2.5 GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL ENGINEERING

This section of the referenced ESP safety analysis report is incorporated by reference with the following variances and/or supplements.

GGNS SUP 2.5.1-1

The introductory information provided in the ESP application is replaced with the following information, to integrate the results of the COL investigations, testing and analyses, with references to previous programs and results performed for the ESP application and Unit 1 included where applicable.

The Grand Gulf Nuclear Station (GGNS) Unit 3 site is located in west-central Mississippi near the town of Port Gibson on a bluff above the Mississippi River floodplain, within the Mississippi Embayment geologic subprovince and along the margin of the Loess Hills and the Mississippi Alluvial Valley physiographic subprovinces (Section 2.5.1.1.1). There is currently one operating nuclear reactor at this location (GGNS Unit 1).

Section 2.5 presents information on the geology, seismology, and geotechnical properties of the Site Region (200-mi radius), Site Vicinity (25-mi radius), Site Area (5-mi radius), and Site Location (0.6-mi radius) used to assess geologic and seismic hazards at the GGNS Unit 3 site. These concentric site investigation boundaries are illustrated in SSAR Figure 2.5-1. This section provides a brief synopsis of the ESP and Unit 3 COL investigations, data, and results for analyses of geology, ground motions, faulting, subsurface stability, and slope stability. These investigations and analyses were performed to satisfy the following applicable federal regulations:

- Code of Federal Regulations, Title 10, Part 50 (10CFR50), Appendix A, General Design Criteria 2, “Design Bases for Protection Against Natural Phenomena”
- 10CFR50, Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants”
- Code of Federal Regulations, Title 10, Part 52 (10CFR52), “Early Site Permits, Standard Design Certifications, and Combined Licenses for Nuclear Power Plants”
- Code of Federal Regulations, Title 10, Part 100 (10CFR100), Subpart 23, “Geologic and Seismic Siting Factors”

In addition, investigations and analyses described in Section 2.5 were performed following the detailed methodology and guidance provided in these applicable regulatory guides:

- Regulatory Guide 1.132, “Site Investigations for Foundations of Nuclear Power Plants”
- Regulatory Guide 1.138, “Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants”
- Regulatory Guide 1.165, “Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion”

- Regulatory Guide 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites"
- Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants—LWR Edition"
- Regulatory Guide 1.208, "A Performance-based Approach to Define Site-Specific Earthquake Ground Motion"
- Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations"

Basic Geologic and Seismic Information

Section 2.5.1 reviews basic geologic data and seismic information pertaining to the GGNS site, specifically information about regional and site geology. Documentation of regional geologic data (Section 2.5.1.1) includes a discussion of geologic, seismic, tectonic, non-tectonic, and man-made hazards within the Site Region, Site Vicinity, and Site Area as completed for SSAR Section 2.5.1.1. This regional information is consistent with material presented in the Unit 1 UFSAR (Reference 2.5.4-201) and is incorporated by reference in FSAR Section 2.5.1.1. The data and conclusions regarding the Site Region, Site Vicinity, and Site Area as incorporated from SSAR Section 2.5.1.1 are consistent with new data and conclusions from the subsequent (Unit 3) Site Location investigation (described below).

Section 2.5.1 also includes documentation of geologic features, seismic conditions, and conditions caused by human activities at the Site Location. Most of this information is from a comprehensive surface and subsurface investigation that permitted refinement of site material characterization (Section 2.5.1.2). This investigation, conducted between April 2006 and August 2007, included logging exploratory boreholes, performing in-situ geophysical testing, installing monitoring and observation wells, advancing Cone Penetrometer Test (CPT) soundings, logging test pits and soil profiles, and performing surface geophysical testing. Additionally, laboratory testing was performed to document static and dynamic properties. Full descriptions of Unit 3 site investigation and testing activities are included in Sections 2.5.4.2 and 2.5.4.3. The results of this investigation provided the necessary context to develop a revised site stratigraphic framework (Section 2.5.1.2.1), develop criteria for evaluating and incorporating stratigraphic data from the SSAR and Unit 1 UFSAR (Section 2.5.1.2.2), develop and refine characterizations of site materials (Section 2.5.1.2.3), present a refined geologic history of the Site Location (Section 2.5.1.2.4), and evaluate seismicity and faulting (Section 2.5.1.2.5).

Section 2.5.1.2.6, incorporates by reference the discussion of conditions caused by human activity at the Site Location provided in SSAR 2.5.1.2.6. This information is consistent with material presented in the Unit 1 UFSAR (Reference 2.5.1-201) and with new data and conclusions from the subsequent (Unit 3) Site Location investigation (described above).

Vibratory Ground Motion

Section 2.5.2 presents the criteria and methodology used to establish the site Ground Motion Response Spectra (GMRS) for GGNS Unit 3. The analyses

performed to establish the Unit 3 GMRS build on the SSAR analysis of the Safe Shutdown Earthquake (SSE), which included updates to components of the Electric Power Research Institute (EPRI) Seismic Owners Group seismic source model, the EPRI central and eastern United States ground motion attenuation model, and the EPRI EQHAZARD software. Additionally, the GMRS analysis was updated from the SSAR SSE analysis by incorporating new site geological, geophysical, and geotechnical data collected during the GGNS Unit 3 Site investigations (Sections 2.5.1.2 and 2.5.4.3). Section 2.5.2 describes the methodology and approach of Regulatory Guide 1.208 for calculation of the GGNS Unit 3 site response and the GMRS (see Sections 2.5.2.3 through 2.5.2.6).

Surface Faulting

Section 2.5.3 describes the investigations and analyses to demonstrate the absence of potential for tectonic or non-tectonic surface deformation in the Site Location and Site Area. This determination is supported by data collected during surface and subsurface geological, seismological, and geophysical investigations completed for the SSAR and supplemented by the COL investigations for Unit 3. Section 2.5.3 describes these investigations and reviews the results of previous investigations in the Site Area and Site Location.

Stability of Subsurface Materials and Foundations

Section 2.5.4 presents a characterization of static and dynamic properties of all materials that may affect Unit 3. This characterization includes description of the stability of materials influencing seismic Category I structures and their foundations. Because of the comprehensive nature of the surface and subsurface investigation performed at the Site Location for Unit 3, data collected during the SSAR site investigation was reevaluated in the context of a refined understanding of subsurface conditions (i.e., Section 2.5.1.2.2) and incorporated into analyses described in Section 2.5.4 as appropriate. The following subjects are addressed in Section 2.5.4: geologic features, properties of subsurface materials, foundation interfaces, geophysical surveys, response of soil and rock to dynamic loading, liquefaction potential, earthquake site characteristics, excavations and backfill, groundwater conditions, static stability, design criteria, and techniques to improve subsurface conditions.

As described in Section 2.5.4, subsurface materials in the Site Location are stable and undeformed with consistent static and dynamic physical properties. The geometry of foundation interface materials are well documented by a comprehensive array of closely spaced boreholes, CPT soundings, and surface and in-situ geophysical testing. Material properties are characterized by static and dynamic laboratory testing. Groundwater conditions are well characterized by an array of monitoring and observation wells. Descriptions of analyses are also included that demonstrate the dynamic and static stability of foundation and adjacent materials. In total these characterizations and analyses demonstrate that the Unit 3 powerblock is on stable ground in an area of low tectonic activity without geologic and geotechnical hazards that could pose a safety hazard to Unit 3. No unstable, or potentially unstable, geologic or geotechnical conditions have been identified in or beneath the Unit 3 powerblock.

Stability of Slopes

Section 2.5.5 presents results of stability analyses of natural and man-made earth slopes with respect to potential impacts on Category I structures. The Unit 3 powerblock area is located on a broad, level pad several hundred feet from two natural slopes that display no evidence of slope instability or incipient slope failure. Based on surface and subsurface site investigations, including exploratory boreholes, CPT soundings, test pits, aerial photograph interpretation, geomorphic and geologic mapping, and laboratory testing, the stability analyses presented in Section 2.5.5 demonstrate that these slopes will meet performance goals under all expected static and dynamic conditions.

2.5.1 BASIC GEOLOGIC AND SEISMIC INFORMATION

Replace the introductory paragraphs of SSAR Section 2.5.1, preceding Section 2.5.1.1 heading, with the following. Re-title Section 2.5.1 as indicated above.

GGNS SUP 2.5.1-1

The basic geologic and seismic information presented here includes data from the Site Region, Site Vicinity, and Site Area as compiled and interpreted for the SSAR (Section 2.5.1.1), as well as presentation of new data from a comprehensive surface and subsurface investigation of the Site Location (Section 2.5.1.2). Study of regional geology conducted for the SSAR included a thorough review of information and data published since the Unit UFSAR (Reference 2.5.1-201). Because this regional analysis prepared for the SSAR is independent of any specific location or technology at the site, it remains current and directly applicable for the Unit 3 analyses.

Conversely, because the SSAR was written prior to selection of a specific location and technology, information and data presented regarding geologic conditions of the Site Location was, by nature, preliminary. Data collected and analyzed subsequent to submittal of the SSAR is specific to the location and technology selected and generally limited to surface mapping and subsurface exploration in the general Unit 3 foundation footprint area and supporting facilities (Figure 2.5.1-201). Therefore, analyses of Site Region, Site Vicinity, and Site Area geology presented in the SSAR are incorporated by reference (Section 2.5.1.1), but site geology reporting for the Site Location presented in 2.5.1.2 supersedes the site geology section presented in SSAR Section 2.5.1.2.

2.5.1.1.1.1 Loess Hills Subprovince

GGNS COL 2.0-26-A

GGNS ESP VAR 2.5-1

Replace the fourth sentence in the third paragraph with the following.

Loess deposits 30 to 80-ft-thick are present in the Site Vicinity.

GGNS ESP VAR 2.5-1

Add the following as the fourth paragraph.

SSAR Figure 2.5-10 is replaced with corrected SSAR Figure 2.5-10R and SSAR Figure 2.5-27 is replaced with corrected SSAR Figure 2.5-27R. References to these SSAR figures in the incorporated (by reference) SSAR text are revised to reflect the revised figure numbers; affected SSAR sections are 2.5.1.1.4,

2.5.1.1.4.2.1, 2.5.1.1.4.2.2.1, 2.5.1.1.4.2.2.2, 2.5.1.1.4.2.3.3, and 2.5.1.1.5.9.1; the specific text changes are editorial and are not included herein.

2.5.1.1.5 Regional Tectonic Setting

Insert the following information as the fourth paragraph.

GGNS COL 2.0-26-A

GGNS ESP COL 2.5-3

Additionally, the maximum earthquake magnitude distribution for the Gulf of Mexico seismic source zones has been revised upward. The magnitude distributions for each EPRI team were raised to be consistent with the occurrence of the 2006 Mb 5.52 and Mb 6.11 events that occurred within this source zone. This revision is discussed in Section 2.5.2.1.1.

2.5.1.2 Site Geology

GGNS ESP VAR 2.5-1

Replace SSAR Sections 2.5.1.2.1 through 2.5.1.2.5 in their entirety with the following. As a result, SSAR Figures 2.5-28, 2.5-29, 2.5-30, 2.5-31, and 2.5-33 through 2.5-37, and SSAR Table 2.5-7 are deleted.

GGNS COL 2.0-26-A

GGNS ESP COL 2.5-3

GGNS ESP COL 2.5-4

A site stratigraphic framework (Table 2.5.1-201) was developed based on field examination of recovered borehole samples (including standard penetration tests (SPTs)), cone penetrometer test (CPT) soundings, and test pits from site investigation (Figure 2.5.1-201) and geologic mapping (Figure 2.5.1-202) undertaken at the GGNS Unit 3 Site from April 2006 to August 2007. Table 2.5.1-202 and Figure 2.5.1-203 summarize stratigraphic data from boreholes and CPT soundings.

Field classifications were reviewed by senior geologists and compared with laboratory test data and classifications to arrive at final geologic unit classifications. This stratigraphic framework was confirmed by comparison of borehole and CPT sounding data to Unit 1 Updated Final Safety Analysis Report (UFSAR) borehole logs (Reference 2.5.1-201) and the SSAR borehole logs (SSAR Figures 2.5-71 through 2.5-74). GGNS Site stratigraphy was placed in regional geologic context presented in various published reports and maps developed by the U.S. Geological Survey, Mississippi Geological Survey, and U.S. Army Corps of Engineers (USACE).

The GGNS Site stratigraphic framework was correlated to previous stratigraphic classifications presented in the Unit 1 UFSAR and the SSAR (Table 2.5.1-201). Subsurface materials were classified during field borehole logging activities pursuant to ASTM D2487-00 (Reference 2.5.1-202). Classification of materials included evaluation of textural composition, degree of sorting, relative density, color, and sedimentary structures. Correlation of subsurface materials to geologic (stratigraphic) units, age assignments, and interpretations of genesis were performed following standard practice geologic interpretive procedures (Reference 2.5.1-203). Figures 2.5.1-204 through 2.5.1-214 and SSAR Figures 2.5-71 through 2.5-74 show summary logs of encountered conditions. Detailed boring logs are included in Appendix 2AA.

All subsurface materials encountered during site exploration at the GGNS Site (Table 2.5.1-201) can be grouped into the following four categories:

- Modern undocumented fill.

- Holocene shallow deposits in stream valleys and along the Mississippi River plain.
- Pleistocene and Pliocene strata east of the steep natural bluff (Mississippi River Bluff) underlying the Unit 3 site.
- Miocene and Oligocene “bedrock” strata underlying the entire site.

Of these, only the second category (Holocene deposits) is not present beneath the Unit 3 powerblock. The spatial distribution of these materials is shown in Figures 2.5.1-215 through 2.5.1-233.

Section 2.5.1.2.1 provides a description of stratigraphic units present within each of the four above categories, Section 2.5.1.2.2 provides a comparison of these units to geologic material descriptions in previous studies, and Section 2.5.1.2.3 describes the geologic history of the site.

2.5.1.2.1 Stratigraphic Units

Several stratigraphic units are recognized within each of the four subsurface material categories except undocumented fill, and are described below. Complete geologic material descriptions are provided in Section 2.5.1.2.2 and engineering material properties are described in Section 2.5.4.2.

Eight surficial Holocene geologic units are recognized at the site in stream valleys and along the Mississippi River plain on the basis of geomorphic mapping and regional studies:

- Stream channel deposits
- Stream terrace deposits
- Colluvium
- Alluvial fan deposits
- Levee deposits
- Lacustrine deposits
- Backswamp deposits
- Mississippi River alluvium (undifferentiated)

These geologic units are recognized by geologic and geomorphic mapping and air photo analysis at the GGNS Site and are shown in Figure 2.5.1-202.

For Sections 2.5.4.2 through 2.5.4.12, the following subunits that exhibit similar age and genesis are grouped into the single designation “Mississippi River alluvium”:

- Alluvial fan deposits
- Mississippi River alluvium (undifferentiated)
- Levee deposits
- Lacustrine deposits
- Backswamp deposits

None of these units occur beneath the Unit 3 powerblock or factor into the geotechnical response and evaluations for ESBWR Seismic Category I safety-related plant structures (Figures 2.5.1-215 through 2.5.1-228). These materials are grouped to simplify discussions in the following sections, because these strata are not important to safety and performance of the plant safety components.

Pleistocene and Pliocene strata are divided into four subsurface geologic units that underlie the Site in the area of geotechnical influence for the Unit 3 powerblock (Figures 2.5.1-215 through 2.5.1-228):

- Upper loess
- Lower loess
- UCA
- Upland Complex old alluvium (UCOA)

Miocene and Oligocene “bedrock” units underlying the Pleistocene and Pliocene strata at the site (Figures 2.5.1-215 through 2.5.1-228):

- Catahoula Formation clay
- Bucatunna Formation clay
- Glendon Formation marlstone and sand

The composite stratigraphic section extending from the Glendon Formation up through the Upper loess represents the geologic/geotechnical profile below the Unit 3 powerblock that was considered for geologic hazard screening, seismic site response (including deeper strata to hard basement), and geotechnical foundation stability evaluation.

2.5.1.2.2 Comparison of Stratigraphy to Previous Studies

Stratigraphy documented during site investigation agrees with the stratigraphy shown on SSAR (SSAR Figures 2.5-71 through 2.5-74) and Unit 1 UFSAR borehole logs (Reference 2.5.1-201), with the following exceptions (Table 2.5.1-201):

- SSAR borehole logs classify some UCOA as Catahoula Formation.
- Unit 1 UFSAR borehole logs classify UCA and UCOA as “terrace alluvium.”
- Unit 1 UFSAR and SSAR borehole logs classify loess but do not differentiate between Upper loess and Lower loess.
- Unit 1 UFSAR and SSAR borehole logs classify stream channel deposits, stream terrace deposits, colluvium, and alluvial fan deposits as “alluvium.”
- Unit 1 UFSAR borehole logs classify Mississippi River alluvium and levee deposits as “alluvium” and SSAR borehole logs classify these materials as “meander belt deposits.”
- Unit 1 UFSAR borehole logs classify lacustrine deposits and backswamp deposits as “alluvium” and SSAR borehole logs classify these materials as “backswamp deposits.”

Material descriptions and contacts from the site investigation are consistent with SSAR and Unit 1 UFSAR borehole log data sets after accounting for these differences in unit nomenclature. Terminology used for the Unit 1 UFSAR is based, in part, on older regional classifications that have been updated and superseded. Changes in terminology used for the SSAR reflect refinement and sub-classification of loess and Holocene deposits based on the additional Unit 3 subsurface exploration data.

2.5.1.2.3 Geologic Material Descriptions

2.5.1.2.3.1 Modern Undocumented Fill

GGNS ESP VAR 2.5-1

GGNS COL 2.0-26-A

GGNS ESP COL 2.5-2

Undocumented fill used to infill pre-existing swales and other topographically low areas to form the current level site grades during construction of the Unit 1 facility was encountered in several boreholes advanced during site investigation (Figures 2.5.1-215 through 2.5.1-228). Undocumented fill was placed outside of the Unit 1 foundation influence zone and therefore was not placed as a controlled engineered fill (Reference 2.5.1-201). This fill material is generally dark yellowish brown to dark gray silt and silty clay with rare silty sand, and appears to be primarily derived from excavated on-site Upper loess spoil material from past plant site grading (Figure 2.5.1-234). Woody and fibrous organic debris is commonly incorporated in the fill and/or forms a basal layer between the fill and native ground surface (Appendix 2AA). Distribution of undocumented fill material described in borehole logs generally corresponds well to the depth and extent of pre-construction swales documented in the Unit 1 UFSAR (Reference 2.5.1-201). Figure 2.5.1-233 shows the generalized distribution and depth of undocumented fill, compiled by integrating pre-construction swale depth below current site grade with undocumented fill thickness values from borehole logs. Thickness of undocumented fill ranges from 0 to 56 ft. in the Unit 3 powerblock area.

In addition, a thin (0.5 to 2.0 ft. thick) surficial veneer of gravelly sandy aggregate placed to develop a level lay-down area for the Unit 1 construction covers most of the Unit 3 powerblock area (Appendix 2AA).

2.5.1.2.3.2 Shallow Holocene Deposits

2.5.1.2.3.2.1 Stream Channel Deposits

GGNS ESP VAR 2.5-1

GGNS COL 2.0-26-A

GGNS ESP COL 2.5-3

Holocene stream channel deposits are shallow deposits of unconsolidated gravel, sand, silt, and clay located in active natural stream channels, such as the drainages that border the powerblock area to the north and south (Figure 2.5.1-202). These materials were deposited by natural fluvial sedimentation, and seasonal fluctuation of water flow has caused reworking and development of micro stratigraphy in these deposits. Stream channel deposits are variable in texture and are unconsolidated. These materials are not present beneath or within the area of influence of Unit 3 safety-related structures (Figures 2.5.1-215 through 2.5.1-228).

2.5.1.2.3.2.2 Stream Terrace Deposits

Holocene stream terrace deposits are unconsolidated gravel, sand, silt, and clay deposited in overbank terraces or point bars adjacent to active natural stream channels, such as the drainages that border the powerblock area to the north and south (Figure 2.5.1-202). Post-deposition incision of the parent stream has

left the deposits as a series of relatively flat terraces above the elevation of modern flooding or stream re-occupation and the terrace surfaces exhibit varying degrees of soil development relative to the age of deposition. Terrace deposits are not present beneath or within the area of influence of any Unit 3 safety-related structures (Figures 2.5.1-215 through 2.5.1-228).

2.5.1.2.3.2.3 Colluvium

Holocene colluvium deposits are shallow (typically 0 to 35 ft. thick; Reference 2.5.1-201) surficial deposits of unconsolidated sand, silt, and clay mantling slopes and swales at the site area, such as the steep natural escarpment or bluff west of the Unit 3 powerblock area which slopes to the Mississippi River floodplain (termed “Mississippi River bluff”) (Figure 2.5.1-202). These materials were deposited by long term creep and erosion of steeper natural slopes and are primarily derived from Upper loess that forms most slopes at the GGNS Site. The loose, heterogeneous character of colluvium deposits reflects continual creep and remobilization. Textural similarity to the parent material (Upper loess) indicates that colluvium collected on or at the base of the Mississippi River bluff slope has not been transported far. Colluvium does not exist below or within the area of influence of any Unit 3 safety-related structures (Figures 2.5.1-215 through 2.5.1-228). Colluvium does occur as a surface mantle on the Mississippi River bluff slopes and was included as a specific layer in the slope stability analysis described in Section 2.5.5.

2.5.1.2.3.2.4 Alluvial Fan Deposits

Holocene alluvial fan deposits are shallow deposits of unconsolidated gravel, sand, and silt associated with streams emanating from incised drainages in the loess uplands bordering the east margin of the Mississippi River valley that discharge onto the Mississippi River plain. These deposits are spatially confined to the alluvial plain west of the Mississippi River bluff, and west of the Unit 3 powerblock area (Figure 2.5.1-202). Alluvial fan deposits locally infill part of the low relief area occupied by Gin Lake and Hamilton Lake where they are estimated to be approximately 0 to 25 ft. thick (Reference 2.5.1-201). Alluvial fan deposits are typically saturated because of their location in low lying areas on the Mississippi River floodplain (Appendix 2AA). Alluvial fan deposits are not present beneath or within the area of influence of any Unit 3 safety-related structures (Figures 2.5.1-215 through 2.5.1-228).

2.5.1.2.3.2.5 Levee Deposits

Holocene levee deposits are shallow (typically 0 to 20 ft. thick; Reference 2.5.1-201) unconsolidated gravel, sand, and silt deposited along the margins of present or former river channels and represent overbank and/or crevasse-splay deposits. Two long, narrow zones of levee deposits form low-relief ridges oriented roughly north-south on the floodplain west of the Mississippi River bluff (Figure 2.5.1-202). The two levees demarcate the positions of active (western levee) and abandoned (eastern levee) Mississippi River channel margins. Levee deposits are not present beneath, or within the area of influence of, any Unit 3 safety-related structures (Figures 2.5.1-215 through 2.5.1-228). They do, however, provide geologic criteria to help evaluate the history of river migration.

2.5.1.2.3.2.6 Lacustrine Deposits

Holocene lacustrine deposits are shallow (typically 0 to 40 ft. thick; Reference 2.5.1-201) unconsolidated clay, silt, and sand deposited in lakes occupying a low relief area former river channel on the river plain west of the Mississippi River bluff (Figure 2.5.1-202). Typically, lacustrine sediments at the GGNS Site are deposited in oxbow lakes formed by abandoned meander loops in the river floodplain. The low-energy ("slack water") suspension settlement mode within the floodplain lakes favors deposition of fine sediment and stratification of deposits. These sediments typically remain in a saturated, unconsolidated condition (Reference 2.5.1-201). Lacustrine deposits are not present beneath or in the area of influence of any Unit 3 safety-related structures (Figures 2.5.1-215 through 2.5.1-228).

2.5.1.2.3.2.7 Backswamp Deposits

Holocene backswamp deposits are shallow (typically 0 to 75 ft. thick; Reference 2.5.1-201) unconsolidated gravel, sand, silt, and clay deposited in ephemeral marshes occupying areas of low relief on the alluvial plain west of the Mississippi River bluff (Figure 2.5.1-202). Backswamp sediments were transported and deposited by a mix of suspension settlement and fluvial transport. These sediments typically remain in a saturated, unconsolidated condition (Reference 2.5.1-201). Backswamp deposits are not present beneath or within the area of influence of any Unit 3 safety-related structures (Figures 2.5.1-215 through 2.5.1-228).

2.5.1.2.3.2.8 Mississippi River Alluvium, Undifferentiated

Holocene Mississippi River Alluvium (undifferentiated) is composed of unconsolidated gravel, sand, silt, and clay deposits that have obvious genetic affiliation to fluvial processes of the Mississippi River, but lack discrete geomorphologic characteristics for further subclassification. These materials occur on the active alluvial plain west of the Mississippi River bluff (Figure 2.5.1-202) and include a combination of levee, lacustrine, and backswamp deposits previously described above (Sections 2.5.1.2.3.2.5 to 2.5.1.2.3.2.7). These materials are not present beneath or within the area of influence of any Unit 3 safety-related structures (Figures 2.5.1-215 through 2.5.1-228).

2.5.1.2.3.3 Pleistocene and Pliocene Strata

2.5.1.2.3.3.1 Upper Loess

Upper loess is correlative to the sequence of Peoria, Roxanna, and Loveland loess sheets of Wisconsin age that are regionally extensive in the GGNS Site vicinity (Reference 2.5.1-204 through Reference 2.5.1-206). The Upper loess deposits underlie the higher elevation uplands that form the eastern border of the Mississippi alluvial valley (SSAR Figure 2.5-2). The bluff that separates the Mississippi River plain from the Unit 3 powerblock area is comprised principally of Upper loess (Figure 2.5.1-202). Upper loess sediment is sourced from glacial outwash and drift material transported to the south along the Late Pleistocene Mississippi River valley (Reference 2.5.1-204, Reference 2.5.1-207, and Reference 2.5.1-208). Upper loess was identified in the majority of boreholes and CPT soundings associated with the Unit 3 site investigation east of the Mississippi River bluff (Table 2.5.1-202). This material represents the uppermost

naturally-occurring geologic strata in the Unit 3 powerblock area (below areas of thin fill), except in active stream channels south and north of the powerblock and in localized areas where undocumented fill was placed in former topographic swales eroded into the upper loess (Section 2.5.1.2.3.1) (Figures 2.5.1-215 through 2.5.1-228). Of the seven subsurface stratigraphic units defined in Section 2.5.1.2.1 that occur within the powerblock area, only Upper loess is exposed in outcrop (Mississippi River bluff and existing cut-slopes) (Figure 2.5.1-202). Thickness of Upper loess ranges from about 30 to 80 ft. thick (Table 2.5.1-202) and is controlled in part by past grading activity that removed portions of the Upper loess soil in some locations (Reference 2.5.1-208). The Upper loess is underlain by the Lower loess, and the contact between these units is a subplanar disconformity (Figures 2.5.1-215 through 2.5.1-229).

Upper loess consists of generally dry to damp, homogeneous yellowish brown silt to clayey silt (ML) with low to moderate plasticity (mean plasticity index 10) and blocky structure (Table 2.5.1-203, Figures 2.5.1-235 and 2.5.1-236, Appendix 2AA). Interspersed and clustered small gastropod shells are common to rare, fine root pores are pervasive, and fine laminations are rare to common (Appendix 2AA). Hydrometer analysis results for Upper loess samples (Section 2.5.4.2) indicate a majority (about 85 percent) silt component (Table 2.5.1-203, Figure 2.5.1-235), imparting a silky texture in hand sample. Upper loess exhibits slight gradational variation defined by minor differences in clay content, color, shell content, and consistency, however these variations are not sufficiently well developed or uniform to trace discrete marker horizons between adjacent boreholes. Geotechnical index properties of Upper loess samples generally fall within a narrow range of values (Table 2.5.1-203) and indicate a lean silt to clay (ML to CL) based on the Uniform Soil Classification System (USCS). It is possible that irregular zones of increased clay content in Upper loess soils represent discontinuous paleosol horizons that formed between discreet pulses of loess deposition. Based on SPT sampling, Upper loess is generally in a medium to very stiff condition (mean corrected N-value 14.5 +/- 7.4 blows/ft).

Upper loess borehole samples produce moderate effervescent response to hydrochloric acid (Appendix 2AA), suggesting weakly developed calcium carbonate cementation. Typically, calcium carbonate cementation in loess deposits occurs as a precipitate in root pores and other void spaces, forming a skeletal bonding between silt grains. Calcite precipitates are visible as small white streaks and blebs in some loess specimens. Carbonate precipitate may be more highly developed in zones of gastropod concentration observed in some loess samples. Additional secondary cohesion imparted by clay film formation on silt grain surfaces (Reference 2.5.1-209) is present in some loess samples. Weak carbonate/clay film cementation in Upper loess increases shear strength, permitting vertical or steep slopes in road cuts and stream banks both regionally and locally. However, carbonate cementation and clay film bonding are affected by water saturation that can re-dissolve carbonate precipitates and soften clay films. Long term loess slopes, such as the Mississippi River bluff have persisted in spite of periodic wetting by rainfall and/or overland sheet flow with good gross stability, but localized gullying and erosion occurs where surface water flows or collects. Initial degradation of loess cementation and resulting erosion typically manifests as small piping holes or shallow rills, with continued saturation and

water flow contributing to development of deep, steep-sided gullies with a characteristic dissected pattern of dendritic ephemeral swales.

2.5.1.2.3.3.2 Lower Loess

Pleistocene Lower loess was identified in the majority of boreholes and CPT soundings during site investigation for Unit 3 east of the Mississippi River bluff. Lower loess is differentiated from Upper loess by stratigraphic position, higher clay content, and less-uniform texture and character. The Lower loess represents the initial pulses of loess soil deposited in low relief areas developed on an eroded landscape. Comparison of GGNS Site investigation borehole logs with Unit 1 UFSAR borehole logs suggests that the Lower loess may be discontinuous in the GGNS Site vicinity and laterally restricted at the GGNS Site between the Mississippi River bluff and west of Unit 1 (Figure 2.5.1-229). This observation is supported by the absence of Lower loess in borehole B-1061 (Table 2.5.1-202) and the absence of material similar to Lower loess in Unit 1 UFSAR borehole logs (Reference 2.5.1-201). Thickness of Lower loess (where present) averages 12 +/- 5 ft. (Table 2.5.1-202). The top of Lower loess ranges in elevation from 67 to 83 ft. (North American Vertical Datum of 1988 (NAVD 88)) (Table 2.5.1-202, Figure 2.5.1-229). Lower loess rests unconformably over Pleistocene UCA.

Lower loess generally consists of damp to moist light yellowish brown silty clay (CL), silty clay (ML), and clayey sand (SC) interstratified in beds ranging in thickness from 0.5 to greater than 9 ft. (Figures 2.5.1-237 and 2.5.1-238). Stratification within Lower loess cannot be reliably correlated between adjacent boreholes and is laterally discontinuous. Silty clay and clayey silt is moderately plastic (mean plasticity index 14) with common to abundant iron oxide and manganese oxide staining and mottling and common fine-grained sand laminae (less than 0.2 in. thick). Gastropod shells, fine root pores, and blocky structure common in Upper loess are generally absent or less well-developed in Lower loess. Clayey sand is low to non-plastic with subrounded to subangular poorly graded fine-grained quartz sand and minor fine-grained mafic sand. Clayey sand is generally restricted to the basal portion of Lower loess deposits and is interpreted to be a product of reworking of the underlying UCA during Lower loess deposition. Hydrometer analysis results for Lower loess samples indicate that this material is primarily (59 percent) silt with significant amounts of fine-grained sand (22 percent) and clay (20 percent) (Table 2.5.1-203, Figure 2.5.1-237). Based on SPT sampling, Lower loess is generally in a medium to very stiff condition (mean corrected N-value 16.3 +/- 9.5 blows/ft.).

Greater clay content in the Lower loess with respect to the Upper loess locally creates a partial aquitard, permitting development of ephemeral perched groundwater in the Lower loess and at the base of the Upper loess (Figure 2.5.1-239). The use of the term perched groundwater in Sections 2.5.4 and 2.5.5 refers to the modeled layer of high water content shown in Figure 2.5.1-239. Lithologic description of continuous core samples collected during site characterization indicated moist to saturated soils were encountered in soil borings in many areas within the Loess. Monitoring wells screened in the Loess identified only small localized areas of perched groundwater. Those wells with measurable perched groundwater are illustrated in Figure 2.4.12-205. CPT soundings also recorded a thin elevated layer of high pore water content within the loess in many locations.

This modeled layer of higher water content is “perched” above the groundwater table but is unconfined and discontinuous throughout the site. Figure 2.5.1-239 shows this modeled surface as continuous within the powerblock for the purposes of evaluating excavation and dewatering analyses and for providing conservative liquefaction and slope stability calculations. Perched water is further discussed in Section 2.4.12.

Borehole samples of Lower loess do not exhibit an effervescent response to contact with hydrochloric acid indicating absent or less well-developed carbonate than the Upper loess (Appendix 2AA). The absent or reduced carbonate in Lower loess appears to be related to several possible factors including general absence of gastropod shells, higher moisture dissolution of carbonate precipitates, and less paleosol development.

2.5.1.2.3.3.3 Upland Complex Alluvium

Pleistocene UCA was identified in the majority of Unit 3 borings located east of the Mississippi River bluff (Table 2.5.1-202). UCA is a fluvial sequence dominated by sugary textured sand that was deposited as overbank, crevasse splay, and point bar sediments of the ancient Mississippi River. These deposits accumulated over an erosional surface (Figures 2.5.1-215 through 2.5.1-228 and 2.5.1-230). The top of the Upland Complex sequence was eroded prior to deposition of the overlying Lower loess and is represented by two subplanar surfaces that range between roughly 75 and 135 ft. (NAVD 88) (Table 2.5.1-202, Figure 2.5.1-230). The irregular, eroded surface between the UCA and overlying loess indicate a significant post-deposition erosional event. Erosion of the formerly thicker alluvial sediments exerted a higher surcharge confining stress on the remaining UCA, resulting in preconsolidation of these deposits with respect to existing topography and confining stress.

The UCA rests unconformably over the UCOA (described below) (Figures 2.5.1-215 through 2.5.1-228 and 2.5.1-230). Comparison of stratigraphy defined by Unit 3 borehole logs (Appendix 2AA) with Unit 1 UFSAR borehole logs (Reference 2.5.1-201) indicates that UCA at the GGNS Site occurs as two separate inset paleoterrace sequences that are laterally disconformable and separated by an elevation difference of about 60 ft. (Figure 2.5.1-230). The lower UCA paleoterrace has a basal elevation of about 75 ft. (NAVD 88), and extends east from the Mississippi River bluff to immediately west of the Unit 1 facility, entirely underlying the Unit 3 powerblock (Figures 2.5.1-215 through 2.5.1-228 and 2.5.1-230). The higher Upland Complex paleoterrace has a base elevation of about 135 ft. (NAVD 88) and extends east from the western edge of the Unit 1 powerblock (Figures 2.5.1-215 through 2.5.1-228 and 2.5.1-230). Because of spatial, temporal, and stratigraphic differences in paleoterrace deposition, discreet subunit stratigraphy within UCA cannot be directly correlated between Unit 3 powerblock and Unit 1 powerblock locations. Thickness of UCA below the Unit 3 powerblock averages 19 ft. +/- 8 (Table 2.5.1-202).

UCA in the powerblock area consists of moist to wet light yellowish brown and gray poorly graded sand (SP) with some discontinuous thin interbeds of silty sand (SM) and clayey silt (ML) (Table 2.5.1-203, Figures 2.5.1-240 and 2.5.1-241, Appendix 2AA). Fine stratification within UCA is laterally discontinuous and cannot be correlated between adjacent boreholes. The predominately poorly

graded sand is non-plastic with subrounded to subangular fine- to medium-grained quartz sand and lesser fine-grained mafic sand (Appendix 2AA). UCA has common iron oxide staining, but less pervasive than the overlying Lower loess (Appendix 2AA). Grain-size analysis indicates that sand content of the alluvium averages about 70 percent, with some fines and trace gravel (Table 2.5.1-203, Figure 2.5.1-240).

Borehole samples of UCA do not exhibit an effervescent response to hydrochloric acid and lack evidence of significant paleosol development (Appendix 2AA). Based on SPT sampling, UCA is generally in a medium to very dense condition (mean corrected N-value 37.8 +/- 19.7 blows/ft.) and CPT soundings commonly met tip refusal in these deposits (Figure 2.5.1-203). The contact between UCA and underlying UCOA is a subplanar erosional disconformity that exhibits relief on the order of about 35 ft. (Figures 2.5.1-215 through 2.5.1-228 and 2.5.1-230). Top of unit elevation ranges from about 30 to 65 ft. (NAVD 88) (Table 2.5.1-202, Figure 2.5.1-230). Laboratory testing performed for the Unit 3 study and field testing reported in the Unit 1 UFSAR (Reference 2.5.1-201) both confirm measurable overconsolidation of the UCA (Section 2.5.4.2).

2.5.1.2.3.3.4 Upland Complex Old Alluvium

Pleistocene UCOA was identified in the majority of Unit 3 boreholes east of the Mississippi River bluff (Table 2.5.1-202). Comparison of Unit 3 site investigation borehole logs with those from the Unit 1 UFSAR (Reference 2.5.1-201) suggests that UCOA is areally restricted between the Mississippi River bluff and west of the Unit 1 facility (Figures 2.5.1-215 through 2.5.1-228 and 2.5.1-231). UCOA appears to have been deposited as fluvial channel sediments over a highly irregular erosional surface developed on the underlying Miocene Catahoula Formation (Figure 2.5.1-231). Because of this irregular erosional/deposition surface, the extent and thickness of the unit is variable under the Unit 3 powerblock area (Figure 2.5.1-231). Thickness of UCA is typically about 38 ft. +/- 26 (Table 2.5.1-202, Figures 2.5.1-215 through 2.5.1-228 and 2.5.1-231). Thicker deposits of UCOA exist where deeper channels were eroded into the top of the Catahoula Formation (Figures 2.5.1-215 through 2.5.1-228 and 2.5.1-231).

A prominent, deep, northeast-trending buried paleochannel in-filled by UCOA is present along the west margin of the Unit 3 powerblock. Dimensions of the channel are well demonstrated by Figure 2.5.1-232, an elevation isopach map of the unconformable contact between UCOA and Catahoula Formation. This buried channel may reflect a former location of a tributary drainage to the Mississippi River that is now located north of the Unit 3 area (Figure 2.5.1-202) or a possible former meander course of the Mississippi River during the early Pleistocene. The buried paleochannel is approximately 750 ft. wide and incised roughly 70 ft. into the top of the Catahoula Formation. Inclination of side slopes on the buried paleochannel range from 10 to 20 degrees (Figures 2.5.1-215 through 2.5.1-228 and 2.5.1-231). The southeast margin of the channel is located directly west of the Unit 3 powerblock, and under the radwaste building (Figures 2.5.1-215 through 2.5.1-228 and 2.5.1-231). Thick lenses of gravelly sand to sandy gravel within the UCOA are abundant within the buried paleochannel and appear to represent channel lag deposits (Appendix 2AA).

UCOA consists of well-graded gravelly sand (SW) and dark gray silty clay (CL) interstratified in laterally discontinuous beds ranging in thickness from less than 0.5 to (especially in the case of gravelly sand) to about 10 ft. (Table 2.5.1-203, Figures 2.5.1-242 and 2.5.1-243, Appendix 2AA). Stratification within UCOA cannot be confidently correlated between adjacent boreholes and the thickness of discrete lenses or zones vary laterally ("pinch and swell"). Well-graded gravelly sand is non-plastic with subrounded to subangular well-graded fine- to coarse-grained sand (Table 2.5.1-203). The majority of grains in the gravelly sand are quartz with abundant lithic and common feldspathic grains, whereas the gravel is largely siliceous (chert) with rare to common irregularly shaped rip-up clasts of greenish clay from the underlying Catahoula Formation (Appendix 2AA). Silty clay lenses are moist and moderately to highly plastic with common carbon streaks and some woody or fibrous plant materials (Appendix 2AA). UCOA is markedly less uniform than the overlying UCA and represents a more dynamic, changing depositional environment. Discrete lenses and layers appear to be crudely bedded with lateral cross cutting erosion/cross bedding interfaces (Appendix 2AA). Catahoula rip up clasts and gravelly lenses indicate high velocity fluvial flow, typical of channel flow (Appendix 2AA). Laboratory grain-size analysis of UCOA samples show that the dominant texture of sandier beds is fine- to coarse-grained sand (average 53 percent) with gravel (Table 2.5.1-203, Figure 2.5.1-242). Hydrometer analyses indicate typical silt percentage of about 26% and clay content of about 14% (Table 2.5.1-203, Figure 2.5.1-242). Based on SPT sampling, UCOA is generally in a medium dense to dense condition (mean corrected N-value 32.1 +/- 17.6 blows/ft).

UCOA borehole samples do not exhibit an effervescent response to contact with hydrochloric acid (Appendix 2AA). Deposits typically are dark colored and range from dark green to dark gray, with a gleyed appearance (Appendix 2AA). This coloration suggests reducing conditions and/or mafic mineralogy. Granular lenses are typically dense and clayey layers and zones generally are medium stiff to stiff (Appendix 2AA). As with the overlying UCA, UCOA appears to be in an overconsolidated state as the result of erosional stripping of former thicker alluvial surcharge. Laboratory testing performed for the Unit 3 study and field testing reported in the Unit 1 UFSAR both confirm significant overconsolidation of the UCOA (Section 2.5.4.2).

2.5.1.2.3.4 Miocene and Oligocene strata

2.5.1.2.3.4.1 Catahoula Formation

Miocene Catahoula Formation is a semi-indurated marine sequence of claystone/clay and sandstone/sand that was identified in all boreholes advanced through the overlying Pleistocene and Holocene deposits in the Unit 3 powerblock (Table 2.5.1-202). Catahoula Formation also was recorded in borehole logs for the Unit 1 UFSAR (Reference 2.5.1-201) and one deep borehole described in the SSAR. Outcrops of Catahoula Formation have been described near the historic town of Grand Gulf, 1 mile north of the GGNS Site (Reference 2.5.1-201). The Catahoula Formation is a regionally extensive formation that is relatively continuous in the subsurface within the Mississippi River embayment, and at the Grand Gulf site represents the first occurrence of "bedrock" (soft rock). One borehole (B-1013) from the Unit 3 investigation was advanced deep enough to penetrate through the Catahoula Formation, 270 ft.

thick at the borehole location (Section 2.5.4.3) (Appendix 2AA). This thickness is similar to documented Catahoula Formation thicknesses in Unit 1 UFSAR borehole logs (Ho). Top of Catahoula elevation ranges between minus 37 and plus 93 ft. (NAVD 88) (Table 2.5.1-202, Figures 2.5.1-215 through 2.5.1-228 and 2.5.1-231) and represents an irregular erosional unconformity with the overlying UCOA. As discussed in Section 2.5.1.2.3.3.4, deep channels were eroded into the top of the Catahoula Formation that later were backfilled by deposition of UCOA (Figures 2.5.1-215 through 2.5.1-228 and 2.5.1-232).

The Catahoula Formation consists of damp to moist greenish gray silty clay (CL) and clayey sand (SC) graded in some beds to weakly indurated claystone that exhibits a “brittle” blocky structure (Table 2.5.1-203, Figures 2.5.1-244 and 2.5.1-245, Appendix 2AA). The weakly indurated Catahoula Formation breaks with strong hand pressure into numerous granule-sized weakly cemented clay shards (Appendix 2AA). Clay beds are moderately to highly plastic with no significant organic materials observed in recovered borehole samples (Appendix 2AA). Clayey sand lenses range from low to non-plastic, and contains fine-grained subangular quartz (Appendix 2AA). Stratification within the Catahoula Formation is laterally discontinuous and it is typically difficult to trace individual marker beds between adjacent boreholes. Hydrometer analysis results for Catahoula Formation samples indicate a substantial (52 percent) silt component with significant fine-grained sand (37 percent) and clay (24 percent) (Table 2.5.1-203, Figure 2.5.1-244).

Borehole samples of the Catahoula Formation do not exhibit an effervescent response to contact with hydrochloric acid (Appendix 2AA), and thermogravimetric analysis of one Catahoula Formation sample yielded a carbonate content of 0.9 percent by weight (Table 2.5.1-204). The measured carbonate content and observed field and hydrochloric acid response indicate that the Catahoula Formation does not contain sufficient carbonate to undergo significant dissolution or karst development. SPT tests and borehole seismic velocity measurements show that the Catahoula Formation is hard (mean corrected N-value 45.1 +/- 17.0 blows/ft), with geotechnical engineering properties typical of very competent, partly cemented soils and soft rock.

Grain size and sedimentary structures in the Catahoula Formation are consistent with an interpretation of deposition in a marine marginal shoreline environment (Reference 2.5.1-201). The indurated nature of rip-up clasts from the Catahoula Formation in UCOA gravelly sand deposits (Appendix 2AA) indicates that a significant amount of time passed between deposition of the two units, allowing for the Catahoula Formation to become weakly indurated. The geologic history of past sedimentation and erosional stripping suggests that the Catahoula Formation is in a significantly overconsolidated state with past surcharge loading perhaps many times greater than the present confinement imposed by the overlying Pleistocene and/or Holocene deposits. Laboratory testing performed for the Unit 3 study and field testing reported in the Unit 1 UFSAR (Reference 2.5.1-201) both confirm significant overconsolidation of the Catahoula Formation (Section 2.5.4.2).

2.5.1.2.3.4.2 Bucatunna Formation

One borehole (B-1013) advanced for the Unit 3 study was deep enough to encounter and penetrate through the Oligocene Bucatunna Formation, which underlies the Catahoula Formation (described above) (Appendix 2AA). The top of the Bucatunna Formation was encountered in the boring at a depth of 372 ft. (-239.5 ft. elevation) below site grade (Section 2.5.4.3) and was about 75 ft. thick at the boring location (Appendix 2AA). Similar depth and thickness values were recorded in Unit 1 UFSAR borehole logs (Reference 2.5.1-201). Based on descriptions of regional geology (SSAR Section 2.5.1.1.4.2.3.3), the Bucatunna Formation is a regionally extensive formation that likely underlies the entire GGNS Site (Reference 2.5.1-201).

The Bucatunna Formation consists of damp to moist greenish black silty clay (CL) and sand with shell hash (SP) (Figure 2.5.1-246, Appendix 2AA). The Bucatunna Formation is weakly indurated and parts easily along common silt laminae (Appendix 2AA). Clay is moderately to highly plastic with no trace of organic materials (Appendix 2AA). Sand component ranges from low to non-plastic and contains abundant mollusk shell fragments (Table 2.5.1-203, Appendix 2AA).

