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REV. 1

Final Site Observational Work Plan for the UMTRA Project Site at Falls City, Texas

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Executive Summary

The requirements for groundwater compliance for Uranium Mill Tailing Remedial Action (UMTRA) Project sites, including the Falls City site, are found in the Uranium Mill Tailings Radiation Control Act (42 USC §7901 *et seq.*) and the U.S. Environmental Protection Agency's Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR Part 192; 60 FR 2854).

Groundwater beneath the Falls City site was contaminated by uranium ore processing activities, open pit mining, and *in situ* solution leaching of tailings. Open pit mining occurred at the Falls City site before the milling activities. Local mines were on parcels A and B of the site. Also, the shallow groundwater in the mined areas is of naturally poor quality because of ore bodies in the aquifer matrix.

A total of 2.5 million tons (2.3 million tonnes) of uranium ore were extracted and processed on the site. An acid-leach, countercurrent-decantation solvent extraction system was used to extract and concentrate uranium. The Deweesville sandstone containing the uranium was mined, ground, and then agitated in a sulfuric acid solution. An organic solution (tertiary amine and kerosene) was added during the extraction circuit. The uranium was stripped from the organic solution with either a sodium carbonate or an acidified sodium chloride solution. The residue sands, sandy-slimes, and slimes from processing uranium ore (tailings) were left on the mill site.

During surface remedial action, an estimated 7.0 million tons (6.4 million tonnes) of uranium mill tailings and other contaminated materials were consolidated and stabilized on the site. The groundwater protection strategy at the Falls City disposal site for the UMTRA Surface Project was an application for supplemental standards, based on limited use groundwater in the uppermost aquifer. This water is not a current or potential source of drinking water. Groundwater from the uppermost aquifer (groundwater from the Deweesville/Conquista Members and the Dilworth Member) contains widespread ambient contamination resulting from naturally occurring conditions and from the effects of human activity not related to uranium milling operations (uranium exploration and mining activities). The groundwater cannot be effectively cleaned up for drinking purposes with treatment methods reasonably employed by public water supply systems. The U.S. Nuclear Regulatory Commission (NRC) and the state of Texas concurred with the groundwater protection strategy for the disposal site in September 1992. Surface remedial action in accord with 40 CFR Part 192 Subpart A was completed in April 1994.

The proposed groundwater clean-up compliance strategy at the Falls City site is to perform no remedial action based on application for supplemental standards because the groundwater in the uppermost aquifer is classified as limited-use groundwater. Limited-use groundwater includes groundwater that is not a current or potential source of drinking water because of widespread, ambient contamination that cannot be cleaned up using treatment methods reasonably employed by public water supply systems (40 CFR §192.11[e]).

Contents

Page

Acronyms and Abbreviations iii

1.0 Introduction 1–1
1.1 Groundwater Compliance Strategy 1–1
1.2 UMTRA Project Programmatic Documents 1–1
1.3 Relationship to Site-Specific Documents 1–1
1.4 SOWP Revisions 1–2

2.0 Regulatory Framework 2–1
2.1 Uranium Mill Tailings Radiation Control Act 2–1
2.1.1 EPA Groundwater Protection Standards 2–1
2.1.2 Cooperative Agreements 2–3
2.2 National Environmental Policy Act 2–3

3.0 Summary of Additional Data Collected 3–1
3.1 Statement of Data Collected 3–1
3.1.1 Qualitative Analysis of Background Groundwater Quality 3–1
3.1.2 Land and Water Use Survey 3–1
3.1.3 Hydrogeologic Investigations 3–3

4.0 Site Conditions 4–1
4.1 Site History 4–1
4.1.1 Physical Setting 4–1
4.1.2 Land and Water Use 4–1
4.1.3 History of Operations 4–1
4.1.4 Milling Process 4–4
4.1.5 Surface Remedial Action 4–4
4.2 Sources of Existing Data 4–5
4.3 Conceptual Site Model 4–6
4.3.1 Hydrogeologic Setting 4–9
4.3.1.1 Deweesville/Conquista Aquifer 4–10
4.3.1.2 Dilworth Aquifer 4–13
4.3.1.3 Hydraulic and Transport Properties 4–13
4.3.2 Background Groundwater Quality 4–14
4.3.2.1 Deweesville/Conquista 4–14
4.3.2.2 Dilworth 4–18
4.3.3 Magnitude of Site-Related Groundwater Contamination 4–35
4.3.3.1 Deweesville/Conquista Contaminant Plume 4–36
4.3.3.2 Dilworth Contaminant Plume 4–43
4.3.4 Contaminant Fate and Transport 4–44
4.3.5 Risk Evaluation 4–48
4.3.5.1 Dilworth Aquifer 4–48
4.3.5.2 Deweesville/Conquista Aquifer 4–50

Contents (continued)

5.0 Groundwater Compliance Strategy Selection 5–1
5.1 Compliance Strategy Selection Process 5–1
5.2 Falls City, Texas, Compliance Strategy Selection 5–1
5.3 Deviations, Contingencies, and Decision Rules 5–3
5.4 Future Monitoring Activities 5–4

6.0 References 6–1

Figures

Figure 3–1. Areal Coverage of Land and Water Use Survey 3–2
Figure 3–2. New Monitor Wells Installed in 1995 3–5
Figure 4–1. Location of the Falls City, Texas, Site 4–2
Figure 4–2. Topographic Map of the Disposal Site Area, Falls City, Texas, Site 4–3
Figure 4–3. Monitor Well Locations 4–7
Figure 4–4. Potentiometric Surface of the Deweesville/Conquista Aquifer, January 1997 4–11
Figure 4–5. Potentiometric Surface of the Dilworth Aquifer, January 1997 4–15
Figure 4–6. Locations of the Dilworth Background Wells and the Deweesville/Conquista Conoco 600 Series Wells, Falls City, Texas, Site 4–19
Figure 4–7. Trilinear Plot of Data from Deweesville/Conquista Monitor Wells 667, 668, and Selected Hobson Monitor Wells, Falls City, Texas, Site 4–26
Figure 4–8. Trilinear Plot of Dilworth Background Groundwater and Deweesville/Conquista Reference Water, Falls City, Texas, Site 4–27
Figure 4–9. Bimodal Distribution of pH Values from BEG 1992 4–35
Figure 4–10. pH in Deweesville/Conquista Aquifer 4–37
Figure 4–11. Aluminum in Deweesville/Conquista Aquifer 4–39
Figure 4–12. Alkalinity in Deweesville/Conquista Aquifer 4–41
Figure 4–13. pH in Dilworth Aquifer 4–45
Figure 5–1. Framework Application of Contaminants of Potential Concern in the Uppermost Aquifers, Falls City, Texas, Site 5–2

Tables

Table 2–1. Maximum Concentration of Inorganic Constituents for Groundwater Protection for UMTRA Project Sites 2–2
Table 4–1. Typical Water Quality Data for Dilworth and Deweesville/Conquista Background Wells 4–17
Table 4–2. Water Quality in the Deweesville/Conquista Aquifer at the Falls City, Texas, Site 4–20
Table 4–3. Statistical Summary of the Dilworth Groundwater Quality at the Falls City, Texas, Site 4–28
Table 4–4. Comparison of Groundwater Results Obtained for Monitor Wells 833 and 893 4–44
Table 4–5. Contaminants of Potential Concern for the Dilworth Aquifer 4–49

Appendices

Acronyms and Abbreviations

ac	acre
ACL	alternate concentration limit
cm/s	centimeter(s) per second
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FM	Farm-to-Market
ft	foot (feet)
ft/d	foot per day
GCAP	Groundwater Compliance Action Plan
in.	inch(es)
km	kilometer(s)
m	meter(s)
mm	millimeter(s)
MAP	UMTRA Groundwater Management Action Process
MCL	maximum concentration limit
mg/L	milligrams per liter
mi	mile
NEPA	National Environmental Policy Act
NRC	U.S. Nuclear Regulatory Commission
PEIS	Programmatic Environmental Impact Statement
PVC	polyvinyl chloride
RAP	Remedial Action Plan
RRM	residual radioactive materials
SOWP	Site Observational Work Plan
SWI	Susquehanna-Western, Inc.
TAC	Technical Assistance Contractor
TDS	total dissolved solids
TKA	Turk, Kehle & Associates
tpd	ton per day
U_3O_8	uranium oxide
UMTRA	Uranium Mill Tailings Remedial Action
UMTRCA	Uranium Mill Tailings Radiation Control Act
USGS	U.S. Geological Survey

1.0 Introduction

Produced by the U.S. Department of Energy (DOE), this site observational work plan (SOWP) will be used to determine a site-specific approach to comply with the U.S. Environmental Protection Agency (EPA) groundwater standards at the Falls City Uranium Mill Tailings Remedial Action (UMTRA) Project site. The purpose of the SOWP is to recommend a site-specific groundwater clean-up compliance strategy at the Falls City UMTRA Project site. The Falls City SOWP presents a comprehensive summary of site hydrogeological data, delineates a conceptual model of the aquifer system, and discusses the origins of milling-related groundwater contamination. It also defines the magnitude of groundwater contamination, potential environmental and health risks associated with groundwater contamination, and targets a proposed compliance strategy.

1.1 Groundwater Compliance Strategy

The proposed groundwater compliance strategy for the Falls City site is no remediation, with an application for supplemental standards based on the following criteria:

- The shallow groundwater is considered limited-use groundwater. Limited-use groundwater is groundwater that is not a current or potential source of drinking water because widespread ambient contamination cannot be cleaned up with treatment methods reasonably employed by public water supply systems (60 FR 2854). However, EPA standards require the DOE to consider the impact of milling contamination on current or future beneficial uses of groundwater. In the site area, potential beneficial uses would be limited to watering livestock and gardens because the quality of naturally occurring groundwater is poor and the yield is low.

Section 2.0 describes the requirements for meeting standards at UMTRA Project sites. Sections 3.0 and 4.0 provide site-specific data that support the proposed groundwater compliance strategy. Section 5.0 justifies the proposed groundwater compliance strategy.

1.2 UMTRA Project Programmatic Documents

The programmatic documents that guide the SOWP include the *UMTRA Groundwater Management Action Process* (MAP) (DOE 1996b), the *Final Programmatic Environmental Impact Statement* (PEIS) (DOE 1996a), and the *Technical Approach to Groundwater Restoration* (DOE 1993a). The MAP states the mission and objectives of the UMTRA Groundwater Project and provides a technical and management approach for conducting the project. The Final PEIS is the programmatic decision-making framework for conducting the UMTRA Groundwater Project. DOE will follow PEIS guidelines to assess the potential programmatic impacts of the Groundwater Project, to determine site-specific groundwater compliance strategies, and to prepare site-specific environmental impacts analyses more efficiently. Technical guidelines for conducting the groundwater program are found in the *Technical Approach to Groundwater Restoration*.

1.3 Relationship to Site-Specific Documents

The surface remedial action plan (RAP) provides site characterization information (DOE 1992b). This information was updated in developing the SOWP to formulate the site conceptual model. If a groundwater compliance strategy requiring remedial action activities is selected for this site, a groundwater RAP will be prepared, otherwise a modification to the surface RAP will suffice.

In 1995, a baseline risk assessment was prepared (DOE 1995) identifying potential public health and environmental risks at the site. Potential risks identified in the risk assessment are considered in this SOWP to ensure that the proposed compliance strategy is protective of human health and the environment.

After identification of a proposed compliance strategy in the SOWP and described in the Groundwater Compliance Action Plan (GCAP), a site-specific National Environmental Policy Act (NEPA) document (e.g., environmental assessment) will be prepared to determine the potential impacts, if any, of implementing the proposed compliance strategy.

1.4 SOWP Revisions

This SOWP presents a summary of existing data, a conceptual model, and a recommended compliance strategy based on this conceptual model. Additional data were collected in late 1995. Twelve additional monitor wells were installed and two rounds of groundwater samples collected and analyzed to date. This final document presents the additional data, correlates the data to previous information, and updates the site conceptual model.

2.0 Regulatory Framework

This section identifies the requirements for selecting a groundwater compliance strategy for the Falls City, Texas, processing site to achieve compliance with Subpart B of the EPA health and environmental protection standards for uranium and thorium mill tailings (40 CFR Part 192), and the final rule to the standards published in 60 FR 2854.

2.1 Uranium Mill Tailings Radiation Control Act

The United States Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 USC §7901 *et seq.*) in 1978 in response to public concerns about potential health hazards from long-term exposure to uranium mill tailings. The UMTRCA authorized DOE to stabilize, dispose of, and control uranium mill tailings and other contaminated materials at inactive uranium mill processing sites.

Title I of the UMTRCA designates 22 inactive processing sites for remediation. It directs the EPA to promulgate standards; mandates remedial action in accordance with these standards; stipulates that remedial action be selected and performed with the concurrence of the U.S. Nuclear Regulatory Commission (NRC), and in consultation with the states and Indian tribes; directs the NRC to license the disposal sites; and directs the DOE to enter into cooperative agreements with the affected states and Indian tribes. Title II applies to active uranium mills. Title III applies only to certain uranium mills in New Mexico. The UMTRA Project is responsible for administering only Title I of the UMTRCA.

In 1988, Congress passed the Uranium Mill Tailings Remedial Action Amendments Act (Amendments Act) (42 USC §7922 *et seq.*), authorizing the DOE to extend without limitation the time needed to complete groundwater remediation activities at the processing sites.

2.1.1 EPA Groundwater Protection Standards

The UMTRCA requires EPA to promulgate standards for protecting public health, safety, and the environment from radiological and nonradiological hazards associated with uranium processing and the resulting residual radioactive materials (RRM). On January 5, 1983, the EPA published standards (40 CFR Part 192) for RRM disposal and cleanup. The standards were revised and a final rule was published January 11, 1995 (60 FR 2854).

The standards address two groundwater contamination scenarios: future groundwater contamination that might occur from tailings piles after disposal, and the cleanup of contamination resulting from the milling process at the processing sites (60 FR 2854). The UMTRA Surface Project is designed to control and stabilize tailings and contaminated soil. The Groundwater Project addresses residual contamination at the processing sites and is regulated by Subparts B and C of the EPA standards.

Subpart B, "Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials From Inactive Uranium Processing Sites," requires documentation that action at the former processing sites ensure the residual groundwater contamination meets any of the following three criteria:

- Background levels. Concentrations of constituents in nearby groundwater not contaminated by processing activities.

- Maximum concentration limits (MCL). Maximum concentrations set by the EPA for certain hazardous constituents in groundwater, specific to the UMTRA Project (Table 2–1).

- Alternate concentration limits (ACL). An alternate concentration limit for a hazardous constituent that does not pose a substantial hazard (present or potential) to human health or the environment as long as the limit is not exceeded. An ACL may be applied after considering options to achieve background levels or MCLs (60 FR 2867).

Table 2–1. Maximum Concentration of Inorganic Constituents for Groundwater Protection for UMTRA Project Sites

Constituent	Maximum concentration[a]
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Molybdenum	0.1
Nitrate (as N)	10.0[b]
Selenium	0.01
Silver	0.05
Combined radium-226 and radium-228	5 pCi/liter
Combined uranium-234 and uranium-238	30 pCi/liter[c]
Gross alpha-particle activity (excluding radon and uranium)	15 pCi/liter

[a]Concentrations reported in milligrams per liter (mg/L) unless otherwise noted.
[b]Equivalent to 44 mg/L nitrate as nitrate.
[c]Equivalent to 0.044 mg/L, assuming secular equilibrium of uranium-234 and uranium-238.

pCi - picocuries.
Ref: 60 FR 2854.

Subpart B also allows natural flushing to meet the standards. Natural flushing allows natural groundwater processes to reduce the contamination in groundwater to acceptable standards (background levels, MCLs, or ACLs). Natural flushing must allow the standards to be met within 100 years. In addition, institutional controls to protect human health and an adequate monitoring program must be established and maintained during the period of natural flushing; institutional controls would prohibit inappropriate uses of the contaminated groundwater. The groundwater also must not be a current or projected source of municipal drinking water during the period of natural flushing, and beneficial uses of groundwater must be protected (60 FR 2867).

Subpart C, "Implementation," provides guidance for implementing methods and procedures to reasonably ensure the provisions of Subpart B are satisfied. Subpart C requires the following:

- The conditions of Subpart B must be met on a site-specific basis, using information gathered during site characterization and monitoring. The plan to meet the conditions of Subpart B must be stated in a site-specific groundwater compliance action plan. The plan must contain a compliance strategy and a monitoring program, if necessary (60 FR 2868).

Subpart B also describes the conditions under which DOE may apply supplemental standards to contaminated groundwater, rather than meeting background levels, MCLs, or ACLs. The standards define limited-use groundwater as groundwater that is not a current or potential source of drinking water because total dissolved solids (TDS) exceed 10,000 milligrams per liter (mg/L); widespread ambient contamination cannot be cleaned up using treatment methods reasonably employed by public water supply systems; the quantity of water available is less than 150 gallons (570 liters) per day; or because cleanup of groundwater would cause excessive environmental harm; or because cleanup is technically impractical (60 FR 2867). Subpart C requires the DOE to inform private owners and occupants of the area affected by hazardous constituents and to solicit their comments before applying supplemental standards. The DOE has implemented a public participation program in Falls City to meet the requirements of Subpart C.

The DOE proposes a no remediation/supplemental standards compliance strategy for the Falls City, Texas, site. This strategy will achieve compliance with the EPA groundwater standards applicable to Title I UMTRA Project sites. To protect groundwater and to achieve compliance with the EPA groundwater standards under Subpart A (UMTRA Surface Project), a narrative supplemental standard for the Falls City site was proposed and approved. The supplemental standard application for the surface remedial action was based on widespread ambient contamination that could not be cleaned up with methods reasonably employed by public water supply systems. Therefore, the DOE concluded that groundwater in the uppermost aquifer meets the widespread ambient contamination criteria of limited-use groundwater. The NRC and the state of Texas concurred with the DOE groundwater protection strategy for the UMTRA Surface Project in 1992. The Falls City groundwater compliance strategy (to meet Subpart B requirements) is identical to the Surface Project groundwater protection strategy. The regulatory drivers that guide the selection of the proposed groundwater compliance strategy for the Falls City, Texas, site and all other UMTRA sites are identified below.

2.1.2 Cooperative Agreements

The UMTRCA requires remedial action to include full participation of the states and Indian tribes that own land containing uranium mill tailings. The UMTRCA also directs DOE to enter into cooperative agreements with the states and Indian tribes.

2.2 National Environmental Policy Act

The UMTRCA is a major NEPA activity (42 USC §4321 *et seq.*). Regulations of the Council on Environmental Quality (to implement the NEPA) are codified in 40 CFR Part 1500; these regulations require each federal agency to develop its own implementing procedures (40 CFR §1507.3). The DOE-related NEPA regulations are contained in 10 CFR Part 1021, *National Environmental Policy Act; Implementing Procedures*. Guidance is provided in *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* (DOE 1993b).

Pursuant to NEPA, in 1994 the DOE drafted a PEIS for the UMTRA Groundwater Project. The PEIS document was finalized in October 1996. The purpose of the NEPA document was to analyze the potential impacts of implementing four programmatic alternatives for groundwater compliance at the designated processing sites. The preferred alternative for the UMTRA Groundwater Project was published in a record of decision in 1997. All subsequent action on the UMTRA Groundwater Project must comply with the record of decision.

3.0 Summary of Additional Data Collected

3.1 Statement of Data Collected

The DOE evaluated existing site information and identified data gaps (uncertainties) that had been addressed to confirm the appropriateness of the proposed groundwater compliance strategy and the feasibility of alternative strategies if required. These "data gaps" are addressed in this Final SOWP.

Additional characterization data designed to reduce system uncertainties have been collected. These additional data enhance the understanding of site conditions and ensure the appropriate groundwater compliance strategy is implemented.

3.1.1 Qualitative Analysis of Background Groundwater Quality

Background groundwater quality in the Deweesville/Conquista aquifer has been sufficiently characterized to demonstrate that it qualifies for a supplemental standard application (DOE 1992). However, a literature search and a review of groundwater quality data from monitor wells and other wells located near the site was conducted to demonstrate qualitatively that the supplemental standards are protective of potential beneficial uses of groundwater in the site vicinity. Results of the review of the groundwater quality data are presented in the *Final Baseline Risk Assessment* (DOE 1995) and in the Validated Data Packages (DOE 1996c and 1997) for the most recent rounds of groundwater sampling conducted in January 1996 and January 1997.

3.1.2 Land and Water Use Survey

The DOE has demonstrated that the groundwater compliance strategy will protect human health and the environment and protect potential beneficial uses of the groundwater. To evaluate the health risks and environmental impacts associated with groundwater contamination, investigators identified potential exposure pathways within and downgradient from the contaminated zones and further assessed the likelihood of direct or indirect human contact with contaminated groundwater through the exposure pathways. Results of the land and water use survey are presented in the *Final Baseline Risk Assessment* (DOE 1995). The land and water use survey expanded the area of the previous survey, which was conducted within a 2-mile (mi) (3-kilometer [km]) radius of the site. The latest survey covers an area that extends well beyond the current, known lateral extent of groundwater contamination (Figure 3–1). Locations of other wells identified in the latest survey are presented in Plate 3. During the land and water use survey, the following activities were conducted:

- A literature search and review of groundwater quality data from existing wells to further define background groundwater quality.

- A well record search by reviewing appropriate files from the state of Texas. The well records help determine well construction information, depth to water, well productivity information, and water quality.

- Review of aerial photography of the region to quickly locate and identify stock ponds that could be used to water livestock.

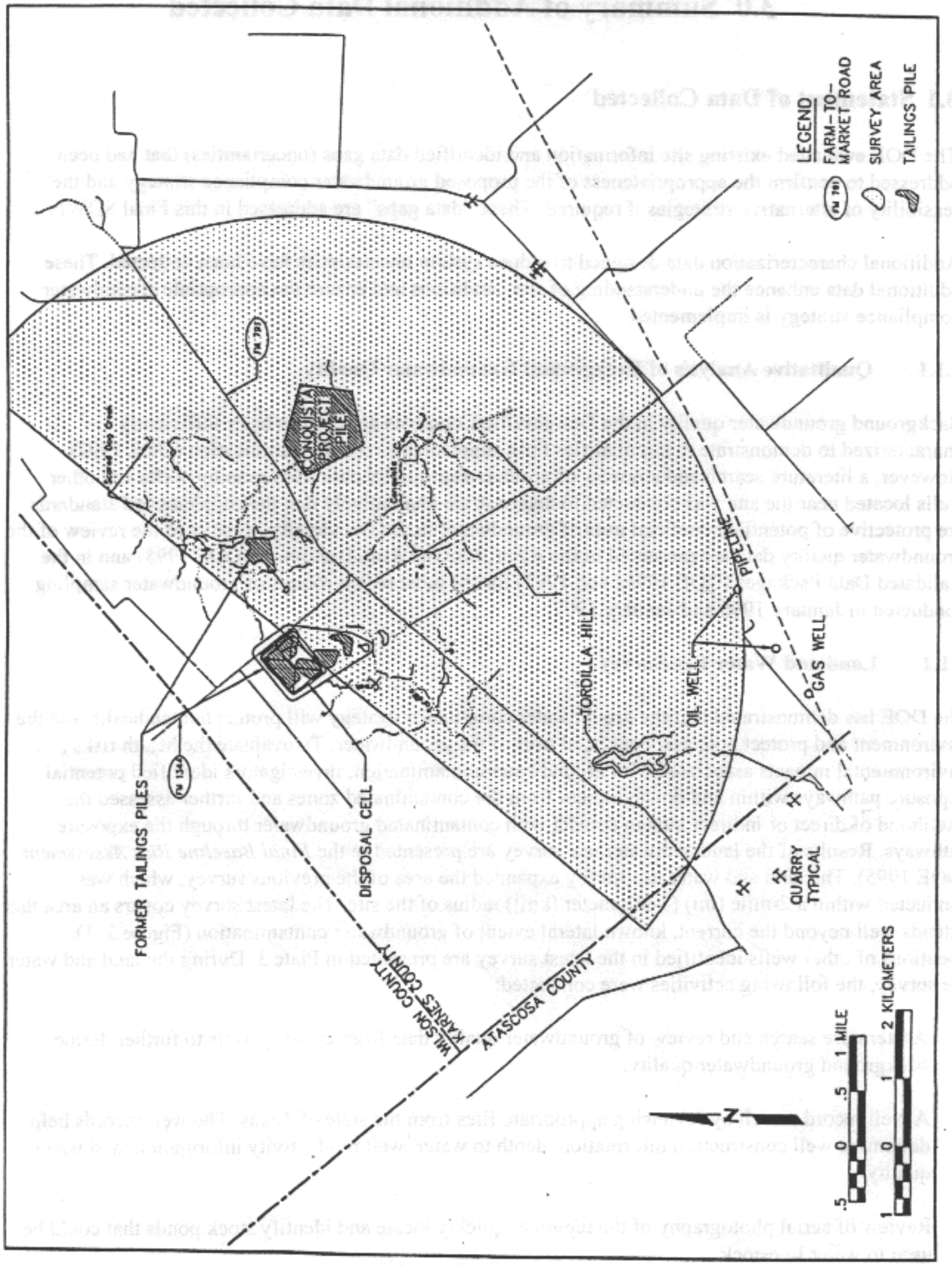


Figure 3–1. Areal Coverage of Land and Water Use Survey

- A door-to-door survey to interview local landowners regarding past and present land and water use. Domestic wells and stock ponds were located and sampled, if possible. Depth-to-water was measured in domestic wells.

3.1.3 Hydrogeologic Investigations

Installing Monitor Wells and Groundwater Sampling

DOE installed twelve additional monitor wells at the site to further define the extent and magnitude of contamination in the uppermost aquifer, refine the understanding of groundwater flow direction(s), further assess the potential affects of the contamination on other aquifers, and further assess potential beneficial uses of those aquifers. Monitor well construction details and lithologic information are provided in Appendix A. The location of each new monitor well is shown in Figure 3–2.

- Monitor well 883 was installed at a location southeast of the disposal cell and southeast of Farm-to-Market (FM) Road 791 to further characterize the downgradient extent of contamination in the Deweesville/Conquista aquifer that is associated with the former tailings piles 1, 2, 4, 5, 6, and 7.

- Monitor wells 884, 885, 886, and 887 were installed to further characterize the extent of groundwater contamination in the Deweesville/Conquista aquifer associated with former tailings pile 3. These monitor wells are located south and east of former tailings pile 3 and north of FM 791.

- Monitor well 888 was completed in the Dilworth aquifer east of former tailings pile 3 to verify that contamination has not reached the Dilworth aquifer in this area.

- Monitor wells 889, 890, and 891 were installed north of former tailings pile 3 to further characterize the extent of groundwater contamination in the Dilworth aquifer along Scared Dog Creek.

- Monitor well 892 was completed in the Conquista and Deweesville aquifer to further characterize the downgradient extent of contamination south of the disposal cell along Tordilla Creek.

- Monitor well 893 was installed at a location downgradient from former tailings pile 4 near the former location of monitor well 833. Abandoned during surface remediation activities, well 833 is believed to have been improperly completed in the Dilworth aquifer, thus water samples collected from well 833 have shown evidence of mill-related contamination. Monitor well 893 was completed in the Dilworth aquifer to evaluate if mill-related contamination is present in the Dilworth aquifer in this area.

- Monitor well 894 was completed in the Deweesville and Conquista aquifer, next to the existing Deweesville/Conquista well 880, to serve as an observation well during a proposed aquifer test.

Water Level Monitoring

During routine groundwater sampling, the depth to water in monitor wells completed in the uppermost aquifer was measured to observe short- and long-term fluctuations in groundwater levels and to evaluate the rate of groundwater mound dissipation immediately downgradient of the disposal cell. Potentiometric contour maps of the groundwater surface for the Deweesville/Conquista and Dilworth aquifers, measured during the January 1997 sampling campaign, are presented in Section 4.0.

Core/Analysis

Core analysis for porosity, bulk density, grain size analysis, and saturated hydraulic conductivity was conducted on selected samples to provide more detailed, small-scale information on aquifer characteristics. Core tests relate the parameters determined on a small portion of the aquifer (cubic centimeters) to the macroscopic behavior of the aquifer (cubic kilometers). Results of the tests conducted by Daniel B. Stephens & Associates, Inc., are provided in Appendix B.

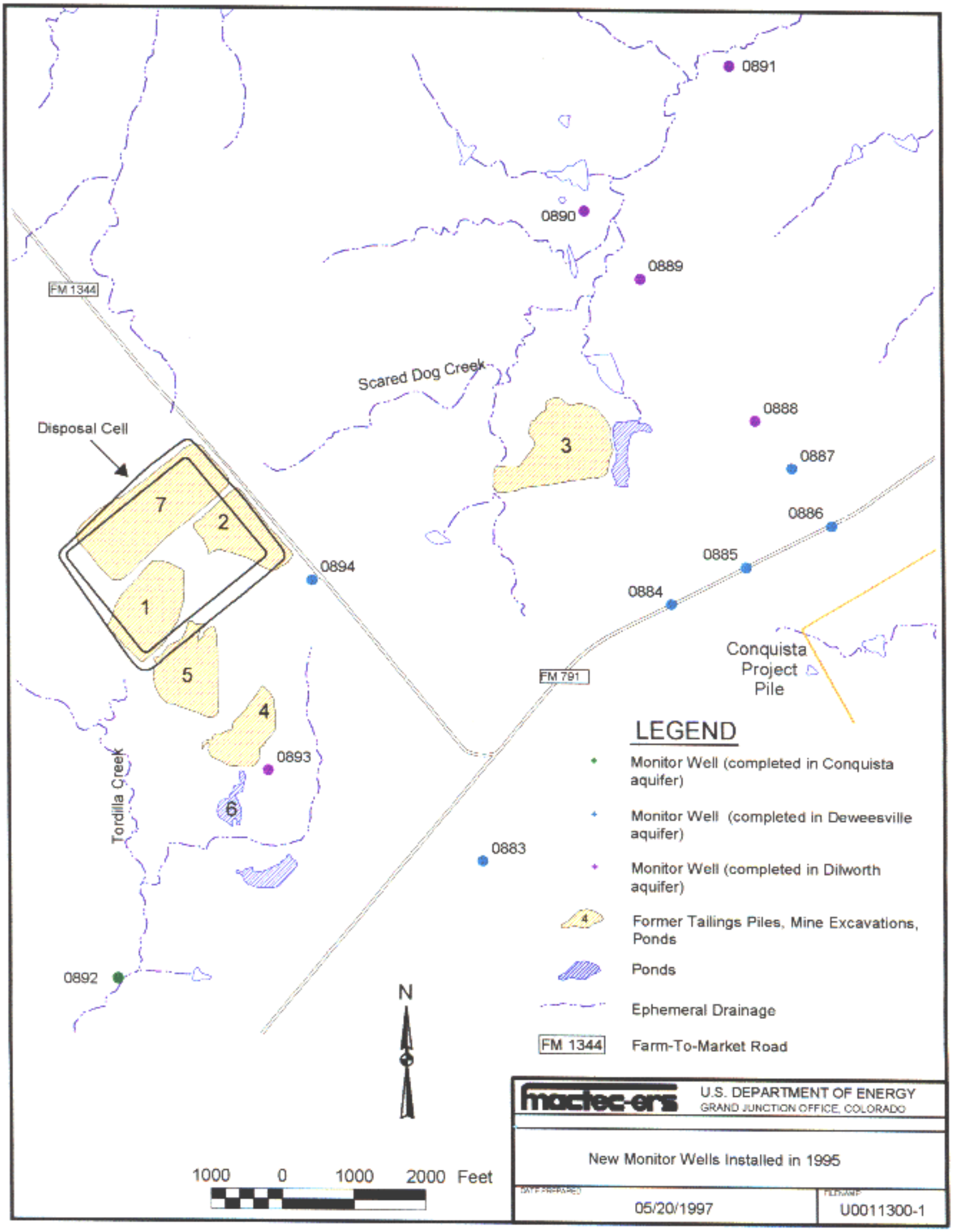


Figure 3–2. New Monitor Wells Installed in 1995

4.0 Site Conditions

This section discusses past uranium mining and milling activities at and in the vicinity of the Falls City site, the surface remedial action, and the status of surface cleanup efforts. Site characterization data are summarized and the site conceptual model is presented. The site conceptual model is based on groundwater characterization data and is intended to enhance the understanding of the extent and magnitude of contamination, exposure pathways, and risk to public health and the environment. The model also provides the rationale for the proposed groundwater compliance strategy.

Hydrogeologic and geochemical characterization activities at the Falls City site began before surface cleanup and continued throughout surface remedial action (Falls City Site Technical Notebook, January 1995). Thus, sufficient data are available to develop a conceptual model for the former processing site. Section 4.3 presents the conceptual model and discusses the nature and extent of the groundwater contamination based on the most recent rounds of groundwater sampling conducted in January 1996 and January 1997.

4.1 Site History

4.1.1 Physical Setting

The Falls City site is in Karnes County, Texas, approximately 8 mi (13 km) southwest of the town of Falls City and 46 mi (74 km) southeast of San Antonio, Texas (Figure 4–1). Before surface remedial action, the tailings site consisted of two parcels. Parcel A consisted of the mill site, one mill building, five tailings piles, and one tailings pond south of FM Road 1344 and west of FM 791. A sixth tailings pile, designated Parcel B, was north of FM 791 and east of FM 1344 (Figure 4–2).

4.1.2 Land and Water Use

Most of the land surrounding the former processing site is used for cattle grazing and dry farming. Local residents primarily grow hay and other livestock feed crops. Most livestock in the site area are beef cattle; some residents keep small poultry flocks.

The Deweesville/Conquista and the Dilworth aquifers are not used as domestic or potable water supplies in the site vicinity, although the Dilworth aquifer is occasionally used within a 2-mi (3-km) radius of the site to water stock (DOE 1992). The Three Oaks Water Company supplies residences within the site area with water from a Carrizo Sandstone well. This well is 2,000 feet (ft) (600 meters [m]) deep and is approximately 10 mi (16 km) northwest of the site. Livestock are watered primarily from surface collection tanks or stock ponds.

4.1.3 History of Operations

In late 1955, the Climax Molybdenum Company identified uranium ore deposits averaging 0.20 percent uranium oxide (U_3O_8) in an area 8 mi (13 km) west of Falls City. Open-pit mining occurred from 1959 to 1960 and was completed when Susquehanna-Western, Inc. (SWI) acquired the property as a mill site in 1961. Open-pit mining occurred at the former locations of piles 3, 4, 5, and 6. The mill was constructed as a nominal 300-ton-per-day (tpd) operation, but operated at 220 tpd from April 1961 until early 1968 (Merritt 1971). In 1968, the mill expanded to operate at 900 tpd and, for short periods, up to

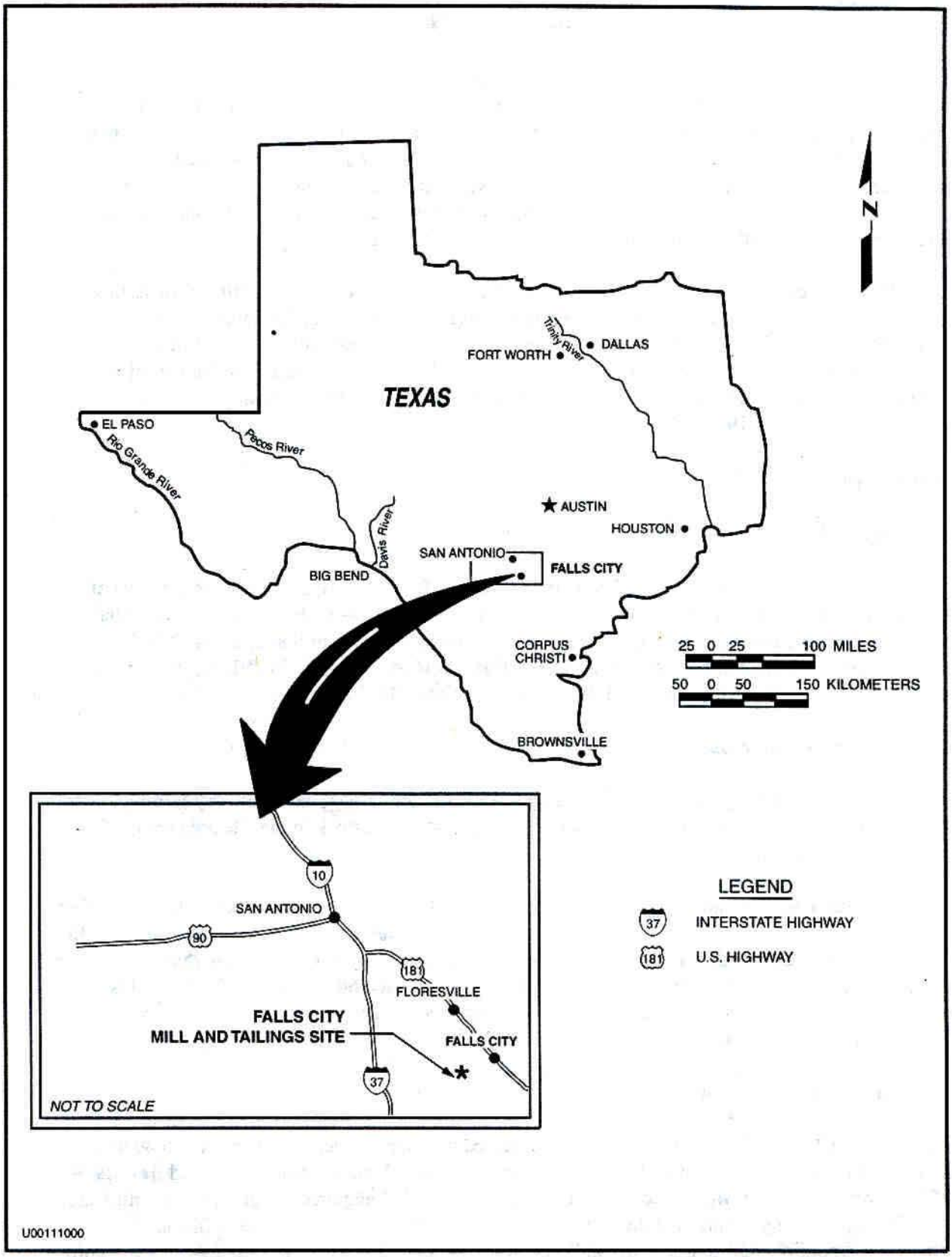


Figure 4–1. Location of the Falls City, Texas, Site

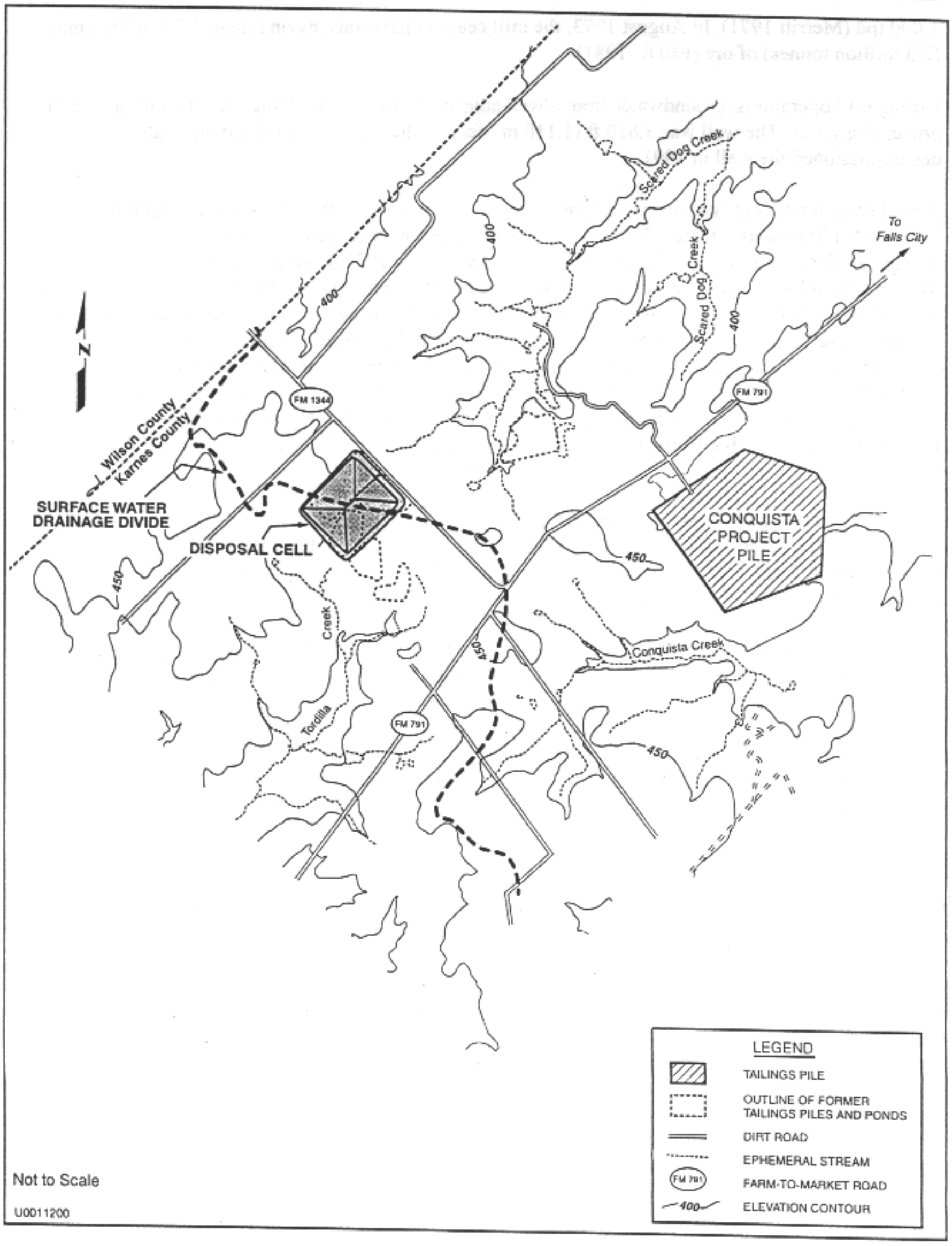


Figure 4–2. Topographic Map of the Disposal Site Area, Falls City, Texas, Site

1,000 tpd (Merritt 1971). In August 1973, the mill ceased operations, having treated 2.5 million tons (2.3 million tonnes) of ore (FBDU 1981).

During mill operations, groundwater from a well adjacent to the mill building was the only source of processing water. The well was 3,650 ft (1,110 m) deep in the Carrizo Sandstone; the state decommissioned the well in 1991.

A SWI solid waste registration application submitted in 1973 stated that fresh water consumption ranged from 50 to 150 gallons (190 to 570 liters) per minute. Consumption depended on the ore, amount of rainfall, and/or tailings pond solution available for recycle (in 1973 ponded water from tailings pile 7 was the only solution in active use), and reagent consumption required by the process. SWI also stated in the application that "75 gpm [gallons per minute] fresh water consumption may be considered a fair average." That measurement represents a net discharge to tailings pile 7 of approximately 121 acre (ac)-ft per year. The ponds on the tailings piles were not lined, but sumps along the pile perimeters pumped runoff and seepage back to the tailings piles. During mill operation (1961 to 1973), approximately 865 ac-ft of ore-processing water and precipitation that fell on the ponds might have infiltrated the Deweesville/Conquista aquifer. This calculation is included as Appendix C to this document.

At the completion of SWI operations in 1973, a 40-ac (16-hectare [ha]) pond had been created at the top of pile 7. The liquids in this pond were acidic raffinates. In August 1978, Solution Engineering, Inc., of Alice, Texas, initiated *in situ* extraction mining on the tailings piles, installing an injection/withdrawal system in pile 7. Fluids from the raffinate pond were injected to a depth of 30 to 45 ft (9 to 14 m) at a rate of about 500 gallons (1,900 liters) per minute. Between 300 and 550 gallons (1,140 to 2,100 liters) per minute of fluids were extracted from the pile; those uranium-bearing solutions were processed at the mill. Eventually, the operation expanded to piles 1, 2, 4, and 5. *In situ* solution mining ended in February 1982. In 1983, after 3.5 years of leaching operations, the state of Texas annulled Solution Engineering's operating license and directed the company to conduct interim restoration activities. Interim restoration consisted of spray-evaporating the large ponds on top of piles 7 and 2, capping piles 7 and 2 with a 1- to 2-ft (0.3- to 0.6-m)-thick clay cover, and dismantling the mill. The interim restoration was completed in 1986 and probably reduced the rate of pore fluid seepage into the aquifer (DOE 1992).

4.1.4 Milling Process

An acid-leach countercurrent-decantation solvent-extraction system extracted and concentrated the uranium (as U_3O_8). This process is described below (Merritt 1971).

Sulfuric acid was added as a leaching agent to the ore slurry, producing a slurry with a pH near 1.0. A five-stage, countercurrent washing circuit included a polyacrylamide-type flocculent to assist in separating the slimes from the process stream. The solvent extraction circuit included an organic solution containing 7.5 percent tertiary amine and 2.5 percent isodecanol in kerosene. Uranium was stripped from the loaded organic with either a sodium carbonate or acidified sodium chloride solution. The final uranium product ("yellow cake") was precipitated by adding caustic soda.

4.1.5 Surface Remedial Action

Remedial action consolidated and stabilized 7.0 million tons (6.4 million tonnes) of tailings and contaminated materials into a disposal cell covering 132 ac (53.4 ha) in the vicinity of piles 7 and 2. The approximate footprint of the cell is 2,600 x 2,200 ft (790 x 670 m). At least 30 monitor wells within or around the construction area were decommissioned (cutoff and grouted) during surface remedial action.

The DOE is required to demonstrate that RRM surface cleanup and disposal will not impact (or further impact) groundwater in the vicinity of the former processing site. Thus, the NRC required the site-specific RAP to include a groundwater protection strategy.

To protect the groundwater and achieve compliance with the EPA groundwater standards, a narrative supplemental standard for the Falls City site was proposed. The supplemental standard for the surface remedial action was based on widespread ambient contamination that could not be cleaned up using methods reasonably employed by public water supply systems. Also, there were few potential beneficial uses of the groundwater due to poor quality and low yield. Historically, the uppermost aquifer has not been used as a drinking water source for those two reasons. Because the groundwater quality is so poor (TDS 7,500 mg/L) in the upper aquifers, they are rarely used except as a water source for limited stock watering and occasional home garden irrigation. Therefore, groundwater in the uppermost aquifers meets the widespread ambient contamination criterion of limited-use groundwater (DOE 1992).

The NRC and the state of Texas concurred with the surface RAP and groundwater protection strategy in September 1992. Surface remedial action was completed in May 1994.

4.2 Sources of Existing Data

The UMTRA Project and other investigators conducted several hydrologic, geologic, and geochemical studies at and in the vicinity of the Falls City processing site.

In a U.S. Geological Survey (USGS) report based largely on data from the exploratory drilling programs conducted in the late 1950s, Bunker and MacKallor (1973) describe the geology of uranium ore deposits in the Falls City area. The USGS report includes detailed discussions of the stratigraphy and mineralogy of several ore deposits in the Tordilla Hill-Deweesville area, including the two deposits (Nuhn and Luckett) mined at the Falls City site (open pit mines).

Kallus (1975) prepared a report for EPA Region VI on the general environmental impacts of uranium mining and milling in the South Texas uranium district. That report summarizes surface and groundwater monitoring data compiled from USGS and Texas Water Quality Board records. Groundwater data were derived from approximately 100 samples, with complete chemical analyses performed on one-third of the samples. Kallus found highly variable natural levels of radioactivity, arsenic, molybdenum, and selenium in South Texas groundwater. The only reported health impact from uranium mining was molybdenosis in cattle that grazed in runoff-contaminated areas near overburden piles.

Turk, Kehle & Associates (TKA) conducted the first site-specific hydrogeologic study at the Falls City mill site in 1976 (TKA 1976). This study was a reconnaissance-level investigation that relied on existing water level and water quality data from 26 monitor wells around the site and included a general characterization of the local climate, geology, surface water quality, and groundwater conditions. The TKA study concluded radioactive contamination (gross alpha and beta activity) was not evident in the aquifer system beneath the site.

Ford, Bacon & Davis Utah, Inc. (FBDU 1981) prepared an engineering assessment of the Falls City site that included field sampling of the 14 monitor wells installed by Solution Engineering, Inc. around the tailings piles. Analyses of samples from these wells indicated contamination of the shallow aquifer in the vicinity of the tailings piles.

In 1983, Geochemistry and Environmental Chemistry Research, Inc. (GECR 1983), initiated a geochemical investigation of the Falls City site. Approximately 50 surface water and soil core samples were analyzed to define the extent of surficial contamination on and around the tailings piles. However, only two wells in the vicinity of the site were sampled.

The recent site characterization program conducted by the UMTRA Project included a four-phase hydrogeologic field investigation. In the first phase (December 1985 through May 1986), 39 new 4-inch (in.) (100 millimeter [mm]) polyvinyl chloride (PVC) cased monitor wells were installed and sampled; 25 existing wells were sampled as well.

The second phase of the investigation (December 1988 through March 1990) was designed to gather supplemental data from the site to fill data gaps and achieve full compliance with the EPA groundwater protection standards. In addition, 12 more monitor wells were installed at depths ranging from 40 to 230 ft (2 to 70 m), completed primarily in the Dilworth Sandstone Member and the upper Manning Clay Formation; groundwater from 50 to 55 monitor wells was sampled, including the 12 new wells and selected Conoco background wells in the site vicinity; and 16 lysimeters were installed to characterize the water quality of tailings fluids in piles 1, 2, 4, 5, 7, and pond 6.

