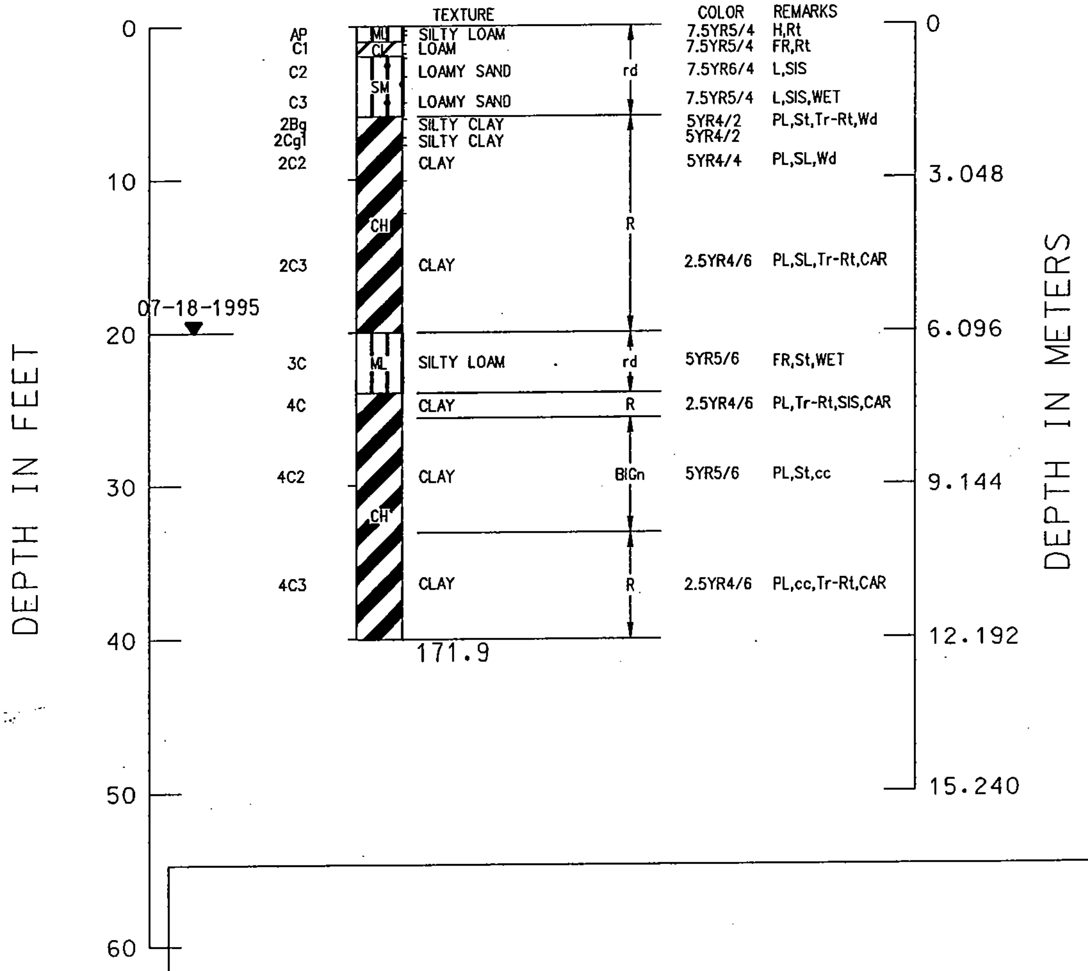
Sec27 T18S R26W
Doddridge NE
07-18-1995
G.S.E. 211.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-60

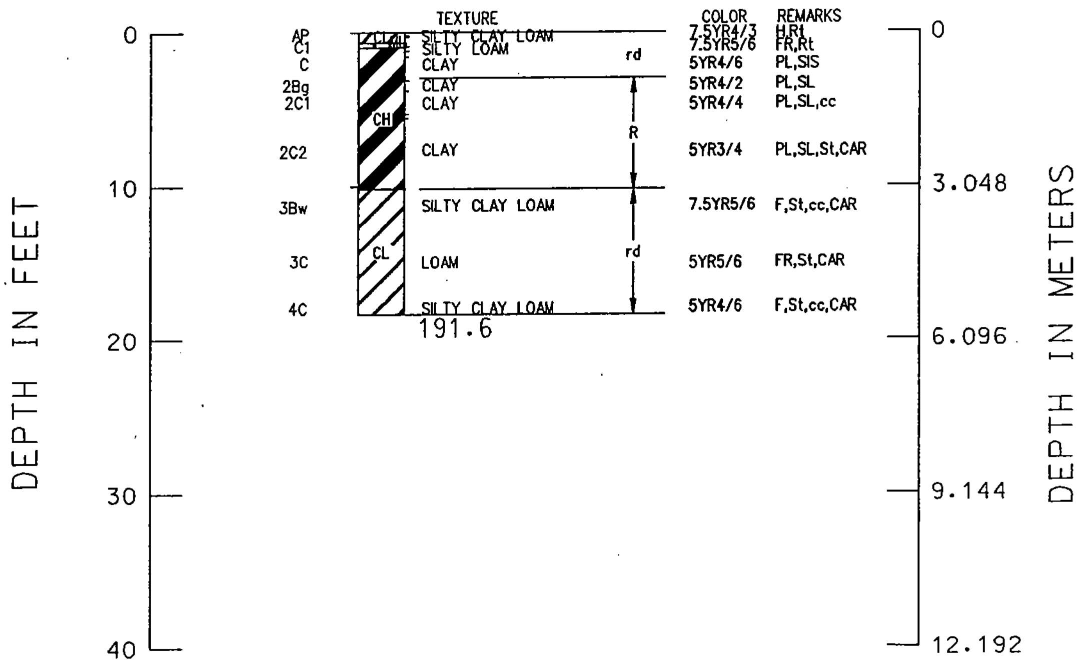
Sec 30 T18N R26W
Doddridge NE
07-18-1995
G.S.E. 211.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-61

Sec30 T18N R26W
Doddridge NE
07-18-1995
G.S.E. 210.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

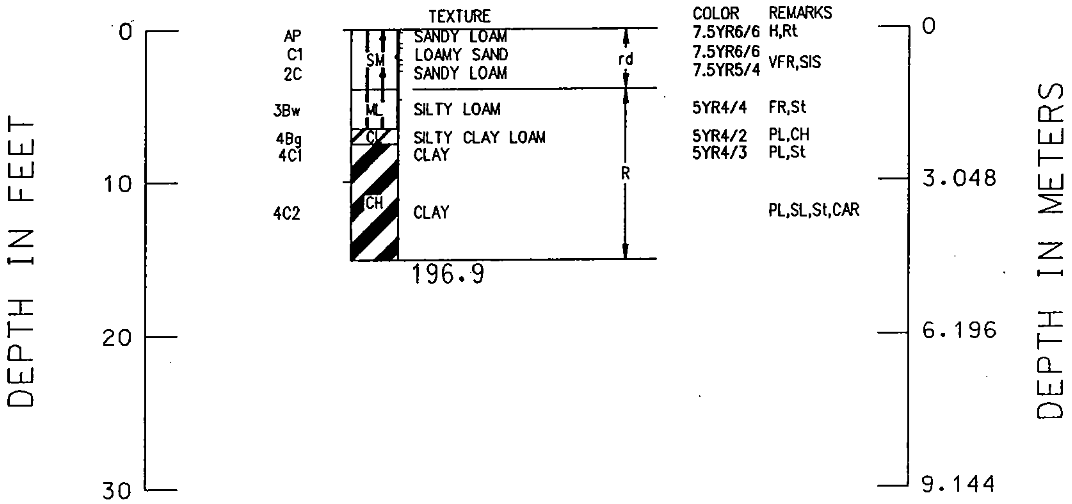
R-62

Sec30 T18N R26W

Doddridge NE

07-18-1995

G.S.E. 211.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

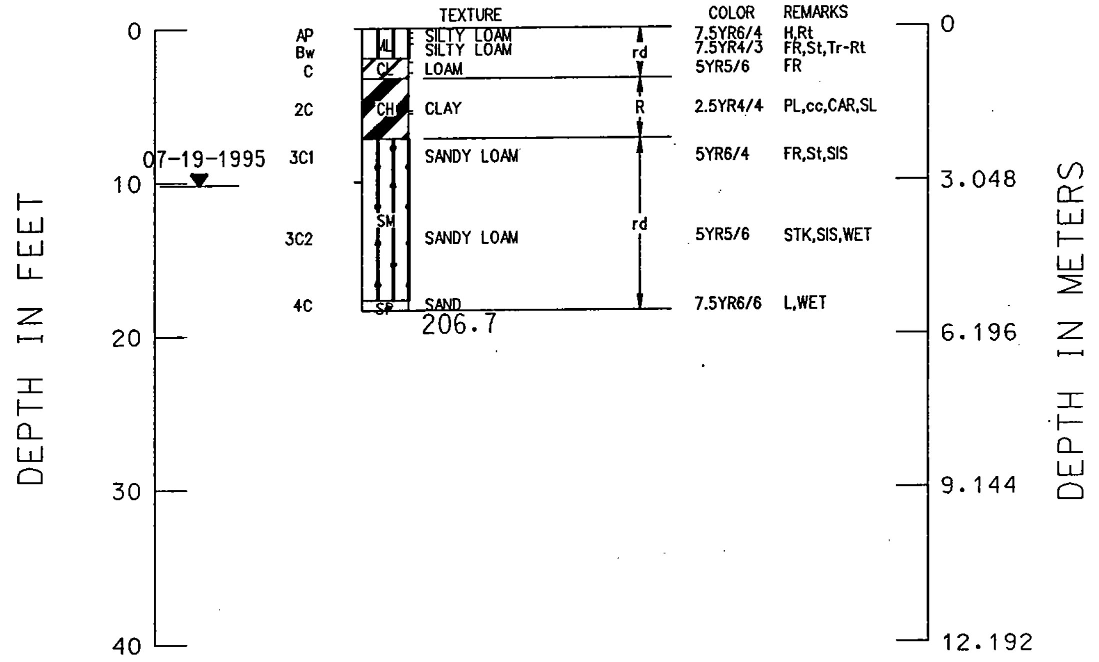
R-63

Sec35 T16S R25W

Garland

01-19-1995

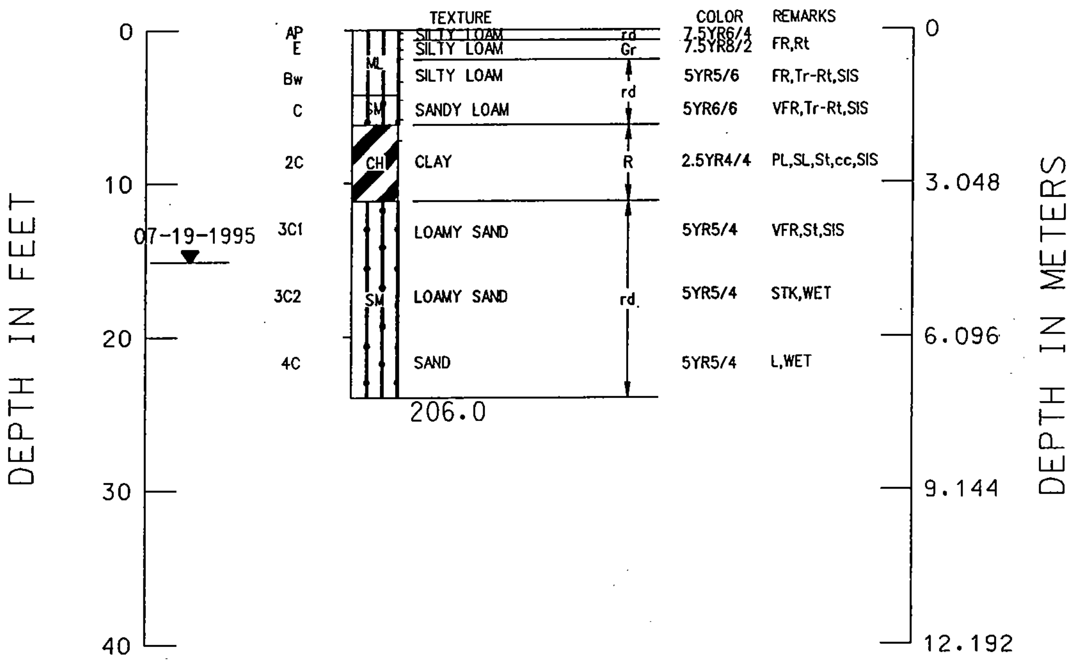
G.S.E. 225.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-64