Borehole samples of the Bucatunna Formation do not exhibit an effervescent response to contact with hydrochloric acid (Appendix 2AA), and thermogravimetric analysis of one Bucatunna Formation sample yielded a carbonate content of 3.3 percent by weight (Table 2.5.1-204). The measured carbonate content and observed field and hydrochloric acid response, indicate that the Bucatunna Formation does not contain sufficient carbonate to undergo significant dissolution or karst development. Borehole sample descriptions (Appendix 2AA) and seismic velocity measurements (Section 2.5.4.2.2.7) show that the Bucatunna Formation is very stiff to hard, with geotechnical engineering properties ranging between those typical for very competent, partly cemented soils and soft rock.

The Byram Marl, a roughly five foot-thick unit recorded between the Bucatunna and Glendon Formations in three Unit 1 UFSAR borehole logs (Reference 2.5.1-201), was not encountered during Unit 3 site exploration (Appendix 2AA).

2.5.1.2.3.4.3 Glendon Formation

The Glendon Formation is the deepest strata encountered during site exploration and was identified in the deepest borehole (B-1013) at a depth of 447 ft. (-314.5 ft. elevation) below site grade (Appendix 2AA). This borehole was terminated in the Glendon Formation and the local unit thickness was therefore not determined (Appendix 2AA). Regional geologic descriptions suggest that the Glendon Formation is on the order of 300 ft. thick (SSAR Figure 2.5-9). Some deep Unit 1 UFSAR borehole logs also record the Glendon Formation, at depths similar to that in Unit 3 borehole B-1013 (Reference 2.5.1-201). A structure contour map of the top of the Glendon Formation in SSAR Figure 2.5-15 has been used for regional evaluation of salt dome occurrence and deformation.

The Glendon Formation encountered in B-1013 consists of two to six foot-thick interbeds of light gray marly limestone and greenish gray sandy clay (CL) (Figure 2.5.1-247, Appendix 2AA). Sandy clay is moderately to plastic and weakly

indurated with abundant mollusk shell fragments and no visible trace of organic materials (Appendix 2AA). The limestone component of the Glendon Formation is weak to medium strong and recovered samples effervesce in response to contact with hydrochloric acid (Appendix 2AA).

No dissolution features were identified in the core samples. Additionally, thermogravimetric analysis of two Glendon Formation samples yielded carbonate contents of 87.9 percent and 87.1 percent by weight (Table 2.5.1-204). These laboratory measurements indicate significant carbonate content in the formation beds, but the level of purity is below typical percentages common to limestone formations with documented well-developed dissolution and karst (Reference 2.5.1-211). The samples tested were selected based on field determination that the samples were of the highest carbonate content recovered.

Borehole seismic velocity measurements show that the Glendon Limestone Formation is dense with geotechnical engineering properties typical of soft rock (Section 2.5.4.2.2.8).

2.5.1.2.4 Geologic History

Geological formations underlying the GGNS Site record a long history of tectonic stability, deposition, and transition from marine to terrestrial sedimentation, as described in SSAR Section 2.5.1.2.2. Unconformities between geologic formations record changes in depositional environment, climate, and glacial-eustatic cycles over the past 34 Ma (SSAR Section 2.5.1.2). Regionally, laterally continuous deposits of Oligocene age and younger dip very gently southward along the plunge direction of the Mississippi River embayment towards the Gulf of Mexico (SSAR Figures 2.5-6, 2.5-11 and 2.5-12). Long term tectonic stability is reflected by lack of deformation in these deposits.

During the Oligocene epoch, paleogeography of the GGNS Site and surrounding region was dominated by shallow marine seas in which the Glendon and Byram Marl Formations of the Vicksburg Group were deposited (Reference 2.5.1-201). These deposits primarily consist of limestone and marl with interbedded calcareous sands and clays (Appendix 2AA, Reference 2.5.1-201). The Byram Marl was later buried by clay of the late Oligocene Bucatunna Formation, representing a transition to a low-energy, deep water environment. These deposits are overlain unconformably by the Miocene Catahoula Formation (Figures 2.5.1-215 through 2.5.1-228).

GGNS Site paleogeography during the Miocene included marine to marginal shoreline depositional environments reflected by deposition of silty clay and clayey sand of the Catahoula Formation (Reference 2.5.1-201).

In the Late Pliocene or Early Pleistocene, the Site paleogeography changed to an alluvial environment dominated by fluvial sedimentation from the ancestral Mississippi River, during which the surface of the Catahoula Formation was deeply incised by a southwest-trending river/stream channel (Figure 2.5.1-232). The geometry of this channel, represented by the eroded top of the Catahoula Formation, is shown by the structure contour map in Figure 2.5.1-232. This river/stream channel was subsequently backfilled with alluvial deposits correlative with the UCA, probably in response to a rise in regional base level (Figures 2.5.1-215 through 2.5.1-228). These deposits consist of coarse sand

and gravel derived from both glacial and non-glacial sources (Reference 2.5.1-208), termed UCOA in this report. One or more episodes of alluvial erosion and deposition resulted in emplacement of fine sands and clays of the UCA in a series of two inset terraces shown in Figures 2.5.1-225 and 2.5.1-230.

At various periods in the late Pleistocene, strong seasonally prevailing winds transported silt from unvegetated glacial outwash in the central United States (Reference 2.5.1-201), depositing loess sheets in the region between Vicksburg and Natchez (SSAR Figure 2.5-8). The youngest loess sheet, the Peoria Loess, is late Wisconsin in age (Reference 2.5.1-205). Texture of Lower loess reflects deposition in an alluvial environment that blended windblown silt with clay and sand, probably reworked from eroded UCA (Table 2.5.1-203). The disconformable contact between Lower and Upper loess represents a depositional hiatus of unknown length, after which windblown silt of Upper loess was deposited across the site to a thickness of greater than 50 to 80 ft. (Figures 2.5.1-215 through 2.5.1-228).

Throughout the Holocene, loess deposits were deeply eroded by tributary streams to the Mississippi River through establishment of dendritic drainage systems (Figure 2.5.1-202). During this time alluvial sediment was also deposited on the Mississippi River plain west of the Mississippi River bluff and in tributary stream valleys along the northern and southern portions of the site (Figure 2.5.1-202).

GGNS ESP VAR 2.0-2

GGNS ESP VAR 2.5-1

GGNS ESP VAR 2.5-2

GGNS COL 2.0-26-A

2.5.1.2.5 Seismicity and Faulting

There have been no recorded historical earthquakes at the Site Area (see Section 2.5.3.4). Additionally, there is no documented evidence for paleo-earthquakes at the Site Area (see Section 2.5.3.3). Absence of tectonic structure at the Site Area is discussed in Sections 2.5.3.5 and 2.5.4.1.

2.5.1.3 REFERENCES

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GGNS COL 2.0-26-A

TABLE 2.5.1-201 (Sheet 1 of 3)
SUMMARY OF STRATIGRAPHIC UNITS AND CORRELATION TO PREVIOUS STUDIES

Epoch	GGNS Unit 1 UFSAR	GGNS ESP SSAR	GGNS Unit 3 FSAR(1)
Modern	**not described**	**artificial fill**	**af - undocumented fill**
	alluvium sand, gravel, silt, and clay	**alluvium** gravel, sand, silt and clay in active river and stream channels	**Qhc - stream channel deposits (latest Holocene)** unconsolidated gravel, sand, silt and clay deposited in active, natural stream channels.
Holocene			**Qht - stream terrace deposits (Holocene)** unconsolidated gravel, sand, silt and clay associated with stream channel point bar and overbank deposits adjacent to fluvial channels.
			Qc - colluvium (Holocene) unconsolidated sand, silt and clay deposits accumulated on or at the base of slopes.
			Qhf - alluvial fan deposits (Holocene) unconsolidated gravel, sand and silt deposits associated with streams emanating from confined drainages onto alluvial valleys.
		meander belt deposits upward-fining gravel, sand, silt, and clay sequences	**Qha - Mississippi River alluvium, undifferentiated (Holocene)** unconsolidated gravel, sand, silt and clay deposited by the Mississippi River.
			Qhlv - levee deposits (Holocene) unconsolidated gravel, sand and silt deposited in a low ridge adjacent to present or former river and stream channels.
		backswamp deposits silt and fine sand overbank deposits	**Qhlu - lacustrine deposits (Holocene)** unconsolidated clay, silt and sand associated with lake deposition.
			Qhb - backswamp deposits (Holocene) unconsolidated sand, silt and clay deposited in the flood basin behind a natural levee.

GGNS COL 2.0-26-A

TABLE 2.5.1-201 (Sheet 2 of 3)
SUMMARY OF STRATIGRAPHIC UNITS AND CORRELATION TO PREVIOUS STUDIES

Epoch	GGNS Unit 1 UFSAR	GGNS ESP SSAR	GGNS Unit 3 FSAR[1]
Pleistocene	**loess** dry, homogeneous, unstratified silt (ML) approximately 65 ft. thick	**loess** yellowish brown silt to clayey silt (ML) featuring a weak blocky structure and gastropod shells	**Qpl - Upper loess (late Pleistocene)** silt with clay (ML), massive, weak blocky structure, very thinly laminated and rare gastropod shells. gradual, planar, conformable contact with underlying Lower loess
Pliocene-Pleistocene	**Terrace deposits** single or multiple fluvial fining upward sequences of silty clay, sand, and gravel incorporates Lower loess, Upland Complex alluvium, and Upland Complex old alluvium of GGNS ESP SSAR and GGNS Unit 3 FSAR (archaic as used)	**Upland Complex alluvium** partially overconsolidated sand, silty to clayey sand, and gravel include both Lower loess and Upland Complex alluvium of COLA	**Lower loess (late Pleistocene)** light gray clayey silt (CL-MH) approximately 10 ft. to 20 ft. thick and featuring abundant Fe and Mn oxide mottling abrupt unconformable subplanar contact above Upland Complex alluvium
			Upland Complex alluvium (mid-Pleistocene) poorly graded fine subrounded fine-grained quartz sand and silty sand (SP-SM) approximately 20 ft. to 25 ft. thick subplanar unconformable contact above Upland Complex old alluvium
		Upland Complex old alluvium overconsolidated dense clay (very stiff to hard), sand, and gravel (minor) at least 40 ft. to 90 ft. thick some sand and clayey sand reclassified as Catahoula Formation in COLA	**Upland Complex old alluvium (mid- Pleistocene)** well graded sand and gravel (SW-GW) interbedded with clay (CH); thickness varies from 0 ft. to more than 100 ft. abrupt, high relief erosional contact with underlying Catahoula Formation
Miocene	**Catahoula Formation** hard to very hard gray-green silty to sandy clay with locally indurated sand and silt seams estimated thickness 320 ft.	**Catahoula Formation** weakly cemented claystone that is significantly more dense and lithified than the overlying alluvium and old alluvium	**Catahoula Formation (Pliocene to Miocene)** greenish gray silty clay (CL) and clayey sand (SC), very weakly lithified with rare to common cemented beds, 270 ft. thick below proposed reactor building unconformable contact with underlying Bucutana Formation

GGNS COL 2.0-26-A

TABLE 2.5.1-201 (Sheet 3 of 3)
SUMMARY OF STRATIGRAPHIC UNITS AND CORRELATION TO PREVIOUS STUDIES

Epoch	GGNS Unit 1 UFSAR	GGNS ESP SSAR	GGNS Unit 3 FSAR(1)
Oligocene	**Bucatana Formation** stiff to hard greenish-black clay with thin fine-grained sand seams	**below exploration depth**	**Bucatunna Formation (Oligocene)** stiff to hard greenish-black clay with thin fine-grained sand seams, reached only in deepest boring at 371 ft. below site grade; includes 20 ft. of greenish-black clay intercalated with fossiliferous sandy clay beds lithologically similar to Glendon Formation
	Byram Marl hard to very hard, green to gray, sandy calcareous clay roughly five ft. thick	**below exploration depth**	**not identified**
	Glendon Limestone interbedded light gray fossiliferous limestones and hard to partly indurated grayish green sandy calcareous clay with no evidence of solution activity approximately 46 ft. thick	**below exploration depth**	**Glendon Formation (Oligocene)** intercalated marlstone beds, clayey sand with shell hash, and green clay reached only in deepest boring at 447 ft. below site grade; no evidence of solution activity
	Mint Springs Marl hard grayish-green fossiliferous glauconitic sand and clay	**below exploration depth**	**below exploration depth**

Note:

(1) Geologic map nomenclature provided for surficial units (Figure 2.5.1-202)

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Table 2.5.1-202 (Sheet 1 of 4)
Summary of Borehole and CPT Stratigraphic Data

Borehole/ sounding ID	Top of hole elevation	Base of hole depth	Top of MSA	Top of colluvium	Top of Upper loess	Top of Lower loess	Top of UCA	Top of UCOA	Top of Catahoula Formation
	ft. amsl	ft. bgs	ft. bgs	ft. bgs	ft. bgs	ft. bgs	ft. bgs	ft. bgs	ft. bgs
B-1003	132	200	---	43	---	59	80	84	104
B-1006	139	239	---	---	13	71	79	87	109
B-1007	133	200	---	---	32	68	78	83	105
B-1008	135	201	---	---	1	53	68	83	100
B-1009	134	225	---	---	1	55	72	87	105
B-1010	134	300	---	---	23	58	63	89	100
B-1011	155	301	---	---	7	73	84	105	159
B-1012	134	226	---	---	2	58	74	88	99
B-1013	134	506	---	---	13	61	67	84	103
B-1014	134	292	---	---	0	57	68	88	94
B-1015	155	200	---	---	7	77	89	114	182
B-1016	156	212	---	---	21	75	85	103	193
B-1019	134	224	---	---	2	60	75	89	167
B-1020	132	215	---	---	19	52	63	78	140
B-1022	134	201	---	---	2	55	62	79	163
B-1023	155	193	---	---	24	76	81	108	178
B-1024	156	198	---	---	17	70	84	109	150
B-1025	148	202	---	---	28	67	85	104	175
B-1026	132	200	---	---	7	53	64	82	140
B-1027	133	201	---	---	5	52	60	83	105
B-1029	109	99	---	12	---	---	47	57	77
B-1030	147	119	---	---	0	67	77	92	115
B-1032	148	124	---	---	7	67	77	97	122
B-1033	156	201	---	---	0	71	86	---	108
B-1035	150	200	---	---	0	72	87	107	119
B-1037	194	119	---	---	0	---	72	---	117
B-1040	159	200	---	---	0	81	94	103	129
B-1042	85	150	9	---	---	---	---	---	68

GGNS COL 2.0-26-A

Table 2.5.1-202 (Sheet 2 of 4)
Summary of Borehole and CPT Stratigraphic Data

Borehole/ sounding ID	Top of hole elevation	Base of hole depth	Top of MSA	Top of colluvium	Top of Upper loess	Top of Lower loess	Top of UCA	Top of UCOA	Top of Catahoula Formation
	ft. amsl	ft. bgs	ft. bgs	ft. bgs	ft. bgs	ft. bgs	ft. bgs	ft. bgs	ft. bgs
B-1043	122	202	---	---	5	44	49	69	128
B-1044	112	75	---	---	17	38	42	57	---
B-1045	100	150	10	---	---	---	---	73	129
B-1046	85	78	6	---	---	---	---	---	---
B-1047	82	75	6	---	---	---	---	---	---
B-1048	78	75	12	---	---	---	---	---	---
B-1049	75	77	6	---	---	---	---	---	---
B-1050	75	77	4	---	---	---	---	---	---
B-1051	72	120	0	---	---	---	---	---	---
B-1057	155	75	---	---	15	---	---	---	---
B-1058	155	100	---	---	0	72	87	---	---
B-1059	156	99	---	---	8	77	87	---	---
B-1061	137	75	---	---	0	52	57	72	---
B-1063	126	80	---	---	0	---	8	---	68
B-1067	155	92	---	---	2	74	90	---	---
B-1068	156	144	---	---	7	77	92	109	138
B-1069	155	75	---	---	4	---	---	---	---
B-1070	132	75	---	---	6	56	65	---	---
B-1074	154	115	---	---	0	77	87	95	---
B-1075	152	75	---	---	5	---	---	---	---
B-1078	156	182	---	---	6	76	82	111	179
B-1079	159	117	---	---	8	78	83	113	---
B-1082	196	202	---	---	0	---	79	---	103
B-1083	155	225	---	---	37	82	87	107	180
B-1084	155	249	---	---	18	73	86	109	183
B-1085	133	68	---	---	6	56	64	---	---
B-1086	133	63	---	---	20	58	67	---	---
B-1100	134	149	---	---	6	57	64	86	104
B-1101	134	130	---	---	4	51	71	81	102
B-1102	133	149	---	---	56	71	77	85	102

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Table 2.5.1-202 (Sheet 3 of 4)
Summary of Borehole and CPT Stratigraphic Data

Borehole/ sounding ID	Top of hole elevation ft. amsl	Base of hole depth ft. bgs	Top of MSA ft. bgs	Top of colluvium ft. bgs	Top of Upper loess ft. bgs	Top of Lower loess ft. bgs	Top of UCA ft. bgs	Top of UCOA ft. bgs	Top of Catahoula Formation ft. bgs
B-1103	134	105	---	---	1	56	67	83	102
B-1104	134	150	---	---	27	61	71	89	102
B-1105	133	140	---	---	21	56	64	93	100
B-1106	134	140	---	---	2	54	68	93	98
B-1107	135	150	---	---	16	53	66	87	117
B-1108	134	120	---	---	1	53	68	88	98
B-1109	134	149	---	---	5	56	68	---	95
B-1110	134	169	---	---	2	52	67	90	125
B-1111	134	149	---	---	2	51	71	97	106
B-1112	133	150	---	---	12	53	61	---	73
B-1113	133	167	---	---	4	52	68	---	73
B-1114	134	170	---	---	6	52	68	88	133
B-1115	134	174	---	---	2	51	71	81	124
B-1116	133	167	---	---	7	52	62	79	82
B-1117	133	179	---	---	6	52	68	86	126
B-1118	133	159	---	---	0	52	62	80	106
B-1119	135	197	---	---	8	58	73	83	163
B-1120	133	151	---	---	0	---	68	77	137
B-1121	133	179	---	---	6	52	67	92	137
B-1123	134	169	---	---	3	52	67	83	167
B-1124	132	150	---	---	2	52	64	87	---
B-1125	133	139	---	---	0	52	67	92	134
B-1134	134	202	---	---	---	55	67	78	110
B-1135	156	139	---	---	7	72	94	107	132
B-1136	156	199	---	---	0	77	94	107	166
B-1137	155	204	---	---	8	76	85	105	190
B-1138	133	190	---	---	2	52	67	87	166
B-1139	134	139	---	---	1	55	67	86	138

GGNS COL 2.0-26-A

Table 2.5.1-202 (Sheet 4 of 4)
Summary of Borehole and CPT Stratigraphic Data

Borehole/ sounding ID	Top of hole elevation	Base of hole depth	Top of MSA	Top of colluvium	Top of Upper loess	Top of Lower loess	Top of UCA	Top of UCOA	Top of Catahoula Formation
	ft. amsl	ft. bgs	ft. bgs	ft. bgs	ft. bgs	ft. bgs	ft. bgs	ft. bgs	ft. bgs
B-1140	155	194	---	---	22	77	81	102	187
B-1142	134	140	---	---	0	52	72	82	97
B-1143	133	119	---	---	27	52	67	88	104
CPT-1001	132	76	---	---	36	46	62	---	---
CPT-1002	128	59	---	---	29	48	56	---	---
CPT-1003	133	68	---	---	8	49	64	---	---
CPT-1004	133	75	---	---	30	63	69	---	---
CPT-1005	135	71	---	---	4	50	63	---	---
CPT-1006	133	55	---	---	5	50	---	---	---
CPT-1010	133	66	---	---	19	50	63	---	---
CPT-1011	155	82	---	---	8	70	80	---	---
CPT-1012	133	65	---	---	7	52	59	---	---
CPT-1013	133	66	---	---	3	52	60	---	---
CPT-1015	155	81	---	---	24	71	79	---	---
CPT-1016	155	86	---	---	4	68	72	---	---
CPT-1017	71	67	11	---	---	---	---	---	---
CPT-1018	70	53	12	---	---	---	---	---	---
CPT-1019	71	75	0	---	---	---	---	---	---
CPT-1020	70	57	3	---	---	---	---	---	---
CPT-1021	77	28	2	---	---	---	---	---	---
CPT-1022	72	79	3	---	---	---	---	---	---
CPT-1023	80	28	2	---	---	---	---	---	---
CPT-1024	133	65	---	---	0	51	64	---	---
CPT-1025	133	63	---	---	5	51	62	---	---
CPT-1026	133	65	---	---	6	53	62	---	---
CPT-1027	132	66	---	---	13	51	62	---	---
CPT-1028	132	71	---	---	33	53	67	---	---
CPT-1028a	132	35	---	---	35	---	---	---	---

Note: Borehole data summarized from GGNS Unit 3 borehole logs (Appendix 2AA)

GGNS COL 2.0-26-A

Table 2.5.1-203 (Sheet 1 of 7)
Summary of Static Laboratory Analysis

Sample ID	Geologic unit(1)	Data source (2)	Depth (ft. bgs) from	Depth (ft. bgs) to	Sample method (3)	USCS class Lab	USCS class Field	Natural moisture (%)	Dry unit weight (pcf)	G_s	Atterberg Index(4) LL	Atterberg Index(4) PI	Mechanical sieve analysis % gravel	Mechanical sieve analysis % sand	Mechanical sieve analysis % fines	Hydrometer analysis % silt	Hydrometer analysis % clay	Cohesion (5) (psf)	Internal friction angle (effective)(5) (degrees)	Maximum dry density (pcf)	Optimum moisture %	Permeability (cm/sec.)	pH	Chlorate (8) ppm	Sulfate ppm	Consolidation testing(11) p_c (psf)	Consolidation testing(11) C_c	Consolidation testing(11) C_r
1059-1	Fill	FSAR	3.5	5.0	SPT	---	MH	13.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.2	2.0(9,10)	11.4(9)	---	---	---
SC-3TOP	MSA	FSAR	10.0	12.0	SC	---	SM	1.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	7.9	2.3(9)	2.1(9,10)	---	---	---
1045-15	MSA	FSAR	70.0	71.5	SPT	---	CL	38.6	---	---	49	27	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1048-7A	MSA	FSAR	23.5	24.5	SPT	SM	SM	---	---	---	26	1	0.0	64.7	35.3	---	---	---	---	---	---	---	---	---	---	---	---	---
1048-13	MSA	FSAR	53.5	55.0	SPT	SP	SP	---	---	---	---	---	0.4	99.2	0.4	---	---	---	---	---	---	---	---	---	---	---	---	---
1049-3	MSA	FSAR	15.5	17.0	SPT	---	CL	19.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.0	2.7(9)	37.5(9)	---	---	---
1049-4	MSA	FSAR	20.5	22.0	SPT	---	CL	39.3	---	---	42	19	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1049-8	MSA	FSAR	40.5	42.0	SPT	---	CL	34.3	---	---	47	23	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1049-12	MSA	FSAR	60.5	62.0	SPT	---	GP	---	---	---	---	---	45.6	44.9	9.5	---	---	---	---	---	---	---	---	---	---	---	---	---
1050-2	MSA	FSAR	10.0	11.5	SPT	---	SM	5.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	7.9	2.5(9)	68.1(9)	---	---	---
1050-4	MSA	FSAR	20.0	21.5	SPT	---	ML	38.6	---	---	37	12	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1050-11	MSA	FSAR	55.0	56.5	SPT	SP-SM	SP-SM	---	---	---	NV	NP	0.0	93.6	6.4	---	---	---	---	---	---	---	---	---	---	---	---	---
1050-13	MSA	FSAR	65.0	66.5	SPT	SM	SM	---	---	---	NV	NP	0.0	84.4	15.6	---	---	---	---	---	---	---	---	---	---	---	---	---
1011-9	UL	FSAR	38.2	39.7	SPT	---	ML	18.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.3	13.9(9)	7.5(9)	---	---	---
1012-2	UL	FSAR	9.0	10.0	SC	ML	ML	14.0	---	---	28	5	0.0	0.6	99.4	88.3	11.1	---	---	---	---	---	---	---	---	---	---	---
1012-4	UL	FSAR	19.0	20.0	SC	---	ML	17.6	---	---	---	---	0.0	0.2	98.8	88.0	11.8	---	---	---	---	---	---	---	---	---	---	---
1012-6	UL	FSAR	29.0	30.0	SC	---	ML	14.5	---	---	---	---	0.0	0.4	99.6	89.6	10.0	---	---	---	---	---	---	---	---	---	---	---
1012-8	UL	FSAR	39.0	40.0	SC	---	ML	14.9	---	---	---	---	0.1	0.6	99.3	90.5	8.8	---	---	---	---	---	---	---	---	---	---	---
1012-10	UL	FSAR	49.0	50.0	SC	---	ML	15.7	---	---	---	---	0.0	0.9	99.1	90.1	9.0	---	---	---	---	---	---	---	---	---	---	---
1013-12	UL	FSAR	50.0	52.0	UD	ML	ML	---	---	2.77	27	2	0.0	2.7	97.3	87.6	9.7	---	---	---	---	---	---	---	---	---	---	---
1015-7	UL	FSAR	33.5	35.0	SPT	---	ML	17.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.5	3.1(9)	22.3(9)	---	---	---
1043-3	UL	FSAR	12.0	13.0	SC	---	ML	---	---	---	---	---	0.0	1.2	98.8	91.3	7.5	---	---	---	---	---	---	---	---	---	---	---
1043-8	UL	FSAR	35.0	36.0	SC	---	ML	---	---	---	---	---	7.1	10.7	82.2	73.3	8.9	---	---	---	---	---	---	---	---	---	---	---
1044-6	UL	FSAR	28.5	30.0	SPT	---	ML	23.6	---	---	24	3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1059-6	UL	FSAR	18.5	20.0	SPT	---	ML-MH	12.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.3	6.5(9)	15.4(9)	---	---	---
1061-1	UL	FSAR	3.5	5.0	SPT	---	ML	15.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.7	2.3(9,10)	1.9(9,10)	---	---	---
1061-2	UL	FSAR	8.5	10.0	SPT	---	ML	18.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.1	1.9(9,10)	3.3(9,10)	---	---	---
1084-7	UL	FSAR	34.5	36.0	SPT	---	ML	20.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.4	1.9(9,10)	5.7(9,10)	---	---	---
1102-14	UL	FSAR	67.5	69.0	SPT	---	ML	29.7	---	---	26	3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1106-2	UL	FSAR	10.0	11.5	SPT	---	ML	10.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.3	ND	7.7(9)	---	---	---
1106-4	UL	FSAR	20.0	21.5	SPT	---	ML	---	---	---	---	---	0.0	0.7	99.3	86.6	12.7	---	---	---	---	---	---	---	---	---	---	---
1106-6	UL	FSAR	30.0	31.5	SPT	---	ML	21.5	---	---	27	4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1106-8	UL	FSAR	40.0	41.5	SPT	---	ML	---	---	---	---	---	0.0	0.5	99.5	90.1	9.4	---	---	---	---	---	---	---	---	---	---	---
1106-10	UL	FSAR	50.0	51.5	SPT	---	ML-CL	24.5	---	---	29	8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1107-3	UL	FSAR	13.5	15.0	SPT	---	ML	17.8	---	---	27	4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1107-UD-3	UL	FSAR	58.0	60.0	UD	CL	CL	---	---	2.66	33	14	0.0	2.8	97.2	65.3	31.9	---	---	---	---	---	---	---	---	---	---	---
1107-5	UL	FSAR	23.5	25.0	SPT	---	ML	---	---	---	---	---	0.0	0.4	99.6	89.5	10.1	---	---	---	---	---	---	---	---	---	---	---
1107-7	UL	FSAR	33.5	35.0	SPT	---	ML	21.6	---	---	24	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1107-9	UL	FSAR	43.5	45.0	SPT	---	ML	---	---	---	---	---	0.0	1.5	98.5	89.9	8.6	---	---	---	---	---	---	---	---	---	---	---
1107-10	UL	FSAR	50.0	51.5	SPT	---	CH	23.5	---	---	89	56	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1108-6	UL	FSAR	30.0	31.5	SPT	---	ML	20.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.8	4.0(9)	13.4(9,10)	---	---	---
1108-7	UL	FSAR	34.5	36.0	SPT	---	CL-ML	19.4	---	---	26	5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1108-9	UL	FSAR	45.0	46.5	SPT	---	ML	---	---	---	---	---	0.0	0.6	99.4	89.6	9.8	---	---	---	---	---	---	---	---	---	---	---
1108-10	UL	FSAR	49.0	50.5	SPT	---	ML	17.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.7	3.0(9)	4.7(9,10)	---	---	---

GGNS COL 2.0-26-A

Table 2.5.1-203 (Sheet 2 of 7)
Summary of Static Laboratory Analysis

Sample ID	Geologic unit(1)	Data source(2)	Depth (ft. bgs) from	Depth (ft. bgs) to	Sample method(3)	USCS class Lab	USCS class Field	Natural moisture (%)	Dry unit weight (pcf)	G_s	Atterberg Index(4) LL	Atterberg Index(4) PI	Mechanical sieve analysis % gravel	Mechanical sieve analysis % sand	Mechanical sieve analysis % fines	Hydrometer analysis % silt	Hydrometer analysis % clay	Cohesion(5) (psf)	Internal friction angle (effective)(5) (degrees)	Maximum dry density (pcf)	Optimum moisture %	Permeability (cm/sec.)	pH	Chlorate(8) ppm	Sulfate ppm	Consolidation testing P_c (psf)	Consolidation testing C_c	Consolidation testing C_r
1117-10	UL	FSAR	45.5	47.5	UD	ML	ML	24.2	100.1	2.68	---	---	0.3	2.5	97.2	90.2	7.0	0.0	35.8	---	---	---	---	---	---	---	---	---
1117-12	UL	FSAR	50.5	52.5	UD	CL	CL	23.0	---	---	29	11	0.0	6.2	93.8	67.2	26.6	---	---	---	---	---	---	---	---	9000	0.178	0.025
1125-9	UL	FSAR	43.5	45.5	UD	ML	ML	31.2	89.7	2.74	---	---	0.0	0.7	99.3	88.6	10.7	---	---	---	---	---	---	---	---	11000	0.198	0.027
1135-6	UL	FSAR	28.0	30.0	UD	CL	CL	24.9	95.9	2.72	32	15	4.1	1.2	94.7	69.6	25.1	516(6)	8.8(6)	---	---	---	---	---	---	21500	0.155	0.024
1135-11	UL	FSAR	48.0	50.0	UD	ML	ML	16.1	91.7	2.72	---	---	0.0	0.3	99.7	88.4	11.3	---	---	---	---	---	---	---	---	---	---	---
TP-1-1	UL	FSAR	4.0	4.0	Bulk	CL	ML	8.6	101.6	---	31	8	0.0	6.6	93.4	75.6	17.8	---	---	101.6	15.2	---	---	---	---	---	---	---
TP-1-2	UL	FSAR	4.0	4.0	Bulk	---	ML	8.1	107.6	---	---	---	---	---	---	---	---	---	---	107.6	12.7	---	---	---	---	---	---	---
TP-2-1	UL	FSAR	4.0	4.0	Bulk	CL	ML	9.1	110.4	---	36	13	0.0	0.6	99.4	76.3	23.1	---	---	110.4	15.2	---	---	---	---	---	---	---
TP-3-1	UL	FSAR	4.0	4.0	Bulk	CL	ML	11.4	101.7	---	39	17	0.0	0.4	99.6	73.8	25.8	---	---	101.7	20.7	---	---	---	---	---	---	---
1-4A	UL	ESP	11.0	12.5	PD	CL	ML-CL	25.6	---	---	28	13	0.0	0.7	99.3	---	---	---	---	---	---	---	---	---	---	---	---	---
1-8A	UL	ESP	22.5	23.0	PD	ML	ML	19.6	93.1	---	---	---	0.0	0.3	99.7	89.1	10.6	---	---	---	---	---	---	---	---	---	---	---
1-8B	UL	ESP	22.0	22.5	PD	ML	ML	20.2	97.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1-8C	UL	ESP	21.5	22.0	PD	ML	ML	22.3	---	---	---	---	0.0	0.9	99.1	---	---	---	---	---	---	---	---	---	---	---	---	---
1-10	UL	ESP	29.0	31.0	UD	ML	ML	27.3	85.8	---	30	3	0.0	2.0	98.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1-12	UL	ESP	36.0	38.0	SPT	CL	ML-CL	26.1	---	---	26	9	0.0	1.4	98.6	---	---	---	---	---	---	---	---	---	---	---	---	---
1-14A	UL	ESP	45.5	46.0	PD	ML	ML-CL	29.5	89.1	2.69	---	---	---	---	---	---	---			---	---	---	---	---	---	---	---	---
1-14B	UL	ESP	45.0	45.5	PD	ML	ML-CL	28.1	90.6	2.69	---	---	---	---	---	---	---	0.0	33.0	---	---	---	---	---	---	---	---	---
1-14C	UL	ESP	44.5	45.0	PD	ML	ML-CL	25.6	93.7	2.69	---	---	---	---	---	---	---			---	---	---	---	---	---	---	---	---
1-15	UL	ESP	46.0	48.0	SPT	ML	ML-CL	24.2	---	---	---	---	0.0	2.6	97.4	89.2	8.2	---	---	---	---	---	---	---	---	---	---	---
2-1A	UL	ESP	4.5	5.0	PD	ML	ML	15.7	92.8	---	---	---	0.4	0.6	99.0	---	---	---	---	---	---	---	---	---	---	---	---	---
2-3	UL	ESP	13.5	15.0	SPT	ML	ML	24.8	---	---	---	---	0.0	0.8	99.2	---	---	---	---	---	---	---	---	---	---	---	---	---
2-4A	UL	ESP	19.5	20.0	PD	CL	ML	16.4	96.1	---	29	11	0.0	0.2	99.8	90.2	9.6	---	---	---	---	---	---	---	---	---	---	---
2-6A	UL	ESP	29.5	30.0	PD	ML	ML	17.3	96.1	---	---	---	0.0	0.4	99.6	---	---	---	---	---	---	---	---	---	---	---	---	---
2-6B	UL	ESP	29.0	29.5	PD	ML	ML	20.0	97.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2-9A	UL	ESP	44.5	45.0	PD	ML	ML-SM	22.6	96.6	2.69	---	---	---	---	---	---	---	0.0	34.0	---	---	---	---	---	---	---	---	---
2-9B	UL	ESP	44.0	44.5	PD	ML	ML-SM	22.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2-10	UL	ESP	48.5	50.0	SPT	CL	ML	24.2	---	---	25	9	0.0	1.1	98.9	---	---	---	---	---	---	---	---	---	---	---	---	---
3-3A	UL	ESP	16.0	16.5	PD	CL	ML-CL	22.9	94.1	---	32	16	0.0	0.2	99.8	---	---	---	---	---	---	---	---	---	---	---	---	---
3-3B	UL	ESP	15.5	16.0	PD	ML	ML-CL	23.9	---	---	---	---	0.0	0.5	99.5	---	---	---	---	---	---	---	---	---	---	---	---	---
3-5	UL	ESP	25.0	26.5	SPT	ML	ML	24.2	---	---	---	---	0.0	0.8	99.2	89.1	10.1	---	---	---	---	---	---	---	---	---	---	---
3-9	UL	ESP	45.0	46.5	SPT	CL	ML-CL	26.3	---	---	28	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3-10A	UL	ESP	51.0	51.5	PD	ML	ML-CL	20.1	99.5	---	---	---	0.0	0.2	99.8	88.7	11.1	---	---	---	---	---	---	---	---	---	---	---
3-10B	UL	ESP	50.5	51.0	PD	ML	ML-CL	23.3	---	---	---	---	0.0	0.9	99.1	---	---	---	---	---	---	---	---	---	---	---	---	---
1009-16	LL	FSAR	68.5	70.0	SPT	CL	CL	25.3	---	---	29	9	0.0	10.1	89.9	70.4	19.5	---	---	---	---	---	---	---	---	---	---	---
1012-13	LL	FSAR	64.0	65.0	SC	---	ML	18.8	---	---	---	---	0.0	7.4	92.6	64.6	28.0	---	---	---	---	---	---	---	---	---	---	---
1012-15	LL	FSAR	72.0	73.0	SC	CL	SC	24.4	---	---	28	9	0.0	14.2	85.8	65.8	20.0	---	---	---	---	---	---	---	---	---	---	---
1030-14	LL	FSAR	68.5	70.0	SPT	---	CL	18.7	---	---	30	12	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1030-15	LL	FSAR	73.5	75.0	SPT	---	CL	22.6	---	---	29	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1032-14	LL	FSAR	68.5	70.0	SPT	---	CH	20.4	---	---	52	34	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

GGNS COL 2.0-26-A

Table 2.5.1-203 (Sheet 3 of 7)
Summary of Static Laboratory Analysis

Sample ID	Geologic unit[1]	Data source[2]	Depth (ft. bgs) from	Depth (ft. bgs) to	Sample method[3]	USCS class Lab	USCS class Field	Natural moisture (%)	Dry unit weight (pcf)	G_s	Atterberg Index[4] LL	Atterberg Index[4] PI	Mechanical sieve analysis % gravel	Mechanical sieve analysis % sand	Mechanical sieve analysis % fines	Hydrometer analysis % silt	Hydrometer analysis % clay	Cohesion[5] (psf)	Internal friction angle (effective)[5] (degrees)	Maximum dry density (pcf)	Optimum moisture %	Permeability (cm/sec.)	pH	Chlorate[8] ppm	Sulfate ppm	Consolidation testing P_c (psf)	Consolidation testing C_c	Consolidation testing C_r
1035-16	LL	FSAR	78.5	80.0	SPT	CL	CL	19.1	---	---	33	17	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1035-17	LL	FSAR	83.5	85.0	SPT	---	CL	---	---	---	---	---	0.0	29.9	70.1	54.6	15.5	---	---	---	---	---	---	---	---	---	---	---
1104-14	LL	FSAR	68.0	69.5	SPT	CL	CL	---	---	---	26	8	0.0	22.3	77.7	---	---	---	---	---	---	---	---	---	---	---	---	---
1106-3	LL	FSAR	58.0	60.0	UD	CL	CL-ML	21.4	105.8	2.70	32	16	0.0	10.7	89.3	61.1	28.2	0.0	26.0	---	---	---	---	---	---	---	---	---
1106-12	LL	FSAR	60.0	61.5	SPT	---	CL	16.6	---	---	34	17	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1107-12	LL	FSAR	60.0	61.5	SPT	---	CL	15.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.2	3.2[9]	1.7[9,10]	---	---	---
1108-12	LL	FSAR	60.0	61.5	SPT	---	MH	16.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.2	3.4[9]	2.9[9,10]	---	---	---
1108-13	LL	FSAR	64.2	65.7	SPT	---	MH	16.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.0	13.8[9]	3.8[9,10]	---	---	---
1135-20	LL	FSAR	88.0	90.0	UD	SC	SC	22.6	102.7	2.70	27	18	0.0	54.4	45.6	34.2	11.4	125[7]	33.7[7]	---	---	---	---	---	---	24500[12]	0.162[12]	0.021[12]
1-18	LL	ESP	56.0	57.5	SPT	SP-SM	ML	19.6	---	---	---	---	0.0	26.8	73.2	---	---	---	---	---	---	---	---	---	---	---	---	---
2-11	LL	ESP	58.5	60.5	UD	CL	ML-CL	22.2	104.7	---	32	13	0.0	2.0	98.0	---	---	---	---	---	---	---	---	---	---	---	---	---
3-13	LL	ESP	80.0	82.0	UD	ML	SC-CL	19.0	108.7	---	22	4	0.0	46.0	54.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1009-19	UCA	FSAR	83.5	85.0	SPT	---	SP-SM	---	---	---	---	---	0.0	88.1	11.6	---	---	---	---	---	---	---	---	---	---	---	---	---
1010-14	UCA	FSAR	65.0	67.0	UD	---	ML	---	---	---	---	---	0.0	28.8	71.2	---	---	---	---	---	---	---	---	---	---	---	---	---
1010-15	UCA	FSAR	67.0	68.5	SPT	---	SM-MH	18.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.4	4.1[9]	13.5[9]	---	---	---
1010-16	UCA	FSAR	75.0	76.5	SPT	---	ML	---	---	---	---	---	0.0	27.1	72.9	---	---	---	---	---	---	---	---	---	---	---	---	---
1012-16	UCA	FSAR	75.3	76.5	SPT	SP	SP	---	---	---	---	---	0.0	98.9	1.1	---	---	---	---	---	---	---	---	---	---	---	---	---
1012-17	UCA	FSAR	80.5	81.5	SPT	SP	SP	---	---	---	---	---	0.0	99.0	1.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1012-18	UCA	FSAR	85.0	86.5	SPT	SP		---	---	---	---	---	0.0	99.8	0.2	---	---	---	---	---	---	---	---	---	---	---	---	---
1013-18	UCA	FSAR	75.0	77.0	UD	---	SP-SM	---	---	---	---	---	0.6	66.0	33.4	---	---	---	---	---	---	---	---	---	---	---	---	---
1013-19	UCA	FSAR	77.0	78.5	SPT	---	SP-SM	---	---	---	---	---	0.0	91.1	8.9	---	---	---	---	---	---	---	---	---	---	---	---	---
1014-17	UCA	FSAR	75.0	75.9	UD	---	SP	11.9	93.1	---	---	---	0.0	94.9	5.1	---	---	---	---	---	---	---	---	---	---	---	---	---
1030-17	UCA	FSAR	83.5	85.0	SPT	---	SP	---	---	---	---	---	0.0	81.5	18.5	---	---	---	---	---	---	---	---	---	---	---	---	---
1032-18	UCA	FSAR	88.5	90.0	SPT	---	SP	---	---	---	---	---	0.0	84.4	15.6	---	---	---	---	---	---	---	---	---	---	---	---	---
1035-18	UCA	FSAR	88.5	90.0	SPT	---	SP-SM	---	---	---	---	---	0.0	92.0	8.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1035-19	UCA	FSAR	93.5	95.0	SPT	---	SP/CL	---	---	---	---	---	3.4	44.3	52.3	---	---	---	---	---	---	---	---	---	---	---	---	---
1079-21	UCA	FSAR	105.0	106.5	SPT	---	SM	---	---	---	---	---	1.8	83.0	15.2	---	---	---	---	---	---	---	---	---	---	---	---	---
1100-17	UCA	FSAR	73.5	74.4	SPT	SM	SM	18.3	---	---	NV	NP	0.0	81.0	19.0	14.0	5.0	---	---	---	---	---	---	---	---	---	---	---
1100-19	UCA	FSAR	83.5	85.0	SPT	---	SP	---	---	---	---	---	0.0	93.1	6.9	---	---	---	---	---	---	---	---	---	---	---	---	---
1101-15	UCA	FSAR	73.0	74.5	SPT	---	SP-SC	---	---	---	---	---	0.0	88.3	11.7	---	---	---	---	---	---	---	---	---	---	---	---	---
1101-16	UCA	FSAR	78.0	79.5	SPT	---	ML/SP	---	---	---	---	---	0.0	43.0	57.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1102-P04	UCA	FSAR	81.0	83.5	UD	---	SP	24.6	93.2	2.65	NV	NP	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1103-10A	UCA	FSAR	70.0	70.4	SPT	CL	CL	---	---	---	28	9	0.0	18.1	81.9	---	---	---	---	---	---	---	---	---	---	---	---	---
1103-11	UCA	FSAR	75.0	76.5	SPT	---	SM	---	---	---	---	---	0.0	76.0	24.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1104-16	UCA	FSAR	78.0	79.5	SPT	---	SP-SM	---	---	---	---	---	0.0	88.3	11.7	---	---	---	---	---	---	---	---	---	---	---	---	---
1105-P01	UCA	FSAR	73.5	76.0	UD	---	CL-ML	20.1	97.8	---	---	---	0.0	15.0	85.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1105-P02	UCA	FSAR	76.0	77.5	UD	SP	SP	23.8	95.6	---	---	---	0.0	95.9	4.1	---	---	---	---	---	---	---	---	---	---	---	---	---
1105-P03	UCA	FSAR	88.5	91.0	UD	SM	SP	---	---	2.66	NV	NP	0.0	78.4	21.6	13.7	7.9	---	---	---	---	---	---	---	---	---	---	---
1105-UD4	UCA	FSAR	73.0	74.5	UD	SM	SM	23.3	99.4	---	---	---	0.0	61.2	38.8	---	---	1440[7]	30.0[7]	---	---	---	---	---	---	---	---	---