Between 1990 and 1992, with the assistance of the Texas Bureau of Economic Geology, the UMTRA Project conducted a third phase of the field program to further characterize site geochemistry. The program included drilling 13 coreholes, analyzing the geochemistry of the cores, and installing 17 new monitor wells.

In 1991 and in early spring of 1994, domestic well surveys were conducted in a 2-mi (3-km) radial area centered upon the site. The survey determined the historical and current use of groundwater in the Deweesville/Conquista and Dilworth aquifers. Plate 3 shows locations of all wells drilled or sampled by the DOE at the Falls City site.

During the final phase in late 1995, twelve additional monitor wells were installed to: 1) refine the conceptual model of the groundwater flow system, 2) further quantify the extent and magnitude of groundwater contamination at the site, and 3) determine aquifer characteristics by analyzing core samples for porosity, hydraulic conductivity, particle size characteristics, and bulk density.

4.3 Conceptual Site Model

A conceptual model of the site was developed to understand the site and to support the proposed groundwater compliance strategy and remediation objectives. The conceptual model is summarized below. Figure 4–3 shows the locations of all the monitor wells used to develop the model. Sections 4.3.1 through 4.3.5 provide details of the model.

Two low-yield (generally less than 1 gallon [4 liters] per minute) aquifers underlying the site have been identified: the Deweesville/Conquista and the Dilworth. The Deweesville and Conquista Members are grouped together as one aquifer because no continuous impermeable strata separates them and exploration drilling during past uranium mining left boreholes that may not have been thoroughly decommissioned.

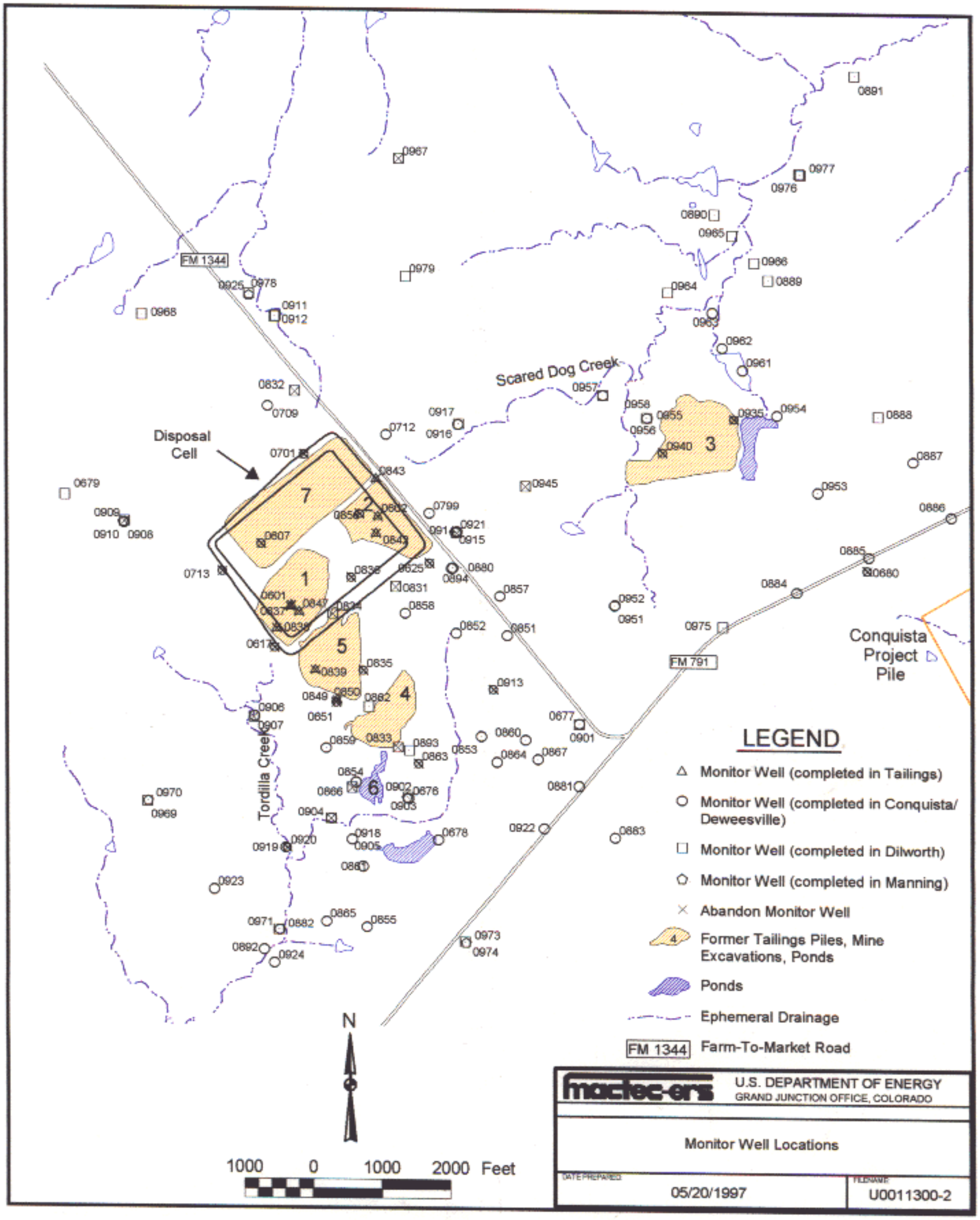


Figure 4–3. Monitor Well Locations

Several investigators, including the Technical Assistance Contractor (TAC) and the Texas Bureau of Economic Geology, concluded the upper portions of the Deweesville/Conquista Formations (the subsurface at the processing site) historically were unsaturated, and milling and *in situ* mining activities caused the current saturated conditions beneath the site. The TAC and the Texas Bureau of Economic Geology determined that processing and mining water created a ground water mound under the site and that ground water from the mound moved radially outward and downdip. The TAC used MODFLOW (USGS 1988) to simulate groundwater flow at the site; preliminary modeling results support the hydrologic representation of site conditions suggested by the TAC and Texas Bureau of Economic Geology.

The principal ore-bearing unit at the site is the Deweesville Sandstone. Because the uranium mineralization associated with the ore bodies causes background ground water quality in both the Deweesville/Conquista and Dilworth aquifers to vary with depth and location, the ground water quality is difficult to define deterministically. Thus, the understanding of geochemical conditions at the site is best described qualitatively. Contaminants of concern in the aquifer that are related to the mill processing have been identified.

4.3.1 Hydrogeologic Setting

The Falls City site is on the coastal plain of the Gulf of Mexico. The main topographic element in the Karnes County area is a series of ridges trending predominantly northeast to southwest. These ridges are mainly cuestas (sloping plains) formed by resistant gulfward-dipping strata, although some river terrace gravels also form local topographic highs. Small intermittent streams follow the easily eroded strata between cuestas, producing a pronounced northeast trend in the drainage pattern in the site area. Relief from ridges to intervening drainage pathways is generally less than 100 ft (30 m) (TKA 1976). Figure 4–2 presents a topographic map of the site area.

Mean annual precipitation in the site area is 30 in. (760 mm) (NOAA 1979). Virtually all measurable precipitation is in the form of rain, which reaches monthly maxima in both May and September (NOAA 1979). Most precipitation occurs as heavy rainfall during brief thunderstorms, which causes great spatial and temporal variability in rainfall distribution.

The Falls City site is underlain by clastic sedimentary strata that dip gently southeast (approximately 20 ft per 1,000 ft) as part of the thick homoclinal sequence of the Gulf Coastal Plain. The local sedimentary strata are comprised of generally unlithified sand, silt, and clay deposits of the Whitsett and Manning Clay Formations. The site rests on outcrops of the Dubose Clay, Deweesville Sandstone, and Conquista Clay Members of the Whitsett Formation (Plate 1). Tailings were placed in several old open pits excavated through the ore-bearing Deweesville and upper Conquista Members. Underlying the Conquista Clay is the Dilworth Sandstone Member, which, in turn, overlies the Manning Clay Formation. The Manning Clay is the oldest geologic unit encountered during the site drilling program. The site is located on a groundwater divide. This divide is oriented west-northwest through the disposal cell area.

Three low-yield water-bearing strata are within the upper 200 ft (60 m) of the Whitsett Formation sediments underlying the site. These water-bearing strata in descending order are the Deweesville Sandstone Member, the Conquista Clay Member, and the Dilworth Sandstone Member. The Conquista Clay Member is composed of three subunits: an oxidized upper Conquista Clay/silt, the Conquista Sandstone, and a lower Conquista Clay (Plate 2). The Conquista Sandstone extends downdip into the subsurface but thins significantly and becomes considerably finer-grained. The Deweesville Sandstone Member, upper Conquista Clay, and Conquista Sandstone subunits are grouped together as one aquifer because continuous impermeable strata do not separate the members, with no apparent restrictions in groundwater movement between the two members. Although the Deweesville/Conquista and Dilworth

are referred to as aquifers in this document, these members have never been developed as a source for drinking water supply because of their low yield (generally less than 1 gallon [4 liters] per minute) and poor water quality.

4.3.1.1 Deweesville/Conquista Aquifer

Shallow groundwater in the site vicinity is found in the Deweesville/Conquista aquifer at depths of 5 to 30 ft (2 to 9 m) below land surface. Groundwater within the aquifer occurs under unconfined conditions in the northern and western portions of the site vicinity and along creek beds. In areas where the Deweesville/Conquista aquifer is unconfined, the potentiometric surface generally is a subdued replica of the surface topography. The saturated condition of the Deweesville/Conquista in the immediate vicinity of the disposal cell is due, in part, to the discharge of past milling-process water.

The top of the lower Conquista Clay defines the lower boundary of the Deweesville/Conquista aquifer. The intersection of the Deweesville/Conquista water table and the top of the lower Conquista Clay marks the approximate updip limit of saturation in the Deweesville/Conquista aquifer (Plate 2). Because the former tailings piles were located on the updip surface of the Deweesville Sandstone and the upper Conquista Clay outcrops, it is impossible to install upgradient, background monitor wells screened in the Deweesville/Conquista aquifer.

Groundwater within the Deweesville/Conquista aquifer is recharged by infiltrating precipitation in the Deweesville/Conquista outcrop areas (Plate 1), past seepage of tailings fluids, and interformation leakage in downdip areas. As shown on the potentiometric surface contour map developed from water level measurements collected in 1997 (Figure 4–4), groundwater from the former tailings piles flows in three directions: east, away from former tailings pile 2; south, toward the eastern tributary of Tordilla Creek; and southeast, down the structural dip of the Deweesville beneath FM 791 and into the deeper subsurface.

Seepage from tailings disposed of in old pits and on the outcrop of the Deweesville Sandstone and upper and middle Conquista members has resulted in a groundwater mound in the Deweesville/Conquista aquifer (Figure 4–4). The Deweesville/Conquista potentiometric surface beneath tailings piles 1, 2, 4, and 5 is higher than background groundwater levels. Groundwater levels near the tailings have risen since initial mining. Before milling and tailings disposal activities, there was little water in the Deweesville/Conquista from the tailings area down to the tributary of Tordilla Creek (BEG 1992). A review of the scientific literature on this site suggests this zone of the Deweesville/Conquista might have contained very little water prior to milling activity. The floor of open pit mine 5 (former tailings pile 5) extended several feet below the Deweesville/Conquista interface; a 1960 photograph of this pit (Bunker and MacKallor 1973) shows the contact between the Deweesville and the Conquista was dry. After these pits were filled with saturated tailings and the later leachate injection/*in situ* leaching began, large volumes of tailings pore water were introduced to the Deweesville/Conquista. Consequently, a groundwater mound developed on the processing site in and around the tailings piles. Currently, the water table in the outcrop area of the Deweesville is 8 to 17 ft (2 to 5 m) above the base of the Deweesville. The Conquista Clay also was affected by these milling-related processes and water levels beneath pile 7 (on the Conquista outcrop) may have been as much as 40 ft (10 m) higher than the background water table elevation (BEG 1992). Background groundwater conditions do not exist in the outcrop area of the Deweesville Sandstone immediately east of the site. Naturally occurring groundwater might only exist where the Deweesville/Conquista aquifer dips below the Dubose Clay (BEG 1992).

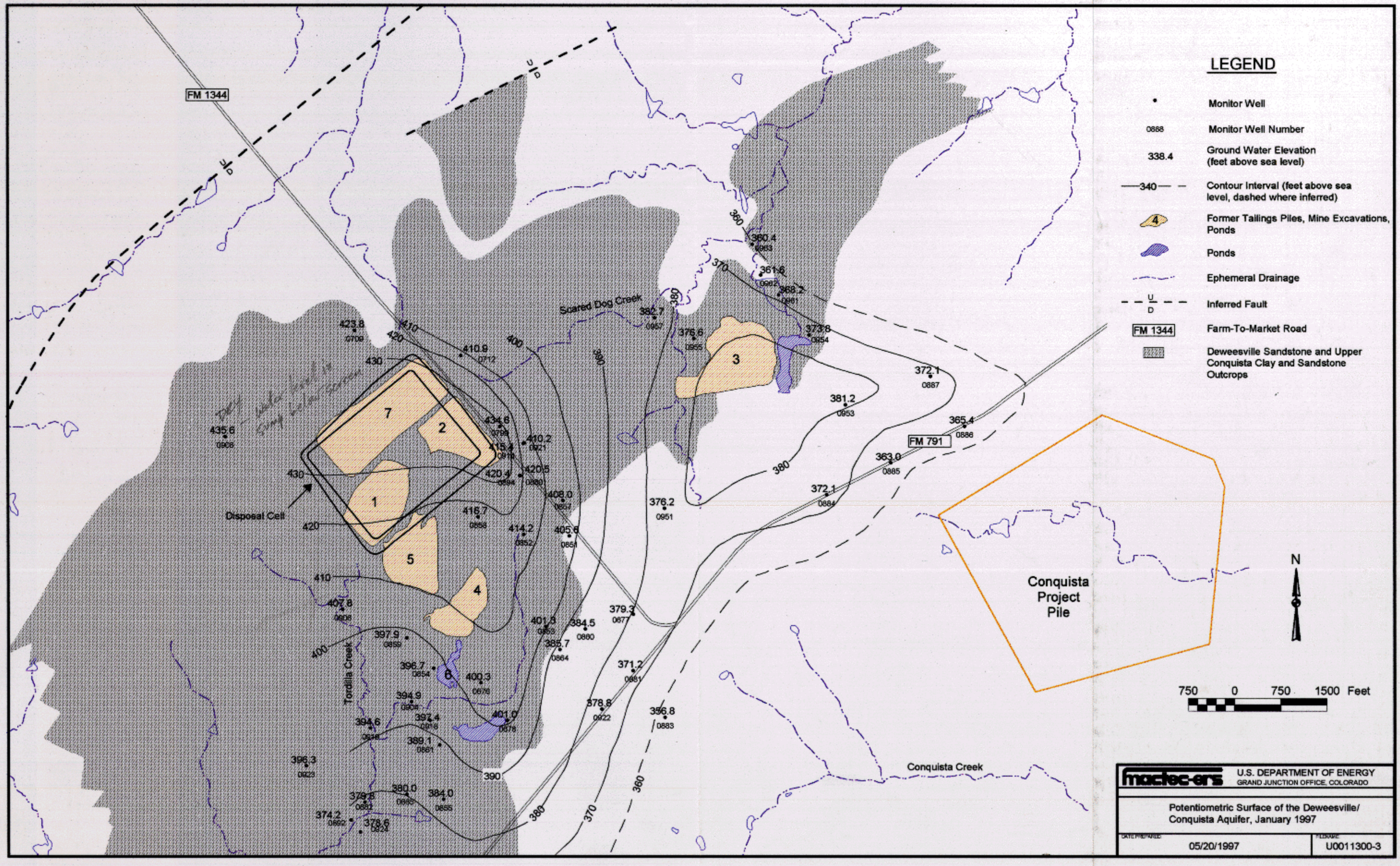


Figure 4–4. Potentiometric Surface of the Deweesville/Conquista Aquifer, January 1997

4.3.1.2 Dilworth Aquifer

The Dilworth aquifer is a sandstone member of the Whitsett Formation. Groundwater is unconfined north of the site where the Dilworth sandstone is recharged at the outcrop (Plate 1). A potentiometric surface map of the Dilworth aquifer is shown in Figure 4–5 using water level measurements collected in January 1997. In general, the groundwater flows along strike in the recharge area. Depth to groundwater in the Dilworth aquifer is approximately 100 ft (30 m) below ground level in the area where the disposal cell is located. Downdip to the southeast, groundwater in the Dilworth aquifer becomes confined by the lower Conquista clay.

The Dilworth aquifer is separated from the Deweesville/Conquista aquifer by 30 to 50 ft (9 to 15 m) of carbonaceous clay of the lower Conquista Clay subunit, which acts as an aquitard to downward seepage. A downward hydraulic gradient occurs between the Dilworth aquifer and the overlying Deweesville/Conquista aquifer.

The Texas Bureau of Economic Geology identified three discrete potentiometric highs as an indication of leakage from the Deweesville/Conquista aquifer into the Dilworth aquifer. These leakages were caused by extensive deep drilling by mining companies exploring for ore. The potentiometric highs are near monitor wells 901, 915 and 917, and 905 and 907. The mining exploration programs drilled approximately 370 boreholes that typically penetrated through the Dilworth and were not abandoned properly (BEG 1992). The monitor wells were constructed with the filter pack interval placed across the Conquista/Dilworth contact. The elevated water levels might be influenced by drainage from the Deweesville/Conquista aquifer through the well bore annulus rather than drainage through the formations. The Dilworth is underlain by the carbonaceous clays and lignite seams of the Manning Clay Formation which effectively forms a 300-ft (90-m)-thick aquitard.

Because improperly abandoned exploratory boreholes create a potential hydraulic interconnection between the Deweesville/Conquista aquifer and the Dilworth aquifer, the Dilworth Sandstone Member is included as part of the uppermost aquifer.

4.3.1.3 Hydraulic and Transport Properties

The saturated hydraulic conductivities of the most permeable beds of the Whitsett Formation aquifer system, as determined by aquifer tests and single-packer pressure testing, range from approximately 0.5 to 2.6 ft per day (ft/d) (1.8×10^{-4} to 9.0×10^{-4} centimeters per second [cm/s]). The TAC conducted this aquifer test (and all other aquifer tests discussed here) in the spring of 1991. The hydraulic conductivities are consistent with the ranges generally reported in the hydrologic literature for sandy clays, silty to clayey sands, and fine sandstones. The sandy members contain a high percentage of silts and clays, and yield small amounts of water (1 to 2 gallons [4 to 8 liters] per minute) to extraction wells. The lowest hydraulic conductivities are found in the carbonaceous clays of the lower Conquista Clay Unit and the silty to clayey sands of the upper Dilworth Sandstone Member. The most permeable intervals tested are the fossiliferous sands of the middle Conquista Clay Unit and the unconsolidated, fine-to-medium sands of the lower Dilworth Sandstone.

The horizontal hydraulic conductivities in the Deweesville and Conquista Members are highly variable, with a value range of 2 orders of magnitude. The maximum horizontal hydraulic conductivity for the Deweesville/Conquista aquifer is 2.6 ft/d (9.0×10^{-4} cm/s), calculated from aquifer test data from a well screened in the Conquista Sandstone (DOE 1992). Using Darcy's Law, an assumed effective porosity of 0.1, and an average hydraulic gradient of 0.013 to the east-southeast, the maximum average linear groundwater velocity is 130 ft (40 m) per year.

Average linear groundwater velocities in the Dilworth aquifer were calculated using a hydraulic conductivity of 0.68 ft/d (2.4×10^{-4} cm/s) (approximate maximum value from aquifer test), a hydraulic gradient of 0.009 to the east-southeast, and an assumed effective porosity of 0.1 for the fine sands of this zone (DOE 1992). The average linear velocity for groundwater flow in the lower Dilworth aquifer is approximately 22 ft (6.7 m) per year.

A downward hydraulic potential flow exists between the Deweesville/Conquista and Dilworth aquifers. During a 10-hour aquifer test of monitor well 902 completed in the Dilworth, drawdown was observed in an adjacent monitor well (676) screened in the Deweesville. Vertical leakage was calculated to be 7.4×10^{-5} day^{-1} from the analysis of time-drawdown data. Considering an aquitard thickness of 60 ft (20 m), the vertical hydraulic conductivity is 4.4×10^{-3} ft/d (1.6×10^{-6} cm/s).

4.3.2 Background Groundwater Quality

Background groundwater quality for the Deweesville/Conquista and Dilworth aquifers is defined as the quality of groundwater at the Falls City site that would be present if uranium processing activities had not occurred.

There is no single background groundwater quality for each of these aquifers. The natural groundwater quality varies within these aquifers as a function of residence time and aquifer matrix composition. The Deweesville/Conquista and Dilworth aquifers can each be separated into three general regions or zones with different mineralogical and compositional characteristics. These zones are defined as the oxidized, transitional, and reduced zones. Although these zones overlap, the groundwater in each zone typically is distinct in composition from the groundwater in the other zones. Table 4–1 summarizes the range of background groundwater quality at the site. The constituents and concentrations presented in Table 4–1 are based on the latest available data. Other background water quality data are presented in the Falls City RAP (DOE 1992). The numerous unmined and mined ore bodies in the oxidizing, transitional, and reducing zones of the regional sediments cause considerable variation in the concentrations of hazardous constituents from zone to zone.

4.3.2.1 Deweesville/Conquista

The oxidized zone of the Deweesville/Conquista is defined as the outcrop area and shallow subsurface. At the Falls City UMTRA site, this zone was largely unsaturated before mining and milling. The oxidized zone later became saturated by the influx of large volumes of tailings leachate and mill processing water. Thus, groundwater in this zone at the mill site is not the result of natural processes, and a background groundwater quality for the oxidized, outcrop zone of the Deweesville/Conquista aquifer does not exist in the mill site area.

The transitional zone begins at the downdip edge of the Deweesville/Conquista outcrop (where the sediments are dominantly oxidized) and ends before the downgradient limit of the DOE monitor well array (e.g., 922 and 881, where the sediments are dominantly reduced). Groundwater quality before mining and milling activities in the uranium mineralized zone might have varied from conditions found in monitor well 951 to the much poorer quality groundwater found in monitor well 922. The interaction of oxidizing water from the recharge area with the pyrite- and ore-bearing sediments causes high variability in the background groundwater in the transitional zone.

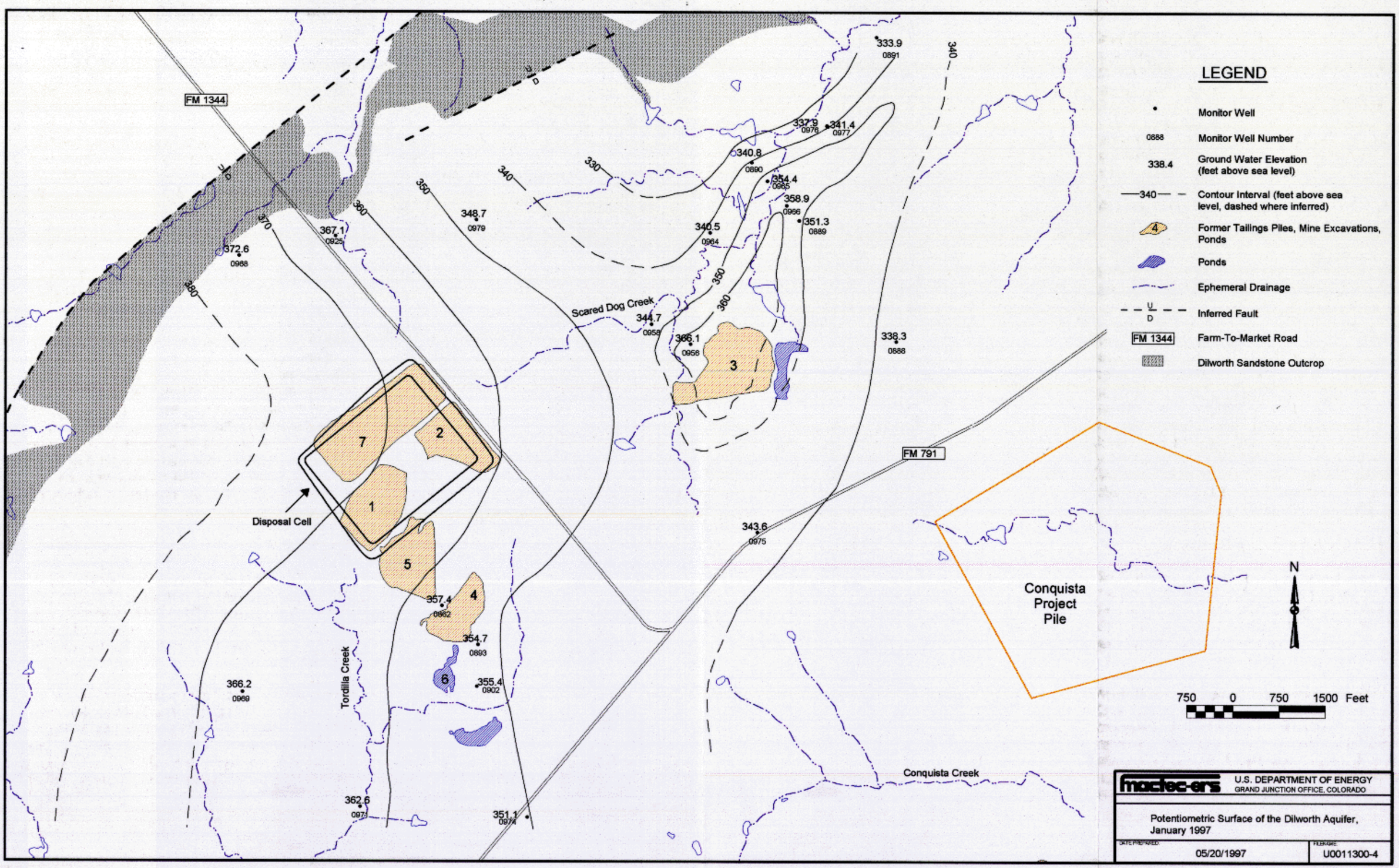


Figure 4–5. Potentiometric Surface of the Dilworth Aquifer, January 1997

Table 4–1. Typical Water Quality Data for Dilworth and Deweesville/Conquista Background Wells

	Tailings Fluid	Reduced Zone		Transitional Zone		Oxidized Zone (outcrop area)		
Constituents	**607**	**667**	**668**	**951**	**969**	**967**	**968**	**979**
Alkalinity		252	250	307	291	116	226	193
Calcium	510	335	405	364	495	278	90	258
Chloride	1040	785	944	708	779	793	338	672
Iron	544	0.45	0.19	0.03	0.87	<0.03	<0.03	<0.03
Magnesium	214	31.8	45.1	29	61	30.5	8.1	28.3
Manganese	22.6	0.21	0.78	0.21	2.94	0.02	<0.01	0.07
Nitrate	<1.0	4.9	3.5	4	1.3	10.2	12.4	4.4
pH	2.93	6.65	6.63	6.75	6.70	5.98	6.58	6.08
Potassium	2.38	43	29	45	43	30	18	36
Sodium	832	678	583	652	550	675	121	531
Sulfate	7390	1043	930	856	1290	817	156	569
Total dissolved solids	11900	3120	3310	2291	3650	2750	624	2210
Uranium	0.908	0.015	0.017	0.008	0.010	0.003	0.068	0.25

Note:

1. Most recent water quality data from same time period, June 1991 and July 1991.
2. Concentrations are reported in milligrams per liter except for pH.
3. Alkalinity reported as mg/L $CaCO_3$.

The upgradient limit of the reduced zone for the Deweesville/Conquista is defined by the DOE and Texas Bureau of Economic Geology as the downgradient edge of the DOE monitor well array (beginning at FM 791). Groundwater quality data from Conoco monitor wells 667 and 668 suggest the groundwater quality of the Deweesville/Conquista in parts of this zone is lower in sulfate, chloride, and many other constituents than water from the transitional zone. Figure 4–6 shows the locations of the Conoco monitor wells (667 and 668) and Dilworth background monitor wells.

To expand the background water quality data base for the Deweesville/Conquista aquifer, groundwater quality data from other areas in the Deweesville/Conquista were evaluated. Thirty-nine monitor wells were completed in the Deweesville Sandstone before mining activities began at the Hobson *in situ* uranium mine site, 8 or 9 mi (about 13 km) east of the UMTRA site. Of those 39 wells, 28 were completed in the ore body and the remaining 11 were completed nearby. Table 4–2 presents a statistical summary of water quality data obtained from the Deweesville monitor wells.

The Deweesville wells at the Hobson site are generally screened between 300 and 450 ft (90 to 140 m) below land surface. Therefore, groundwater from the Hobson site has probably migrated farther into the reduced zone of this aquifer than groundwater from monitor wells 667 and 668. The greater residence time of contaminants in deeper groundwater is reflected in the lower concentrations of sulfate, chloride, and other major and minor constituents in the Hobson groundwater relative to the 600 series wells (Table 4–2). Nonetheless, the groundwater from the 600 series wells and the Hobson wells might have followed a similar groundwater quality evolutionary trend. Figure 4–7 shows a trilinear plot of wells 667 and 668 and the 11 Hobson wells drilled around the ore body.

Unlike the major and minor element data, the trace element data from the Hobson area groundwater differ from those of monitor wells 667 and 668. The Hobson data show significantly elevated levels of lead, radium-226, and uranium (Table 4–2) because most of the Hobson samples were Deweesville groundwater equilibrating with uranium ore.

4.3.2.2 Dilworth

Four upgradient Dilworth monitor wells (967, 968, 969, and 979) are used to delineate the background water quality of this aquifer at the Falls City site. As shown on a trilinear plot (Figure 4–8), the upgradient Dilworth groundwaters are dominated by no single anionic species, and they contain subequal milliequivalents of sulfate and chloride with lesser bicarbonate. Sodium and calcium are the dominant cations. Table 4–3 presents a statistical summary of the water quality of Dilworth background groundwater.

Of the four DOE Dilworth background wells at the UMTRA site, three (967, 968, and 979) are completed in the oxidized zone, and one (969) is screened in the transitional zone of the aquifer. The groundwater quality of monitor well 969 is more representative of the remaining Dilworth wells at the site. The three upgradient wells in the oxidized zone of the Dilworth aquifer produce groundwater of higher quality than is probably typical of Dilworth groundwater beneath the site.

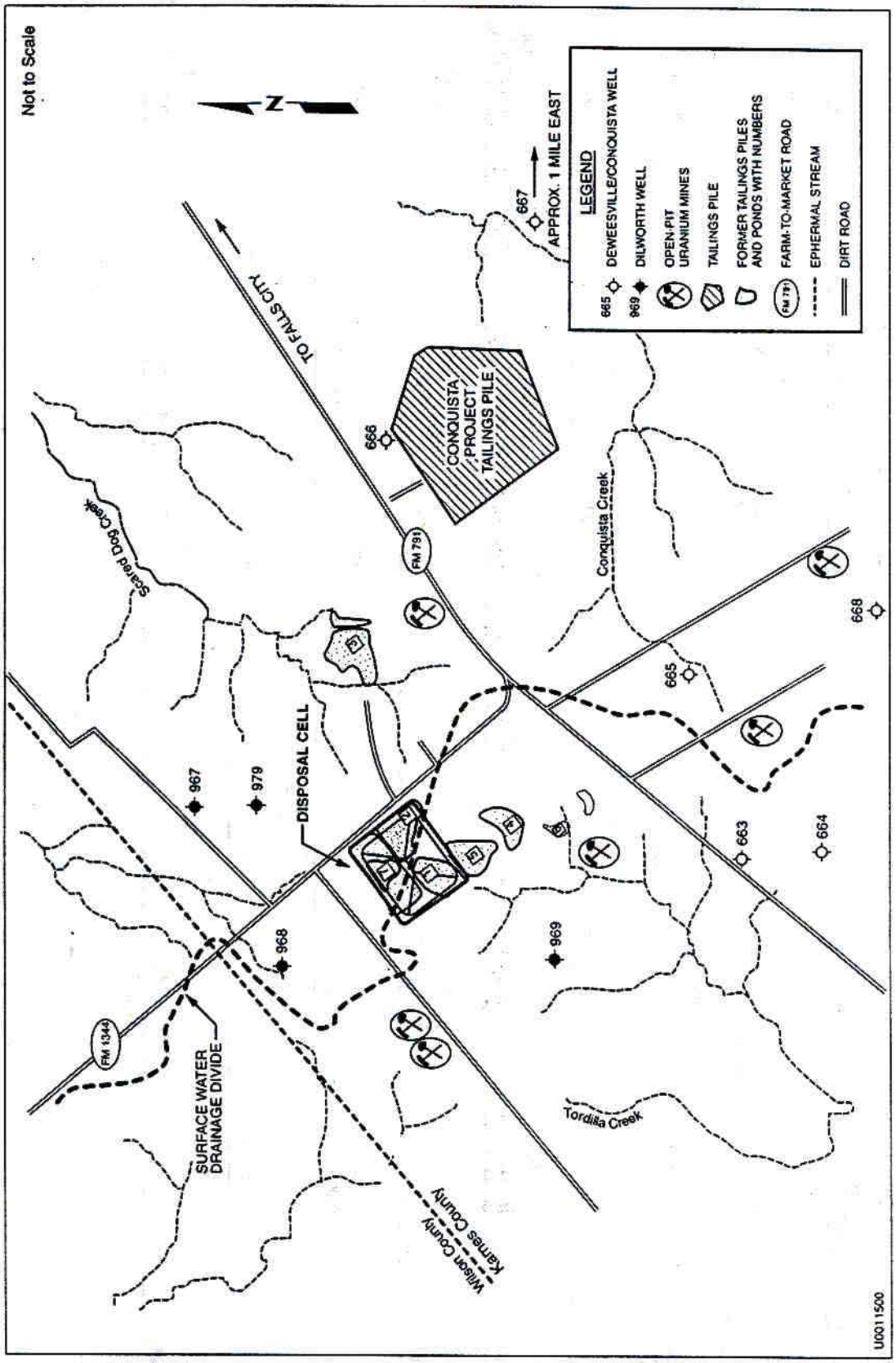


Figure 4–6. Locations of the Dilworth Background Wells and the Deweesville/Conquista Conoco 600 Series Wells, Falls City, Texas, Site

Table 4–2. Water Quality in the Deweesville/Conquista Aquifer at the Falls City, Texas, Site

	Background Ground Water				Ground Water at Mill Site by Region			
			Hobson Area[a]					
Constituent	On-site Crossgradient Well[b]	Area Southeast of FM 791[c]	Mine Zone	Production Zone	East[d]	North[e]	South[f]	West[g]
Aluminum								
FOD	2/6	0/4	NA	NA	41/44	16/29	27/44	31/36
Range	<0.05-0.05	<0.05-<0.1			<0.05-97.5	<0.014-796	<0.05-109	<0.05-66.2
Ammonia as NH4								
FOD	5/6	2/4	NA	NA	27/35	17/23	34/35	28/31
Range	<0.1-0.8	<0.1-0.3			<0.01-3.9	0.0323-268	<0.1-2.1	0.09-2.67
Antimony								
FOD	1/7	0/4	NA	NA	7/33	3/22	3/26	3/23
Range	<0.003-0.014	<0.003-<0.003			<0.003-0.031	<0.001-0.007	0.003-0.008	<0.003-0.013
Arsenic								
FOD	4/7	4/4	?	?	10/37	12/25	17/33	8/31
Range	0.008-0.01	0.01-0.02	0.003-0.035	0.003-0.09	0.001-0.09	<0.005-0.16	0.004-0.39	0.001-0.25
Barium								
FOD	6/7	2/4	?	?	22/33	16/19	24/28	23/27
Range	0.02-0.04	0.03-0.06	<0.4	<0.4	<0.01-0.06	0.01-0.04	0.01-0.05	0.02-0.11
Beryllium								
FOD	0/7	0/4	NA	NA	26/37	10/24	16/31	19/27
Range	<0.005-<0.01	<0.005-<0.01			<0.005-0.62	0.0012-0.38	<0.005-0.2	<0.005-0.09
Boron								
FOD	6/6	4/4	0.06-2.3	0.8-3.0	29/29	18/18	25/25	21/21
Range	0.69-0.96	0.56-1			0.48-2.38	1.11-3.09	0.87-2.37	0.77-2.23
Bromide								
FOD	6/6	4/4	NA	NA	40/42	24/28	38/41	31/32
Range	1-3.9	2.5-4.8			<0.1-11.7	<0.15-18.9	0.8-28.2	0.3-25.4

Table 4–2 (continued). Water Quality in the Deweesville/Conquista Aquifer at the Falls City, Texas, Site

	Background Ground Water				Ground Water at Mill Site by Region			
			Hobson Area[a]					
Constituent	On-site Crossgradient Well[b]	Area Southeast of FM 791[c]	Mine Zone	Production Zone	East[d]	North[e]	South[f]	West[g]
Cadmium								
FOD	3/7	0/4	?	?	35/42	20/25	21/36	27/34
Range	<0.001-0.009	<0.001-<0.01	0.01-0.01	0.005-0.01	<0.001-0.392	<0.001-0.55	<0.0005-0.22	<0.0005-0.048
Calcium								
FOD	7/7	4/4	?	?	52/52	31/31	48/48	41/41
Range	297-364	330-422	75-180	69-120	323-1060	430-1760	396-2120	540-1720
Chloride								
FOD	7/7	4/4	?	?	50/51	31/31	47/47	41/41
Range	708-780	785-1090	379-600	264-542	<1-2500	1460-4140	704-7480	540-7000
Chromium								
FOD	1/7	0/4	?	?	4/41	7/25	4/36	5/34
Range	<0.01-0.01	<0.01-<0.01	<0.01-0.1	<0.01-0.1	<0.004-0.01	<0.004-0.0351	<0.004-0.02	<0.004-0.07
Cobalt								
FOD	1/7	0/4	NA	NA	38/42	8/24	18/34	24/30
Range	0.01-0.01	<0.03-<0.05			<0.03-1.17	<0.005-0.776	<0.005-0.61	0.0212-0.26
Copper								
FOD	1/7	0/4	?	?	13/33	9/22	13/26	13/23
Range	<0.01-0.03	<0.01-<0.02	0.01-0.2	<0.01-0.5	<0.01-0.25	<0.005-0.12	<0.01-0.07	<0.01-0.11
Fluoride								
FOD	6/6	4/4	?	?	27/32	17/18	25/27	20/24
Range	0.2-0.8	0.6-0.6	0.1-2	0.04-0.4	<0.003-42.5	<0.1-98	<0.1-12	<0.003-4.4
Iron								
FOD	4/7	3/4	?	?	43/52	18/31	43/48	29/41
Range	0.02-0.06	<0.03-0.45	0.06-2.3	0.07-5.8	<0.006-126	0.0237-458	0.02-49.3	<0.03-103
Lead								
FOD	1/7	0/4	?	?	13/41	5/25	7/36	7/34
Range	0.001-0.001	<0.005-<0.01	0.03-0.10	0.02-0.15	0.001-0.04	0.001-0.02	0.001-0.03	0.001-0.02

Table 4–2 (continued). Water Quality in the Deweesville/Conquista Aquifer at the Falls City, Texas, Site

	Background Ground Water				Ground Water at Mill Site by Region			
			Hobson Area[a]					
Constituent	On-site Crossgradient Well[b]	Area Southeast of FM 791[c]	Mine Zone	Production Zone	East[d]	North[e]	South[f]	West[g]
Magnesium								
FOD	7/7	4/4	?	?	52/52	31/31	48/48	41/41
Range	26.1-32.6	31.8-51	0.3-9.4	1.8-4.2	35.6-574	81-1630	43.5-655	79.1-381
Manganese								
FOD	7/7	4/4	?	?	47/48	30/31	45/45	38/38
Range	0.04-0.55	0.21-0.78	0.1-0.4	0.3-0.3	<0.01-51.4	<0.01-95.1	0.7-50.5	0.34-16.3
Mercury								
FOD	0/6	0/4	?	?	3/41	1/22	1/38	4/30
Range	<0.0002-<0.000	2 <0.0002-<0.0002	<0.001-0.001	<0.001	<0.0002-0.0027	<0.0002-0.0011	<0.0002-0.0002	<0.0002-0.009
Molybdenum								
FOD	3/7	2/4	?	?	9/52	18/31	24/48	10/41
Range	<0.01-0.02	<0.01-0.02	<0.1-0.1	<0.1-0.2	<0.001-0.0219	0.0021-0.09	0.0016-0.68	<0.001-0.25
Nickel								
FOD	2/7	0/4	?	?	36/42	12/25	22/36	28/34
Range	0.01-0.1	<0.04-<0.04	<0.02-0.2	<0.01-0.08	0.03-1.3	0.0212-1.14	<0.007-0.99	0.039-0.29
Nitrate								
FOD	4/7	2/4	?	?	36/43	20/25	32/39	27/36
Range	<0.1-4.4	<1-4.9	1-4	2-9	<0.008-15.4	<0.008-53	<0.008-73.9	<0.008-29.2
Potassium								
FOD	7/7	4/4	?	?	52/52	31/31	48/48	41/41
Range	38-46.4	29-44	31-51	30-45	21.1-96	13-237	36.7-139	39-114
Selenium								
FOD	2/7	0/4	?	?	27/44	18/25	18/39	22/36
Range	0.002-0.012	<0.005-<0.005	0/004-0.05	0.003-0.06	0.00042-0.6	<0.005-0.217	<0.0002-1.2	<0.0002-1.2
Silica								
FOD	6/6	4/4	?	?	33/33	19/19	31/31	29/29
Range	43-49.2	34-58.4	53-76	55-103	11-165	43-171	21.7-141	41.9-198

Table 4–2 (continued). Water Quality in the Deweesville/Conquista Aquifer at the Falls City, Texas, Site

	Background Ground Water				Ground Water at Mill Site by Region			
			Hobson Area[a]					
Constituent	On-site Crossgradient Well[b]	Area Southeast of FM 791[c]	Mine Zone	Production Zone	East[d]	North[e]	South[f]	West[g]
Silver								
FOD	0/7	0/4	?	?	2/33	1/18	1/26	1/23
Range	<0.01-<0.01	<0.01-<0.01	<0.01-0.02	<0.01-0.09	<0.01-0.08	<0.01-0.07	<0.01-0.01	<0.01-0.01
Sodium								
FOD	7/7	4/4	?	?	52/52	31/31	48/48	41/41
Range	530-652	577-678	313-564	248-399	383-1560	697-4430	606-2280	713-2310
Strontium								
FOD	6/6	4/4	NA	NA	33/33	19/19	32/32	29/29
Range	2.24-2.86	2.4-3			2.51-11.9	6.65-19.6	3-17.9	5.95-27.4
Sulfate								
FOD	7/7	4/4	?	?	51/51	31/31	47/47	41/41
Range	833-910	898-1043	133-345	78-334	1400-5780	1190-16000	1450-3100	1570-2560
Sulfide								
FOD	3/5	2/4	NA	NA	3/27	5/20	3/18	3/18
Range	<0.1-9.2	<0.05-1.4			<0.1-5.4	<0.1-2.6	<0.1-19.2	<0.1-3.1
Thallium								
FOD	0/7	0/4	NA	NA	2/33	3/22	2/26	4/23
Range	<0.01-<0.1	<0.01-<0.01			<0.01-0.1	0.0015-0.4	<0.01-0.08	<0.01-0.1
Tin								
FOD	1/7	0/4	NA	NA	8/33	6/22	2/26	2/23
Range	<0.005-0.06	<0.005-<0.05			<0.005-0.13	<0.001-0.18	<0.005-0.04	<0.005-0.105
Total Cyanide								
FOD	0/5	0/4	NA	NA	1/24	1/15	0/13	2/14
Range	<0.01-<0.02	<0.01-<0.01			<0.01-0.01	<0.01-0.02	<0.01-<0.02	<0.01-0.02

Table 4–2 (continued). Water Quality in the Deweesville/Conquista Aquifer at the Falls City, Texas, Site

	Background Ground Water				Ground Water at Mill Site by Region			
			Hobson Area[a]					
Constituent	On-site Crossgradient Well[b]	Area Southeast of FM 791[c]	Mine Zone	Production Zone	East[d]	North[e]	South[f]	West[g]
Total Phosphorus as PO4								
FOD	5/6	2/4	NA	NA	25/32	16/18	21/29	18/25
Range	0.1-0.3	<0.1-0.1			<0.1-1.1	<0.1-13.6	<0.1-2.4	<0.1-1.6
Uranium								
FOD	7/7	4/4	?	?	49/53	31/31	39/47	39/40
Range	0.008-0.078	0.015-0.0201	0.01-0.06	0.-1-11	<0.001-69.8	0.043-32.9	<0.001-7.96	<0.001-17.9
Vanadium								
FOD	1/7	0/4	?	?	10/37	10/25	4/33	4/31
Range	<0.01-0.04	<0.01-<0.01	<0.2	<0.2	<0.01-0.55	<0.004-3	<0.01-0.05	<0.01-0.09
Zinc								
FOD	6/7	3/4	?	?	38/40	22/25	35/36	32/33
Range	<0.005-0.028	<0.005-0.301	0.12-2.4	0.02-1.2	<0.005-2.64	<0.005-3.1	0.005-2.8	<0.005-1.65
Gross Alpha								
FOD	7/7	4/4			41/41	22/22	35/35	34/34
Range	0-123	0-12.3			0-43000	74.1-17400	-4.25-4200	0-12200
Gross Beta								
FOD	7/7	4/4			41/41	22/22	35/35	34/34
Range	37-81.5	19-64.3			44.5-21500	172-10500	0-2550	0-5500
Lead-210								
FOD	2/2	NA	NA	NA	11/11	8/8	7/7	8/8
Range	0-1.7				0-500.2	0.5-74.5	0.1-57.5	0.5-118
Polonium-210								
FOD	2/2	NA	NA	NA	13/13	9/9	9/9	8/8
Range	0-0.1				0-1.4	0.2-5	0-5.4	0.4-17.5

Table 4–2 (continued). Water Quality in the Deweesville/Conquista Aquifer at the Falls City, Texas, Site

	Background Ground Water				Ground Water at Mill Site by Region			
			Hobson Area[a]					
Constituent	On-site Crossgradient Well[b]	Area Southeast of FM 791[c]	Mine Zone	Production Zone	East[d]	North[e]	South[f]	West[g]
Radium-226								
FOD	7/7	4/4	?	?	37/37	24/24	32/32	31/31
Range	1.3-2.7	2.1-2.5	0.4-15.5	3.7-1023	0-14.2	1.1-33.5	0.3-140	0.2-654
Thorium-230								
FOD	2/2	NA	NA	NA	13/13	10/10	12/12	12/12
Range	0.1-0.4				0-8.1	0-45.6	0.2-3.6	0.2-53.9

[a]Near mine zone—H102, H48, B110, B46, B98, B99, B100, B108, B109, B40, B42, with 11 ground-water samples collected from these wells from 1979 to 1981. Production zone wells—T6–A, M95, M94, M93, T92, M10, M9, M7, M5, M3, T95A, M96, M97, M98, P100, P101, I102, I103, I104, I105, I106, I107, M16, M96, M97, M98, H96, H97; 28 ground-water samples were collected from these wells from 1979 to 1979.
[b]Monitor well 951.
[c]Monitor wells 667 and 668. Filtered-sample data are from 1991 sampling.
[d]Wells 940, 953, 955, 963, 965, 966.
[e]Wells 625, 713, 799, 880, 914, 921.
[f]Wells 677, 853, 860, 864, 867, 881, 913.
[g]Wells 854, 859, 882, 904, 918, 919.

NA = Data not available (sample was not analyzed for this constituent).
? = Detection limit not reported.
FOD = Frequency of detection; the number of measurements at or above detection limits divided by total number of measurements.

Notes: 1.Filtered samples 1989 to January 1997, except as noted.
2.Concentrations are reported in milligrams per liter, except radionuclides which are reported in picocuries per liter.