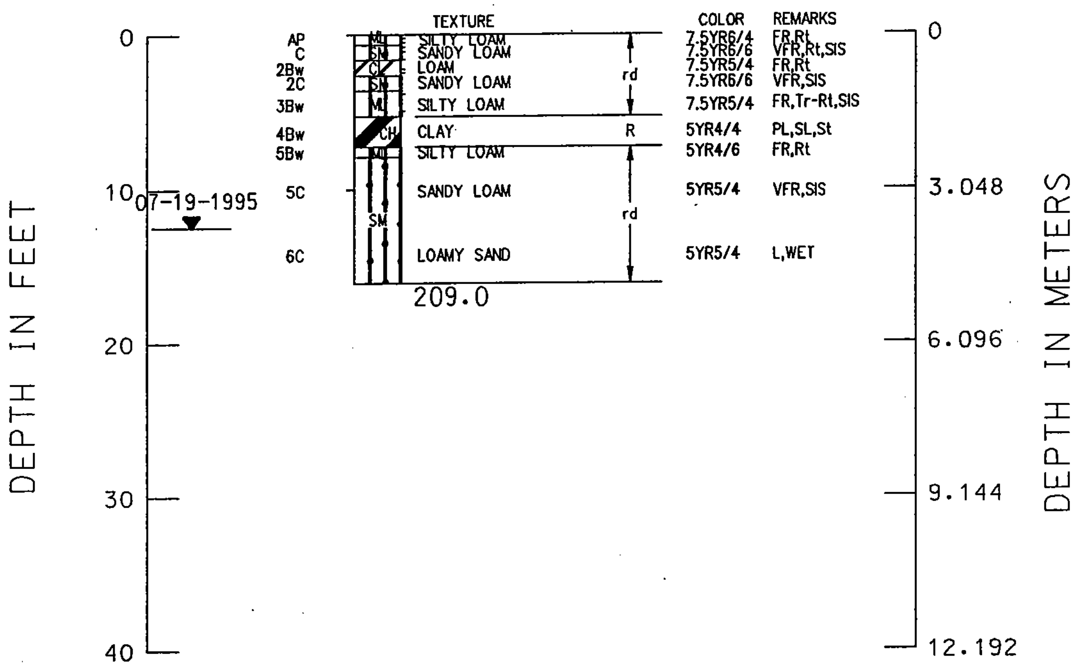
Sec35 T16S R25W
Garland
07-19-1995
G.S.E. 230.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-65

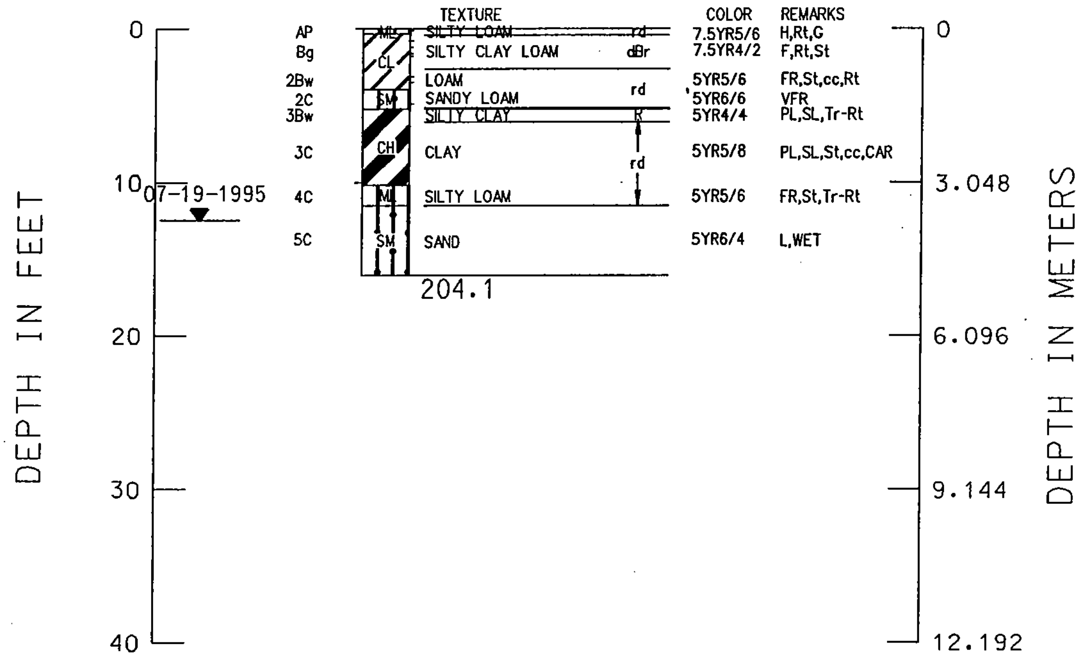
Sec34 T16N R25W
Garland
07-19-1995
G.S.E. 225.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-66

Sec23 T17S R25W
Garland
07-19-1995
G.S.E. 220.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

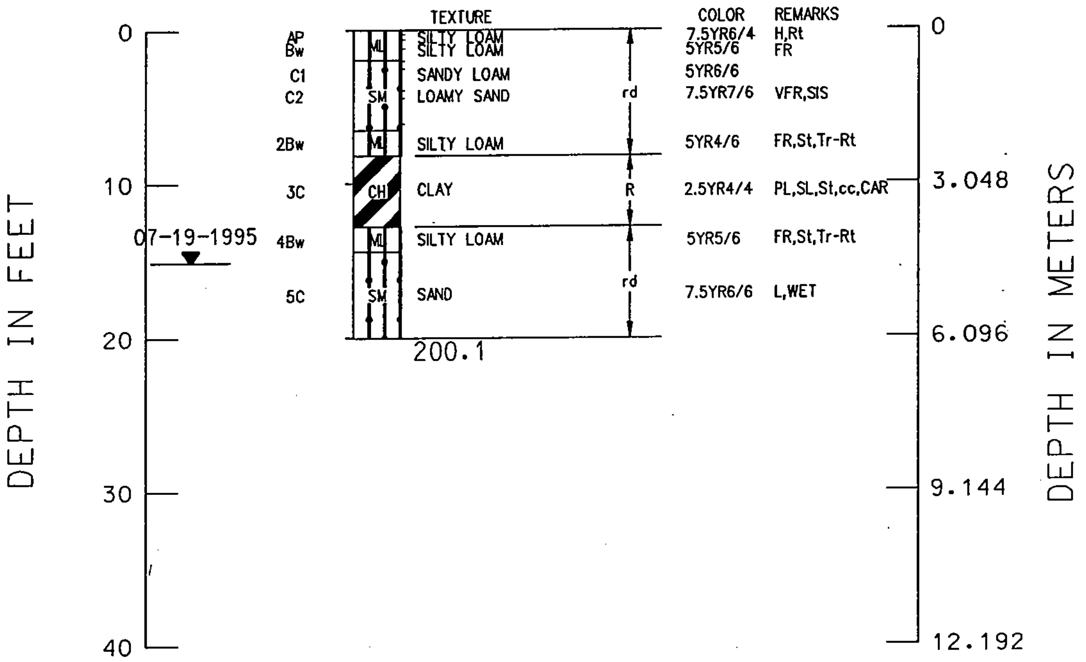
R-67

Sec15 T17S R25W

Garland

07-19-1995

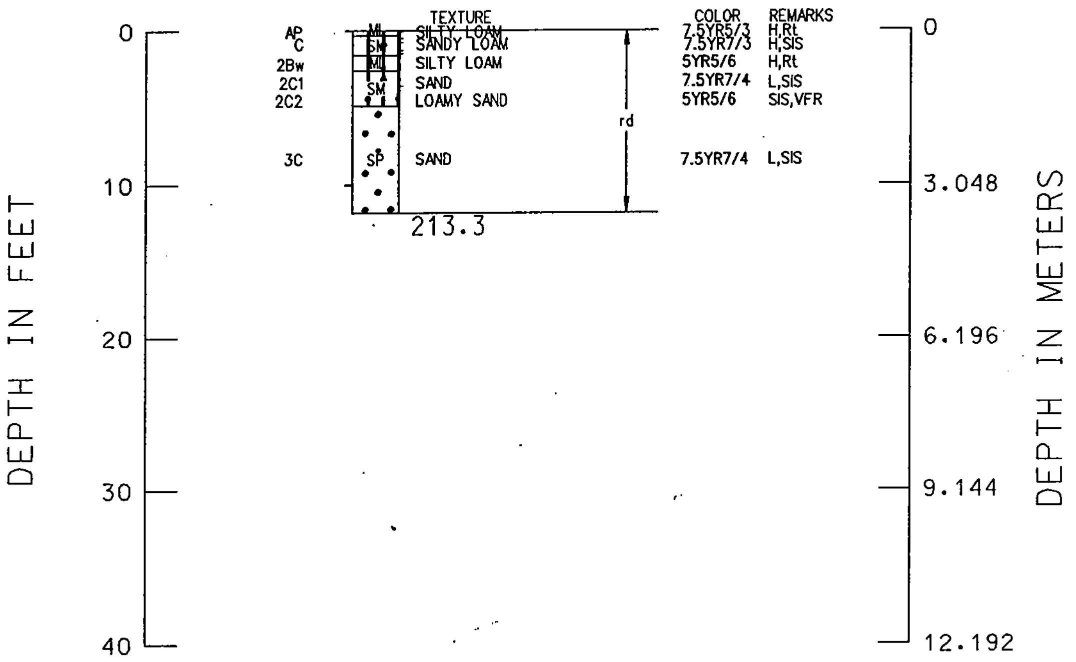
G.S.E. 220.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-68

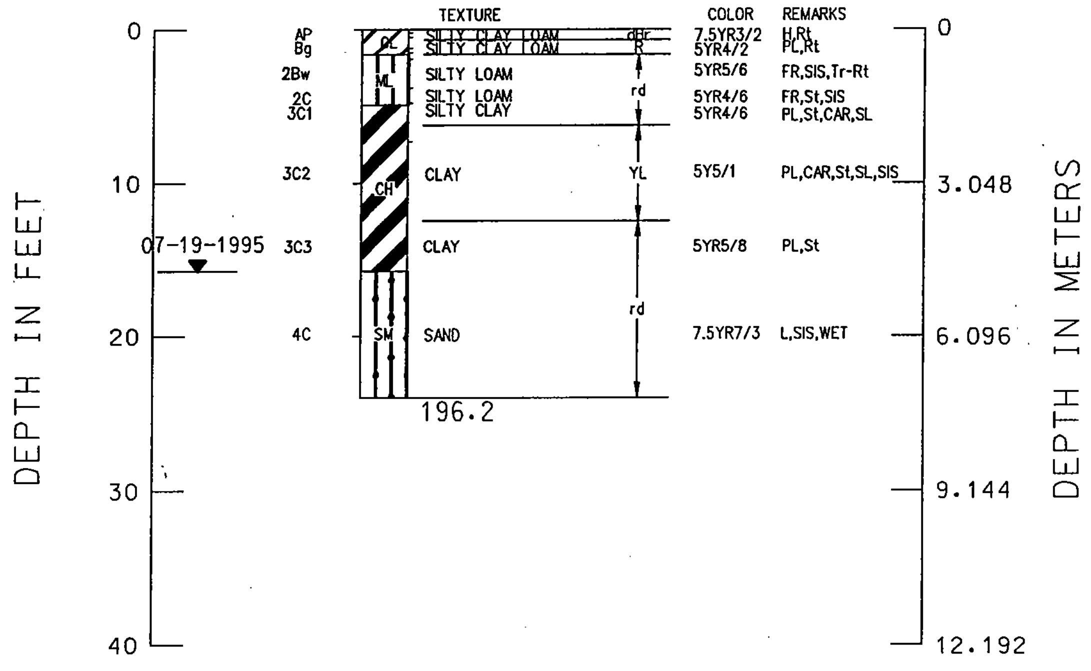
Sec15 T17S R25W
Garland
07-19-1995
G.S.E. 225.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-69