GGNS COL 2.0-26-A

Table 2.5.1-203 (Sheet 4 of 7)
Summary of Static Laboratory Analysis

Sample ID	Geologic unit[1]	Data source[2]	Depth (ft. bgs)		Sample method[3]	USCS class		Natural moisture	Dry unit weight	G_s	Atterberg Index[4]		Mechanical sieve analysis			Hydrometer analysis		Cohesion[5]	Internal friction angle (effective)[5]	Maximum dry density	Optimum moisture	Permeability	pH	Chlorate[8]	Sulfate	Consolidation testing		
			from	to		Lab	Field	(%)	(pcf)		LL	PI	% gravel	% sand	% fines	% silt	% clay	(psf)	(degrees)	(pcf)	%	(cm/sec.)		ppm	ppm	P_c (psf)	C_c	C_r
1105-P04	UCA	FSAR	91.0	93.5	UD	ML	SP	---	---	2.68	19	2	0.0	45.3	54.7	39.8	14.9	---	---	---	---	---	---	---	---	---	---	---
1105-18	UCA	FSAR	88.5	90.0	SPT	---	SM	---	---	---	---	---	0.0	87.9	12.1	---	---	---	---	---	---	---	---	---	---	---	---	---
1106-14	UCA	FSAR	70.0	71.5	SPT	---	SC	---	---	---	---	---	0.0	50.9	49.1	---	---	---	---	---	---	---	---	---	---	---	---	---
1107-13	UCA	FSAR	68.5	70.0	SPT	---	SP-SC	---	---	---	---	---	0.0	93.4	6.6	---	---	---	---	---	---	---	---	---	---	---	---	---
1108-14B	UCA	FSAR	70.5	71.5	SPT	---	SP-SM	15.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.3	4.6[9]	5.4[9,10]	---	---	---
1108-16	UCA	FSAR	78.1	79.6	SPT	---	SP-SM	---	---	---	---	---	0.0	94.9	5.1	---	---	---	---	---	---	---	---	---	---	---	---	---
1109-P01	UCA	FSAR	68.5	71.0	UD	---	SP	19.8	108.7	---	---	---	0.0	10.0	90.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1109-P02	UCA	FSAR	71.0	73.5	UD	---	CL-ML	22.5	104.1	---	23	5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1109-P04	UCA	FSAR	76.0	77.5	UD	---	SP-SM	20.4	93.3	---	---	---	0.0	93.1	6.9	---	---	---	---	---	---	---	---	---	---	---	---	---
1109-P05	UCA	FSAR	78.5	80.0	UD	---	SP-SM	22.1	95.4	---	---	---	0.0	92.7	7.3	---	---	---	---	---	---	---	---	---	---	---	---	---
1109-P06	UCA	FSAR	88.5	91.0	UD	CL-ML	CL	---	---	2.68	27	6	0.0	17.8	82.2	59.4	22.8	---	---	---	---	---	---	---	---	---	---	---
1109-P07	UCA	FSAR	91.0	93.5	UD	CL	SC-SM	---	---	2.70	33	15	0.0	21.8	78.2	52.2	26.0	---	---	---	---	---	---	---	---	---	---	---
1109-16	UCA	FSAR	77.5	79.0	SPT	---	SM	---	---	---	---	---	0.0	67.3	32.7	---	---	---	---	---	---	---	---	---	---	---	---	---
1109-18	UCA	FSAR	87.5	89.0	SPT	---	CL	30.8	---	---	49	29	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1109-19	UCA	FSAR	92.5	94.0	SPT	---	CL	26.0	---	---	42	23	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1110-14	UCA	FSAR	68.5	70.0	SPT	---	SM	14.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8.5	3.6[9]	1.4[9,10]	---	---	---
1116-14	UCA	FSAR	65.0	67.0	UD	---	SP	22.7	103.3	---	---	---	0.0	38.6	61.4	---	---	---	---	---	---	---	---	---	---	---	---	---
1116-15	UCA	FSAR	67.0	68.5	SPT	---	SP	11.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	9.0	2.9[9]	3.1[9,10]	---	---	---
1116-16	UCA	FSAR	69.0	71.0	UD	---	SP	---	---	---	---	---	0.0	94.5	5.5	---	---	---	---	---	---	---	---	---	---	---	---	---
1-21	UCA	ESP	64.0	66.0	UD	---	SM	17.0	107.0	---	22	NP	0.0	66.0	34.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1-22A	UCA	ESP	66.0	67.5	SPT	SP-SM	SP-SM	24.9	---	---	---	---	0.0	88.3	11.7	9.5	2.2	---	---	---	---	---	---	---	---	---	---	---
1-22B	UCA	ESP	66.0	67.5	SPT	SP-SM	SP-SM	---	---	---	---	---	0.0	90.3	9.7	---	---	---	---	---	---	---	---	---	---	---	---	---
1-26	UCA	ESP	75.1	76.3	SPT	SP	SP	25.5	---	---	---	---	0.0	95.3	4.7	---	---	---	---	---	---	---	---	---	---	---	---	---
2-12A	UCA	ESP	69.5	70.0	PD	SP	SM	16.5	113.0	2.65	---	---	0.0	55.8	44.2	35.9	8.3	0.0	36.0	---	---	---	---	---	---	---	---	---
2-12B	UCA	ESP	69.0	69.5	PD	SP	SM	17.0	111.8	2.65	---	---	0.0	55.8	44.2	35.9	8.3			---	---	---	---	---	---	---	---	---
2-13	UCA	ESP	78.5	80.0	SPT	SC	SM	16.7	---	---	---	---	2.8	85.0	12.2	---	---	---	---	---	---	---	---	---	---	---	---	---
3-14A	UCA	ESP	90.5	91.0	PD	SP	SP-SC	23.2	93.2	2.65	---	---	---	---	---	---	---	0.0	39.0	---	---	---	---	---	---	---	---	---
3-14B	UCA	ESP	90.0	90.5	PD	SC	SP-SC	22.9	---	2.65	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1007-17	UCOA	FSAR	85.0	86.5	SPT	SP	SP	---	---	---	---	---	30.7	65.8	3.5	---	---	---	---	---	---	---	---	---	---	---	---	---
1008B-2	UCOA	FSAR	85.0	86.5	SPT	---	CL	20.7	---	---	45	28	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1008B-3	UCOA	FSAR	90.0	91.5	SPT	---	SP-SM	45.4	---	---	---	---	45.4	47.6	7.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1009-20	UCOA	FSAR	88.5	90.0	SPT	---	CL	26.1	---	---	40	23	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1009-21	UCOA	FSAR	93.5	95.0	SPT	---	SM	---	---	---	---	---	28.3	44.3	27.4	---	---	---	---	---	---	---	---	---	---	---	---	---
1010-21	UCOA	FSAR	95.0	96.5	SPT	SP	SP	---	---	---	---	---	46.0	50.2	3.8	---	---	---	---	---	---	---	---	---	---	---	---	---
1012-19	UCOA	FSAR	90.0	90.9	SPT	---	SP-SM	---	---	---	---	---	10.1	84.6	5.3	---	---	---	---	---	---	---	---	---	---	---	---	---
1012-20	UCOA	FSAR	94.0	95.5	SPT	SP	SP	---	---	---	---	---	45.3	50.2	4.5	---	---	---	---	---	---	---	---	---	---	---	---	---
1013-24	UCOA	FSAR	90.2	91.7	SPT	SP	SP	---	---	---	---	---	3.5	94.5	2.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1030-20	UCOA	FSAR	98.5	100.0	SPT	CL	CL	21.2	---	---	33	25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1032-22	UCOA	FSAR	108.5	110.0	SPT	GW	GW	---	---	---	---	---	55.6	40.1	4.3	---	---	---	---	---	---	---	---	---	---	---	---	---

GGNS COL 2.0-26-A

Table 2.5.1-203 (Sheet 5 of 7)
Summary of Static Laboratory Analysis

Sample ID	Geologic unit(1)	Data source(2)	Depth (ft. bgs) from	Depth (ft. bgs) to	Sample method(3)	USCS class Lab	USCS class Field	Natural moisture (%)	Dry unit weight (pcf)	G_s	Atterberg Index(4) LL	Atterberg Index(4) PI	Mechanical sieve analysis % gravel	Mechanical sieve analysis % sand	Mechanical sieve analysis % fines	Hydrometer analysis % silt	Hydrometer analysis % clay	Cohesion(5) (psf)	Internal friction angle (effective)(5) (degrees)	Maximum dry density (pcf)	Optimum moisture %	Permeability (cm/sec.)	pH	Chlorate(8) ppm	Sulfate ppm	Consolidation testing p_c (psf)	Consolidation testing C_c	Consolidation testing C_r
1035-22	UCOA	FSAR	108.5	110.0	SPT	GW	GW	---	---	---	---	---	51.8	45.3	2.9	---	---	---	---	---	---	---	---	---	---	---	---	---
1040-23	UCOA	FSAR	109.0	110.5	SPT	CL	CL	26.5	---	---	37	19	---	2.9	97.1	---	---	---	---	---	---	---	---	---	---	---	---	---
1101-17	UCOA	FSAR	83.5	85.0	SPT	---	CL	14.5	---	---	22	9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1101-19	UCOA	FSAR	94.0	95.5	SPT	GW	GW	---	---	---	---	---	51.5	46.5	2.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1104-19	UCOA	FSAR	94.0	95.5	SPT	GW	GW	---	---	---	---	---	59.9	38.2	1.9	---	---	---	---	---	---	---	---	---	---	---	---	---
1105-P06	UCOA	FSAR	96.0	98.5	UD	SC	SP	17.7	109.7	2.66	49	28	6.5	46.7	46.8	34.1	12.7	---	---	---	---	---	---	---	---	21500	0.083	0.025
1105-P07	UCOA	FSAR	98.5	100.5	UD	GP-GC	GP-GC	18.5	98.6	2.60	50	25	85.9	7.7	6.4	3.5	2.9	---	---	---	---	---	---	---	---	22500	0.173	0.026
1105-20	UCOA	FSAR	98.5	100.0	SPT	---	CL	21.5	---	---	44	24	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1106-19	UCOA	FSAR	95.0	96.5	SPT	---	SM	---	---	---	---	---	15.4	70.6	14.0	---	---	---	---	---	---	---	---	---	---	---	---	---
1107-17	UCOA	FSAR	88.5	90.0	SPT	---	CL-ML	38.7	---	---	28	6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1107-20	UCOA	FSAR	103.5	105.0	SPT	SP	SP	---	---	---	---	---	39.2	56.2	4.6	---	---	---	---	---	---	---	---	---	---	---	---	---
1107-21A	UCOA	FSAR	108.5	109.2	SPT	GW	GW	---	---	---	---	---	51.9	46.0	2.1	---	---	---	---	---	---	---	---	---	---	---	---	---
1108-19B	UCOA	FSAR	95.5	96.5	SPT	---	CL	21.8	---	---	39	22	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1109-P09	UCOA	FSAR	96.0	98.2	UD	SC	SC	19.6	105.7	2.59	52	29	5.6	46.2	48.2	35.7	12.5	---	---	---	---	---	---	---	---	22600	0.146	0.029
1117-28	UCOA	FSAR	122.5	124.0	UD	ML	ML	22.5	102.1	2.69	---	---	0.0	30.3	69.7	51.0	18.7	---	---	---	---	---	---	---	---	23000	0.180	0.028
1123-UD3	UCOA	FSAR	83.5	85.3	UD	ML	ML	21.0	103.2	---	---	---	0.0	49.9	50.1	---	---	---	---	---	---	---	---	---	---	---	---	---
1142-21	UCOA	FSAR	88.5	91.0	UD	CH	SW	---	---	2.71	51	29	0.0	0.9	99.1	47.3	51.8	---	---	---	---	---	---	---	---	---	---	---
1-27A	UCOA	ESP	86.0	86.5	PD	SP	SM	20.3	106.5	2.66	---	---	0.0	62.9	37.1	26.5	10.6	0.0	40.0	---	---	---	---	---	---	---	---	---
1-27B	UCOA	ESP	85.5	86.0	PD	SP	SM	22.2	105.8	2.66	---	---	0.0	84.2	15.8	11.7	4.1			---	---	---	---	---	---	---	---	---
1-28	UCOA	ESP	86.5	88.0	SPT	SM	SM	22.1	---	---	---	---	0.0	75.9	24.1	16.1	8.0	---	---	---	---	---	---	---	---	---	---	---
1-30	UCOA	ESP	95.3	96.7	SPT	SM	SM	19.4	---	---	---	---	4.4	83.5	12.1	---	---	---	---	---	---	---	---	---	---	---	---	---
1-32	UCOA	ESP	105.6	107.0	SPT	SP	SP	16.5	---	---	---	---	24.3	71.3	4.4	---	---	---	---	---	---	---	---	---	---	---	---	---
1-33A	UCOA	ESP	115.0	115.5	PD	SP-SM	SP	20.2	---	---	---	---	9.1	82.3	8.6	---	---	---	---	---	---	---	---	---	---	---	---	---
1-33B	UCOA	ESP	114.5	115.0	PD	SP	SP	19.9	101.8	2.65	---	---	0.8	95.7	3.5	---	---	0.0	41.0	---	---	---	---	---	---	---	---	---
1-33C	UCOA	ESP	114.0	114.5	PD	SW	SP	14.5	---	---	---	---	6.9	83.3	9.8	---	---	---	---	---	---	---	---	---	---	---	---	---
1-34	UCOA	ESP	115.5	117.0	SPT	SP	SP	15.2	---	---	---	---	4.5	87.6	7.9	5.1	2.8	---	---	---	---	---	---	---	---	---	---	---
1-36	UCOA	ESP	124.2	125.8	SPT	SC	SC-CL	24.7	---	---	24	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2-15	UCOA	ESP	98.5	100.0	SPT	SP-SM	SP-SM	16.1	---	---	---	---	5.0	86.2	8.8	---	---	---	---	---	---	---	---	---	---	---	---	---
2-16	UCOA	ESP	108.5	110.5	UD	CL	CL	27.2	94.9	---	33	12	0.0	1.0	99.0	---	---	---	---			---						
2-29	UCOA	ESP	121.5	122.1	RC	CL	CL-ML	5.6	---	---	---	---	8.5	13.3	78.2	---	---	---	---	---	---	---	---	---	---	---	---	---
2-31	UCOA	ESP	122.7	123.6	RC	SM	SM	5.6	---	---	17	1	0.0	67.3	32.7	---	---	---	---	---	---	---	---	---	---	---	---	---
2-32	UCOA	ESP	126.5	127.5	RC	SM	SM	8.4	---	---	---	---	0.0	73.3	26.7	20.5	6.2	---	---	---	---	---	---	---	---	---	---	---
2-33	UCOA	ESP	128.0	128.9	RC	ML	SP	12.5	---	---	---	---	0.0	14.4	85.6	---	---	---	---	---	---	---	---	---	---	---	---	---
3-16	UCOA	ESP	110.0	111.5	SPT	SP-SM	SP-SM	9.9	---	---	---	---	41.6	51.7	6.7	---	---	---	---	---	---	---	---	---	---	---	---	---
1007-22	CF	FSAR	110.0	111.5	SPT	---	CL-CH	22.6	---	---	51	24	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1008B-6	CF	FSAR	105.0	106.5	SPT	---	CH	21.6	---	---	58	28	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1008B-10	CF	FSAR	125.0	126.5	SPT	---	CH	23.2	---	---	65	40	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1009-22	CF	FSAR	108.5	110.0	SPT	---	CH	18.6	---	---	54	29	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1009-28	CF	FSAR	138.5	140.0	SPT	---	MH	27.7	---	---	60	27	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

GGNS COL 2.0-26-A

Table 2.5.1-203 (Sheet 6 of 7)
Summary of Static Laboratory Analysis

Sample ID	Geologic unit[1]	Data source[2]	Depth (ft. bgs) from	Depth (ft. bgs) to	Sample method[3]	USCS class Lab	USCS class Field	Natural moisture (%)	Dry unit weight (pcf)	G_s	Atterberg Index[4] LL	Atterberg Index[4] PI	Mechanical sieve analysis % gravel	Mechanical sieve analysis % sand	Mechanical sieve analysis % fines	Hydrometer analysis % silt	Hydrometer analysis % clay	Cohesion[5] (psf)	Internal friction angle (effective)[5] (degrees)	Maximum dry density (pcf)	Optimum moisture %	Permeability (cm/sec.)	pH	Chlorate[8] ppm	Sulfate ppm	Consolidation testing p_c (psf)	Consolidation testing C_c	Consolidation testing C_r
1009-33	CF	FSAR	163.5	165.0	SPT	---	SM	---	---	---	---	---	0.0	73.7	26.3	---	---	---	---	---	---	---	---	---	---	---	---	---
1010-22	CF	FSAR	100.0	101.5	SPT	---	MH	21.4	---	---	44	23	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1010-23	CF	FSAR	105.0	105.7	UD	---	MH	27.6	86.9	2.65	---	---	---	---	---	---	---	---	---	---	---	1.5E-08	---	---	---	---	---	---
1010-27	CF	FSAR	118.0	119.5	SPT	---	CH	24.2	---	---	63	34	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1010-29	CF	FSAR	128.0	129.5	SPT	---	SP	---	---	---	---	---	0.0	88.7	11.3	---	---	---	---	---	---	---	---	---	---	---	---	---
1012-22	CF	FSAR	100.0	101.5	SPT	CL	SC	51.6	---	---	37	18	0.0	13.7	86.3	56.7	29.6	---	---	---	---	---	---	---	---	---	---	---
1012-25	CF	FSAR	115.0	116.5	SPT	CL	CL	27.2	---	---	48	27	0.0	2.7	97.3	59.7	37.6	---	---	---	---	---	---	---	---	---	---	---
1012-27	CF	FSAR	125.0	126.5	SPT	CL	CL	19.6	---	---	40	21	0.0	33.7	66.3	37.8	28.5	---	---	---	---	---	---	---	---	---	---	---
1012-31	CF	FSAR	145.0	146.5	SPT	CH	CH	33.6	---	---	56	29	0.0	1.6	98.4	51.3	47.1	---	---	---	---	---	---	---	---	---	---	---
1012-36	CF	FSAR	170.0	171.5	SPT	CL	CL	25.0	---	---	35	14	0.0	11.5	88.5	70.9	17.6	---	---	---	---	---	---	---	---	---	---	---
1012-41	CF	FSAR	195.0	195.5	SPT	CL	CL	26.7	---	---	39	16	0.0	18.8	81.2	58.7	22.5	---	---	---	---	---	---	---	---	---	---	---
1013-29	CF	FSAR	108.0	109.5	SPT	---	MH	26.7	---	---	60	24	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1013-33	CF	FSAR	128.0	129.5	SPT	---	CL	16.9	---	---	46	24	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1013-34	CF	FSAR	133.0	134.5	SPT	---	ML	---	---	---	---	---	0.0	47.8	52.2	---	---	---	---	---	---	---	---	---	---	---	---	---
1014-24	CF	FSAR	100.0	101.2	UD	---	CL	14.9	99.6	2.68	---	---	---	---	---	---	---	---	---	---	---	1.3E-07	---	---	---	---	---	---
1035-26	CF	FSAR	123.5	125.0	SPT	---	CH	19.8	---	---	53	29	0.0	7.0	93.0	69.2	23.8	---	---	---	---	---	---	---	---	---	---	---
1100-23	CF	FSAR	103.5	105.0	SPT	---	CH	21.3	---	---	61	35	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1100-28	CF	FSAR	127.5	129.0	SPT	---	CL	23.5	---	---	47	30	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1101-25	CF	FSAR	128.0	129.5	SPT	---	CL	24.0	---	---	46	28	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1104-21	CF	FSAR	104.0	105.5	SPT	---	CL	25.8	---	---	48	28	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1104-25	CF	FSAR	123.0	124.5	SPT	---	MH	24.9	---	---	58	25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1104-27	CF	FSAR	133.0	134.5	SPT	---	SM	---	---	---	---	---	0.0	74.8	25.2	---	---	---	---	---	---	---	---	---	---	---	---	---
1104-29	CF	FSAR	143.0	144.5	SPT	---	MH	31.4	---	---	63	28	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1107-23	CF	FSAR	118.5	120.0	SPT	---	CL	21.5	---	---	33	7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1109-P09	CF	FSAR	96.0	98.2	UD	---	SC	19..1	102.9	2.62	52	29	---	---	---	---	---	---	---			3.1E-08	---	---	---	---	---	---
1109-P10	CF	FSAR	98.5	101.0	UD	CL	SM	---	---	2.68	43	21	0.0	34.8	65.2	34.3	30.9	---	---	---	---	---	---	---	---	---	---	---
1109-P11	CF	FSAR	101.0	102.2	UD	SM	SM	20.1	101.2	2.60	---	---	34.1	43.7	22.2	14.8	7.4	---	---	---	---	3.7E-08	---	---	---	20000[12]	0.206[12]	0.038[12]
1109-20	CF	FSAR	97.5	99.0	SPT	---	CL	19.5	---	---	44	25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1142-25	CF	FSAR	103.5	104.0	UD	CH	CH	32.7	87.3	2.61	51	28	12.9	34.7	52.4	34.3	18.1	---	---	---	---	---	---	---	---	19000[12]	0.258[12]	0.036[12]
1-41A	CF	ESP	155.0	155.5	PD	ML	CL-ML	33.8	85.5	---	---	---	0.0	14.4	85.6	63.4	22.2	---	---	---	---	---	---	---	---	---	---	---
1-41B	CF	ESP	154.5	155.0	PD	ML	CL-ML	38.4	77.9	---	---	---	0.0	15.2	84.8	60.9	23.9	---	---	---	---	---	---	---	---	---	---	---
1-42	CF	ESP	154.0	154.5	SPT	CL	CL-ML	35.1	---	---	40	15	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1-43	CF	ESP	164.0	166.0	UD	SM	CL-ML	28.6	89.3	---	29	NP	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1-44	CF	ESP	166.0	167.5	SPT	ML	CL-ML	31.5	---	---	---	---	0.0	21.4	78.6	68.6	10.0	---	---	---	---	---	---	---	---	---	---	---
1-46	CF	ESP	175.5	177.0	SPT	CL	CL-ML	29.8	---	---	37	16	0.3	21.3	78.4	---	---	---	---	---	---	---	---	---	---	---	---	---
1-47	CF	ESP	184.0	185.5	SPT	ML	CL-ML	36.1	---	---	---	---	0.2	24.8	75.0	62.8	12.2	---	---	---	---	---	---	---	---	---	---	---
2A-2	CF	ESP	173.0	174.0	SPT	SC	SM	35.2	---	---	---	---	22.0	48.5	29.5	---	---	---	---	---	---	---	---	---	---	---	---	---
2A-3	CF	ESP	202.0	203.0	SPT	CH	CH-CL	21.5	---	---	54	35	0.4	19.0	80.6	---	---	---	---	---	---	---	---	---	---	---	---	---
3-17	CF	ESP	150.0	151.5	SPT	SP-SM	SP-SM	21.0	---	---	---	---	0.0	92.9	7.1	---	---	---	---	---	---	---	---	---	---	---	---	---

GGNS COL 2.0-26-A

Table 2.5.1-203 (Sheet 7 of 7)
Summary of Static Laboratory Analysis

Sample ID	Geologic unit(1)	Data source(2)	Depth (ft. bgs) from	Depth (ft. bgs) to	Sample method(3)	USCS class Lab	USCS class Field	Natural moisture (%)	Dry unit weight (pcf)	G_s	Atterberg Index(4) LL	Atterberg Index(4) PI	Mechanical sieve analysis % gravel	Mechanical sieve analysis % sand	Mechanical sieve analysis % fines	Hydrometer analysis % silt	Hydrometer analysis % clay	Cohesion(5) (psf)	Internal friction angle (effective)(5) (degrees)	Maximum dry density (pcf)	Optimum moisture %	Permeability (cm/sec.)	pH	Chlorate(8) ppm	Sulfate ppm	Consolidation testing p_c (psf)	Consolidation testing C_c	Consolidation testing C_r
3-18	CF	ESP	180.5	181.5	SPT	SP-CL	SP-SM	24.9	---	---	---	---	0.0	89.2	10.8	---	---	---	---		---	---	---	---	---	---	---	---
Average Mississippi River alluvium								25.3	---	---	40	12	9.2	77.4	13.4	---	---	---	---	---	---	---	8.0	2.5	35.9	---	---	---
Average Upper loess								20.8	96.9	2.71	32	10	0.3	1.5	98.1	84.7	13.2	0.0	34.3	105.3	16.0	---	8.5	4.1	9.1	13833	0.177	0.025
Average Lower loess								19.9	105.5	2.70	31	14	0.0	22.4	77.6	58.5	20.4	0.0	26.0	---	---	---	8.1	6.8	2.8	24500	0.162	0.021
Average Upland Complex alluvium								20.5	99.7	2.67	30	8	0.2	70.2	29.6	32.1	12.4	0.0	37.5	---	---	---	8.6	3.8	5.9	---	---	---
Average Upland Complex old alluvium								19.9	102.8	2.65	38	19	22.0	53.0	25.0	25.8	13.7	0.0	40.5	---	---	---	---	---	---	22400	0.146	0.027
Average Catahoula Formation								26.4	92.7	2.63	49	25	3.2	37.2	59.6	52.4	23.7	---	---	---	---	5.3E-08	---	---	---	19500	0.232	0.037

Notes:
(1) CF = Catahoula Formation; Fill = Undocumented fill; LL = Lower loess; UCA = Upland Complex alluvium; UCOA = Upland Complex old alluivum; UL = Upper loess;
(2) ESP = GGNS ESP SSAR; FSAR = GGNS Unit 3 FSAR
(3) PD = 2.5-inch I.D. push drive split spoon sampler; RC = rock core; SC = soil core; SPT = Standard Penetration Test; UD = Shelby tube
(4) LL = liquid limit; NV = sample slid in cup; NP = non-plastic; PI = plasticity index
(5) consolidated, undrained test results unless otherwise noted
(6) consolidated, drained results, not included in unit averages
(7) unconsolidated, undrained results, not included in unit averages
(8) ND = analyte not detected above method detection limit
(9) estimated result; result is less than the reporting limit
(10) method blank contamination; associated method blank contains target analyte at a reportable level
(11) p_c = preconsolidation pressure; C_c = coefficient of consolidation; C_r = Coefficient of Recompression
(12) Values from tests with excessive strain levels on recompression which indicates significant disturbance

GGNS COL 2.0-26-A

Table 2.5.1-204
Thermogravimetric Analyses of Calcium Carbonate Content

Sample ID	TGA data (weight percent)(1)	Percent Carbonate as $CaCO_3$
1013:350.9'-351.1'	0.38	0.9
1013:400.7'-400.9'	1.45	3.3
1013:455.2'-455.4'	38.65	87.9
1013:499.8'-499.9'	38.31	87.1

Notes:
(1) weight loss due to decomposition of carbonates and liberation of CO_2

GGNS COL
2.0-26-A

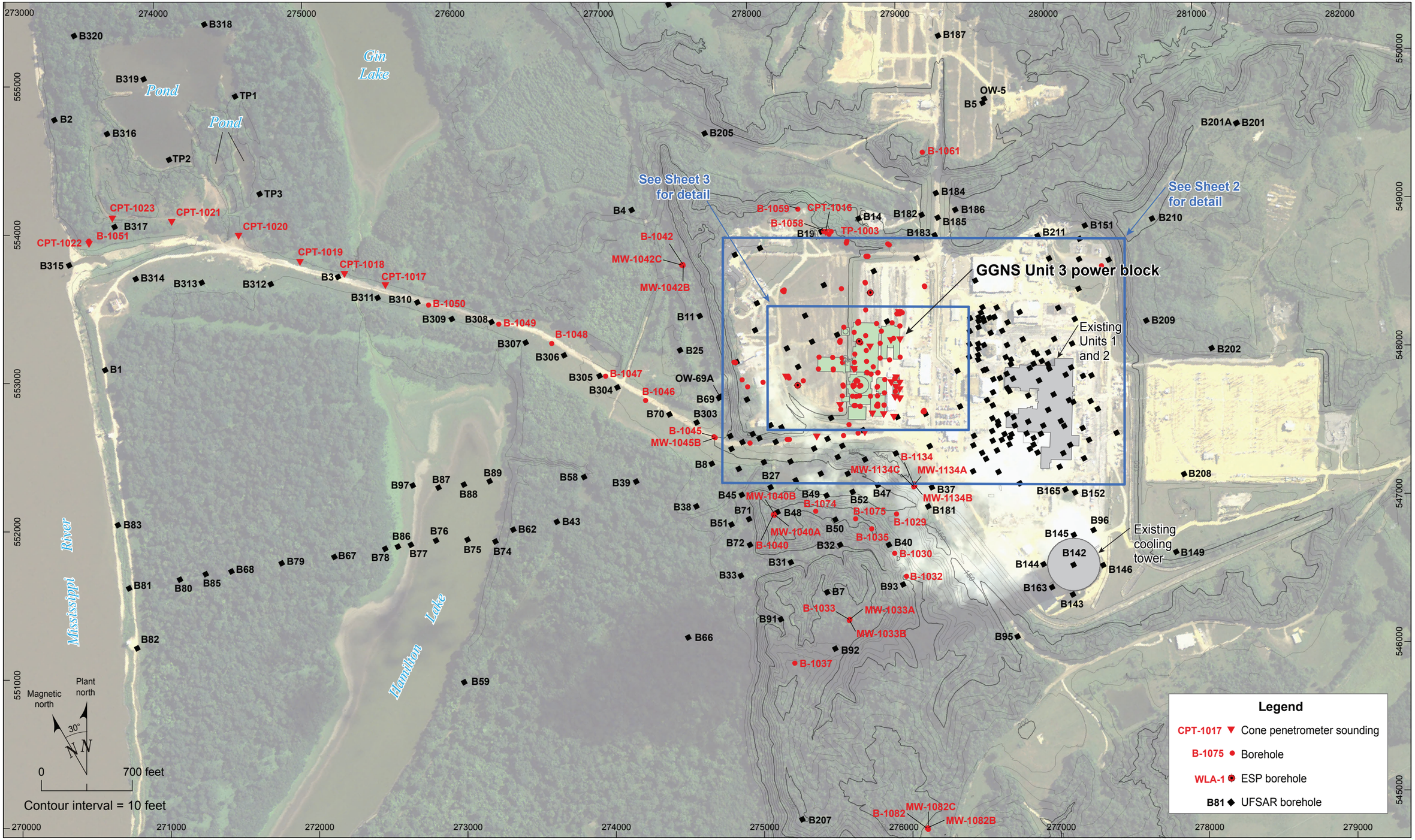
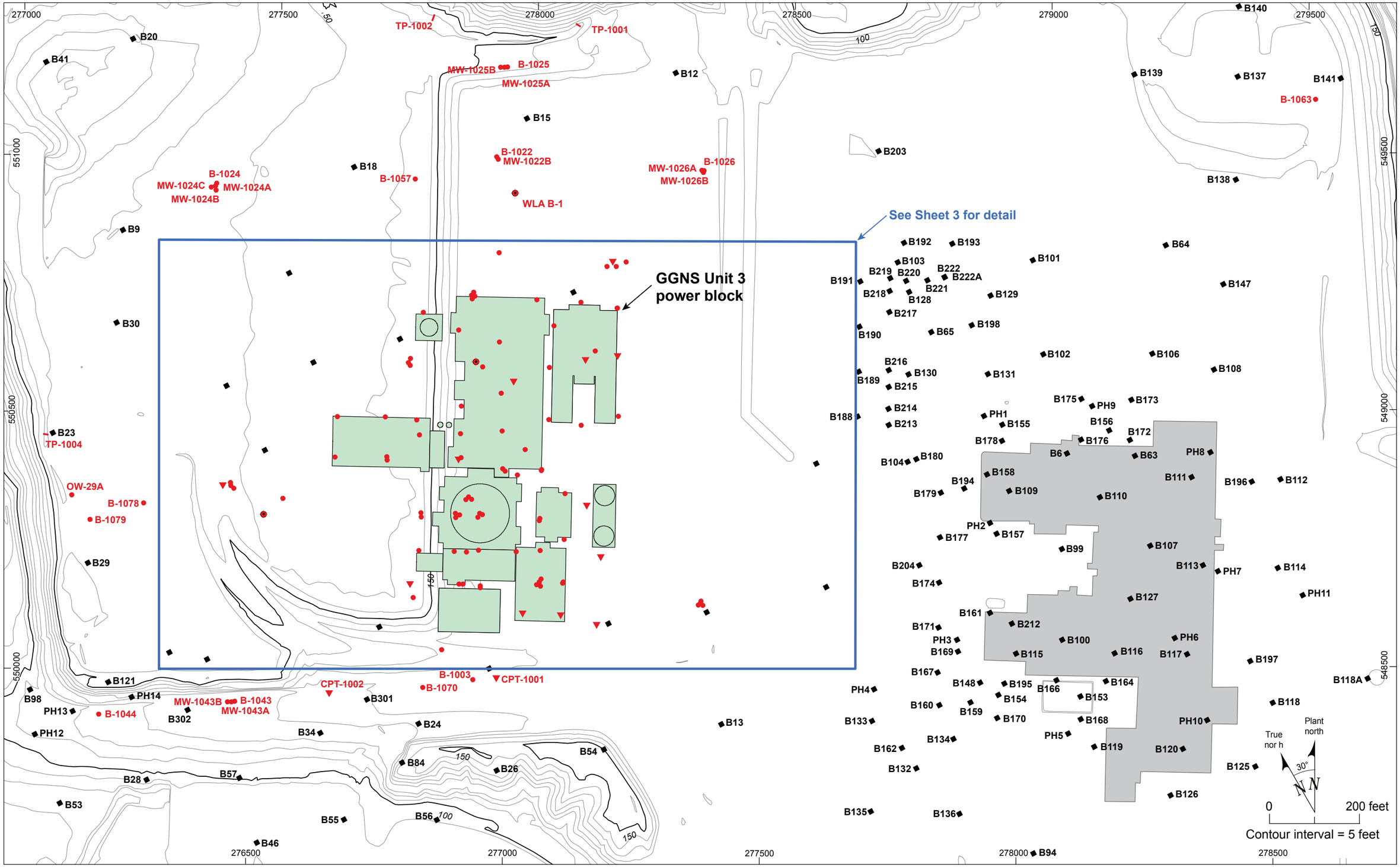


Figure 2.5.1-201. Site Exploration Maps (1 of 4)

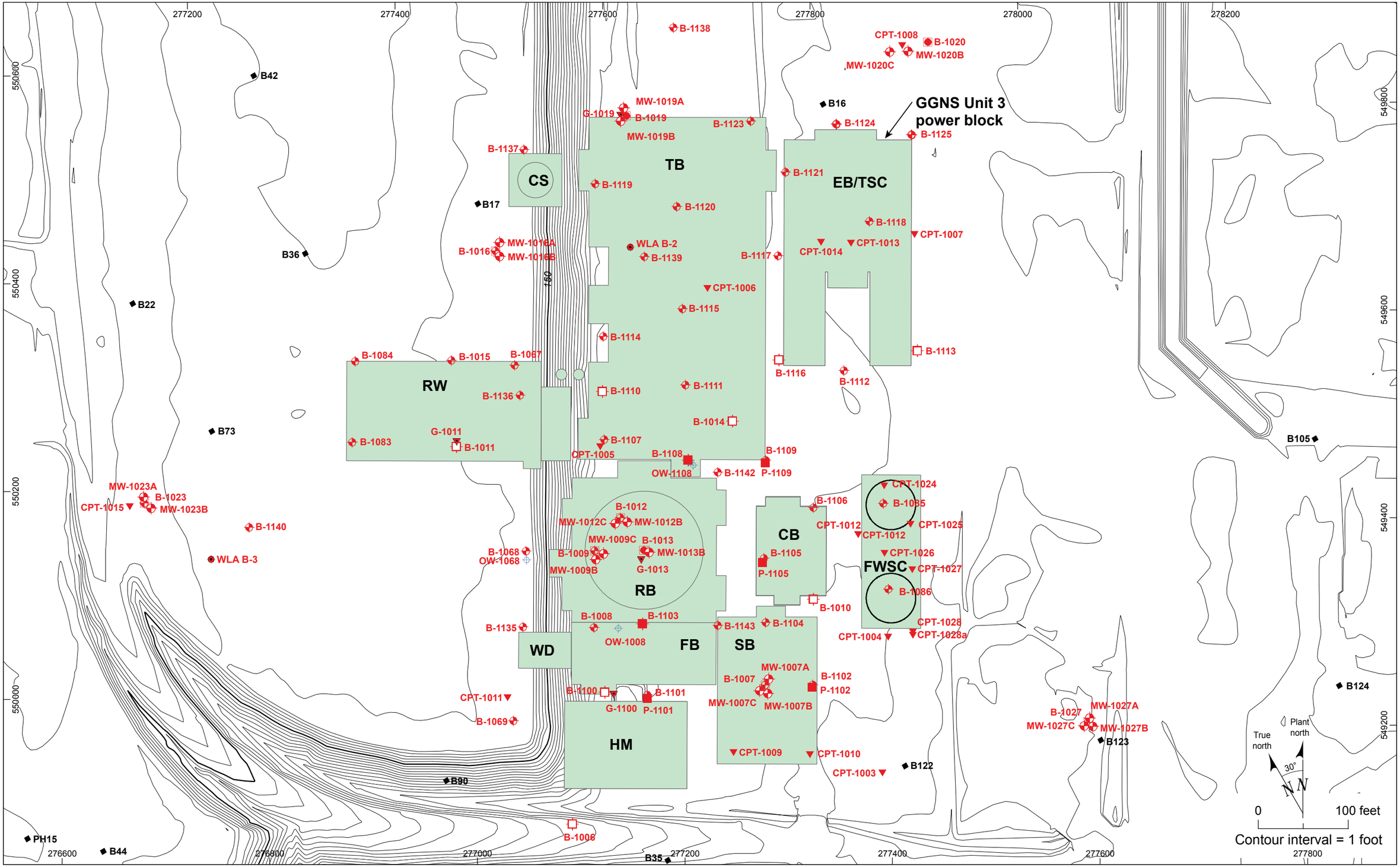
GGNS COL
2.0-26-A



Note: See Sheet 4 for explanation of symbols used.

Figure 2.5.1-201. Site Exploration Maps (Sheet 2 of 4)

GGNS COL
2.0-26-A



Note: See Sheet 4 for explanation of symbols used.

Figure 2.5.1-201. Site Exploration Maps (Sheet 3 of 4)

GGNS COL
2.0-26-A

Legend

B-1138	Borehole
B-1016	Borehole and monitoring well
B-1020	Borehole and monitoring well with suspension logging
MW-1020C	Monitoring well
OW-1068	Observation well
B-1108	Borehole with pressuremeter test
B-1113	Borehole with suspension logging
CPT-1007	Cone penetrometer test sounding
G-1100	GardnerDenver drill rig borehole
P-1109	Pitcher barrel sampler borehole
B16	GGNS Unit 1 UFSAR borehole
WLA B-3	GGNS ESP borehole

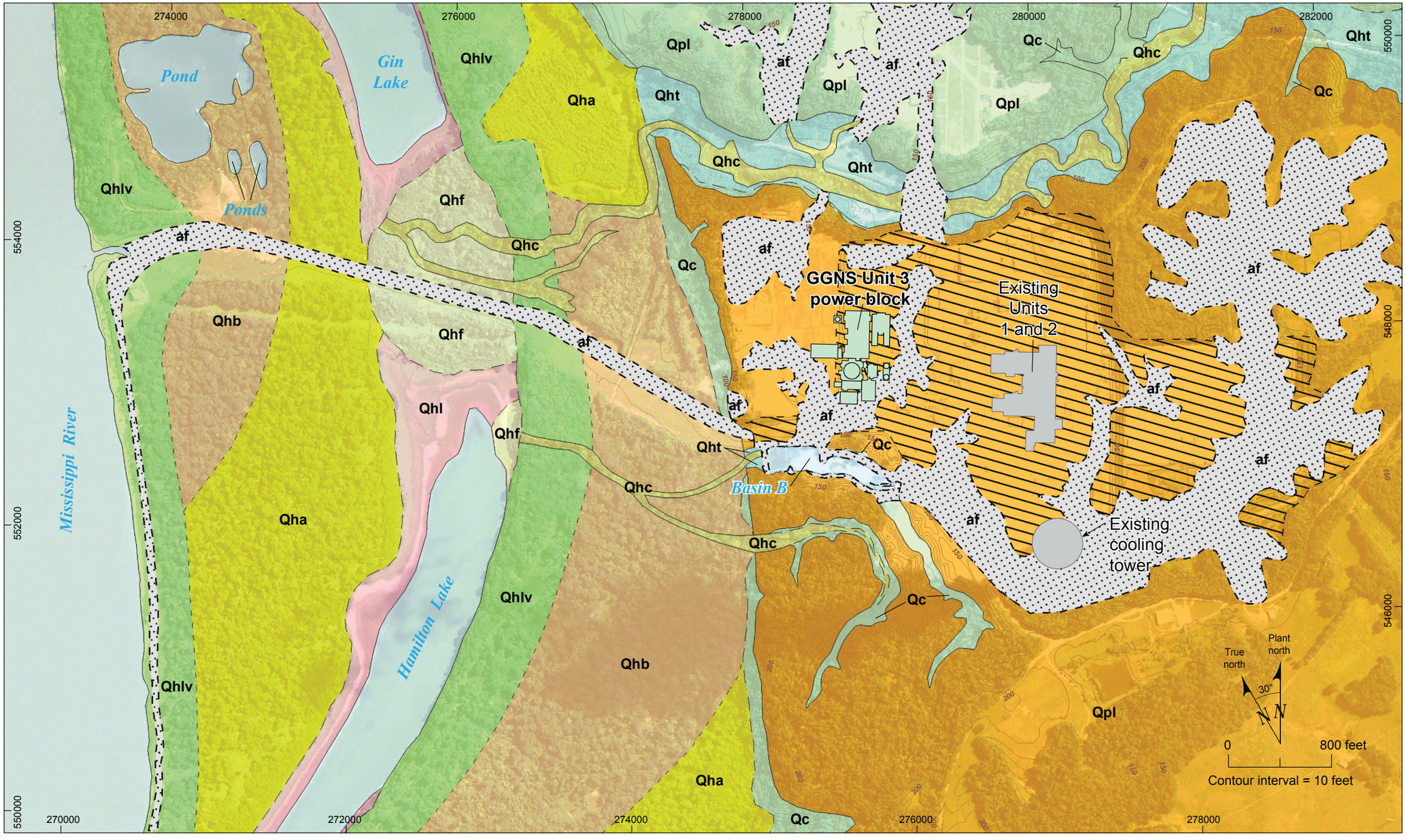
GGNS Unit 3
Power Block Facilities

CB	Control building
CS	Condensate storage tank
EB	Electrical building
FB	Fuel building
FWSC	Fire water service complex
HM	Hot machine shop
RB	Reactor building
RW	Radwaste building
SB	Service building
TB	Turbine building
TSC	Technical support center
WD	Wash down bays

Notes: 1. Projection NAD 27 State Plane Mississippi West FIPS.
2. Vertical datum NAVD88.

Figure 2.5.1-201. Site Exploration Maps (Sheet 4 of 4)

GGNS COL
2.0-26-A



Notes: 1. Projection NAD 27 State Plane Mississippi West FIPS.
2. Vertical datum NAVD 88.
3. See Sheet 2 for Legend.