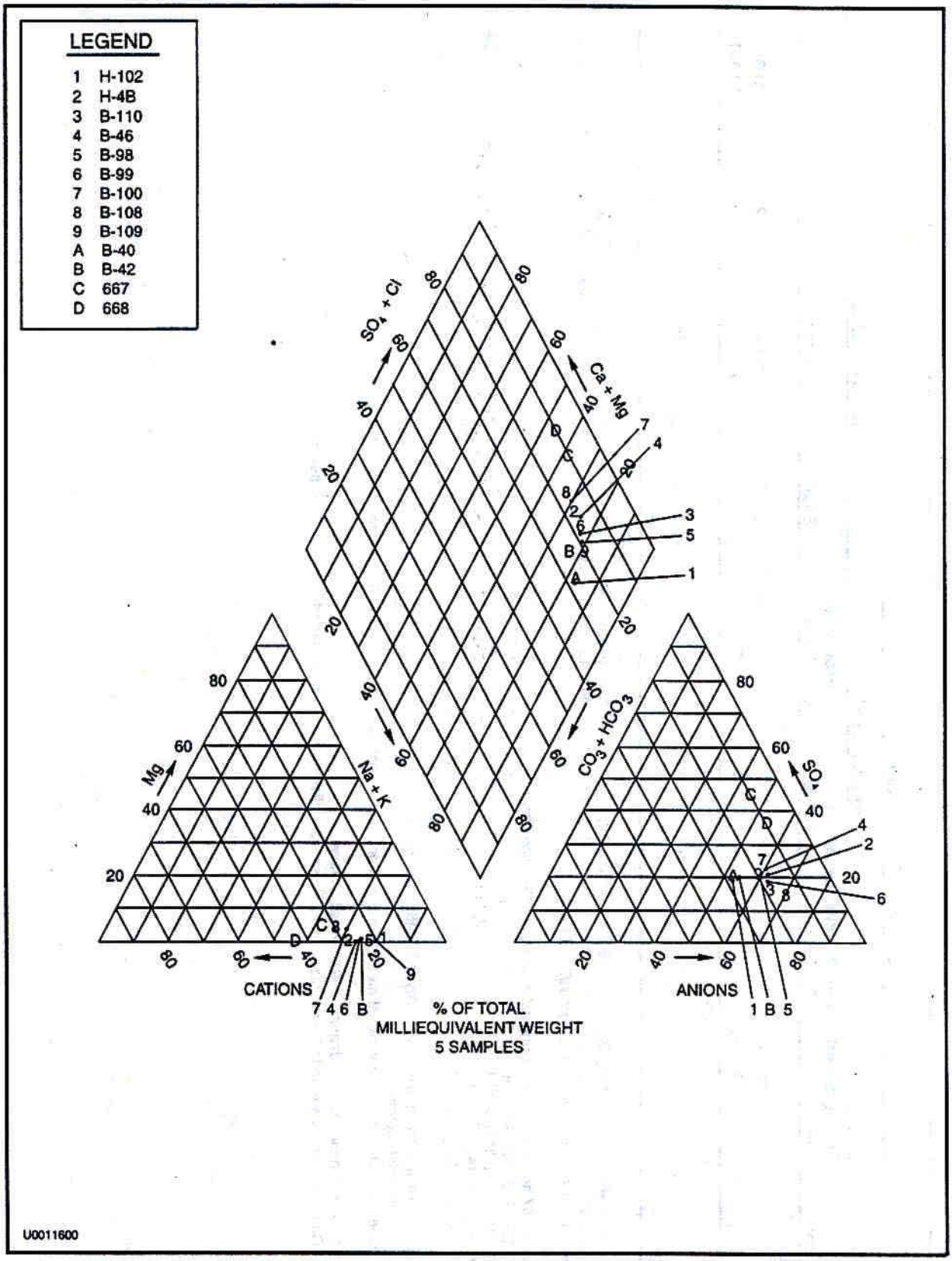
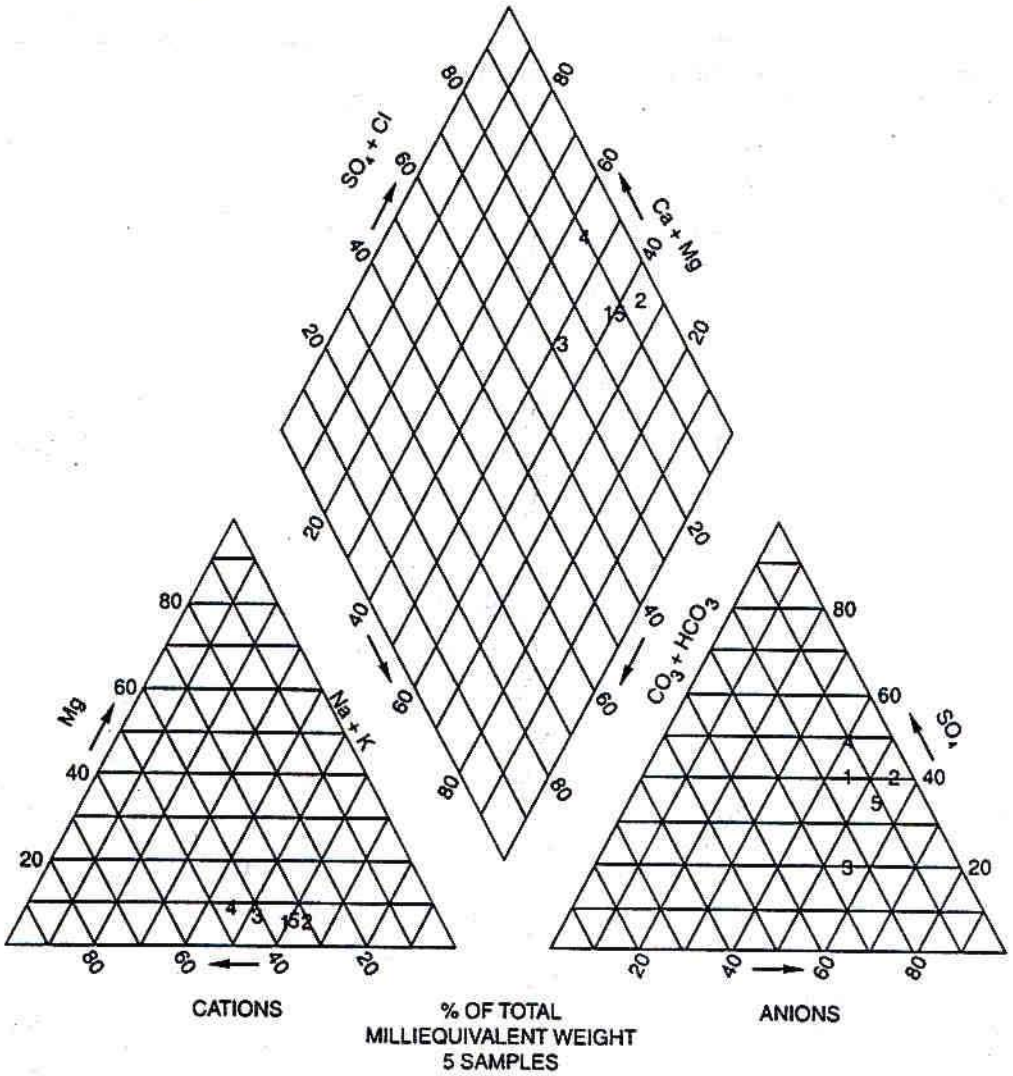


Figure 4–7. Trilinear Plot of Data from Deweesville/Conquista Monitor Wells 667, 668, and Selected Hobson Monitor Wells, Falls City, Texas, Site



LEGEND

1 MW 951 - DEWEESVILLE/CONQUISTA REFERENCE WELL
2 MW 967 - DILWORTH BACKGROUND WELL
3 MW 968 - DILWORTH BACKGROUND WELL
4 MW 969 - DILWORTH BACKGROUND WELL
5 MW 979 - DILWORTH BACKGROUND WELL

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Figure 4–8. Trilinear Plot of Dilworth Background Groundwater and Deweesville/Conquista Reference Water, Falls City, Texas, Site

Table 4–3. Statistical Summary of the Dilworth Groundwater Quality at the Falls City, Texas, Site

Constituent	Frequency of Detection	Observed Concentration		
		Minimum (mg/L)	Median[a] (mg/L)	Maximum (mg/L)
Aluminum				
Background[b]	2/27	<0.05	[d]	0.05
0833[c]	1/1	0.71	0.71	0.71
0977[e]	7/7	0.45	0.62	1.2
Ammonia as NH4				
Background[b]	14/24	<0.1	0.1	2
0833[c]	1/1	5.7	5.7	5.7
0977[e]	4/5	<0.1	0.13	0.9
Antimony				
Background	2/22	<0.003	[d]	0.008
0833	0/1	<0.003	[d]	<0.003
0977	1/5	<0.003	[d]	0.004
Arsenic				
Background (969)	7/7	0.1	0.22	0.39
0833	1/1	0.05	0.05	0.05
0977	0/5	<0.01	[d]	<0.05
Barium				
Background	6/6	0.04	0.05	0.1
0833	1/1	0.03	0.03	0.03
0977	4/5	0.01	0.02	0.02
Beryllium				
Background (969)[b]	0/26	<0.005	[d]	<0.01
0833[c]	0/1	<0.005	[d]	<0.005
0977[e]	1/5	<0.005	[d]	0.005
Boron				
Background (967)	4/4	0.88	1.03	1.1
0833	1/1	0.85	0.85	0.85
0977	4/4	0.72	0.825	0.98

Table 4–3 (continued). Statistical Summary of the Dilworth Groundwater Quality at the Falls City, Texas, Site

Constituent	Frequency of Detection	Observed Concentration		
		Minimum (mg/L)	Median[a] (mg/L)	Maximum (mg/L)
Bromide				
Background (969)	10/10	2.6	3.075	5.8
0833	1/1	1	1	1
0977	7/7	1.7	1.8	2.1
Cadmium				
Background	7/27	<0.001	[d]	0.005
0833	0/1	<0.001	[d]	<0.001
0977	7/7	0.011	0.017	0.022
Calcium				
Background (969)	11/11	450	489	560
0833	1/1	367	367	367
0977	9/9	188	231	282
Chloride				
Background (967,969)[b]	17/17	680	804	1020
0833[c]	1/1	472	472	472
0977[e]	9/9	178	352	553
Chromium				
Background	4/26	<0.01	[d]	0.02
0833	0/1	<0.01	[d]	<0.01
0977	1/6	<0.004	[d]	0.01
Cobalt				
Background	3/27	0.01	[d]	0.05
0833	1/1	0.08	0.08	0.08
0977	7/7	0.06	0.07	0.09

Table 4–3 (continued). Statistical Summary of the Dilworth Groundwater Quality at the Falls City, Texas, Site

Constituent	Frequency of Detection	Observed Concentration		
		Minimum (mg/L)	Median[a] (mg/L)	Maximum (mg/L)
Copper				
Background	4/22	<0.01	[d]	0.06
0833	0/1	<0.01	[d]	<0.01
0977	2/5	<0.01	[d]	0.03
Fluoride				
Background (979)[b]	5/5	0.4	0.4	0.5
0833[c]	1/1	1	1	1
0977[e]	1/5	<0.003	[d]	0.2
Iron				
Background (969)	11/11	0.24	0.44	2.7
0833	1/1	127	127	127
0977	9/9	0.14	1.1	1.43
Lead				
Background	2/26	0.001	[d]	0.002
0833	0/1	<0.005	[d]	<0.005
0977	0/6	<0.001	[d]	<0.1
Magnesium				
Background (969)	11/11	54	57.8	64.7
0833	1/1	66.5	66.5	66.5
0977	9/9	20	27	32.9
Manganese				
Background (969)	11/11	2.28	2.78	3.7
0833	1/1	3.26	3.26	3.26
0977	8/8	1.37	1.69	2.37

Table 4–3 (continued). Statistical Summary of the Dilworth Groundwater Quality at the Falls City, Texas, Site

Constituent	Frequency of Detection	Observed Concentration		
		Minimum (mg/L)	Median[a] (mg/L)	Maximum (mg/L)
Mercury				
Background[b]	0/30	<0.0002	[d]	<0.0002
0833[c]	0/1	<0.0002	[d]	<0.0002
0977[e]	2/7	<0.0002	[d]	0.0005
Molybdenum				
Background (968,969)	12/17	<0.01	0.03	0.07
0833	1/1	0.02	0.02	0.02
0977	1/9	<0.001	[d]	0.01
Nickel				
Background	2/27	0.01	[d]	0.01
0833	1/1	0.09	0.09	0.09
0977	7/7	0.07	0.09	0.11
Nitrate				
Background	21/28	<1	3	12.8
0833	1/1	1.8	1.8	1.8
0977	5/7	<0.008	1.8	6.4
Potassium				
Background (969)[b]	11/11	37	40	43.9
0833[c]	1/1	44	44	44
0977[e]	9/9	24	31.3	60.9
Selenium				
Background	9/27	0.002	[d]	0.024
0833	0/1	<0.005	[d]	<0.005
0977	1/7	<0.0002	[d]	0.007

Table 4–3 (continued). Statistical Summary of the Dilworth Groundwater Quality at the Falls City, Texas, Site

Constituent	Frequency of Detection	Observed Concentration		
		Minimum (mg/L)	Median[a] (mg/L)	Maximum (mg/L)
Silica				
Background (968)	5/5	88	89.4	99.7
0833	1/1	44.5	44.5	44.5
0977	4/4	88	101.85	121
Silver				
Background	1/22	<0.01	[d]	0.02
0833	0/1	<0.01	[d]	<0.01
0977	0/5	<0.01	[d]	<0.01
Sodium				
Background (967, 969)	17/17	482	541	675
0833	1/1	604	604	604
0977	9/9	412	484	520
Strontium				
Background (979)[b]	6/6	1.51	1.77	76.8
0833[c]	1/1	3.27	3.27	3.27
0977e	4/4	1.65	2.32	2.62
Sulfate				
Background (969)	11/11	1080	1290	1440
0833	1/1	1930	1930	1930
0977	9/9	1160	1310	1580
Sulfide				
Background	6/24	<0.1	[d]	55
0977	0/5	<0.1	[d]	<1
Thallium				
Background	1/22	<0.01	[d]	0.1
0833	0/1	<0.05	[d]	<0.05
0977	0/5	<0.01	[d]	<0.1

Table 4–3 (continued). Statistical Summary of the Dilworth Groundwater Quality at the Falls City, Texas, Site

Constituent	Frequency of Detection	Observed Concentration		
		Minimum (mg/L)	Median[a] (mg/L)	Maximum (mg/L)
Tin				
Background	5/22	<0.005	[d]	0.019
0833	0/1	<0.1	[d]	<0.1
0977	2/5	0.01	[d]	0.02
Total Cyanide				
Background	2/20	<0.01	[d]	0.02
0977	1/5	<0.01	[d]	0.01
Total Phosphorus as PO4				
Background	19/22	<0.1	0.5	1.6
0833	1/1	0.5	0.5	0.5
0977	3/4	<0.1	0.15	0.2
Uranium				
Background (968)[b]	6/6	0.026	0.06025	0.094
0833[c]	1/1	3.04	3.04	3.04
0977e	9/9	0.016	0.025	0.054
Vanadium				
Background	11/26	<0.01	[d]	0.05
0833	0/1	<0.01	[d]	<0.01
0977	1/5	<0.01	[d]	0.03
Zinc				
Background	19/27	<0.005	0.016	0.544
0833	1/1	0.213	0.213	0.213
0977	6/6	0.12	0.171	0.206
Gross Alpha				
Background	26/26	0	15.65	183
0833	1/1	1400	1400	1400
0977	6/6	0	27.45	76.2

Table 4–3 (continued). Statistical Summary of the Dilworth Groundwater Quality at the Falls City, Texas, Site

Constituent	Frequency of Detection	Observed Concentration		
		Minimum (mg/L)	Median[a] (mg/L)	Maximum (mg/L)
Gross Beta				
Background	26/26	12.7	38.75	340
0833	1/1	650	650	650
0977	6/6	28.78	55.35	169
Lead-210				
Background[b]	10/10	0	1.45	6.8
0833[c]	[d]	[d]	[d]	[d]
0977[e]	2/2	0	0.4	0.8
Polonium-210				
Background	12/12	0	0.25	2.6
0833[c]	[d]	[d]	[d]	[d]
0977	2/2	0	0.05	0.1
Radium-226				
Background (969)	7/7	2	2.8	4.6
0833	1/1	[d]	2.4	[d]
0977	5/5	0.7	1.2	1.9
Thorium-230				
Background	12/12	0.1	0.35	0.9
0833	[d]	[d]	[d]	[d]
0977	2/2	0.1	0.3	0.5

[a]The median, or 50th percentile of the sample data, cannot be determined if 50 percent or less of the data are above detection.
[b]Data are pooled from monitor wells 967, 968, 969, and 979 unless one or more of these wells has significantly higher levels than the others. In such cases, background represents the higher levels. Well numbers are indicated in parenthesis.
[c]Represents the western contaminated zone. Water quality data from one sampling round in December 1991 were used to determine constituents of concern for this contaminated zone.
[d]Data not available
[e]Represents the eastern contaminated zone. Water quality data from 1989 through 1997.

Note: Filtered Samples are 1989 through 1997.

4.3.3 Magnitude of Site-Related Groundwater Contamination

A statistical, geochemical, and hydrological analysis of the Falls City water quality data for 1989 through 1997 indicates tailings-related contamination in the Deweesville/Conquista aquifer, with less contamination in the Dilworth aquifer. The extent of contamination in the aquifers can be inferred by using pH measurement results to discriminate tailings related contaminated groundwater from background waters. Previous geochemical characterization of tailings related contaminants by the Bureau of Economic Geology (BEG 1992) demonstrated that the dissolution of aluminosilicates present in the ore matrix (clay and shale) by sulfuric acid solutions used in the acid leaching process buffer the pH of the tailings solutions to about 3 or 4. Dissolution of the ore matrix is also the source of elevated levels of aluminum, arsenic, cadmium, manganese, molybdenum, selenium, and uranium observed in many of the groundwater samples collected at the Falls City site. Thus, low pH values are a useful geochemical parameter indicative of tailings related contamination.

A bimodal distribution of pH values at the Falls City site (Figure 4–9) can be seen by examining the frequency diagram of pH measurements from groundwater and tailing solutions (BEG 1992). The frequency diagram shows an absence of waters with pH values between 4.75 and 5.0 indicating the presence of two different pH buffers. The dominant source of acidity in the contaminated groundwater is the aluminum-sulfate pH buffer illustrated by the distribution of relatively low pH values ranging from 2.75 to 4.5. Bicarbonate is the high pH buffer reflecting background water quality with values ranging from 5.25 to 7.0. Therefore, groundwater having a pH less than 4.75 to 5.0 is considered an indicator of tailings related contamination.

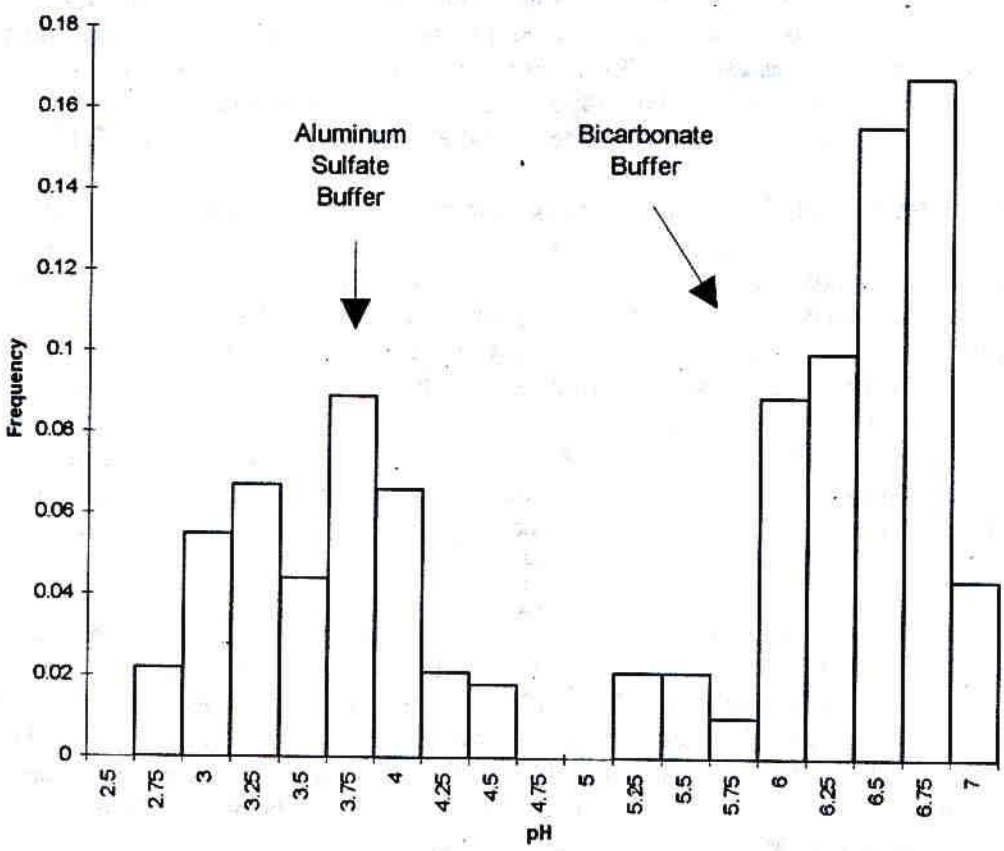

Figure 4–9. Bimodal Distribution of pH Values from BEG 1992

4.3.3.1 Deweesville/Conquista Contaminant Plume

Tailings related contaminants in the Deweesville/Conquista aquifer can be inferred by the distribution of the low pH values delineated in Figure 4–10. In general, contamination at the Falls City site occurs in two distinct zones; an eastern contaminant zone and a western contaminant zone. The eastern zone is associated with the former tailings pile 3 and the western zone is associated with former tailings piles 1, 2, 4, 5, 6, and 7. Although both contaminated zones contain many chemical similarities, each zone has important chemical differences that give it a distinct geochemical signature.

Eastern Contaminant Zone

The eastern contaminant zone originates from tailings pile 3. Groundwater with relatively low pH values, indicative of tailings related contamination, extends from former tailings pile 3 in two directions; north beneath Scared Dog Creek and east beneath FM 791.

Contaminated groundwater appears to extend approximately 3,000 ft (900 m) to the north along the direction of Scared Dog Creek. The leading edge of the contaminant plume migrating beneath Scared Dog Creek can be inferred by the relatively low pH value of 3.7 observed in water sampled from monitor well 963, the most downgradient sample location. The width of the pH plume in this area is relatively narrow (approximately 750 ft), as evidenced by an increase in pH to 4.7, 6.1, and 5.1 at monitor wells 957, 955, and 962, respectively.

The extent that the contaminant plume has migrated east of former pile 3 can be inferred by examination of groundwater samples collected in January 1997 from several new monitor wells installed in 1995 near FM 791. A pH value of 4.5 measured in water collected from monitor well 886 indicates the leading edge of the plume has migrated beneath FM 791, approximately 3,500 ft (1,100 m) east of former pile 3. The width of the plume is approximately 600 ft (450 m), as inferred by an increase in pH values to 5.4 and 6.7 observed in water samples collected from downgradient monitor wells 885 and 887, respectively.

Aluminum, and to a lesser extent iron, comprise the predominant sulfate salts in tailings solutions which control the acidity of the pH plumes at the Falls City site (BEG 1992). Geochemical reactions with common aluminum silicates (e.g., potassium feldspars) as the pH plume migrates through the Conquista sandstone, clay, and shale units will not neutralize the plume because the waters are already near equilibrium with the aluminosilicates due to the relatively high concentrations of aluminum, silica, and alkalies. However, the pH plume may be neutralized naturally by reacting with calcite or bicarbonate (alkaline) groundwaters. Only a small amount of calcite (0.06 volume percent) present in the Deweesville/Conquista sediments or mixing approximately 8 percent of the plume with 92 percent alkaline groundwaters is required to neutralize the plume. The lower the aluminum and iron content of the groundwater, regardless of pH, the greater the probability that reaction with calcite or mixing with alkaline waters will neutralize the pH plume.

Aluminum concentrations and alkalinity measured in groundwater samples from the most recent sampling rounds (1996 and 1997) are presented in Figures 4–11 and 4–12, respectively. Relatively low aluminum concentrations and relatively high alkalinity values are observed in water samples collected from monitor wells 884, 885, and 887 which are located near the lateral edges of the pH plume that has migrated beneath FM 791. Results for monitor well 886 located near the leading edge of the plume is only slightly elevated in aluminum (0.5 mg/L), suggesting that aluminum contamination related to the tailings is precipitating, thereby lowering the aluminum concentrations and increasing the pH in the plume due to reactions with alkaline groundwater. Since the pH (4.5) at this location is at the upper range

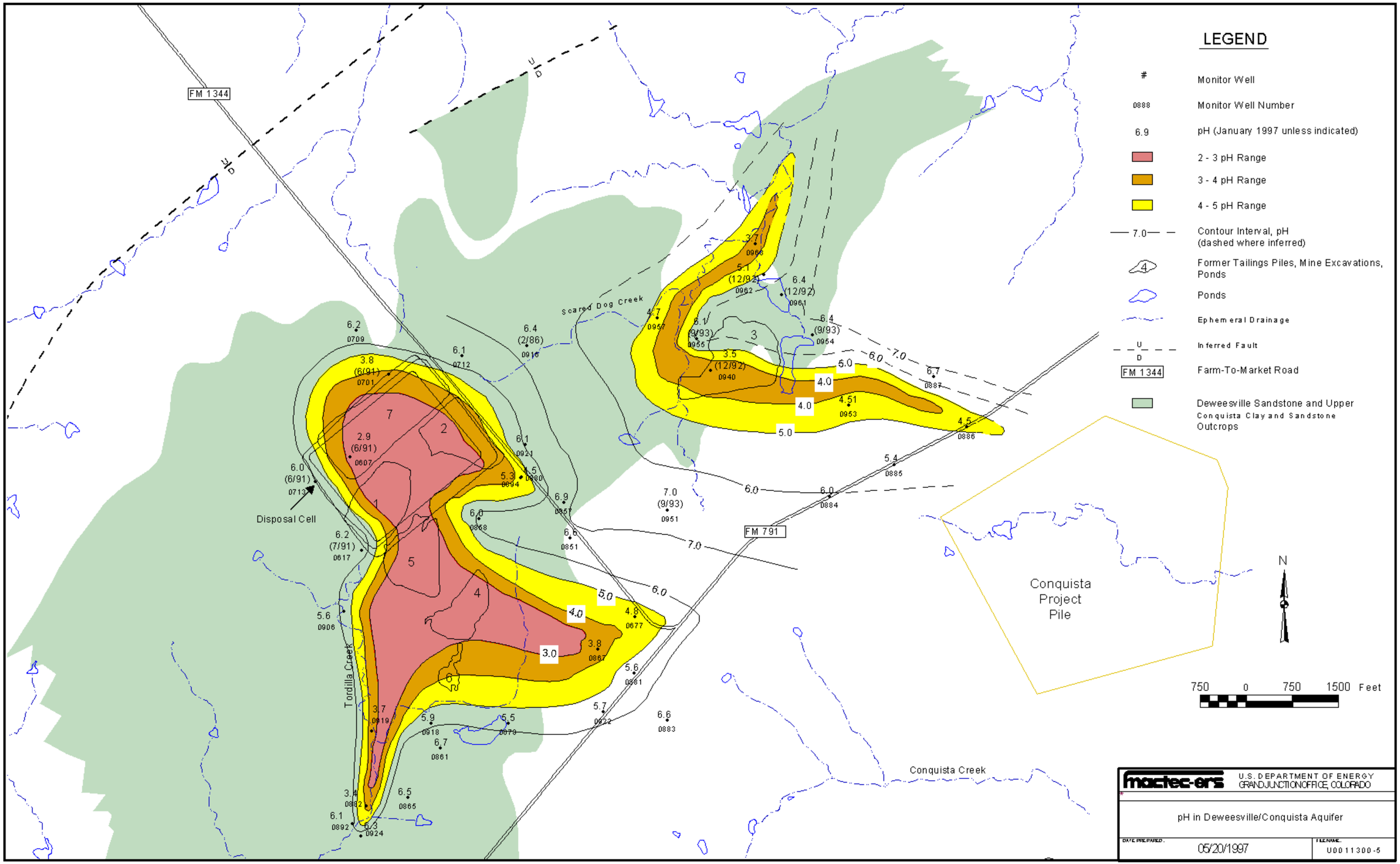

Figure 4-10. pH in Deweesville/Conquista Aquifer

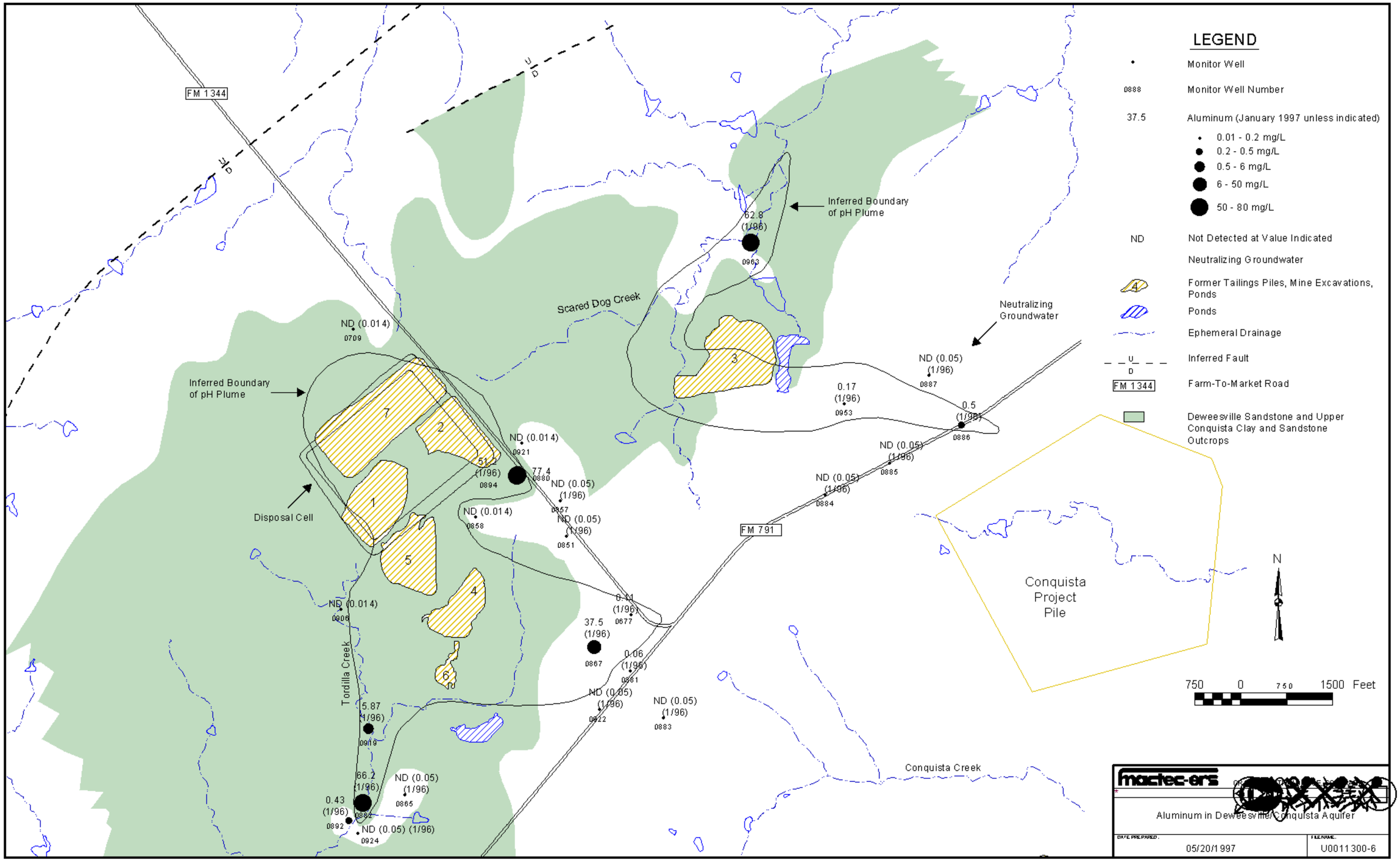

Figure 4-11. Aluminum in Deweesville/Conquista Aquifer

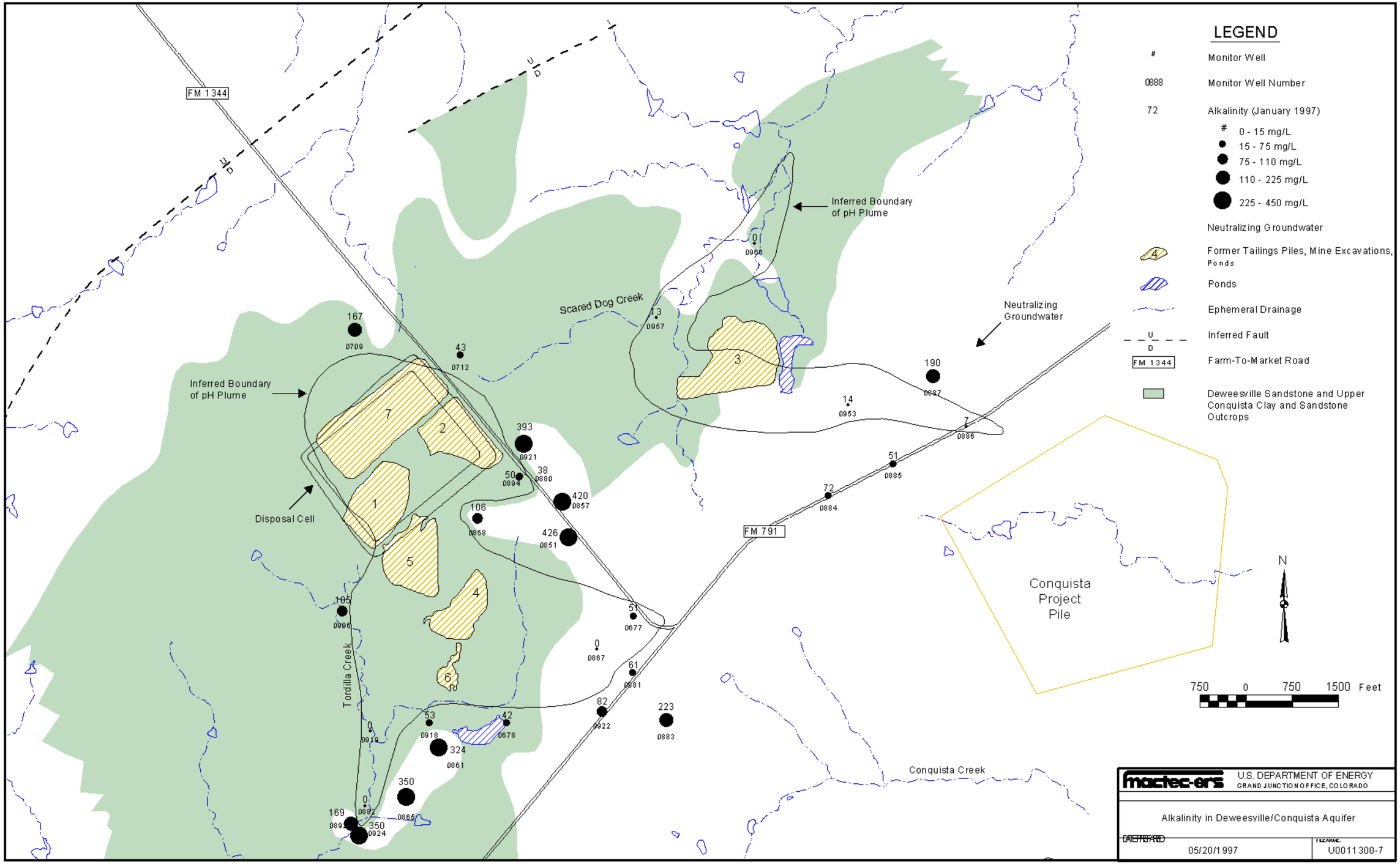

Figure 4-12. Alkalinity in Deweesville/Conquista Aquifer

of pH for the aluminum-sulfate buffer (Figure 4–9), and the aluminum concentrations are relatively low, additional mixing with the down gradient alkaline groundwater will raise the pH into the bicarbonate buffer range. Thus, further down gradient migration of the pH plume beneath FM 791 is limited.

Western Contaminant Zone

The western contaminant zone is associated with former tailings piles 1, 2, 4, 5, 6, and 7. Relatively low pH groundwater extends radially away from former tailings piles 2 and 7 (Figure 4–10). The radial shape of the pH plume in this area is consistent with a groundwater mound as are the potentiometric groundwater surface contours shown in Figure 4–4.

Locally in this zone, sulfate levels in the groundwater are high; 16,000 and 15,300 mg/L in monitor wells 880 and 894, respectively. The high sulfate concentrations in this part of the Deweesville/Conquista aquifer are probably associated with a tailings pond that existed in the southern end of former pile 2. Sulfate contamination decreases significantly within a short distance away from the former pile. For example, sulfate concentrations decrease to 1,460 mg/L in water from monitor well 921, located approximately 500 ft north of monitor wells 880 and 894. Concentrations decrease to 1,680 mg/L sulfate at monitor well 858 and to 232 mg/L sulfate at monitor well 857, located approximately 1,000 ft south and southeast, respectively, of former pile 2.

Contaminated groundwater from tailings piles 4 and 5 appears to extend in two directions; southeast approximately 2,500 ft (760 m) to FM 791 and south more than 3,000 ft (900 m) beneath Tordilla Creek. Both contaminant plumes are characterized by low pH waters (Figure 4–10). Further migration of the pH plume appears to be limited by loss of the aluminum-sulfate pH buffering capacity due to the presence of low aluminum concentrations (Figure 4–11) and the bicarbonate levels (Figure 4–12) in background water quality downgradient from the plume.

The area between former piles 4 and 5 contains a 1- to 3-ft (0.3- to 1-m)-thick zone of acid-, sulfate-, and possibly metals-rich groundwater perched on top of a thin but laterally extensive silicified layer in the Deweesville/Conquista. The shallow perched saturated zone was probably generated by horizontal flow along this silicified layer when tailings leachate was injected into piles 4 and 5 during *in situ* mining operations (DOE 1992).

4.3.3.2 Dilworth Contaminant Plume

Tailings related contaminants associated with the former tailings pile 3 are present in the Dilworth aquifer as evidenced by the distribution of the low pH values delineated in Figure 4–13. The pH plume map presented in Figure 4–13 reveals that contaminated groundwater has migrated at least 2,000 feet (1,200 m) north of former pile 3 where relatively low pH (3.7) water is present at monitor well 965. Contamination does not appear to be present at the most down gradient monitor well 891, located approximately one mile north of the former pile 3. The pH value (5.7) in the groundwater at this down gradient location (well 891) is consistent and within the pH range expected for the bicarbonate buffer system (background water quality) shown in Figure 4–9. Moderate levels of alkalinity (76 mg/L as $CaCO_3$) and non-detectable levels of aluminum (<0.05 mg/L) at this location provide additional evidence that contamination has not migrated down gradient to monitoring well 891.

The width of the contaminant plume is approximately 1,000 feet (300 m) wide as inferred by the sampling results for monitor wells 889, 890, 965 and 966. Monitor wells 889 and 890 were installed in 1995 to provide additional control to characterize the plume.

Contamination in the Dilworth aquifer was previously identified in groundwater samples collected from monitor well 833 situated near the southern end of the former tailings pile 4 (DOE 1995). However, only two samples (February 1986 and December 1991) were collected from the well before it was abandoned during construction of the disposal cell. Results of the 1986 and 1991 groundwater analyses for selected analytes are presented in Table 4–4.

Results for monitor well 833 indicate a decrease in pH and a significant increase in ammonium, iron, manganese, sulfate, and uranium concentrations between 1986 and 1991 (DOE, 1992b), suggesting the Dilworth may be contaminated in this area. For this reason, monitor well 893 was installed in 1995 adjacent to the former location of monitor well 833, to evaluate the potential of contamination in the Dilworth aquifer (Figure 4–3).

The new monitor well 893 was sampled in 1996. Results are presented in Table 4–4. Examination of the results presented in Table 4–4 do not indicate contamination in the Dilworth by the former processing site activities, suggesting the samples collected from well 833 may have been cross contaminated from the Deweesville/Conquista aquifer as a result of an improper well completion.

Table 4–4. Comparison of Groundwater Results Obtained for Monitor Wells 833 and 893

Parameter	Monitor Well 833		Monitor Well 893
	1986	1991	1996
pH	6.7	5.8	6.9
ammonium (mg/L)	0.6	5.7	0.4
iron (mg/L)	35.3	127	0.12
manganese (mg/L)	1.5	3.3	0.3
sulfate (mg/L)	1,170	1,930	749
uranium (mg/L)	0.6	3.0	ND (0.001)[a]

[a]ND = value is less than indicated detection limit

4.3.4 Contaminant Fate and Transport

The chemical species present in aqueous systems are a function of pH, Eh, and the concentrations of different anions and cations. Speciation determines the mobility of the chemicals and might also influence their toxicity. The predominant species of the contaminants of concern for human health were predicted through the geochemical model MINTEQA2 (Allison et al. 1991). The contaminants of concern are identified in the site-specific baseline risk assessment (in preparation): cadmium, cobalt, fluoride, nickel, iron, sulfate, and uranium.

Constituents in the contaminated zone waters are subject to dilution and to different chemical reactions including oxidation/reduction, precipitation and coprecipitation, possible reactions with biologic organisms, and adsorption onto aquifer mineral surfaces. Concentrations of the dominantly cationic metals and the major cations calcium, magnesium, potassium, and sodium are controlled by dilution and

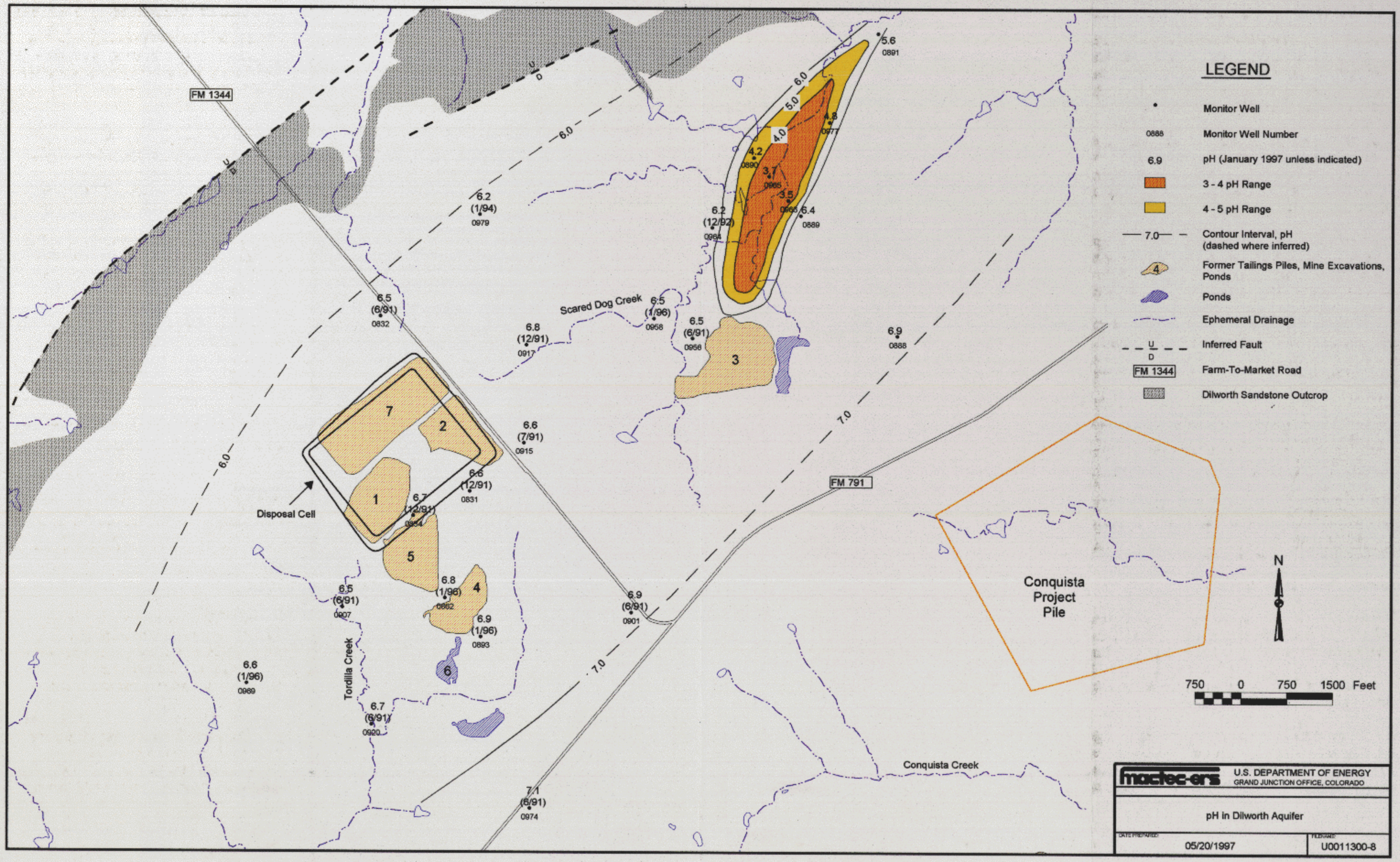

Figure 4–13. pH in Dilworth Aquifer

precipitation and sorption reactions. Cadmium, iron, cobalt, nickel, and fluoride concentrations will also be controlled by these processes. Chloride concentrations are affected only by dilution or evaporation. Attenuation mechanisms that should control the concentrations of the contaminants of concern for the Falls City site are discussed below.

Cadmium

Cadmium will be removed rapidly by the precipitation of otavite ($CdCO_3$) and by hydrolysis reactions as the low pH of the tailings leachate is neutralized by alkaline groundwater and the calcite in the aquifer matrix. Dilution with background water produces cadmium concentrations below detection limits in downgradient groundwater. Elevated cadmium levels are restricted to the areas underneath or immediately adjacent to the tailings pile.

Iron, Cobalt, and Nickel

Aqueous species of iron are typically not stable in groundwater that is oxidizing and that has a pH near or above 6. Dissolved iron in oxidizing water with a pH of 7 should oxidize rapidly and remove as iron oxyhydroxides. Although groundwater from many downgradient monitor wells in the Deweesville/Conquista yields pH measurements below 4 and has iron levels significantly higher than reference well 951, groundwater from only one Dilworth well (977) has an acidic pH. The pH in groundwater from Dilworth background well 969 is historically between 6.5 and 7 (DOE 1992). Nonetheless, iron concentrations in these waters are well above the values present in the other Dilworth background wells at the site.

Elevated cobalt levels might have been introduced to the aquifer by acidic tailings leachate. Because of its chemical similarity to iron, however, cobalt typically coprecipitates during the precipitation of manganese and iron hydroxides. At the typical pH range (6 to 8) observed for groundwater in the Dilworth aquifer at the Falls City site, cobalt should be present at levels below or near the detection limit. Slightly elevated cobalt levels (e.g., up to 0.05 mg/L in monitor well 969) and iron levels could be expected in naturally reducing, alkaline, background Dilworth groundwaters. More elevated cobalt concentrations can occur in low-pH contaminated groundwater (up to 0.09 mg/L in acidic Dilworth monitor well 977). When the pH of this oxidizing water rises above 5.5, cobalt concentrations should be much lower.

Sulfate

Sulfate concentrations in the contaminated zones of the aquifer immediately adjacent to the processing site are controlled primarily by gypsum solubility. Farther downgradient, sulfate concentrations are controlled largely by physical processes such as dispersion and dilution. Reduction of sulfate to sulfide is also possible if the contaminated zone interacts with reducing sediment or groundwater.
Presently, gypsum precipitation predominantly controls sulfate concentrations because the shallow groundwater in and around the tailings piles was saturated with gypsum. As the tailings piles are consolidated and covered, the sulfate level in groundwater around the former piles will decrease. Eventually, as sulfate levels drop below gypsum saturation, the gypsum that precipitated previously will begin to redissolve. The dissolution of gypsum will buffer the sulfate concentrations at fairly high levels until the gypsum supply is exhausted. At this point, natural flushing with background water will substantially lower the sulfate concentrations in the former tailings pile area.

Because the sulfate concentrations are high, adsorption reactions probably will not significantly affect sulfate concentrations in the shallow groundwater. Given the high redox potential of the shallow groundwater in the Deweesville/Conquista and Dilworth aquifers, sulfate removal by reduction to sulfide is not likely until the contamination migrates well off the site.

Uranium

Uranium is mobile in acidic groundwater (e.g., pH is 3 to 4) where it typically exists as positively charged uranyl, uranium hydroxyl, and (in high sulfate systems) uranium sulfate complexes. In oxidizing, alkaline groundwater over a range of elevated pH values (e.g., between 6.5 and 8.5), uranium can form stable anionic carbonate complexes that facilitate uranium transport in groundwater.

Uranium levels are elevated in both acidic and alkaline groundwater at the Falls City site. In both these environments, uranium concentrations will be reduced mainly by adsorption onto aquifer materials and by dilution with uncontaminated groundwater.

4.3.5 Risk Evaluation

The uranium milling activities at the Falls City site led to groundwater contamination in the Deweesville/Conquista and Dilworth aquifers. The near-surface geologic members include the Deweesville, the Conquista, and the Dilworth. For assessing risk to potential groundwater users, the Deweesville and Conquista water-bearing members are evaluated as a single aquifer.

Residents near the site use groundwater from the deeper Carrizo aquifer (2,000 to 3,000 ft [600 to 900 m] below the surface). Because of its depth below the land surface and the confining layer overlying the aquifer, the Carrizo aquifer is not affected by mining and milling activities at the Falls City site.

4.3.5.1 Dilworth Aquifer

Groundwater from the Dilworth aquifer was historically considered to be poor quality. No drinking-water wells are screened in the Dilworth aquifer within a 2-mi (3-km) radius of the site (DOE 1995). This is because historically the Dilworth groundwater was considered to be of poor quality. Although the DOE does not have evidence of its use, groundwater from the Dilworth aquifer might have been used for watering livestock in the vicinity of the site. Using these livestock for food could create an exposure pathway to humans. Therefore, the potential current and future use of the Dilworth aquifer at the site was evaluated.

Levels of aluminum, ammonium, cadmium, cobalt, fluoride, iron, nickel, sulfate, uranium, and zinc in groundwater from two monitor wells completed in the Dilworth aquifer were significantly higher (at the 0.10 level of significance) than the concentrations reported in groundwater from background wells (DOE 1994). As discussed in Section 4.3.3.2, groundwater contamination in monitor well 833 (Figure 4–3) may have been due to vertical leakage through the monitor well's annulus. Groundwater contamination in monitor well 977 (Figure 4–3) is derived from the zone of contamination along Scared Dog Creek that intercepts the Dilworth outcrop. Therefore, the contamination in the Dilworth appears to be confined to a few isolated areas. The constituents elevated above background are presented in Table 4–5.