Sec34 T17S R25W
Canfield
07-19-1995
G.S.E. 220.1

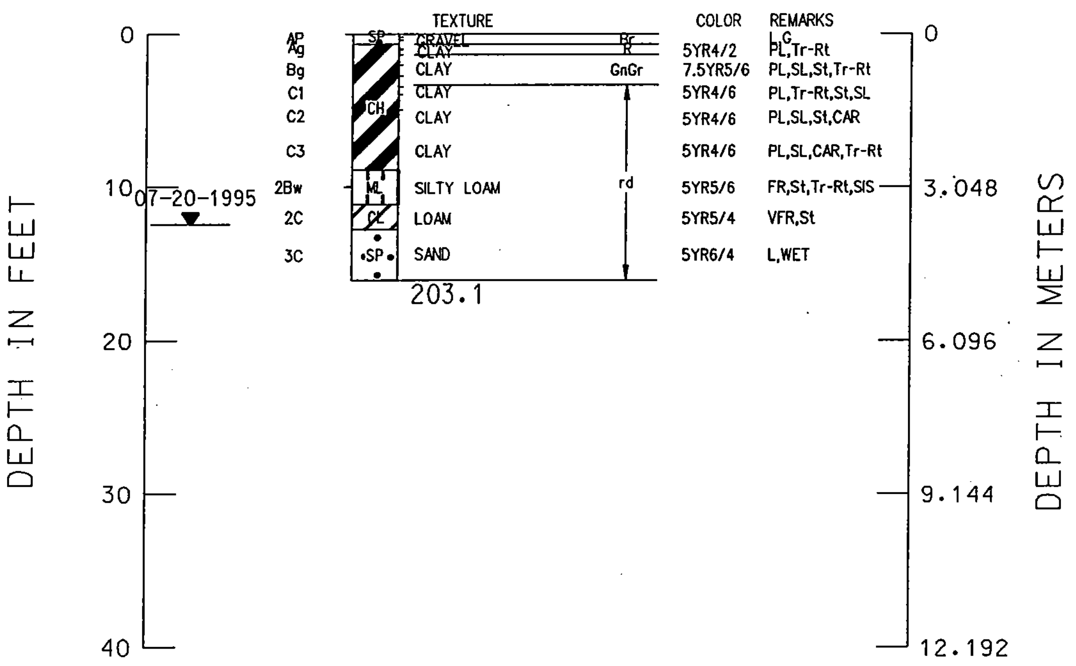


	TEXTURE		COLOR	REMARKS
AP	SILTY CLAY LOAM	dBr	7.5YR3/2	H,Rt
Bg	SILTY CLAY LOAM	R	5YR4/2	PL,Rt
2Bw	SILTY LOAM	rd	5YR5/6	FR,SIS,Tr-Rt
2C	SILTY LOAM		5YR4/6	FR,St,SIS
3C1	SILTY CLAY		5YR4/6	PL,St,CAR,SL
3C2	CLAY	YL	5Y5/1	PL,CAR,St,SL,SIS
3C3	CLAY		5YR5/8	PL,St
4C	SAND	rd	7.5YR7/3	L,SIS,WET

RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-70

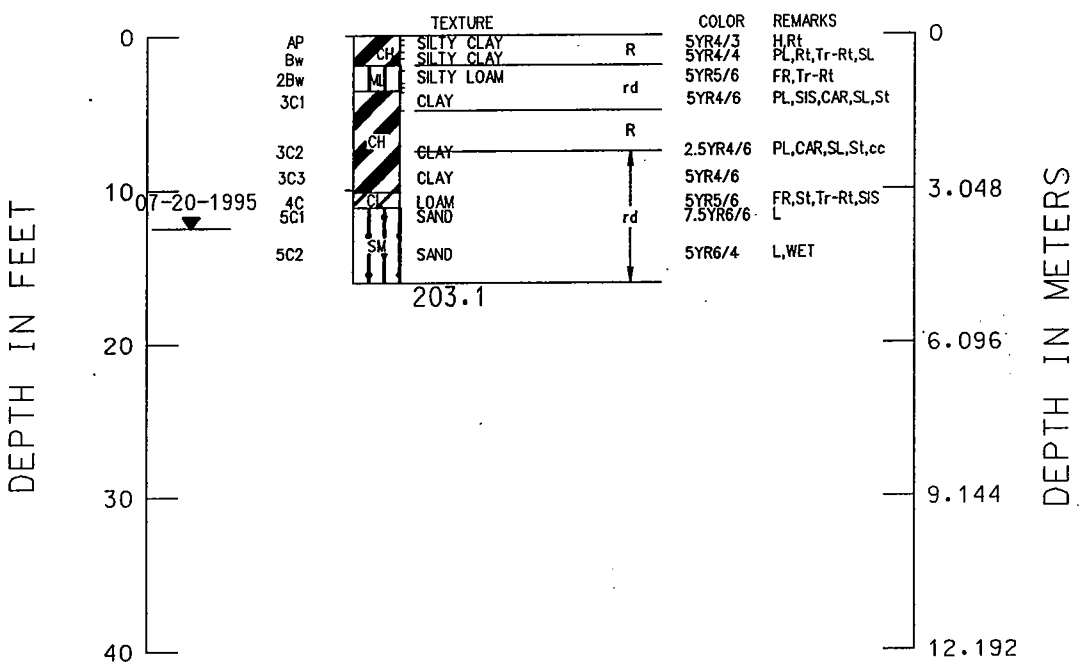
Sec4 T18S R25W
Canfield
07-20-1995
G.S.E. 219.2



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-71

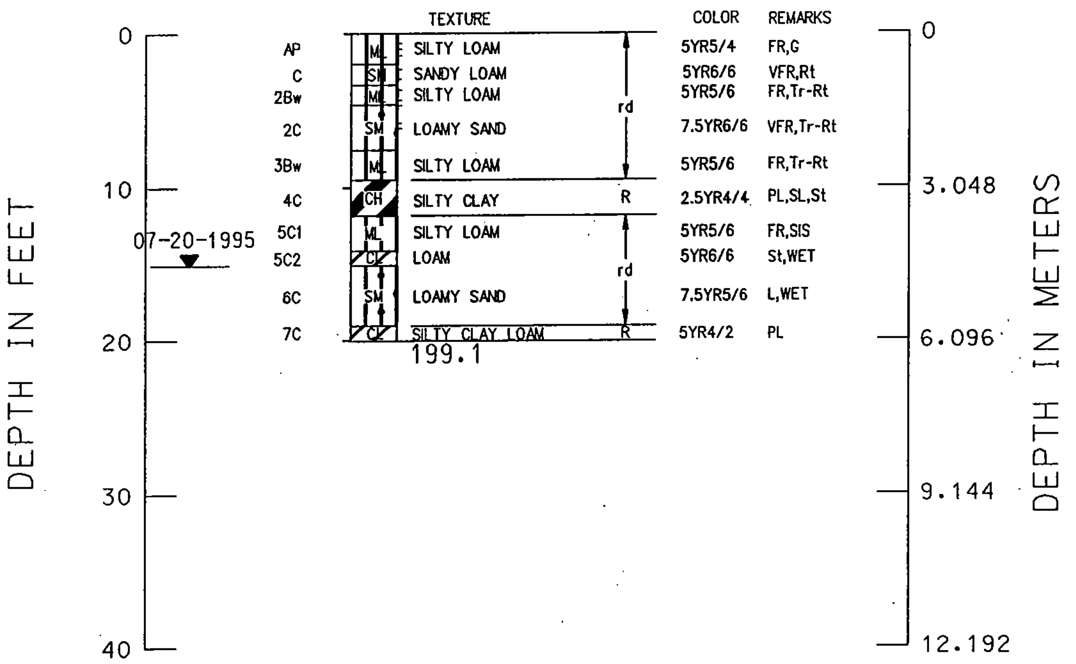
Sec4 T18S R25W
Canfield
07-20-1995
G.S.E. 219.2



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-72

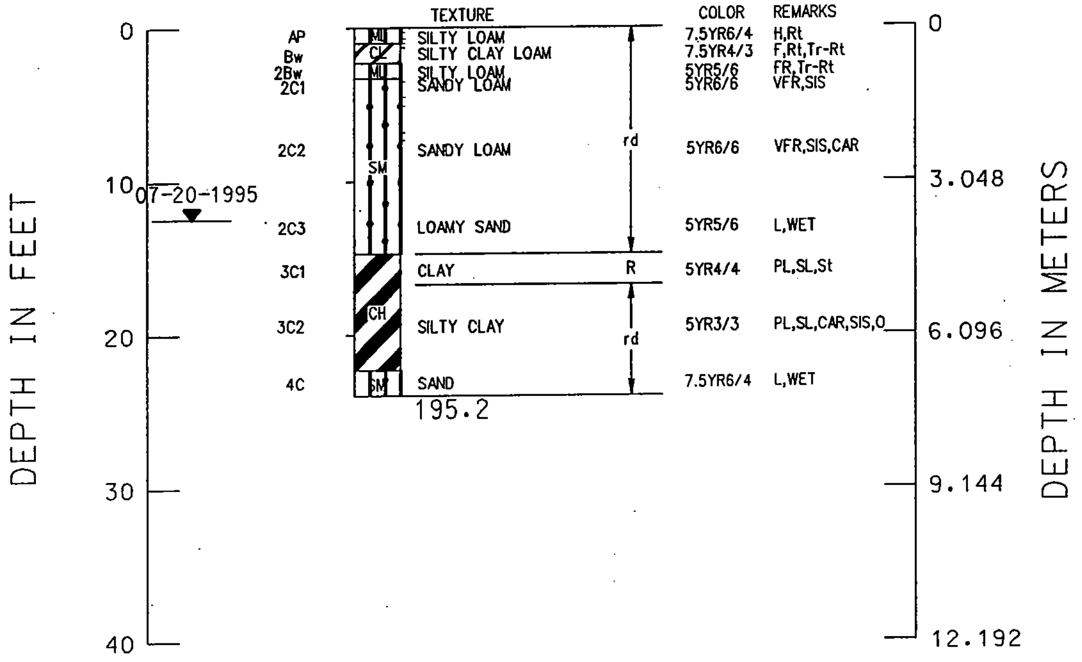
Sec17 T18S R25W
Canfield
07-20-1995
G.S.E. 219.2



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-73

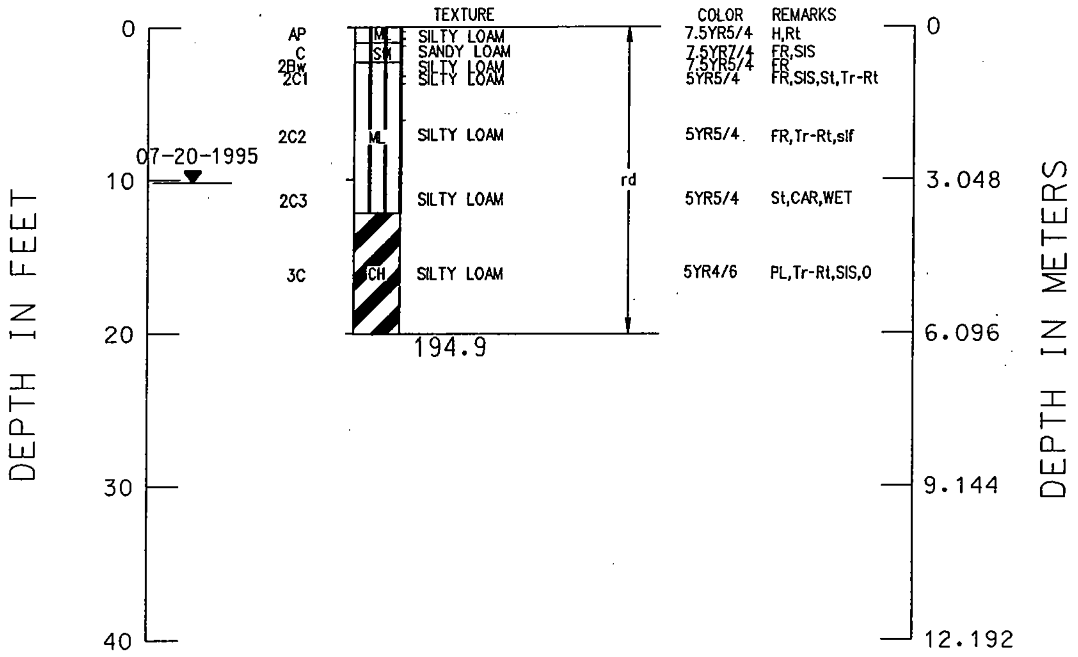
Sec16 T18S R25W
Canfield
07-20-1995
G.S.E. 219.2