Figure 2.5.1-202. GGNS Site Geologic Map (Sheet 1 of 2)

GGNS COL
2.0-26-A

Legend

Unit Descriptions

Holocene

- **af** — Undocumented fill - may be engineered and/or non-engineered
- **Qhc** — Stream channel deposits - gravel, sand, silt and clay deposited in active natural stream channels
- **Qht** — Stream terrace deposits - gravel, silt, sand and clay deposits associated with stream channel point bar and overbank deposits adjacent to fluvial channels
- **Qha** — Mississippi River alluvium, undifferentiated - unconsolidated gravel, sand, silt and clay deposited by the Mississippi River
- **Qhf** — Alluvial fan deposits - gravel, sand, and silt associated with streams emanating from confined drainages onto alluvial valleys
- **Qhlu** — Lacustrine deposits - clay, silt, and sand deposits associated with lake deposition
- **Qhb** — Backswamp deposits - sand, silt and clay deposited in the floodbasin behind a natural levee
- **Qhlv** — Levee deposits - gravel, sand and silt deposited in a low ridge adjacent to present or former river channels
- **Qc** — Colluvium - unconsolidated sand, silt and clay accumulated on or at the base of slopes

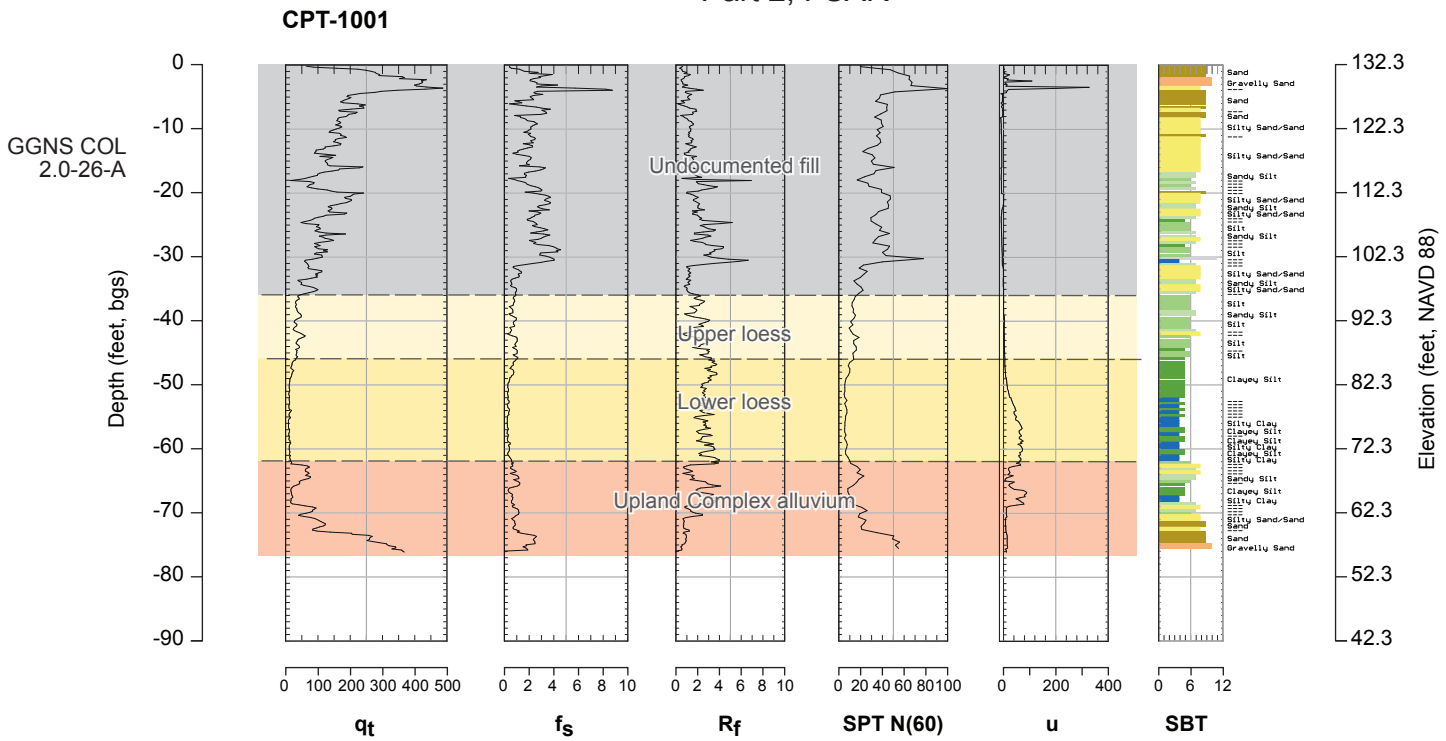
Pleistocene

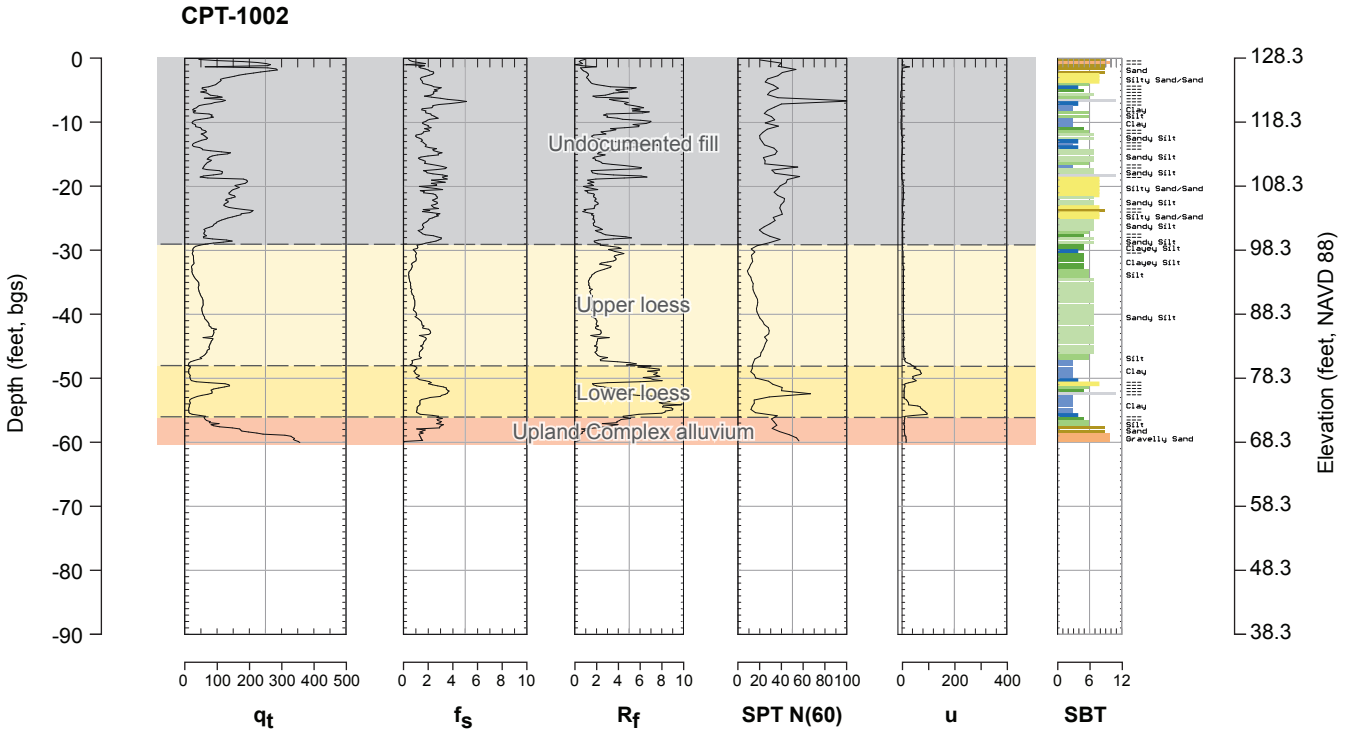
- **Qpl** — Loess (upper) - silt, trace clay, massive, weak blocky structure, very thinly laminated, and occasional gastropod shells

Symbols

- GGNS Unit 3 power block
- Contacts between map units; solid where accurately located; long dashed line where approximately located; short dashed line where inferred
- Cut

Figure 2.5.1-202. GGNS Site Geologic Map (Sheet 2 of 2)



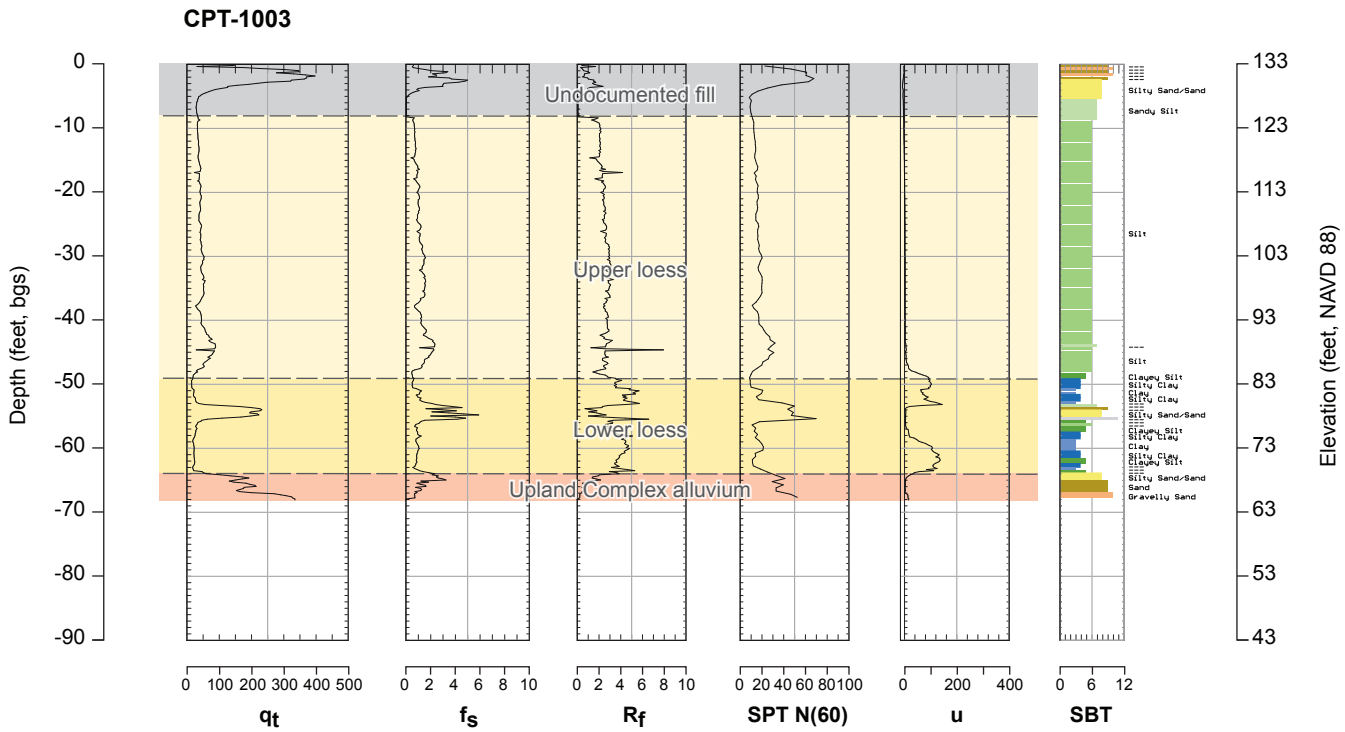


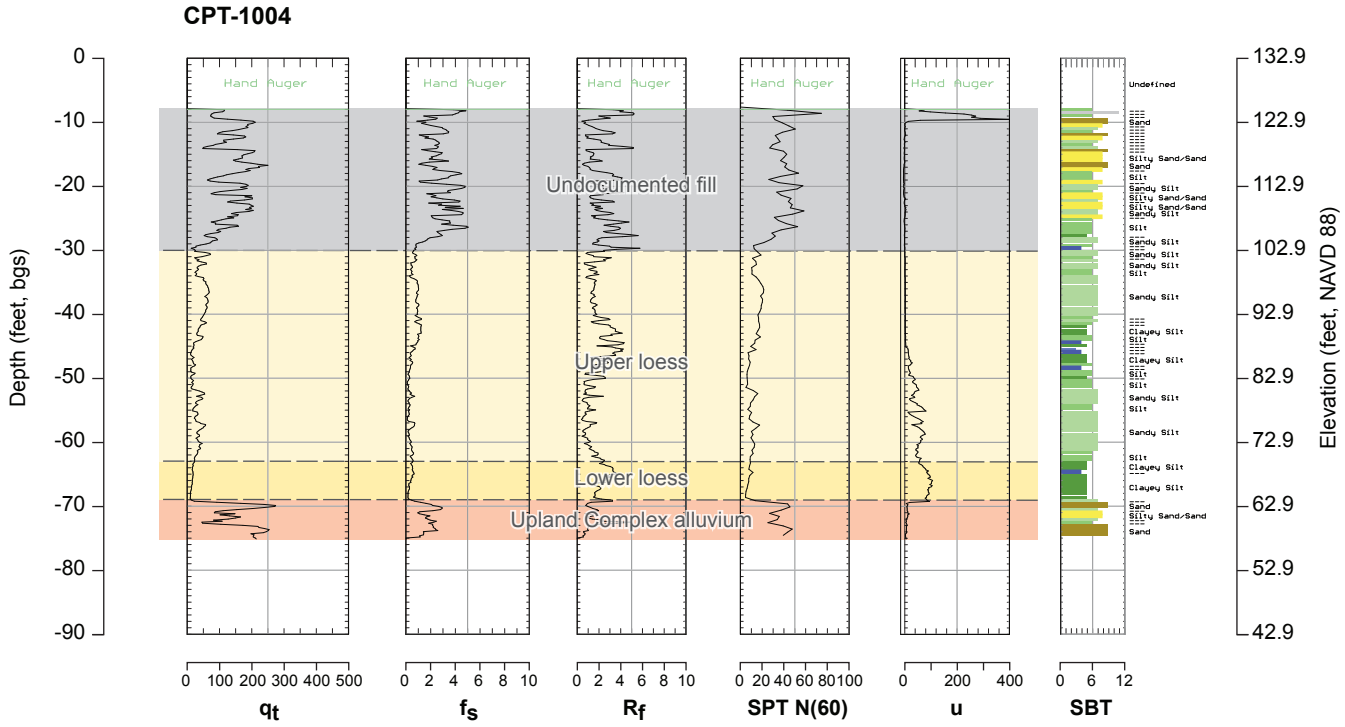
Legend

q_t	Corrected tip resistance (tons/sq. foot)	**SPT N(60)**	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
SBT	Soil behavior type	**R_f**	Friction ratio (%)
f_s	Sleeve friction (tons/sq. foot)		
u	Dynamic pore pressure (lbs./sq. inch)		

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 1 of 14)

GGNS COL
2.0-26-A



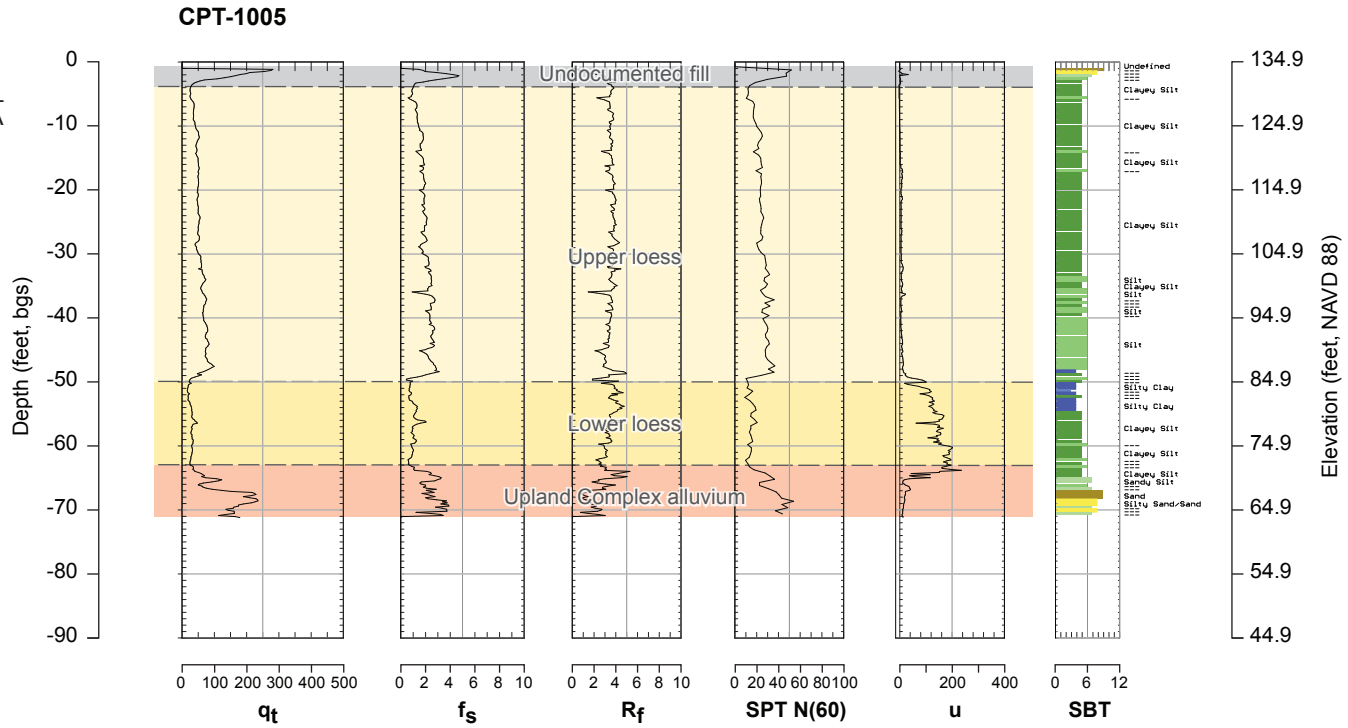


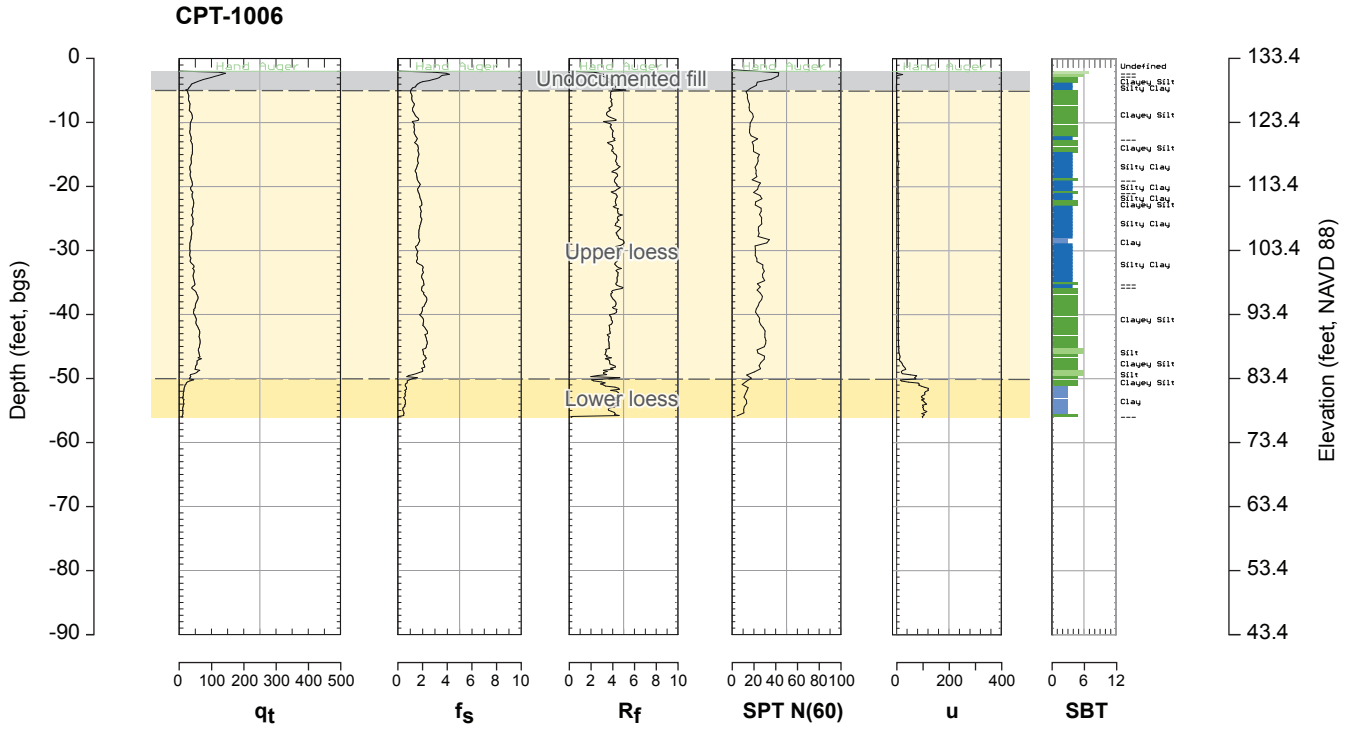
Legend

q_t	Corrected tip resistance (tons/sq. foot)
SBT	Soil behavior type
f_s	Sleeve friction (tons/sq. foot)
u	Dynamic pore pressure (lbs./sq. inch)
SPT N(60)	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
R_f	Friction ratio (%)

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 2 of 14)

GGNS COL
2.0-26-A



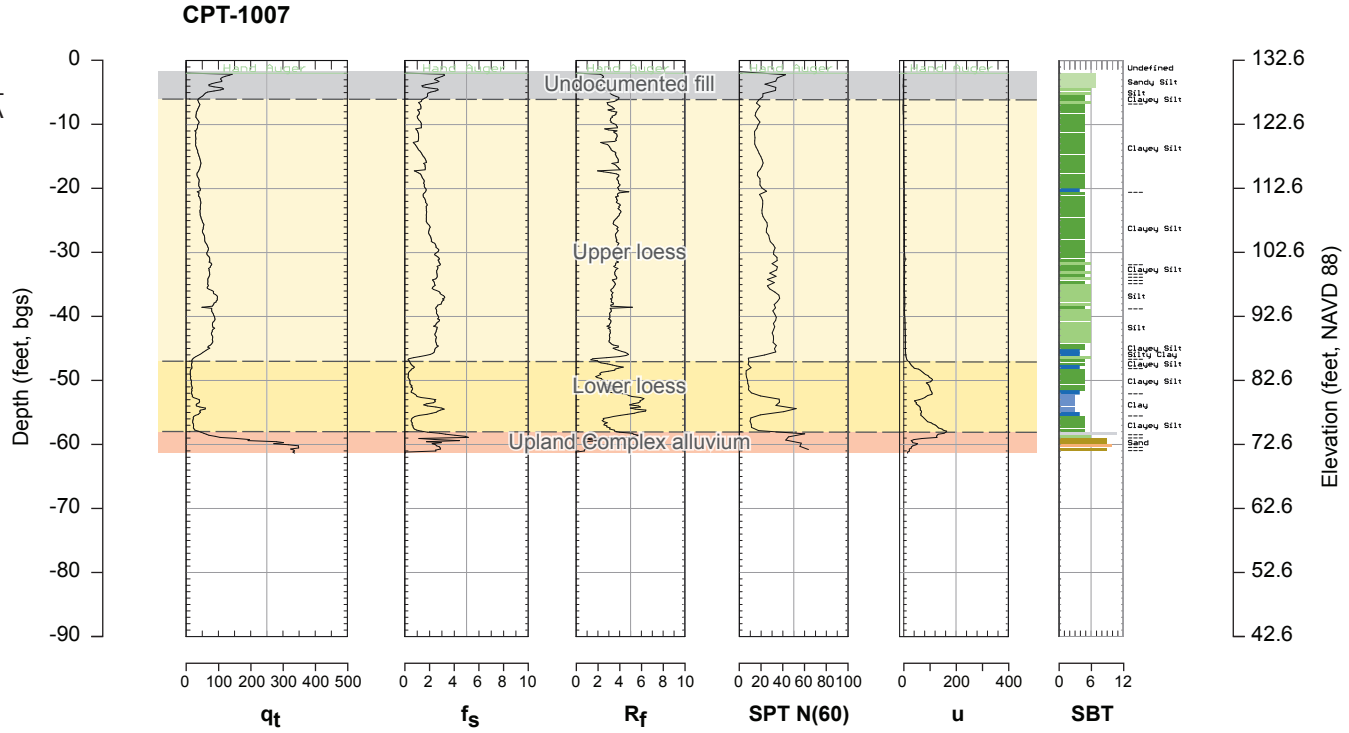


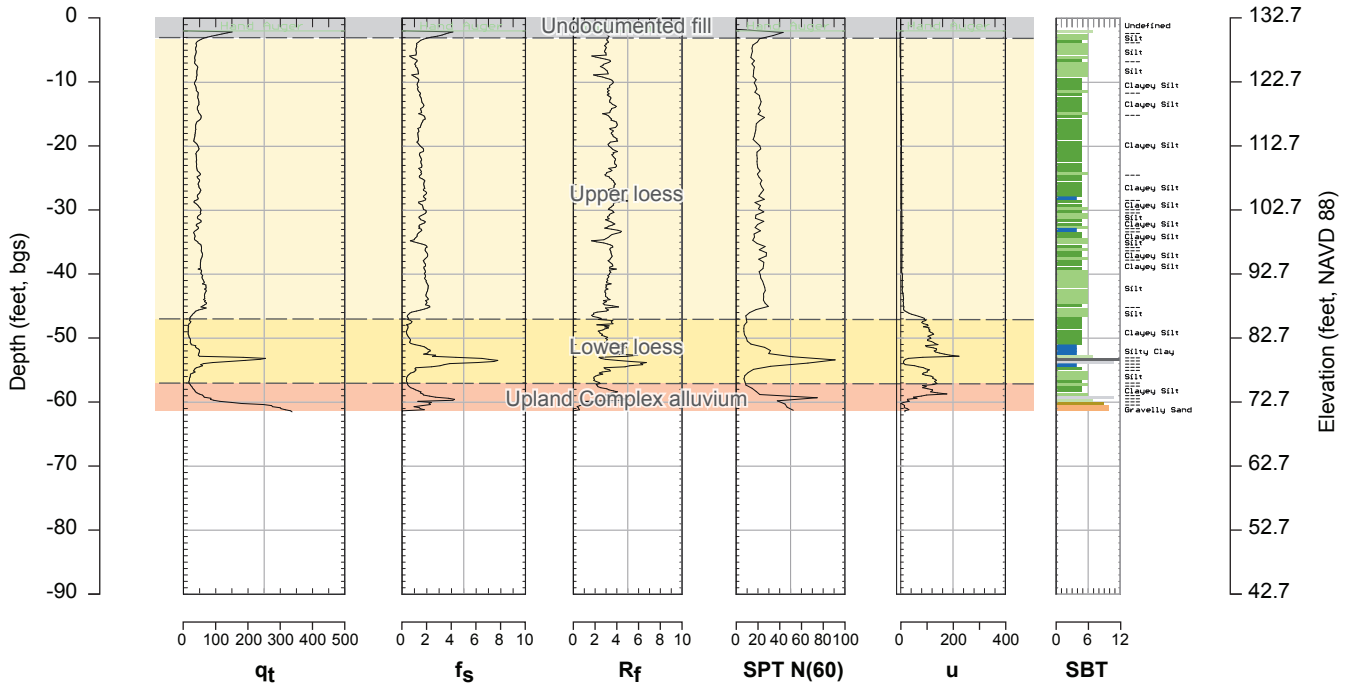
Legend

q_t	Corrected tip resistance (tons/sq. foot)	**SPT N(60)**	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
SBT	Soil behavior type	R_f	Friction ratio (%)
f_s	Sleeve friction (tons/sq. foot)		
u	Dynamic pore pressure (lbs./sq. inch)		

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 3 of 14)

GGNS COL
2.0-26-A

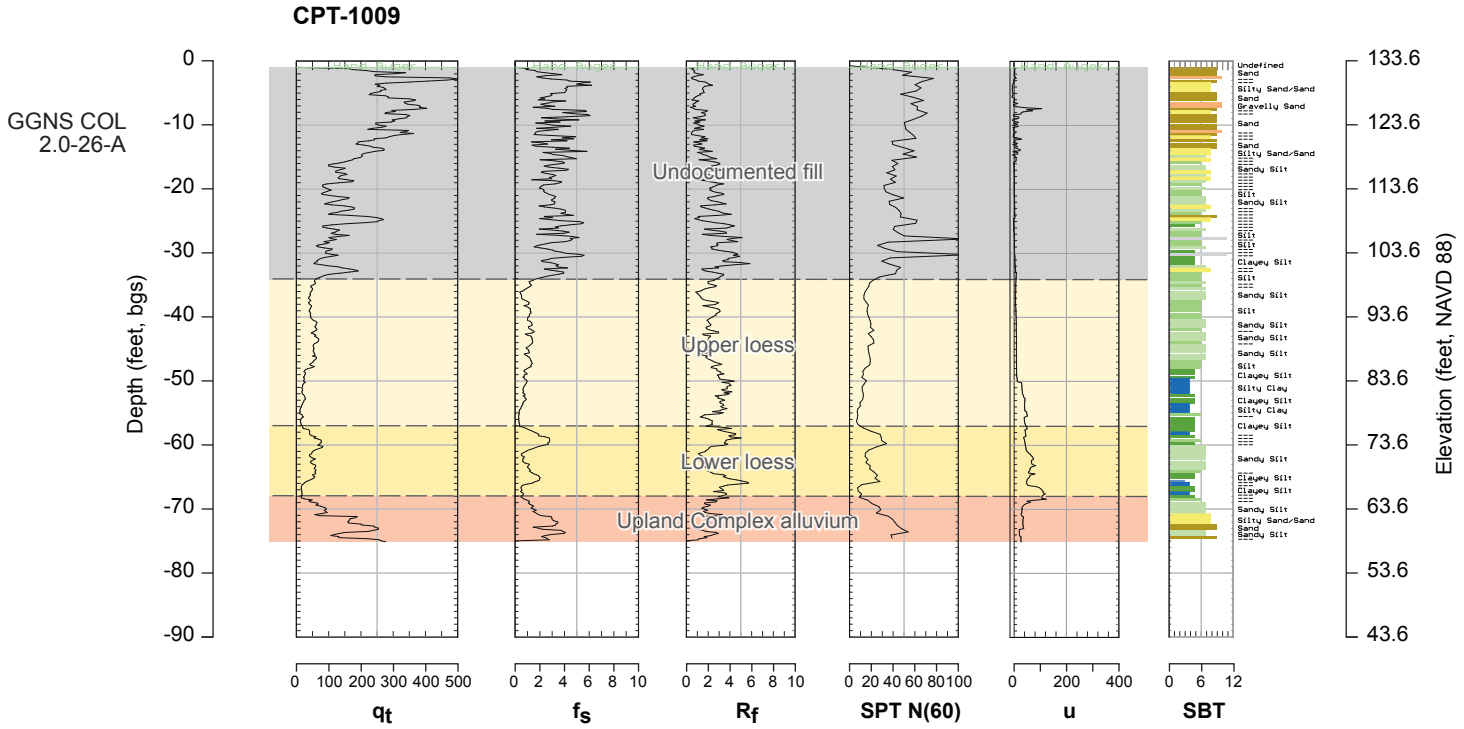


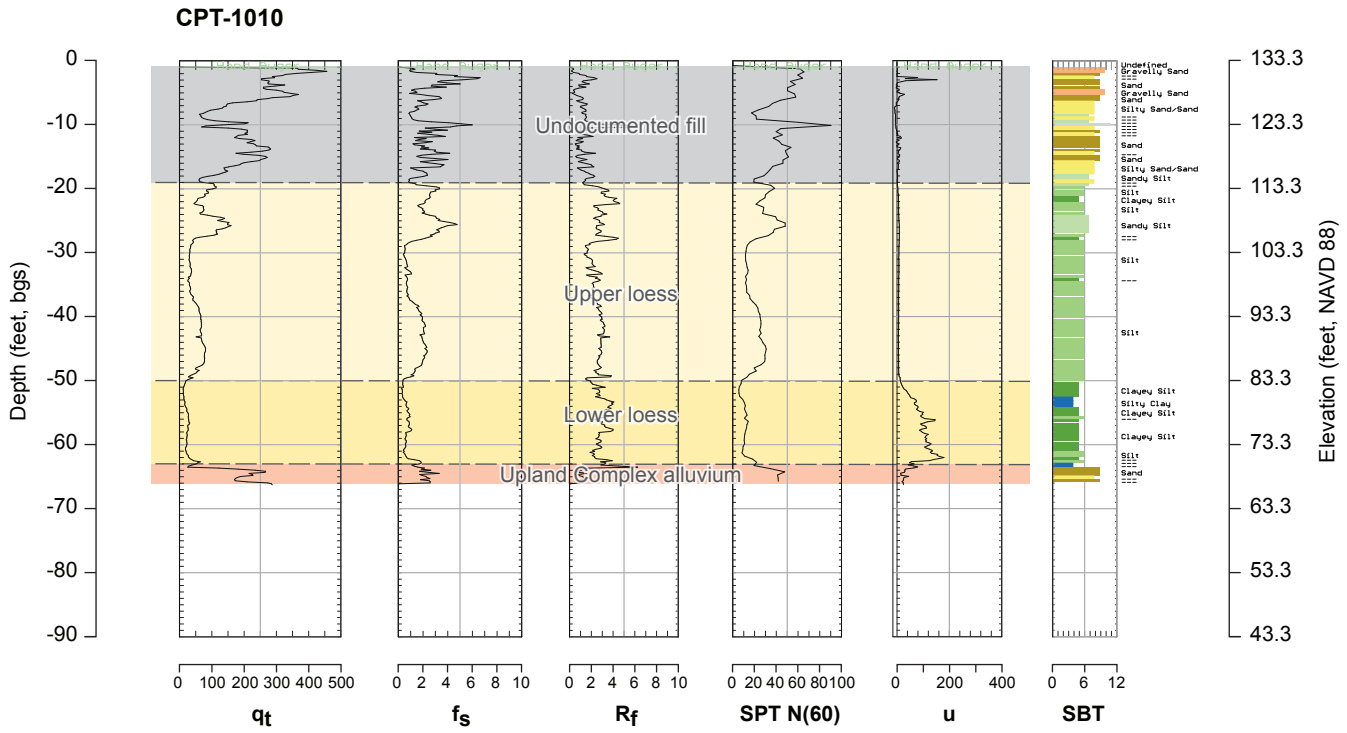


Legend

q_t	Corrected tip resistance (tons/sq. foot)
SBT	Soil behavior type
f_s	Sleeve friction (tons/sq. foot)
u	Dynamic pore pressure (lbs./sq. inch)
SPT N(60)	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
R_f	Friction ratio (%)

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 4 of 14)



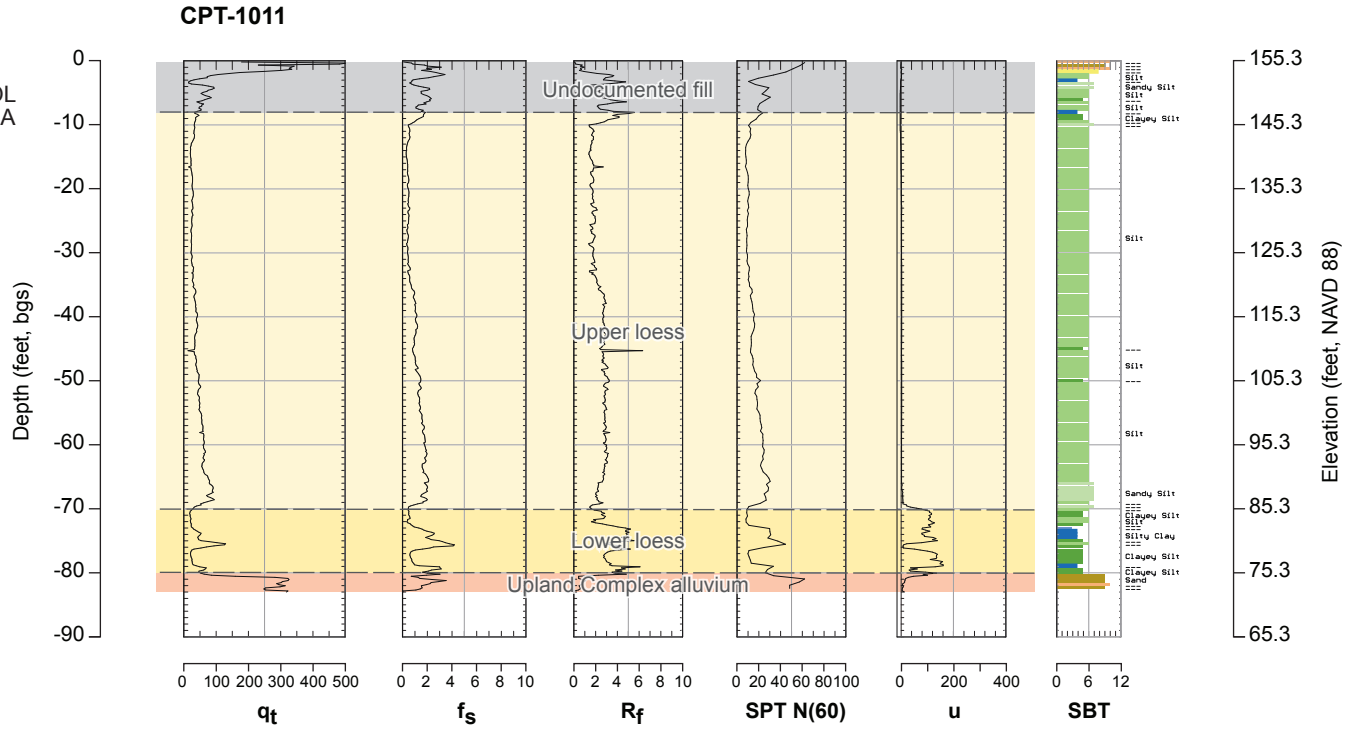


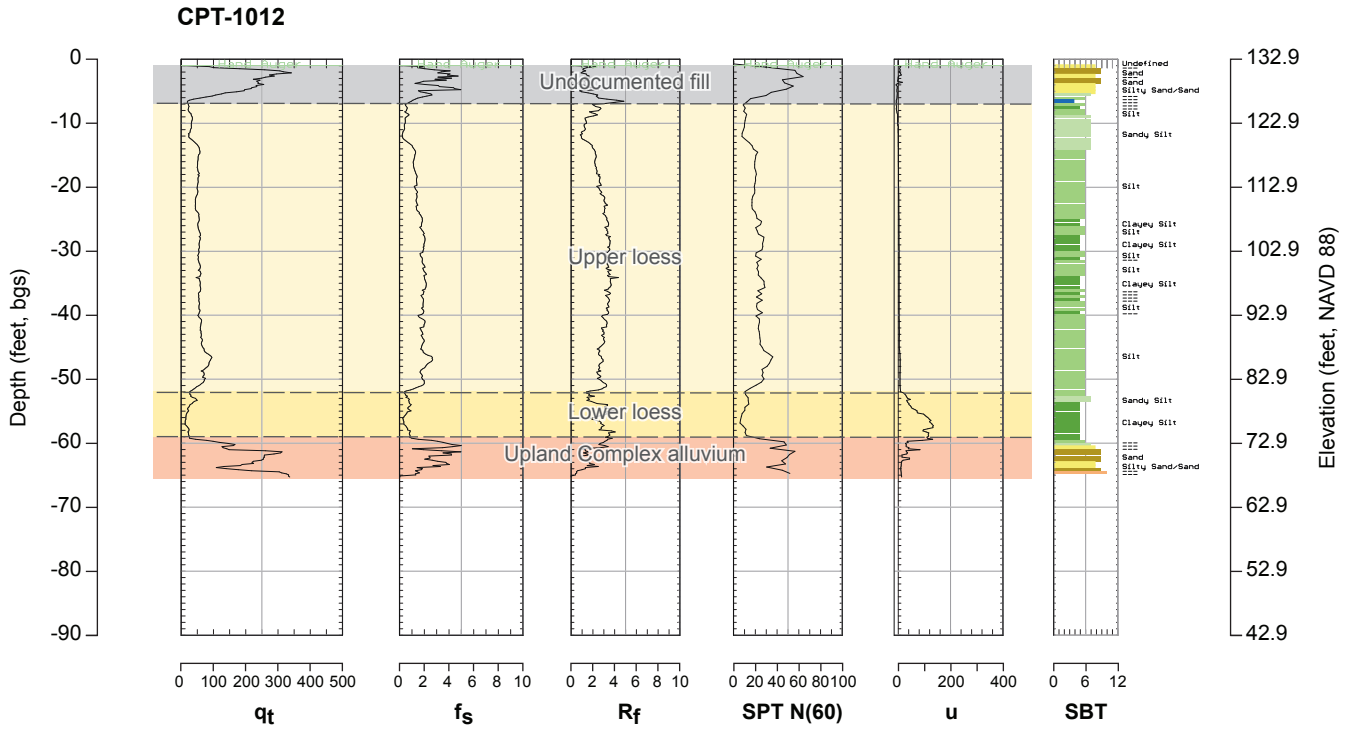
Legend

q_t	Corrected tip resistance (tons/sq. foot)
SBT	Soil behavior type
f_s	Sleeve friction (tons/sq. foot)
u	Dynamic pore pressure (bs./sq. inch)
SPT N(60)	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
R_f	Friction ratio (%)

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 5 of 14)

GGNS COL
2.0-26-A



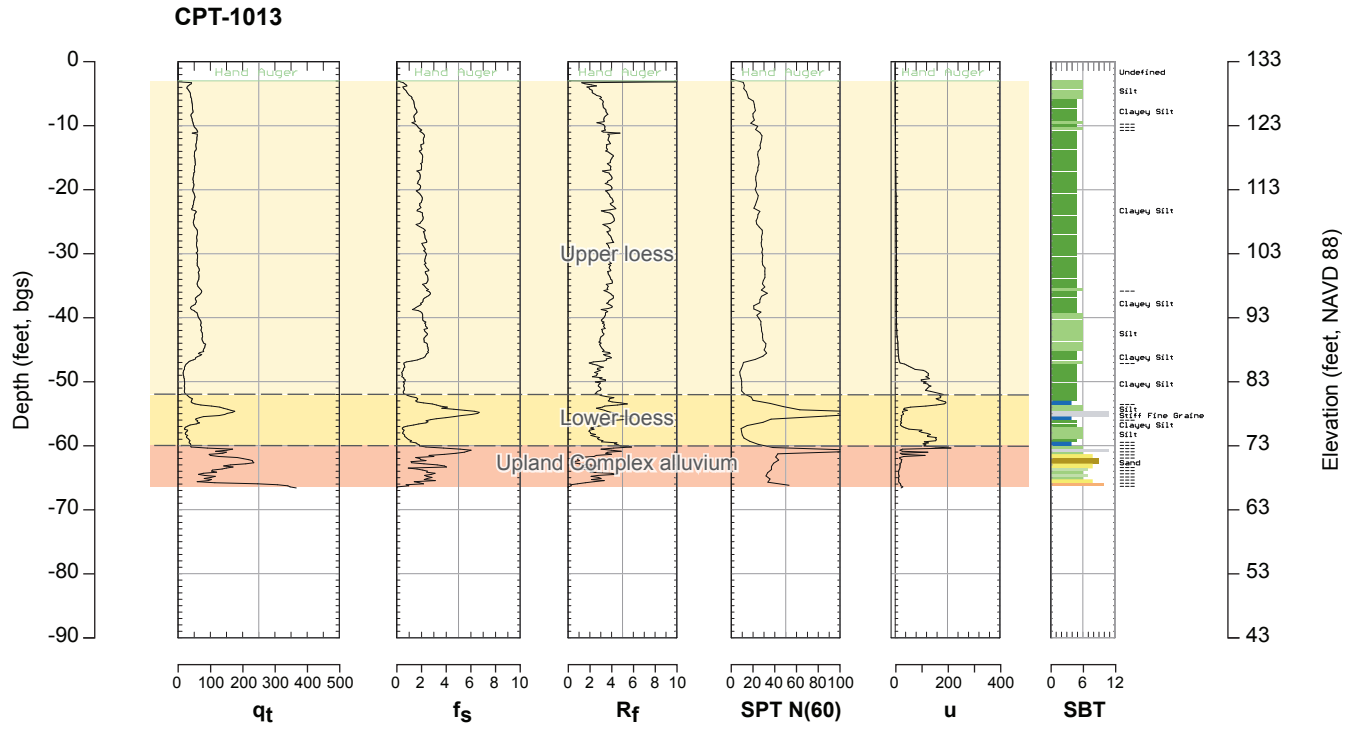


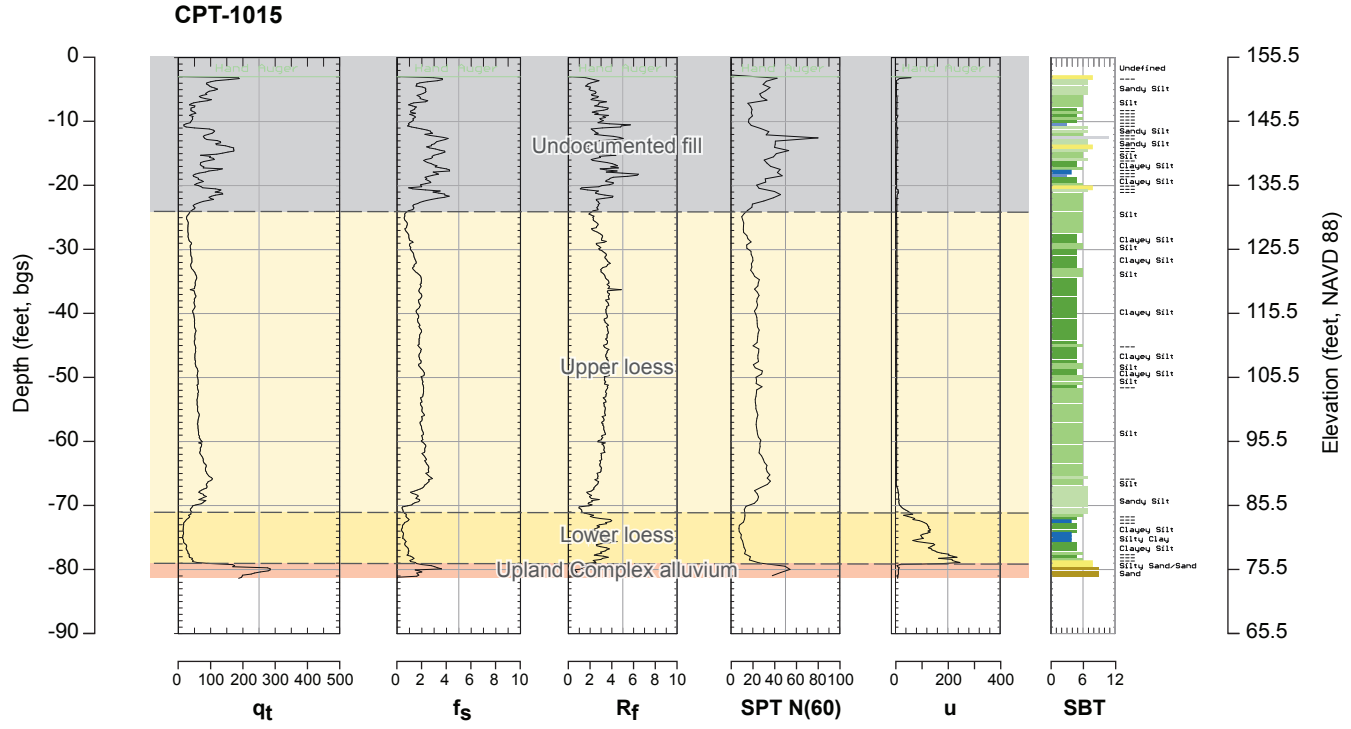
Legend

q_t	Corrected tip resistance (tons/sq. foot)
SBT	Soil behavior type
f_s	Sleeve friction (tons/sq. foot)
u	Dynamic pore pressure (bs./sq. inch)
SPT N(60)	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
R_f	Friction ratio (%)

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 6 of 14)

GGNS COL
2.0-26-A



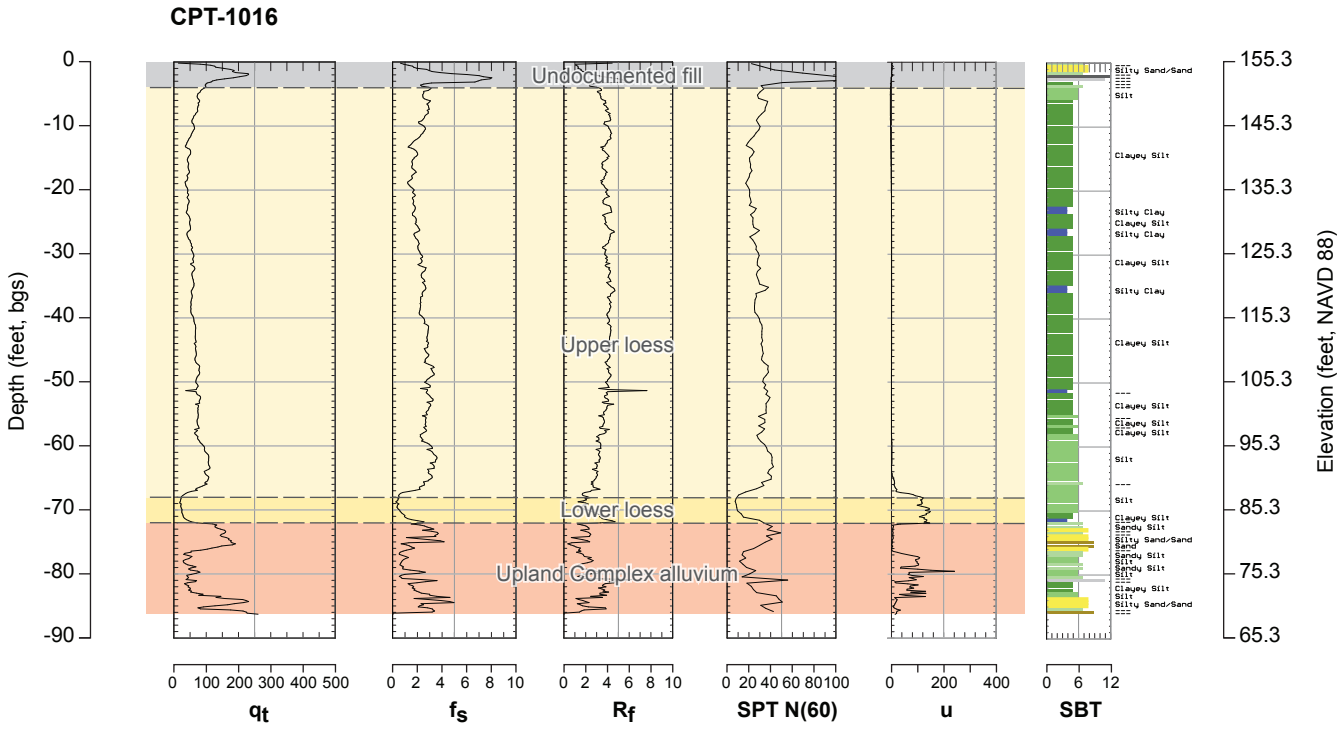


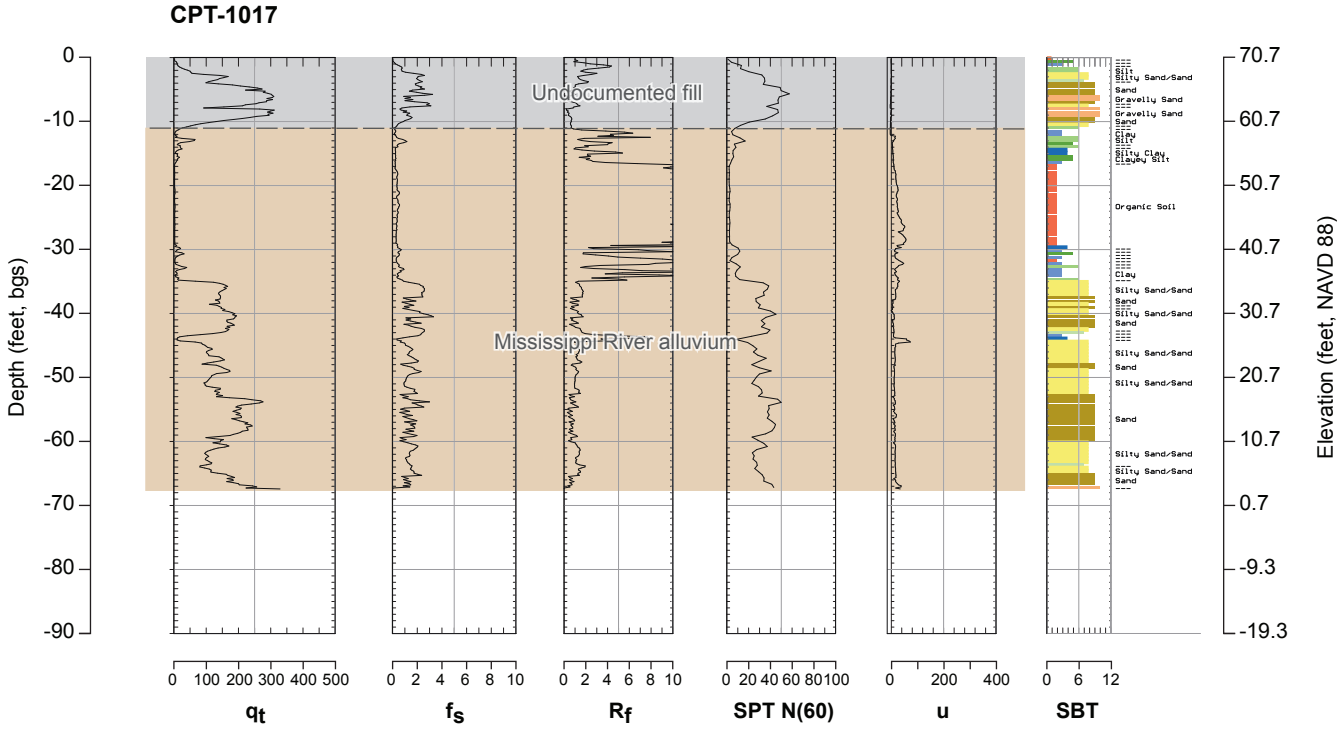
Legend

q_t	Corrected tip resistance (tons/sq. foot)
SBT	Soil behavior type
f_s	Sleeve friction (tons/sq. foot)
u	Dynamic pore pressure (lbs./sq. inch)
SPT N(60)	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
R_f	Friction ratio (%)