Table 4–5. Contaminants of Potential Concern for the Dilworth Aquifer

Contaminant levels exceed background	Contaminant levels in nutritional range	Contaminants of low toxic potency and/or high dietary range	Contaminants of potential concern[a]
Aluminum	Zinc	Aluminum	Cadmium
Ammonium		Ammonium	Cobalt
Cadmium			Fluoride
Cobalt			Iron
Fluoride			Nickel
Iron			Sulfate
Nickel			Uranium
Sulfate			
Uranium			
Zinc			

[a]Screening process has started with the first column; constituents listed in the second and third columns were subtracted from the list of constituents in the first column; the remaining constituents form the list shown in the last column.

High levels of arsenic and manganese occur naturally in some areas of the Dilworth aquifer. Both arsenic and manganese typically are associated with the uranium ore deposits found in the Falls City site area. Also, high levels of sulfate occur naturally in the Dilworth groundwater and are associated with gypsum deposits.

Although zinc was observed above background, it was eliminated as a contaminant of potential concern because it is an essential nutrient and because the levels at which it is observed are within nutritional ranges, even when added to expected dietary intake. Ammonium and aluminum were eliminated as contaminants of potential concern based on low toxicity, and because the levels at which they are observed in the most contaminated downgradient monitor wells will not produce adverse health effects. Cadmium, cobalt, fluoride, iron, nickel, sulfate, and uranium remain as the contaminants of potential concern for the Dilworth.

Potential adverse health effects are a function of the contaminant amount an individual takes into his or her body. The risk of exposure to humans was estimated by examining the three ways in which contaminants can enter the body: drinking the water, eating meat from livestock which drank the water, or drinking milk from livestock which drank the water.

It should be kept in mind that the highest contaminant concentrations from the most contaminated wells were used to estimate the amount of exposure. Therefore, this evaluation provides the upper limit of possible risks resulting from Dilworth groundwater contamination; real risks are not likely to reach that limit. Only people who drilled a drinking water well in the most contaminated area (a small portion of the site) could experience the health problems discussed below.

Considering these relevant human exposure pathways, small amounts of the contaminants could be passed from the livestock to humans or from garden produce to humans. The estimated amounts of contaminants that could be ingested could cause adverse health effects if the Dilworth aquifer background groundwater were used to water domestic stock and irrigate gardens.

Iron and sulfate concentrations in the groundwater make the human health risks associated with the potential future use of this groundwater as a drinking water source unacceptable. However, such consumption is unlikely because of the water's unpleasant taste and odor, historical knowledge of poor water quality, and the presence of better quality water from other sources. Nevertheless, the estimated iron exposure level could be associated with elevated levels of iron (above normal values) in internal

organs such as the liver and pancreas. Elevated levels of iron in the body would lead to increased skin pigmentation and possibly cirrhosis of the liver. Although no drinking water wells are within a 2-mi (3-km) radius of the site, if the Dilworth groundwater were used as untreated drinking water for infants, sulfate levels could result in severe persistent diarrhea, potentially leading to dehydration, because infants are sensitive to sulfate toxicity. Laxative effects could be produced in adults who drink the water. Moreover, natural levels of sulfate present in the Dilworth groundwater near the site, and typically found in this area of Texas, are known to produce diarrhea in some individuals.

Human health would not be at risk from exposure to cadmium, cobalt, fluoride, or nickel through these pathways. Exposure to uranium may be of health concern due to its chemical toxicity and potential radiological damage. Chemical toxicity from exposure to uranium is not anticipated if humans drink the Dilworth groundwater. The additional cancer risk from radioactive uranium and longer-lived progeny of the uranium decay series, however, is at an unacceptable level of 1 in 1,000 over a lifetime. Any excess lifetime cancer risks associated with radionuclides due to human consumption of meat or milk from cattle that drank this water as their sole drinking water source are within an acceptable range as defined by the National Contingency Plan range, which is between 1 in 10,000 and 1 in 1,000,000.

The levels of manganese and arsenic observed in the natural Dilworth groundwater that is unaffected by the former mill tailings could lead to an increased risk of developing nervous system disorders resembling Parkinson's disease and/or skin cancer if the water were used as the sole source for a prolonged period. Naturally occurring manganese and arsenic, therefore, limit the potential use of groundwater in some areas as a source for drinking water.

An evaluation of the potential effects on livestock, if the Dilworth groundwater were used to water cattle, showed livestock would suffer no adverse health effects from drinking Dilworth groundwater. The Dilworth groundwater is also suitable for crop irrigation.

4.3.5.2 Deweesville/Conquista Aquifer

Although no livestock, domestic, or drinking water wells are screened in the Deweesville/Conquista aquifer within a 2-mi (3-km) radius of the site, the use of Deweesville/Conquista groundwater downgradient and farther than 2 mi (3 km) from the site has not been evaluated. The shallow groundwater at the Falls City site appears to have originated largely from past *in situ* mining and milling operations, and its use as a water supply is unlikely. Although the DOE has not determined whether the groundwater in the Deweesville/Conquista farther downgradient from the site is a usable water resource, it has not historically been used as a drinking-water source.

The background water quality in the Deweesville/Conquista aquifer was partially assessed before surface remedial action began. Sulfate, manganese, and uranium concentrations in the Deweesville/Conquista groundwater are high enough to cause serious adverse health effects. The health effects associated with exposure to sulfate, manganese, and uranium make the groundwater unsuitable for drinking, irrigating crops, or watering livestock (DOE 1995).

5.0 Groundwater Compliance Strategy Selection

The groundwater compliance strategies for the Falls City site and an explanation of the application of site-specific data to the groundwater compliance selection framework are presented below (Figure 5–1)

5.1 Compliance Strategy Selection Process

A health- and environmental risk-based framework for selecting site-specific compliance strategies is being applied to each UMTRA Project processing site. This compliance selection framework was developed in the UMTRA Groundwater PEIS. The framework enables the DOE to apply the same criteria to determine the groundwater compliance strategy at each site and to determine the appropriate compliance strategy.

A step-by-step approach is followed until one or a combination of three compliance strategies below is selected for a specific site.

- No remediation. Compliance with the EPA groundwater protection standards would be met without altering the groundwater or cleaning it up in any way. This strategy could be applied at sites with contamination at or below MCLs or background levels or at sites that have contamination above MCLs or background levels but qualify for supplemental standards or ACLs.

- Natural flushing. Allows natural groundwater movement and geochemical processes to decrease contaminant concentrations to levels within regulatory limits within a given time period. This strategy could be applied at sites where groundwater compliance would be achieved with natural flushing within 100 years, where effective monitoring and institutional controls could be maintained, and where the groundwater is not and is not projected to be a drinking water source.

- Active groundwater remediation. Requires application of engineered groundwater remediation methods such as gradient manipulation, groundwater extraction and treatment, and *in situ* groundwater treatment to achieve compliance with the standards.

5.2 Falls City, Texas, Compliance Strategy Selection

The groundwater compliance selection framework was applied to the uppermost aquifer characterized to be affected by activities at the processing site. Site conditions were used to determine that the no-remediation application of supplemental standards strategy is appropriate for the uppermost aquifer based on widespread ambient contamination and acceptable risks to human health and the environment (DOE 1995). Figure 5–1 shows how this target was selected.

Uppermost Aquifer Compliance Strategy

To protect groundwater and to achieve compliance with EPA groundwater standards under the UMTRA Surface Project (Subpart A of 40 CFR Part 192), the DOE proposed a narrative supplemental standard for Parcel A of the Falls City site and the disposal site. The supplemental standard for surface remedial action classified groundwater from the uppermost aquifer as limited use, based on widespread ambient contamination that could not be cleaned up with methods reasonably employed by public water systems.

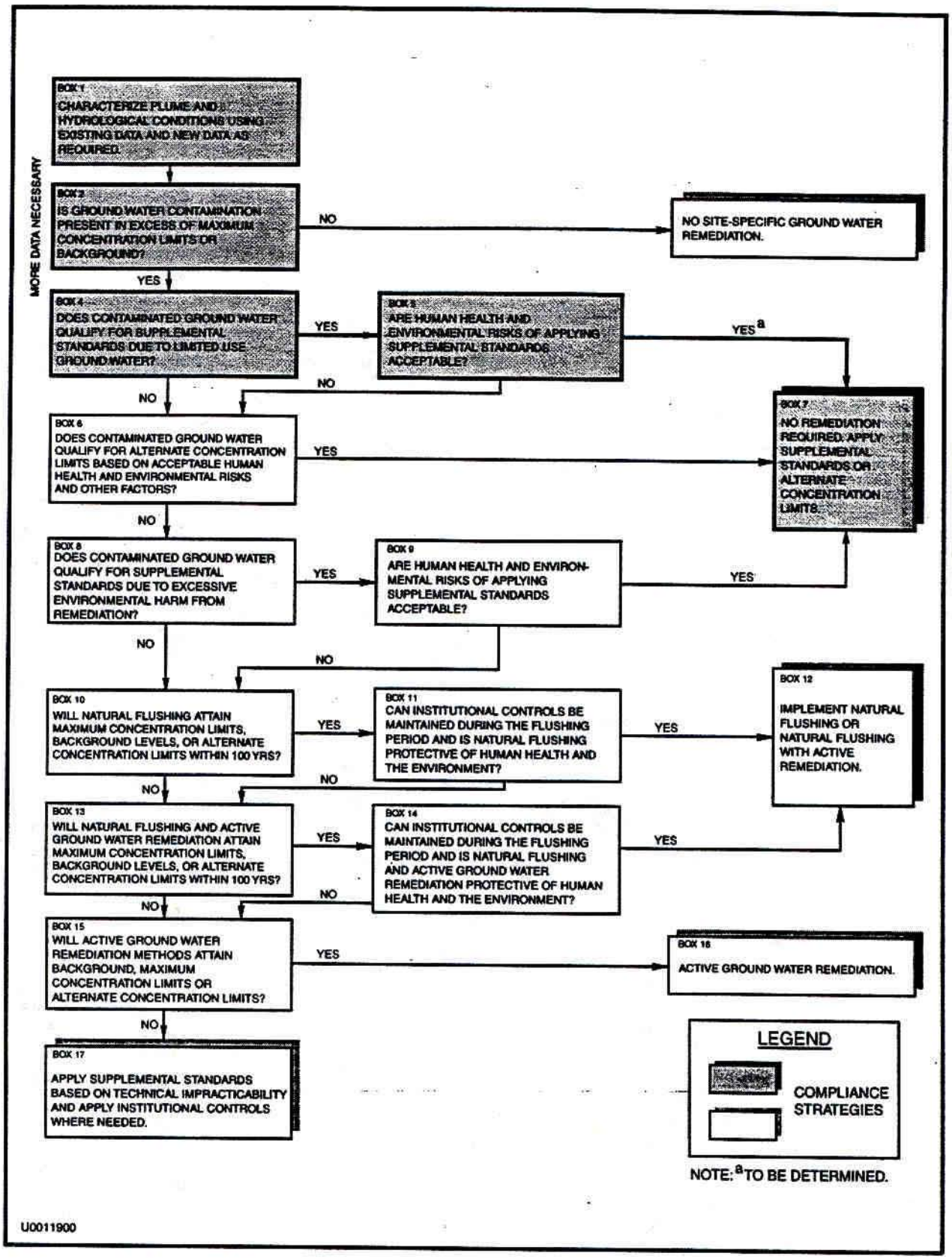

Figure 5–1. Framework Application of Contaminants of Potential Concern in the Uppermost Aquifers, Falls City, Texas, Site

To demonstrate existing widespread contamination in the uppermost aquifer, the DOE established background groundwater quality in the site vicinity (DOE 1992). Supplemental standards did not apply to Parcel B. However, there is no evidence that conditions are different in the uppermost aquifer in the vicinity of Parcel B. Background monitor wells were installed and monitored to demonstrate widespread ambient contamination of the uppermost aquifer in the vicinity of the disposal site. The DOE, NRC, and the state concurred with the supplemental standard application and agreed that the uppermost aquifer was limited use in 1992 (DOE 1992). Thus, the first step toward achieving compliance with the groundwater standards was to determine that widespread, ambient contamination persists in the uppermost aquifer in the site vicinity.

The second step was to determine whether compliance with the standards could still be achieved by applying supplemental standards based on limited use groundwater. Regulations define limited use groundwater as groundwater that is not a current or potential source of drinking water for the following three reasons: the concentration of total dissolved solids exceeds 10,000 mg/L; the groundwater contains widespread, ambient contamination, not caused by activities involving RRM from a designated processing site, that cannot be cleaned up with treatment methods reasonably employed by public water-supply systems; or the quantity of water available from a well is less than 150 gallons (570 liters) per day.

Hydrogeologic conditions and groundwater contamination conditions at the Falls City site have been characterized and are presented in Section 3.0. The background water in the uppermost aquifer still meets the criteria for limited use groundwater based on widespread, ambient contamination not caused by activities involving RRM from a designated processing site. The background water cannot be cleaned up with treatment methods reasonably employed by public water-supply systems. Making water from the uppermost aquifer potable would require multiple treatment technologies not typically used in Texas or in the region. Removing radionuclides from the groundwater will produce treatment plant wastes containing both hazardous and radioactive constituents. Also, treated groundwater from the uppermost aquifer would cost local residents considerably more than what they now pay for drinking water (DOE 1992b).

The DOE has determined from the data that supplemental standards are protective of human health and the environment, and that site-specific remediation is not required. Section 4.3.5 describes the limited uses of groundwater from the uppermost aquifer and the risk associated with exposure to contaminants of concern.

5.3 Deviations, Contingencies, and Decision Rules

The DOE's environmental restoration process generally, and the UMTRA Groundwater Project specifically, must make restoration decisions under conditions of inherent uncertainty. Uncertainties associated with limited site condition information and with uncertain remedial strategy performance are reduced to the extent practicable, in an effort to minimize time and resources spent on studying the problems and to expedite restoration activities. In developing this SOWP, the DOE maximized the use of existing and recently collected information to select a realistic remedial strategy. This SOWP developed and used a conceptual model to provide a foundation for compliance planning and action.

5.4 Future Monitoring Activities

Selected monitor wells located near the disposal cell will continue to be monitored as part of the Long Term Surveillance Monitoring Plan (LTSP). Additional monitor wells not currently identified in the Falls City LTSP could be added to the LTSP as best management practice to ensure protection of beneficial uses of the upper most aquifer. This decision has not been made. The LTSP will be modified, if necessary, to include future groundwater monitoring activities at the Falls City site.

6.0 References

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Appendix A

Monitoring Well Construction Details and Lithologic Information

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 851

JOB NO. FCT01 DATE 91/3/29

SURFACE ELEVATION 431.86
TOP OF FILTER PACK 18.00
WELL CASING TYPE 4.0-in sched. 40 PVC
FORMATION of COMPLETION Deweesville/Conquista contact

TOTAL DEPTH 50.0 feet
RIG TYPE Rotary and core rig
BORING TYPE Rotary air
LOCATION N 59877.71 E 67424.58
DATUM MSL, GROUND SURFACE

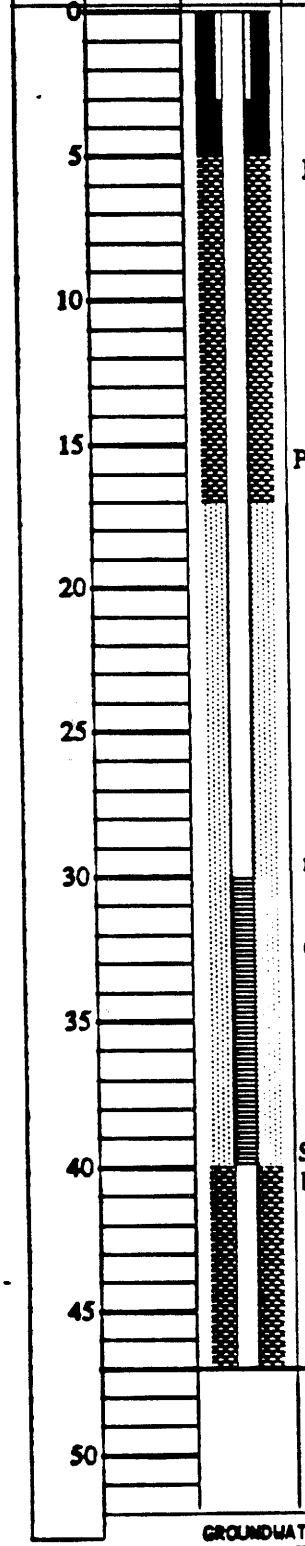
Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CH	SOIL. Silty Clay, little sand, high plasticity, black.
5		4-in well installed		CH	DUBOSE MEM. Claystone, poorly indurated, soft, dark gray.
10		Grout installed from 0 to 10 feet		CL	DUBOSE MEM.- DEWEESEVILLE MEM. GRAD. ZONE Claystone, sandy, occ. sandstone lenses, limonite staining,soft, light tan.
15		Bentonite chips placed from 10 to 13 feet Bentonite pellets placed from 13 to 18 feet		SP	DEWEESVILLE MEM. Sandstone, poorly indurated, fine grained, soft, light greyish tan.
20		Sand pack installed from 18 to 44 feet		SC CL	Mudstone,very soft, lt. tan.
25				CL	Claystone, silty, with organics, soft, light to dark brown.
30		Screen installed from 27 to 37 feet		SM	Silty Sandstone, fine grained, uncemented, soft, lt. tan.
35					
40		Blank sump placed from 44 to 37 feet		CL	CONQUISTA MEM. Claystone, poorly indurated, soft, lt. greyish tan to lt. grey
45		Borehole sealed at 44 to 48.8 feet with bentonite pellets.			
50					TD AT 50 FEET

GROUNDWATER

DEPTH	HOUR	DATE
31.0	09:30	3-29-91

Texas — LOG OF TEST BORING NO. 852

JOB NO. FCT01 DATE 91/2/17 TOTAL DEPTH 47.0 feet
SURFACE ELEVATION 437.85 RIG TYPE ROTARY AND CORE RIG
TOP OF FILTER PACK 17.00 BORING TYPE ROTARY AIR
WELL CASING TYPE 4.0-IN.SCHED.40 PVC LOCATION N 59902.03 E 66684.55
FORMATION of COMPLETION Deweesville /Conquista contact DATUM MSL, GROUND SURFACE



Remarks	Lithology	USCS	Visual Classification
Installed 4-in. well Installed grout seal to 4.6 feet.		ML SC	SOIL Clayey Silt, mod. plast., dk. grey, moist. DEWEESVILLE MEM. Clayey Sand, fine grained, loose, lt. yellow, to tan, moist
Placed bentonite pellets at 4.6 to 17 feet Installed No.8-12 sandpack at 17 to 39 feet.		SP SM	Sandstone, fine, mod. hard, lt. tan to buff. Silty Sand, fine, uncemented, yellow green, slightly moist.
installed 10 -ft. screen at 30 to 40 feet. Cuttings v. moist at 32 to 35 feet. Sealed hole bottom with bent. pellets at 39 to 47 feet. Water in boring upon completion of hole		CL	CONQUISTA CLAY MEM. Silty Clay, soft, dk. grey, limonite stained zone 37 to 39 feet. TD AT 47 FEET

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 879
DATE COMPL. 91/2/1
RIG TYPE ROTARY AND CORE RIG
METHOD CORE BIT
CORE SIZE,IN. 4.0
GRID COORD. N / E N56764.4 E65276.2
SURFACE ELEV. FT. 407.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE >20 IN	MOD. 5-20 IN	CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS
	X	0										
	X	100	100									
160	X	100	100									
	X	100	50									
165											CL	
170												
175												
180												
185												
190												
195												
200												
205												

STRATIGRAPHIC DESCRIPTION

From 157 feet the Claystone is the major lithology.

MANNING FORMATION:
Claystone, massive, soft, grey.
TD AT 168 FEET.

GROUNDWATER

DEPTH	HOUR	DATE

upper [illegible]

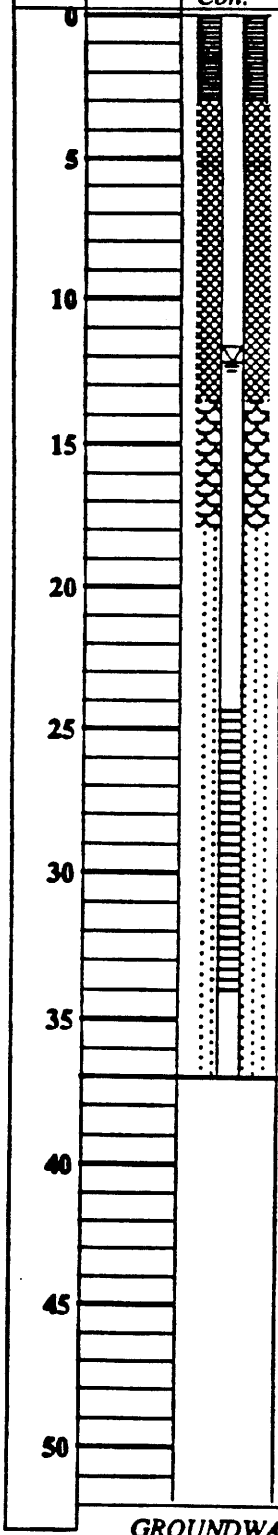
LOG OF WELL BORING NO. ~~968~~ 880

PROJECT Falls City Site
Texas

JOB NO. FCT01 DATE 04/14/93

SURFACE ELEVATION 444.14
TOP OF FILTER PACK 18.00
WELL CASING TYPE 2.0-IN.SCHED.40 PVC
COMPLETION DEWEESVILLE

TOTAL DEPTH 37.0 feet
RIG TYPE JEDI
BORING TYPE HOLLOW STEM AUGER
LOCATION N 60857.90 E 66634.30
DATUM MSL, GROUND SURFACE



Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2.0-inch PVC well to 37 feet.		CL	DEWEESVILLE MEM.: SANDY CLAY, fine sand, weakly cemented, olive-tan.
		Installed steel casing with grout to 3 feet.			
5		Bentonite chips seal placed from 3 to 13.5 feet.		CL	SILTY CLAY, very moist, high plasticity, brown.
10				SC	SANDSTONE, with clay, very moist, high plasticity, brown.
		Bentonite pellet seal placed from 13.5 to 18 feet.			
15				CL	CLAY, very moist, high plasticity.
		Installed sandpack from 18 to 37 feet			
20					Note: Color change to greyish green from 20 ft., very moist, no odor.
		Blank PVC casing installed to 24.1 feet			
25		Installed .050 screen from 24.1 to 34.1 feet		SP	SILTY SANDSTONE, very moist to wet, partially lithified, with traces of limonite, grey. Note: Water encountered at 27 feet.
30				CH	SILTY CLAY, high plasticity, partially lithified, very moist, grey.
		Installed blank sump from 34.1 to 37 feet			
35					
					TD AT 37 FEET.
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
12.2	07:40	4-14-93

Note!
Logs for Wells 868 - 870 have been Temporarily called 968-970 because of existing boreholes with same Number

Note:
- Northing for Well 869 (969) needs to be Confirmed
- No lithology log for Well 870 (970
- How about sample method? spoons at 5 feet Continuous

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 879
DATE COMPL. 91/2/1
RIG TYPE ROTARY AND CORE RIG
METHOD CORE BIT
CORE SIZE,IN. 4.0
GRID COORD. N / E N56764.4 E65276.2
SURFACE ELEV. FT. 407.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE >3/8 IN	MOD. 3/8-1/8 IN	CLOSE <1/8 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55													Some interbedded Shale and Siltstone, thin bedded. **LOWER, CONQUISTA CLAY MEM.:** Claystone to clay, massive to thin bedded, soft, dk. grey moist.
	RC	20	0										
	DX	100	43										
60													Clayey Siltstone layer at 59 to 60.7 feet
	DX	100	52										
65													
	DX	70	65								CL		Claystone, laminated to massive, mod. soft, dk. grey. Some Siltstone seams and fossil burrows present. Odor of petroleum on fresh fracture.
	DX	84	83										
70	DX	92	90										
75	DX	100	84										
80	DX	96	92										Lignite, sandy, soft, black. Odor of methane present.
											ML		**DILWORTH MEM.:** Clayey Sandstone to Siltstone
85	DX	72	36								SP CL		Silty sandstone, fine, carbonaceous, thin bedded, mod. soft, lt. green to lt. grey; interbedded with Claystone, massive to thin bedded, mod. soft, dk. grey.
90	DX	84	56										
	DX	90	75										
95	DX	93	82										
100	DX	96	96								CL		Claystone, massive to thin bedded, mod. hard, interbedded with minor siltstone, thin bedded, mod.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 879
DATE COMPL. 91/2/1
RIG TYPE ROTARY AND CORE RIG
METHOD CORE BIT
CORE SIZE,IN. 4.0
GRID COORD. N / E N56764.4 E65276.2
SURFACE ELEV. FT. 407.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NUMBER	FRACTURES: ANGLE, DEG.	FRACTURES: WIDE >20 IN	FRACTURES: MOD. 5-20 IN	FRACTURES: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105													hard, grey.
	X	58	30										
110											LS		Limestone, w/ calcite, mod. thick bedded, mod. hard, grey.
	X	74	44								SC		Sandstone, clayey, mod. thick bedded, mod. soft, friable grey to lt. grey.
115													Cross bedded with 0.3 ft fossiliferous zone at upper contact. Some carbonaceous material present.
	X	60	17										
120													
	X	73	60										
125													
	X	100	90										
130													
	X	20	18								SP CL		Sandstone, fine, thin bedded, mod. soft, lt. grey,; interbedded with Claystone/Shale, laminated, soft, grey. The stratum is bioturbated with fossil burrows throughout.
135													
	X	60	60										
	X	100	98										
140													
	X	98	90										
145													
	X	52	40										
150													
	X	0	0										
155	X	100	95										

GROUNDWATER

	DEPTH	HOUR	DATE
WATER			

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 878
DATE COMPL. 91/1/22
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE,IN. 4.0.
GRID COORD. N / E N60374.5 E67198.7
SURFACE ELEV. FT. 442.9

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	MOD. 4-20 IN	CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	GB	100								SM		**SOIL:** Silty Sand, fine to med., dk.brn. moist.
										SP	Attempted continuous sampling using grab samples and HX core.	**DEWEESVILLE MEM. OF WHITSETT FM.:** Sandstone, med. to fine, thin to mod. bedded, mod. soft, lt. tan. Some cross bedding and some thin bentonite seams present.
5	HX	93										
	HX	90	76									
10	HX	100	95							CH		Claystone to clay, little sand, laminated, soft, bentonitic, lt. yellowish green to lt. tan.
15	HX	34	0							SP	Strata and sample description taken from average of two holes	
20	HX	82	75								Lost first hole due to caving at 29 feet.	Silty Sandstone, very fine to med., thin bedded, mod. soft, with clay seams present, lt. brown to grey. Brecciated zone at 22 to 22.5 feet.
25	HX	24	0								Second hole nearby lost samples from 32 to 42.5 feet	One inch lignite seam at 24 feet. Mod. hard from 27 to 27.5.
30	HX	38	0									
	HX	0	0									**Unknown Strata** due to lack of sample recovery from 32.3 to 42.5 feet.
35												
40											Hole plugged with bentonite pellets and chips.	
	HX	60	0							SC		Clayey Sandstone, very fine, thin bed.,soft, lt .yellow.
45												TD AT 44.5 FEET
50												

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT	Falls City Site Texas ;UMTRA	LOG OF CORE HOLE NO.	879
JOB NO.	FCT01	DATE COMPL.	91/2/1
		RIG TYPE	ROTARY AND CORE RIG
		METHOD	CORE BIT
		CORE SIZE,IN.	4.0
		GRID COORD. N / E	N56764.4 E65276.2
		SURFACE ELEV. FT.	407.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE >20 IN	MOD. 5-20 IN	CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	SP	73									CH		**SOIL:** Silty Clay, brown.
											SM	Upon completion the hole caved from 168 to 90 feet.	**DEWEESVILLE MEM.:** Silty sand, fine to med., slightly plast., mod. hard, brown to tan, moist. Occ. thin cemented seams from 3 to 10 feet.
5												Plugged hole with bentonite chips from 90 to 2 feet installed grout plug at surface.	
	SP	86											
10	SP	82	77								CL		Sandy Clay, fine sand, soft, med. plast., tan, moist. Some iron stain on partings.
	SP	82	30										
	PC	44	18										
15	PC	46	21									Continuous samples taken with spoon, Punch Core, and HX core bit.	Thin gypsum seam on bedding plane at 19 feet.
20	PC	70	22								CL		**CONQUISTA CLAY MEM., UPPER:** Claystone, thin bedded to massive, soft to very soft, grey. Occasional minor siltstone seams.
25	PC	100	80										
30	PC	90	0										
	PC	100	20										
35	PC	98	63										
40	PC	100	80										
	PC	87	60										
45	HX	100	75								CL		**MIDDLE, CONQUISTA CLAY MEM:** Sandstone, fine, fossiliferous, thin bedded, mod. hard, lt. grey to green.
50	PC	83	42										

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 877
DATE COMPL. 91/5/21
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE,IN. 4
GRID COORD. N / E N58781.7 E65317.1
SURFACE ELEV. FT. 433.4

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: CORE	FRACTURES: ANGLE, DEG.	FRACTURES: HIGH >20 IN MOD 5-20 IN CLOSE <5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	SS	82							SP		**DEWEESVILLE MEM.:** Intercalated Sandstone and Sandy Claystone; very soft, tan to lt. tan. With some limonite staining and minor amounts of carbonaceous material in partings.
	SS	55							CL	Continuous sampling using spoon, Punch Core or HX core bit..	
5	SS	71									
	PC	100	73								Increasing clay content with depth.
	PC	100	80								
10	PC	65	0						SP	Hole was plugged with bentonite pellets and ships.	Sandstone, fine, thinly bedded, mod. hard, lt. brn.
	HX	90	25								Softer with little orange limonite stain from 13 feet.
15	HX	78	50						SP		Sandstone, with clay, fine mod. spaced fractures, soft, lt. brn. to greenish grey. Some cross bedding.
	HX	25	0								
20	HX	60	30								
25											
	HX	92	38								
30									CL		**CONQUISTA CLAY MEM., UPPER:** Claystone, soft, lt. greenish grey. Occasional Siltstone lenses, and some limonite staining on partings.
	HX	92	30								Occasional thin green banding from 31 to 33 feet.
35	HX	92	28								Occ. thin gypsum seam and varigated zone from 35 to 38 feet.
	HX	100	88								
40									CL		Claystone, massive, soft, dark olive grey.
	HX	100	82								
45											
	HX	86	81								
50											

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 877
DATE COMPL. 91/5/21
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE,IN. 4
GRID COORD. N / E N58781.7 E65317.1
SURFACE ELEV. FT. 433.4

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: HOR. >20 IN.	FRACTURES: VERT. >20 IN.	FRACTURES: CLOSE <5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	DX	100	100										
60	DX	98	80								ML		MIDDLE, CONQUISTA CLAY MEM.: Sandy siltstone, with fossils, very soft, olive grey. Occ. Claystone seams. Limestone lens at 59.9 ft. TD AT 60 FEET.
65													
70													
75													
80													
85													
90													
95													
100													

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 876
DATE COMPL. 91/5/15
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE,IN. 4
GRID COORD. N / E N59175.1 E64429.0
SURFACE ELEV. FT. 439.3

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: WIDE >2.0 IN.	FRACTURES: MOD. 2-.5 IN.	FRACTURES: CLOSE <.5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105	DX	100	100								CL		Claystone, massive, soft, olive grey. Occasional sandstone lenses and lignite partings.
	DX	82	50										
110											SP		Sandstone, fine, mod. spaced fractures, soft, lt. greenish grey. Two inch thich seam of shell frag. at upper contact.
	DX	75	50										
115											SC		Clayey Sandstone, v. fine, fractured, soft,lt. olive grey.
	DX	100	100								CL		Claystone, fractured, soft, olive grey. Occasional thin Sandstone seam. micro-compaction slickensides at 118 feet.
120	DX	91	62										sandy zone from 120 to 123 feet.
125	DX	79	25								SP		Sandstone, closely fractured, soft, lt. greenish grey. Occasional thin Claystone seam.
	DX	55	25										
130	DX	89	70										
135	DX	25	12										
140	DX	0	0										
145	PC	24	0										
	PC	70	25										
150													
	DX	100	74								SC		Clayey Sandstone, v. fine, soft, lt. olive grey. Occasional coaly frag.
155													

GROUNDWATER

	DEPTH	HOUR	DATE
4/90			

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 876
DATE COMPL. 91/5/15
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE,IN. 4
GRID COORD. N / E N59175.1 E64429.0
SURFACE ELEV. FT. 439.3

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: LIKE >20 IN	FRACTURES: MOD 3-20 IN	FRACTURES: CLOSE <3 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
	X	100	74								SP		Sandstone, fine, mod. spaced fractures, soft, lt. greenish grey. Occasional Claystone seam and lignite parting.
160													
	X	85	62										
165	X	8	0										
	X	66	49										
170													Frequent Claystone seams from 170 feet.
	X	73	64								CL		Claystone, fractured, soft, olive grey. Occasional thin Sandstone lenses and lignite partings.
175													
	X	100	100										
180													
	X	100	100										Claystone, lignite rich, olive grey to greenish grey.
											CL		Claystone, soft, olive grey.
185	X	82	65										Lignite layer at 186 to 186.5 feet.
	X	100	100										Lignite, soft, dark brn.
190											CL		MANNING MEM. OF McELROY FM.: Claystone, massive, some coaly seams, soft, lt. bluish green.
													TD AT 193 FEET
195													
200													
205													

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 876

DATE COMPL. 91/5/15

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH, SPOON & CORE

CORE SIZE,IN. 4

GRID COORD. N / E N59175.1 E64429.0

SURFACE ELEV. FT. 439.3

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE, >20 IN	MOD. 5-20 IN	CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
	HX	100	100										
55	HX	100	100										
60	HX	100	100										
	HX	82	58										Sandy at 62 to 64 feet; varved from 64 to 67 feet.
65													
	HX	100	100										
70													
	HX	98	98										
75	HX	100	100										Scattered fossil shell frag. at 74 feet.
80	HX	100	100										
	HX	100	88								SP		Lignite, soft, widely spaced fractures. dk. brn. to black. Occ. Claystone seam.
85													**DILWORTH MEM.:** Sandstone, fine, widely spaced fractures, soft to mod. hard, lt. greenish grey.
	HX	82	52										Becoming Clayey at 87 ft. Some coaly frag. and partings; some Claystone seams from 91 feet.
90	HX	100	93										
95	HX	96	82								SP CL		Intercalated Sandstone and Claystone: widely spaced fractures, soft, lt. greenish grey to olive grey.
100	HX	100	95										Claystone predominates from 100 feet.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 875

DATE COMPL. 91/5/12

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH, SPOON & CORE

CORE SIZE,IN. 4.0

GRID COORD. N / E N62305.0 E64184.3

SURFACE ELEV. FT. 445.6

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE, >20 IN	MOD, 5-20 IN	CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
	NX	98	98										**MANNING MEM. OF McELROY FM.:** Claystone, massive, soft, lt. greenish grey. Occasional thin carbonaceous partings.
160													TD AT 160 FEET
165													
170													
175													
180													
185													
190													
195													
200													
205													

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 876

DATE COMPL. 91/5/15

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH, SPOON & CORE

CORE SIZE,IN. 4

GRID COORD. N / E N59175.1 E64429.0

SURFACE ELEV. FT. 439.3

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: WIDE, >20 IN	FRACTURES: MOD, 5-20 IN	FRACTURES: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	SP	37									CH	Continuous sampling using Punch Core, spoon, grab sample or HX core bit.	**DEWEESVILLE MEM:** Sandy Clay, med. plasticity, tan. (possibly disturbed material)
	SP	71											
	SP	87									CL		**CONQUISTA CLAY MEM., UPPER:** Silty Claystone, high plast., soft, tan, some limonite stain on partings. Possible traces of uranium mineralization at 5.5 to 10 feet.
5	PC	73											
10	PC	100										Hole was plugged using bentonite pellets or chips.	
15	PC	100	77										Color becoming variable tan to lt. greenish tan to orange at 15 feet.
	PC	83	34										
20	PC	100	91										Occasional thin gypsum seam from 17 feet.
25	PC	100	60										
30	PC	90	30										
	HX	100	50								SP		**MIDDLE, CONQUISTA CLAY MEM.:** Sandstone fine, soft, lt. greenish tan. Occasional thin gypsum seam. Occasional carbonaceous seam.
35	HX	40	8										
	PC	30	0										Becoming more clayey from 37 feet.
40	PC	0	0								SP		Sandstone, very fine, very soft, lt. greenish grey. Occasional thin Claystone seam. Occ. thin gypsum seam.
	PC	65	0										
45	HX	75	0										
	HX	100	83								CL		**LOWER, CONQUISTA CLAY MEM.:** Claystone, laminated, widely spaced fractures, soft, lt. greenish grey to olive grey. Occasional coaly frag.
50	HX	95	95										

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 875
DATE COMPL. 91/5/12
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE,IN. 4.0
GRID COORD. N / E N62305.0 E64184.3
SURFACE ELEV. FT. 445.6

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE >20 IN	MOD. 5-20 IN	CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	HX	100	100										
	HX	92	88										Lignite, soft, dark brown to black. Occasional seam of bentonitic clay.
60	HX	97	75										
	HX	72	48								SP		DILWORTH MEM.: Sandstone, fine, wide spaced fractures, fresh, soft to mod. hard, lt. greenish grey.
65	HX	21	10										
70	HX	85	22										
	HX	90	69								CL		Claystone, v. thinly bedded, mod. spaced fractures parallel to bedding, soft, lt. olive grey. Occasional thin sandstone lenses.
75	HX	100	100										
80	HX	48	32										
											SP		Sandstone, fine, soft to mod. hard, lt. greenish grey. Occasional coaly frag. Occasional thin claystone seams.
85	HX	8	0										
90	PC	42	0										
95	HX	0	0										
	PC	0	0										
100	HX	0	0										
	HX	18	0								SP CL		Intercalated Sandstone and Claystone; moderately spaced

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 875
DATE COMPL. 91/5/12
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE,IN. 4.0
GRID COORD. N / E N62305.0 E64184.3
SURFACE ELEV. FT. 445.6

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE, >2"	MOD., 2-.2"	CLOSE, <.1"	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105													fractures, soft, lt. greenish grey to dark olive grey.
	BX	45	25								CL		
	BX	95	40										Claystone, thickly bedded to laminated, soft to v. soft, dark olive grey. Occasional thin seam of Clayey Sandstone.
110	BX	55	0										
	BX	0	0								SC		Clayey Sandstone, very fine, soft, lt. greenish grey.
115	BX	67	33										
	BX	47	12										Less clay content from 117 feet.
120	BX	47	0										
	BX	17	0										
125	BX	77	0								CL		
130	BX	69	58										Sandy Claystone, thinly bedded to massive, widely spaced fractures, soft, olive grey. Occasional coaly fragment.
	BX	100	100								SP		Sandstone, fine, soft, widely spaced fractures, some carbonaceous partings olive grey.
135	BX	91	91								CL		Claystone, massive, soft, dark olive grey. Occasional sandy seam.
140	BX	100	85										
145	BX	98	98										
150	BX	100	100										
	BX	73	50										Very thin Lignite seams at 154 to 155 feet.
155											CL		

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 874

DATE COMPL. 91/5/9

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH, SPOON & CORE

CORE SIZE,IN. 4.0

GRID COORD. N / E N58062.5 E68789.1

SURFACE ELEV. FT. 441.1

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE, >20 IN	MOD. 5-20 IN	CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
	HX	100	100								SP		**DILWORTH MEM.:** Sandstone, fine, massive, soft, lt. greenish grey. With coaly frag. and partings to 158.5 feet.
160	HX	32	32										
165	HX	0	0										TD AT 167 FEET
170													
175													
180													
185													
190													
195													
200													
205													

GROUNDWATER

DEPTH	HOUR	DATE

875

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO.

DATE COMPL. 91/5/12

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH, SPOON & CORE

CORE SIZE,IN. 4.0

GRID COORD. N / E N62305.0 E64184.3

SURFACE ELEV. FT. 445.6

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE >20 IN	MOD. 5-20 IN	CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS
0	SP	49									CH	
	SP	87									CL	Continuous sampling using Punch Core, spoon, HX core barrel, or rotary cuttings.
5	SP	79									SC	
	PC	100	30									
	HX	40	0								LS	
10	PC	100									SC	
												The hole was plugged using bentonite pellets or chips.
	PC	100										
15												
	PC	74	0								CL	Changed from air to air/mist circulation at 16 ft.
20	PC	50	0									
25	PC	100										
	PC	100										
30	HX	100	65								CL	
35	HX	100	70									
	HX	80	72									
40												
	HX	45	30								CL	
45												
	HX	100	100									
	HX	64	56									
50	HX	100	100									

STRATIGRAPHIC DESCRIPTION

SOIL: Silty Clay, high plasticity, black.

Sandy Clay, oxid. staining.

MIDDLE, CONQUISTA CLAY MEM: Clayey Sandstone, soft, with thin clay lenses,lt. tan.

Limestone, mod. close fract. manganese coating on fract.

Clayey Sandstone, very soft, with limonite staining, lt. greyish tan to tan.

Becoming moist at 16 feet.

Sandstone, soft to mod. hard, mod. to thin bedded, mod. to closely fractured, lt. greyish tan.

LOWER, CONQUISTA CLAY MEM.: Silty Claystone, highly oxidized, very soft, lt. tan. Occasional zone of gypsum fragments. Mineralization becoming more reduced from 25 feet.

Claystone, thinly bedded, mod. closely fractured, soft, dk. tan. Occasional thin gypsum seams, and limonite staining on partings.

End of oxidation zone at 36 feet. Becoming olive grey. Thin gypsum and lignite seams at 35 feet. Occasional carbonaceous partings.