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-74

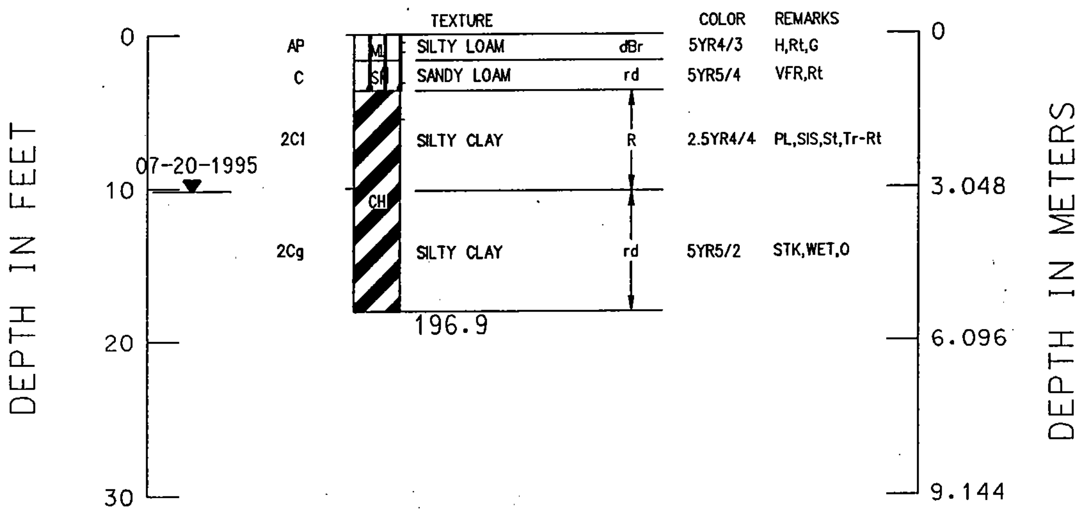
Sec30 T18S R25W
Canfield
07-20-1995
G.S.E. 214.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-75

Sec29 T18S R25W
Canfield
07-20-1995
G.S.E. 214.9

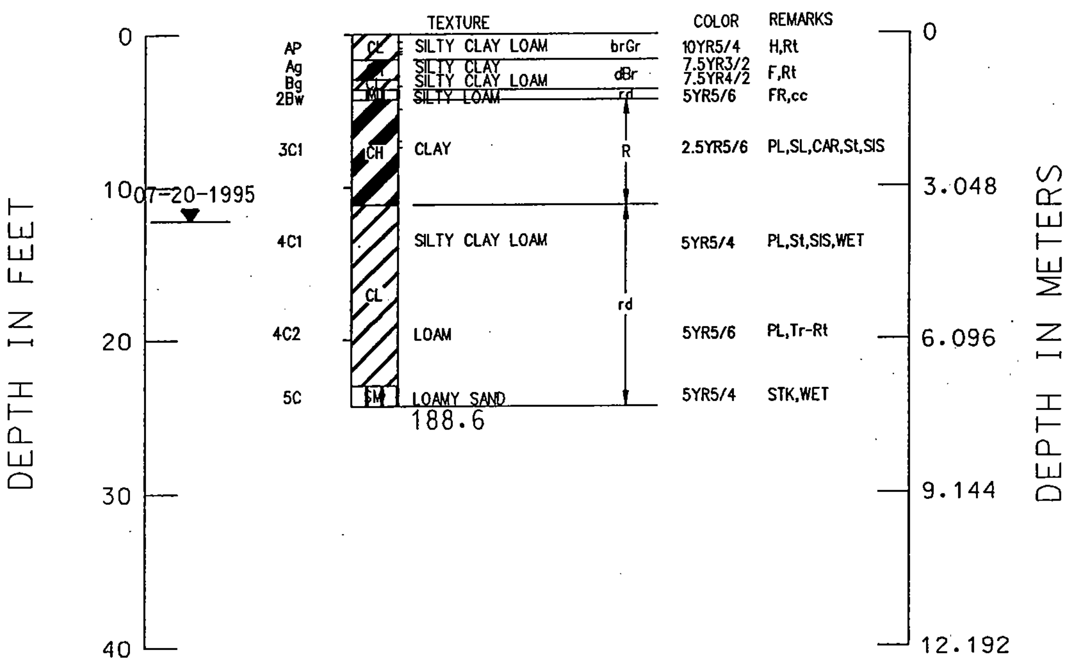


RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-76

Sec29 T18S R25W
Canfield
07-20-1995

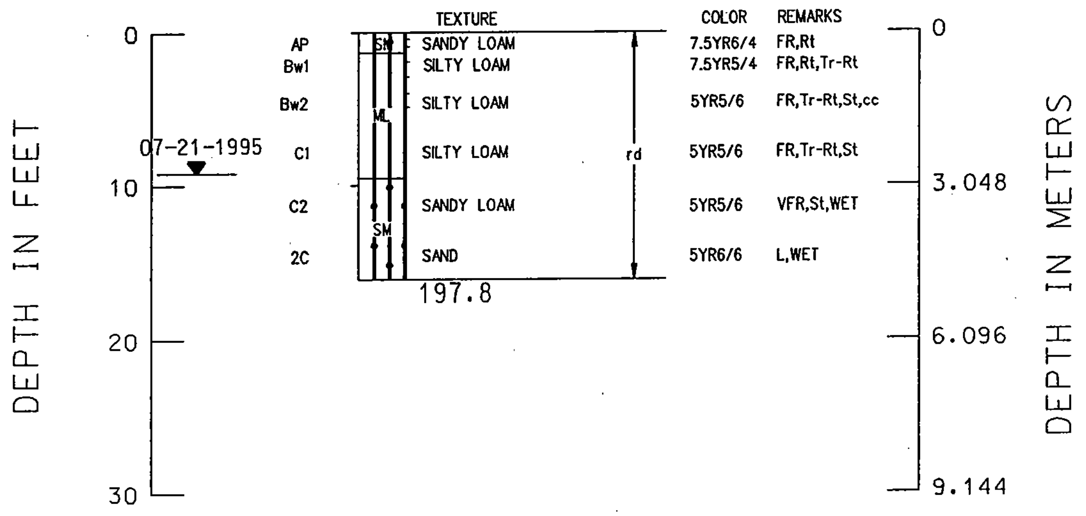
G.S.E. 212.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-77

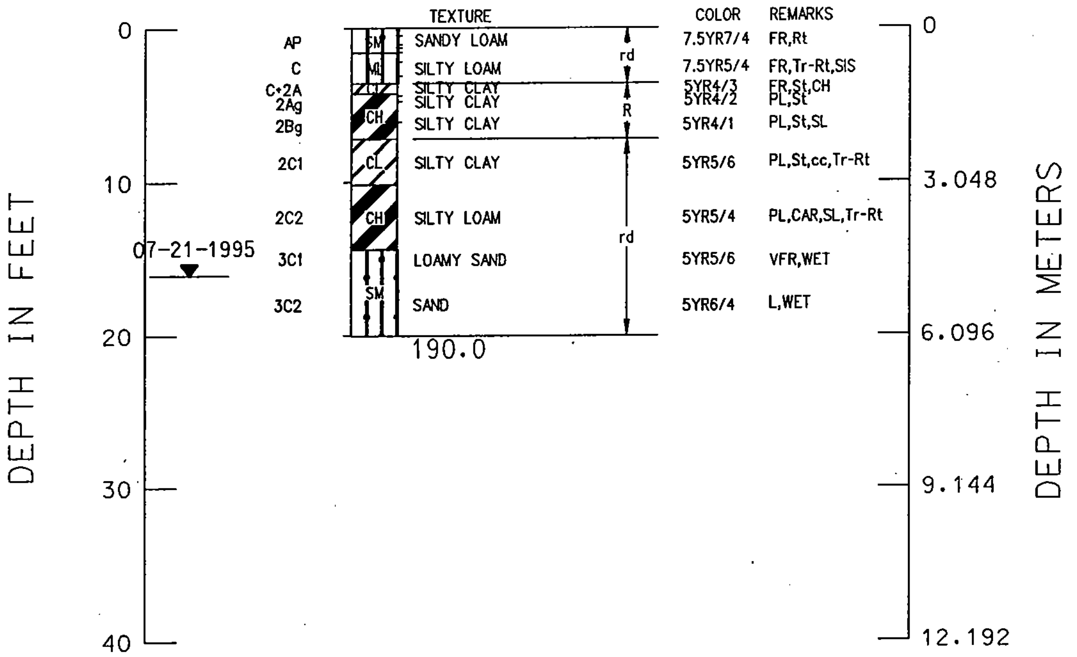
Sec36 T18S R26W
Doddridge NE
07-21-1995
G.S.E. 213.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-78

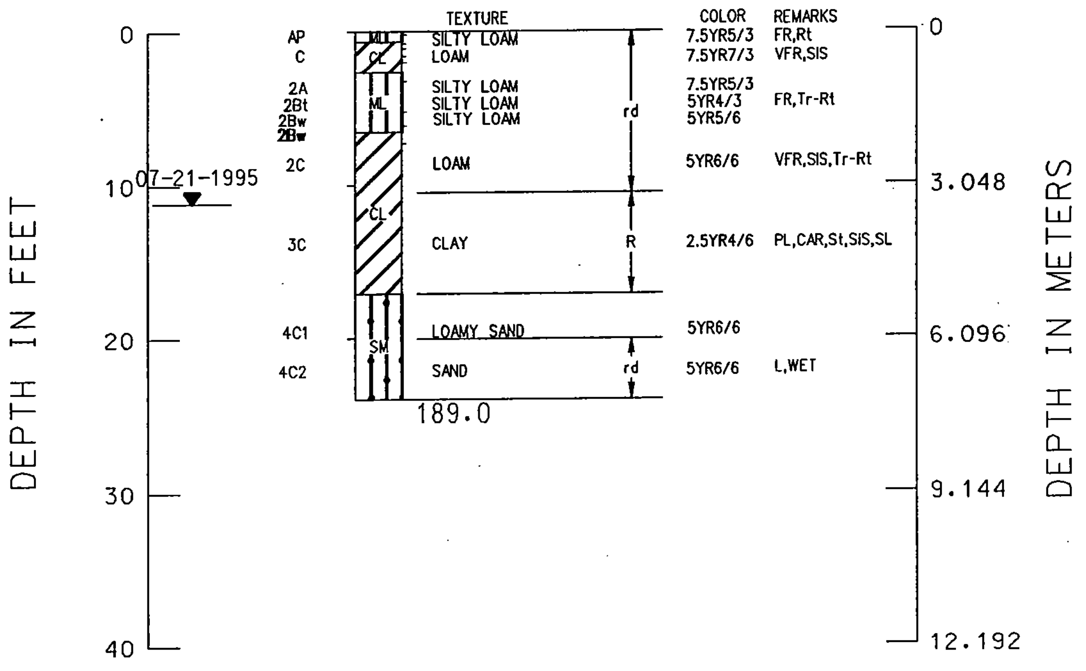
Sec1 T19S R26W
Doddridge NE
07-21-1995
G.S.E. 210.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-79

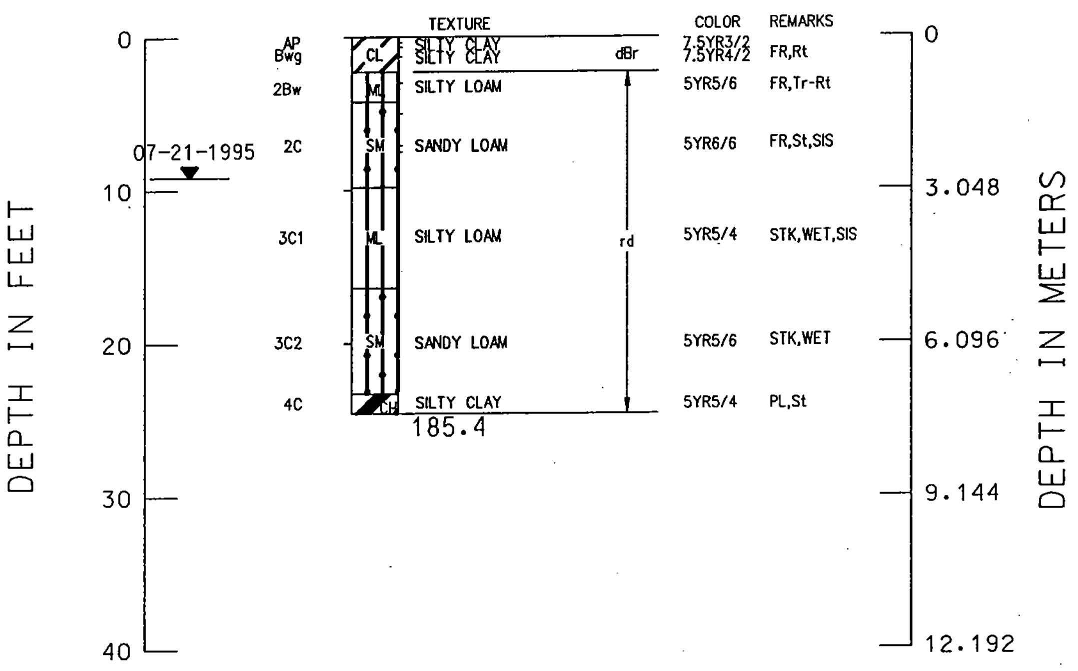
Sec4 T19S R26W
Doddridge NE
07-21-1995
G.S.E. 212.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-80