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 7 of 14)

GGNS COL
2.0-26-A

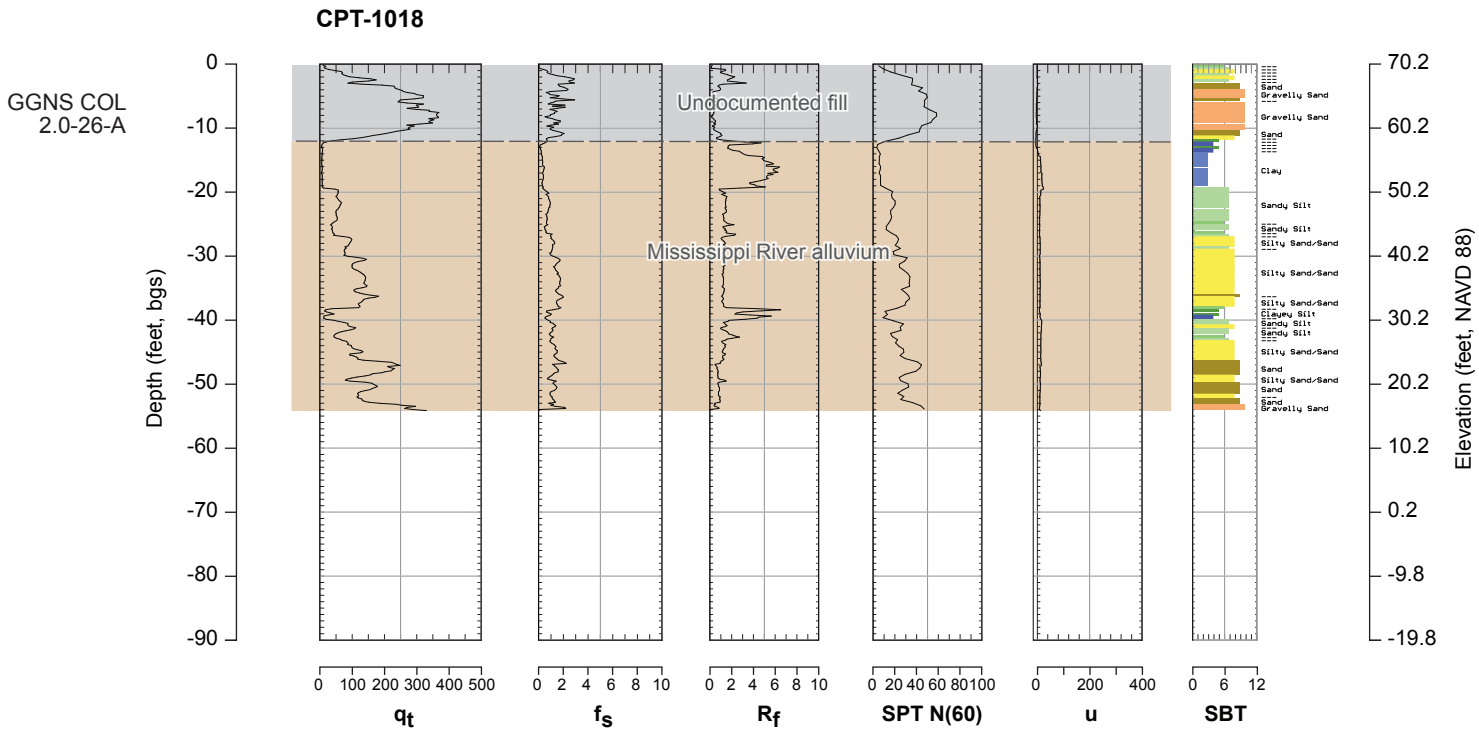


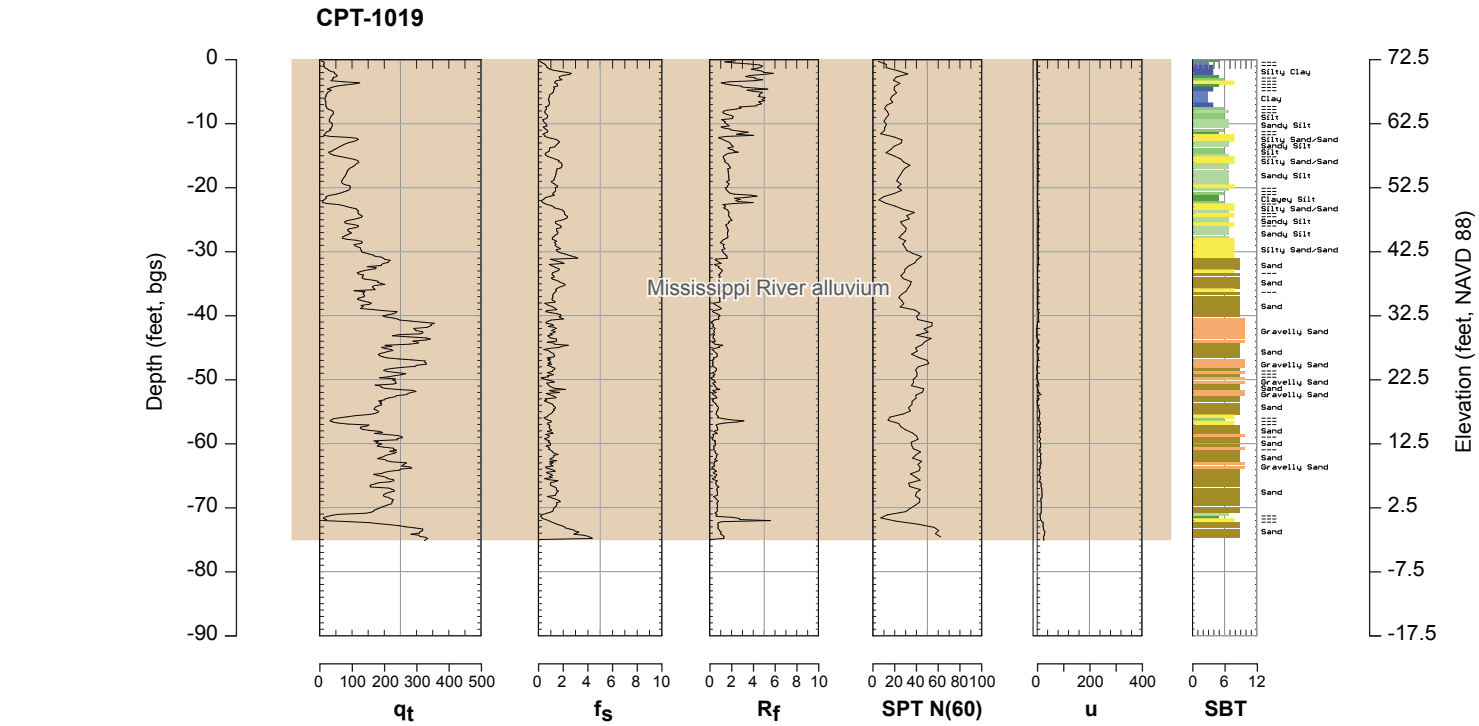


Legend

q_t	Corrected tip resistance (tons/sq. foot)
SBT	Soil behavior type
f_s	Sleeve friction (tons/sq. foot)
u	Dynamic pore pressure (lbs./sq. inch)
SPT N(60)	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
R_f	Friction ratio (%)

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 8 of 14)



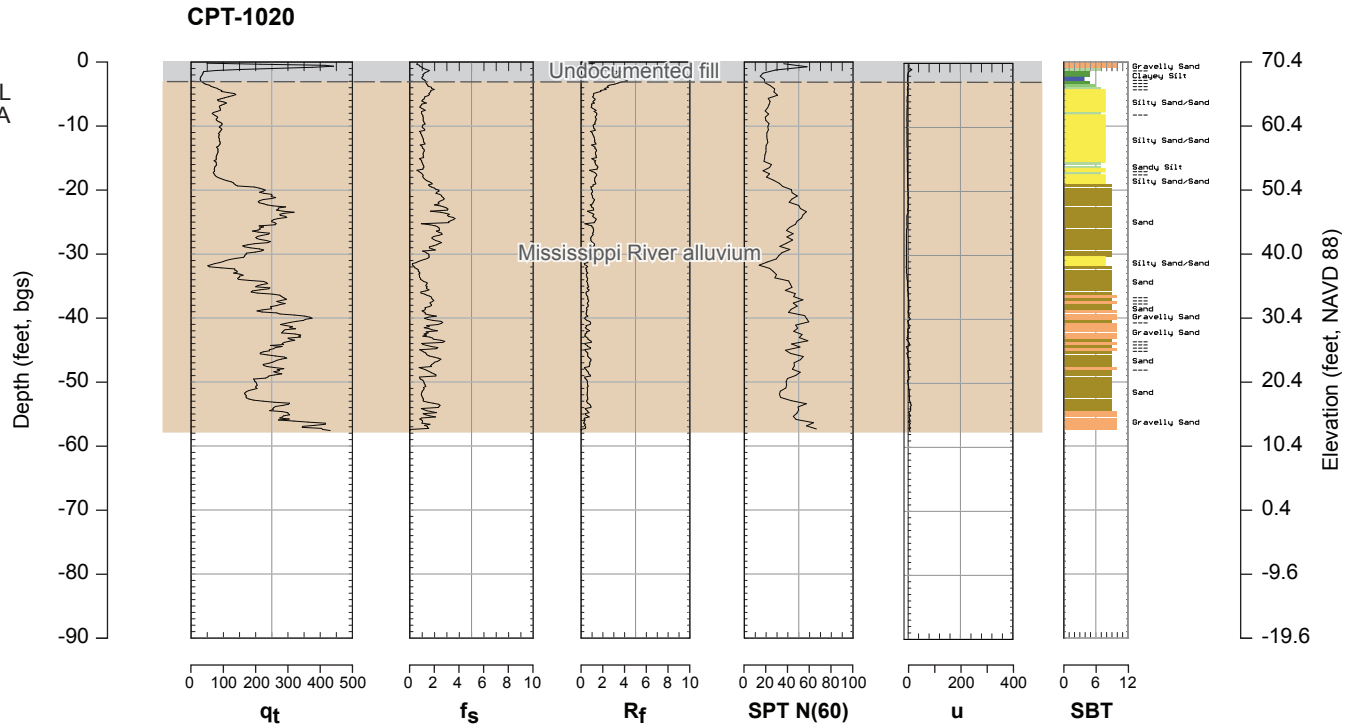


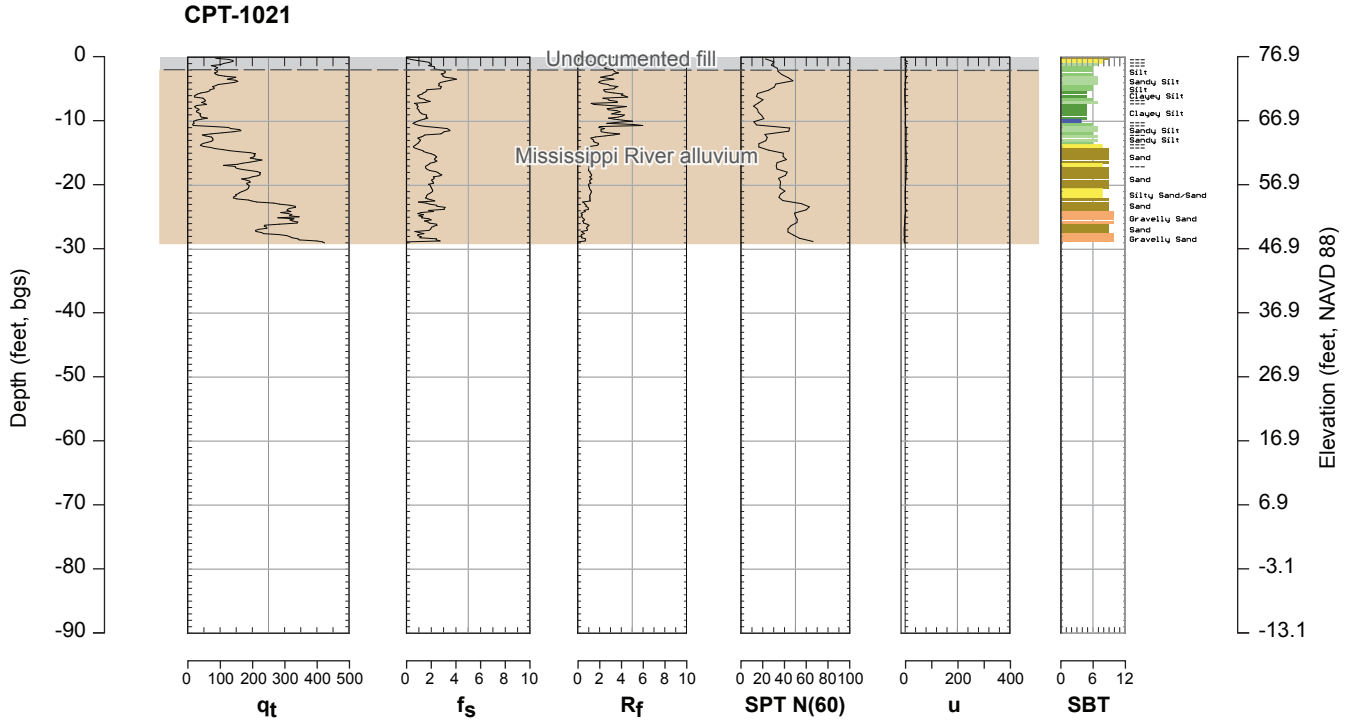
Legend

q_t	Corrected tip resistance (tons/sq. foot)
SBT	Soil behavior type
f_s	Sleeve friction (tons/sq. foot)
u	Dynamic pore pressure (lbs./sq. inch)
SPT N(60)	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
R_f	Friction ratio (%)

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 9 of 14)

GGNS COL
2.0-26-A

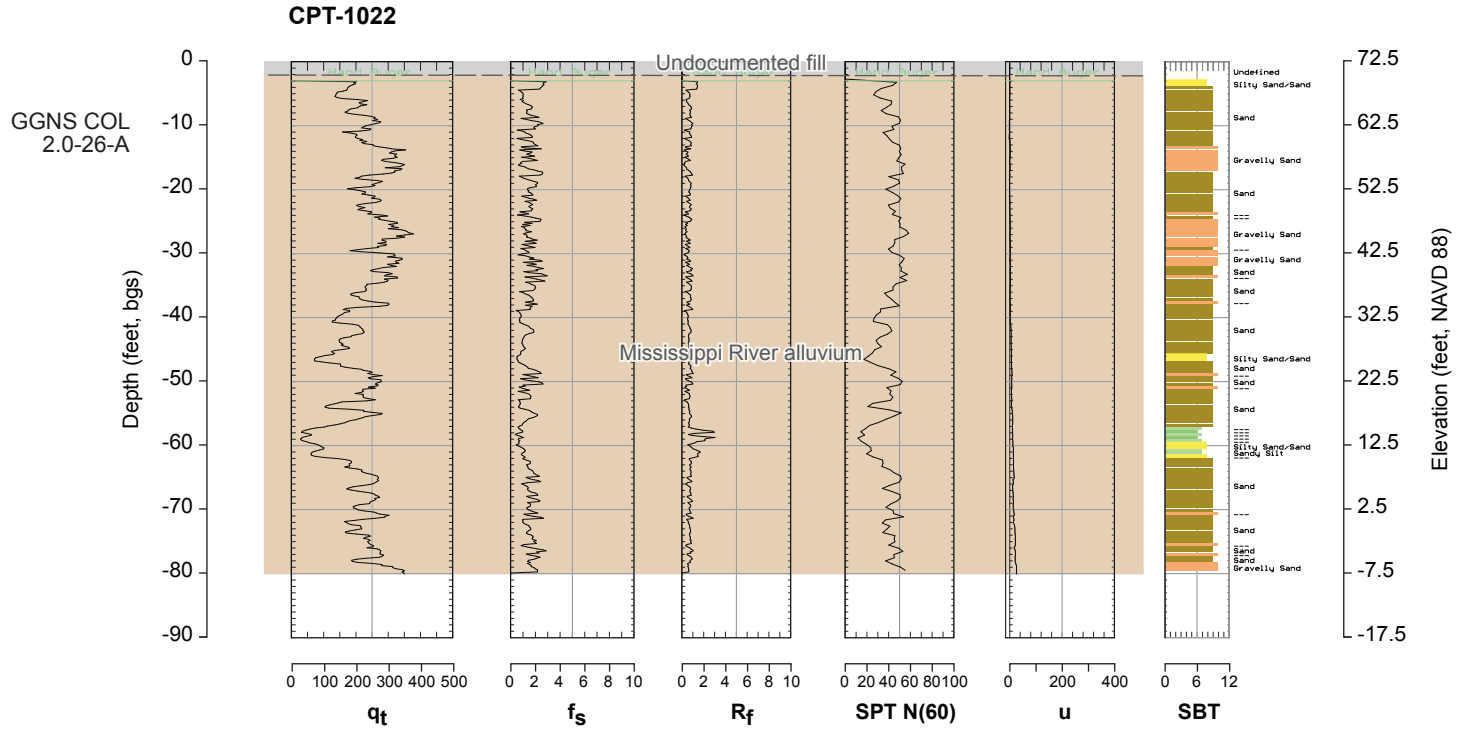


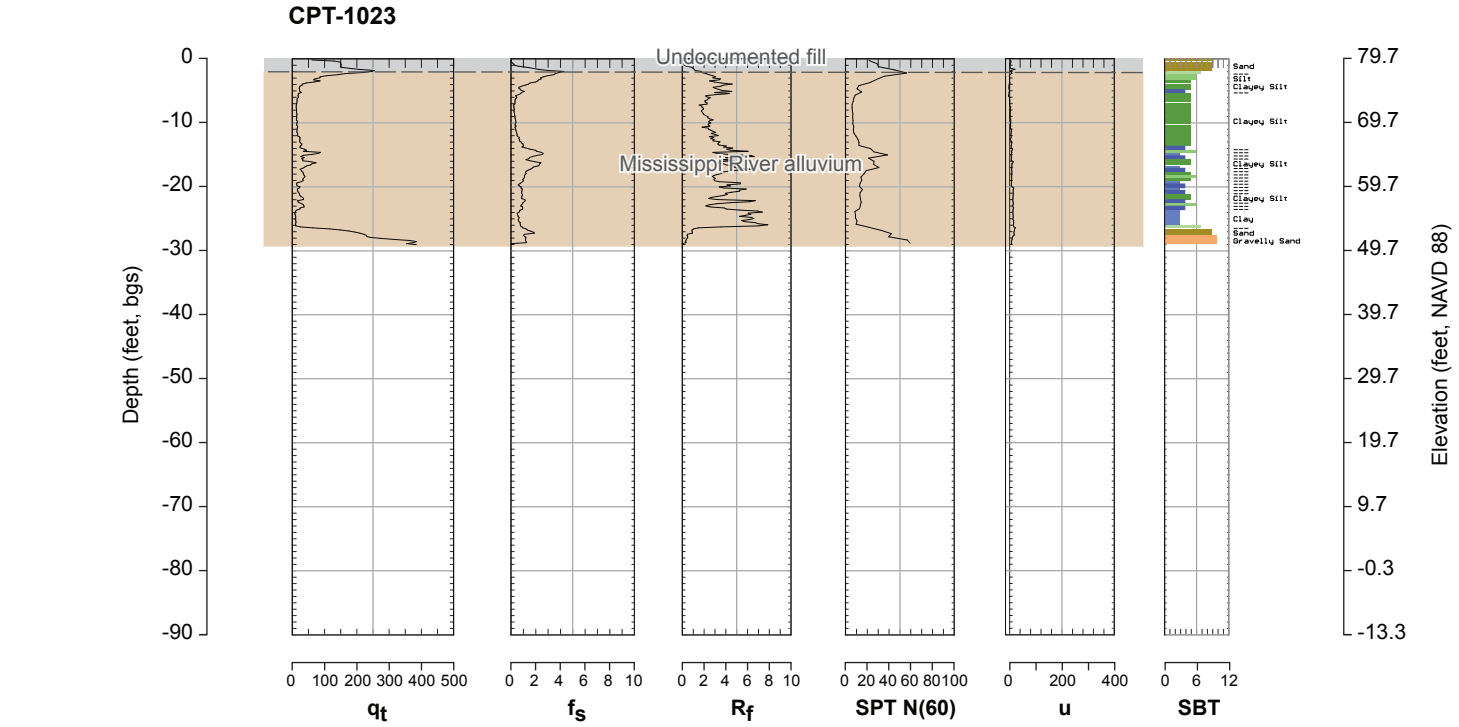


Legend

q_t	Corrected tip resistance (tons/sq. foot)	**SPT N(60)**	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
SBT	Soil behavior type	**R_f**	Friction ratio (%)
f_s	Sleeve friction (tons/sq. foot)		
u	Dynamic pore pressure (lbs./sq. inch)		

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 10 of 14)



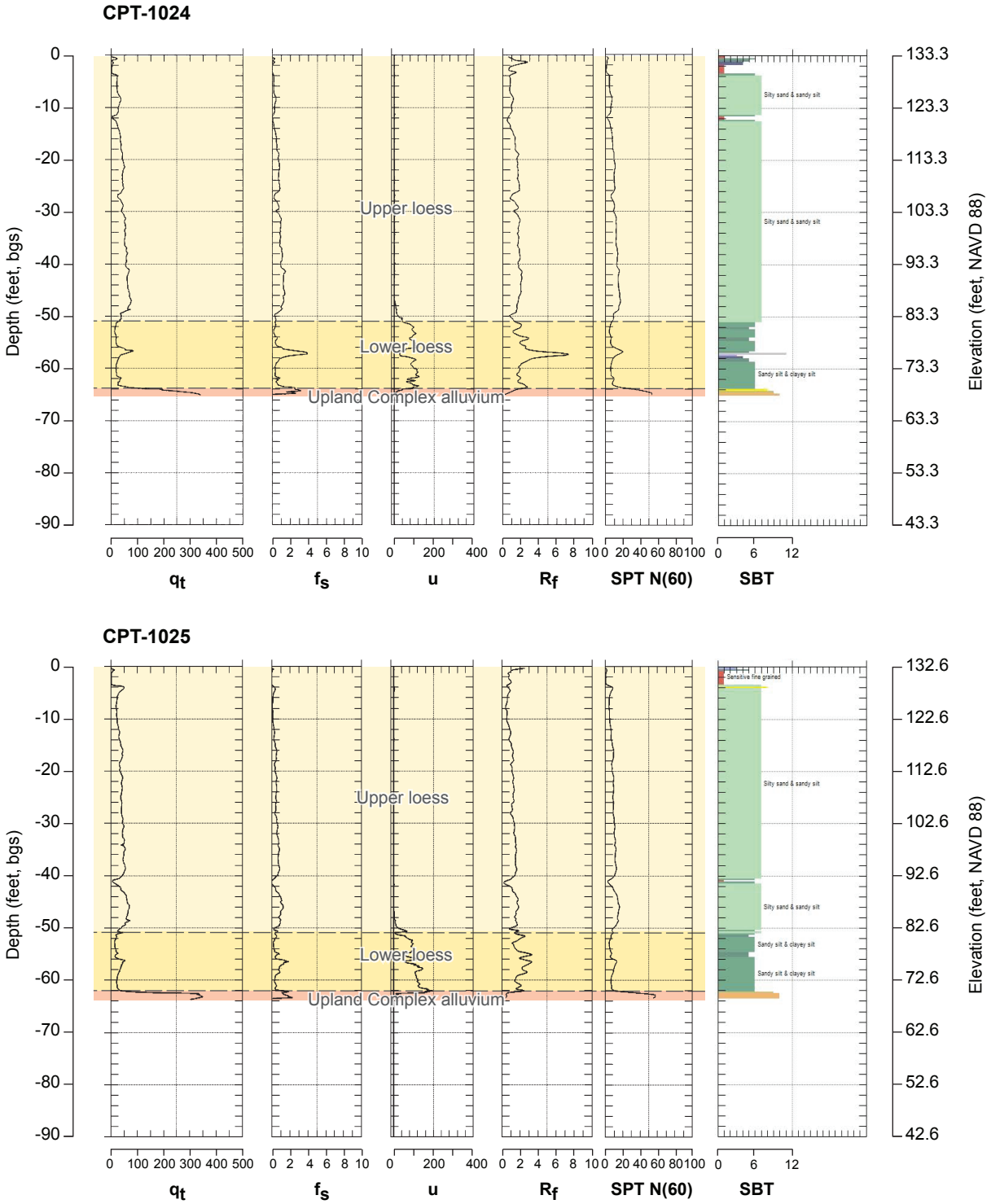


Legend

q_t	Corrected tip resistance (tons/sq. foot)	**SPT N(60)**	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
SBT	Soil behavior type	R_f	Friction ratio (%)
f_s	Sleeve friction (tons/sq. foot)		
u	Dynamic pore pressure (lbs./sq. inch)		

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 11 of 14)

GGNS COL
2.0-26-A

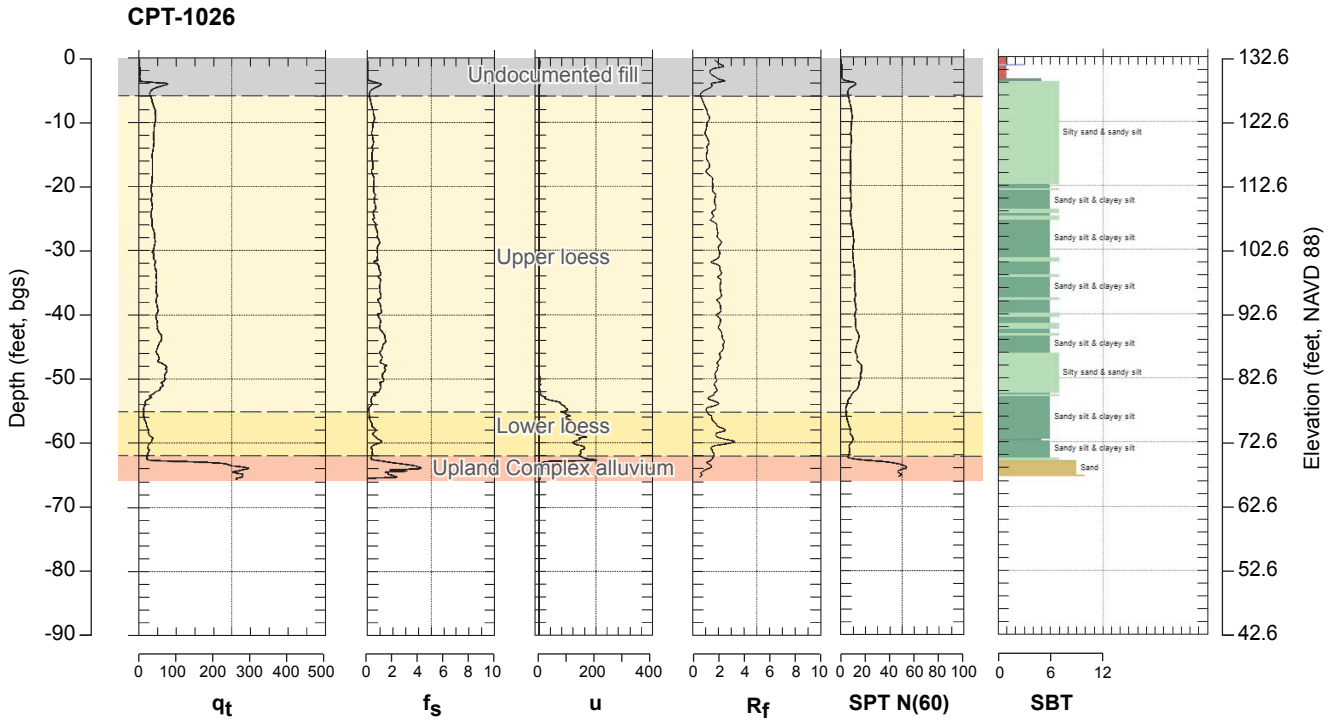


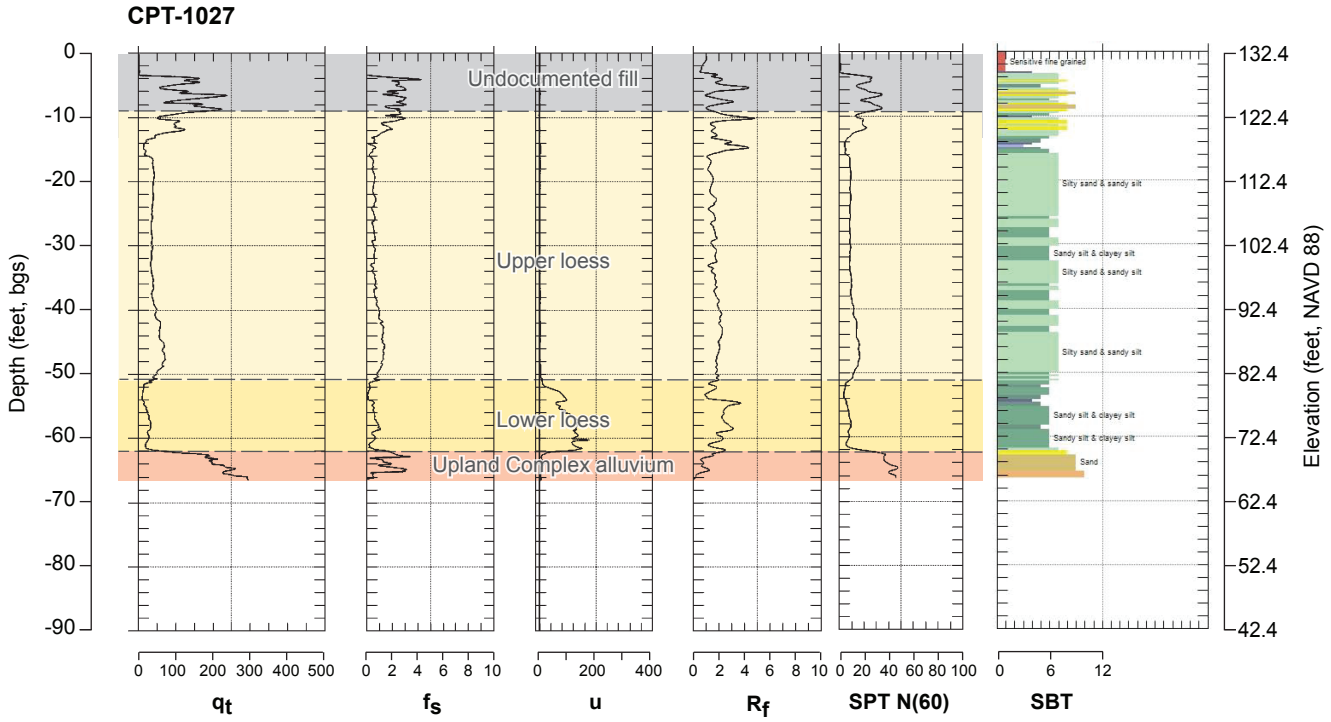
Legend

q_t	Corrected tip resistance (tons/sq. foot)	**SPT N(60)**	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
SBT	Soil behavior type	R_f	Friction ratio (%)
f_s	Sleeve friction (tons/sq. foot)		
u	Dynamic pore pressure (lbs./sq. inch)		

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 12 of 14)

GGNS COL
2.0-26-A



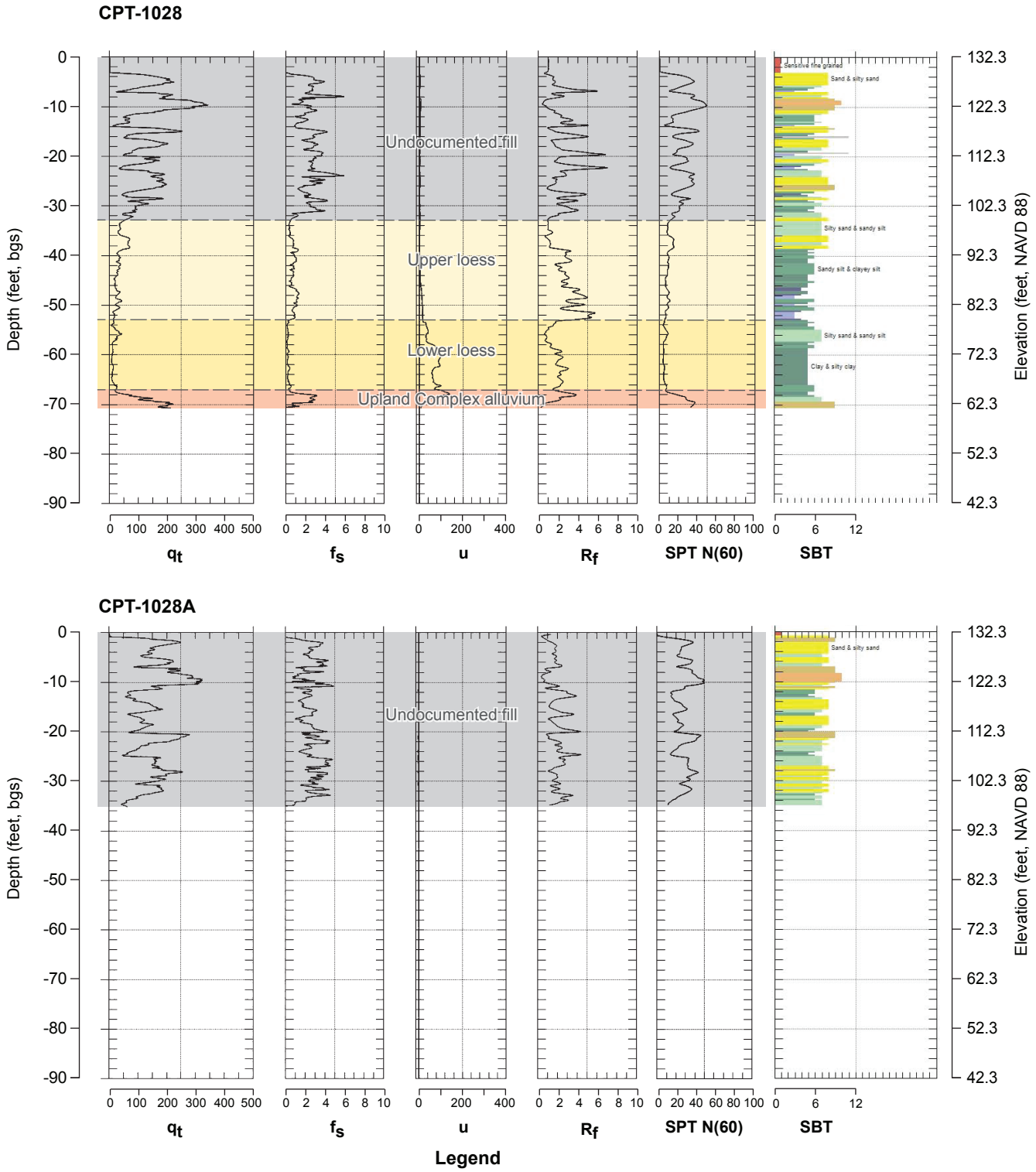


Legend

q_t	Corrected tip resistance (tons/sq. foot)	**SPT N(60)**	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
SBT	Soil behavior type	**R_f**	Friction ratio (%)
f_s	Sleeve friction (tons/sq. foot)		
u	Dynamic pore pressure (bs./sq. inch)		

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 13 of 14)

GGNS COL
2.0-26-A

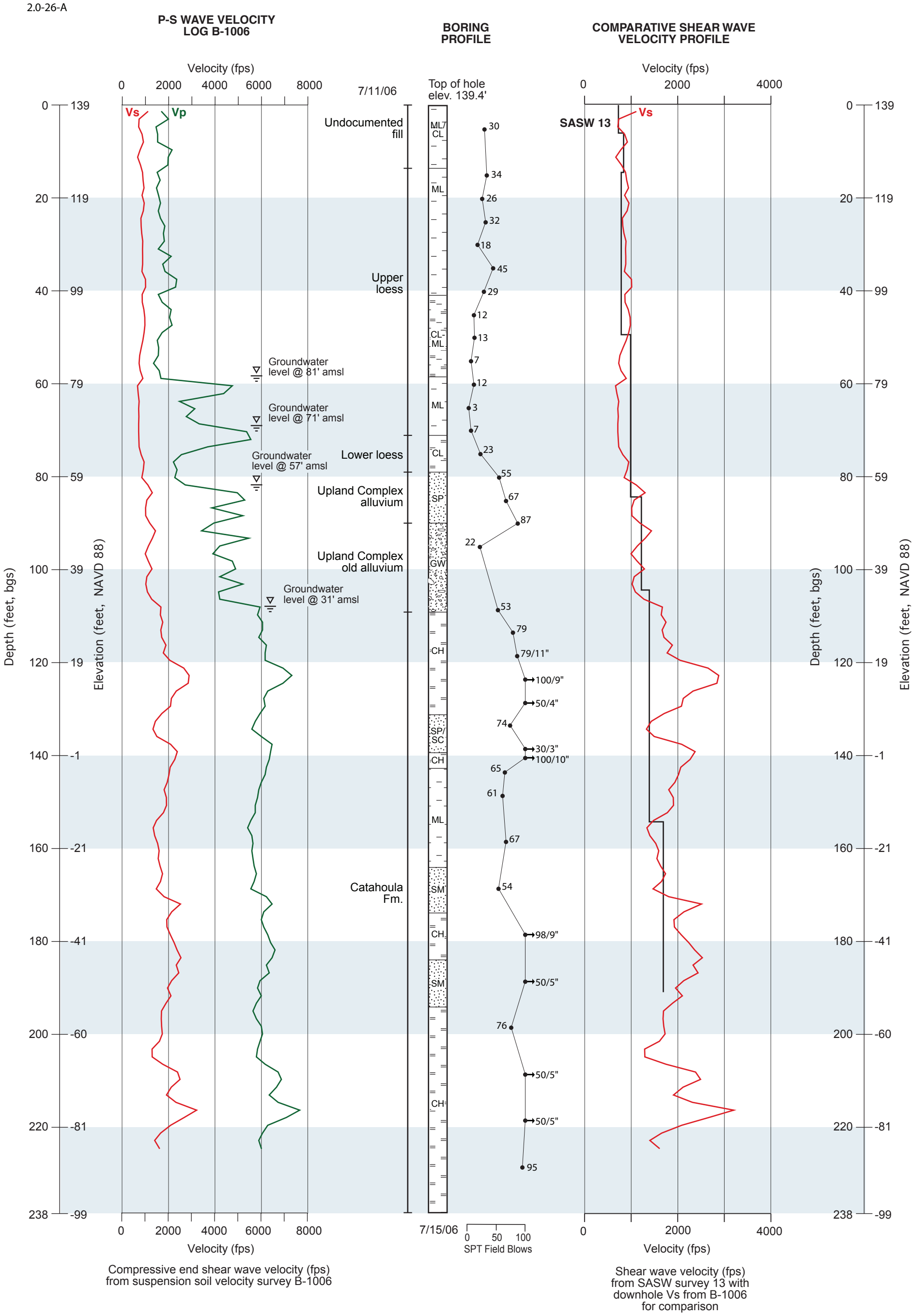


Legend

q_t	Corrected tip resistance (tons/sq. foot)	**SPT N(60)**	Standard Penetration Test N-value at 60% energy calculated from qt/N ratios assigned to each SBT zone
SBT	Soil behavior type	R_f	Friction ratio (%)
f_s	Sleeve friction (tons/sq. foot)		
u	Dynamic pore pressure (lbs./sq. inch)		

Figure 2.5.1-203. Cone Penetrometer Test Summary Logs (Sheet 14 of 14)

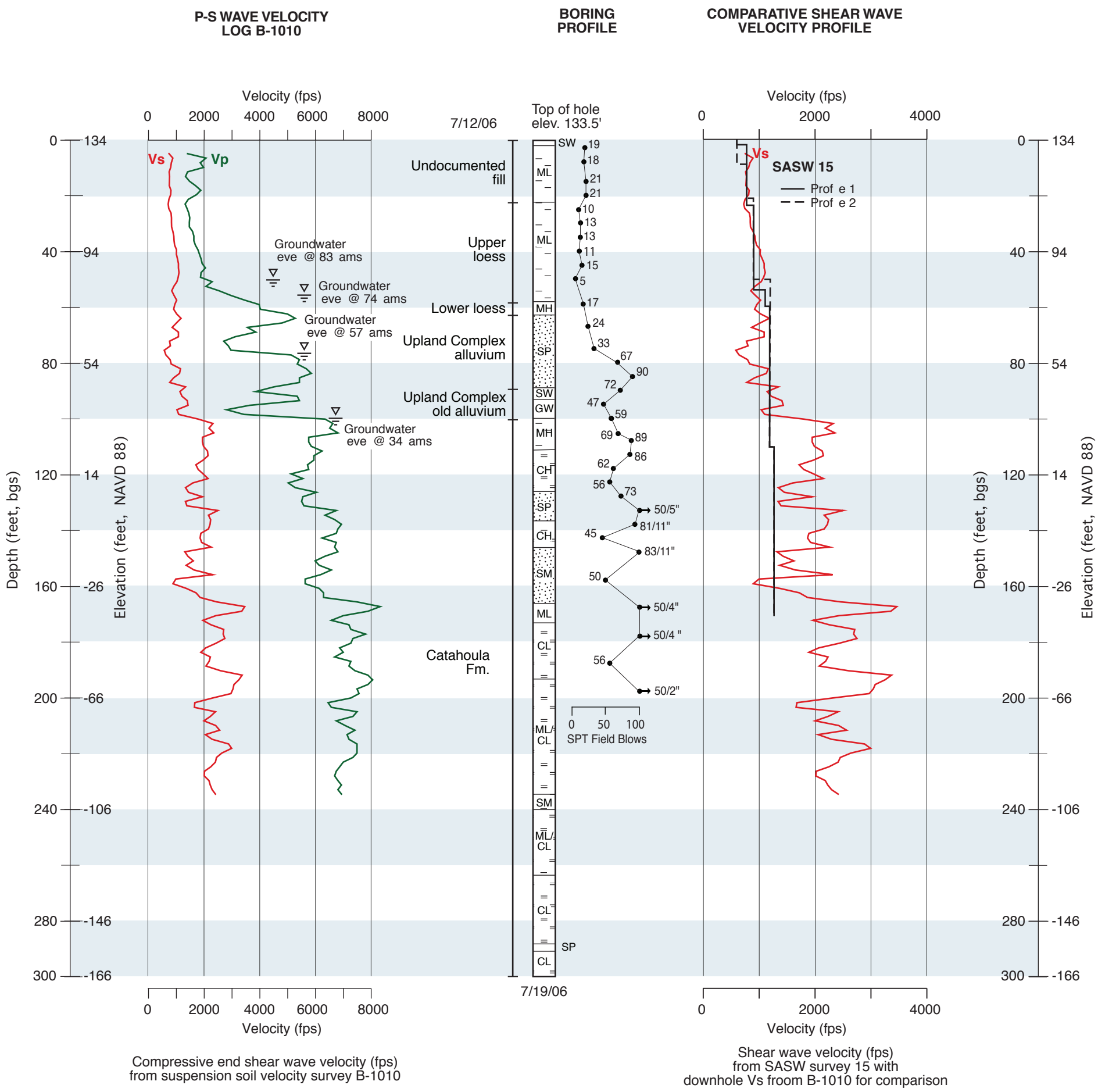
GGNS COL
2.0-26-A



Notes: 1. Groundwater levels interpreted from geophysical log.
2. SPT field blows are uncorrected n-values.