Claystone, massive, fresh, mod. hard to soft, olive grey.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 874

DATE COMPL. 91/5/9

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH, SPOON & CORE

CORE SIZE,IN. 4.0

GRID COORD. N / E N58062.5 E68789.1

SURFACE ELEV. FT. 441.1

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: WIDE >2IN	FRACTURES: MOD. 5-2IN	FRACTURES: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	PC	100	78								CL		DUBOSE / DEWEESVILLE TRANSITION ZONE Claystone.
											SC		DEWEESVILLE MEM:
60	PC	100	50										Clayey Sandstone, v. fine, v. thinly bedded,soft, dk. olive grey. Occasional coaly frag.
	PC	100											
65	PC	100	68										
	PC	100	0										Lignite, dk. brn.
70	DX	46	29								SP		Sandstone, mod. hard,grey.
											SP		Sandstone, fine, soft,lt. olive grey.
	DX	30	0										mod. hard from 73 to 74 feet.
75													
	DX	0	0										
80	PC	90	0										
	PC	60	25										Occasional thin carbonaceous parting.
85													
	PC	60	33										
90	PC	100	71										
	PC	40	0										
											CL		UPPER CONQUISTA CLAY MEM:
95	DX	40	31										Claystone, fissile, soft, dark grey. Occasional sandy zones.
	DX	100	71										
	DX	78	77										
100													
	DX	93	83								CL		Claystone, slightly fractured,

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 874
DATE COMPL. 91/5/9
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE,IN. 4.0
GRID COORD. N / E N58062.5 E68789.1
SURFACE ELEV. FT. 441.1

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE >1/2 IN	MOD. 1-20 IN	CLOSE <1IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105													fresh, soft, variable color lt. olive to dk. olive grey.
	HX	100	70										
110											CL		Sandy Claystone,, slightly fractured, fresh, soft, lt. olive grey.
	HX	98	98										
115	HX	83	38								CL		Claystone, massive, slightly fractured, mod. hard, lt greyish green to dk. olive grey.
	HX	77	74										
120	HX	93	82										
											CL		Sandy Claystone, some shell fossils, mod fractured, very soft, lt. olive grey.
	HX	85	80										.M=CL Claystone, fresh, slightly fractured, massive, mod. hard, dk. olive grey.
125													
	HX	92	86										
130													
	HX	100	100										
135													
	HX	100	100										
140	HX	88	88										
													Thin lignite seam at 143 feet
145	HX	100	95										
	HX	100	100										Slightly fossiliferous from 148 feet.
150													
	HX	100	100										
155											CL		Claystone, considerable lignite, slightly fract.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 873

DATE COMPL. 91/4/26

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH,SPOON & CORE

CORE SIZE,IN. 4.0

GRID COORD. N / E N60405.2 E65278.0

SURFACE ELEV. FT. 456.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: JOINT	FRACTURES: ANGLE, DEG.	FRACTURES: HIGH >20 IN	FRACTURES: MOD. 5-20 IN	FRACTURES: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	EX	91	26								CL		Sandy Claystone, massive, considerable fossil shell frag., very soft, med. grey.
	EX	20	0										Fossils becoming less frequent at 56.5 feet
60											SP		**CONQUISTA CLAY MEM. SAND UNIT:** Sandstone, very fine, very soft, greenish grey.
	PC	80	0										
	PC	100	0										
65	PC	27											
											CL		**LOWER CONQUISTA CLAY MEM.:** Claystone, soft, greenish grey. Small amount of fossils at 67 and 69 feet. Hard Sandstone layer at 69.5 to 70 feet.
	PC	85	23										
70	EX	100	50										
	EX	92	83										
75													TD AT 75 FEET
80													
85													
90													
95													
100													

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 874

DATE COMPL. 91/5/9

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH, SPOON & CORE

CORE SIZE,IN. 4.0

GRID COORD. N / E N58062.5 E68789.1

SURFACE ELEV. FT. 441.1

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: CORE	FRACTURES: ANGLE, DEG.	FRACTURES: LITHOLOGY SYMBOL	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	SP	60							CH	Sampled continuously with Punch core, Spoon, HX core, or grab sample.	SOIL: Silty Clay, high plast. dk. grey. (cultivated area)
	SP	31									
	SP	80									
5	PC	100							CH		DUPLICATE MEM.: Silty Clay, some iron staining on partings, high plast., lt. tan
	PC	100							ML		Clayey Silt, with organic matter, occ. oxidized zone, med. plast., dk. brn.
10	PC	100							ML	Hole plugged using bentonite pellets and chips.	Clayey Silt, laminated, with iron staining, med. to high plasticity, lt. tan.
	PC	100									
15	PC	100									
	PC	100									
	PC	100									
20	PC	30							CH		Silty clay, iron stain on partings, lt. tan.
	PC	10									
25	PC	90									
	PC	100									
	PC	100									
30	PC	100									
	PC	100									
35	PC	100									
	PC	100									
40	PC	67									
	PC	100	90						CL		Claystone, thinly bedded, some iron staining, soft, lt. greyish tan to dark yellowish brown.
45	PC	100	98								
50	PC	100	80								Occasional thin gypsum seam from 50 feet.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 872

DATE COMPL. 91/3/30

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH, CORE,& SPOON

CORE SIZE,IN. 4.0

GRID COORD. N / E N55630.2 E64917.2

SURFACE ELEV. FT. 419.9

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: WIDE >1/2 IN.	FRACTURES: MOD. 1/2-1/4 IN.	FRACTURES: CLOSE <1/4 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	HX	91	64								CL		Sandy Claystone, laminated, soft, lt. grey. Becoming less sandy from 55 feet.
60	HX	98	98										
65	HX	100	100										Becoming harder below 65 feet.
70	HX	100	100										
75	HX	97	97								CL		Claystone, greenish grey, with scattered fossil frag.
80	HX	97	67										
	HX	94	69										Lignite, laminated, very soft, dk. brn. to black. Odor of H2S.
											ML		DILWORTH MEM. Siltstone.
85	HX	90	50								SP		Sandstone, very fine, mod. bedded, fresh, mod. hard, lt. grey Becoming finer grained at 86 ft.
	HX	62	8										
90	PC	100	55										
95	PC	65	0										
	HX	90	0								SP		Sandstone, laminated, mod. hard, grey.
	HX	100	55										
100													TD AT 100 FEET.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 873

DATE COMPL. 91/4/26

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH,SPOON & CORE

CORE SIZE,IN. 4.0

GRID COORD. N / E N60405.2 E65278.0

SURFACE ELEV. FT. 456.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: CORE	FRACTURES: ANGLE, DEG.	FRACTURES: WIDE >20 IN	FRACTURES: MOD. 5-20 IN	FRACTURES: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	SP	68									CH		**SOIL** Silty Clay, high plast. black.
	SP	78										Continuous samples taken by grab samples, Punch Core, Spoon or, HX core barrel.	
	CB	100									CL		**DEWEESVILLE MEM** Sandy Claystone, some iron staining on partings, very, soft, lt. tan.
5	PC	100											
10	PC	92											
	PC	90										Hole plugged with bentonite pellets and chips.	Occasional thin seam of gypsum.
15	PC	100											
	PC	100											
20	PC	100											
	HX	96									CL ML		**UPPER CONQUISTA CLAY MEM.** Intercalated Claystone and Siltstone, laminated, soft, occ. thin gypsum seam, tan to lt. brown.
25	HX	78											
30	HX	62											
35	HX	82									CL		Claystone, massive, soft, medium grey.
40	HX	77	75										
45	HX	100	94										
50	HX	100	100										

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 871
DATE COMPL. 91/3/18
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, CORE & SPOON
CORE SIZE,IN. 4.0
GRID COORD. N / E N58672.1 E68073.8
SURFACE ELEV. FT. 421.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NUMBER	FRACTURES: ANGLE, DEG.	FRACTURES: TIGHT >20 IN	FRACTURES: MOD. 5-20 IN	FRACTURES: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105													
	X	100	76										Scattered occurrences of shell fossil frag. from 105 to 111 feet.
110													Observed compaction slickenside at 108 feet.
	X	96	88										Lignite, very soft, brown to dk. brown with thin claystone seams.
115											SP		DILWORTH MEM. Sandstone, fine, fresh, massive, mod. hard, lt. greenish grey. Thin bedded from 118 feet.
	X	75	52										
120													
	X	33	16										
125											ML CL		Intercalated Siltstone and Sandy claystone, soft to moderately hard, lt. grey.
	X	68	30										
	X	100	60										
130													TD AT 130 FEET
135													
140													
145													
150													
155													

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 872

DATE COMPL. 91/3/30

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH, CORE,& SPOON

CORE SIZE,IN. 4.0

GRID COORD. N / E N55630.2 E64917.2

SURFACE ELEV. FT. 419.9

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE, >20 IN	MOD, 5-20 IN	CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	SP	87									CH		**SOIL** Silty clay, fine, brn.
	SP	100									SP	Sampled using Punch Core, Spoon, core barrel, and grab samples.	**DEWEESVILLE MEM.** Sandstone, fine, mod. hard, lt. tan.
	GB	100											
5	PC	100											Becoming soft at 5.0 feet.
	PC	100											
	PC	88											
10	PC	75										Plugged hole with bentonite pellets and chips.	From 10 feet observed some iron staining and small amount of gypsum frag.
	PC	90											
15	PC	85											
	PC	100											
20	PC	100									SP		**DEWEESVILLE / CONQUISTA TRANSITION ZONE** Interbed. Sandstone/ Claystone.
	PC	83	53								CL	Began using air/mist at 20.75 feet	
	PC	80	50										
	HX	100	0								CL		**CONQUISTA CLAY MEM.** Claystone, very thinly bedded,some iron staining, soft, v. lt. tan to grey
25	HX	80	0										
	HX	100	60										Occasional thin gypsum seam and carbonaceous partings.
	HX	95	0										
30	HX	67	33										
	HX	100	40										
35	HX	100	100								CL		Claystone, some silt,soft, grey.
	HX	98	87										
40	HX	100	93										Encountered hard sandstone seam at 42.7 to 43.0 feet.
45	HX	96	66										Considerable fossil shells from 47 feet.
50	HX	100	75										V. thin hard sandstone lens at 51.7 feet. End of fossils.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 871

DATE COMPL. 91/3/18

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH, CORE & SPOON

CORE SIZE,IN. 4.0

GRID COORD. N / E N58672.1 E68073.8

SURFACE ELEV. FT. 421.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	HIGH >20 IN	MOD. 5-20 IN	CLOSE <5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	SP	55									CH	All samples retained by State of Texas.	**SOIL** Silty Clay, hi. plast., black.
	SP	61											
	SP	78									CH		**DUBOSE MEM. OF WHITSETT FM.** Silty Clay, high plasticity, very soft, light tan, with small gypsum fragments and some iron staining along partings. Small sandstone concretions from 6 to 8 feet
5	SP	91										used Punch Core, split spoon and hx core to sample.	
	PC	100	20										
10	PC	100	55									Plugged hole with bentonite chips and pellets.	
15	PC	100	89										V. thin gypsum seam at 14 feet. Occasional silty and fine sandy seams with considerable iron oxide staining
20	PC	100	75										
	PC	99	0								SC		**DUBOSE / DEWEESVILLE TRANSITION ZONE** Clayey Sand, fine, limonite stains, lt. tan.
25	PC	100	0								SP		**DEWEESEVILLE MEM.** Sandstone, fine, soft, lt. tan; with occ. thin seams of Sandy Clay, med plast. lt. brn.
	PC	40	0									Began water injection w/air at 24.5 feet	
	PC	50	50								ML		Clayey Silt, with fine sand, some lignite, dk brn.
	PC	100	100										
30	PC	27	0										
	PC	35	0								SP		Sandstone, fine, mod. indurated, soft, brown to lt. grey. Occasional thin lenses of claystone, some zones with iron staining. Becoming moderately hard at 32.5 feet.
	PC	30	0										
	HX	100	90										
35	HX	96	92										
	HX	5	0								SP		Sandstone, fine, thinly bedded, soft, lt. grey.
40													
	HX	17	0								SP		**DEWEESVILLE / CONQUISTA TRANSITION ZONE** Intercalated Sandstone, and Claystone, some lignite, very soft, to lt. tan
45	HX	10	0								CL		
	PC	85	25										
50	PC	72	0								ML		**CONQUISTA CLAY MEM.** Siltstone, some fine sand, very soft, lt. tan

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 871
DATE COMPL. 91/3/18
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, CORE & SPOON
CORE SIZE,IN. 4.0
GRID COORD. N / E N58672.1 E68073.8
SURFACE ELEV. FT. 421.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: WIDE >20 IN	FRACTURES: MOD. 5-20 IN	FRACTURES: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	PC	87	83								CL		Silty Claystone, w/ gypsum and iron stain.
	RX	93	50								CL		Claystone, massive, fresh, thin bedded, soft, grey; Some carbonaceous fragments on bedding planes.
60	RX	44	11										
	RX	67	40										
65	RX	100	100										
	RX	100	100										
70													
	RX	96	96										
75													
	RX	100	52										
80											CL		Claystone, thin bedded, with fossil shell frag.
											CL		Claystone, fresh, thin bedded, occ. fine sandy lenses, soft, lt. grey. Thin fossil zone at 82.5 With black carbonaceous partings from 83 feet.
	RX	95	86										
85													
	RX	100	94										
90													Encountered thin silty stratum from 90 to 91.5 feet
	RX	100	90										
95													
	RX	100	100										
100													From 100 feet observed occasional thin lignite parting.
	RX	97	97										

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 870
DATE COMPL. 91/2/20
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH CORE & SPOON
CORE SIZE,IN. 4
GRID COORD. N / E N60494.5 E63340.0
SURFACE ELEV. FT. 473.2

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: WIDE >20 IN	FRACTURES: MOD. 5-20 IN	FRACTURES: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
	PC	100	100										massive ,indurated, mod. hard , iron stains on partings, lt. grey.
55	PC	100	50										Clayey Sand lens encountered at 56 to 57 feet.
60	PC	100	86										
65	PC	100	76										Encountered gypsum filled fracture (50 deg.) at 66 feet. No iron staining observed below 67 feet.
70	PC	70	59										Lignite lens at 67.5 to 68.5 feet.
75	PC	100	95										
80	PC	96	92										
85	PC	100	80										Increasing carbonaceous and shaley from 85 feet.
													Lignite (marker bed), shaley to thin bedded, mod. hard, dk. brn.
90	PC	100	92								SC		DILWORTH MEM. Clayey Sandstone, fine, carbonaceous, thin bedded, thin clayey lamina present, mod. soft, with fossil burrows, greyish green.
95	PC	70	30								SP CL		Claystone, thin bedded, med. plast., greyish green. interbedded with Sandstone,fine thin bedded, mod. hard, green.
100	PC	84	52								CL		Claystone, massive, mod. hard, greyish green.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 870
DATE COMPL. 91/2/20
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH CORE & SPOON
CORE SIZE,IN. 4
GRID COORD. N / E N60494.5 E63340.0
SURFACE ELEV. FT. 473.2

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: LITH. >20 IN	FRACTURES: MOD. 5-20 IN	FRACTURES: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105	X	100	76										(Continued)
110													TD AT 110 FEET.
115													
120													
125													
130													
135													
140													
145													
150													
155													

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 869

DATE COMPL. 91/12/15

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH-CORE & SPOON

CORE SIZE,IN. 4.0

GRID COORD. N / E N61668.9 E64537.9

SURFACE ELEV. FT. 468.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE, >20 IN.	MOD. 5-20 IN.	CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105	HX	100	60								CL		Claystone, massive, mod. soft, greyish green.
	HX	100	88										
110	HX	100	90										
115	HX	50	36								SP ML		**LOWER DILWORTH MEM.** Sandstone, fine carbonaceous, friable, greyish green; interbedded with Siltstone, grey to green ;and minor Claystone, grey green. Vugs and burrows present throughout.
120	HX	80	0										
125	HX	100	0										TD AT 127 FEET.
130													
135													
140													
145													
150													
155													

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 870
DATE COMPL. 91/2/20
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH CORE & SPOON
CORE SIZE,IN. 4
GRID COORD. N / E N60494.5 E63340.0
SURFACE ELEV. FT. 473.2

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: CORE	FRACTURES: ANGLE, DEG.	FRACTURES: HOR. >20 IN.	FRACTURES: MOD. 5-20 IN.	FRACTURES: CLOSE <5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	PC	80									ML		**SOIL** Clayey Silt, dk. brn.
	PC	70										Corehole decommissioned as follows:	
	PC	72											
5	PC	80									SC	Placed bentonite pellets from 110 to 71 feet	**DEWEESVILLE MEM.** Clayey Sand, very fine, ltgrn.
	PC	80									CL	The formation caved from 71 to 59 feet. Bentonite pellets	Clay, little sand, med. plasticity, iron staining on partings, lt. tan to yellow, moist.
10	PC	100										installed from 59 to 40 feet.	Occ. zones of Sandy Clay.
	PC	100										the formation caved at 40 to 29 feet. Bentonite chips	
15	PC	97	83								CH	installed from 29 TO 4 feet.	Clay/Claystone, high plasticity, massive, mod. soft.,lt. yellow to grey, iron staining on partings surfaces.
	PC	98	58									grout placed from 0 to 4 feet	
20													
	PC	30	0										
25													
	PC	75	0										
	HX	100	25								SP		**MIDDLE CONQUISTA CLAY MEM.:** Sandstone, fine, interbedded with Sandy Claystone.
30	HX	80									CL	Continuous samples taken with split spoon, Punch	
	PC	80									SP	Core, and HX core.	Sand, fine grained, soft, tan.
35													
40	HX	70											
	HX	70									SP		Sandstone, fine, medium bedded, mod. soft, to mod. hard, tan, iron stains on partings, filled burrows/vugs present: interbedded with Claystone, thin bedded, mod. soft,, lt. tan, with iron stain partings.
	PC	0	40								CL		
45	PC	73											
	PC	73	40										
50	PC	43	43								CH		**LOWER CONQUISTA CLAY MEM** Clay/Claystone, high plasticity,

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 869

DATE COMPL. 91/12/15

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH-CORE & SPOON

CORE SIZE,IN. 4.0

GRID COORD. N / E N61668.9 E64537.9

SURFACE ELEV. FT. 468.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: HIGH >20 IN	FRACTURES: MOD. 5-20 IN	FRACTURES: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS
0	SP	100									CL	Continuous sampling with split spoon, Punch Core, and HX core bit.
											SC	
5	PC	0										
	PC	0										
	PC	75									SC	
10	PC	50										
	PC	100										
15	PC	48										Began using water injection at 47 feet.
	PC	100										
20	PC	100										The hole was plugged using bentonite pellets and chips.
	PC	100										
25	PC	100										
30	PC	0										
	PC	75										
	PC	75										
35	PC	100										
	PC	100									CH	
40	PC	100										
	PC	100										
	PC	100										
45	PC	100										
	PC	70										
	HX	60										
											SP	
50	HX	100										
	HX	74										

STRATIGRAPHIC DESCRIPTION

FILL: Silty Clay, dk. brn.

TAILINGS:
Sandy Clay to Clayey Sand, fine sand, mod. to high plast. grey to green, v. moist to wet.

Clayey Sand (slimes?), very loose ,slightly plastic, grey, very moist to wet.

SOIL:
Sandy Clay to Clayey Sand, fine, high plasticity, yellow brown, moist to wet.

CONDUIT? MIDDLE SAND

DEWEESVILLE MEM.: Sandstone, fine,mod. to thin bedded, mod. soft, oxidized,lt. red/ tan.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 869
DATE COMPL. 91/12/15
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH-CORE & SPOON
CORE SIZE,IN. 4.0
GRID COORD. N / E N61668.9 E64537.9
SURFACE ELEV. FT. 468.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: WIDE >20 IN	FRACTURES: MOD 5-20 IN	FRACTURES: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	PC	74									SP SC		Sand, fine to med., soft, lt. red, very moist: interbedded with Clayey Sand, fine, mod. plast., v. moist, lt. red.
	PC	74											
	PC	74											
	PC	74	0										
60	PC	100	80								CL		**CONQUISTA CLAY MEM:** Clay to Claystone, thin bedded to massive, iron stained, gypsum on partings, soft, grey to geyish brown, moist.
65	PC	100	60										
	HX	88	64										
70													Possible oxidation/reduction boundary at 68.9 feet. No iron staining obeserved below this depth.
	HX	70	33										
75													
	HX	100	83										
80	HX	98	98										
85	HX	100	98										
90	HX	100	78										
95	HX	100	76								SP		**DILWORTH MEM.** Sandstone, fine. Lignite, soft, black.
											SP CL		Sandstone, fine, thin bedded, mod. soft; interbedded with Claystone, thin bedded, mod. soft, greyih green.
100	HX	69	32										

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 868
DATE COMPL. 91/2/12
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH CORE & SPOON
CORE SIZE,IN. 4.0
GRID COORD. N / E N60839.5 E66253.0
SURFACE ELEV. FT. 444.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: MOD. 5-20 IN.	FRACTURES: CLOSE <5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
												(continued)
55	PC	100	88									
	PC	44	0							CL		Clay/ Clay Shale, shell frag. mod. soft, grey.
60												
	PC	100	100							CL		CONQUISTA MEM; LOWER: Clay/ Clay Shale, massive, to laminated, slightly carboniferous at occ. intervals, mod. soft, grey.
65	PC	100	52									
70	PC	100	98							CL		Claystone, silty, massive to laminated, mod. indurated, mod. hard, grey.
75	PC	100	90									
80	PC	90	84									
85	PC	100	100									
90	PC	92	92									Fossilferous from 90.3 to 91.
95	PC	100	87									Lignite, highly carbonaceous, mod. soft, dk. brn. to black.
100	PC	77	70							SC		DILWORTH SANDSTONE MEM. Clayey Sandstone, fine, medium bedded, mod. soft, friable, greyish green.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO. 868

DATE COMPL. 91/2/12

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH CORE & SPOON

CORE SIZE,IN. 4.0

GRID COORD. N / E N60839.5 E66253.0

SURFACE ELEV. FT. 444.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	FRACTURES: ANGLE, DEG.	FRACTURES: WIDE, >20 IN.	FRACTURES: MOD. 5-20 IN.	FRACTURES: CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105	PC	95	92										(continued)
110	PC	98	93										
115	PC	100	88										TD AT 117 FEET.
120													
125													
130													
135													
140													
145													
150													
155													

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 867

JOB NO. FCT01 DATE 91/5/25
SURFACE ELEVATION 427.19
TOP OF FILTER PACK 45.50
WELL CASING TYPE 4.0-IN SCHED 40 PVC
FORMATION of COMPLETION DEWEESVILLE MEM.

TOTAL DEPTH 168.0 feet
RIG TYPE ROTARY /CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 56471.97 E 67450.59
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Installed .050 slot screen from 53 to 63.			From 52 feet encountered moderately hard to hard zones.
60					
65		Placed 2-ft. sump from 63 to 65.			TD AT 65 FEET.
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 868
DATE COMPL. 91/2/12
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH CORE & SPOON
CORE SIZE,IN. 4.0
GRID COORD. N / E N60839.5 E66253.0
SURFACE ELEV. FT. 444.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES: NONE	ANGLE, DEG.	WIDE >20 IN	MOD. 5-20 IN	CLOSE <5IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0											SC	Continuous samples taken by grab samples (GB) from rotary, split spoon (SP), Punch Core (PC), or HX core bit (HX).	**SOIL:** Clayey Sand, med. to fine, mod. plast. brn, moist.
5													
10	PC	35	0								SC		**DEWEESVILLE MEM.** Clayey Sand; interbedded with Sandstone,fine, mod. soft, lt. grey to lt. green.
	SP	58	0										
15	PC	100	48								SC	Water injection used from 14 to TD.	Clayey Sand, fine, soft, slightly plastic, lt. greyish green.
20	PC	96	40										
25	PC	40	0									The hole was plugged using bentonite chips from 117 to 3 feet. Placed grout from 0 to 3 feet.	
30	PC	63	48								CH		**CONQUISTA CLAY MEM., UPPER:** Sandy Clay, laminated, thin seams oxidized stain, soft, mod. to high plasticity, lt. brn.
	PC	85	50								CH		Clay, massive, occasional Shale laminations, iron oxide stains on partings, soft, grey.
35	PC	100	84										Gypsum deposits in bedding planes from 34 to 39.
40	PC	100	60										Organic material on plane at 42 feet.
45	PC	100	94										
50	PC	100	86										

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 866

JOB NO. FCT01 DATE 91/5/23

SURFACE ELEVATION 406.96

TOP OF FILTER PACK 108.00

WELL CASING TYPE 4-IN SCHED 40 PVC

FORMATION of COMPLETION DILWORTH MEM.

TOTAL DEPTH 124.2 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 57630.75 E 65174.90

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					(continued)
		Placed bentonite pellet seal from 108 to 106 feet.			
110		Installed sandpack from 122 to 108 feet			
115					
		Installed blank PVC casing from 0 to 117 feet			
120		Installed .050 screen from 117.2 to 122.2 feet.			
125		Installed blank sump from 122.2 to 124.2s			TD AT 124.2 FEET
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE

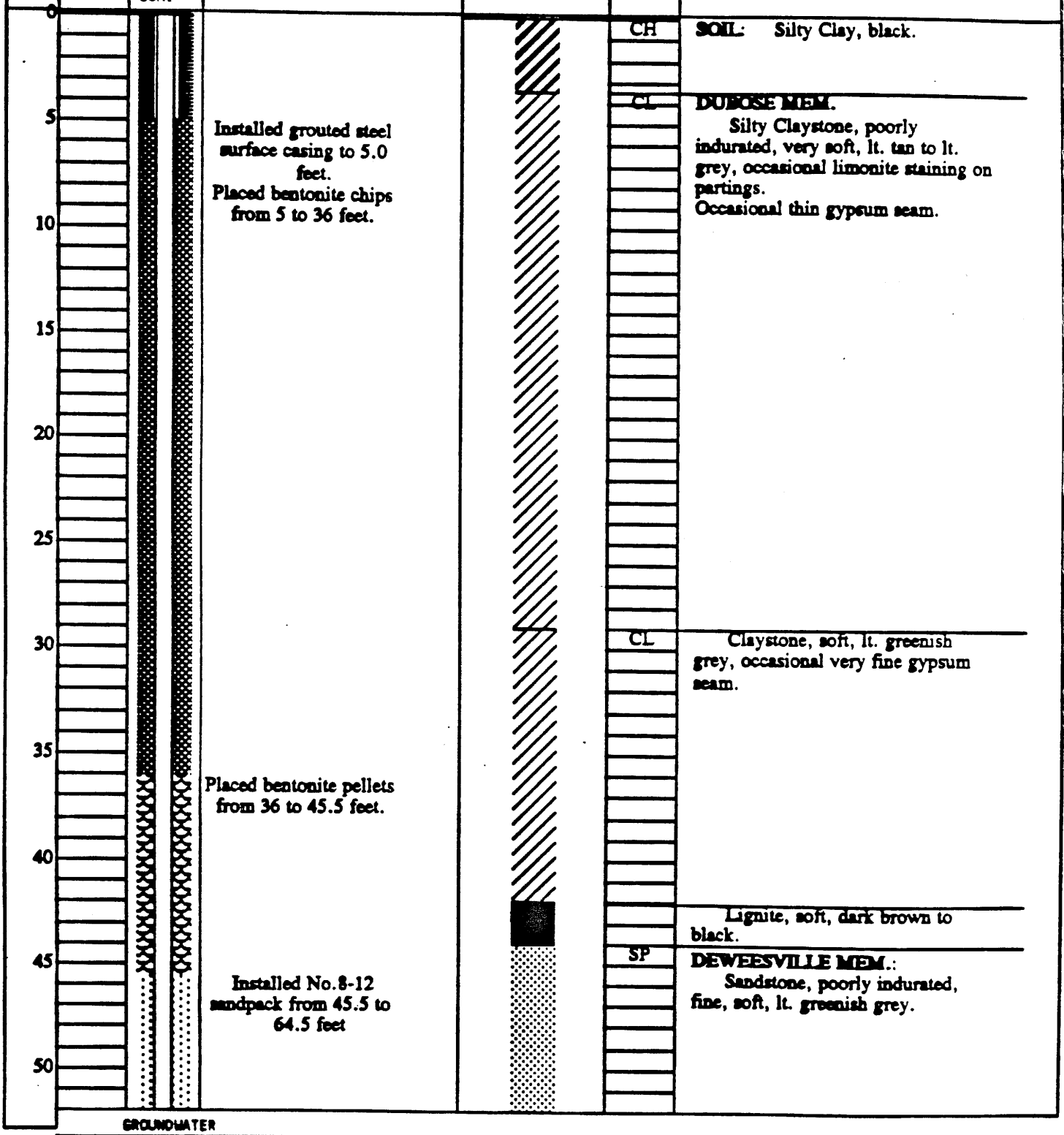
PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 867

JOB NO. FCT01 DATE 91/5/25

SURFACE ELEVATION 427.19
TOP OF FILTER PACK 45.50
WELL CASING TYPE 4.0-IN SCHED 40 PVC
FORMATION of COMPLETION DEWEESVILLE MEM.

TOTAL DEPTH 168.0 feet
RIG TYPE ROTARY /CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 56471.97 E 67450.59
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 866

JOB NO. FCT01 DATE 91/5/23

SURFACE ELEVATION 406.96
TOP OF FILTER PACK 108.00
WELL CASING TYPE 4-IN SCHED 40 PVC
FORMATION of COMPLETION DILWORTH MEM.

TOTAL DEPTH 124.2 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 57630.75 E 65174.90
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				SC	SOIL: Clayey Sand, fine, tan.
		Installed 4-in. well			Possibly tailings or fill.
5		installed grouted steel casing to 5 feet.		CH	TRANSITION ZONE: DEWEESVILLE TO CONQUISTA MEM.: Silty clay, high plasticity, lt.
10		Installed bentonite chips from 5 to 21 feet		CL	tan. CONQUISTA CLAY MEM.: Claystone, poorly indurated, some oxidized staining, very soft, tan.
15					
20		Switched from air circulation to bentonite mud rotary at 20 feet Placed heavy bentonite slurry seal from 21 to 106 feet			
25					
30					
35					Becoming more sandy at 33 feet.
40		Added polymer, "Fluid Drill", to mud at 42 feet.		SC	MIDDLE ZONE ?, CONQUISTA CLAY: Clayey sandstone, very fine grained, very soft, some oxidized staining, tan.
45					Occasional hard sandstone seam.
50					

GROUNDWATER

DEPTH	HOUR	DATE

SCT Falls City Site
Texas

LOG OF TEST BORING NO. 866

JOB NO. FCT01 DATE 91/5/23
SURFACE ELEVATION 406.96
TOP OF FILTER PACK 168.00
WELL CASING TYPE 4-IN SCHED 40 PVC
FORMATION of COMPLETION DILWORTH MEM.

TOTAL DEPTH 124.2 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 57630.75 E 65174.90
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Allowed slurry to settle overnite before topping off at 21 feet			Occasional lignite seam from 51 feet.
60				SP CL	Sandstone intercalated with Claystone, poorly indurated, soft to very soft, trace lignite seams, tan. Possible transition from lower to upper Conquista Mem.
65				CH	LOWER CONQUISTA CLAY MEM.: Claystone, massive, soft, med. grey.
70					
75					
80					
85					
90					
95				SP	DILWORTH MEMBER: Sandstone, fine, soft to mod. hard, lt. greenish grey.
100					

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Texas

LOG OF TEST BORING NO. 865

JOB NO. FCT01 DATE 91/3/31

SURFACE ELEVATION 414.96

TOP OF FILTER PACK 26.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

FORMATION of COMPLETION CONQUISTA CLAY MEM.

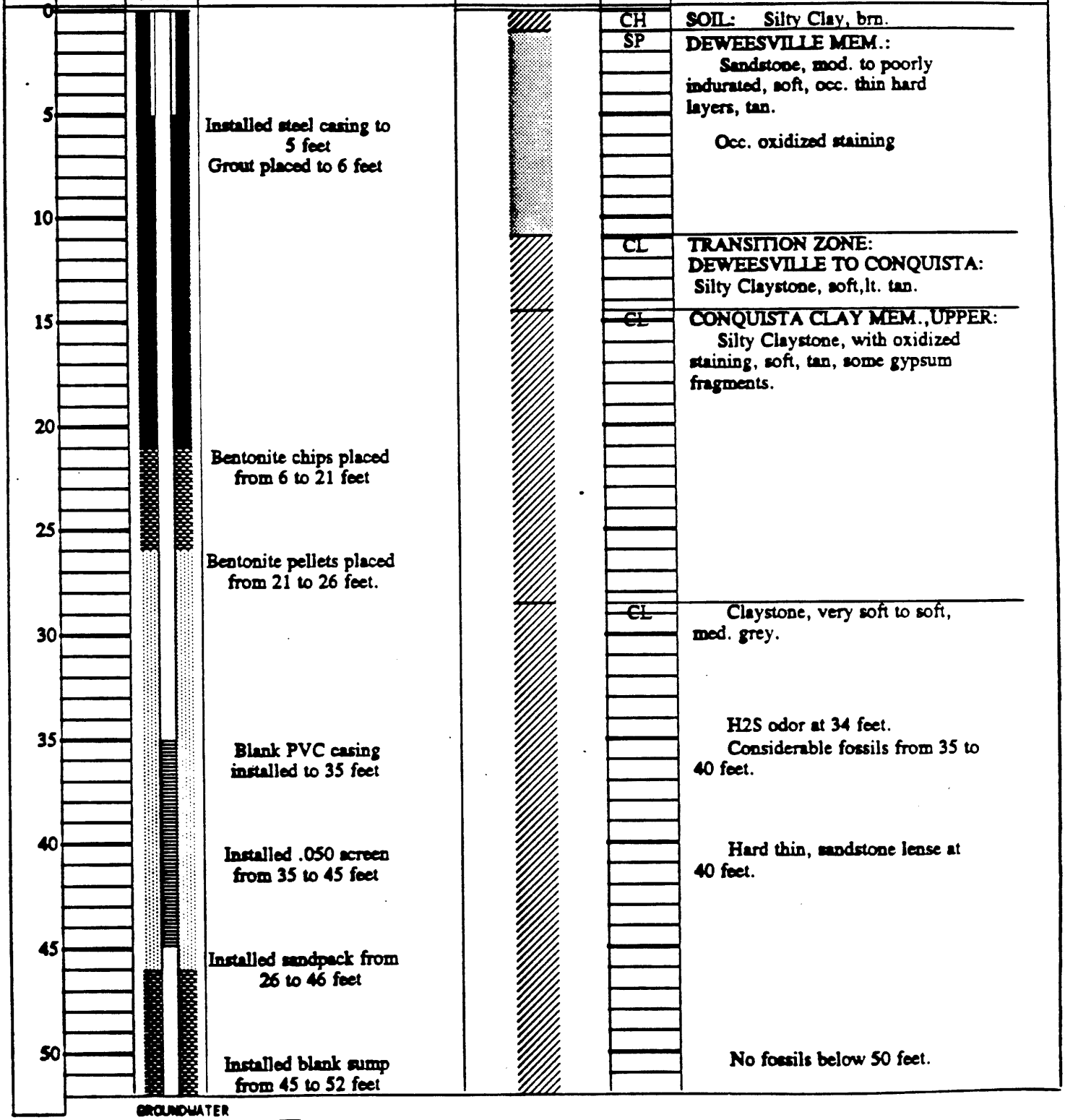
TOTAL DEPTH 60.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 55659.62 E 64803.20

DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 865

JOB NO. FCT01 DATE 91/3/31

SURFACE ELEVATION 414.96
TOP OF FILTER PACK 26.00
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION of COMPLETION CONQUISTA CLAY MEM.

TOTAL DEPTH 60.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 55659.62 E 64803.20
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Installed bentonite pellets from 46 to 60 feet			Very thin sandstone lens at 54 feet.
60					TD AT 60 FEET
65					
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

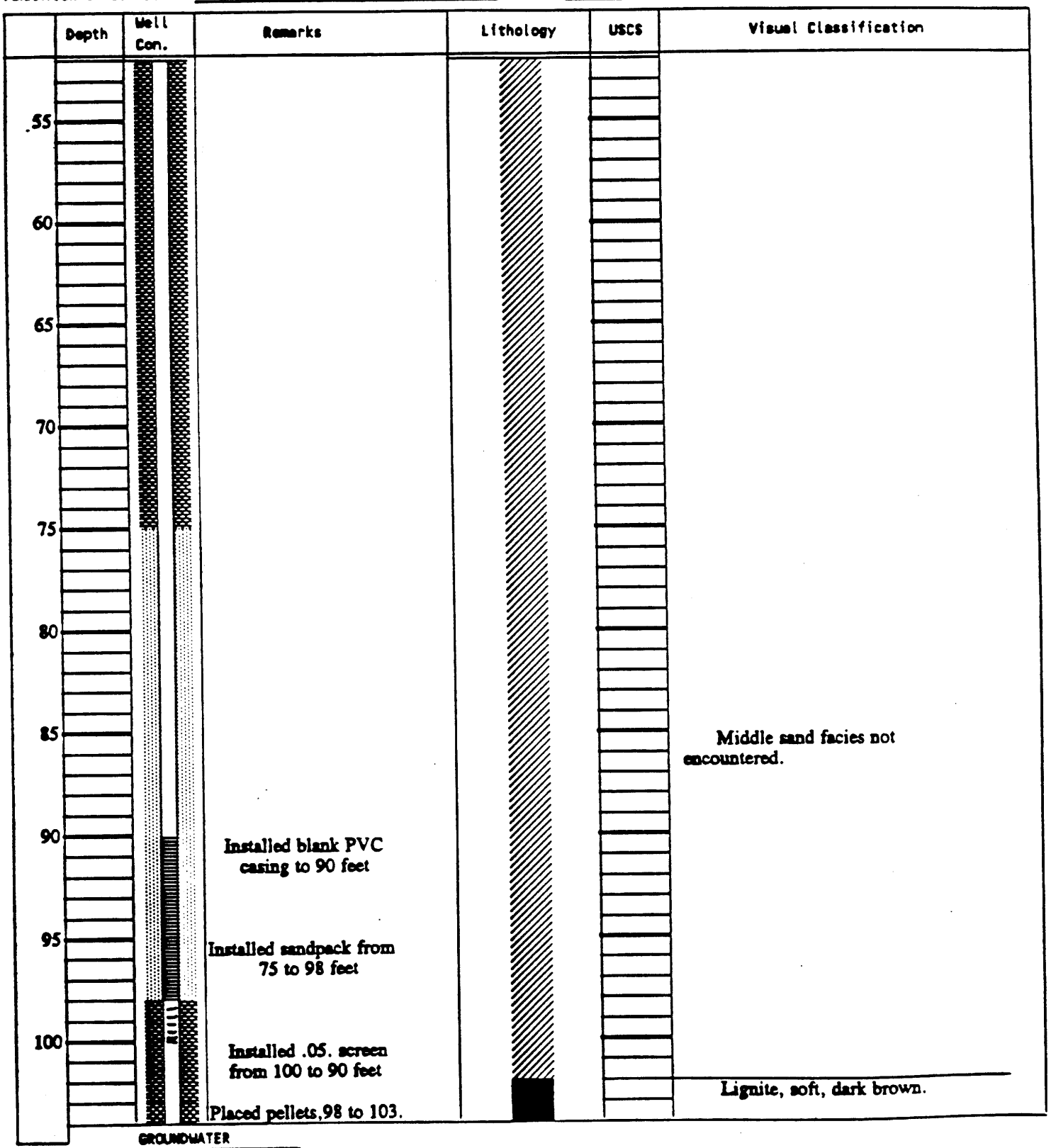
PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 864

JOB NO. FCT01 DATE 91/3/4

SURFACE ELEVATION 416.07
TOP OF FILTER PACK 75.00
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION of COMPLETION CONQUISTA CLAY MEM.

TOTAL DEPTH 107.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 58028.61 E 67276.16
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE
32.0	15:45	3-4-91

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 864

JOB NO. FCT01 DATE 91/3/4

SURFACE ELEVATION 416.07

TOP OF FILTER PACK 75.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

FORMATION of COMPLETION CONQUISTA CLAY MEM.

TOTAL DEPTH 107.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 58028.61 E 67276.16

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Installed blank sump from 107 to 100 feet		SP	DILWORTH MEM.: Sandstone, fine, mod. hard, light greenish grey.
					TD AT 107 FEET.
110					
115					
120					
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

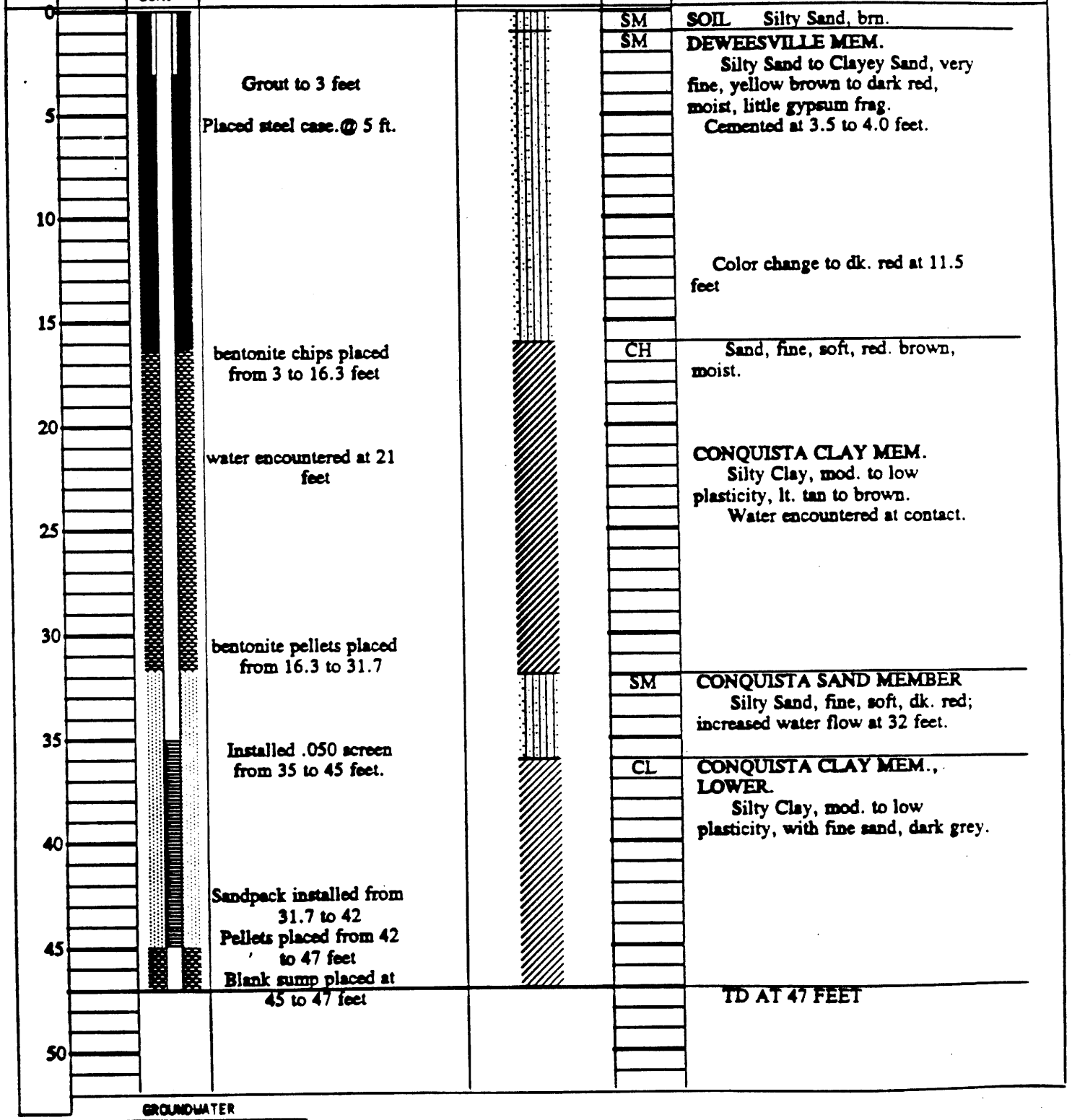
DEPTH	HOUR	DATE
32.0	15:45	3-4-91

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 863

JOB NO. FCT01 DATE 91/3/3
SURFACE ELEVATION 416.05
TOP OF FILTER PACK 31.70
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION of COMPLETION CONQUISTA CLAY MEM.,LOWER

TOTAL DEPTH 47.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 57986.41 E 66138.58
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

Texas

LOG OF TEST BORING NO. 864

JOB NO. FCT01 DATE 91/3/4

SURFACE ELEVATION 416.07

TOP OF FILTER PACK 75.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

FORMATION of COMPLETION CONQUISTA CLAY MEM.

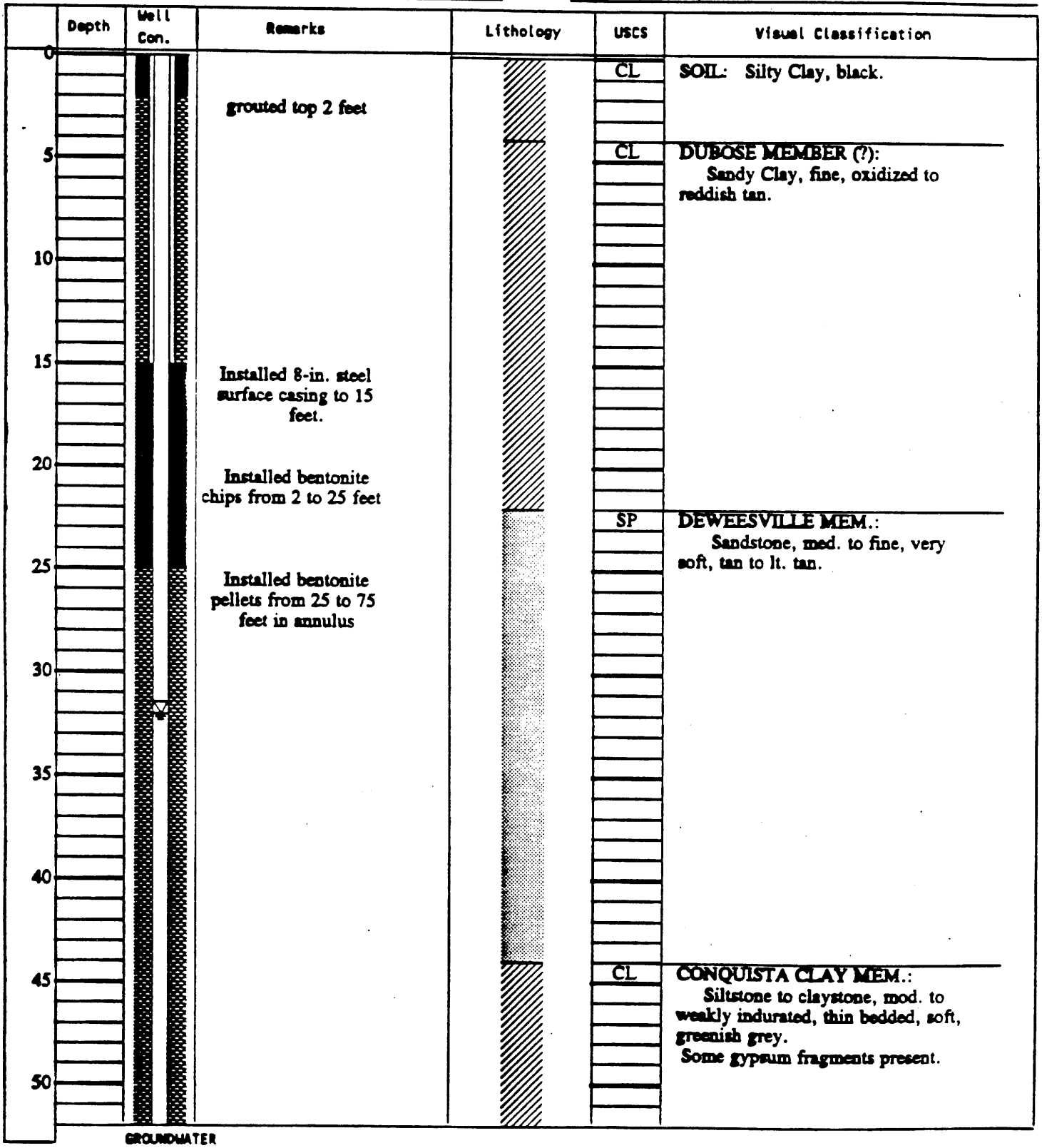
TOTAL DEPTH 107.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 58028.61 E 67276.16

DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE
32.0	15:45	3-4-91

PROJECT Texas

LOG OF TEST BORING NO. 862

JOB NO. FCT01 DATE 91/4/1

SURFACE ELEVATION 437.17

TOP OF FILTER PACK 111.30

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

FORMATION of COMPLETION DILLWORTH SANDSTONE MEM.

TOTAL DEPTH 150.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 58816.97 E 65415.51

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					Becoming sandier at 55 feet.
60					Below 60 feet fossiliferous to 65 feet.
65					Becoming harder with color changing to dark olive grey below 65 feet.
70					
75					
80					
85					
90		Bentonite pellets installed from 87 to 111.3 feet.			
95					Lignite, some Claystone seams, soft, dark brown, mod. weathered.
100				SP	DILWORTH MEMBER Sandstone, very fine grained, mod. hard to soft, light greenish grey.

GROUNDWATER

DEPTH	HOUR	DATE
22.0	14:40	4-1-91

JOB NO. FCT01 DATE 91/4/1

SURFACE ELEVATION 437.17

TOP OF FILTER PACK 111.30

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

FORMATION of COMPLETION DILLWORTH SANDSTONE MEM.

TOTAL DEPTH 150.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 58816.97 E 65415.51

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Water added at 105 feet to aid in drilling			
110					
115		Sandpack installed from 111.3 to 135			
120		Blank PVC casing installed to 120 feet			From 120 feet, with occasional thin hard sandstone seams.
125		Installed .050 screen at 120 t0 130 feet			
130					
135		Blank sump installed from 130 t0 137			
140		Bentonite chips installed from 135 to 141 feet. Caved material filled from 141 to 150 feet.			
145					
150					TD AT 150 FEET.
155					

GROUNDWATER

DEPTH	HOUR	DATE
22.0	14:40	4-1-91

PROJECT [redacted] Texas

LOG OF TEST BORING NO. 501

JOB NO. FCT01 DATE 91/2/3

SURFACE ELEVATION 414.61

TOP OF FILTER PACK 40.50

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

FORMATION of COMPLETION CONQUISTA CLAY MEM.,UPPER

TOTAL DEPTH 70.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 56466.90 E 65333.28

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Installed sandpack from 40.5 to 59 feet			At 52 feet observed shell fragments. Possible marker of third Conquista fossiliferrous sand member.
60		Installed .050 screen from 50 to 60 feet			
65		Placed bentonite chips from 59 to 65 feet Placed blank sump from 60 to 67 feet			
70		Placed bentonite pellets from 65 to 70 feet.			TD AT 70 FEET. Possibly into Lower Conquista Zone.
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 862

JOB NO. FCT01 DATE 91/4/1
SURFACE ELEVATION 437.17
TOP OF FILTER PACK 111.30
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION of COMPLETION DILLWORTH SANDSTONE MEM.

TOTAL DEPTH 150.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 58816.97 E 65415.51
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CL	FILL Sandy Clay, w/ gravel.
				CH	SOIL Silty Clay, hi.plast.
5		Grouted steel casing installed to 5 feet		CH	DEWEESVILLE MEM. Sandstone, poorly indurated, fine,soft, lt. tan.
10		Difficult drilling resulted in loss of first three holes attempted. Holes within 15 ft rad.			
15					Claystone seam at 14 to 16.
					Very hard sandstone lense at 16 to 18 feet.
20		Placed bentonite chips from 5 to 87 feet.			Occasional claystone lenses below 18 feet.
					Very moist from 22 feet.
25					Below 20 feet the grain size is increasingly finer, with more silt.
30					CONQUISTA CLAY MEM., UPPER Claystone, poorly indurated, some limonite staining,, very soft, lt. tan to brown.
35					Small amount of gypsum fragments.
40					
				CL	Claystone, mod. indurated, soft, med. grey.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
22.0	14:40	4-1-91

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 860

JOB NO. FCT01 DATE 91/3/13

SURFACE ELEVATION 419.99

TOP OF FILTER PACK 44.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

FORMATION of COMPLETION CONQUISTA CLAY MEM.

TOTAL DEPTH 83.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 58361.82 E 67690.24

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
		feet			
55					
60					Small gypsum fragments at 60 feet. Oxidized tan zone at 60 feet.
65					
70		Installed .050 screen from 65 to 75 feet			Becoming harder at 70 feet. Trace shell fragments.
75					
80		Installed sandpack from 55.8 to 82.5 feet Sump placed @75 to 82 ft.			TD AT 83 FEET
85					
90					
95					
100					

GROUNDWATER

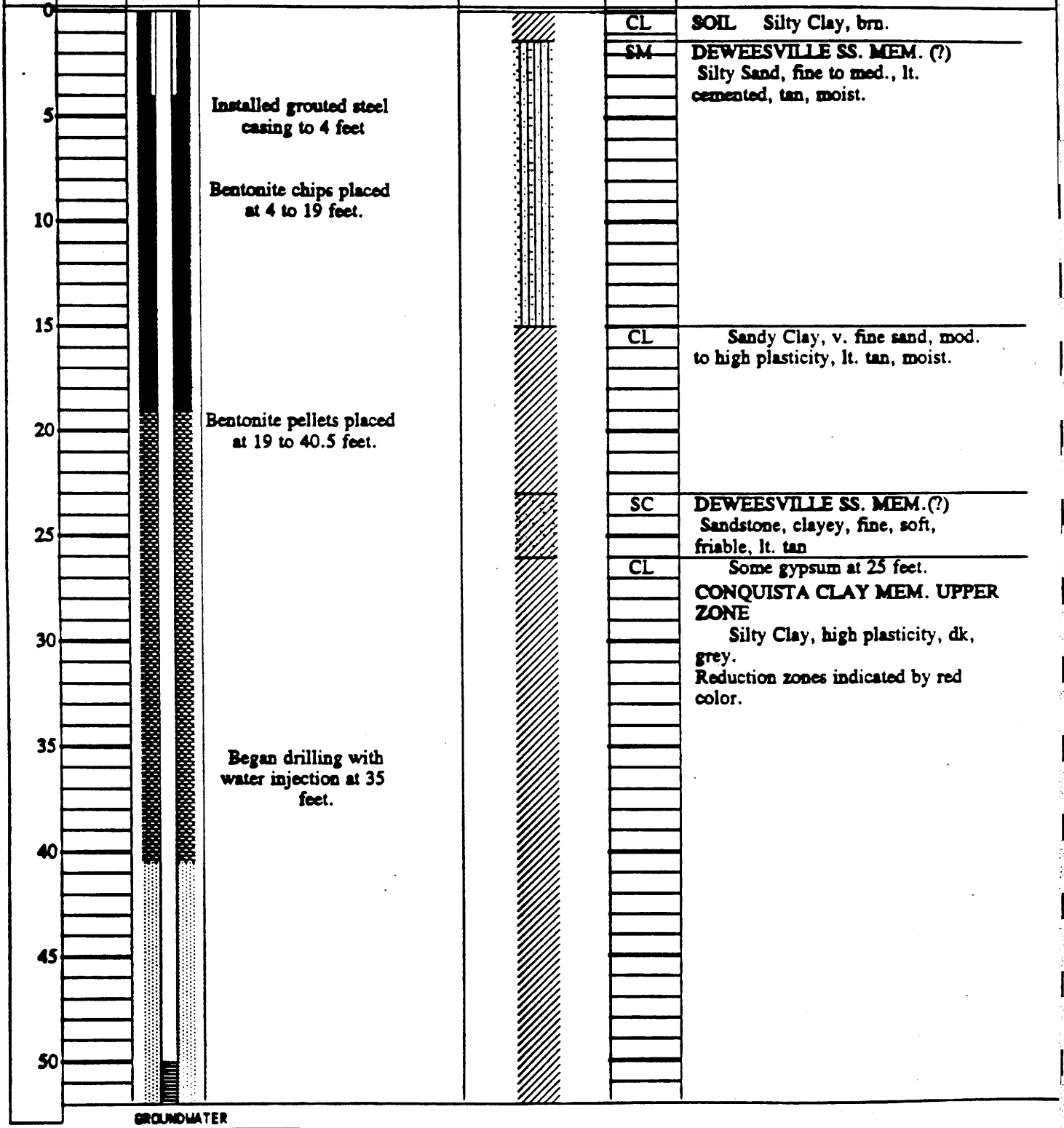
DEPTH	HOUR	DATE
32.0	17:30	3-12-91

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 861

JOB NO. FCT01 DATE 91/2/3
SURFACE ELEVATION 414.61
TOP OF FILTER PACK 40.50
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION of COMPLETION CONQUISTA CLAY MEM.,UPPER

TOTAL DEPTH 70.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 56466.90 E 65333.28
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 859

JOB NO. FCT01 DATE 91/3/4

SURFACE ELEVATION 426.26

TOP OF FILTER PACK 27.30

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

FORMATION of COMPLETION CONQUISTA CLAY MEM.