Sec10 T19S R26W
Doddridge SE
07-21-1995
G.S.E. 210.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

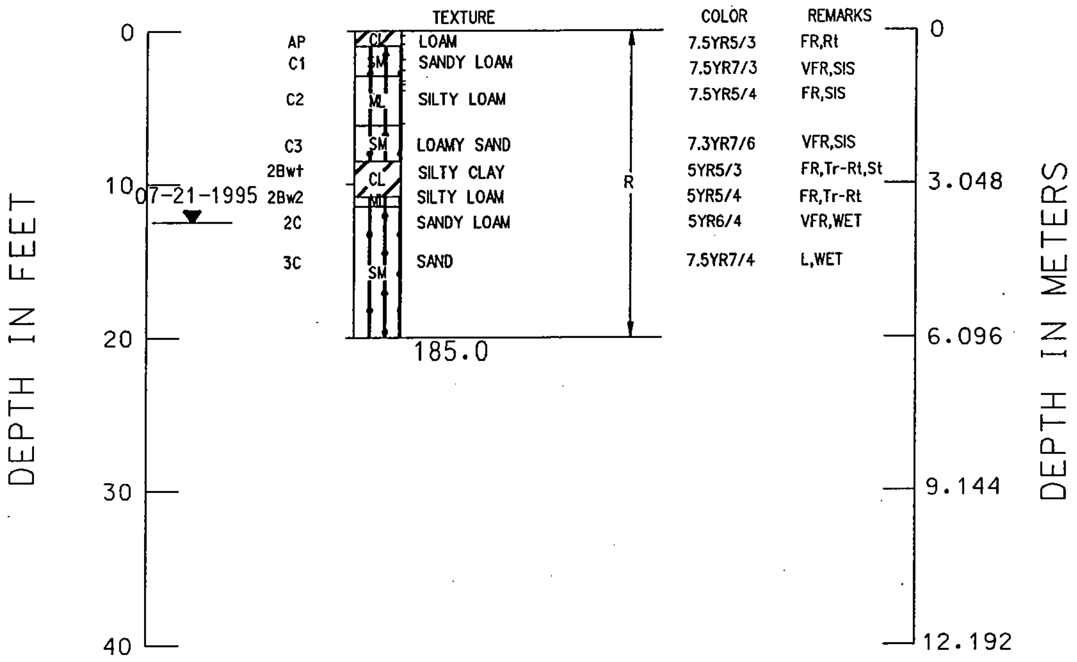
R-81

Sec33 T19S R26W

Doddridge SE

07-21-1995

G.S.E. 205.1



	TEXTURE	COLOR	REMARKS
AP	LOAM	7.5YR5/3	FR,Rt
C1	SANDY LOAM	7.5YR7/3	VFR,SIS
C2	SILTY LOAM	7.5YR5/4	FR,SIS
C3	LOAMY SAND	7.3YR7/6	VFR,SIS
2Bwt	SILTY CLAY	5YR5/3	FR,Tr-Rt,St
2Bw2	SILTY LOAM	5YR5/4	FR,Tr-Rt
2C	SANDY LOAM	5YR6/4	VFR,WET
3C	SAND	7.5YR7/4	L,WET

RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

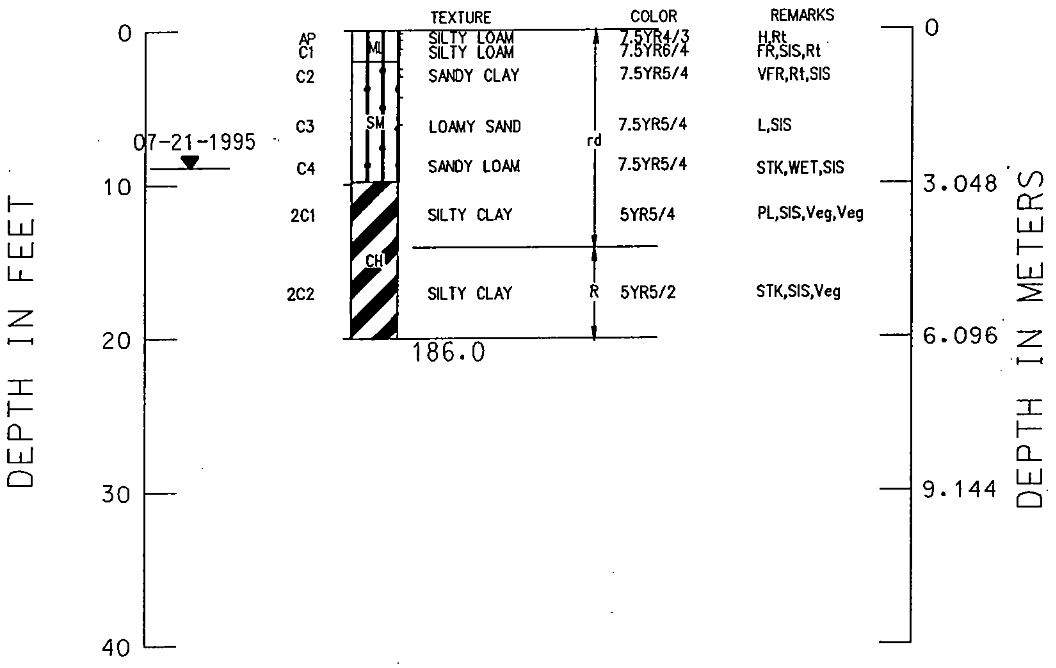
R-82

Sec33 T19S R26W

Doddridge SE

07-21-1995

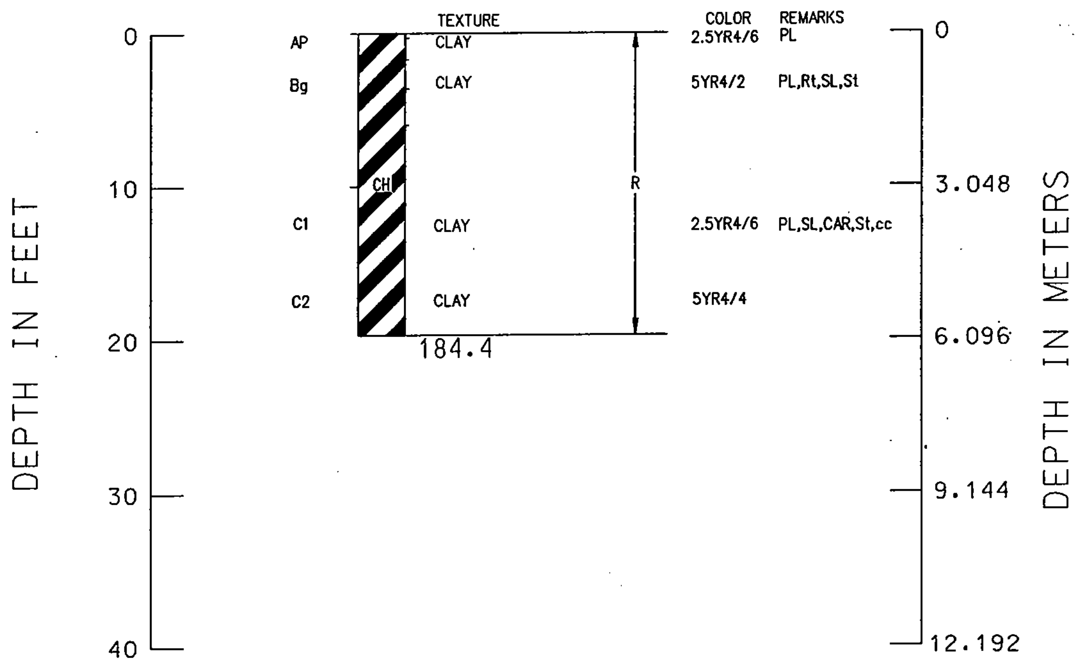
G.S.E. 206.0



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-83

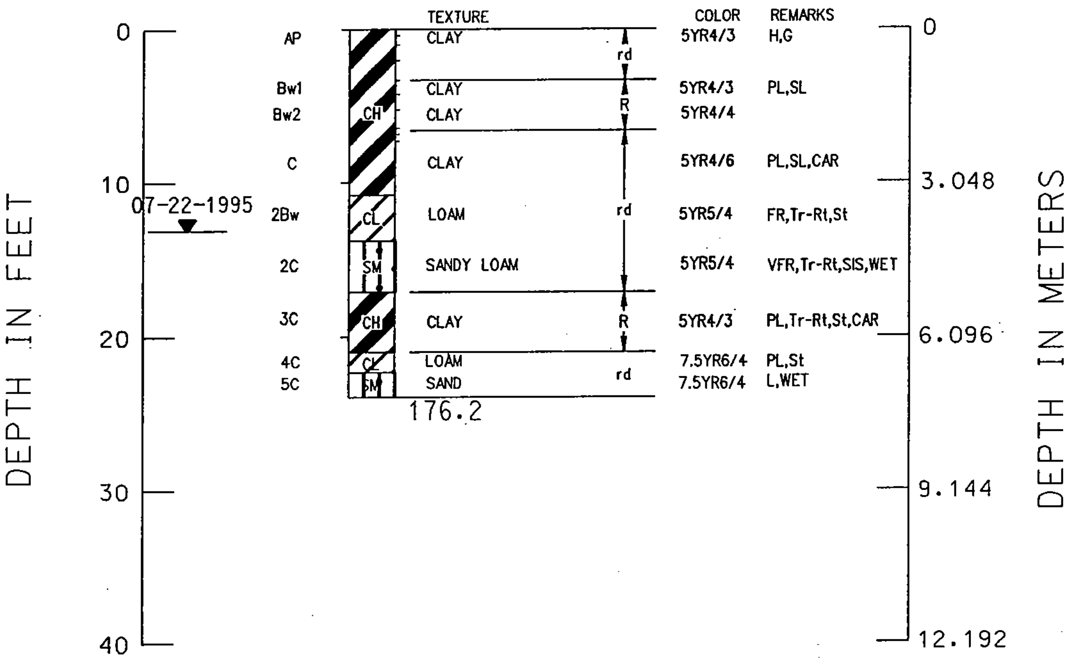
Sec14 T19S R26W
Doddridge SE
07-22-1995
G.S.E. 204.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-84

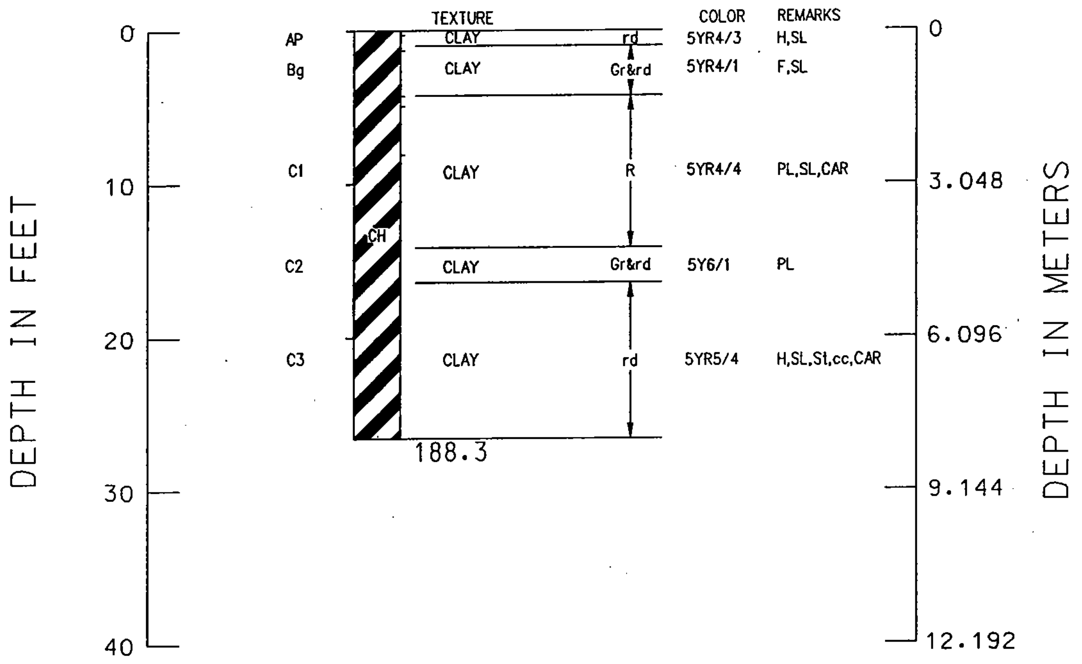
Sec3 T20N R26W
Doddridge SE
07-22-1995
G.S.E. 200.1