Figure 2.5.1-204. Borehole Summary Sheet B-1006

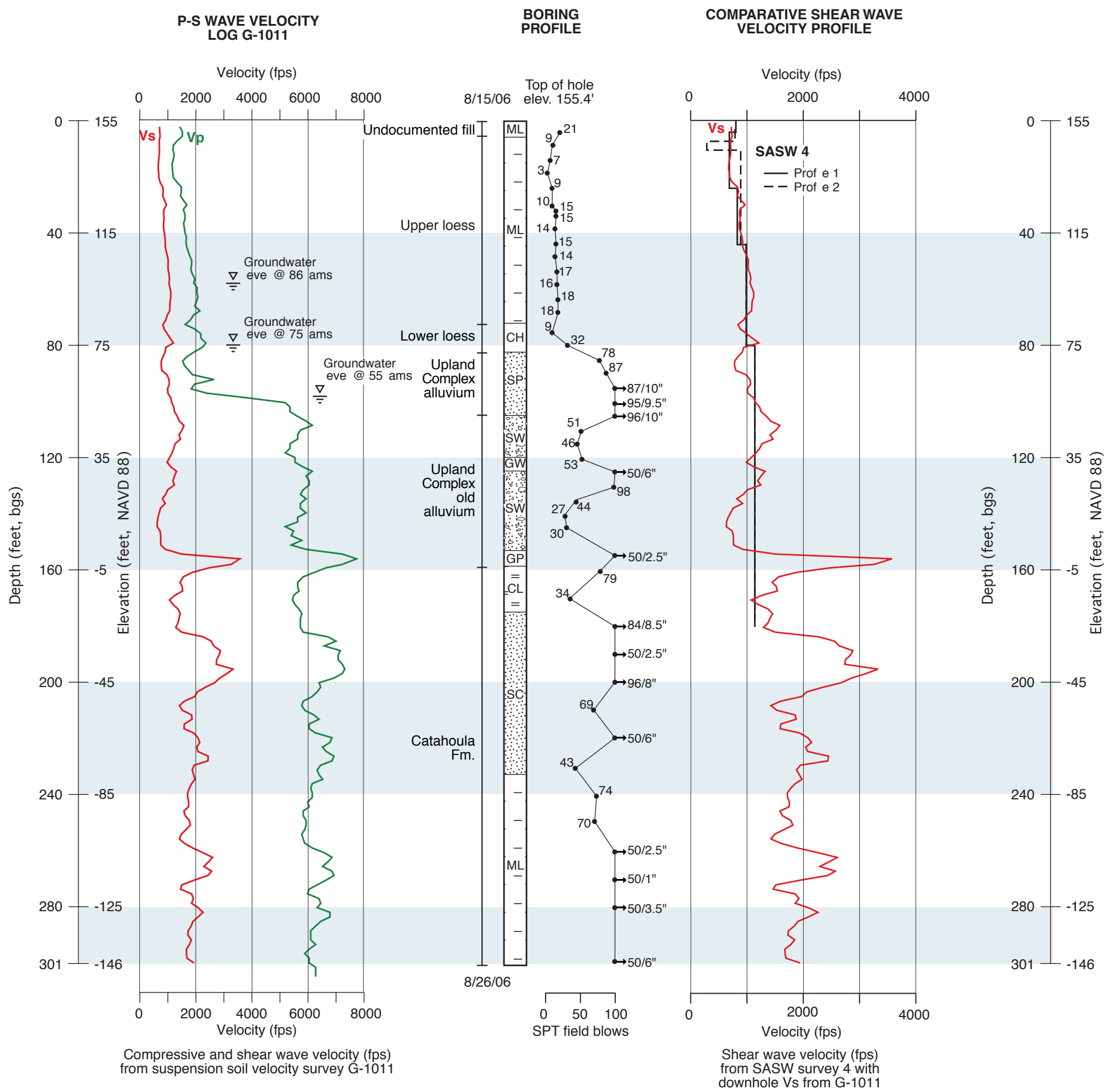
GGNS COL
2.0-26-A



Notes: 1. Groundwater levels interpreted from geophysical log.
2. SPT field blows are uncorrected n-values.

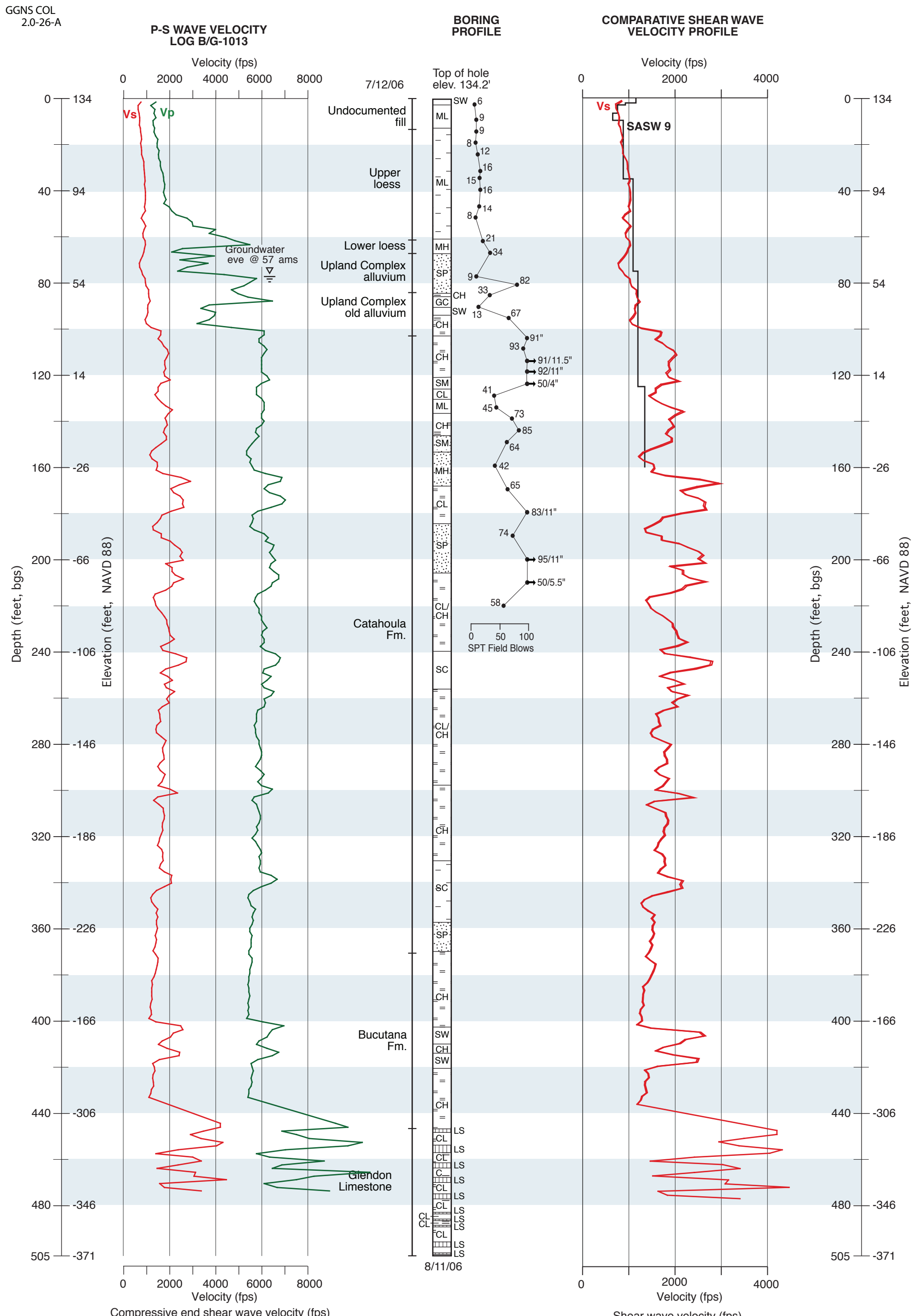
Figure 2.5.1-205. Borehole Summary Sheet B-1010

GGNS COL
2.0-26-A



Notes: 1. Groundwater levels interpreted from geophysical log.
2. SPT field blows are uncorrected n-values.

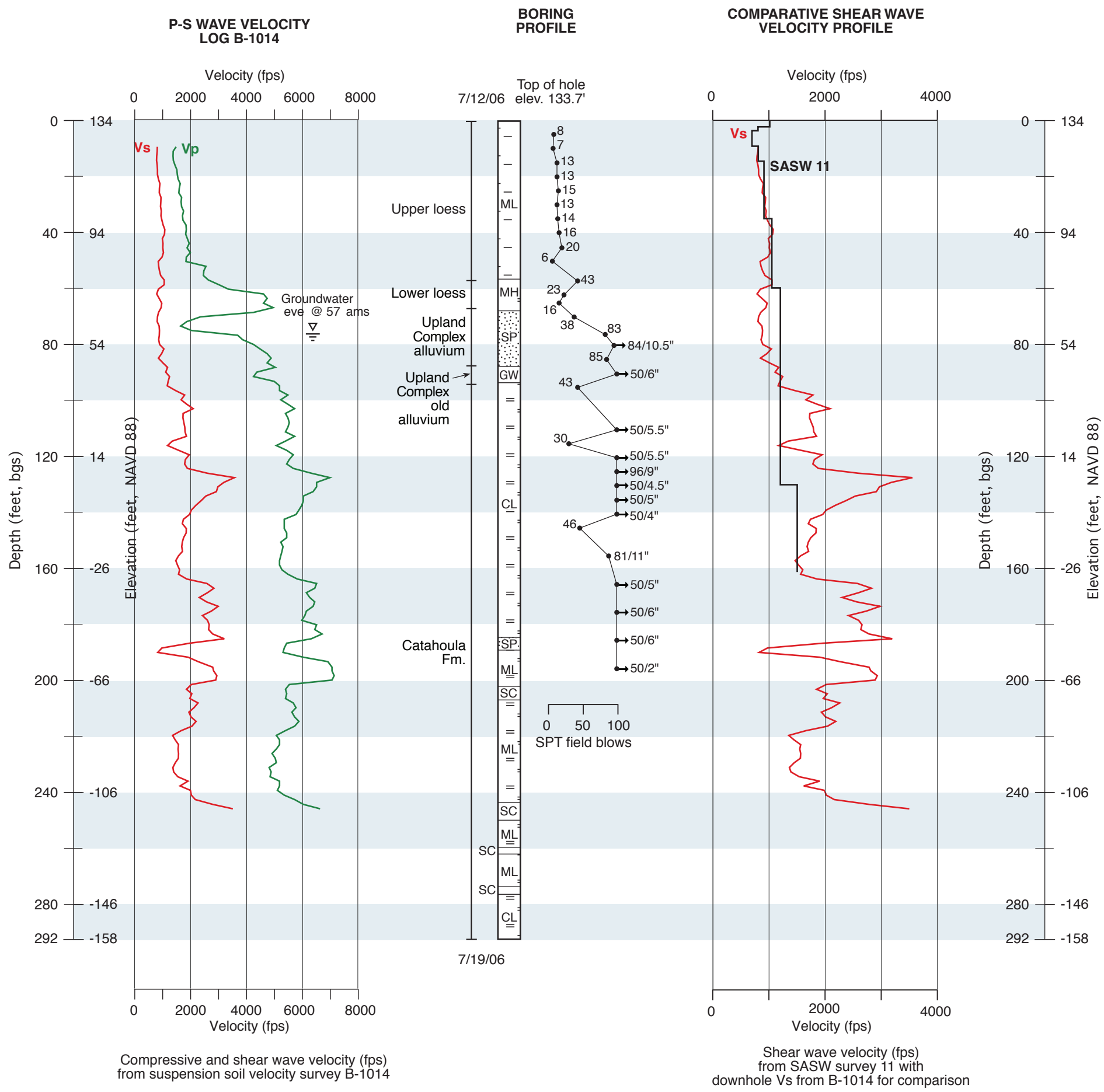
Figure 2.5.1-206. Borehole Summary Sheet B-1011



Notes: 1. Groundwater levels interpreted from geophysical log.
2. SPT field blows are uncorrected n-values.

Figure 2.5.1-207. Borehole Summary Sheet B-1013

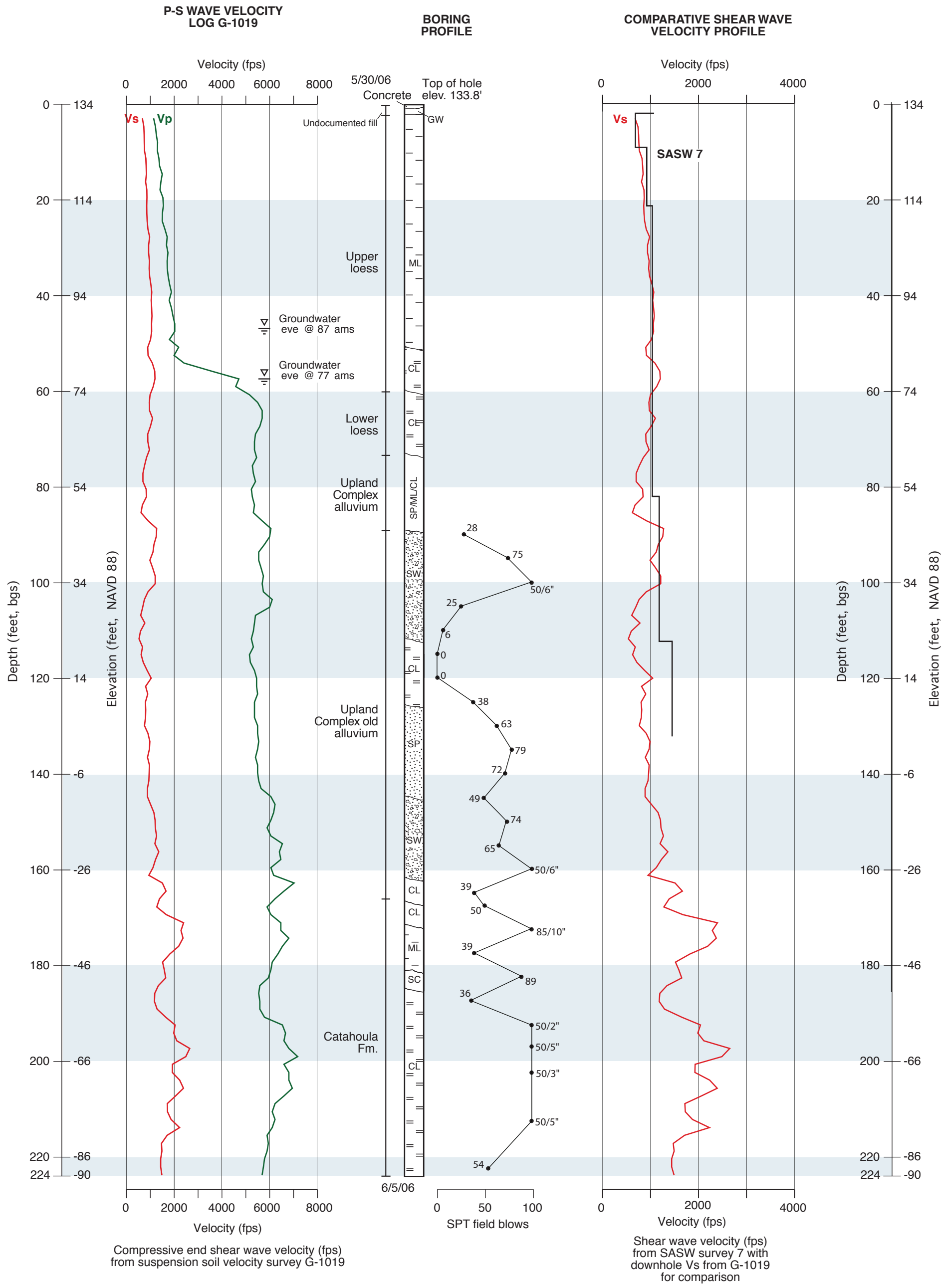
GGNS COL
2.0-26-A



Notes: 1. Groundwater levels interpreted from geophysical log.
2. SPT field blows are uncorrected n-values.

Figure 2.5.1-208. Borehole Summary Sheet B-1014

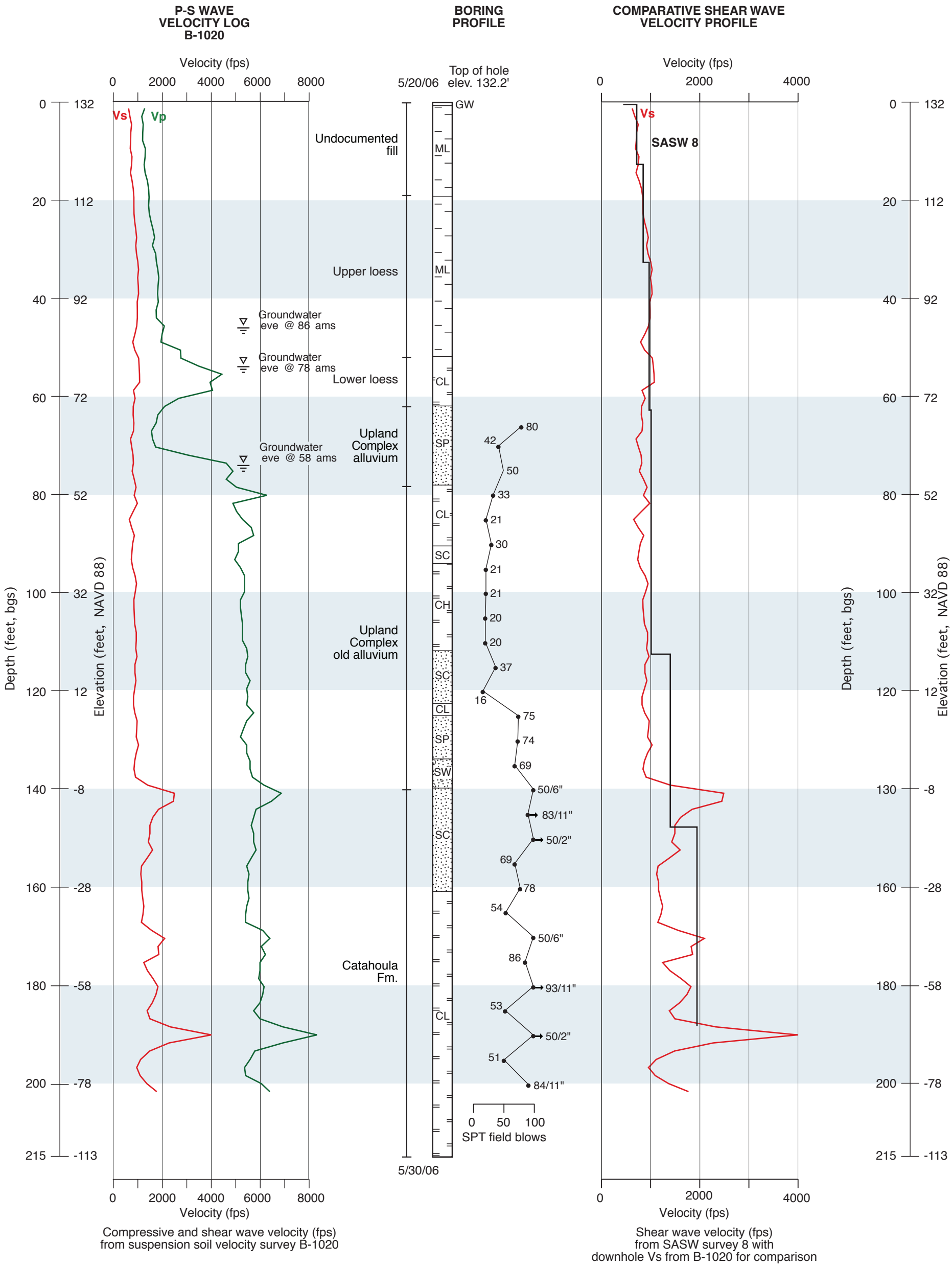
GGNS COL
2.0-26-A



Notes: 1. Groundwater levels interpreted from geophysical log.
2. SPT field blows are uncorrected n-values.

Figure 2.5.1-209. Borehole Summary Sheet B-1019

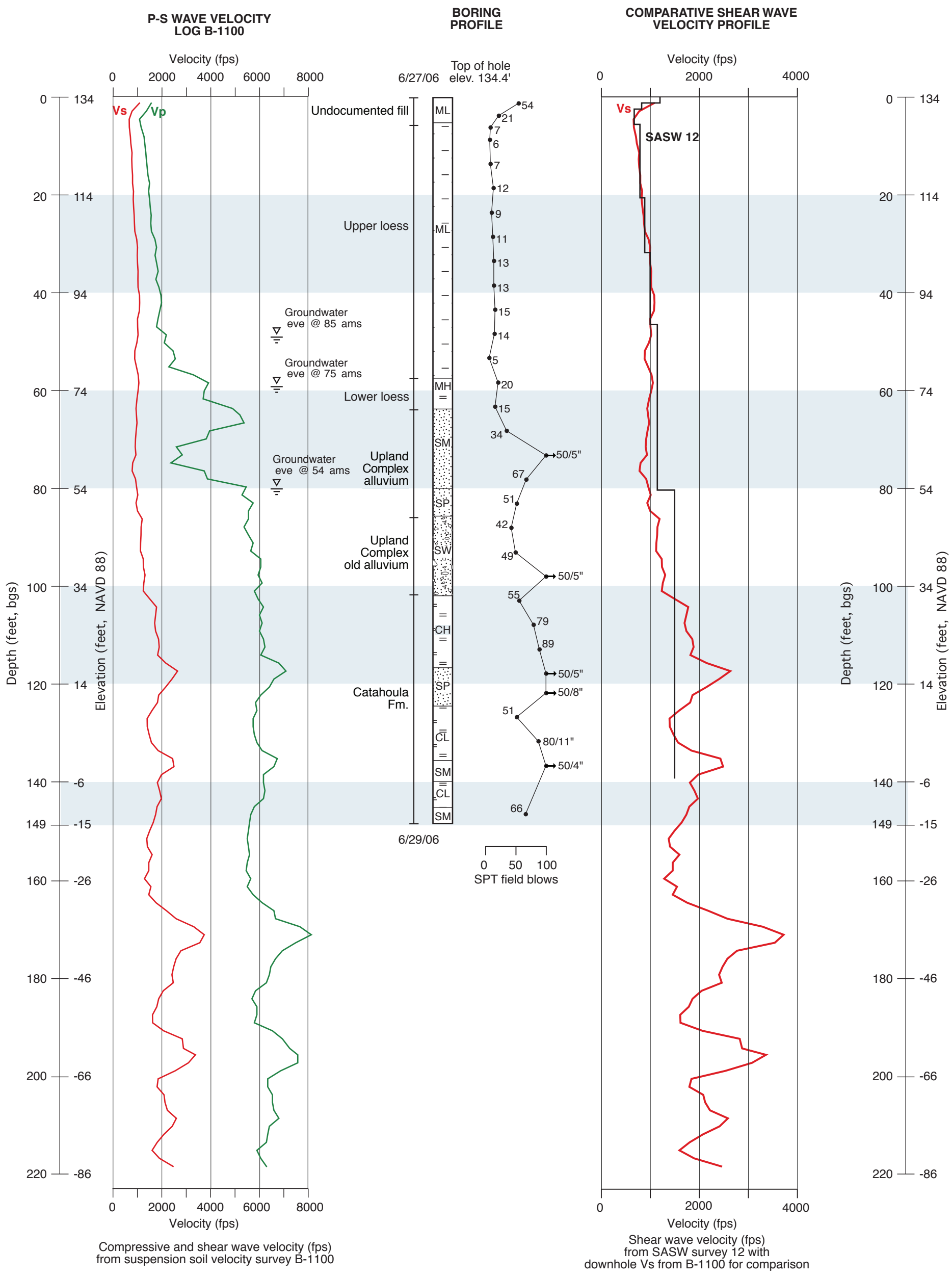
GGNS COL
2.0-26-A



Notes: 1. Groundwater levels interpreted from geophysical log.
2. SPT field blows are uncorrected n-values.

Figure 2.5.1-210. Borehole Summary Sheet B-1020

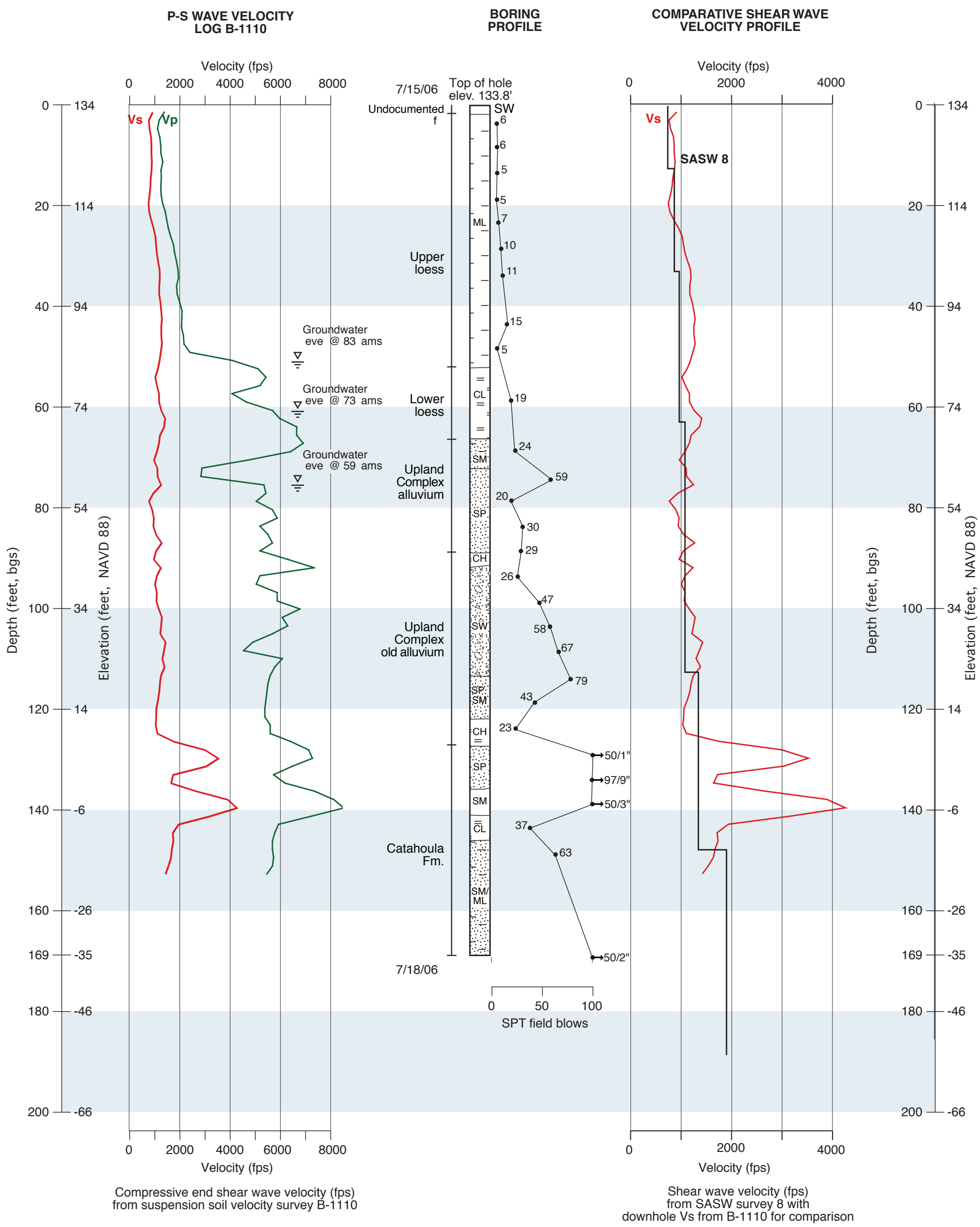
GGNS COL
2.0-26-A



Notes: 1. Groundwater levels interpreted from geophysical log.
2. SPT field blows are uncorrected n-values.

Figure 2.5.1-211. Borehole Summary Sheet B-1100

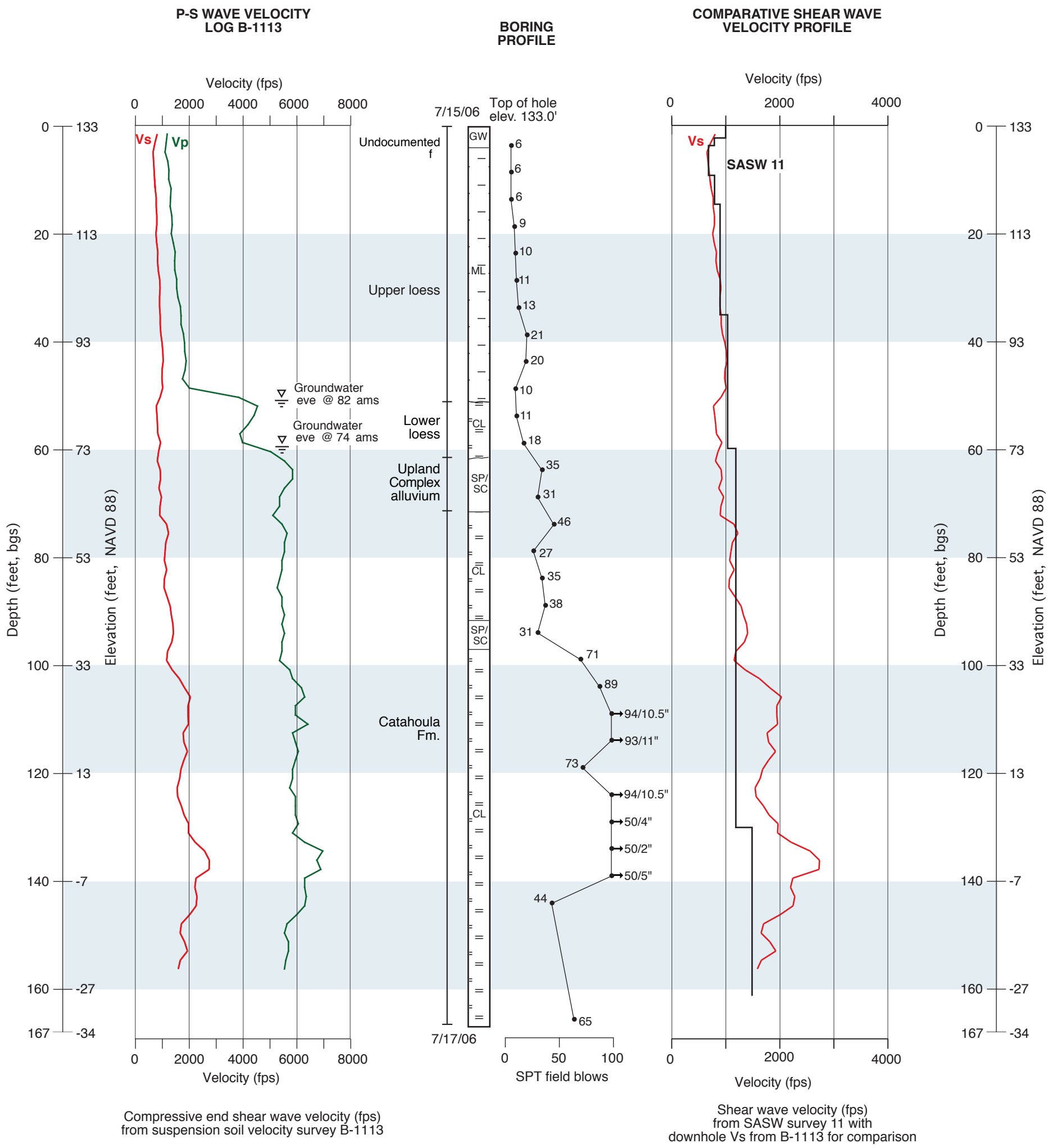
GGNS COL
2.0-26-A



Notes: 1. Groundwater levels interpreted from geophysical log.
2. SPT field blows are uncorrected n-values.

Figure 2.5.1-212. Borehole Summary Sheet B-1110

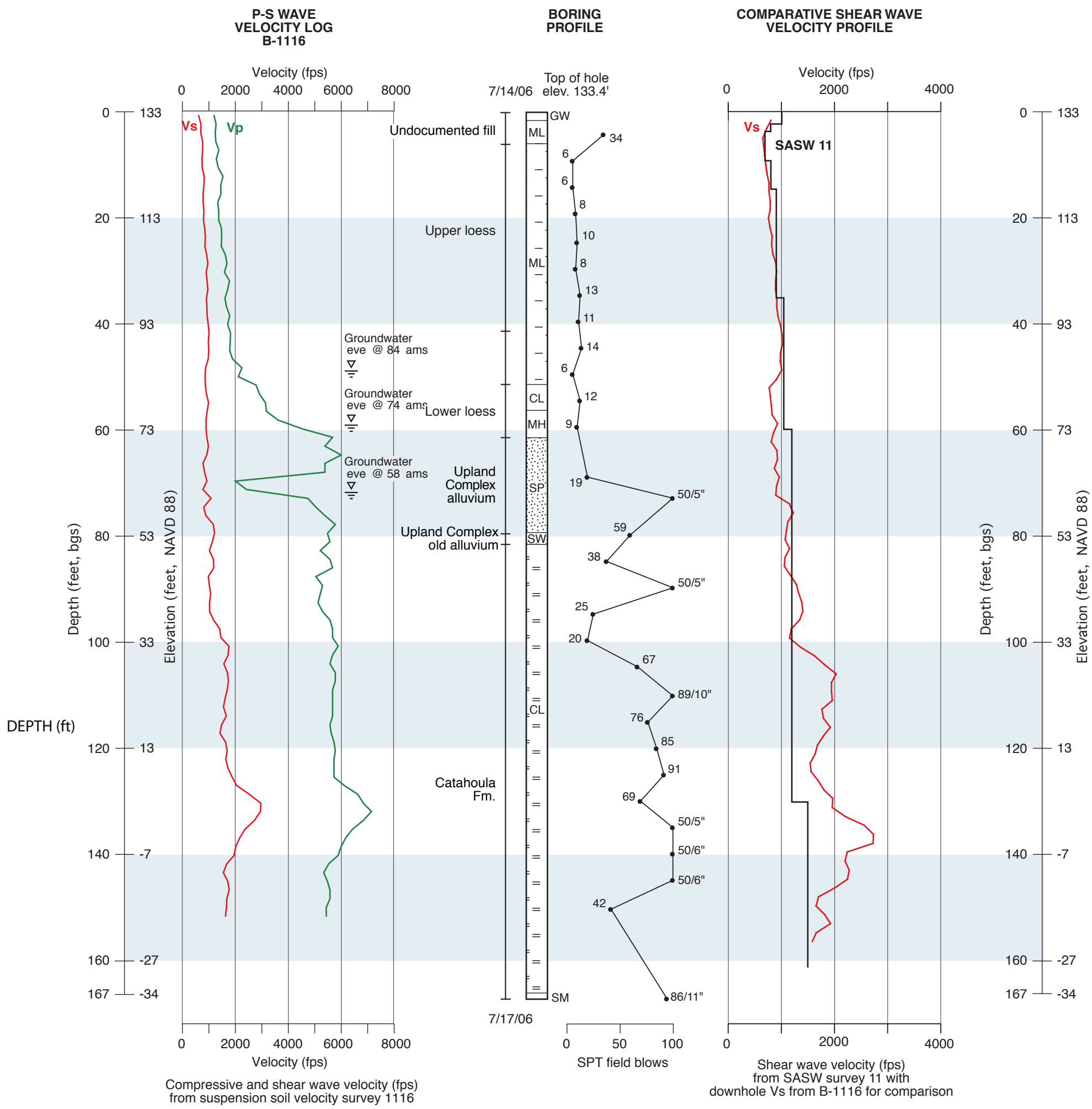
GGNS COL
2.0-26-A



Notes: 1. Groundwater levels interpreted from geophysical log.
2. SPT field blows are uncorrected n-values.

Figure 2.5.1-213. Borehole Summary Sheet B-1113

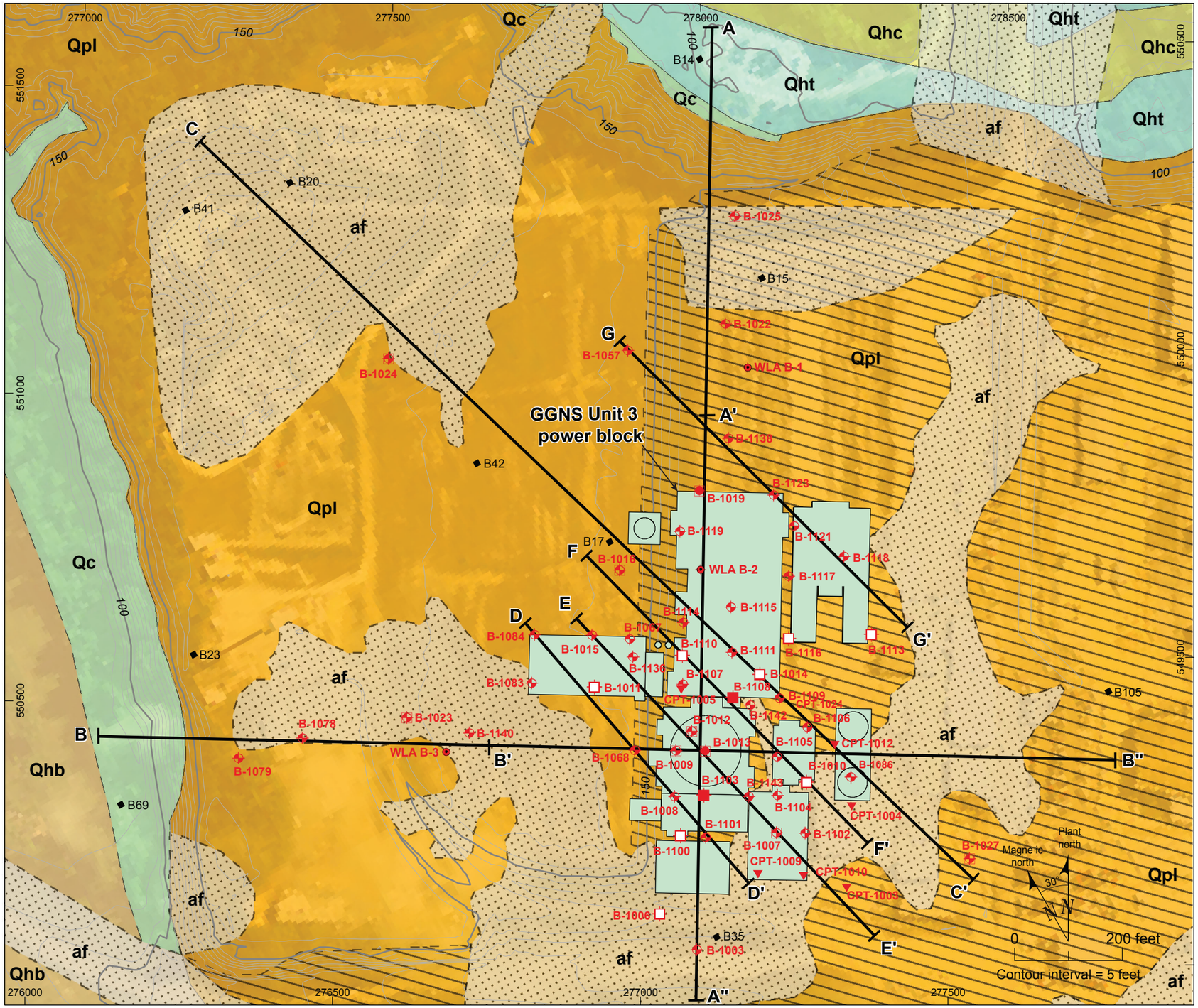
GGNS COL
2.0-26-A



Notes: 1. Groundwater levels interpreted from geophysical log.
2. SPT field blows are uncorrected n-values.

Figure 2.5.1-214. Borehole Summary Sheet B-1116

GGNS COL
2.0-26-A



Legend

Symbols

- B-1119 — Borehole
- B-1025 — Borehole and monitoring well
- B-1019 — Borehole and monitoring well with suspension logging
- B-1103 — Borehole with pressuremeter test
- B-1113 — Borehole with suspension log
- CPT-1009 — Cone penetrometer test
- WLA B-1 — ESP borehole
- B15 — UFSAR borehole
- A — A' — Cross section location
- Geologic contact; solid where accurately located; long dash where approximate; short dash where inferred
- Graded (cut) area

Unit Descriptions

- af — Undocumented fill
- Qhc — Stream deposits
- Qht — Stream terrace deposits
- Qhb — Backswamp deposits
- Qc — Colluvium
- Qpl — Upper loess

Notes: 1. Projection NAD 27 State Plane Mississippi West FIPS.
2. Vertical datum NAVD 88.