TOTAL DEPTH 79.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 58209.29 E 64798.23

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		open hole. below the casing, at 45.5 to 79 feet.		ML CL	Clayey Silt to Silty Clay, low plasticity, dark grey, sl. moist.
				CL	Shale, fissle, mod. soft, dk. grey.
60					
65				CL	Silty Clay, mod. soft, mod. plast., dk. grey, moist.
70					
75					Lignite, mod. soft, dk brn.
				SP	Sandstone, fine, mod. hard, grey to brown.
80					TD AT 79 FEET
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 860

JOB NO. FCT01 DATE 91/3/13

SURFACE ELEVATION 419.99
TOP OF FILTER PACK 44.00
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION of COMPLETION CONQUISTA CLAY MEM.

TOTAL DEPTH 83.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 58361.82 E 67690.24
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CL	SOIL Silty Clay, brn.
5		Placed steel casing to 5 feet		CH	DUBOSE MEM (?) Silty Clay, high plast. brn.
10		Placed grout seal from 0 to 8.5 feet		CH	DUBOSE MEM., WHITSETT FM. Silty Clay, highly weathered shale, high plasticity, tan.
15					Occasional gypsum frag. and limonite staining.
20				SP	DEWEESVILLE MEM. Sandstone, fine, soft, lt. tan. Limonite staining from 20.5 to 21.5. Occasional clay seams.
25					
30				SP	Sandstone, very fine grained, cemented, mod. hard to hard, lt. tan
35				SP	Sandstone, fine, poorly indurated, soft, tan. Becoming very moist at 32 feet.
40		Installed bentonite chips from 8.5 to 44 feet.		SC	TRANSITION ZONE: DEWEESVILLE TO CONQUISTA MEM's Clayey Sandstone, poorly indurated, soft, tan.
45					
50		Installed bentonite pellets from 44 to 55.8		CH	CONQUISTA CLAY MEM. Claystone, poorly indurated, soft, lt. grey.

GROUNDWATER

DEPTH	HOUR	DATE
32.0	17:30	3-12-91

JOB NO. FCT01 DATE 91/3/2

SURFACE ELEVATION 441.84

TOP OF FILTER PACK 35.00

WELL CASING TYPE 4.0-IN SCHED 40 PVC

FORMATION of COMPLETION DEWEESVILLE AND CONQUISTA

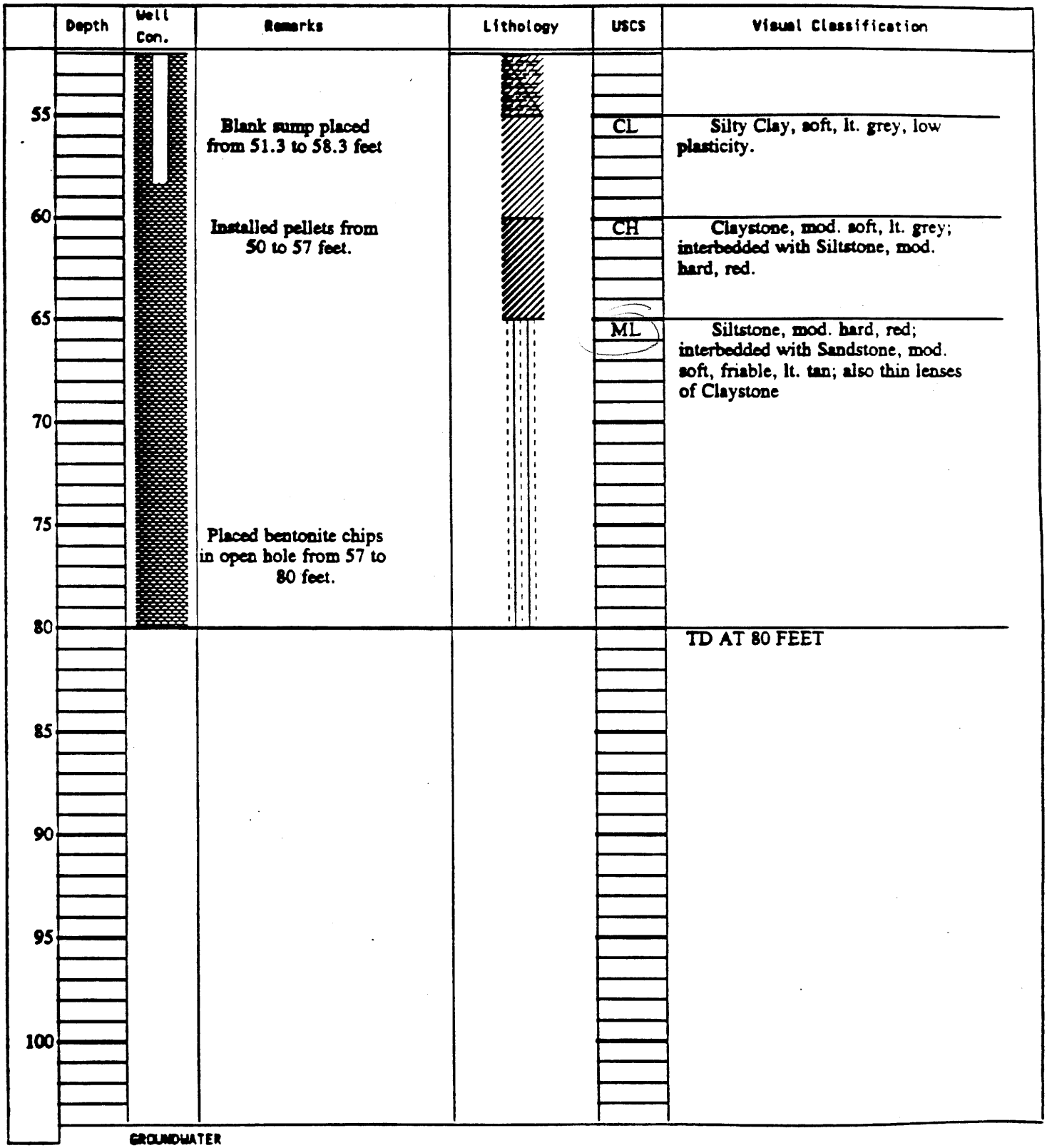
TOTAL DEPTH 80.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 60184.41 E 65945.20

DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

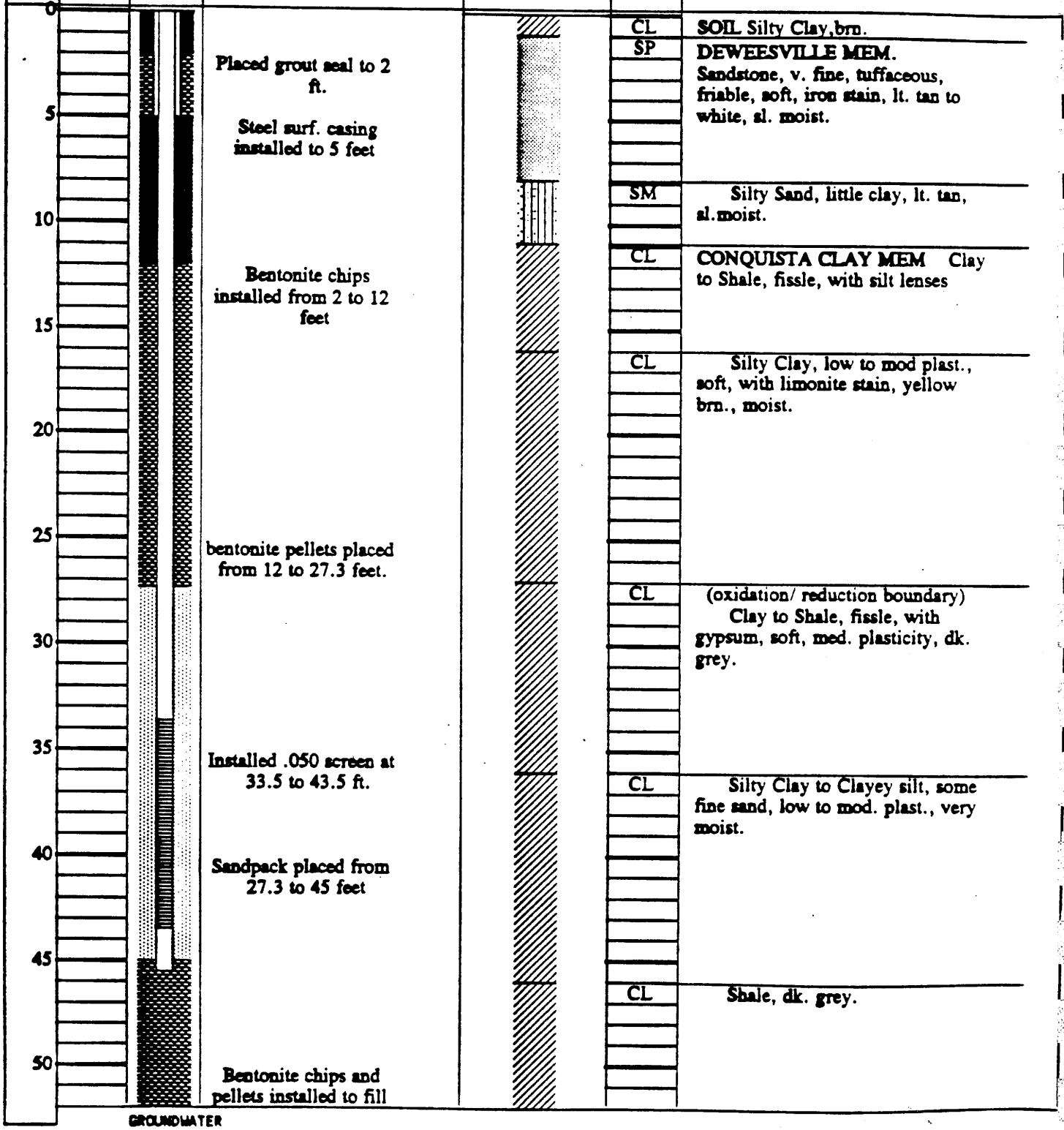
PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 859

JOB NO. FCT01 DATE 91/3/4

SURFACE ELEVATION 426.26
TOP OF FILTER PACK 27.30
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION of COMPLETION CONQUISTA CLAY MEM.

TOTAL DEPTH 79.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 58209.29 E 64798.23
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

JOB NO. FCT01 DATE 91/3/14

SURFACE ELEVATION 442.18

TOP OF FILTER PACK 36.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

FORMATION of COMPLETION CONQUISTA CLAY MEM.

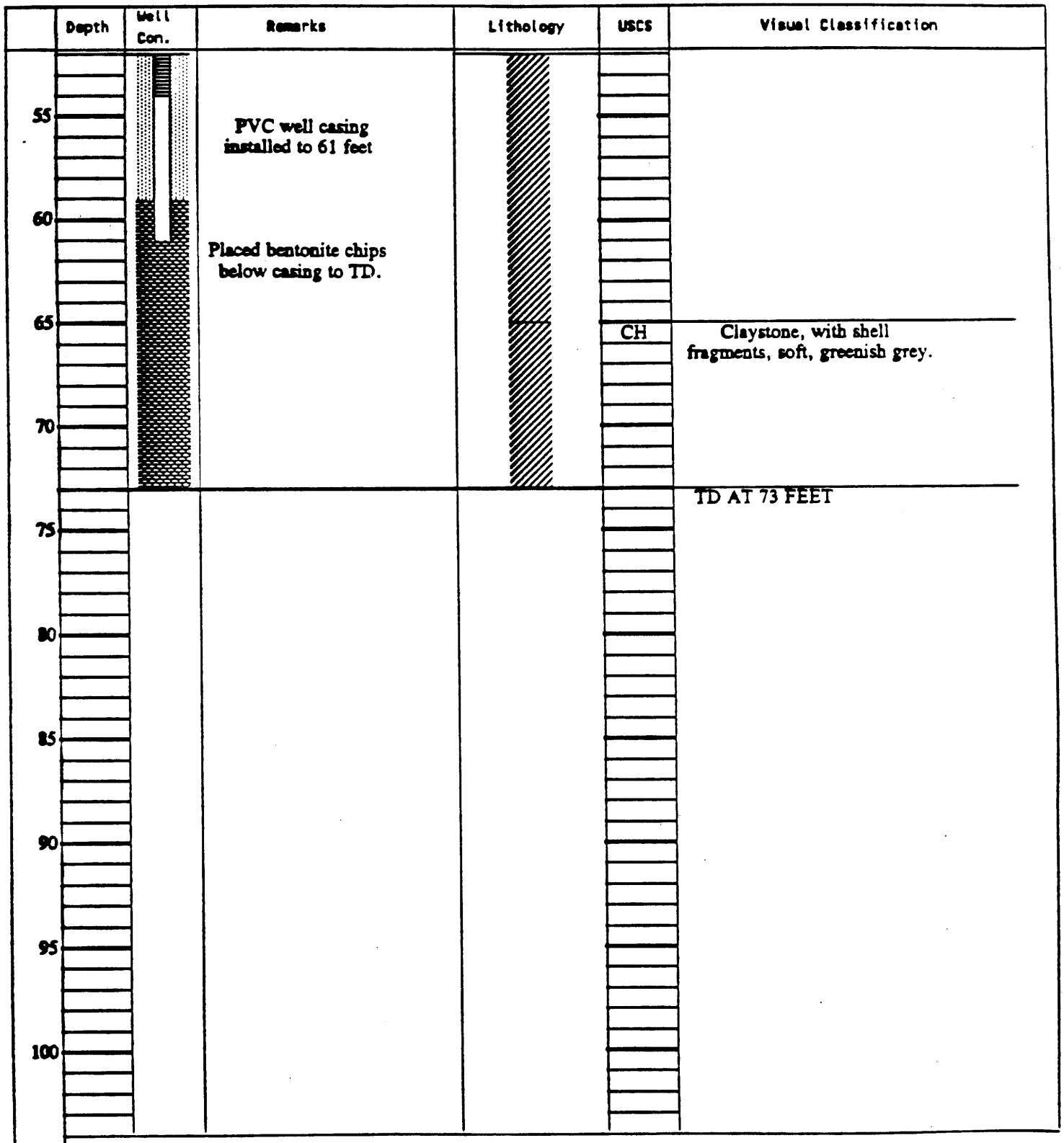
TOTAL DEPTH 73.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 60451.37 E 67319.24

DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE
31.0	11:30	3-14-91

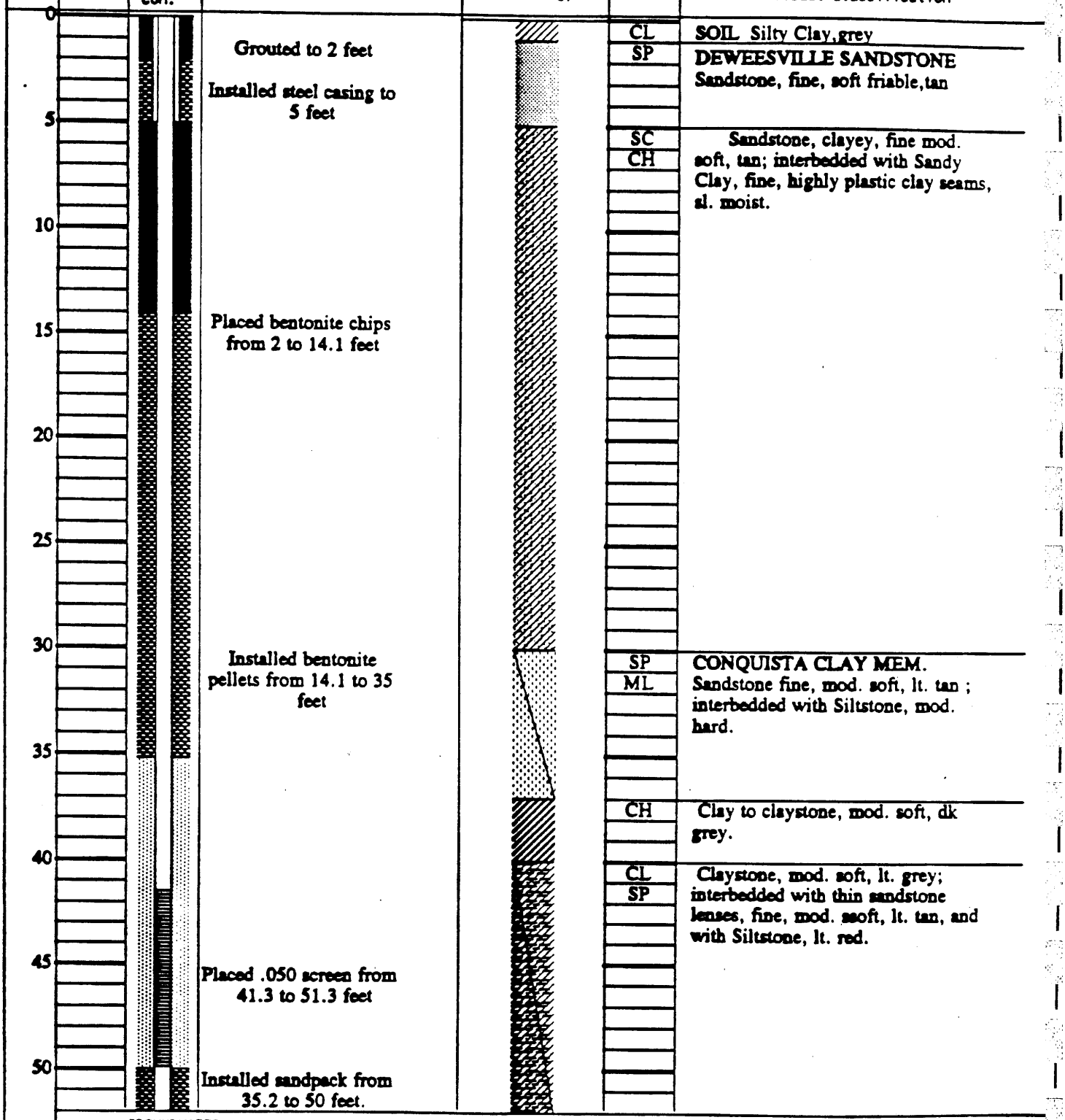
PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 858

JOB NO. FCT01 DATE 91/3/2

SURFACE ELEVATION 441.84
TOP OF FILTER PACK 35.00
WELL CASING TYPE 4.0-IN SCHED 40 PVC
FORMATION of COMPLETION DEWEESVILLE AND CONQUISTA

TOTAL DEPTH 80.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 60184.41 E 65945.20
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 856

JOB NO. FCT01 DATE 91/3/1

SURFACE ELEVATION 458.17
TOP OF FILTER PACK 32.20
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION of COMPLETION CONQUISTA,MIDDLE SAND

TOTAL DEPTH 80.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 61631.13 E 65281.81
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Fill of caved formation from 52.6 to 80 feet.			
60				SP CL	Sandstone, fine, mod. hard, reddish brown, interbedded with; Silty Clay, mod. soft, lt. tan,
65				CH	CONQUISTA,LOWER Clay/ Claystone,mod. hard to hard, high plast. dark grey.
70					
75					
80					TD AT 80 FEET
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
31.9	08:58	3-3-91

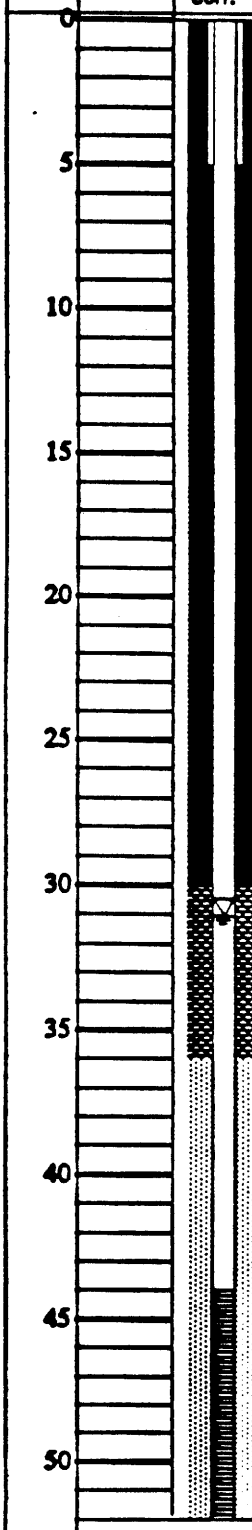
PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 857

JOB NO. FCT01 DATE 91/3/14

SURFACE ELEVATION 442.18
TOP OF FILTER PACK 36.00
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION of COMPLETION CONQUISTA CLAY MEM.

TOTAL DEPTH 73.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 60451.37 E 67319.24
DATUM MSL, GROUND SURFACE



Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CH	SOIL Silty Clay, high plast.
		Installed 4-in. well.		CH	DUBOSE MEM Silty Clay, high plasticity, brownish grey
5		Installed steel casing to 5 feet. Grouted to 9 feet.		SP	DEWEESEVILLE MEM Sandstone, poorly indurated, gravelly at upper contact, fine, soft, lt. tan. Occ. thin lenses of claystone
10		Placed bentonite chips from 9 to 30 feet.		CH	Claystone, very soft, lt. tan.
15					
20				SP	Sandstone, fine, hard, lt. tan
25				SM	Sandstone, silty, fine, soft, lt. tan
30		Placed bentonite pellets from 30 to 36 feet.		CH	Sandy claystone to mudstone, soft, lt. greenish grey, gradational contact zone between Deweesville and Conquista mem.
				CH	CONQUISTA CLAY MEM Claystone, tr. sand, poorly indurated, v. soft, lt. greenish grey
35		Sandpack installed from 36 to 59 feet.			
40					(harder claystone from 38 to 46)
45		Installed .050 slot screen from 44 to 54 feet.		CH	Claystone, mod. soft, some iron oxide staining, dark grey.
50					

GROUNDWATER

DEPTH	HOUR	DATE
▽ 31.0	11:30	3-14-91
▽		
▽		

PROJECT Texas

LOG OF TEST BORING NO. 855

JOB NO. FCT01 DATE 91/4/1

SURFACE ELEVATION 412.29

TOP OF FILTER PACK 12.00

WELL CASING TYPE 4.0-IN.SCHED 40 PVC

FORMATION of COMPLETION CONQUISTA CLAY MEM.

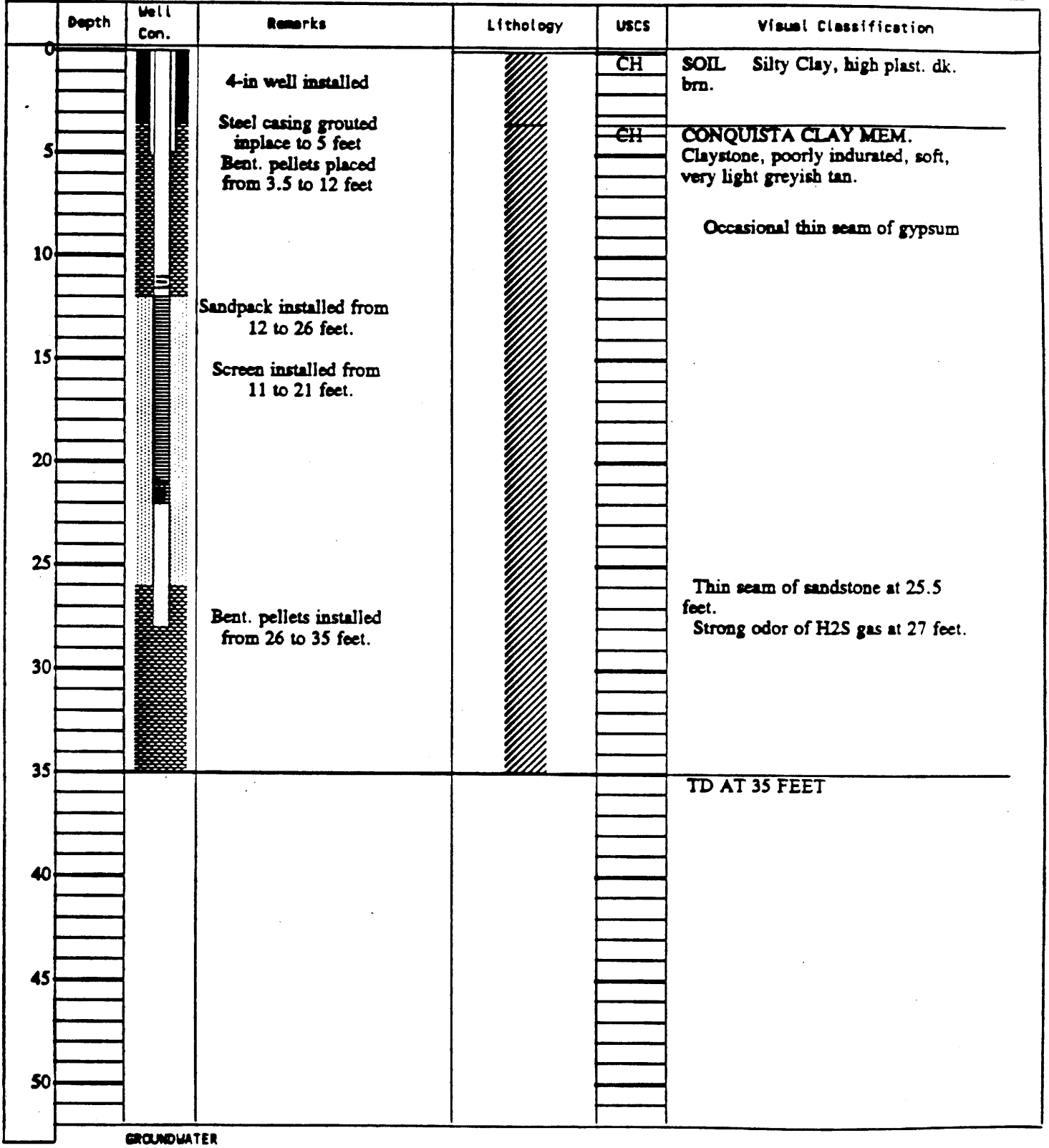
TOTAL DEPTH 35.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 55580.23 E 65392.07

DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

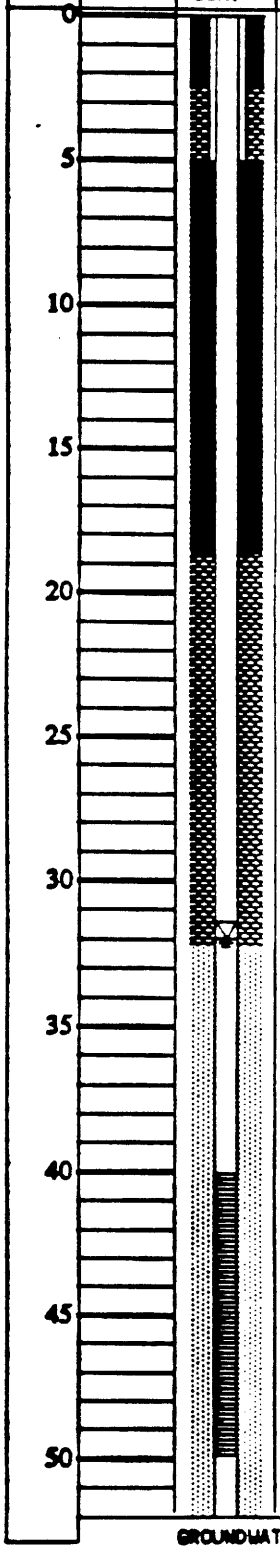
PROJECT Falls City Site
Texas

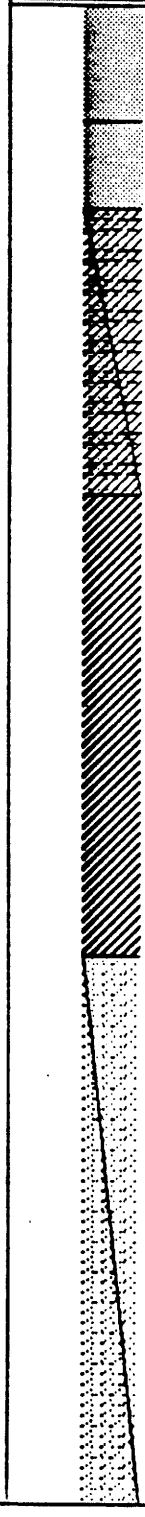
LOG OF TEST BORING NO. 856

JOB NO. FCT01 DATE 91/3/1

SURFACE ELEVATION 458.17
TOP OF FILTER PACK 32.20
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION of COMPLETION CONQUISTA,MIDDLE SAND

TOTAL DEPTH 80.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 61631.13 E 65281.81
DATUM MSL, GROUND SURFACE





Depth	USCS	Visual Classification
0	SP	SOIL Sand, fine,loose,tan,sl. moist
5	SP	DEWEESVILLE MEM Sandstone, fine, soft, friable,tan.
10	CL SC	Clayey Sand, fine, sl. plast., buff, moist; interbedded with lenses of Sandy Clay, mod. plast., lt. brn. moist.
15		
20	CH	CONQUISTA CLAY MEM,UPPER Clay to Claystone, massive,limonite stain in fractures, high plasticity,mod. soft, tan, moist.
25		
30		
35	SP SC	CONQISTA, MIDDLE SAND Sand, fine, low plast., soft, lt. brn., sl. moist.
40		
45		
50		

GROUNDWATER

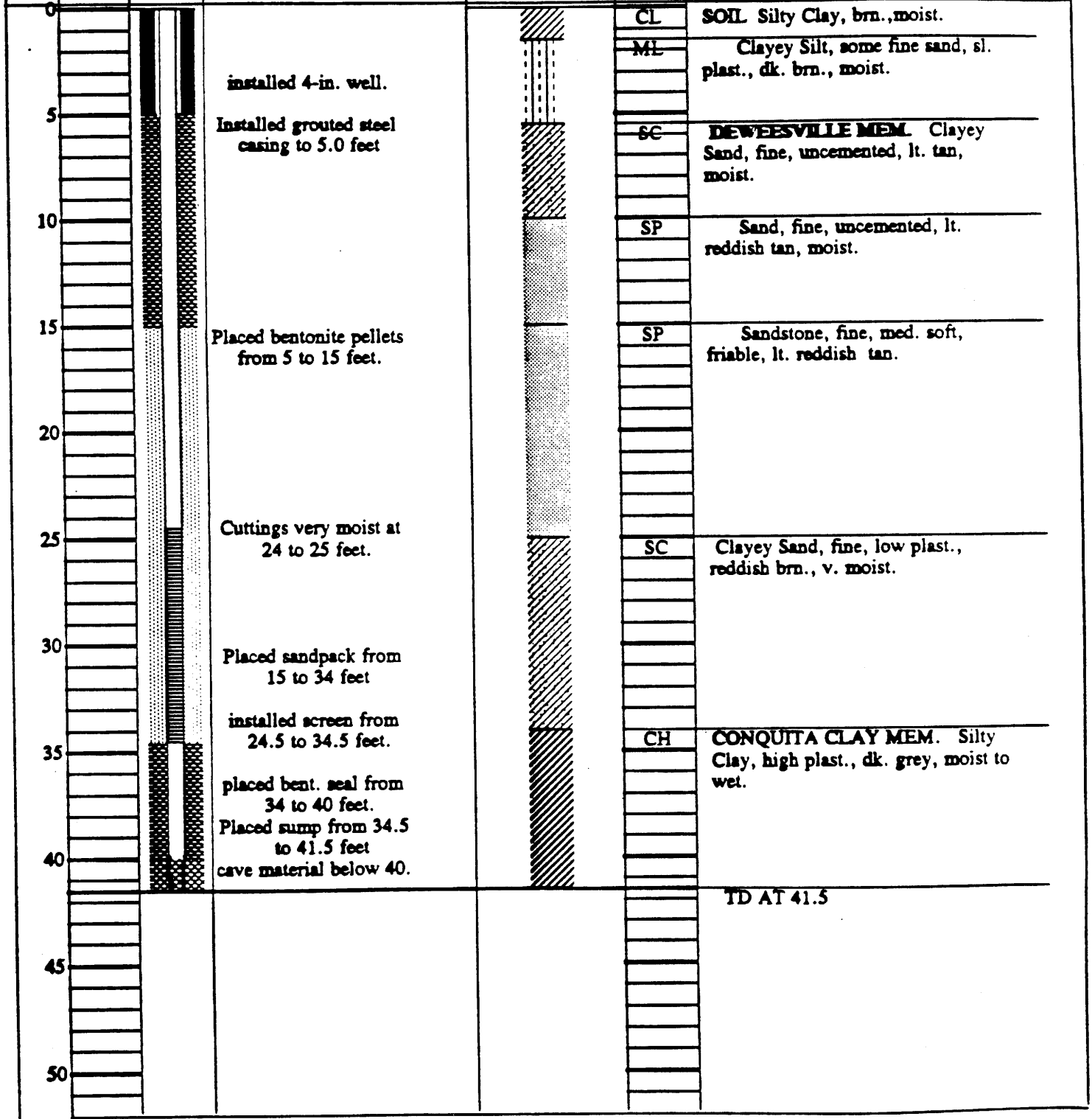
DEPTH	HOUR	DATE
31.9	08:58	3-3-91

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 853

JOB NO. FCT01 DATE 91/2/26
SURFACE ELEVATION 415.38
TOP OF FILTER PACK 15.00
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION of COMPLETION Deweesville Member.

TOTAL DEPTH 41.5 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 58402.85 E 67051.20
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 854

JOB NO. FCT01 DATE 91/2/26

SURFACE ELEVATION ~~412.29~~ 409.98

TOP OF FILTER PACK 9.00

WELL CASING TYPE 4.0-in.Sched.40 PVC

FORMATION of COMPLETION Deweesville Mem.

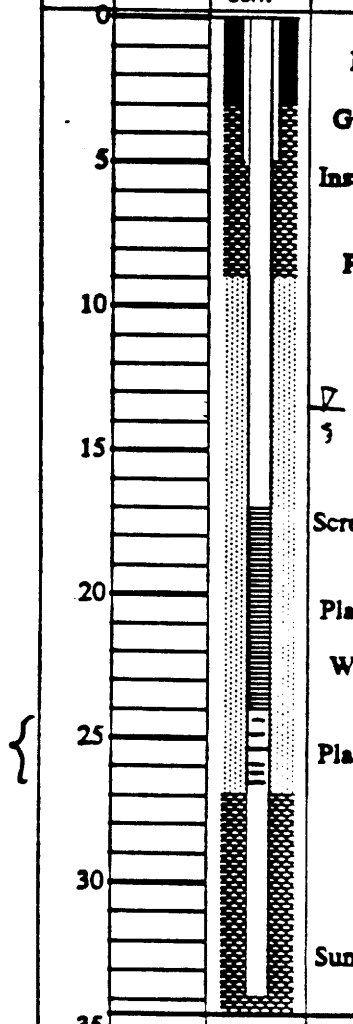
TOTAL DEPTH 34.5 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE Rotary air

LOCATION N 57716.31 E 65230.62

DATUM MSL, GROUND SURFACE



USCS	Visual Classification
CL	SOIL Silty clay, grey, moist
ML	Sandy Silt, v.fine, low plast. brown, moist.
SM	DEWEESVILLE MEM. Silty Sand, fine, low plast., lt. tan, sl. moist.
SC	Clayey Sand, fine, med. plast. lt. reddish tan, moist.
SC / CL	Clayey Sand interbedded with sandy clay, med. plast., lt red v. moist.
CL	Sandy Clay, med. plast., lt. red. v. moist.
CH	CONQUISTA CLAY MEM. Silty Clay, high plasticity, dk. grey, very moist.
	TD AT 34.5 FEET.

GROUNDWATER

DEPTH	HOUR	DATE

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:

See P.1

SITE ID: FCT03 LOCATION ID: 0888
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
50											
55	NQ	100				L				CS	
60											
65	NQ	60				ThB				SS/CS	fossiliferous sandstone, clayey, pelecypod fossils, trace gastropod fossils, fine grained sand, dark gray
70											interbedded sandstone, claystone, and sandy clay / clayey sand, bioturbated, med to dark gray
	NQ	75				ThB				CS/SS	

COMMENTS: _____

BORING OPERATION
H - 6 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: N

See P.1

SITE ID: FCT03 LOCATION ID: 0888
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
75											
80											
85											No core from 84 to 87 because ~~had to~~ set surface(isolation) casing to 84'. Had to ream hole several feet deeper for grout shoe.
	NQ	50								CS	claystone, hard, dark greenish gray (5G 4/1)
90											
95	NQ	75								CS	trace fossils.
											Lignite, dark brown to black, pyritic

COMMENTS: _____

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. ~~969~~ 801

JOB NO. FCT01 DATE 04/08/93

SURFACE ELEVATION 445.68

TOP OF FILTER PACK 71.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION CONQUISTA CLAY,northing?

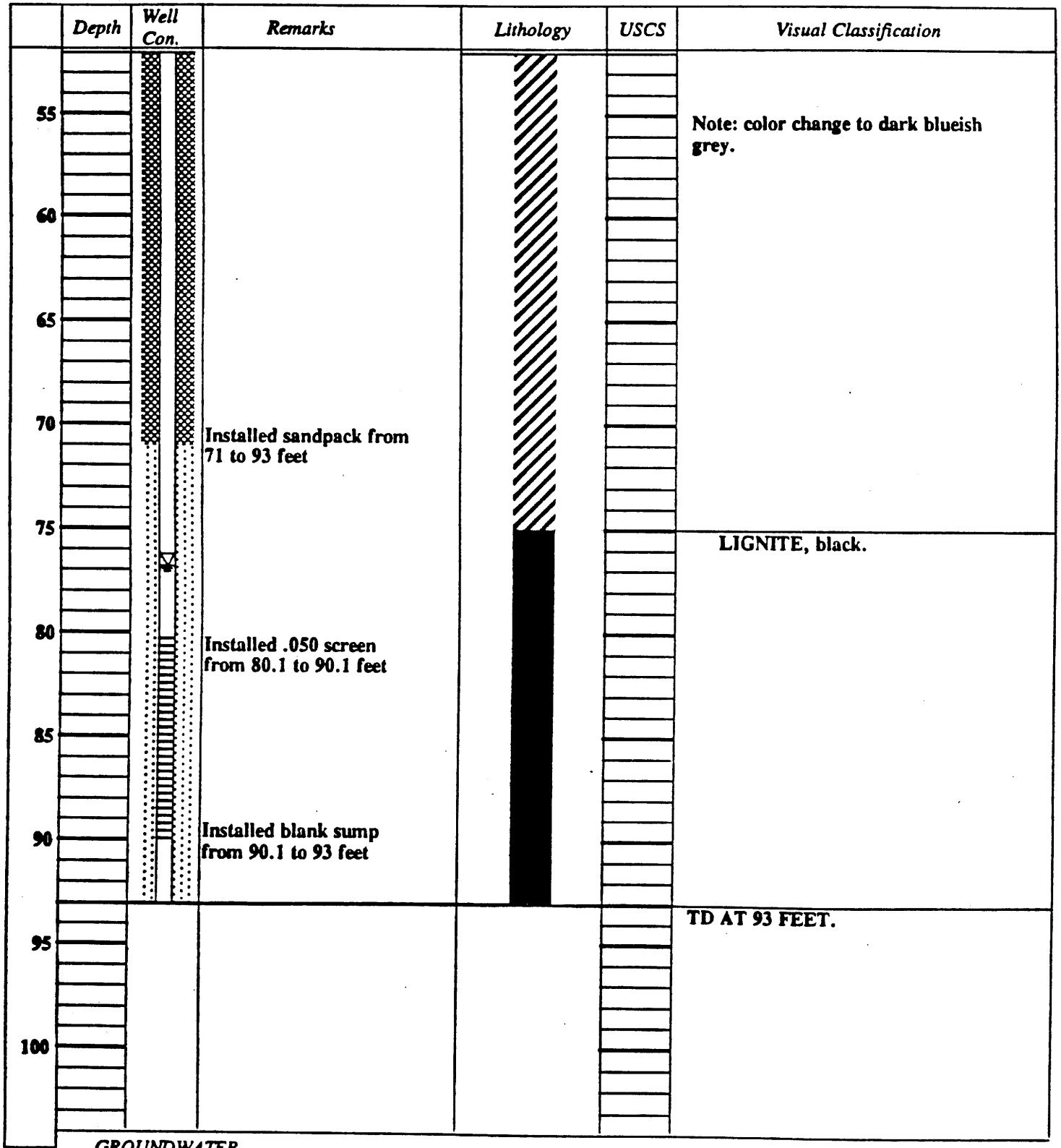
TOTAL DEPTH 93.0 feet

RIG TYPE JEDI

BORING TYPE HOLLOW STEM AUGER

LOCATION N 57678.81 E 68468.88

DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE
76.8	15:53	4-15-93

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 881 ~~969~~

JOB NO. FCT01 DATE 04/08/93

SURFACE ELEVATION 445.68

TOP OF FILTER PACK 71.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION CONQUISTA CLAY, ~~northing:~~

TOTAL DEPTH 93.0 feet

RIG TYPE JEDI

BORING TYPE HOLLOW STEM AUGER

LOCATION ~~N 57678.81~~ E 68468.88 / 57687.81

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2.0-inch PVC well to 93 feet.		SM	SOIL: SILTY SAND, partially cemented, light olive tan.
5		Installed steel casing with grout to 3 feet.		CH	CONQUISTA CLAY MEM.: CLAY, trace of sand, stiff to very stiff, high plasticity, light olive tan.
10		Bentonite slurry seal placed from 3 to 71 feet.			
15		Blank PVC casing installed to 80.1 feet		CH	CLAY, with lignite seams, high plasticity, brown.
20				CH	CLAY, high plasticity, light olive tan.
25					
30					
35					
40					
45					
50					Note: Color change to light tan to grey.

GROUNDWATER

DEPTH	HOUR	DATE
76.8	15:53	4-15-93

JEG TAC TEAM

Attachment 2

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

BOREHOLE/WELL CONSTRUCTION LOG

SITE ID: FCT03 LOCATION ID: 0883 FIELD REP: Rick Dotson

APPROX. SITE COORDINATES (FT.): N 56,929.3407 E 68,990.9053

GROUND ELEVATION (FT. MSL): 462.12 COMPLETION DATE: 10/31/95

BOREHOLE SUMMARY

DRILLER: Aaron Nesbit (JEDI)

RIG TYPE: Mobile Drill B-61

BIT TYPE	HOLE DIA. (in.)	END DEPTH ● (ft.)	FLUID TYPE
NQ core	3.5	134	water/mud
Tricone	7 7/8	116.5	water/mud

CASING SUMMARY

CASING TYPE*	DESCRIPTION	DIA. (in.)	END✚ DEPTH (ft.)
P	Steel	8	4
B	PVC - Schedule 40	4	104
S	PVC - sch 40, 0.010 slot	4	114
Sump	PVC - Sch 40	4	117

* P-Protective S-Screen B-Blank O-Open N-None

✚ Depth from Top of Casing

WELL CONSTRUCTION

TYPE CODE*	DESCRIPTION	END ● DEPTH (ft.)
B	Cap well to WI 10' of surface, cement/ bentonite grout to land surface.	94
S	1/4" bentonite pellets.	99
F	20-40 Silica Sand	115.5

* B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	10/31/95	10:00	14:00
CASING	10/31/95	15:00	17:15
FILTER PACK	10/31/95	"	"
SEAL	10/31/95	"	"
BACKFILL	~~10/31/95~~ 11/1/95	0730	0830
DEVELOPMENT			
OTHER Coring	10/30/95	0845	10/31/95 10:00

WELL DEVELOPMENT

COMMENTS:

JEG-AL-ENG-1 (6/87)

PROJECT Falls City Site, Texas

LOG OF WELL BORING NO. 882 ~~870~~

JOB NO. FCT01 DATE 04/06/93

SURFACE ELEVATION 387.55

TOP OF FILTER PACK

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION CONQUISTA MEM.(SAND)

TOTAL DEPTH 34.0 feet

RIG TYPE

BORING TYPE HOLLOW STEM AUGER

LOCATION N 58793.18 E 69389.33

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2.0-inch PVC well to 34 feet.		SP	Lithology log not available
5		Installed steel casing with grout to 3 feet.			
		Bentonite chips seal placed from 3 to 16 feet.			
10		Blank PVC casing installed to 21 feet			
15		Installed sandpack from 16 to 34 feet			
20		Installed .050 screen from 21 to 31 feet			
25					
30		Installed blank sump from 31 to 34 feet			
35					TD AT 34 FEET
40					
45					
50					

GROUNDWATER

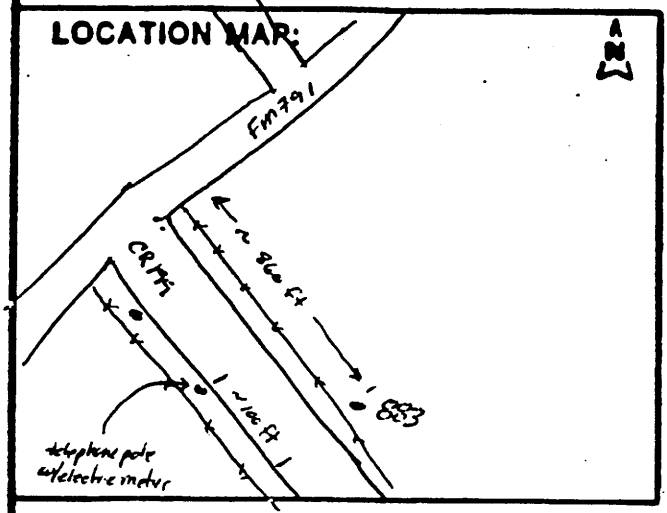
DEPTH	HOUR	DATE

JEG TAC TEAM

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:



SITE ID: FCT 03 LOCATION ID: 0883
SITE COORDINATES (ft.):
N 56,929.3407 E 68,990.9053
GROUND ELEVATION (ft. MSL): 462.12
DRILLING METHOD: NQ wireline coring; 7 7/8 tricone mud rotary
DRILLING CONTR.: Jones Environmental Drilling Inc (JEDI)
DATE STARTED: 10/30/95
DATE COMPLETED: 10/31/95
FIELD REP.: Rick Dotson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
11/1/95	10:15	32.35 BTOC
11/30/95	13:40	109.23 BTOC

LOCATION DESCRIPTION Collazo Property; Along County Road 199
SITE CONDITION Mesquite Scrub brush

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
0											Top soil, sandy clay
											Clay, hard, yellow-gray (5Y 7/2); interbedded sandy clay and clayey sand; fractured, filled with limonite. DuDose Formation
10											
20											
											Clay, hard, interbedded 1/4 to 1/2" clayey sand lens, pale yellowish brown (10YR 6/2); manganese oxide (blk) in some fractures
30											
											clay, clayey sand, and sandy clay, interbedded, fractured w/limonite filling, soft to stiff, very pale orange (10YR 8/2), pale yellowish brown (10YR 6/2), pale brown (5YR 5/2)
40											

COMMENTS:

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
RB - REAR BIT
HX - HX ROCK CORING
NO - NO WIRELINE ROCK CORING

Attachment 1

JE JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WELL COMPLETION RECORD

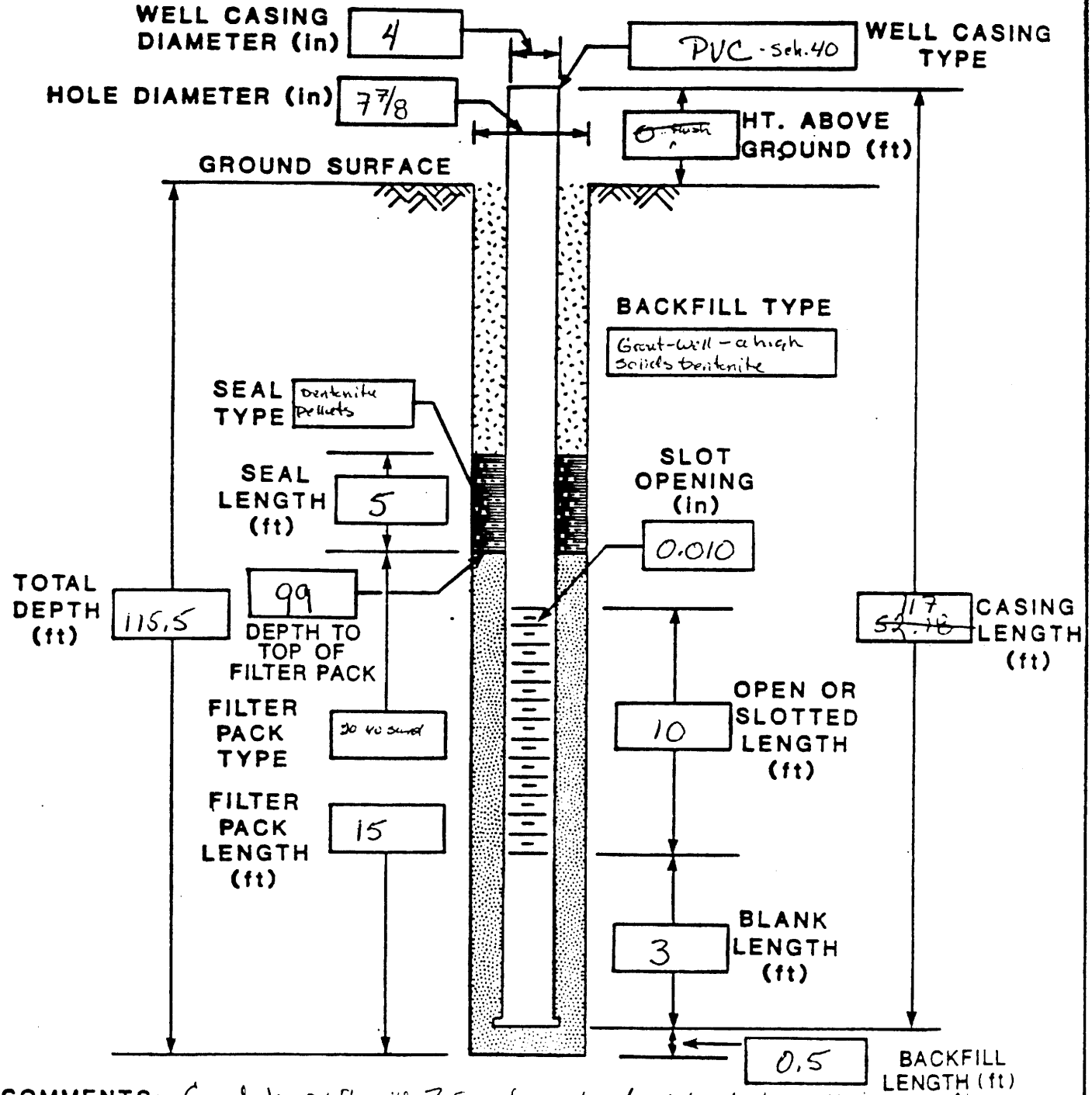
SITE ID: FCT03 LOCATION ID: 0883 DATE INSTALLED: 10/31/95

APPROX. SITE COORDINATES: (FT.) N 56,929.3407 E 68,990.9053

OPEN AREA PER LINEAL FT. (IN^2/FT.)