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-85

Sec2 T18S R18W
Canfield
07-22-1995
G.S.E. 214.9



RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-86

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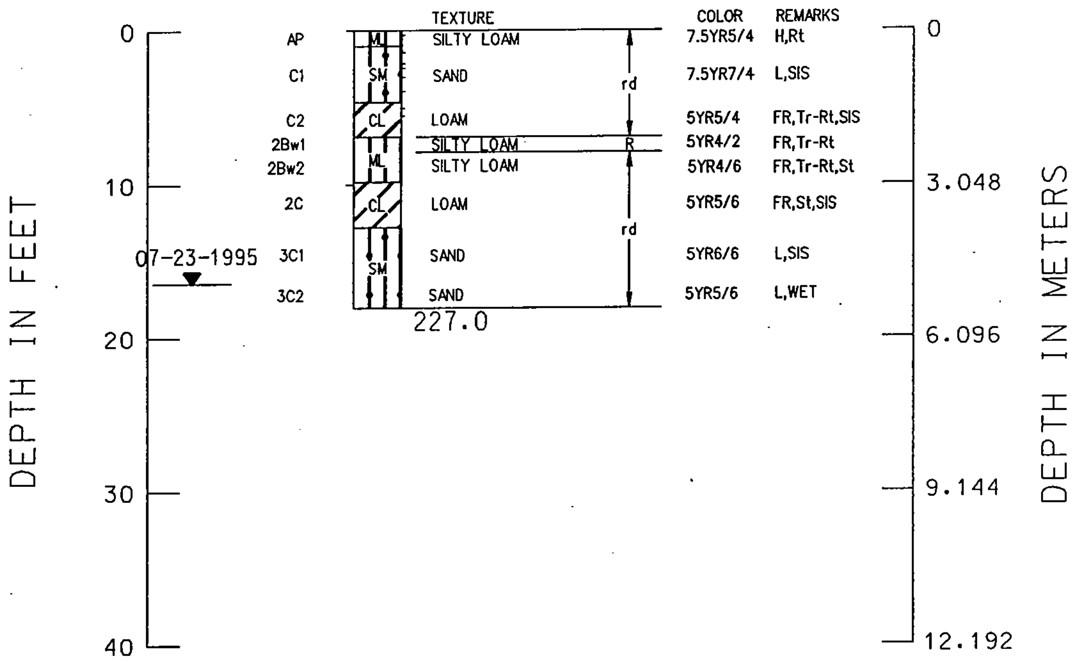

RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

R-87

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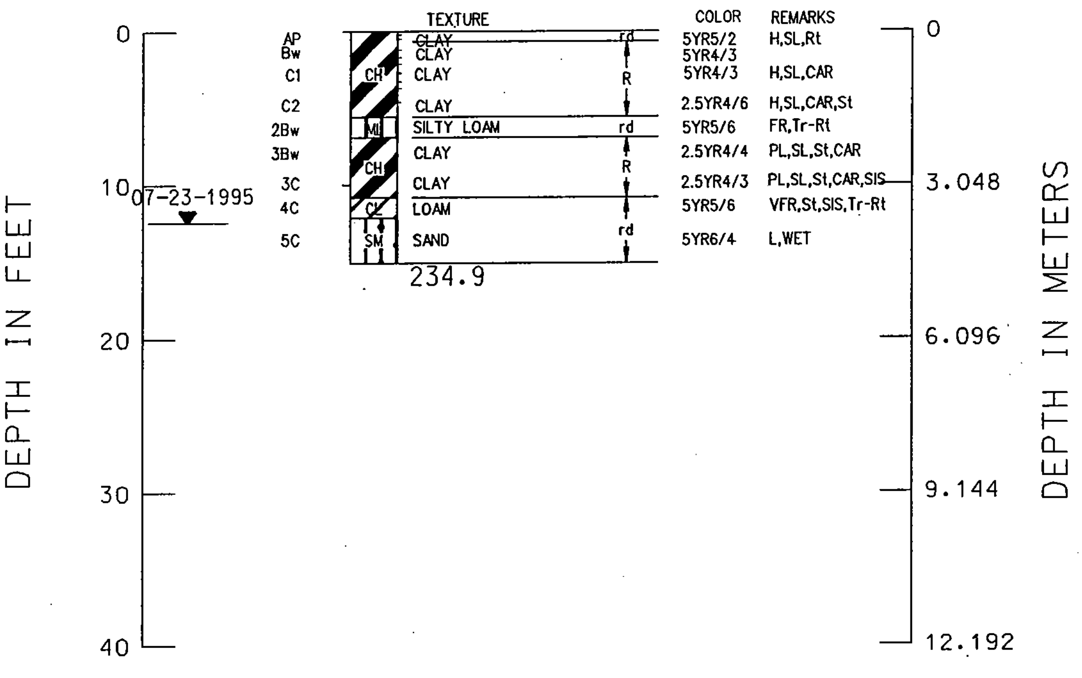


RED RIVER, FULTON, ARKANSAS TO LOUISIANA STATE LINE

Appendix C
Radiometric Age Dates

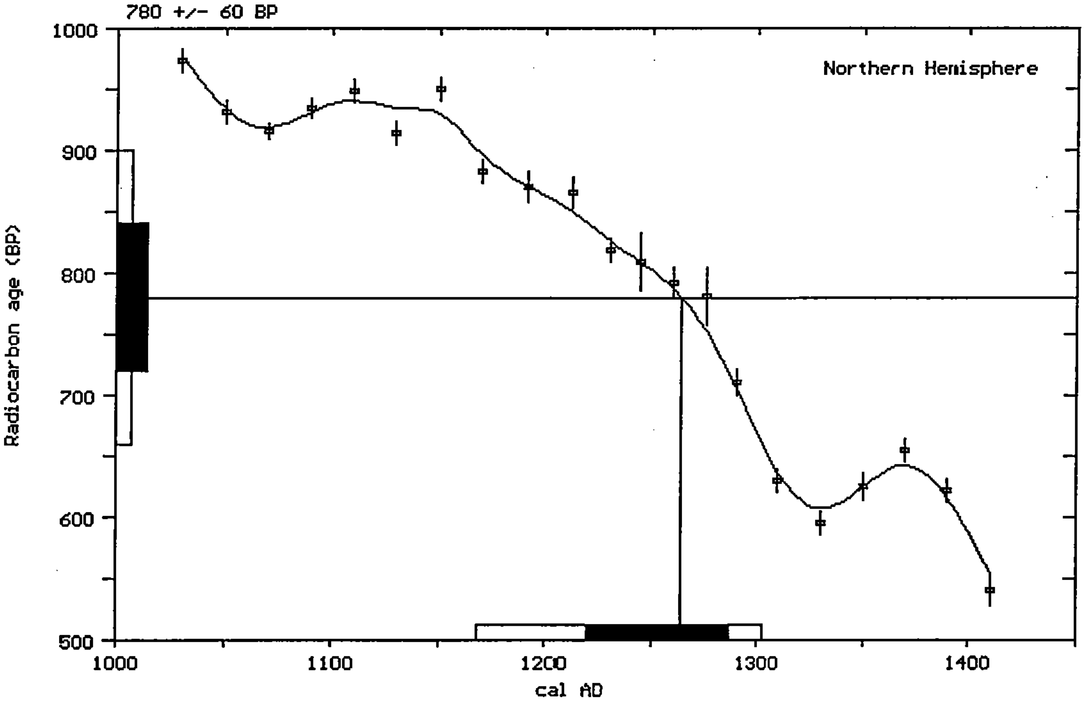
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables:C13/C12=-10.5:lab mult.=1)

Laboratory Number:	Beta-90042
Conventional radiocarbon age:	**780 +/- 60 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal AD 1170 to 1300**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal AD 1265
1 sigma calibrated results: (68% probability)	cal AD 1220 to 1285



References:

Pretoria Calibration Curve for Short Lived Samples

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86

A Simplified Approach to Calibrating C14 Dates

Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Calibration - 1993

Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

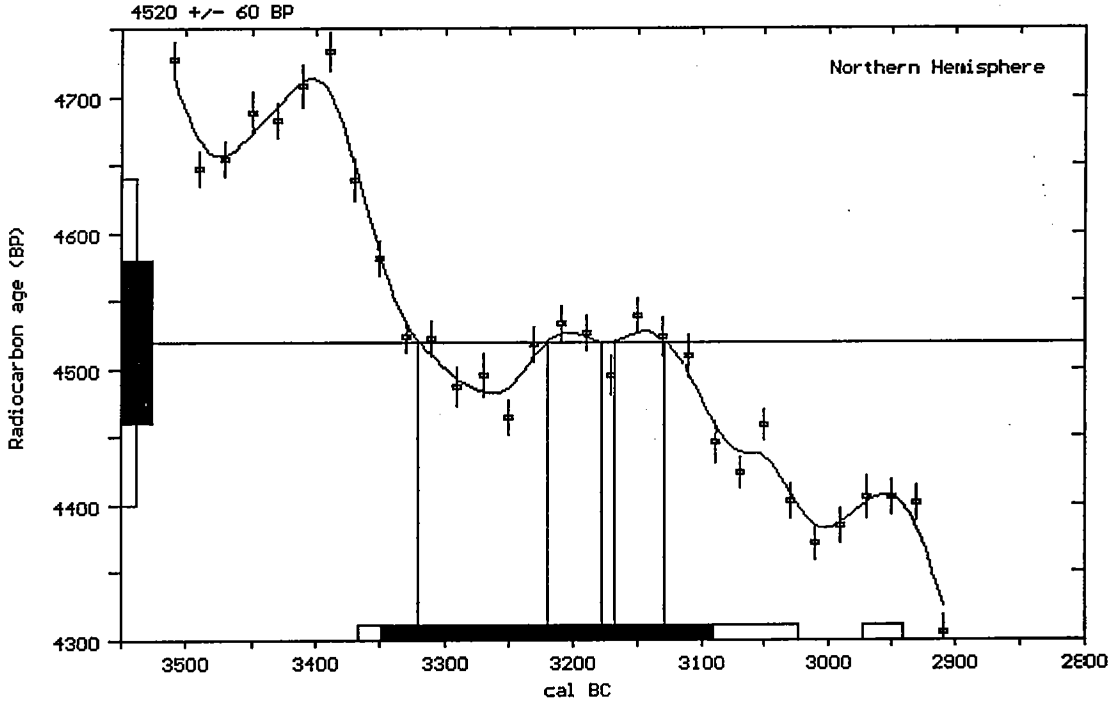
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables:C13/C12=-24.9:lab mult.=1)

Laboratory Number:	Beta-90043
Conventional radiocarbon age:	**4520 +/- 60 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal BC 3365 to 3025 and** **cal BC 2970 to 2940**

Intercept data:

Intercepts of radiocarbon age with calibration curve:	cal BC 3320 and cal BC 3220 and cal BC 3180 and cal BC 3165 and cal BC 3130
1 sigma calibrated results: (68% probability)	cal BC 3350 to 3090



References:

Pretoria Calibration Curve for Short Lived Samples

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A Simplified Approach to Calibrating C14 Dates

Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Calibration - 1993

Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

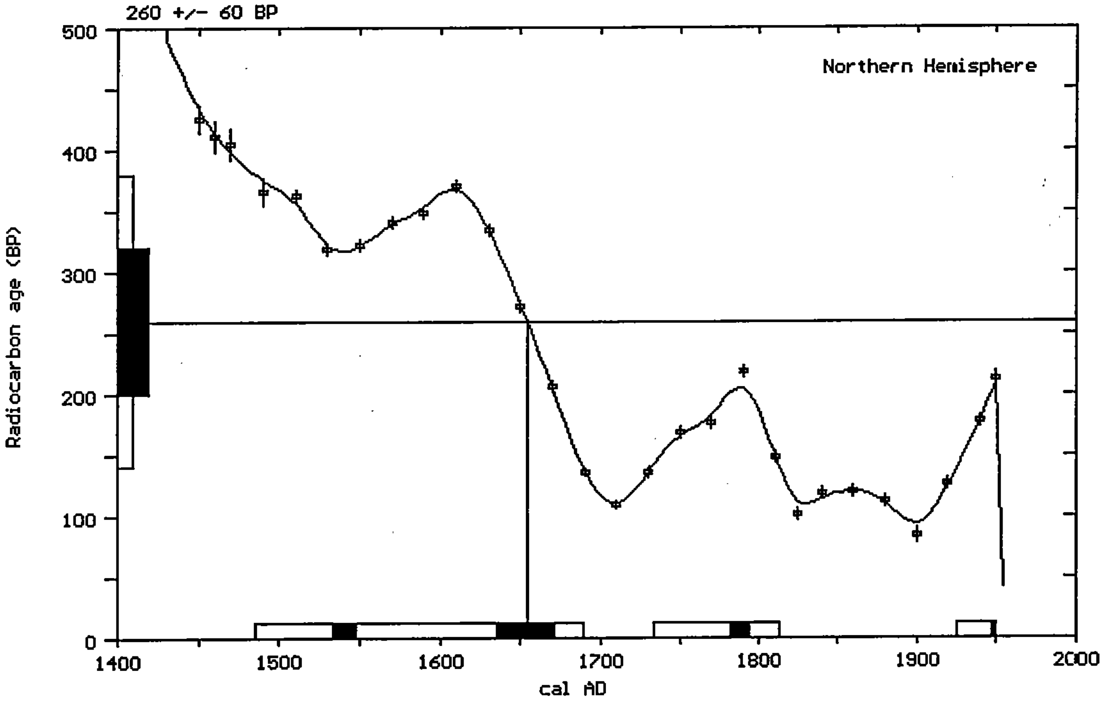
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-27.3:lab. mult=1)

Laboratory Number:	Beta-90044
Conventional radiocarbon age:	**260 +/- 60 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal AD 1485 to 1690 and** **cal AD 1735 to 1815 and** **cal AD 1925 to 1950**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal AD 1655
1 sigma calibrated results: (68% probability)	cal AD 1535 to 1545 and cal AD 1635 to 1670 and cal AD 1780 to 1795 and cal AD 1945 to 1950



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Calibration - 1993
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

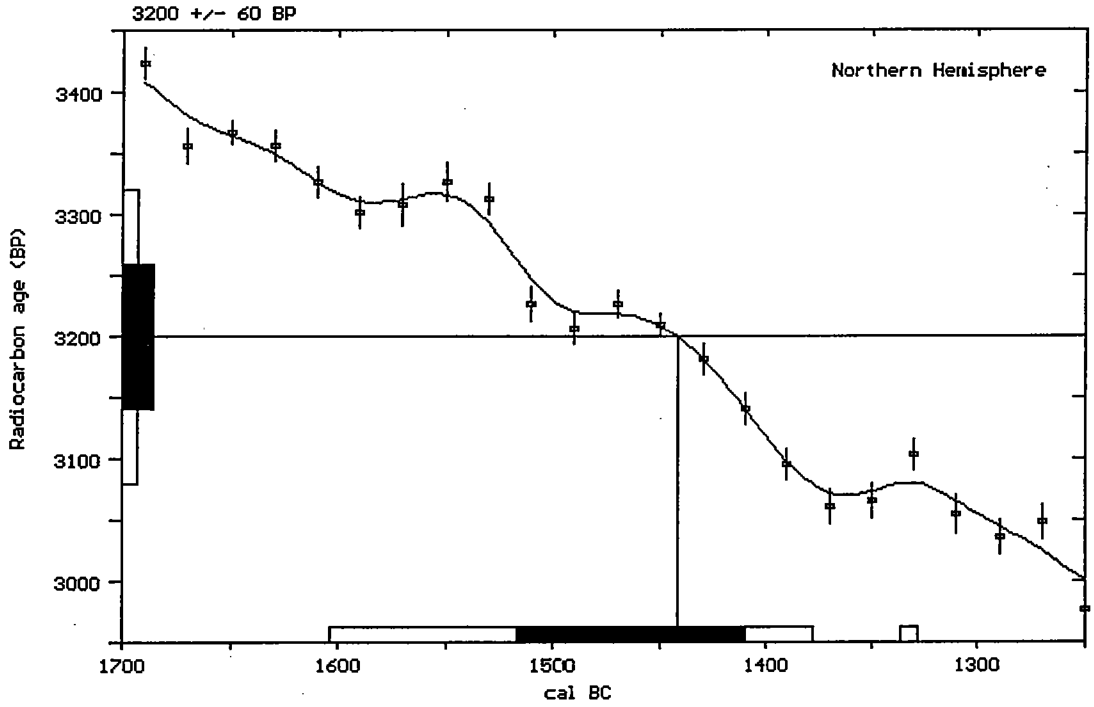
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables:C13/C12=-21.7:lab mult.=1)

Laboratory Number:	Beta-90045
Conventional radiocarbon age:	**3200 +/- 60 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal BC 1605 to 1380 and** **cal BC 1335 to 1330**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal BC 1440
1 sigma calibrated results: (68% probability)	cal BC 1515 to 1410



References:

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Calibration - 1993
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

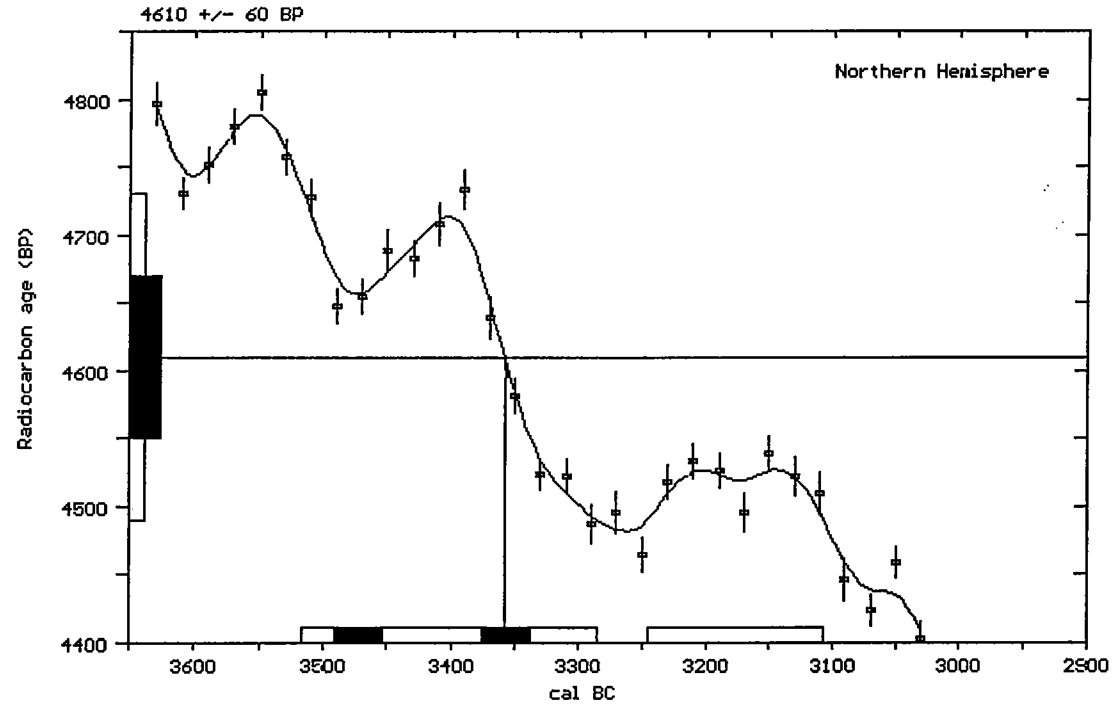
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables:C13/C12=-23.1:lab mult.=1)

Laboratory Number:	Beta-90046
Conventional radiocarbon age:	**4610 +/- 60 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal BC 3515 to 3285 and** **cal BC 3245 to 3105**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal BC 3360
1 sigma calibrated results: (68% probability)	cal BC 3490 to 3455 and cal BC 3375 to 3340



References:

Pretoria Calibration Curve for Short Lived Samples
Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86
A Simplified Approach to Calibrating C14 Dates
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Calibration - 1993
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

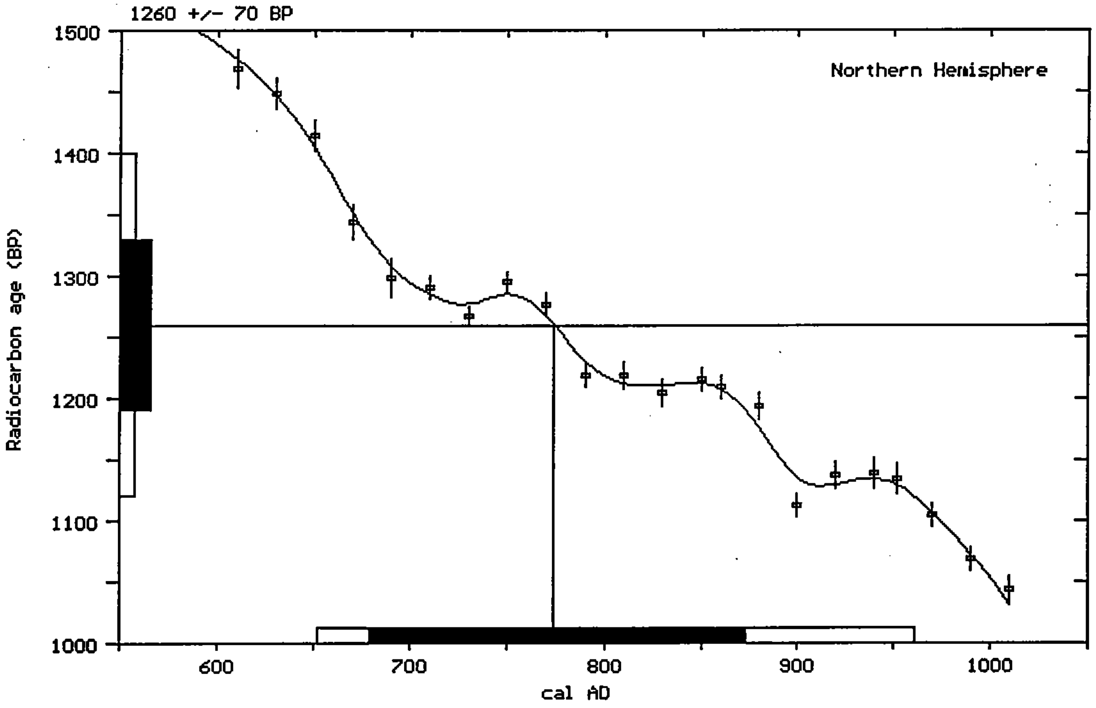
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables:C13/C12=-31.2:lab mult.=1)

Laboratory Number:	Beta-90047
Conventional radiocarbon age:	**1260 +/- 70 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal AD 650 to 960**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal AD 775
1 sigma calibrated results: (68% probability)	cal AD 680 to 875



References:

Pretoria Calibration Curve for Short Lived Samples

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86

A Simplified Approach to Calibrating C14 Dates

Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Calibration - 1993

Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

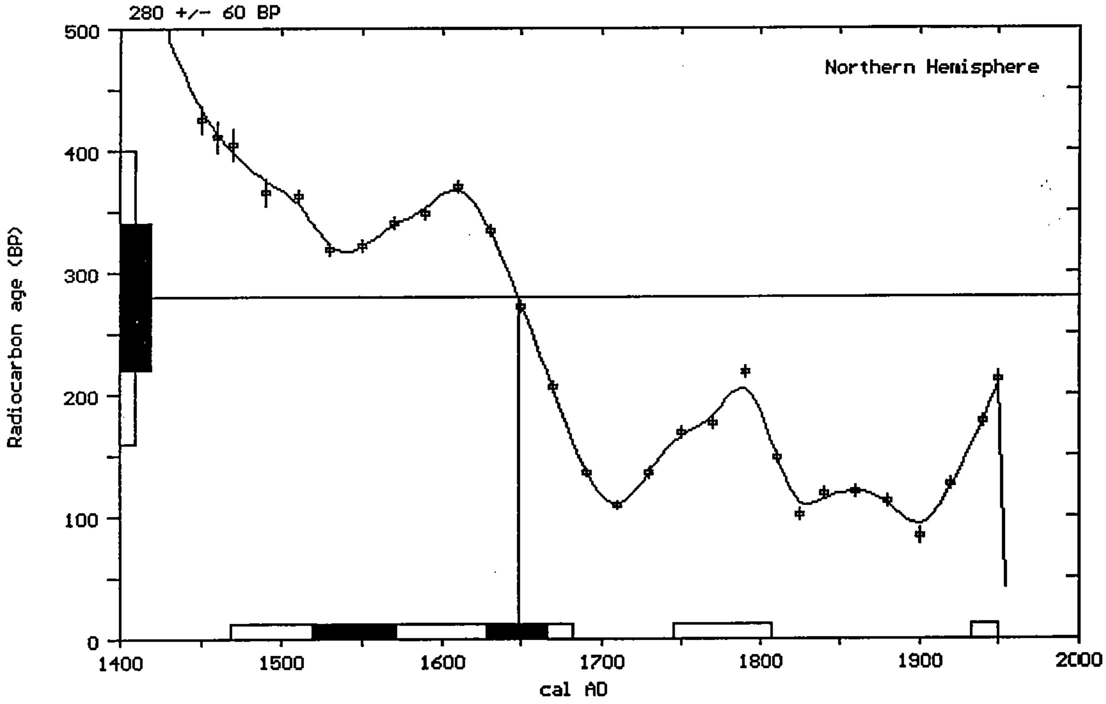
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables:C13/C12=-29.1:lab mult.=1)

Laboratory Number:	Beta-90048
Conventional radiocarbon age:	**280 +/- 60 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal AD 1470 to 1680 and** **cal AD 1745 to 1805 and** **cal AD 1935 to 1950**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal AD 1650
1 sigma calibrated results: (68% probability)	cal AD 1520 to 1570 and cal AD 1630 to 1665



References:

Pretoria Calibration Curve for Short Lived Samples
Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86
A Simplified Approach to Calibrating C14 Dates
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Calibration - 1993
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

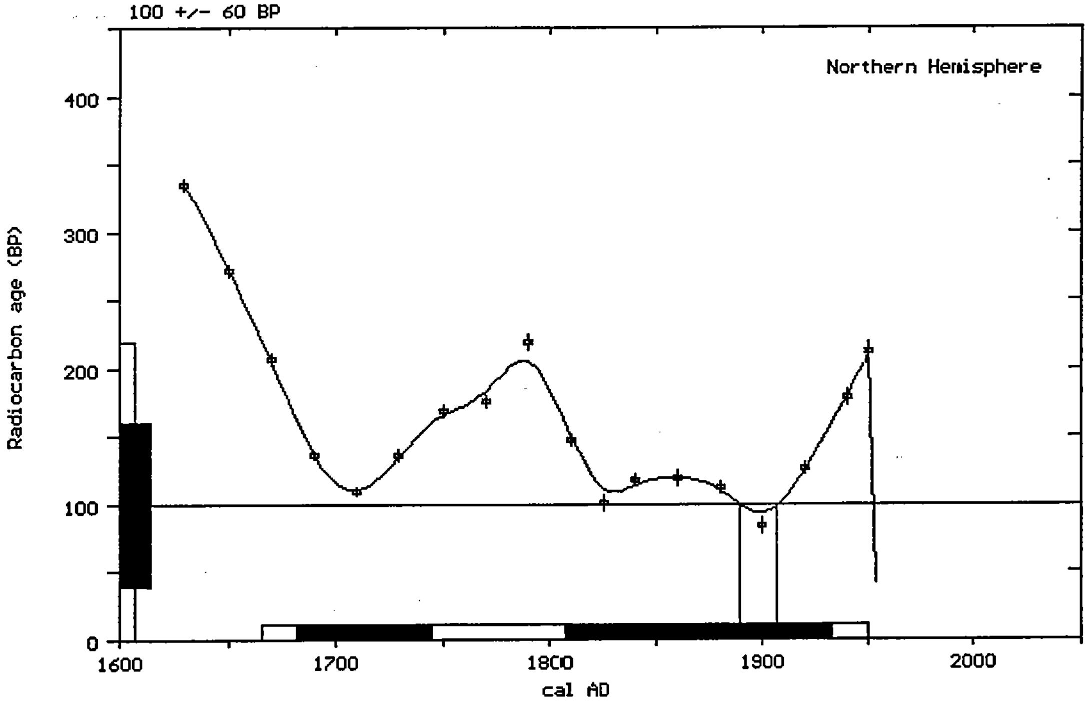
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables:C13/C12=-27.7:lab mult.=1)

Laboratory Number:	Beta-90049
Conventional radiocarbon age:	**100 +/- 60 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal AD 1665 to 1950**

Intercept data:

Intercepts of radiocarbon age with calibration curve:	cal AD 1890 and cal AD 1905
1 sigma calibrated results: (68% probability)	cal AD 1680 to 1745 and cal AD 1805 to 1935



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Calibration - 1993
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

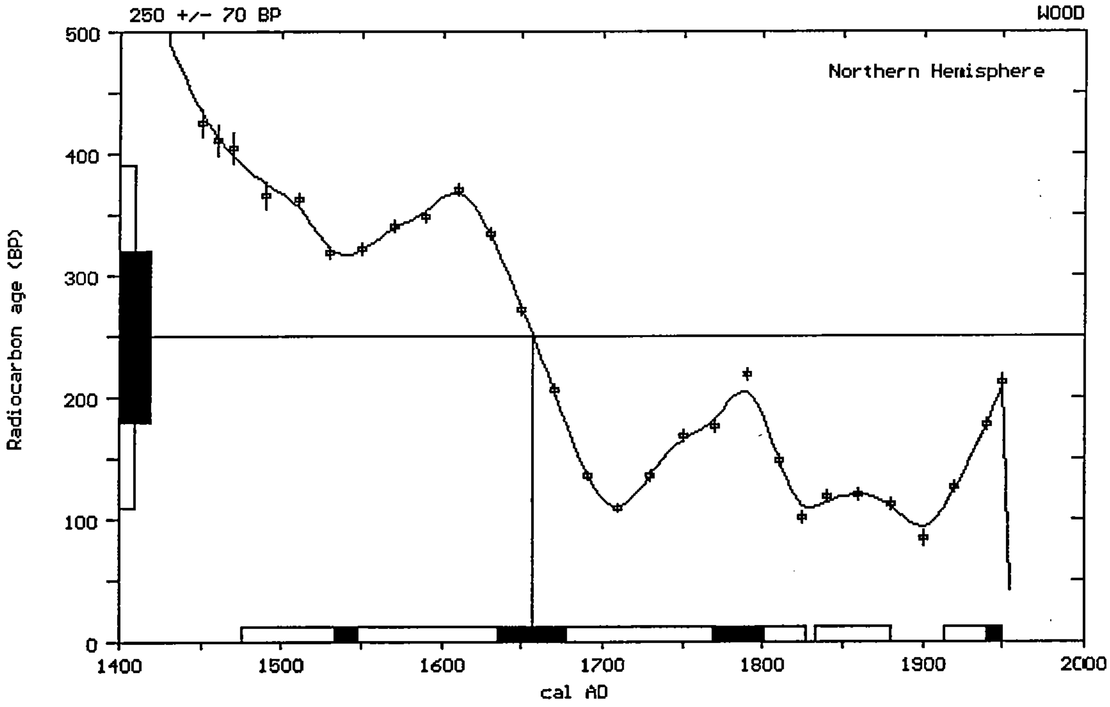
(Variables:estimated C13/C12=-25:lab mult.=1)

Laboratory Number:	Beta-90050
Conventional radiocarbon age*:	**250 +/- 70 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal AD 1475 to 1825 and** **cal AD 1835 to 1880 and** **cal AD 1915 to 1950**

* C13/C12 ratio estimated

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal AD 1655
1 sigma calibrated results: (68% probability)	cal AD 1535 to 1545 and cal AD 1635 to 1675 and cal AD 1770 to 1800 and cal AD 1940 to 1950



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Calibration - 1993
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

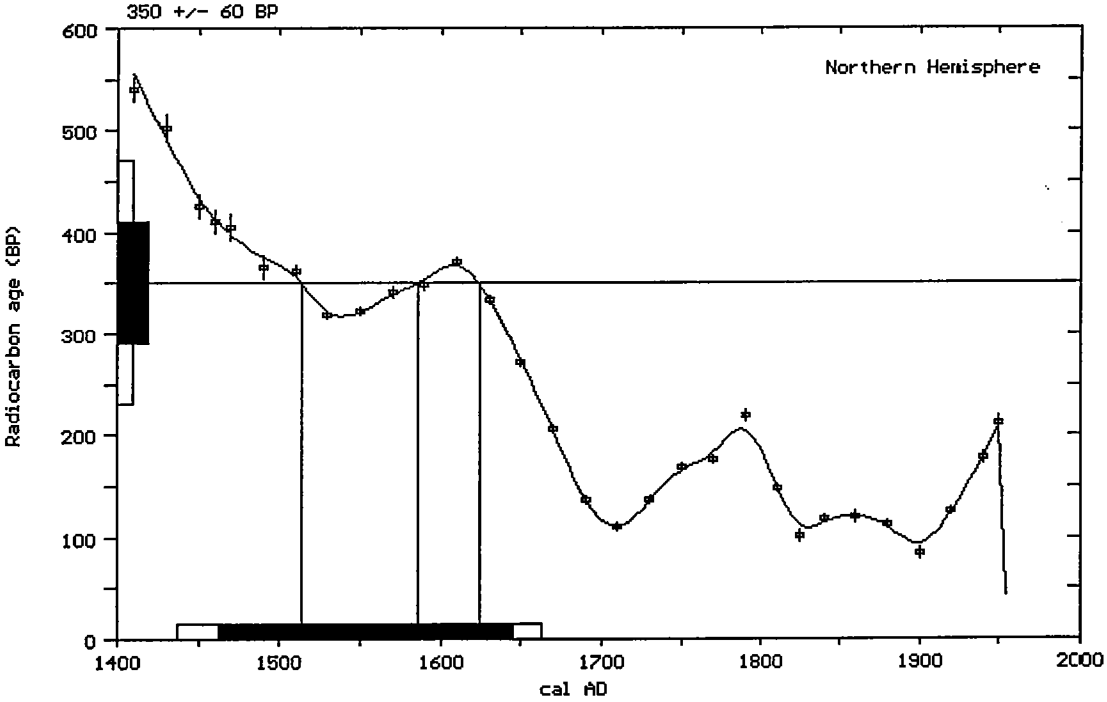
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables:C13/C12=-29.1:lab mult.=1)

Laboratory Number:	Beta-90051
Conventional radiocarbon age:	**350 +/- 60 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal AD 1435 to 1665**

Intercept data:

Intercepts of radiocarbon age with calibration curve:	cal AD 1515 and cal AD 1585 and cal AD 1625
1 sigma calibrated results: (68% probability)	cal AD 1460 to 1645



References:

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Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86

A Simplified Approach to Calibrating C14 Dates

Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Calibration - 1993

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11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution is unlimited.	**12b. DISTRIBUTION CODE**

13. ABSTRACT (Maximum 200 words)

As part of a feasibility study leading to rehabilitation of levees along the Red River in Arkansas, the WES conducted research to establish a geomorphic framework for cultural resource management in the Great Bend region of the Red River Valley. The proposed levee rehabilitation has the potential to impact cultural resource sites both adjacent to current levees and in candidate areas nearby from which the levee construction materials will be removed. This work provides a geomorphic basis for locating archeological sites.

The three major geomorphic surfaces identified in the study area are floodplain, terraces, and bluffs. Relative ages of specific sites were established on the basis of soil development and superposition. A geographic information system (GIS) was built as part of this study, and includes such data layers as: geology, geomorphic features, soil type, elevation, levee locations, known archeological sites, data from soil borings, and surface water. The GIS has been provided to the USAED, Vicksburg (as of October 1996), to be used in cultural resource management.

14. SUBJECT TERMS Geomorphology Geographic Information System GIS Red River Cultural Resources Archeology	**15. NUMBER OF PAGES**
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17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**