Figure 2.5.1-215. Cross Section Location Map A – G

GGNS COL
2.0-26-A

Figure 2.5.1-216. Cross Section Location Map H – L

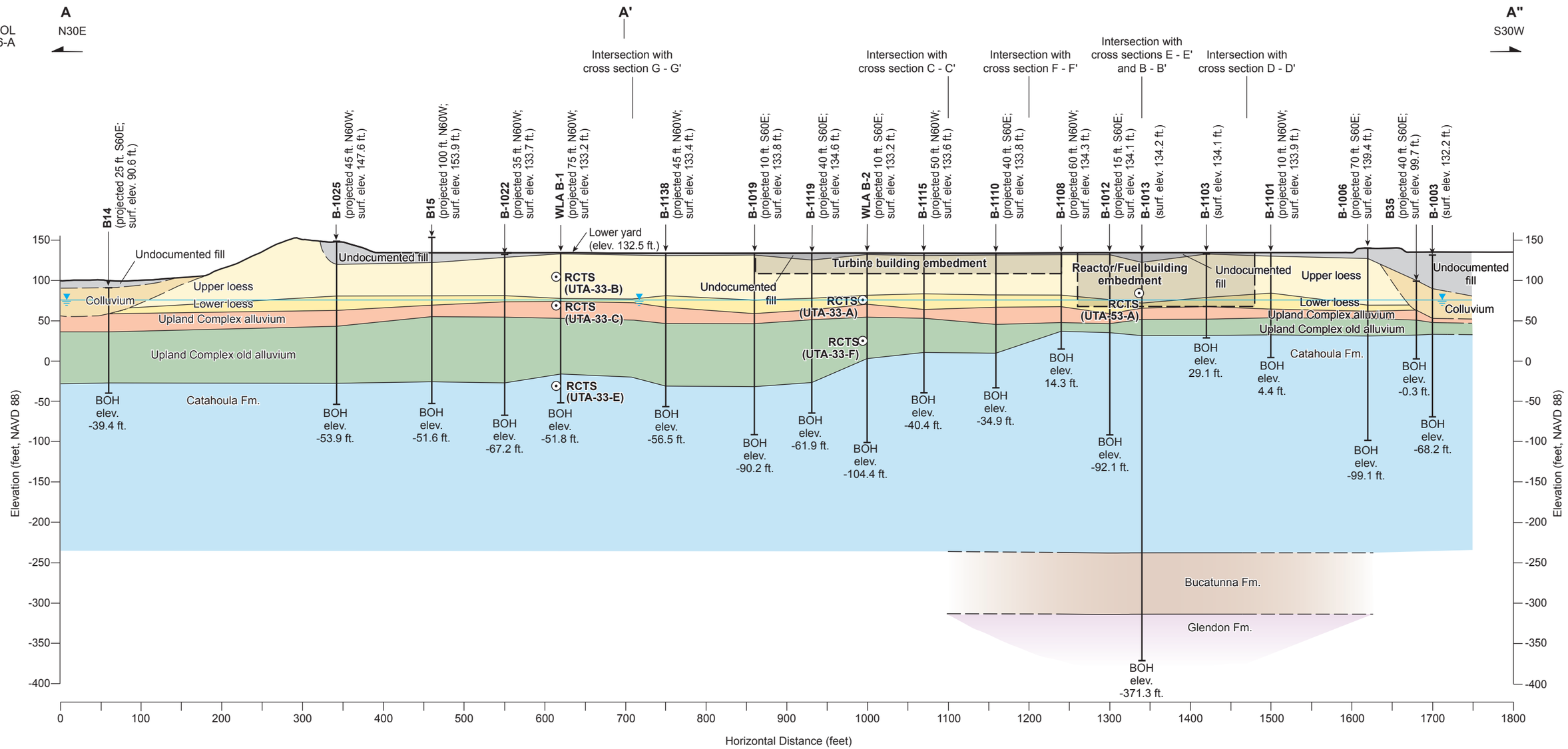


Figure 2.5.1-217. Cross Section A - A"

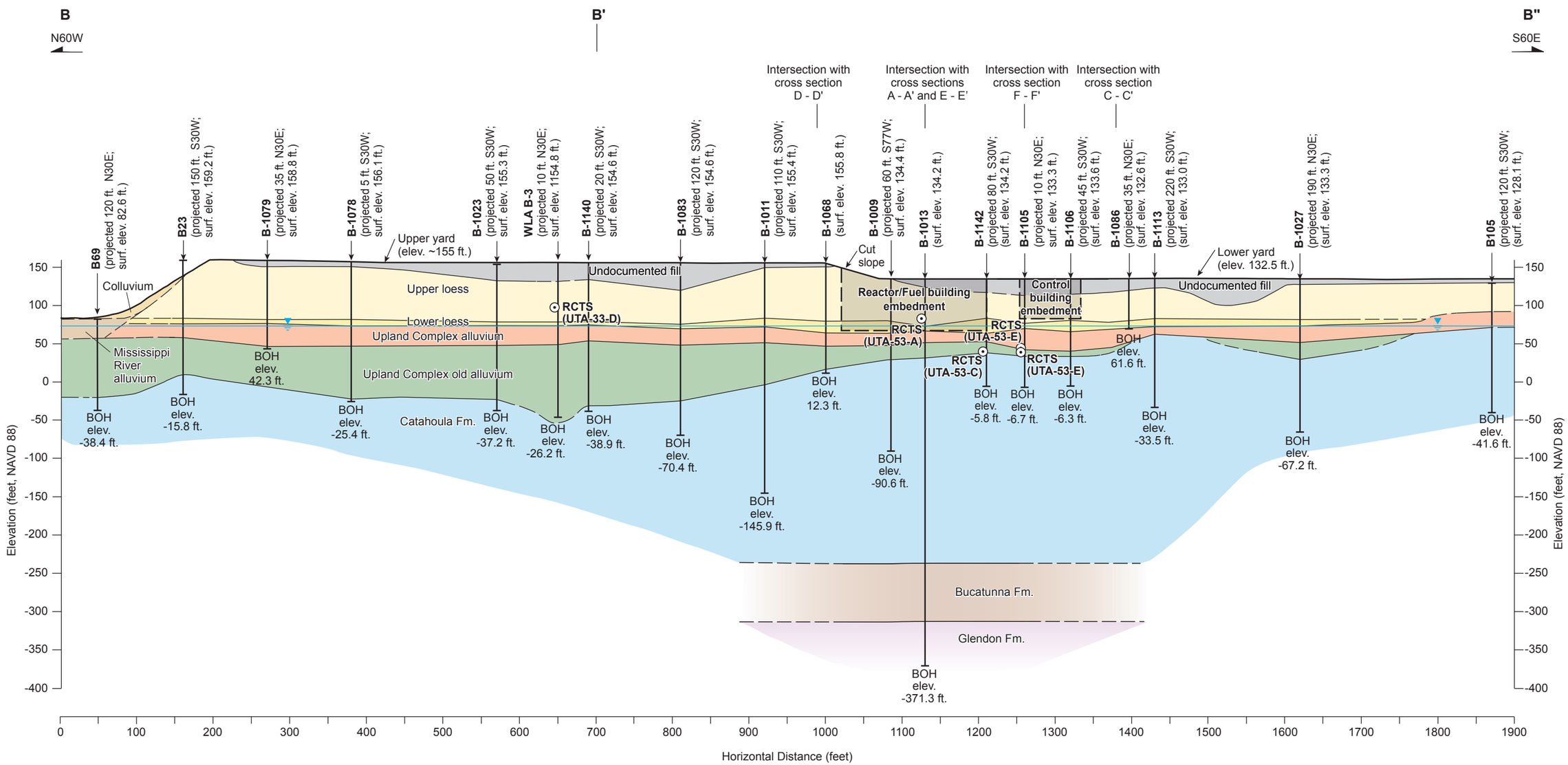


Figure 2.5.1-218. Cross Section B - B"

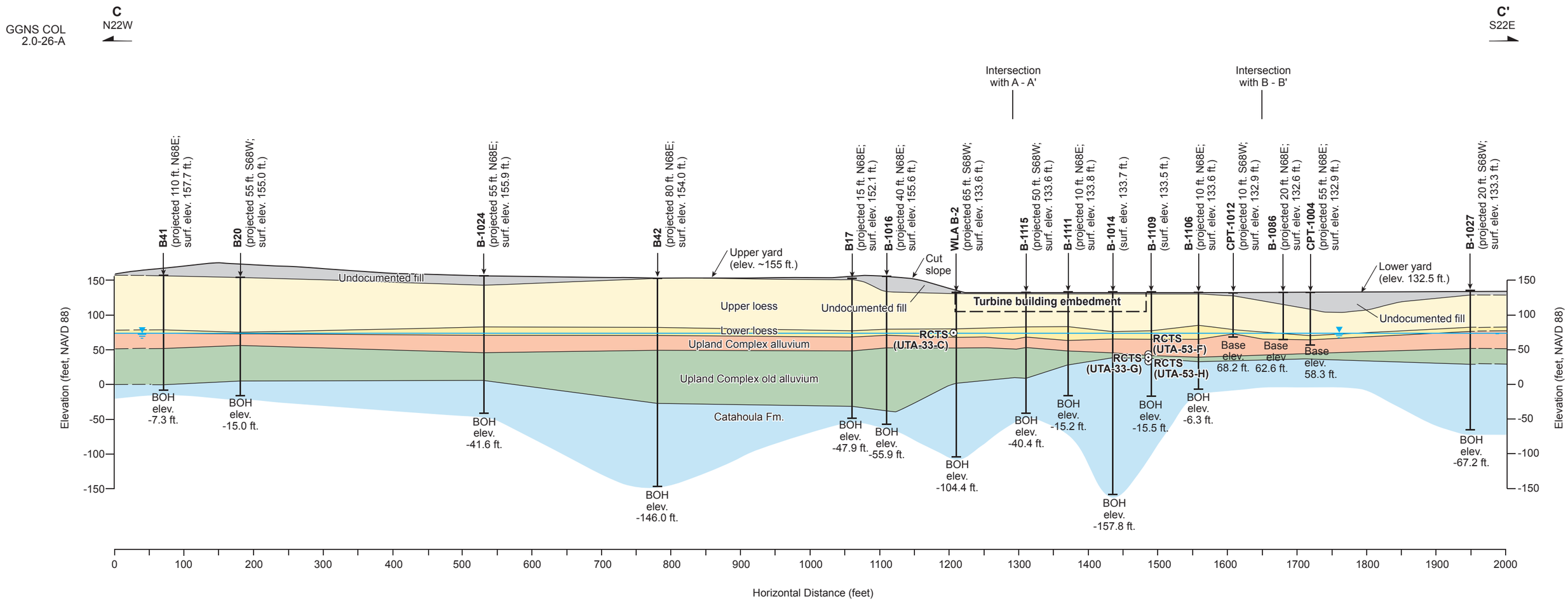


Figure 2.5.1-219. Cross Section C - C'

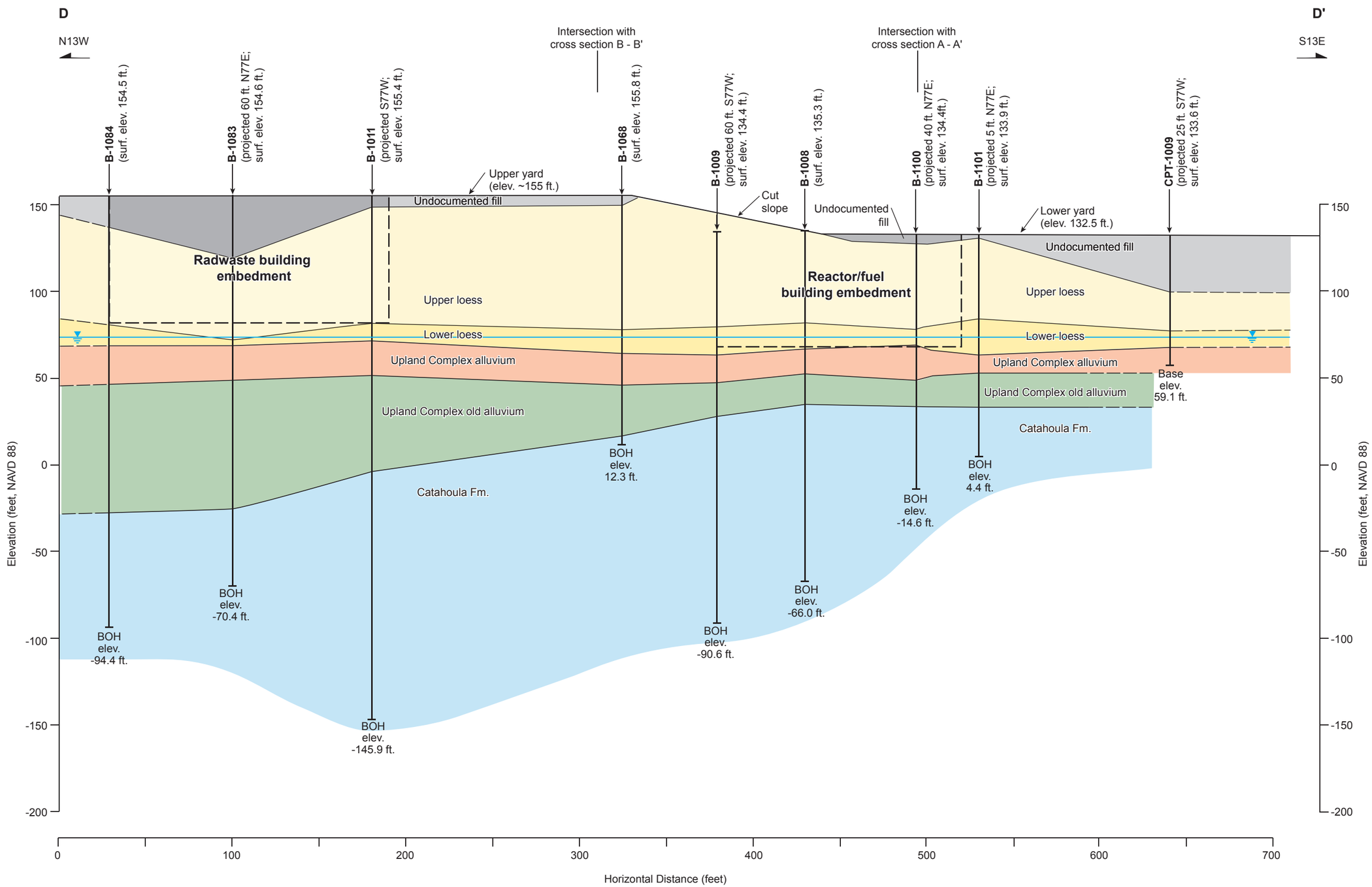


Figure 2.5.1-220. Cross Section D - D'

GGNS COL
2.0-26-A

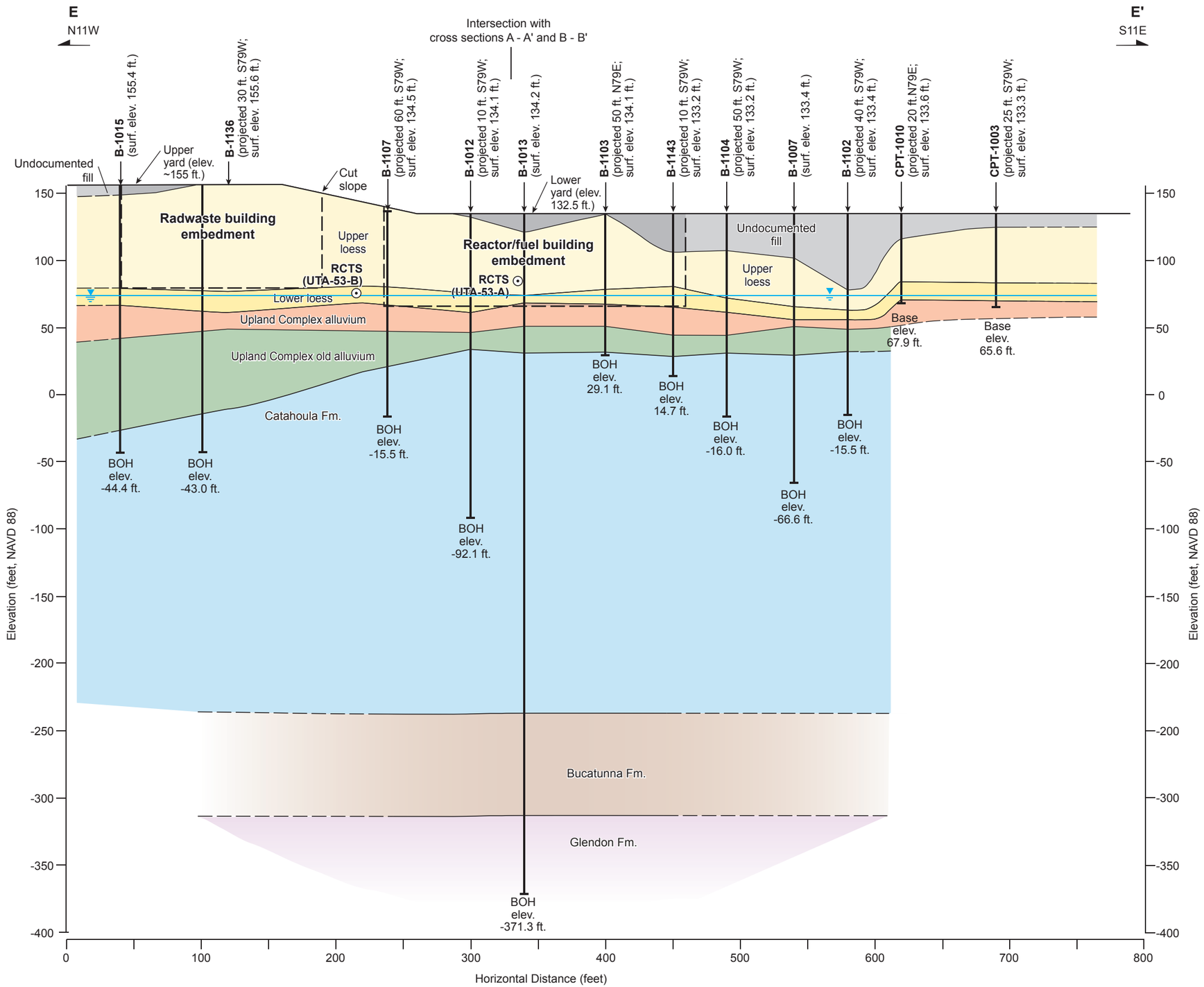


Figure 2.5.1-221. Cross Section E - E'

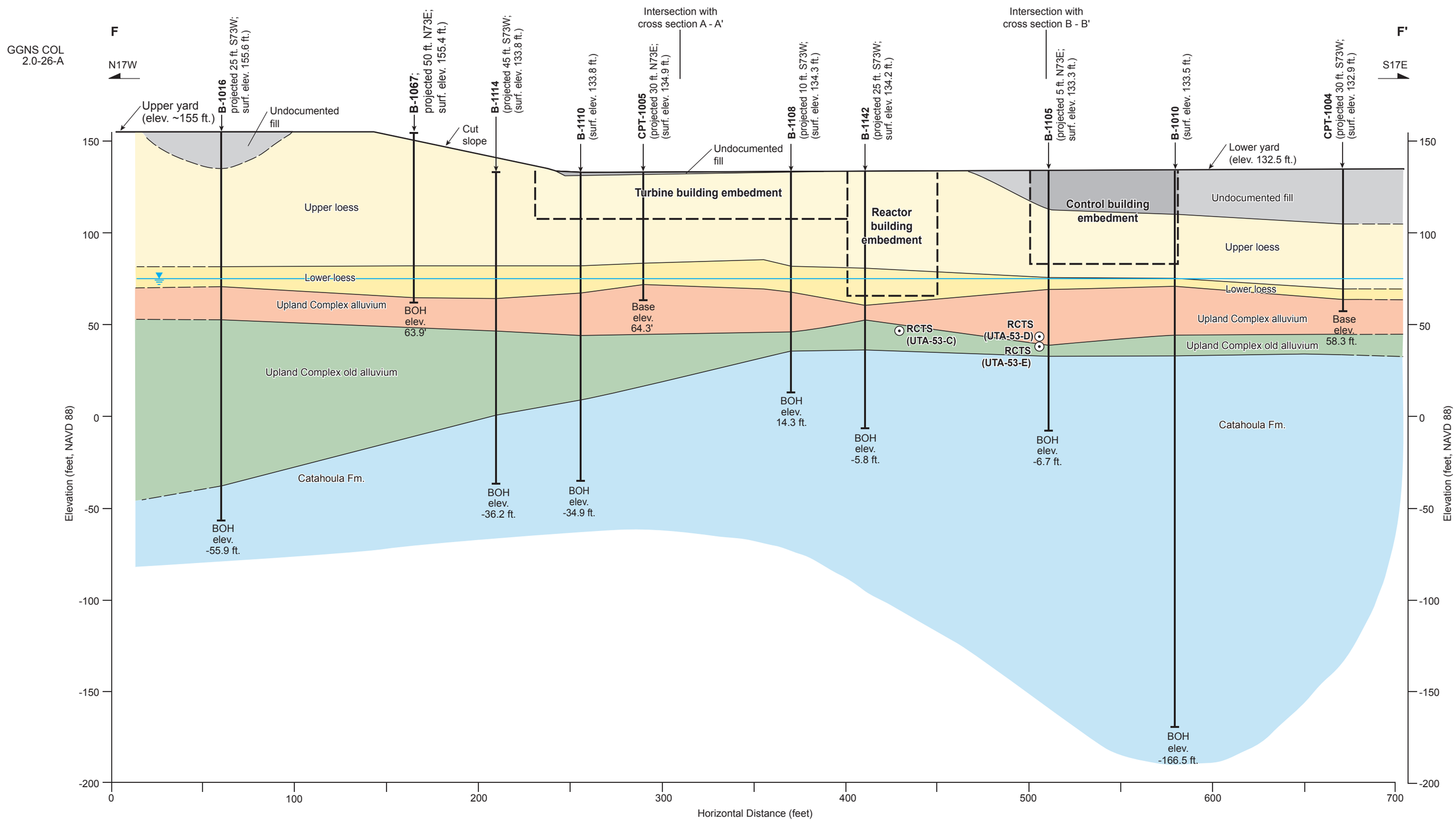


Figure 2.5.1-222. Cross Section F - F'

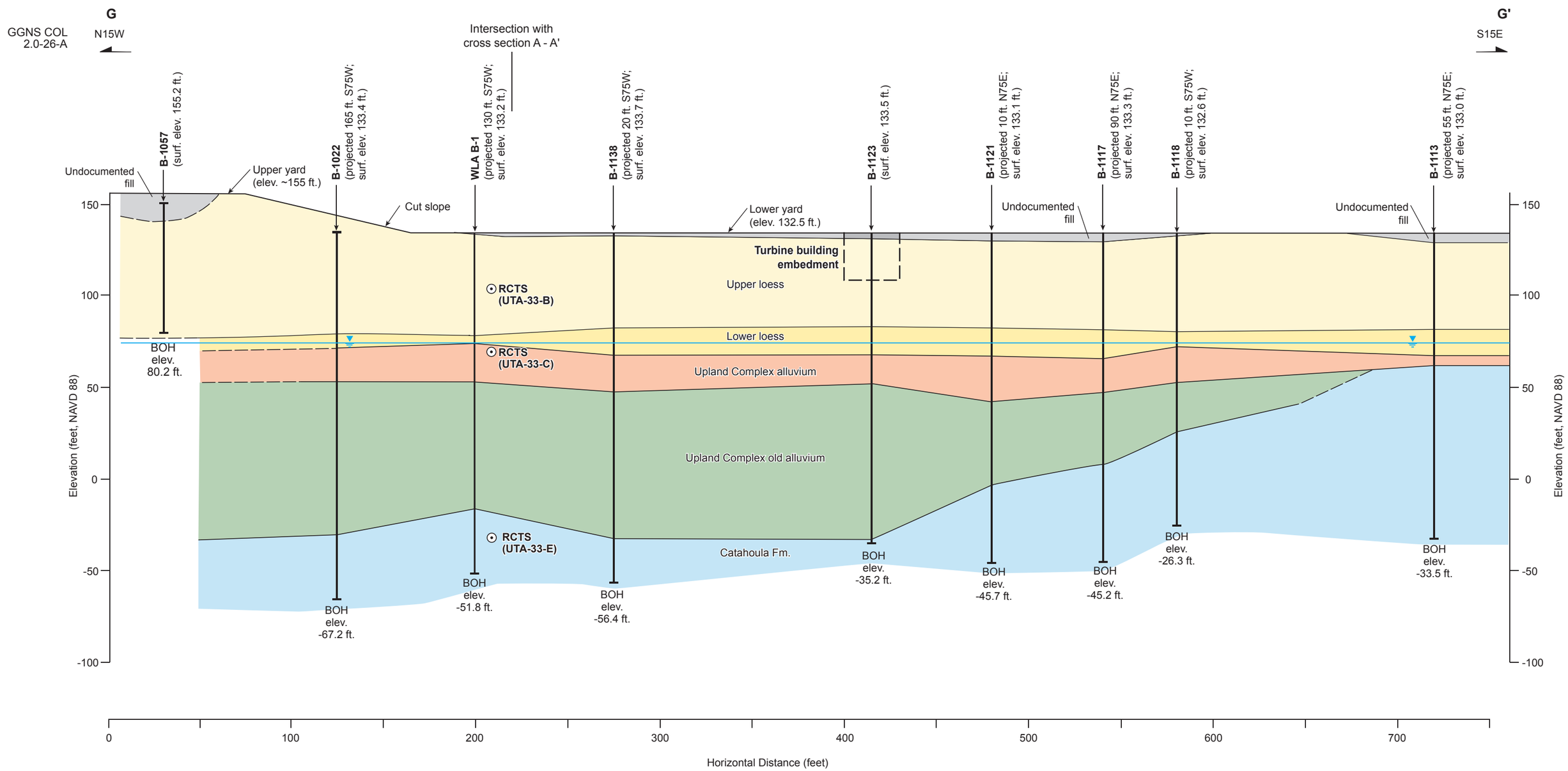


Figure 2.5.1-223. Cross Section G - G'

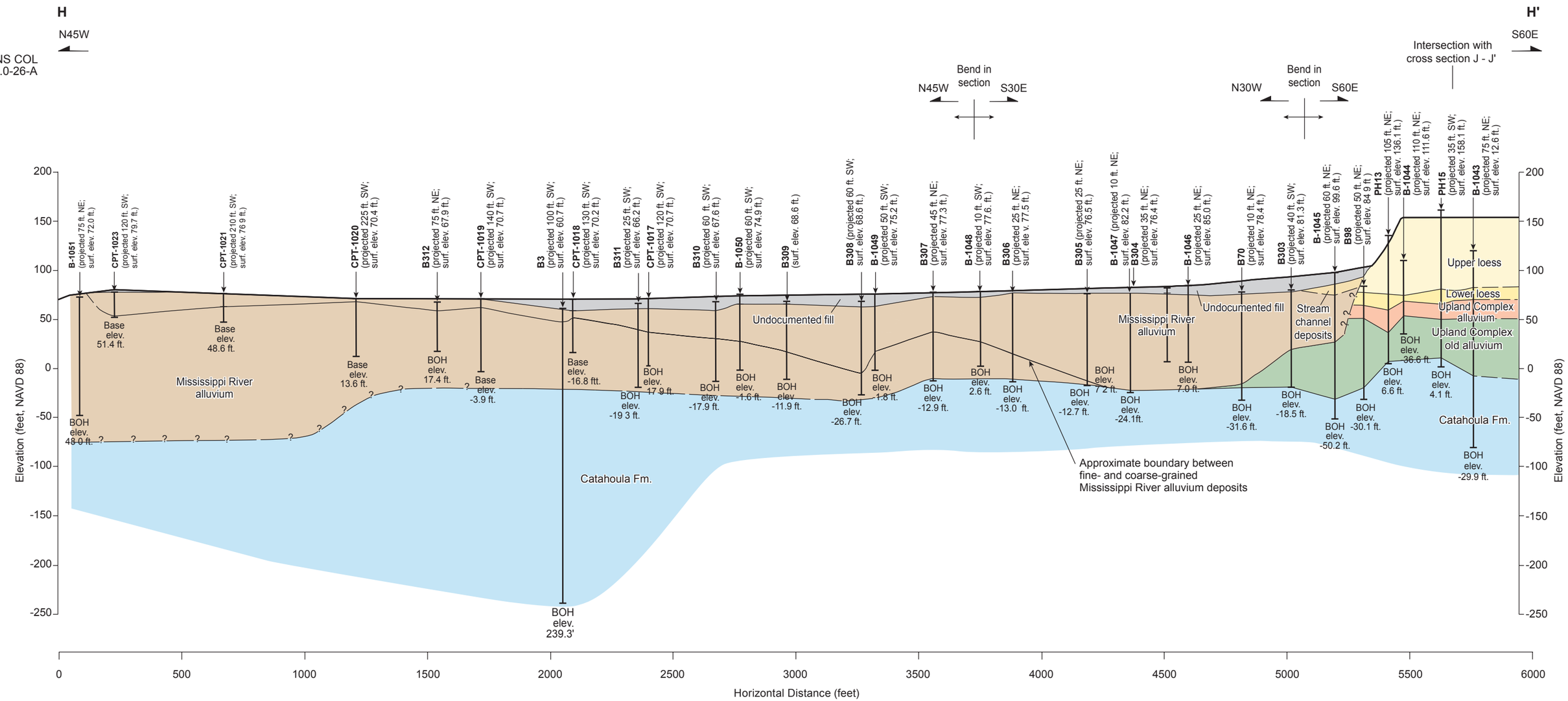


Figure 2.5.1-224. Cross Section H - H'

GGNS COL
2.0-26-A

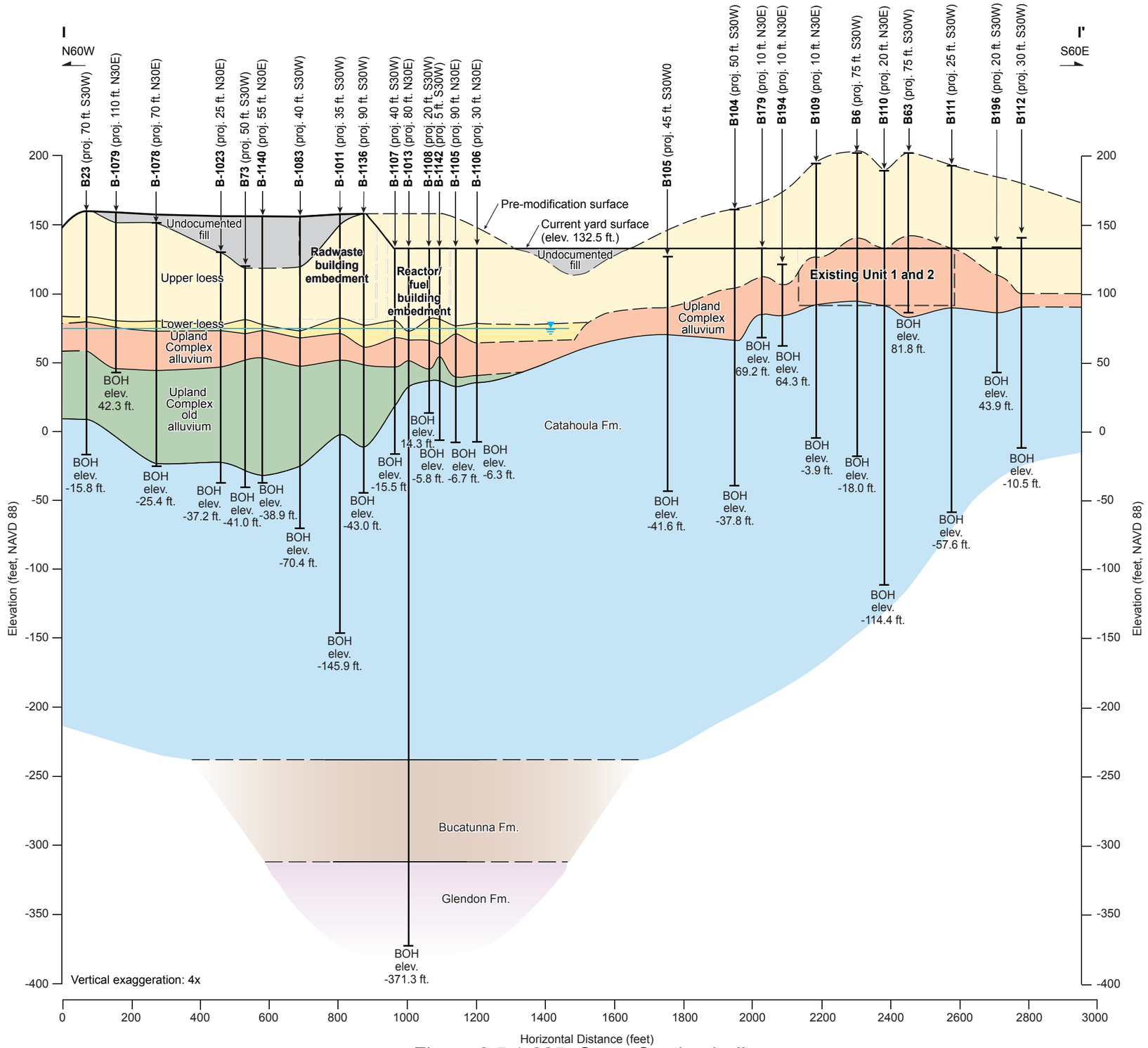


Figure 2.5.1-225. Cross Section I - I'

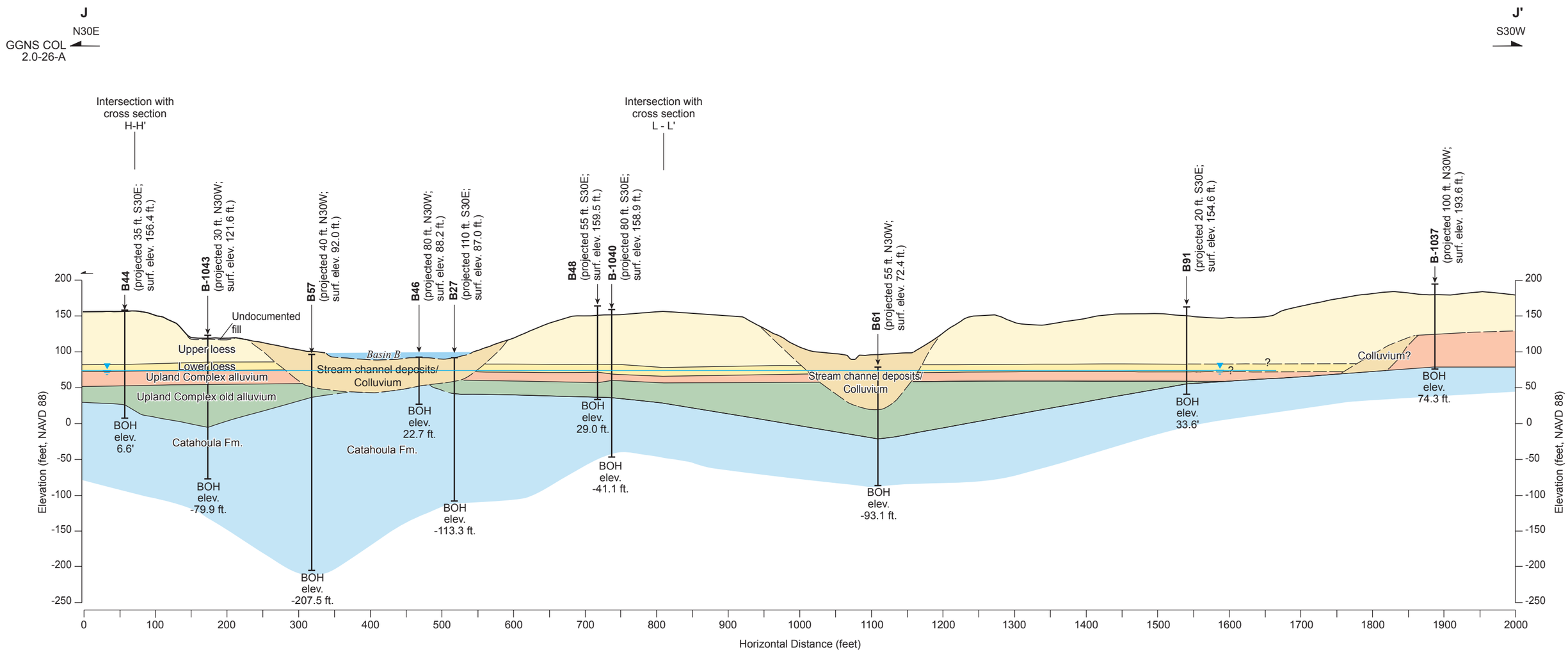


Figure 2.5.1-226. Cross Section J - J'

GGNS COL
2.0-26-A

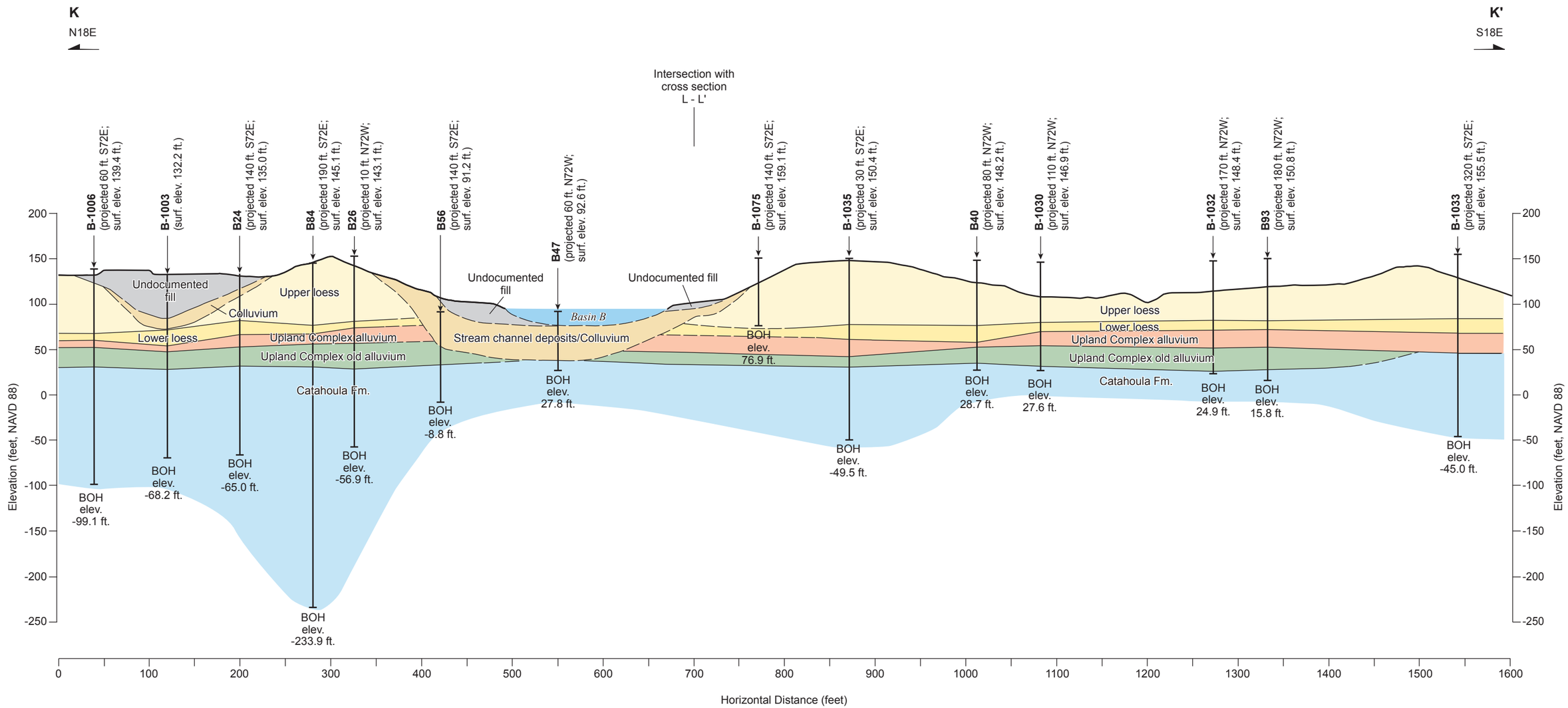


Figure 2.5.1-227. Cross Section K - K'

GGNS COL
2.0-26-A

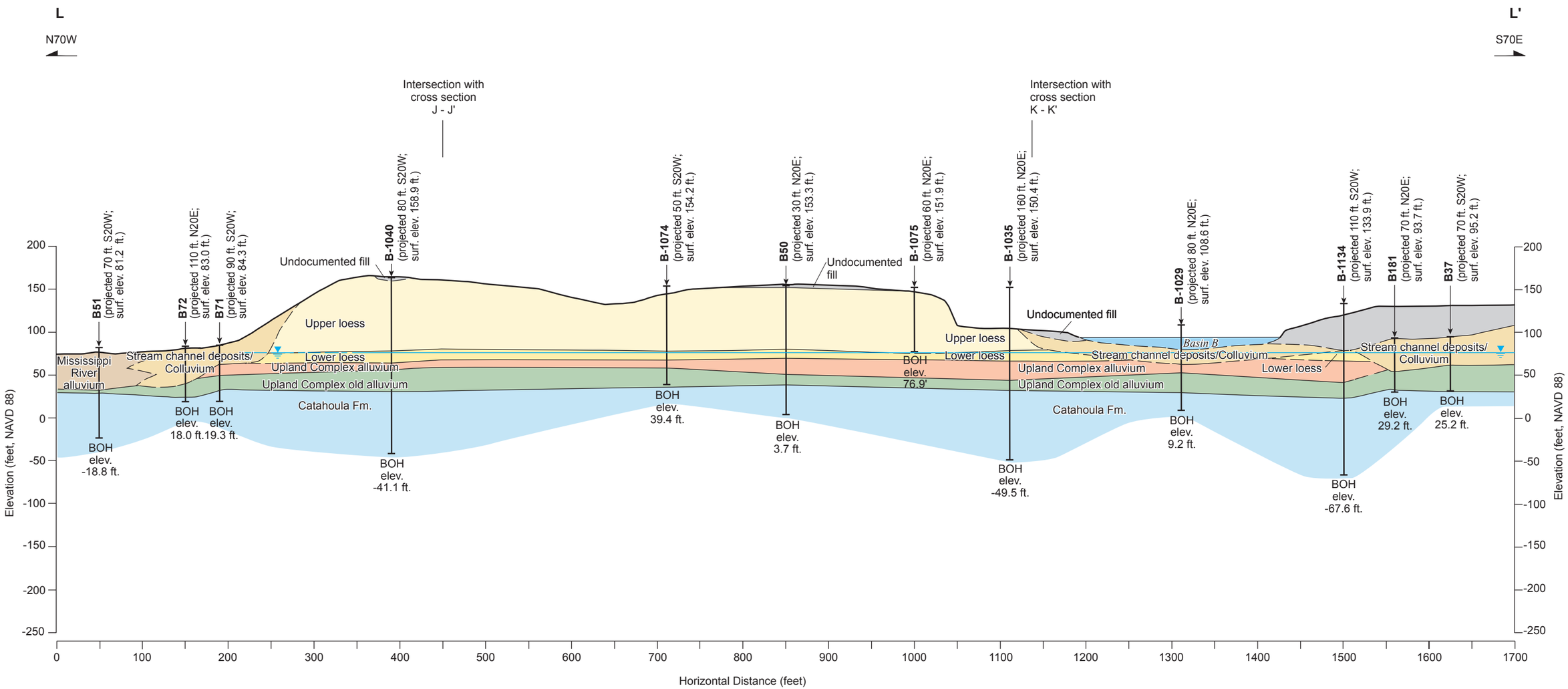
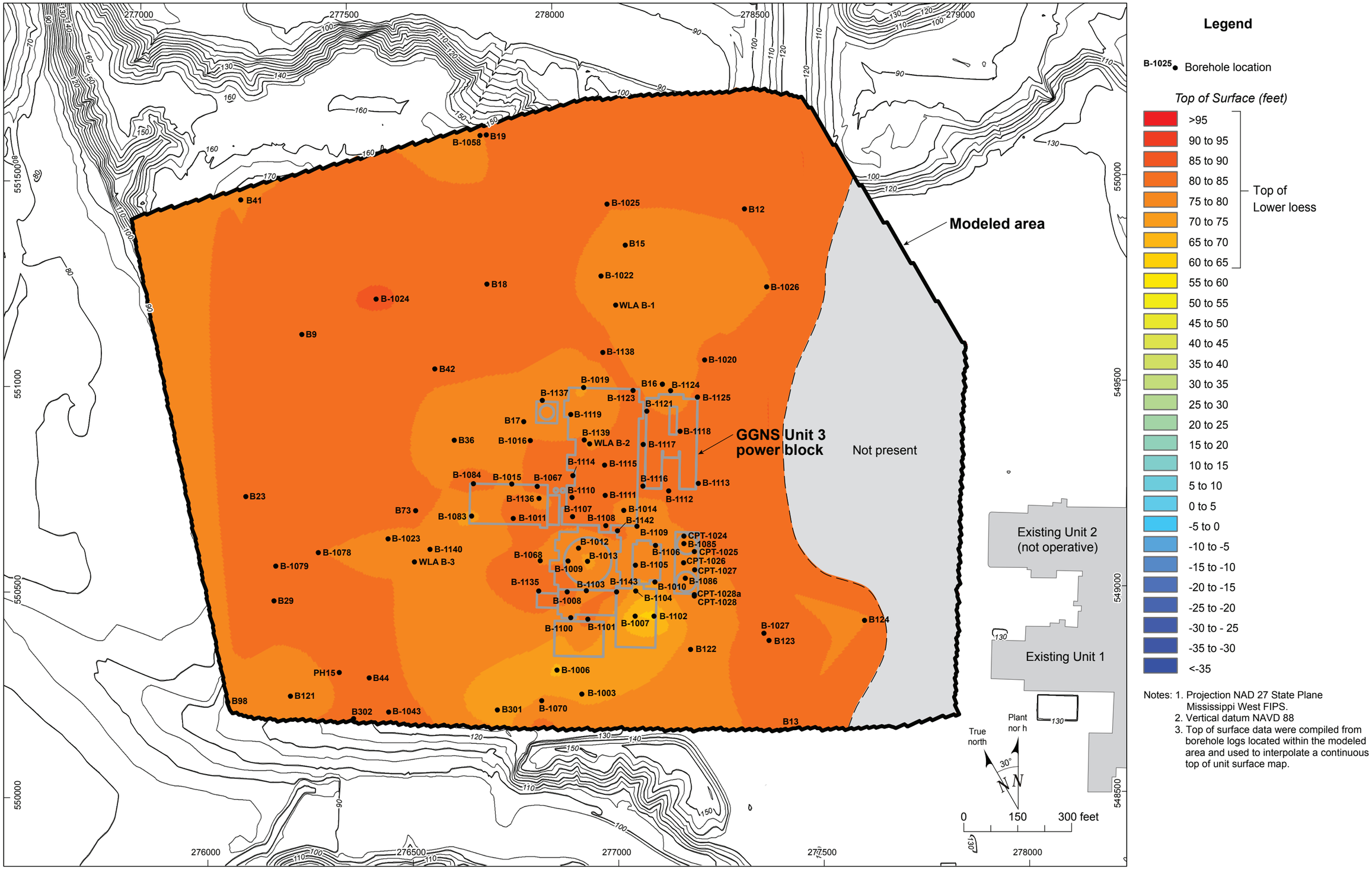


Figure 2.5.1-228. Cross Section L - L'

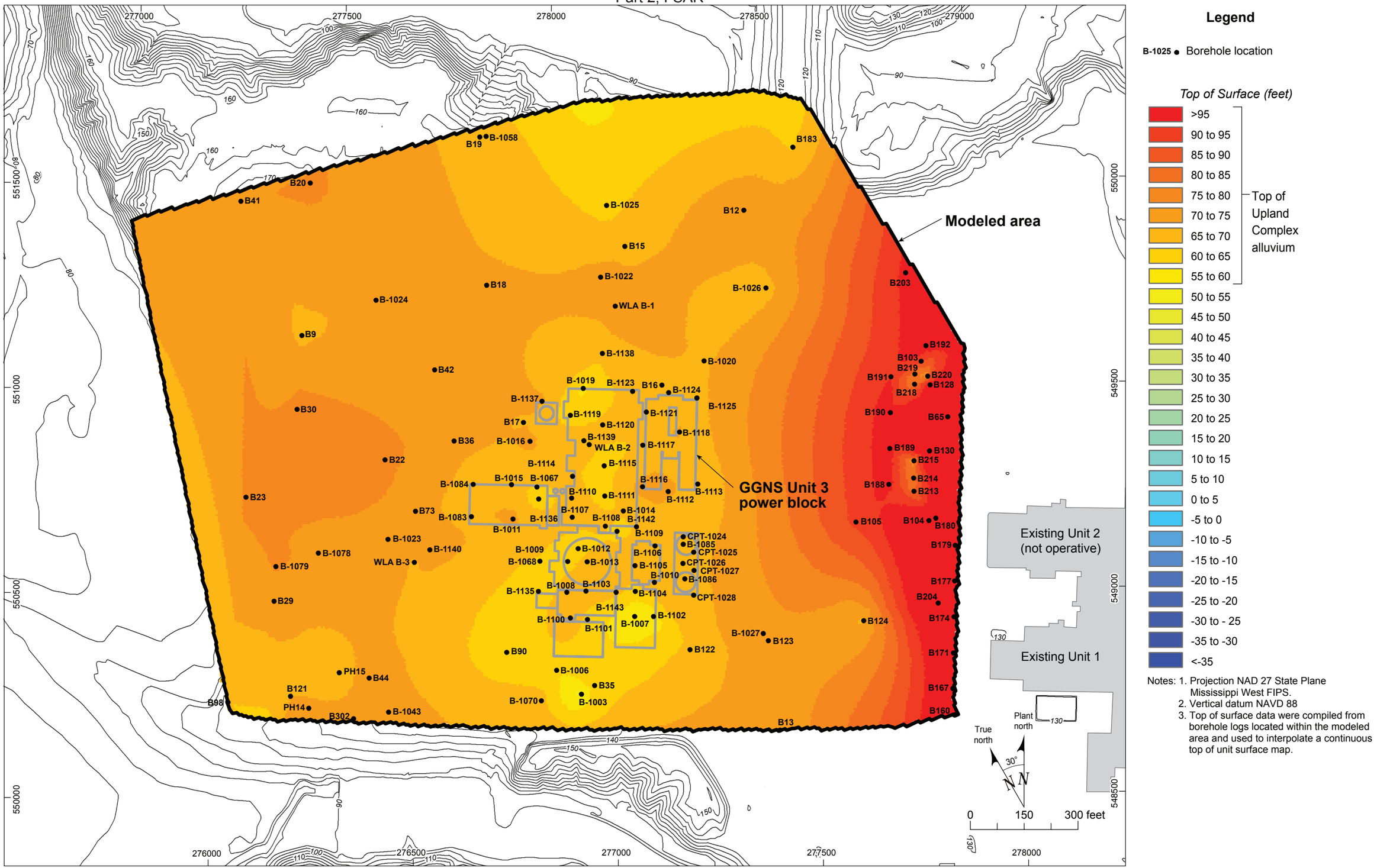
GGNS COL
2.0-26-A



Notes: 1. Projection NAD 27 State Plane Mississippi West FIPS.
2. Vertical datum NAVD 88
3. Top of surface data were compiled from borehole logs located within the modeled area and used to interpolate a continuous top of unit surface map.