FORMATION OF COMPLETION: Dewersville Sandstone

FIELD REP.: Rick Dotson DRILLER: Aaron Nesbitt (JEDI)



COMMENTS: Cored to 134 ft with 3.5 inch core barrel. Natural backfill to 115.5 ft.
1 centralizer @ top of screen. [State Plane Coord N-13509949.0148, E-2250605.64

JEG-AL-ENG-3 (6/87)

JE JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: A N

See P.1

SITE ID: FCT03 LOCATION ID: 883
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
100											Lignite coal, black to dark brown; 4/6 cpm w/ 44-40
											Some thin well-cemented layers of sandstone
110											
		0									
120											thin 1/2" to 1" carbonaceous clay; 116 cpm w/ 44-40
											becoming finer grained, interbedded silty sand, sand, and clay dark greenish gray
130											
											stop coring @ 134 ft
140											

COMMENTS: _____

BORING OPERATION
H - 6 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: N

See P.1

SITE ID: FCT03 LOCATION ID: 883
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
50											
											lignite coal, black to dark brown
											silty sand, olive black (5Y 2/1), f-grained, rounded, ~~broken~~ bioturbated,
60											
70											clay, grayish blue green (5BG 5/2), stiff, sandy clay lens throughout
80											lignite coal, black to dark brown
											Sandstone, poorly cemented, well sorted, fine grained, dark green gray (5G 4/1)
90											
											fossiliferous, bioturbated from 95-96

COMMENTS: _____

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
HX - HX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

Attachment 1

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WELL COMPLETION RECORD

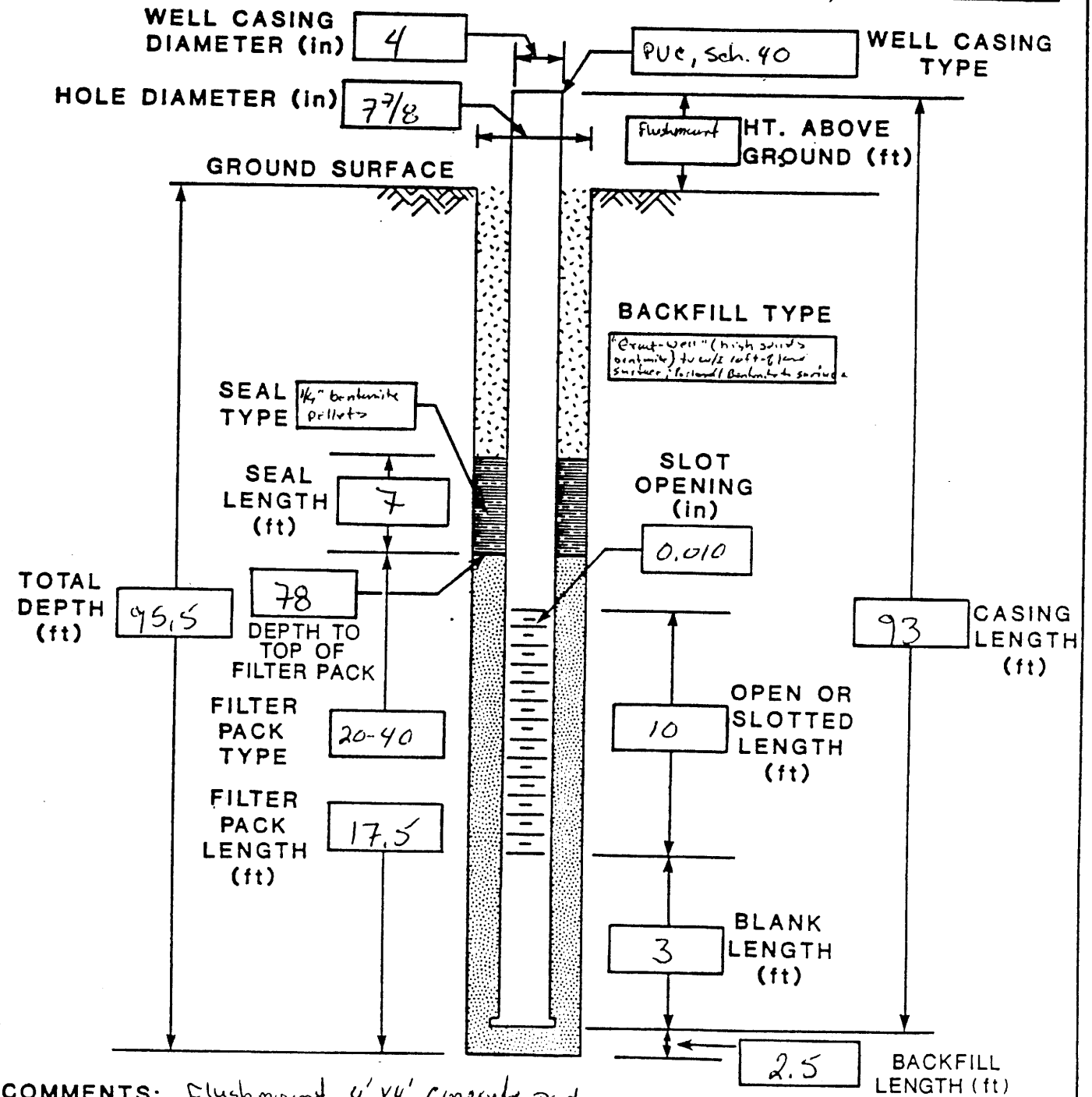
SITE ID: FCT03 LOCATION ID: 0884 DATE INSTALLED: 11/11/95

APPROX. SITE COORDINATES: (FT.) N 60,560.7454 E 71,611.3204

OPEN AREA PER LINEAL FT. ($IN^2/FT.$) _____

FORMATION OF COMPLETION: Deweesville Sandstone

FIELD REP.: Rick Dotson DRILLER: Aaron Nosbit, JEDI



COMMENTS: Flushmount, 4' x 4' Concrete Pad

1 Centralizer @ top of screen. [State Plane Coord. N-13513593.7336, E-2253206.3640]

JEG-AL-ENG-3 (6/87)

Attachment 2

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

BOREHOLE/WELL CONSTRUCTION LOG

SITE ID: FCT03 LOCATION ID: 0884 FIELD REP: Rick Dotson

APPROX. SITE COORDINATES (FT.): N 60,560.7454 E 71,611.3204

GROUND ELEVATION (FT. MSL): 439.03 COMPLETION DATE: 11/11/95

BOREHOLE SUMMARY

DRILLER: Aaron Nesbit, JEDI

RIG TYPE: Mobile Drill B-61, Mud rotary

BIT TYPE	HOLE DIA. (in.)	END DEPTH ● (ft.)	FLUID TYPE
NQ wireline	3.5	94	water
tricone	7 7/8	95.5	water/mud

CASING SUMMARY

CASING TYPE*	DESCRIPTION	DIA. (in.)	END✚ DEPTH (ft.)
B	PVC, schedule 40	4	80
S	PVC, sch. 40, 0.010 in.	4	90
sump	PVC, sch 40	4	93

* P-Protective S-Screen B-Blank O-Open N-None

✚ Depth from Top of Casing

WELL CONSTRUCTION

TYPE CODE*	DESCRIPTION	END● DEPTH (ft.)
B	"Grout seal", high solids bentonite to 10 ft from surface, portland/bentonite to surface (71)	~~78~~
S	1/4" Bentonite Pellets	78
F	20-40 Silica Sand	95.5

* B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	11/10/95	14:00	17:00
CASING	11/11/95	8:30	05:00
FILTER PACK	11/11/95	8:30	05:00
SEAL	11/11/95	09:00	10:10
BACKFILL	11/11/95	10:15	10:40
DEVELOPMENT			
OTHER casing	11/10/95	10:00	13:45

WELL DEVELOPMENT

COMMENTS: Ran SP, 16-64 res, and natural gamma logs

JEG-AL-ENG-1 (6/87)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: : see P. 1

SITE ID: FCT03 **LOCATION ID:** 0884
SITE COORDINATES (ft.):
N _____ **E** _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: Mud rotary
DRILLING CONTR.: JEDI, Aaron Nesbit
DATE STARTED: 11/10/95
DATE COMPLETED: 11/10/95
FIELD REP.: Riel Dotson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
50	↓										
	NQ	100								CS	
60											Silty sand, fg-grained, rounded, poorly consol., carbonaceous, olive gry, burrows
	↓										
	NQ	95								CS	Clay, sandy, v. stiff, olive gry (5Y 4/1)
70											68'-70' - lignite
	↓										Deweesville Sandstone
	NQ	40								SS	Sandstone, fine-grained, rounded, moderately well to well cemented ~~and~~ to poorly consolidated, slightly carbonaceous, burrows, dark greenish ~~tan~~ gray
80											
	↓										
	NQ	35								SS	
90											
	↓										Keystone, dark green gray
											TD@94'

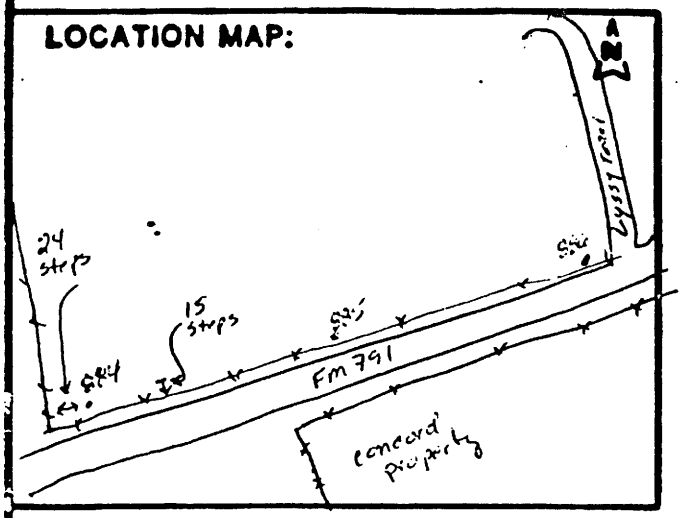
COMMENTS: _____

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
SB - BEAR BIT
HX - HX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:



SITE ID: FCT03 LOCATION ID: 0884
SITE COORDINATES (ft.):
N 60,560.7454 E 71,611.3204
GROUND ELEVATION (ft. MSL): 439.03
DRILLING METHOD: Mud rotary
DRILLING CONTR.: JEDI, Aaron Nastat
DATE STARTED: 11/10/95
DATE COMPLETED: 11/10/95
FIELD REP.: Rick Ditsworth

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
11/8/95	8:09	38.75 BTOC
11/12/95	8:05	32.96 BTOC
11/16/95	11:22	66.82 BTOC

LOCATION DESCRIPTION Lyssy property, B-parcel
SITE CONDITION Coastal Bermuda pasture

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
0	SS										Sandy clay, stiff, dry, very pale orange (10YR 8/2)
	SS										
	SS										
	SS										
10	NQ	100					5°	F,S		CS	
	↓										Clay, very stiff, thinly spaced fractures, filled or stained w/ limonite and gypsum, moderate yellowish brown (10YR 5/4), moderate brown (5YR 3/4), yellowish gray (5Y 8/1), sandy
	NQ	65								CS	
20	↓										
	NQ	85								CS	
30	↓										Clay, very stiff, olive gray (5Y 4/1), carbonaceous, disturbated, carbonaceous layers, sandy in places
	NQ	95								CS	
40	↓										
	NQ	100								CS	45-49 - carbonaceous layer, sandy (almost lignite)
	↓										

COMMENTS:

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
RB - REAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

Attachment 3

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WELL COMPLETION RECORD

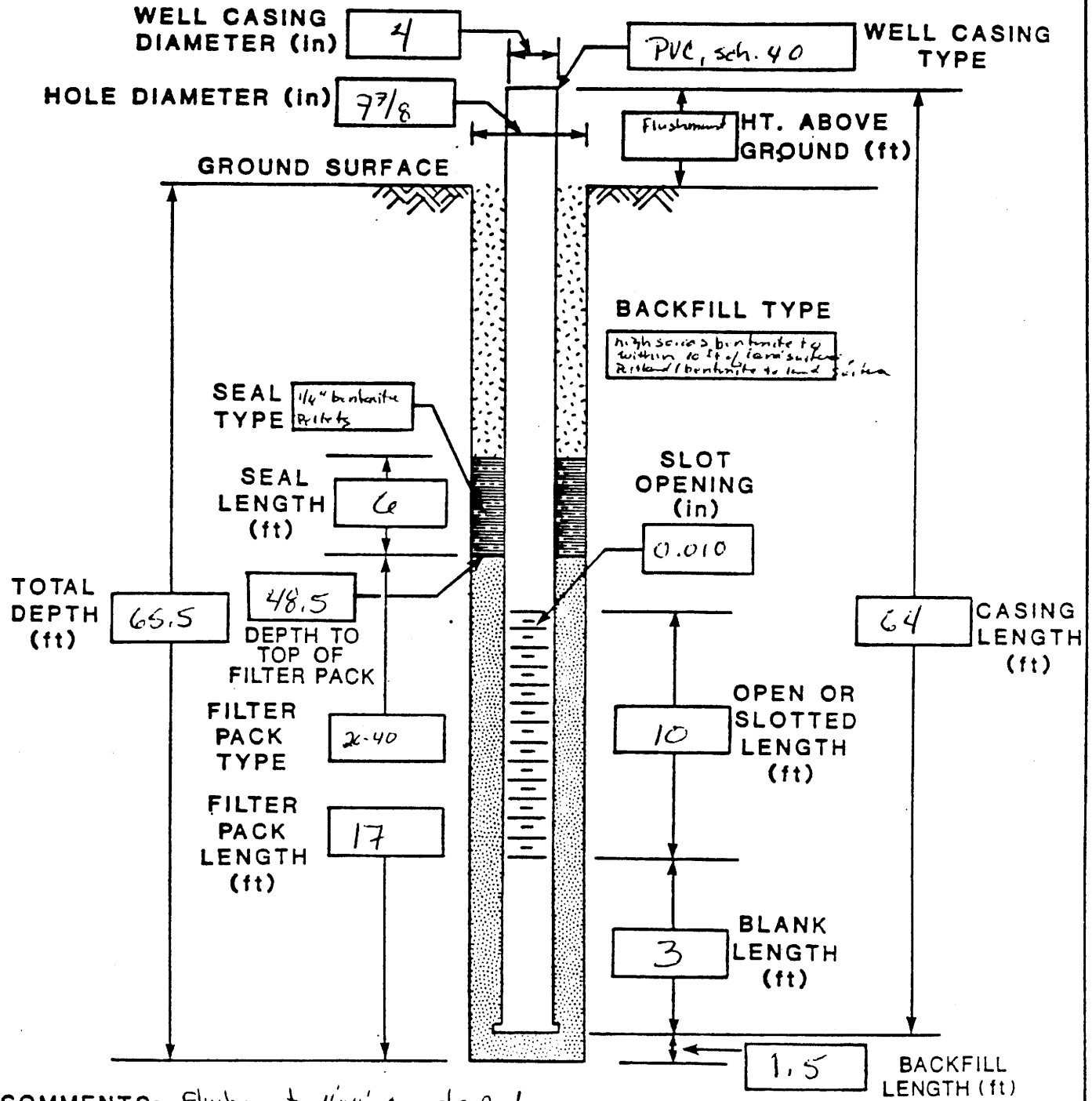
SITE ID: FOT03 LOCATION ID: 0885 DATE INSTALLED: 11/9/95

APPROX. SITE COORDINATES: (FT.) N 61,085.4539 E 72,651.9696

OPEN AREA PER LINEAL FT. ($IN^2/FT.$) _____

FORMATION OF COMPLETION: Dewceswille Sandstone

FIELD REP.: Rick Dotson DRILLER: Aaron Nesbit, JEDJ



COMMENTS: Flushmount, 4'x4' concrete pad.

1 centralizer @ top of screen. [State Plane Coord N-13514123.8789, E-2254244.0594]

JEG-AL-ENG-3 (6/87)

Attachment 2

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

BOREHOLE/WELL CONSTRUCTION LOG

SITE ID: FCT 03 LOCATION ID: 0885 FIELD REP: Rick Dotson

APPROX. SITE COORDINATES (FT.): N 61,085.4539 E 72,651.9694

GROUND ELEVATION (FT. MSL): 412.04 COMPLETION DATE: 11/9/95

BOREHOLE SUMMARY

DRILLER: JEDI, Aaron Nesbit

RIG TYPE: Mobile Drill B-61, mud rotary

BIT TYPE	HOLE DIA. (in.)	END DEPTH ● (ft.)	FLUID TYPE
NQ Core	3.5	64	water
Tricone	7 7/8	65.5	water/mud

CASING SUMMARY

CASING TYPE *	DESCRIPTION	DIA. (in.)	END ✚ DEPTH (ft.)
B	PVC, schedule 40	4	51
S	PVC, sch 40, 0.010 in slot	4	61
Sump	PVC, sch. 40	4	64

* P-Protective S-Screen B-Blank O-Open N-None

✚ Depth from Top of Casing

WELL CONSTRUCTION

TYPE CODE *	DESCRIPTION	END ● DEPTH (ft.)
B	"Grout-Well" to fill 16' of surface cement/ Bentonite grout to land surface	43
S	Bentonite Pellets - 1/4"	~~43~~ 46.5
F	20-40 Silica sand	~~46.5~~ 65.5

* B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	11/9/95	11:00	14:30
CASING	11/9/95	15:00	15:30
FILTER PACK	"	15:00	15:30
SEAL	"	15:30	16:30
BACKFILL	"	16:30	17:00
DEVELOPMENT			
OTHER coring	11/9/95	08:10	10:40

WELL DEVELOPMENT

COMMENTS: Ran SP, 16-arm cal, and natural gamma logs

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: See P. 1

SITE ID: FCT03 LOCATION ID: 885
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
60	↓										carbonaceous clay layers, thin, (<1 inch); black
	NX	40									
60	↓										clay, hard, olive gray (5Y 4/1) @ 63'
											TD - cored to 64'; reamed hole to 65.5'
70											

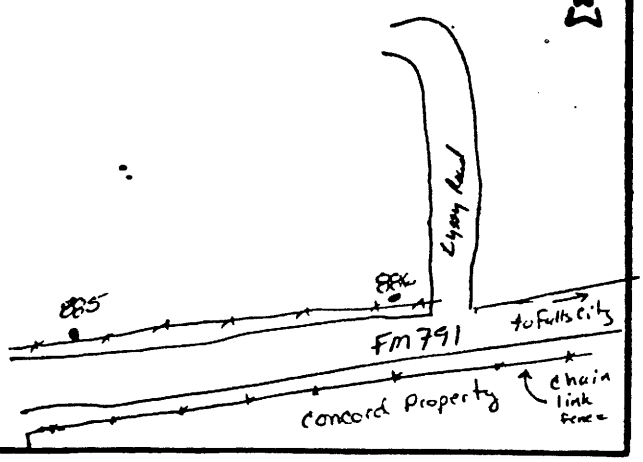
COMMENTS: _____

BORING OPERATION
H - 6 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
CB - CLEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:



SITE ID: FCT03 LOCATION ID: 0885
SITE COORDINATES (ft.):
N 61,085.4539 E 72,651.9694
GROUND ELEVATION (ft. MSL): 412.04
DRILLING METHOD: NQ coring / Mud rotary
DRILLING CONTR.: JEDI, Aaron Nesbit
DATE STARTED: 11/8/95
DATE COMPLETED: 11/9/95
FIELD REP.: Rich Dotson

GROUNDWATER LEVELS

DATE	TIME	DEPTH (ft.)
11/11/95	11:00	48.53 BTOC
11/15/95	11:39	49.98 BTOC

LOCATION DESCRIPTION Lyssy Property; Along Fm 791 fence; in pasture
SITE CONDITION Coastal bermuda pasture.

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
0	SS										Topsoil,
	↓										Sandy clay, stiff, yellowish gray (5Y 7/2), mottled lt orange and lt yellow, dry, fractured filled to stained with limonite, trace gypsum x'ls
10	NQ	0									Dubose Formation
	↓										
	NQ	0									moderate brown (5YR 4/4) sandy clay on bottom of core barrel
20											
	↓										
	NQ	100									Sandy clay, clay, and clayey sand; interbedded, laminated, bioturbated, carbonaceous, soft to med stiff, medium gray
30											
	↓										
	NQ	95									clay, dk greenish gray, hard to stiff,
											lignite coal, black to dark brown, 1/4 cpm w/44-40
40											Sandstone f-grained, rounded, well sorted, mostly poorly to moderately well consolidated, hard, well consolidated @42-43 ft.
	↓										olive gray (5Y 4/1) Deweesville Sandstone
	NQ	50									
	↓										

COMMENTS: Flushmount; Spudded on Dubose; completed in Deweesville; Ran SP, Resistivity, and natural gamma logs

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
CB - CHAIN BIT
HX - HX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

Attachment 1

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WELL COMPLETION RECORD

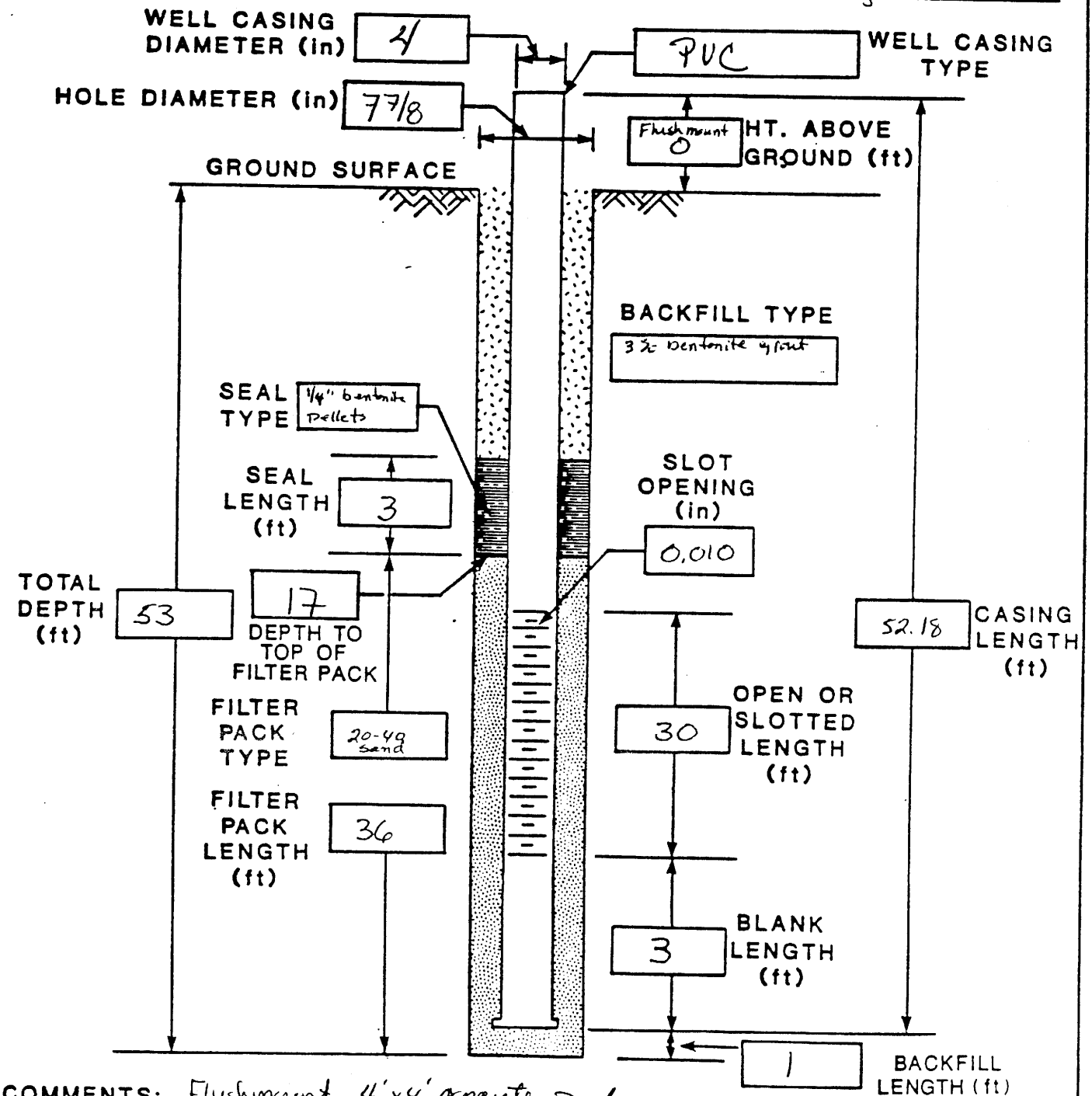
SITE ID: FCT03 LOCATION ID: 0886 DATE INSTALLED: 10/26/95

APPROX. SITE COORDINATES: (FT.) N 61,685.4976 E 73,836.4242

OPEN AREA PER LINEAL FT. ($IN^2/FT.$)

FORMATION OF COMPLETION: Dewey ville Sandstone

FIELD REP.: Rick Dotson DRILLER: Chester Barrington / JEDI



COMMENTS: Flushmount, 4'x4' concrete pad

1 Centralizer @ bottom of screen. [State Plane Coord. N-13514730.1102 E-2255425.13

JEG-AL-ENG-3 (6/87)

Attachment 2

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

BOREHOLE/WELL CONSTRUCTION LOG

SITE ID: FCT03 LOCATION ID: 0886 FIELD REP: Rick Dotson

APPROX. SITE COORDINATES (FT.): N 61,685.4976 E 73,836.4242

GROUND ELEVATION (FT. MSL): 403.69 COMPLETION DATE: 10/26/95

BOREHOLE SUMMARY

DRILLER: JEDI

RIG TYPE: Mobile Drill B-61

BIT TYPE	HOLE DIA. (in.)	END DEPTH ● (ft.)	FLUID TYPE
~~3.5" NQ~~			
NQ core	3.5	62	water
Tricone	7 7/8	~~52~~ 53	water/mud

CASING SUMMARY

CASING TYPE *	DESCRIPTION	DIA. (in.)	END ✚ DEPTH (ft.)
B	PVC, sch. 40	4	19
S	PVC (0.010 inch slot)	4	49
Sump	PVC, sch. 40	4	52

* P-Protective S-Screen B-Blank O-Open N-None

✚ Depth from Top of Casing

WELL CONSTRUCTION

TYPE CODE *	DESCRIPTION	END ● DEPTH (ft.)
B	3% Bentonite/Portland grout	14
S	1/4" Bentonite pellets	17
F	20-40 Silicia Sand	53

* B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	10/25/95	17:00	10/26/95 05:00
CASING	10/26/95	10:30	11:00
FILTER PACK	"	10:30	11:00
SEAL	"	"	11:00
BACKFILL	"	13:00	14:00
DEVELOPMENT			
OTHER NQ Coring	10/24/95	11:00	10/25/95 16:40

WELL DEVELOPMENT

COMMENTS: Ran SP, 16"-64" resistivity, and natural gamma logs.

JEG-AL-ENG-1 (8/87)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: See P.1

SITE ID: FCT03 LOCATION ID: 0886
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: mud rotary; wireline coring, NQ
DRILLING CONTR.: JEDI, Chester Barrington
DATE STARTED: 10/24/95
DATE COMPLETED: 10/26/95
FIELD REP.: Rick Doten

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
25	NQ										interbedded, f-grained, loosely consolidated sand, lt gray w/ lt orange mottling with well consol. med brn SS, iron oxide staining
30	NQ	50								SS	
35											
40											
45	NQ	45					5°	Fld		SS	

COMMENTS: _____

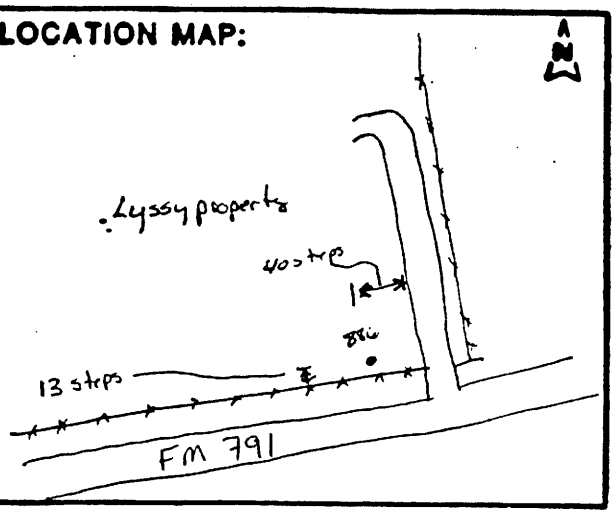
BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NO - NO WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

Page 1 of 3

LOCATION MAP:



SITE ID: FCT03 LOCATION ID: 0886
SITE COORDINATES (ft.):
N 61,685.4976 E 73,836.4242
GROUND ELEVATION (ft. MSL): 403.69
DRILLING METHOD: mud rotary; wireline coring, HQ
DRILLING CONTR.: JEDI, rmaster Berrington
DATE STARTED: 10/24/95
DATE COMPLETED: 10/26/95
FIELD REP.: Rick Dotson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
10/26/95	11:48	~~25.39~~ 25.4 BTOC
10/26/95	14:23	32.4 BTOC
10/28/95	12:35	39.11 BTOC

LOCATION DESCRIPTION Leo Lyssy Sr property
SITE CONDITION Coastal Bermuda grass pasture

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
0	SS	60									Topsoil, clayey sand, dk grey brown
	SS	100									Sand, silty to clayey, very fine, mottled H brn to tan to H orange, white, tr gypsum xls, moist, SC, poorly consolidated
5	SS	0									Dubose Formation
	SS	100									
	SS	100									
10	SS	100									
	SS	100									
15	SS	100									
	SS	100									
	SS	75									
20	SS	25									- hard layer @ 19.5, unable to collect SS Deweesville Formation
	NQ	50								SS	Sandstone, fine-grained, well consolidated, grey-H olive (5Y 5/2) 6 inches recovery in 22'-28' run.; 1/4 to 1/2" solution channel @ 25 ft
25	SS										

COMMENTS: Pushed split spoons to 22 Ft

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

BOREHOLE/WELL CONSTRUCTION LOG

SITE ID: FCT03 LOCATION ID: 0887 FIELD REP: Rick Dotson

APPROX. SITE COORDINATES (FT.): N 62,496.9350 E 73,286.8261

GROUND ELEVATION (FT. MSL): 413.50 COMPLETION DATE: 11/14/95

BOREHOLE SUMMARY

DRILLER: Aaron Nesbit, JEDI

RIG TYPE: Mobile Drill B-61, Mud rotary

BIT TYPE	HOLE DIA. (in.)	END DEPTH ● (ft.)	FLUID TYPE
NQ wireline	3.5	54	Water
triceme	7 7/8	54	Water

CASING SUMMARY

CASING TYPE*	DESCRIPTION	DIA. (in.)	END✚ DEPTH (ft.)
B	PVC, Schedule 40	4	39
S	PVC, sch. 40, 0.010 in. slot	4	49
sump	PVC, sch40	4	52

* P-Protective S-Screen B-Blank O-Open N-None

✚ Depth from Top of Casing

WELL CONSTRUCTION

TYPE CODE*	DESCRIPTION	END● DEPTH (ft.)
B	high solids bentonite to 10 ft from surface, portland/bentonite (3%) grout to surface	29
S	1/4" bentonite pellets	34
F	20-40 Silica Sand	54

* B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	11/14/95	0700	10:30
CASING	11/14/95	12:30	13:00
FILTER PACK	11/14/95	12:30	13:00
SEAL	11/14/95	13:00	14:00
BACKFILL	11/14/95	14:00	14:50
DEVELOPMENT			
OTHER Coring	11/14/95	0730	0700

WELL DEVELOPMENT

COMMENTS: Ran SP, 16-64 & single pt resistivity, and natural gamma logs

JE JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: N

See P.1

SITE ID: FCT03 LOCATION ID: 0886
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
50											
											Claystone, clayey sandstone, and sandy claystone, dk grey dk bin plant material & clay laminations
	NQ	100						L			Conquista Formation
55											
60											
	↓										TD = 62 ft

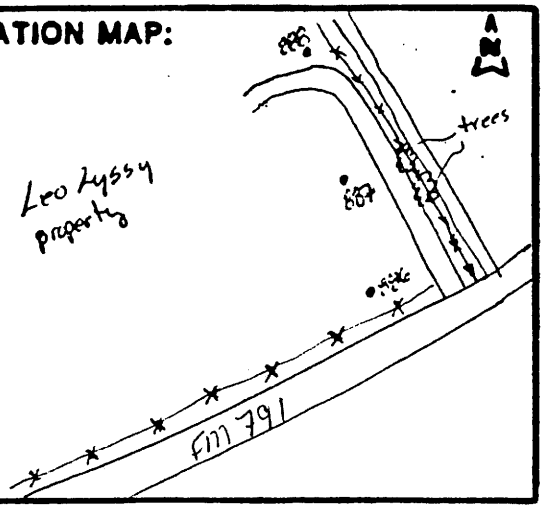
COMMENTS: _____

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:



SITE ID: FCT03 LOCATION ID: 0887
SITE COORDINATES (ft.):
N 162,496.9350 E 73,286.8261
GROUND ELEVATION (ft. MSL): 413.50
DRILLING METHOD: Mud rotary/wireline coring
DRILLING CONTR.: JEDI
DATE STARTED: 11/14/95
DATE COMPLETED: 11/14/95
FIELD REP.: Rick Dotson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
11/16/95	10:05	39.20 BTOC
12/2/95	17:20	42.23 BTOC

LOCATION DESCRIPTION Leo Lyssy Sr property
SITE CONDITION Coastal Bermuda grass pasture

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
0	SS	100									Topsoil, dry, black to dk. brown, sandy clay loam
	SS	100									Interbedded silty clay, clay, and sandstone, light olive gray (5Y 6/1), yellowish gray (5Y 7/2), mottled light orange/light yellow; moderately spaced fractures filled or stained w/ limonite
5	SS	100									
	NQ	35				M		FID		SS	
10											
15	NQ	25								SS	
20											
	NQ	45								SS	Sandstone, interbedded poorly consolidated to well

Dubose Formation

COMMENTS:

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
CB - CEAR BIT
HX - HX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

Attachment 1

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WELL COMPLETION RECORD

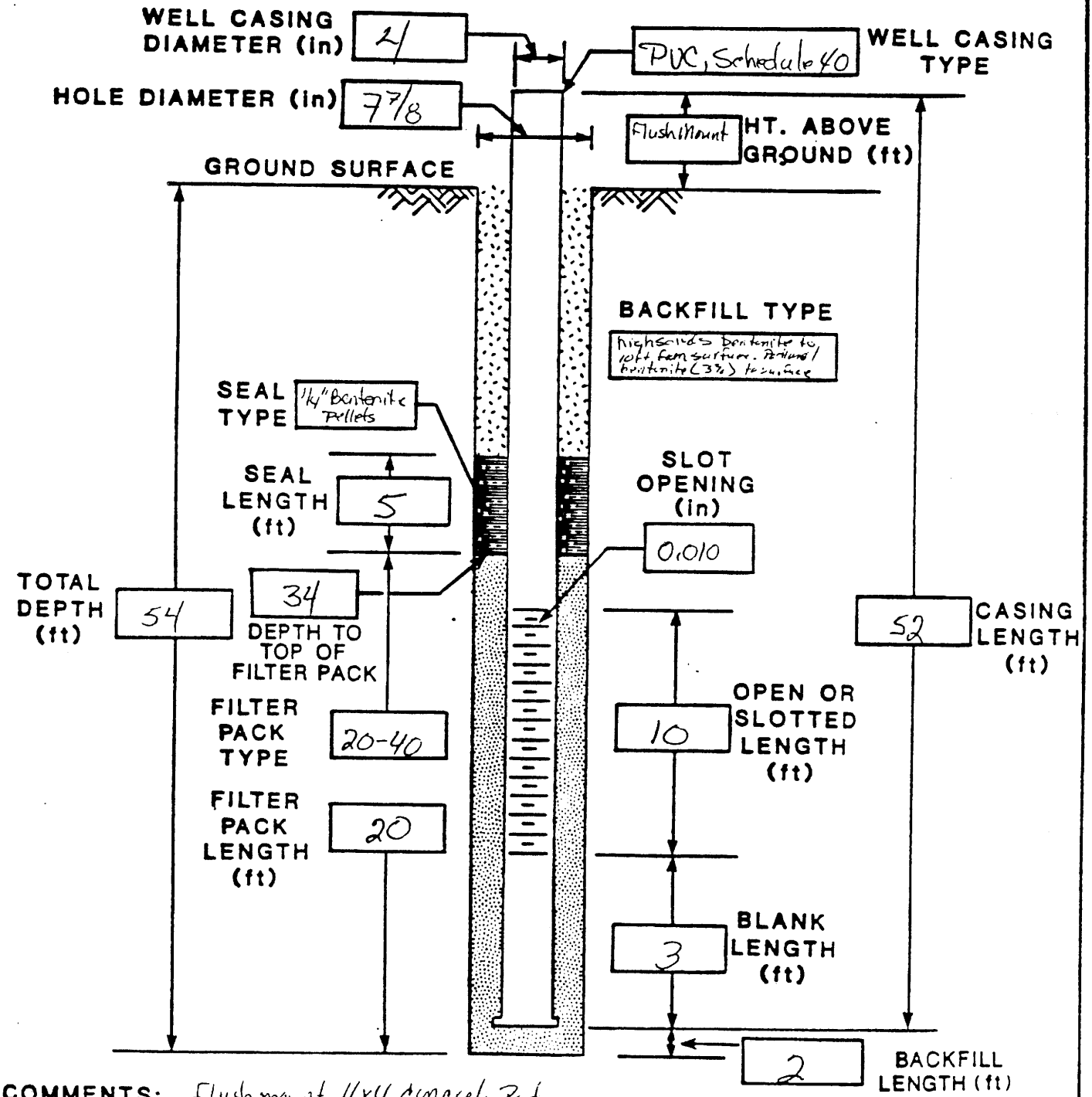
SITE ID: FCT03 LOCATION ID: 0887 DATE INSTALLED: 11/14/95

APPROX. SITE COORDINATES: (FT.) N 62,496.9350 E 73,286.8261

OPEN AREA PER LINEAL FT. ($IN^2/FT.$) _____

FORMATION OF COMPLETION: Dewees ville Sandstone

FIELD REP.: Rick Dotson DRILLER: Aaron Nesbit



COMMENTS: Flushmount, 4x4 concrete Pad

1 centralizer @ top of screen. [State Plane Coord. N-1351553 8.4991, E-2254871.3226]

JEG-AL-ENG-3 (6/87)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: N

See P.1

SITE ID: FCT03 LOCATION ID: 0887
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
50	↓										
55											TD = 54 ft.

COMMENTS: _____

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: See P. 1

SITE ID: FCT03 LOCATION ID: 0887
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
25											consolidated, fine-grained, rounded, light olive gray (5Y 6/1), drill rate indicates hard; soft layers; some thin (1-2 inch) brown clay layers
											Deweesville Formation
30											
35	NQ	20				ThB					
40											
45	NQ	70				M	5	Fkt		CS	claystone, very stiff to hard, olive gray, moderately spaced fractures filled ~~with~~ stained with limonite,
											Conquista Formation

COMMENTS: _____

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

Attachment 1

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WELL COMPLETION RECORD

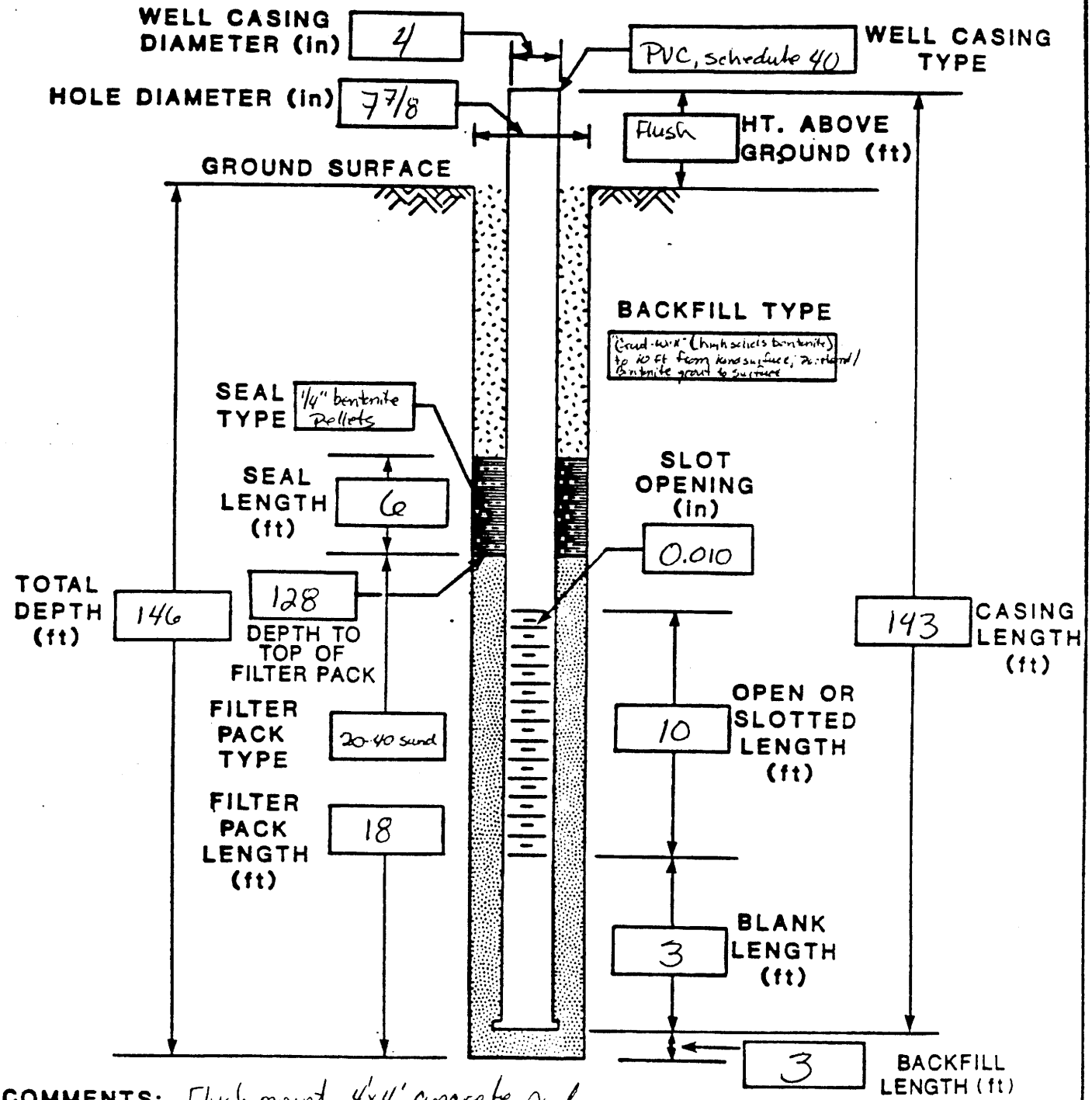
SITE ID: FCT03 LOCATION ID: 0888 DATE INSTALLED: 11/8/95

APPROX. SITE COORDINATES: (FT.) N 63,159.8889 E 72,778.0527

OPEN AREA PER LINEAL FT. ($IN^2/FT.$) _____

FORMATION OF COMPLETION: Dilworth

FIELD REP.: Rick Dotson DRILLER: Aaron Nesbit / JEDI



COMMENTS: Flush mount, 4'x4' concrete pad

1 centralizer @ top of screen. [State Plane Coord. N-13516198.6454, E-2254359.1140]

JEG-AL-ENG-3 (6/87)

Attachment 2

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

BOREHOLE/WELL CONSTRUCTION LOG

SITE ID: FCT03 LOCATION ID: 0888 FIELD REP: Rick Dotson

APPROX. SITE COORDINATES (FT.): N 63,159.8889 E 72,778.0527

GROUND ELEVATION (FT. MSL): 411.97 COMPLETION DATE: 11/8/95

BOREHOLE SUMMARY

DRILLER: Aaron Nesbit / JEDI

RIG TYPE: mobil drill B-61

BIT TYPE	HOLE DIA. (in.)	END DEPTH ● (ft.)	FLUID TYPE
NQ core	3.5	144	water/mud
triane	7 7/8	146	water/mud

CASING SUMMARY

CASING TYPE *	DESCRIPTION	DIA. (in.)	END ✚ DEPTH (ft.)
P	steel	8	84
B	PVC, schedule 40	4	130
S	PVC, sch. 40, 0.010 in	4	140
Sump	PVC, sch 40	4	143

* P-Protective S-Screen B-Blank O-Open N-None

✚ Depth from Top of Casing

WELL CONSTRUCTION

TYPE CODE *	DESCRIPTION	END ● DEPTH (ft.)
B	Portland/bentonite (3%)	10
B	"Grout well" (high solids bentonite)	122
S	1/4" bentonite pellets	128
F	20-40 Silica Sand	146

* B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	10/27/95	13:00	11/7/95 17:30
CASING	11/8/95	13:00	14:00
FILTER PACK	"	"	"
SEAL	"	14:00	15:00
BACKFILL	"	15:00	15:30
DEVELOPMENT			
OTHER NQ Coring	10/26/95	15:00	11/7/95 15:00

WELL DEVELOPMENT

COMMENTS: Ran SP, 16"-64" resistivity, and natural ~~gamma~~ gamma logs

JEG-AL-ENG-1 (8/87)

JE JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: N

See P.1

SITE ID: FCT03 LOCATION ID: 0888
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
25											
30											
35	NQ	70				MB				Sltst	
40											Conquista Formation
											Claystone, interbedded thin sandy silty + clayey sands, laminated, rip-up clasts, burrows, v. stiff, carbonaceous, dark gray, light gray, and olive gray
45	NQ	30				L				CS	

COMMENTS: _____

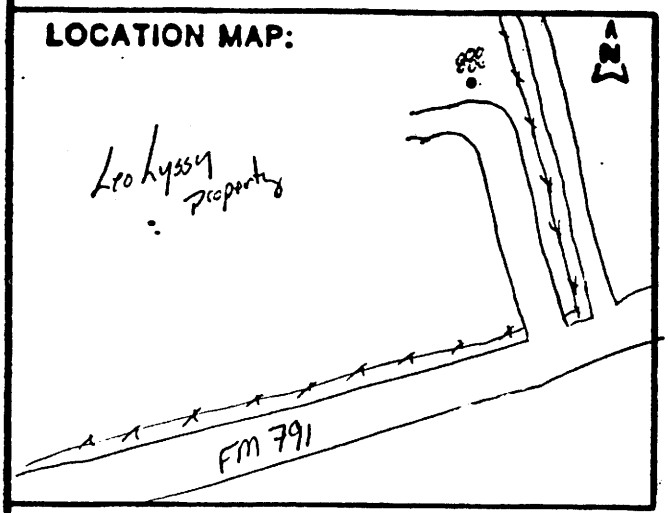
BORING OPERATION
H - 6 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

Page 1 of 6

LOCATION MAP:



SITE ID: FCT03 LOCATION ID: 0888
SITE COORDINATES (ft.):
N 63,159.8889 E 72,778.0527
GROUND ELEVATION (ft. MSL): 411.97
DRILLING METHOD: Wireline coring / mud rotary
DRILLING CONTR.: JEDI / Aaron Nesbit
DATE STARTED: 10/26/95
DATE COMPLETED: 11/8/95
FIELD REP.: Rick Dotson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
11/10/95	0739	50.78 ft btoc
12/1/95	0745	49.09 btoc

LOCATION DESCRIPTION Leo Lyssy Sr property
SITE CONDITION Coastal Bermuda grass pasture land

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
0	SS	10									Topsoil, dk brown to black, sandy clay
	SS	5									
5	SS	90									clay, medium stiff, slightly calcareous, interbedded fine sands, yellowish gray
	SS	5									
	NQ	45								SS	Beaumont formation
10											Sandstone, well cemented, fine to med. grained, rounded, no reaction to acid, yellowish-gray (5Y 7/2) mottled light orange in places, burrows in places
											- wore carbide teeth off core bit @ 14-15 ft, switched to diamond bit to 34 ft.
15	NQ	55								SS	
											sandstone becomes less well cemented with depth; increasing clay content with depth.
30											
	NQ	0								SS	

COMMENTS:

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
CB - GEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: See P.1

SITE ID: FCT03 LOCATION ID: 0888
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
100											Lignite
											Dilworth Formation
	↓										Interbedded Sandy clay, clayey sand + clay, fine grained, rounded sand, clay - soft to stiff, carbonaceous, burrows, dark to light gray, dark greenish gray
105	NQ	65				MB					
110											
	↓										
115	NQ	70				MB					
120											
	↓										
	NQ	100				MB					

COMMENTS: _____

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
HX - HX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: See P-1

SITE ID: FCT03 LOCATION ID: 0888
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY
125										
	NQ	30								SS
130										
135	NQ	5								SS
140										
145										

ROCK TYPE & REMARKS

1/2" thick calcite layer over a very hard, well cemented Sandstone @ 128 ft, fine grained, rounded, light tomato gray
Sandstone, well cemented @ top becoming poorly cemented w/ depth; fine grained, well sorted, rounded, medium dark gray. Formation to loose to hold in core barrel
collected sample for hydrologic testing from 130-131'

Stopped coring @ 144', Reamed hole to 146'.