Figure 2.5.1-229. Structure Contour Map - Top of Lower Loess

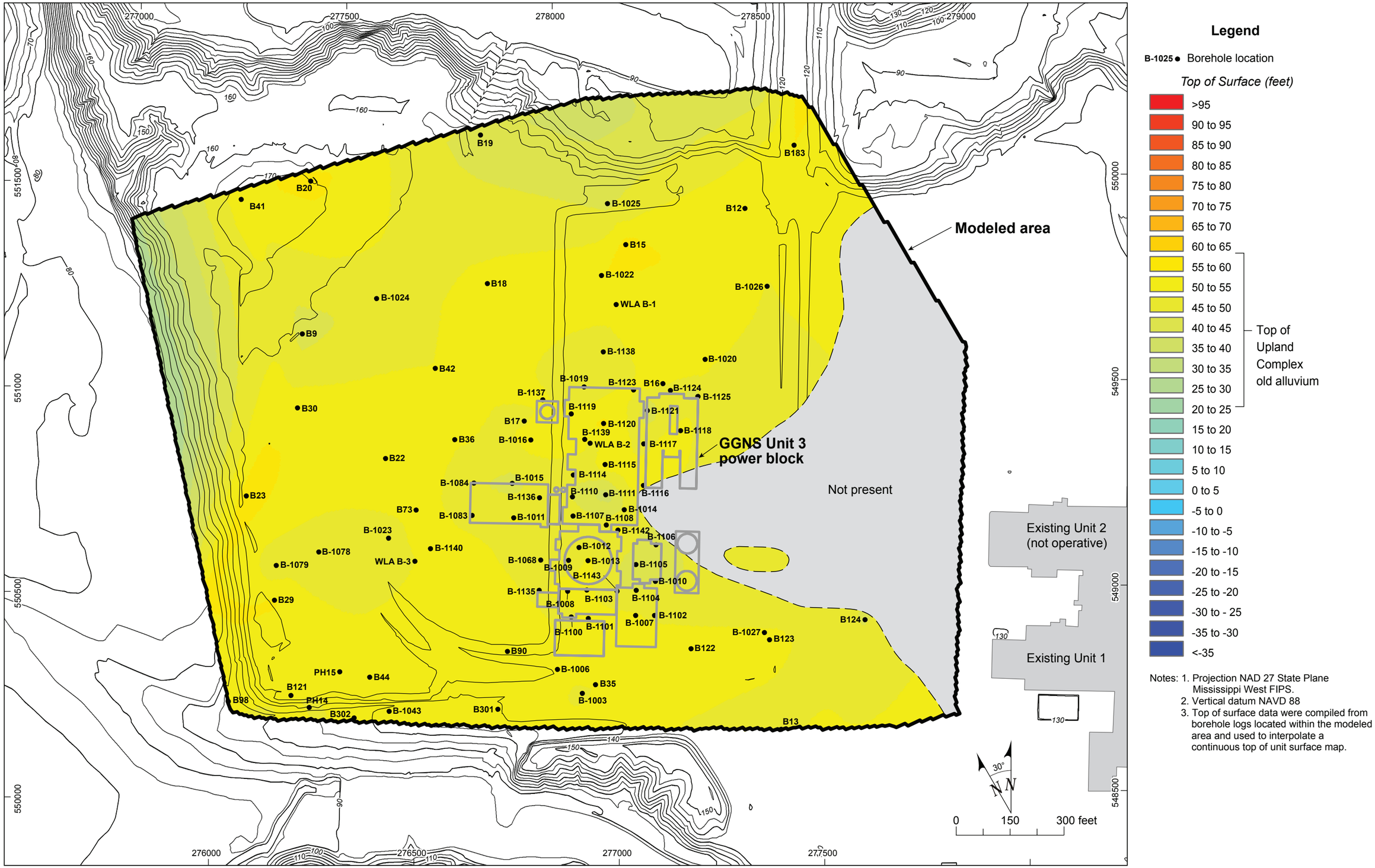
GGNS COL
2.0-26-A



Notes: 1. Projection NAD 27 State Plane Mississippi West FIPS.
2. Vertical datum NAVD 88
3. Top of surface data were compiled from borehole logs located within the modeled area and used to interpolate a continuous top of unit surface map.

Figure 2.5.1-230. Structure Contour Map - Top of Upland Complex Alluvium

GGNS COL
2.0-26-A



Notes: 1. Projection NAD 27 State Plane Mississippi West FIPS.
2. Vertical datum NAVD 88
3. Top of surface data were compiled from borehole logs located within the modeled area and used to interpolate a continuous top of unit surface map.

Figure 2.5.1-231. Structure Contour Map - Top of Upland Complex Old Alluvium

GGNS COL
2.0-26-A

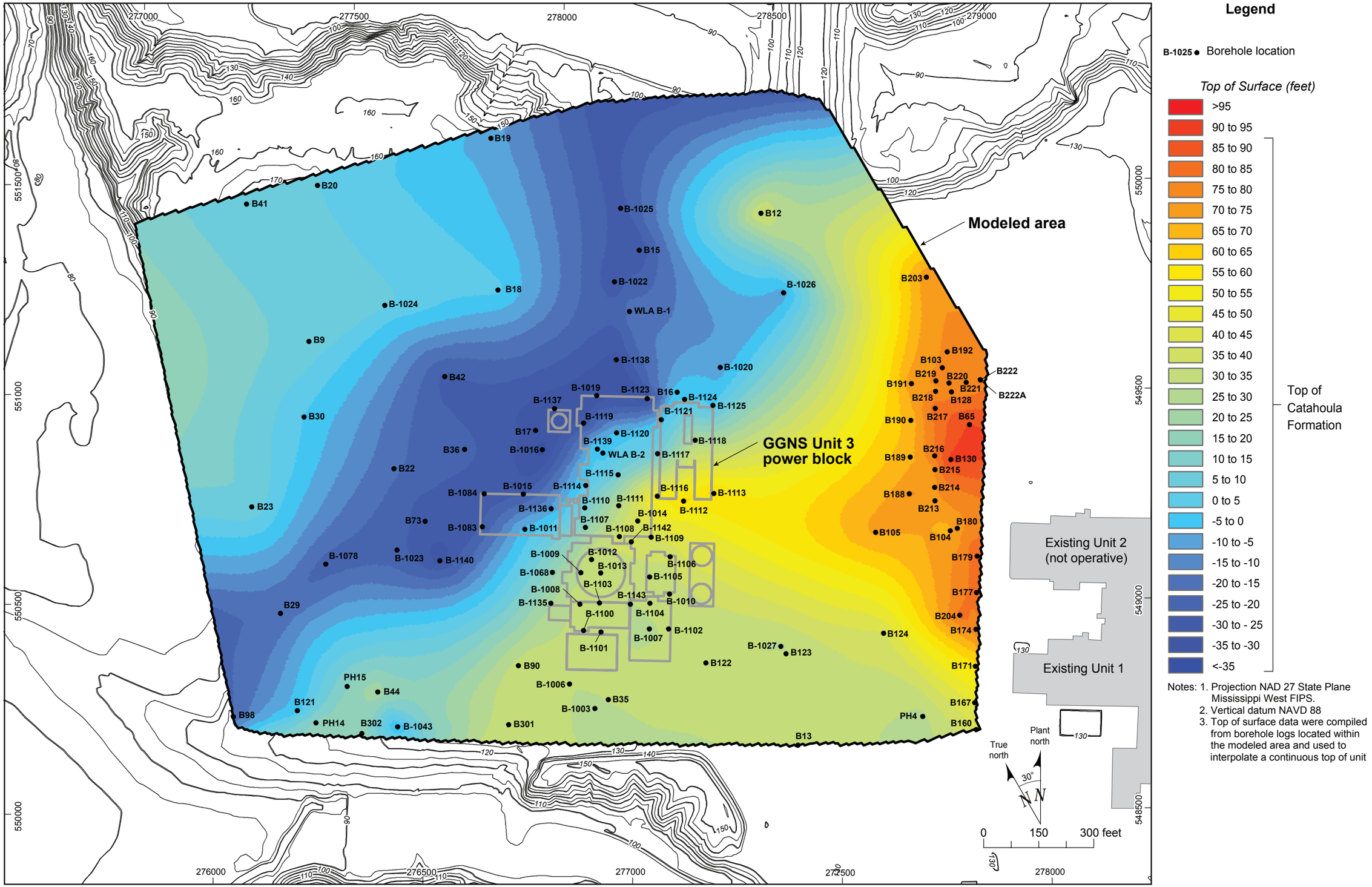


Figure 2.5.1-232. Structure Contour Map - Top of Catahoula

GGNS COL
2.0-26-A

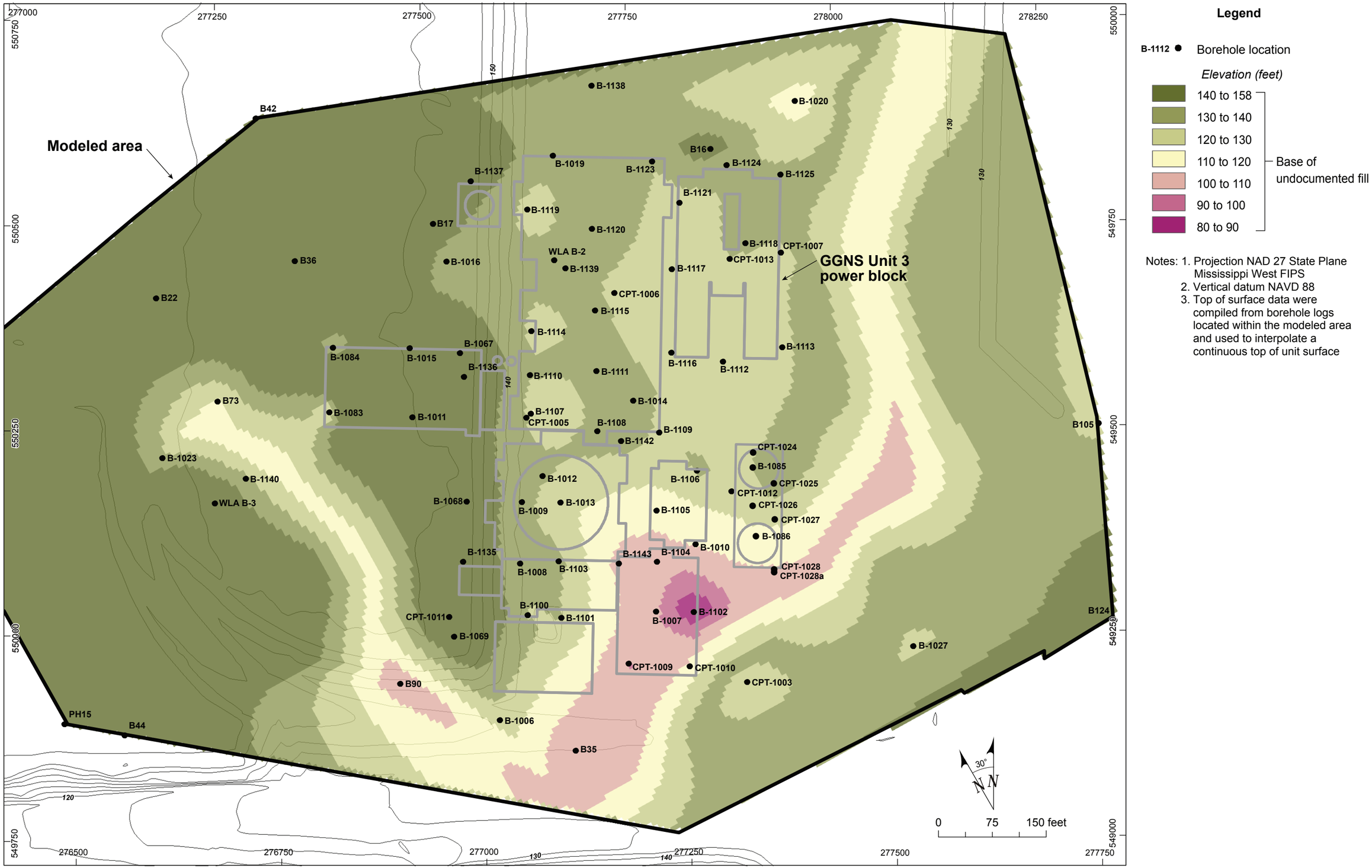


Figure 2.5.1-233. Structure Contour Map - Base of Undocumented Fill

GGNS COL 2.0-26-A

Figure 2.5.1-234. Photographed Sample of Typical Undocumented Fill

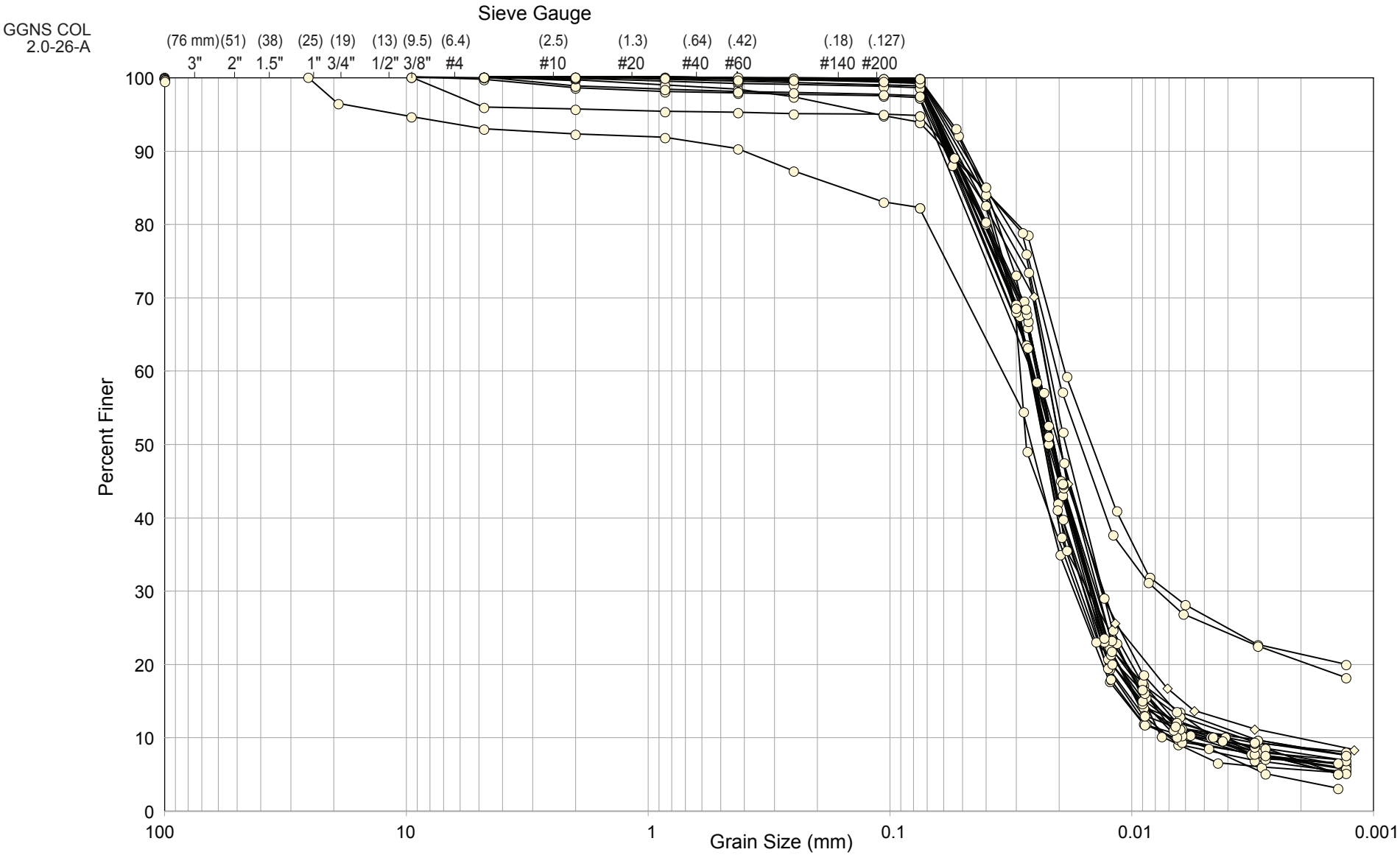


Figure 2.5.1-235. Grain Size Analysis - Upper Loess

GGNS COL 2.0-26-A

Figure 2.5.1-236. Photographed Sample of Typical Upper Loess

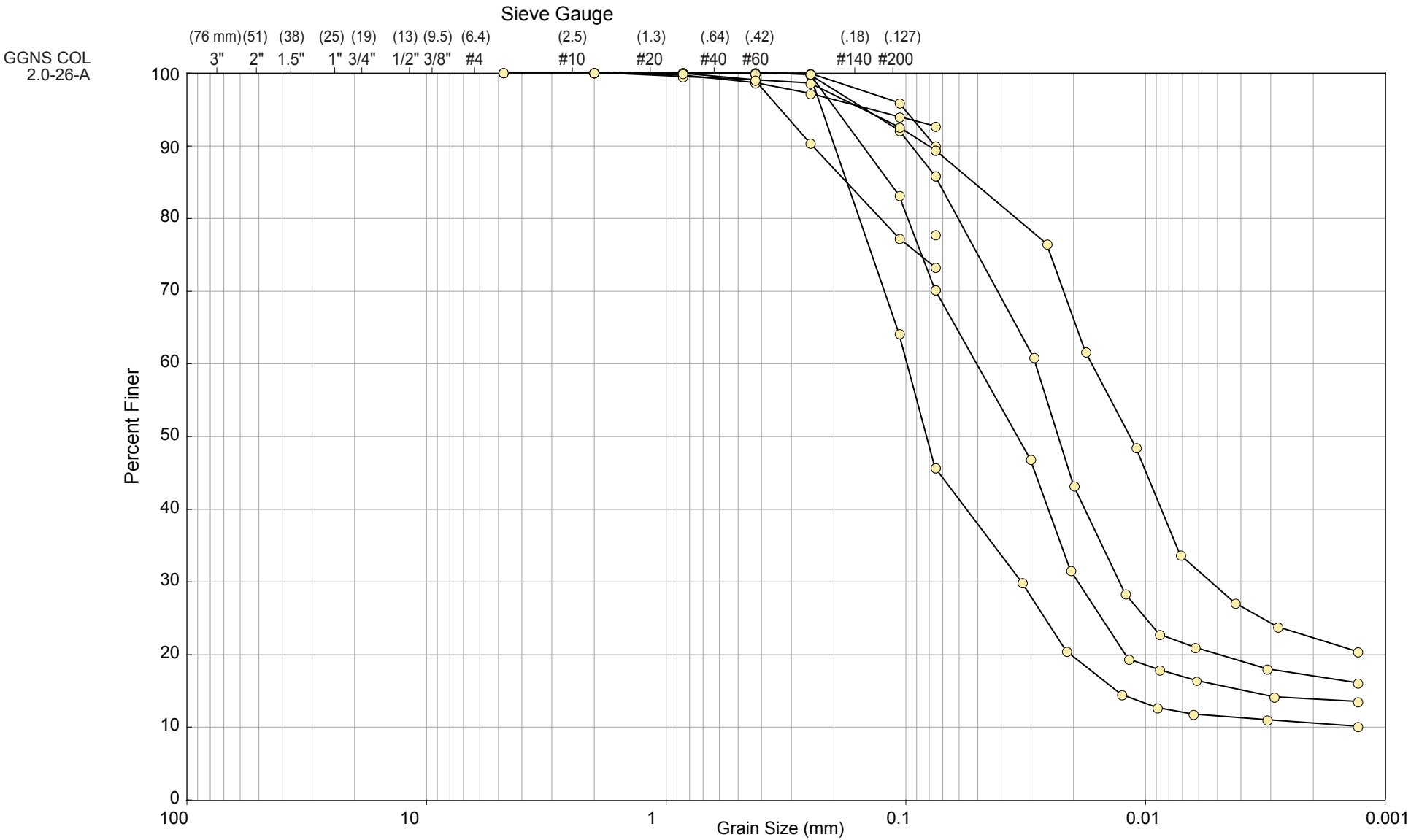


Figure 2.5.1-237. Grain Size Analysis - Lower Loess

GGNS COL 2.0-26-A

Figure 2.5.1-238. Photographed Sample of Typical Lower Loess

GGNS COL
2.0-26-A

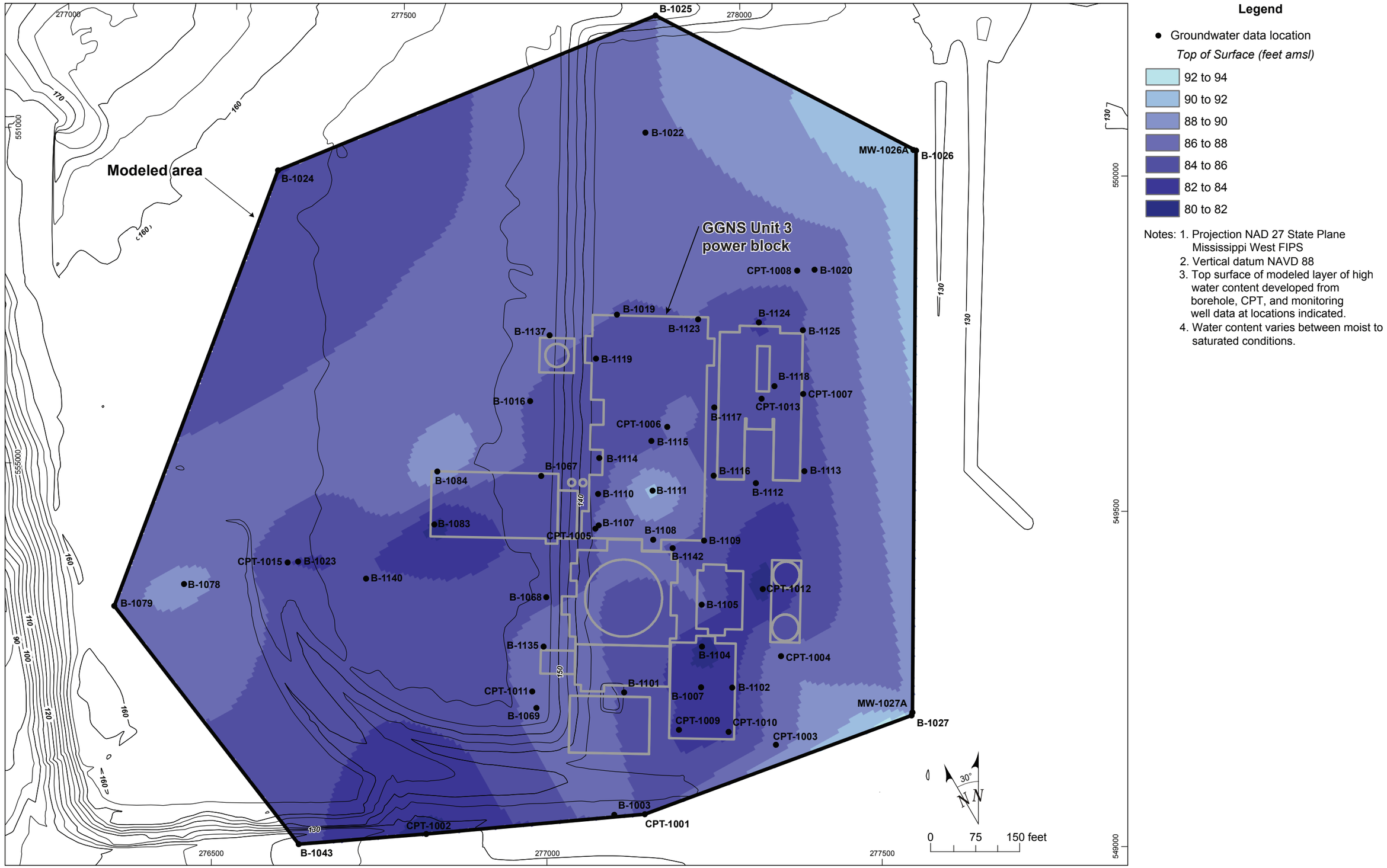


Figure 2.5.1-239. Elevation of Modeled Layer of High Water Content within the Upper and Lower Loess

GGNS COL
2.0-26-A

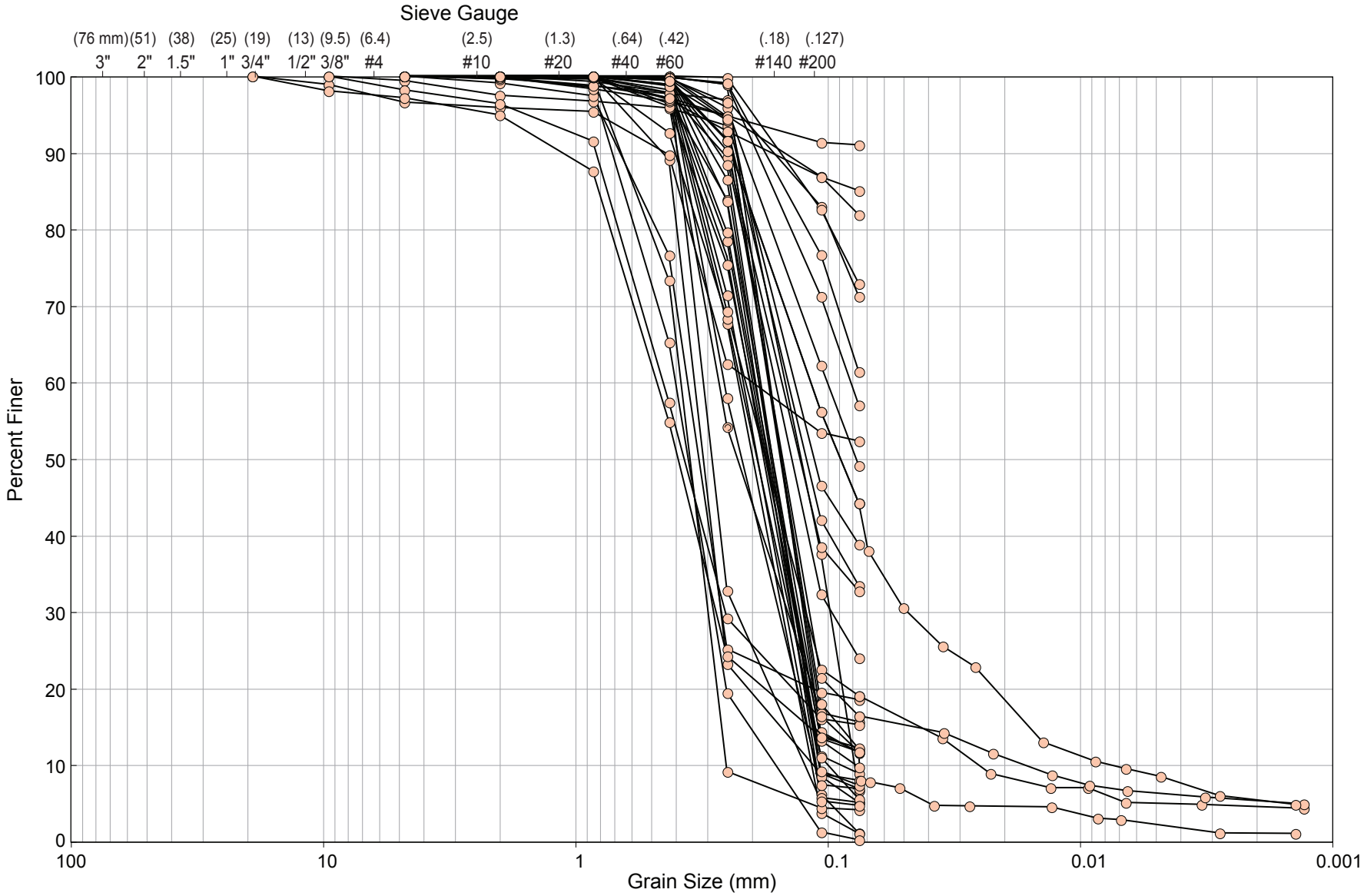


Figure 2.5.1-240. Grain Size Analysis - Upland Complex Alluvium

GGNS COL 2.0-26-A

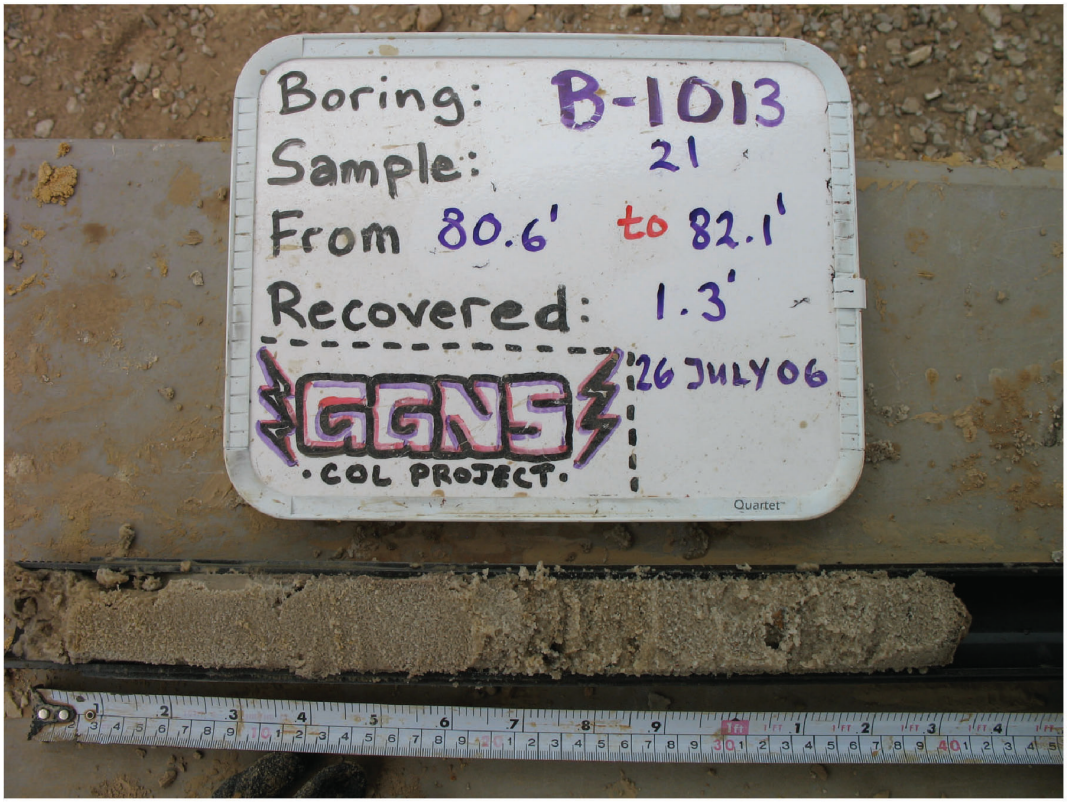


Figure 2.5.1-241. Photographed Sample of Typical Upland Complex Alluvium

GGNS COL
2.0-26-A

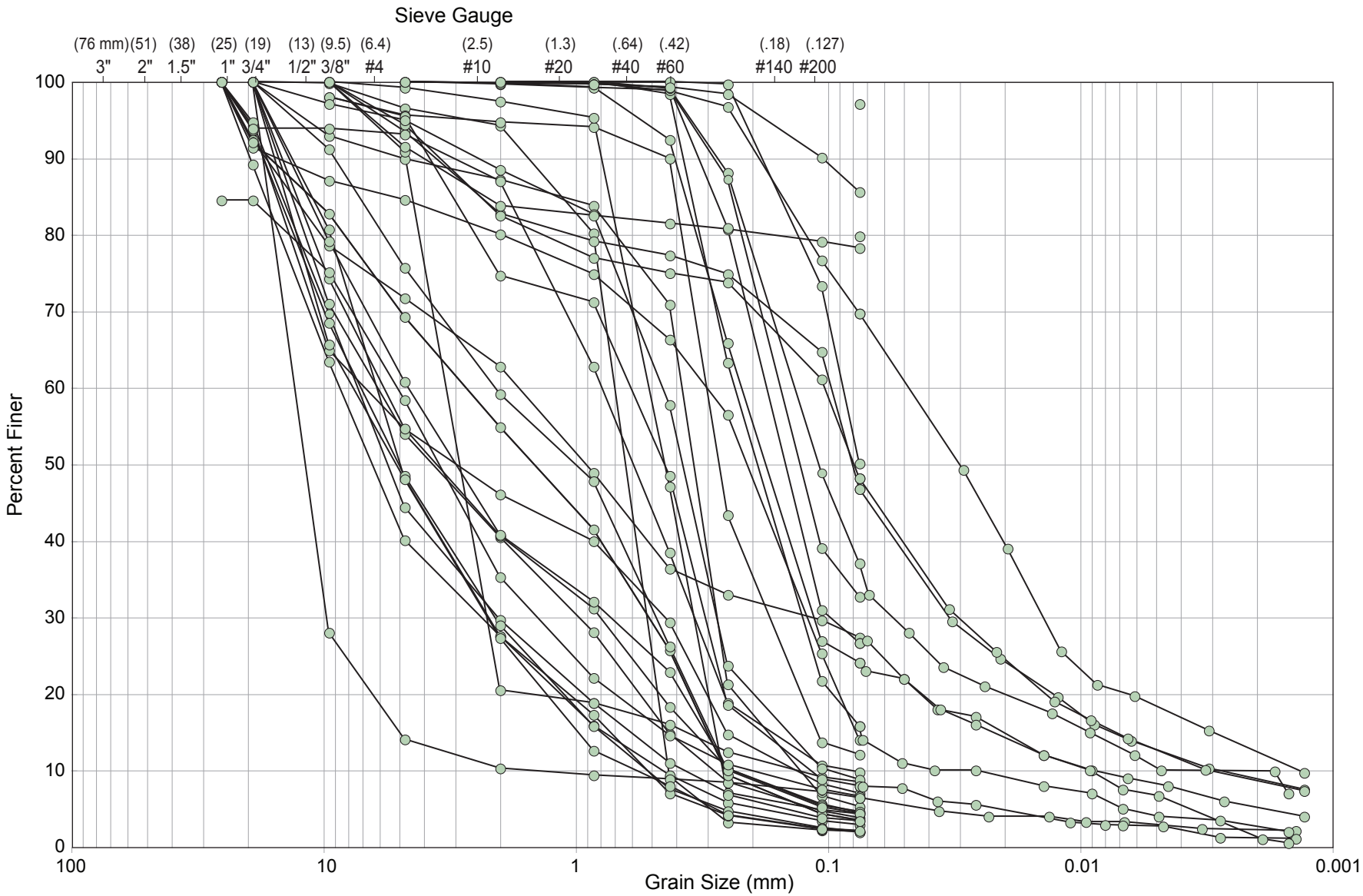


Figure 2.5.1-242. Grain Size Analysis - Upland Complex Old Alluvium

GGNS COL 2.0-26-A

Figure 2.5.1-243. Photographed Sample of Typical Upland Complex Old Alluvium

GGNS COL
2.0-26-A

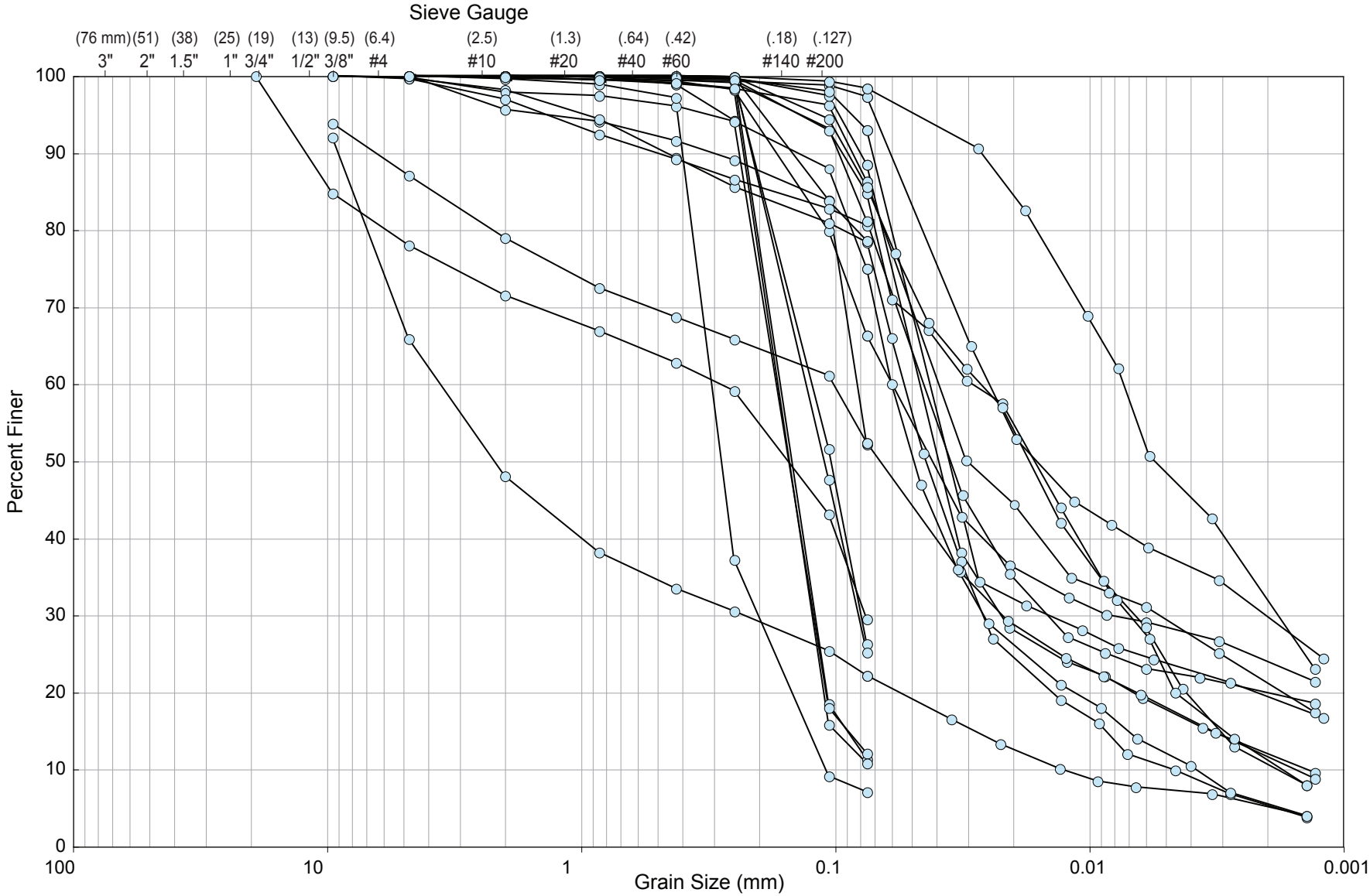


Figure 2.5.1-244. Grain Size Analysis - Catahoula Formation

GGNS COL 2.0-26-A

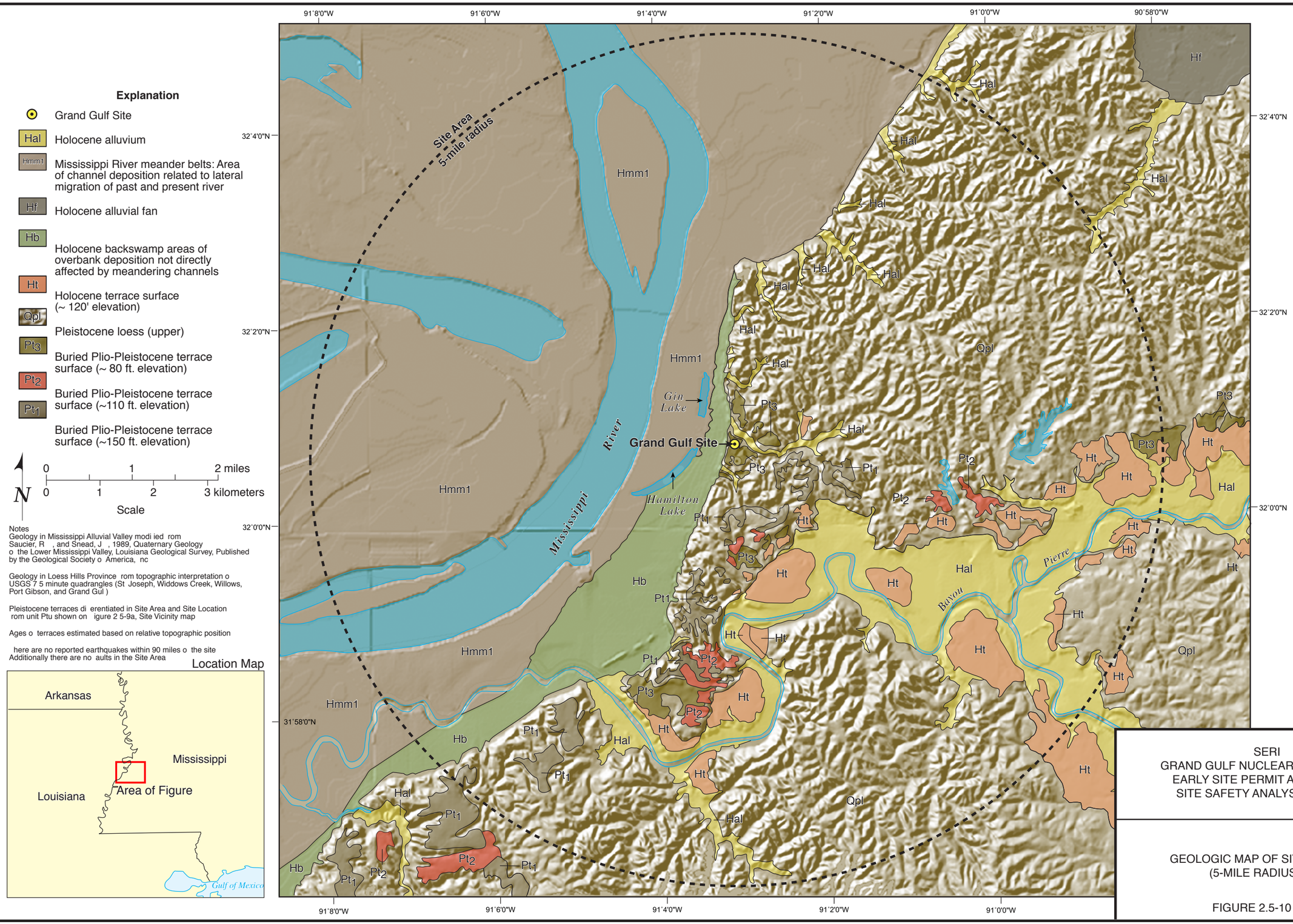
Figure 2.5.1-245. Photographed Sample of Typical Catahoula Formation

GGNS COL 2.0-26-A

Figure 2.5.1-246. Photographed Sample of Typical Bucatunna Formation

GGNS COL 2.0-26-A

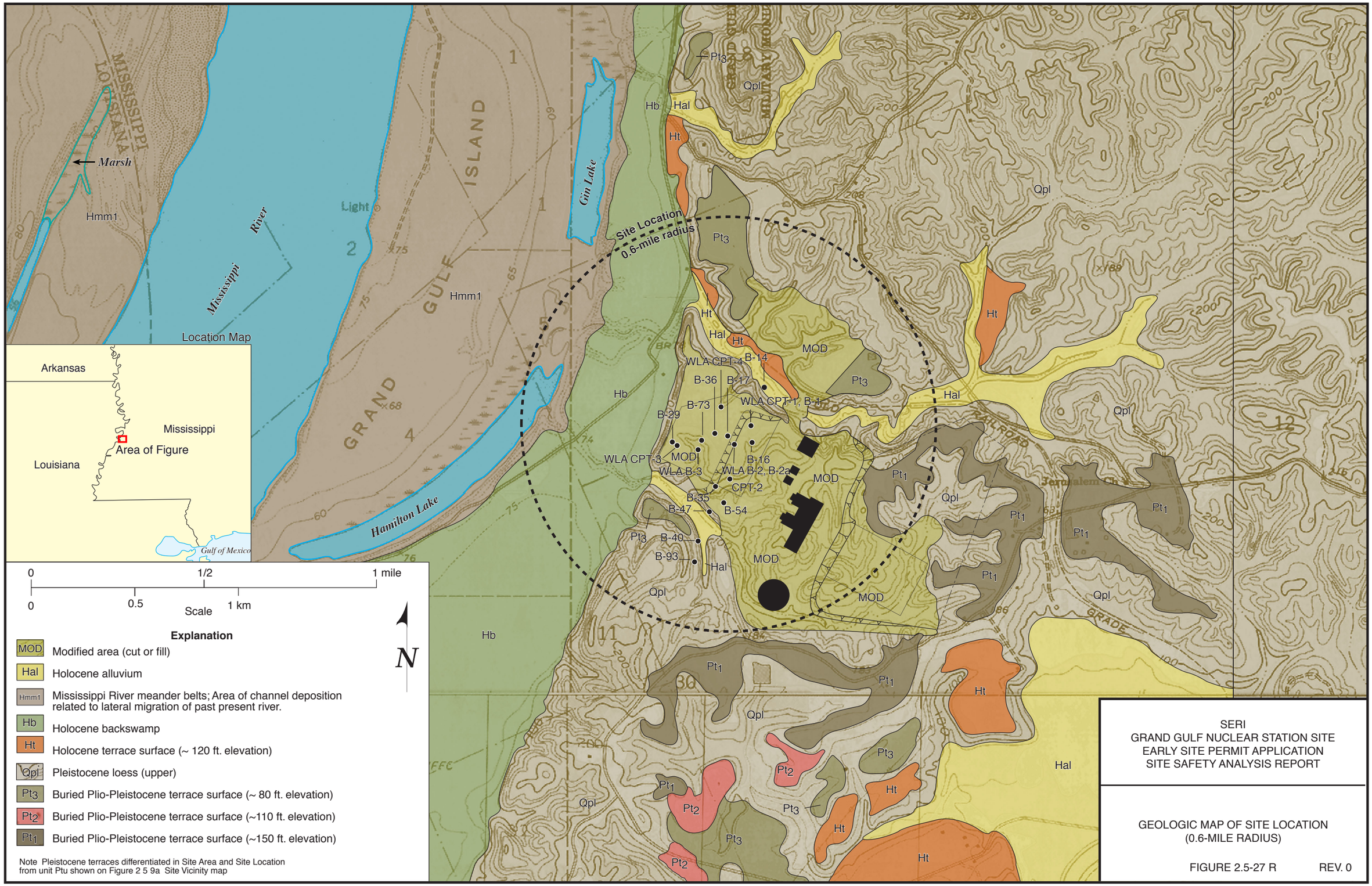
Figure 2.5.1-247. Photographed Sample of Typical Glendon Formation



SERI
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

GEOLOGIC MAP OF SITE AREA
(5-MILE RADIUS)

FIGURE 2.5-10 R REV. 0


Site Location
0.6-mile radius
Location Map
Arkansas
Mississippi
Area of Figure
Louisiana
Gulf of Mexico
Mississippi River
Hamilton Lake
Gin Lake
GRAND GULF ISLAND
MISSISSIPPI
LOUISIANA
Marsh
Light
Hmm1
Hb
Hal
Ht
Qpl
Pt3
Pt2
Pt1
MOD
WLA CPT-4
B-14
B-36
B-17
WLA CPT-1, B-1
B-73
B-29
WLA CPT-3
MOD
WLA B-3
B-16
WLA B-2, B-2a
CPT-2
B-35
B-47
B-54
B-40
B-93
0
1/2
1 mile
0
0.5
1 km
Scale
N
Explanation
MOD Modified area (cut or fill)
Hal Holocene alluvium
Hmm1 Mississippi River meander belts; Area of channel deposition related to lateral migration of past present river.
Hb Holocene backswamp
Ht Holocene terrace surface (~ 120 ft. elevation)
Qpl Pleistocene loess (upper)
Pt3 Buried Plio-Pleistocene terrace surface (~ 80 ft. elevation)
Pt2 Buried Plio-Pleistocene terrace surface (~110 ft. elevation)
Pt1 Buried Plio-Pleistocene terrace surface (~150 ft. elevation)
Note Pleistocene terraces differentiated in Site Area and Site Location from unit Ptu shown on Figure 2 5 9a Site Vicinity map
SERI
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT
GEOLOGIC MAP OF SITE LOCATION
(0.6-MILE RADIUS)
FIGURE 2.5-27 R
REV. 0