COMMENTS: _____

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

Attachment 2

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

BOREHOLE/WELL CONSTRUCTION LOG

SITE ID: FCT03 LOCATION ID: 0889 FIELD REP: Tim Jackson

APPROX. SITE COORDINATES (FT.): N 65,130.0061 E 71,194.4316

GROUND ELEVATION (FT. MSL): 382.55 COMPLETION DATE: 10/25/95

BOREHOLE SUMMARY

DRILLER: JEDI, Paul Daniloff

RIG TYPE: Hollow stem Auger - B-61

BIT TYPE	HOLE DIA. (in.)	END DEPTH ● (ft.)	FLUID TYPE
Auger	8	48	N/A

CASING SUMMARY

CASING TYPE*	DESCRIPTION	DIA. (in.)	END✚ DEPTH (ft.)
B	Sump - sch. 40 PVC	2	47.5
S	Screen - PVC, 0.010 slot	2	44.5
B	Riser - sch. 40 PVC	2	34.5

* P-Protective S-Screen B-Blank O-Open N-None

✚ Depth from Top of Casing

WELL CONSTRUCTION

TYPE CODE*	DESCRIPTION	END● DEPTH (ft.)
B	20-40 sand below sump	48.2
F	20-40 sand 47.5	~~33.7~~
~~B~~		
S	Bentonite Seal (6.7)	33.7
B	Portland / Bentonite Grout	27

* B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	10/24/95	10:00	17:00
CASING	10/24/95	17:00	18:00
FILTER PACK	"	18:00	18:15
SEAL	"	18:15	18:30
BACKFILL	10/25/95	8:00	09:30
DEVELOPMENT			
OTHER			

WELL DEVELOPMENT

COMMENTS: State Plane Coordinates

N 13518160.0384

E 2252765.2963

JEG-AL-ENG-1 (6/87)

Attachment 1

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WELL COMPLETION RECORD

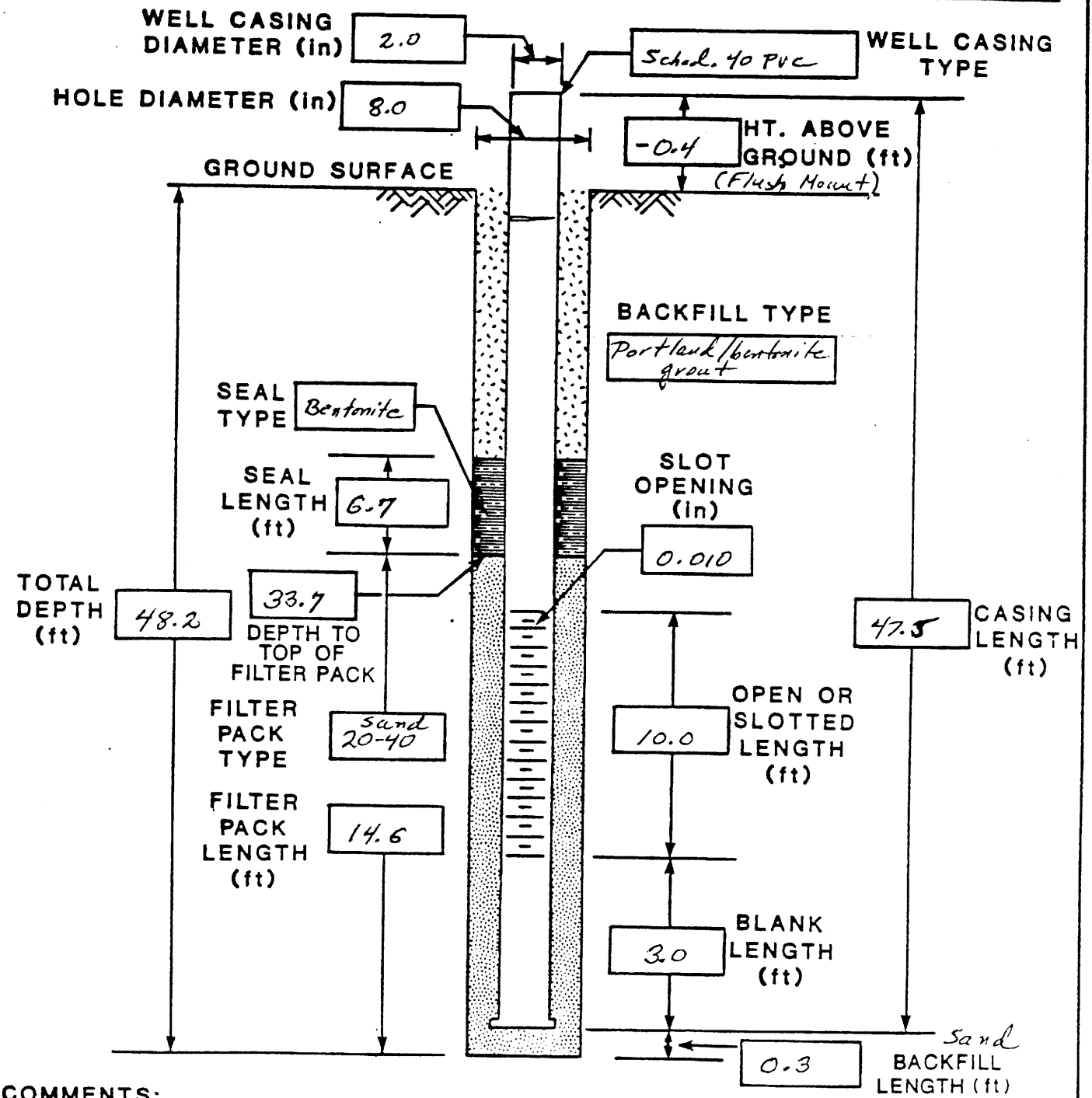
SITE ID: FCT 03 LOCATION ID: 0889 DATE INSTALLED: 10/24-25/85

APPROX. SITE COORDINATES: (FT.) N 65,130.0061 E 71,194.4316

OPEN AREA PER LINEAL FT. ($IN^2/FT.$) _____

FORMATION OF COMPLETION: Dilworth Sandstone

FIELD REP.: Tim Jackson DRILLER: Jedi



COMMENTS: _____

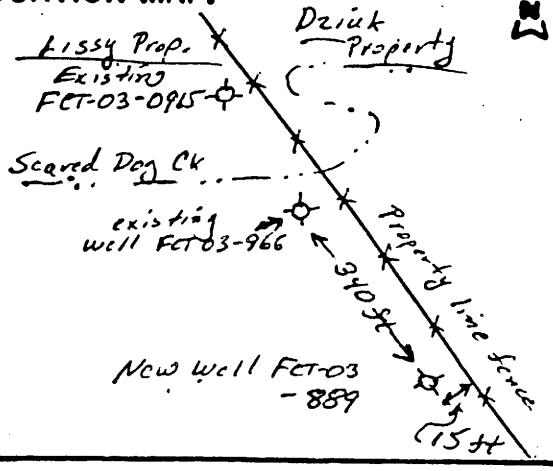
JEG-AL-ENG-3 (6/87)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

Page 1 of 2

LOCATION MAP:



SITE ID: FCT 03 LOCATION ID: 0889
SITE COORDINATES (ft.):
N 65,130.0061 E 71,194.4316
GROUND ELEVATION (ft. MSL): 382.55
DRILLING METHOD: Hollow Stem Auger
DRILLING CONTR.: Jedi
DATE STARTED: 10/24/95
DATE COMPLETED: 10/25/95
FIELD REP.: Tim Jackson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION State Plane Coordinates N 1351,160.0384 E 2252765.2963
SITE CONDITION

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SAMPLE	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
											Note: Spudded just below topo bench formed by Conquista fossiliferous Sandstone
1		100		NA	NA				OXd	Ss	0-1' Sandy brown soil
										Ss	1-2.5' Clayey sand soil with limonitic SS pebbles
										Ss	2.5-3' Sand, vf, light grey. Bedrock
										Cl	3-4' Claystone, reddish brn with calcite laminae.
5							J:				4-9' Claystone, pale yellow brown with pale yellow clay partings. Non-calcareous but with CaCO3 along scattered sand laminae to 8 ft. Gypsum, FeSO4H and H2O on partings at 9 ft.
10										Ss	9-12' Clayey SS, burrowed and mixed. Pinkish grey with pale yellow mottling. Occ. gyp filled 1mm partings/fractures. Non-calcareous
										Cl	12-14' Sandy claystone with thin clayey sand interbeds. 5mm gypsum on partings. Non-calc
15											14-22' Claystone, laminated grey yellow, pale orange, lt brn. Gypsum laminae every 0.5 ft or so. Non-calcareous
											Redox boundary at 22'
20									Redx		22-30' Color change: Claystone laminated olive grey and lt grey. Non-calcareous. Scattered pelecypods (Corbicula) not CaCO3.
25											

Conq Ss — Lower Conquista Claystone

COMMENTS: Hollow stem auger. Cored using split spoon
General log 0-3 sand, 3-30 claystone, 30-33 lignite
33-46 Sandstone, damp to wet 46-48(TD) Claystone.
Agrees with log from well FCT03-966.

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NO - NO WIRELINE ROCK CORING

JE JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: N

See P. 1

SITE ID: FCT03 LOCATION ID: 0889
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	FRACING SAMPLE	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
	100 →								Reduced	Cl	22-30' Claystone, olive grey and lt grey. very compact, plastic, homogeneous. Tight. This clay tends to swell into hole
30										L	30-30.6 Clayey lignite. Non-calcareous
	100										30.6-33 Lignite. Very powdery, dry. Dusky brown
	50									Cl	33-33.5 Claystone, very stiff, dusky yel brn. Non calc.
35	50									Ss	33.5-34 Split spoon refused
	0 →										34-34.5 Sandstone, v.f., light grey with clay clasts, lignite ~~clasts~~ clasts. Non-calc
	100										34.5-36' Auger refusal. Changed bit, drilled out to 36'
	100										
40	100										
	50										36-38' Clayey sand, vf, olive grey. Non-calc. ~~Damp~~ Damp. Damp.
	0										38-40.5' Sand, vf, olive grey. lignite seam (0.5 in) at 40ft. Clay cement. Non-calc. Wet
	0										
	0 →										40.5-44 Hitting hard streaks. Spoon refused
45											44-44.5 Sand, vf with 1cm hard streaks. Dry
										Cl	44.5-46 Spoon refused. Drilled out
											46-46.8 Claystone, olive grey, shaley with sand laminae
											48.2 TD

Incr Comp. Claystone | Dk with Sandstone

COMMENTS: Spoon was refused through sandstone at 34.5 to 48.2', though did recover 0.5 foot samples of sandstone every 2 feet or so. Appears to be perched water in sandstone from 36 to 46ft.

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NO - NO WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

BOREHOLE/WELL CONSTRUCTION LOG

SITE ID: FCT-03 LOCATION ID: 0890 FIELD REP: Tim Jackson

APPROX. SITE COORDINATES (FT.): N 66,077.2797 E 70,417.3032

GROUND ELEVATION (FT. MSL): 374.39 COMPLETION DATE: 10/29/95

BOREHOLE SUMMARY

DRILLER: JEDI Paul Denisoff

RIG TYPE: Hollow stem auger

BIT TYPE	HOLE DIA. (in.)	END DEPTH ● (ft.)	FLUID TYPE
Auger	8.0	49.2	None

CASING SUMMARY

CASING TYPE *	DESCRIPTION	DIA. (in.)	END✚ DEPTH (ft.)
B	Sump - sched. 40 PVC	2	48.2
S	Screen - PVC, 0.010 Slot	2	45.2
B	riser - sched 40 PVC	2	35.7

* P-Protective S-Screen B-Blank O-Open N-None

✚ Depth from ~~Top of Casing~~ Ground Surface

WELL CONSTRUCTION

TYPE CODE*	DESCRIPTION	END● DEPTH (ft.)
B	20-40 sand below sump	49.5
F	20-40 Sand	48.2
B	Sandy natural fill (sloughed)	32.6
S	Bentonite seal (3')	28.0
B	Portland/Bentonite Grout	25.0

* B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	10/28	14:55	17:29
CASING	10/28	17:29	flowing sand.
	10/29	7:40	~~7:40~~ 7:40
FILTER PACK	10/29	7:40	10:30
SEAL	10/29	10:48	12:24
BACKFILL	10/29	12:24	12:54
DEVELOPMENT			
OTHER			

WELL DEVELOPMENT

COMMENTS: State Plane Coordinates:

N 13519103.0340

E 2251983.2677

JEG-AL-ENG-1 (6/87)

Attachment 1

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WELL COMPLETION RECORD

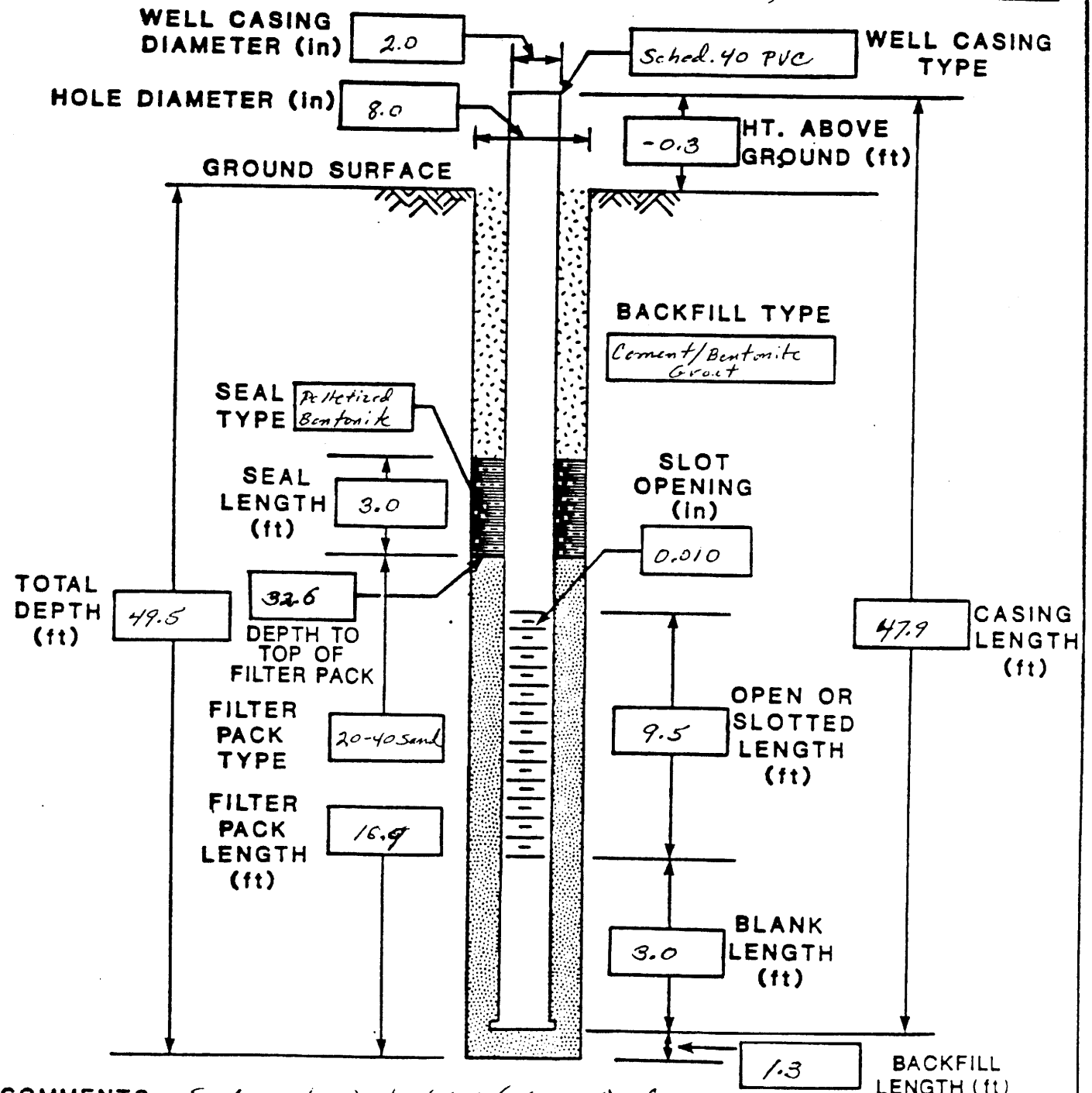
SITE ID: FCT-03 LOCATION ID: 0890 DATE INSTALLED: 10/28-29/85

APPROX. SITE COORDINATES: (FT.) N 66,077.2797 E 70,417.3032

OPEN AREA PER LINEAL FT. ($IN^2/FT.$) _____

FORMATION OF COMPLETION: Dilworth Sandstone

FIELD REP.: Tim Jackson DRILLER: JEDI, Paul Danilcff



COMMENTS: Sandy natural backfill (sloughed) from tip of filter pack (32.6' ~~33'~~) to bottom of bentonite plug (28'). Flush Mount.

JEG-AL-ENG-3 (6/87)

Attachment 1

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

Well Abandoned

WELL COMPLETION RECORD

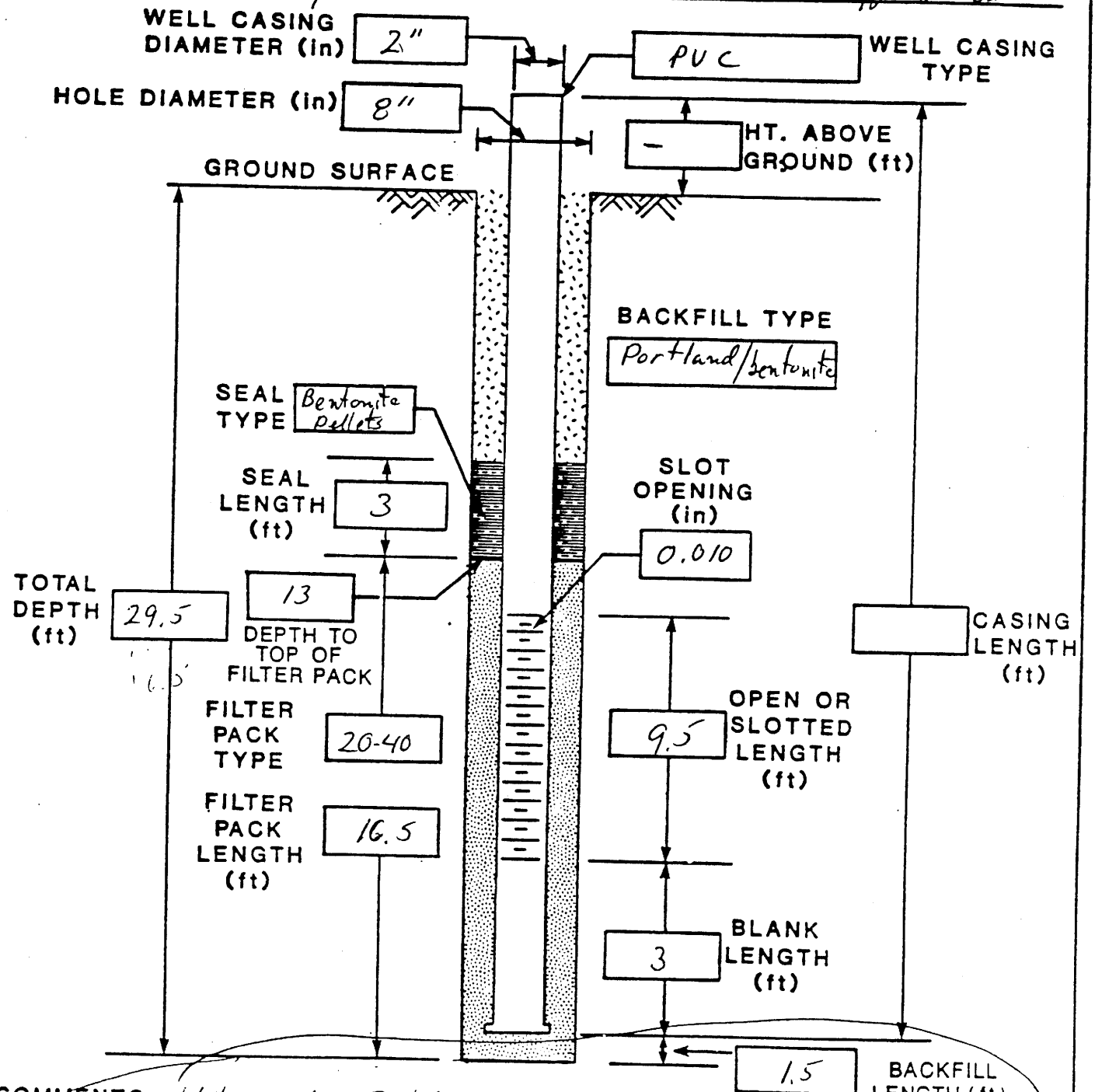
SITE ID: FCT-03-0 LOCATION ID: 03-0890e DATE INSTALLED: 10/26/95

APPROX. SITE COORDINATES: (FT.) N _____ E _____

OPEN AREA PER LINEAL FT. ($IN^2/FT.$) _____

FORMATION OF COMPLETION: _____

FIELD REP.: D Tarlex / T Jackson DRILLER: Paul Daniloff - ABEDI



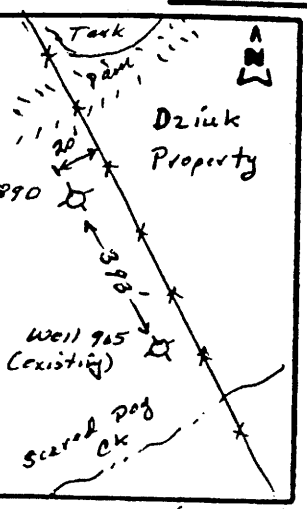
COMMENTS: Well was dry. Pulled casing and grouted open hole with portland/bentonite to 6" below surface on 10/28/95

JEG-AL-ENG-3 (6/87)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP:



SITE ID: FCT-03 LOCATION ID: 0890
SITE COORDINATES (ft.):
N 66,077.2797 E 70,417.3032
GROUND ELEVATION (ft. MSL): 374.39
DRILLING METHOD: Hollow Stem Auger
DRILLING CONTR.: Jedi
DATE STARTED: 10/28/95
DATE COMPLETED: 10/29/95
FIELD REP.: Tim Jackson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
10/31/95	9:06	33.2

LOCATION DESCRIPTION 393' north-northwest of existing well 965, about 20' west of Lyssy east property line. About 800' north of Scared Dog Ck.
SITE CONDITION

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
									0-3' Soil. Clayey sand, dk gel. brn.
									3-5' Clay. Deeply weathered, paleosol, minor $CaCO_3$. Moderate yellow.
									5-12' Sand, vf, with occ. clay and silt laminae. Sand laminated. Gypsum along partings (1-3 mm thick). Non-calc. Yellowish grey. No recovery at 8.5-10'. Fe ooH on partings.
									12-14' Sand/silt, clayey, vf, with thin to med. clay beds. Yellowish grey. Dense, cemented silt at 13.5'.
									14-18' Interbedded silty claystone and very fine (vf) sand/silt. Thin beds, laminated. Scattered gyp. on partings, and Fe ooH. Non-calc.
									18-20' Sandstone, vf., clean. Yellow grey, damp to wet.
									20-22 Barrel refused. No recovery. Appears to be densely cemented sand layer (1" thick) at 20.6'
									22-24 Sand, vf, clean, yellow grey w/ dk grey layer at 22.7', wet. Non-calc
									24-29.5 Claystone. Color change to olive grey. Dense, plastic clay with scattered sand laminae. Non-calc.

COMMENTS: Log is a composite of borings 890a (drilled to 30' and then cleaned) and 890b (drilled out to 30', then logged to 49.5'. Boring 890b completed as well. 890b is 13 feet south of boring 890a.

SAMPLE TYPE
A - Auger cuttings
S - 3" O.D 1.38" I.D drive sample
U - 3" O.D 2.42" I.D tube sample
T - 3" O.D thin-walled Shelby tube

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

LOCATION MAP: See P.1

SITE ID: FCT-03 LOCATION ID: 0890
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: Hollow stem auger
DRILLING CONTR.: Jedi
DATE STARTED: 10/28/95
DATE COMPLETED: 10/28/95
FIELD REP.: Tim Jackson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
30									30-32 Shale, olive grey, bentonitic, slightly silty, non-calc, dry.
								No Rec.	32-35 Barrel refused. 50 blows for 0.2'. Cemented silty clay in shoe with FeOOH & gypsum crystals. Cutting shoe 0.5" silica cmtd sand.
35								Yellow grey	35-40.4 Sand, vf, yel. grey, moist, unconsolidated, clean. Abundant FeOOH on bedding. Non-calc.
40								No rec Prob. sand	40-40.4 - sand with cemented, lignitic clay bed at 40.4. Barrel refused. Sand on bit and in cuttings.
45								Olive grey	44.5-48.5 - Sand, olive grey with pale yel. FeOOH on bedding. Thin bedded, lignitic wood pieces. Wet & unconsolidated, flows, saturated. Barrel won't push.
50									Drilled out to 49.5'
									TD = 49.5

COMMENTS: _____

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D 1.38" I.D drive sample
U - 3" O.D 2.42" I.D tube sample
T - 3" O.D thin-walled Shelby tube

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

BOREHOLE/WELL CONSTRUCTION LOG

SITE ID: ECT-03 LOCATION ID: 0891 FIELD REP: Tim Jackson

APPROX. SITE COORDINATES (FT.): N 68,130.6211 E 72,431.2773

GROUND ELEVATION (FT. MSL): 347.57 COMPLETION DATE: 10/28/95

BOREHOLE SUMMARY

DRILLER: JEDI Paul Danloff

RIG TYPE: Hollow Stem Auger

BIT TYPE	HOLE DIA. (in.)	END DEPTH ● (ft.)	FLUID TYPE
Auger	8.0	26.5	None

CASING SUMMARY

CASING TYPE*	DESCRIPTION	DIA. (in.)	END✚ DEPTH (ft.)
B	Sump - Sched 40 PVC	2	23.8
S	Screen - 0.010 Slot	2	22.8
B	Riser - Sched 40 PVC	2	13.3

* P-Protective S-Screen B-Blank O-Open N-None

✚ Depth from ~~Top of Casing~~ Ground Surface

WELL CONSTRUCTION

TYPE CODE*	DESCRIPTION	END● DEPTH (ft.)
B	20-40 Sand below sump	26.5
F	20-40 Sand	23.8
~~S~~	~~Bentonite seal~~	
B	muddy sand backfill (sloughed)	11.0
S	Bentonite seal ~~(2.9')~~ (2.9')	10.4
B	Portland/bentonite grout	7.5

* B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	10/28	8:15	10:15
CASING	10/28	11:15	11:20
FILTER PACK	10/28	11:20	11:50
SEAL	10/28	11:50	12:00
BACKFILL	10/28	13:16	13:35
DEVELOPMENT			
OTHER			

WELL DEVELOPMENT

COMMENTS: State Plane Coord.

N 13521166.7283

E 2253986.0179

JEG-AL-ENG-1 (6/87)

Attachment 1

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WELL COMPLETION RECORD

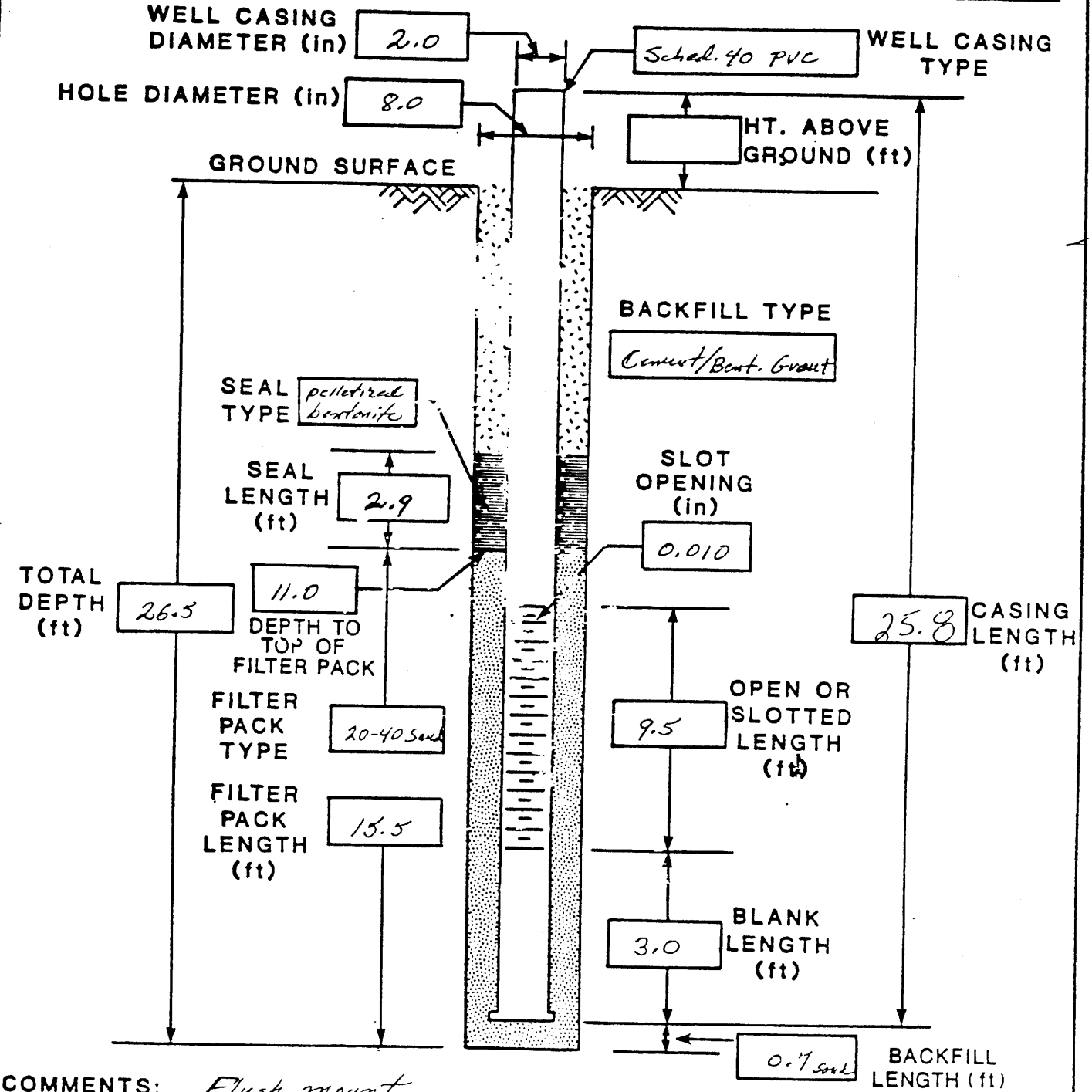
SITE ID: FCT-03 LOCATION ID: 0891 DATE INSTALLED: 10/28/95

APPROX. SITE COORDINATES: (FT.) N 68,130.6211 E 72,431.2773

OPEN AREA PER LINEAL FT. ($IN^2/FT.$) _____

FORMATION OF COMPLETION: Dilworth Sandstone

FIELD REP.: Tim Jackson DRILLER: JEDI Paul Daniloff



COMMENTS: Flush mount.

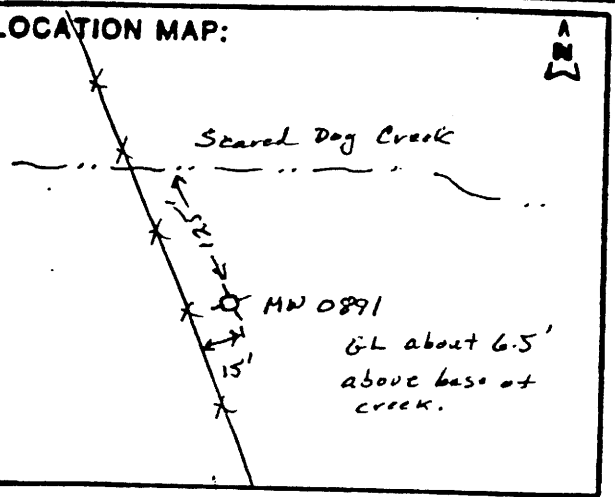
JEG-AL-ENG-3 (6/87)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page 1 of 1

LOCATION MAP:



SITE ID: FCT-03 LOCATION ID: 0891
SITE COORDINATES (ft.):
N 68,130,6211 E 72,431,2773
GROUND ELEVATION (ft. MSL): 347.57
DRILLING METHOD: Hollow stem auger
DRILLING CONTR.: JEDI
DATE STARTED: 10/28/95
DATE COMPLETED: 10/28/95
FIELD REP.: Tim Jackson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
10/28/95	18:56	14.0

LOCATION DESCRIPTION
SITE CONDITION

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
									0-5' Clayey sand, dk greyish brown. non-calc., fine grained. Scattered white salts (gyp?). Alluvial soil.
5									5-6' Clay, brn blk, with scattered sand mottles. Non-calc, white salts. Alluvium
									6-12' Interbedded vf sand and sandy clay. Yellowish grey. Scattered gyp. nodules, FeOOH. Non-calc. Sandstone clasts at base. Alluvium
10									
15									12-16 Sand (Bedrock). Yellow grey, FeOOH staining. wet. v. fine, well sorted, clean. 50% recovery. 2 2cm thick well cemented clay beds at 15.5'
									17-18 Barrel refused. Clay bed in shoe
20									18-24 Sand, v.f., FeOOH stained, yellow grey, non-calc. not cemented, flow when wet. Becomes med. grey and clayey at 22.5' with lignitic matter on laminae. Very wet.
25									No Rec 24-25 No Recovery (washed out)
									25-26 Clay, olive grey with white mottles (kaolinite?). Laminated with silt. Non-calcareous.
									TD = 26 feet.

COMMENTS:

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D 1.38" I.D drive sample
U - 3" O.D 2.42" I.D tube sample
T - 3" O.D thin-walled Shelby tube

Attachment 2

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

BOREHOLE/WELL CONSTRUCTION LOG

SITE ID: FCT LOCATION ID: 0892 FIELD REP: Tim Jackson

APPROX. SITE COORDINATES (FT.): N 55233.7940 E 63901.0024

GROUND ELEVATION (FT. MSL): 386.28 COMPLETION DATE: 10/26/95

BOREHOLE SUMMARY

DRILLER: JEDI Paul Daniloff

RIG TYPE: Hollow stem auger

BIT TYPE	HOLE DIA. (in.)	END DEPTH ● (ft.)	FLUID TYPE
Auger	8.0	35.0	None

CASING SUMMARY

CASING TYPE*	DESCRIPTION	DIA. (in.)	END✚ DEPTH (ft.)
B	Sump - sched 40 PVC	2	26.0
S	Screen - 0.010" slots-PVC	2	23.0
B	Riser - sched 40 PVC	2	13.5
B	Protective Casing	8	2.5

* P-Protective S-Screen B-Blank O-Open N-None

✚ Depth from ~~Top of Casing~~ Ground Surface

WELL CONSTRUCTION

TYPE CODE*	DESCRIPTION	END● DEPTH (ft.)
B	Pelletized bentonite backfill	35.0
B	20-40 Sand below sump	27.2
F	20-40 Sand	26.0
S	Bentonite seal (3.1')	10.0
B	Portland/Bentonite grout	6.9

* B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	10/25	10:34	15:30
CASING	10/25	15:30	15:40
FILTER PACK	10/25	15:00	16:40
SEAL	10/25	16:40	17:08
BACKFILL	10/25	15:40	16:00
	10/26	8:30	9:30
DEVELOPMENT	10/26	8:10	8:30
OTHER			

WELL DEVELOPMENT

COMMENTS: State Plane Coord.

N 13508226.7345

E 2245525.5684

JEG-AL-ENG-1 (6/87)

Attachment 1

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WELL COMPLETION RECORD

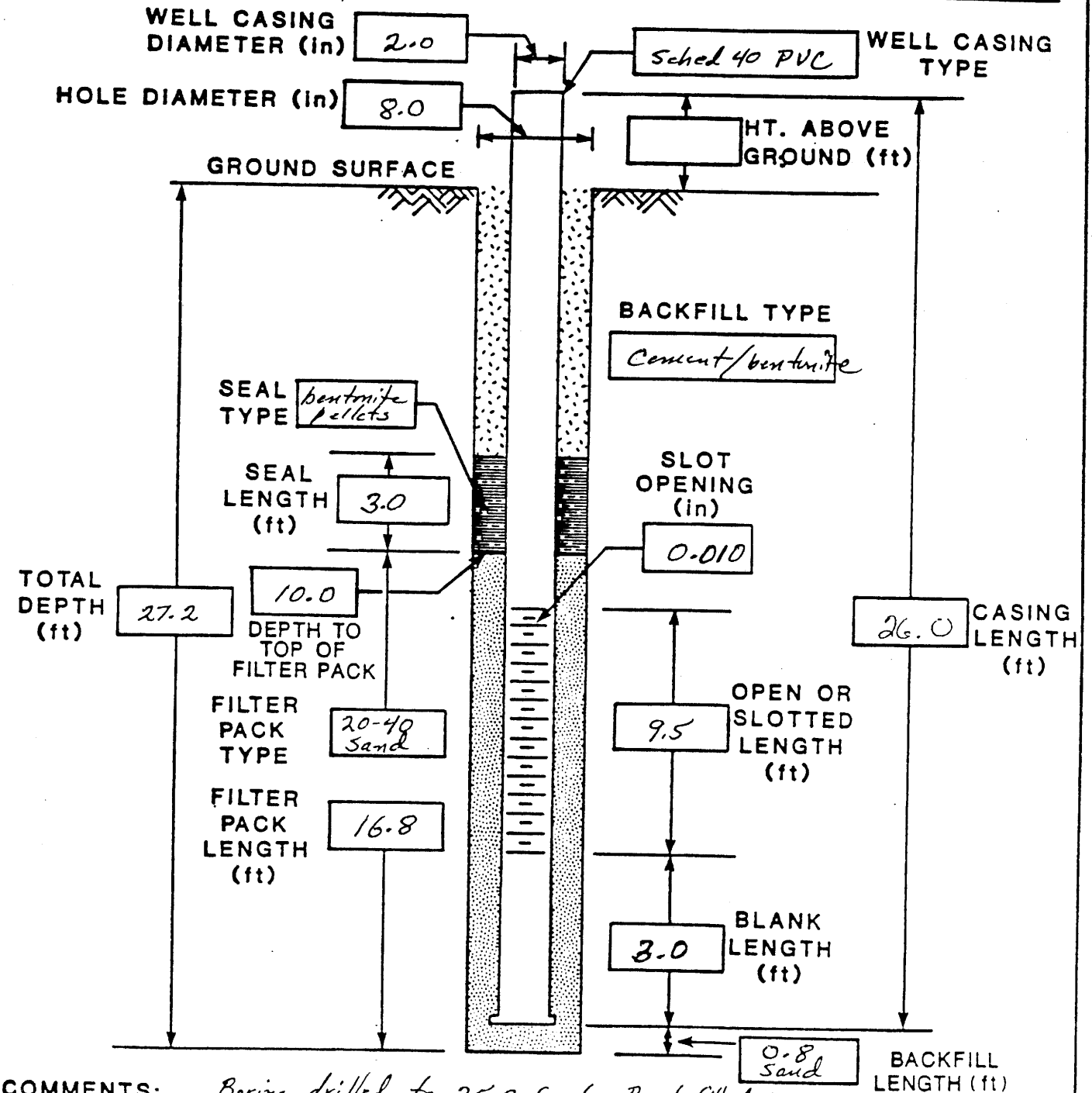
SITE ID: FCT03 LOCATION ID: 0892 DATE INSTALLED: 10/25-26/95

APPROX. SITE COORDINATES: (FT.) N 55,233.7940 E 63,901.0024

OPEN AREA PER LINEAL FT. ($IN^2/FT.$) _____

FORMATION OF COMPLETION: Dilworth and Conquista

FIELD REP.: Tim Jackson/Dave Tarbox DRILLER: Jedi



COMMENTS: Boring drilled to 35.0 feet. Backfilled to 27.2 feet using bentonite pellets.

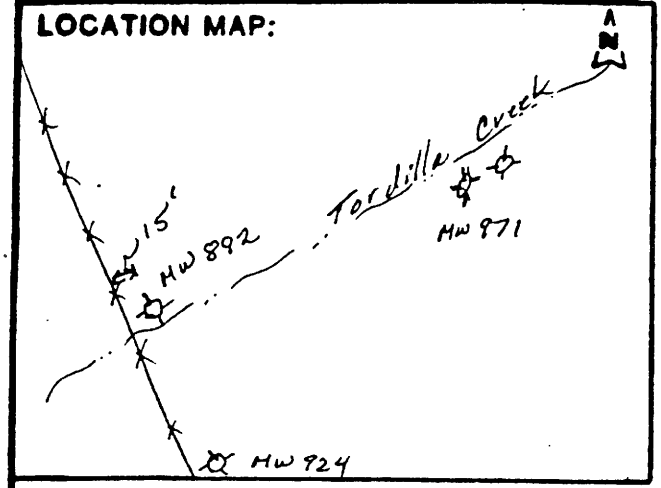
JEG-AL-ENG-3 (6/87)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (SOIL)

Page 1 of ~~2~~ 1

LOCATION MAP:



SITE ID: FCT-03 LOCATION ID: 0892
SITE COORDINATES (ft.):
N 55,233.7940 E 63,901.0024
GROUND ELEVATION (ft. MSL): 386.28
DRILLING METHOD: Hollow stem auger
DRILLING CONTR.: JEDI
DATE STARTED: 10/25/95
DATE COMPLETED: 10/26/95
FIELD REP.: Tim Jackson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
10/30/95	9:00	13.13

LOCATION DESCRIPTION
SITE CONDITION

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS PER 6 in.	N VALUE	USCS	VISUAL CLASSIFICATION
									0-7' Clayey sand, vf, greyish brown with interbedded fine sand. Non-calc. Abundant clay clasts (white) at base. Alluvium
	5								
									7-10' Clay, very dense, clean, plastic. Dusky yellow with FeOOH; gyp. nodules at 10'
	10								10-10.2' Sand, med, gyp. - barrel refused
									11-13.5 Clay with thin beds clayey sand. Non-calc. FeOOH, abundant gyp. xls. barrel refused at 13.5'
	15								14-18' Sandy clay and interbedded clayey sand. Abundant FeOOH. Scattered $CaCO_3$ nodules. Thin lignite laminae. Yellow grey
					0001				
	20								18-22' Clay with sand laminae. mod. yel. brn, laminated, non-calc FeOOH on partings.
									22-28 Claystone, Color change to olive black, silty. Very ~~homogen~~ homogeneous, compact. Scattered organic flecks. shaley.
									28-28.4 Sandstone, calcite cemented, lignite at bottom. Barrel refused.

COMMENTS:

SAMPLE TYPE
A - Auger cuttings
S - 2" O.D 1.38" I.D drive sample
U - 3" O.D 2.42" I.D tube sample
T - 3" O.D thin-walled Shelby tube

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

BOREHOLE/WELL CONSTRUCTION LOG

SITE ID: FCT03 LOCATION ID: 0893 FIELD REP: Rick Dotson

APPROX. SITE COORDINATES (FT.): N 58,184.4632 E 66,001.3354

GROUND ELEVATION (FT. MSL): 415.90 COMPLETION DATE: 11/16/95

BOREHOLE SUMMARY

DRILLER: Aaron Nesbit, JEDI

RIG TYPE: Mobile Drill B-61, Mud rotary

BIT TYPE	HOLE DIA. (in.)	END DEPTH ● (ft.)	FLUID TYPE
NQ wireline	3.5	~~144~~ 143	water
tricone	7 7/8	146	water/mud

CASING SUMMARY

CASING TYPE*	DESCRIPTION	DIA. (in.)	END✚ DEPTH (ft.)
P	Steel (71' below G.S.)	8	74
B	PVC, Sch. 40	4	133
S	PVC, Sch. 40, 0.010 in.	4	~~144~~ 143
Sump	PVC, Sch. 40	4	~~144~~ 143

* P-Protective S-Screen B-Blank O-Open N-None

✚ Depth from Top of Casing

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	~~11/14/95~~ 11/16/95	0900	11:30
CASING	11/16/95	13:00	14:15
FILTER PACK	11/16/95	13:00	14:15
SEAL	11/16/95	14:15	15:15
BACKFILL	11/16/95	15:15	16:30
DEVELOPMENT			
OTHER wireline Coring	11/11/95	13:45	11/16/95 08:30

WELL CONSTRUCTION

TYPE CODE*	DESCRIPTION	END● DEPTH (ft.)
B	Portland/Bentonite (3%)	10
B	"Grout-Well" (high solids bentonite)	~~10~~ 123
S	1/4" Bentonite Pellets	128
F	20-40 Silica Sand	144.5

* B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

WELL DEVELOPMENT

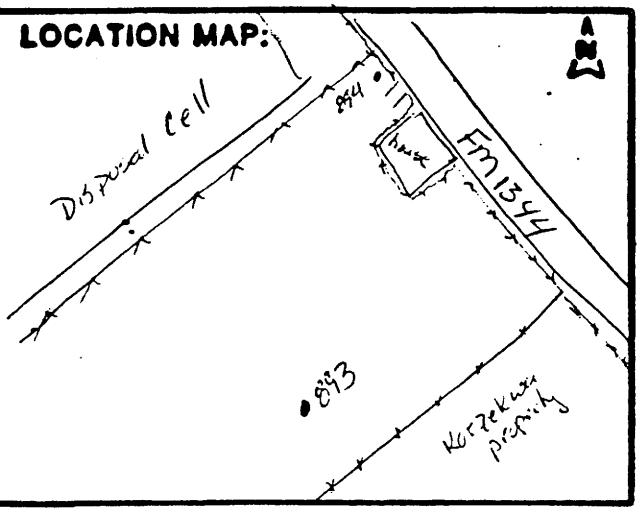
COMMENTS: Ran SP, 16"-64" resistivity, single pt resistivity, and natural gamma logs

JEG-AL-ENG-1 (6/87)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:



SITE ID: FCT03 LOCATION ID: 0893
SITE COORDINATES (ft.):
N 58,184.4632 E 66,001.3354
GROUND ELEVATION (ft. MSL): 415.90
DRILLING METHOD: NQ Wireline / mud return
DRILLING CONTR.: JEDI, Aaron Nesbit
DATE STARTED: 11/11/95
DATE COMPLETED: 11/16/95
FIELD REP.: Rick Dotson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
11/28/95	7:00	60.87 BTOC
12/3/95	15:05	61.59 b.g.s.

LOCATION DESCRIPTION Near former location of 833; Near ~~southeast~~ SE corner of former pile 4
SITE CONDITION Pasture

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY
0	SS	40								
	SS	100								
	SS	100								
	SS	50								
10	NQ	0								
	↓									
	NQ	20				THB	5°	Fld		
20										
	↓									
	NQ	~~45~~ 30					5°	Fld		
30										
	↓									
	NQ	30				THB	5°	Fld		
40										
	↓									
	NQ	95								
	↓									

ROCK TYPE & REMARKS

Deweesville formation
Interbedded sandstone, siltstone, and claystone; f grained, gypsum x/s filling fractures; thinly bedded; fractures moderately spaced (5 to 20 inches); some fractures w/ limonite staining; yellowish gray (5Y 8/1), light gray, pale brown (5YR 5/2)

Conquista Formation
claystone, v stiff, olive gray to lt gray (5Y 4/1), burrows, f fossils, silty, calcareous

COMMENTS: Ran SP, 16-64" resistivity, gamma natural gamma logs.

BORING OPERATION
H - 6 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
CB - CEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

Attachment 1

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WELL COMPLETION RECORD

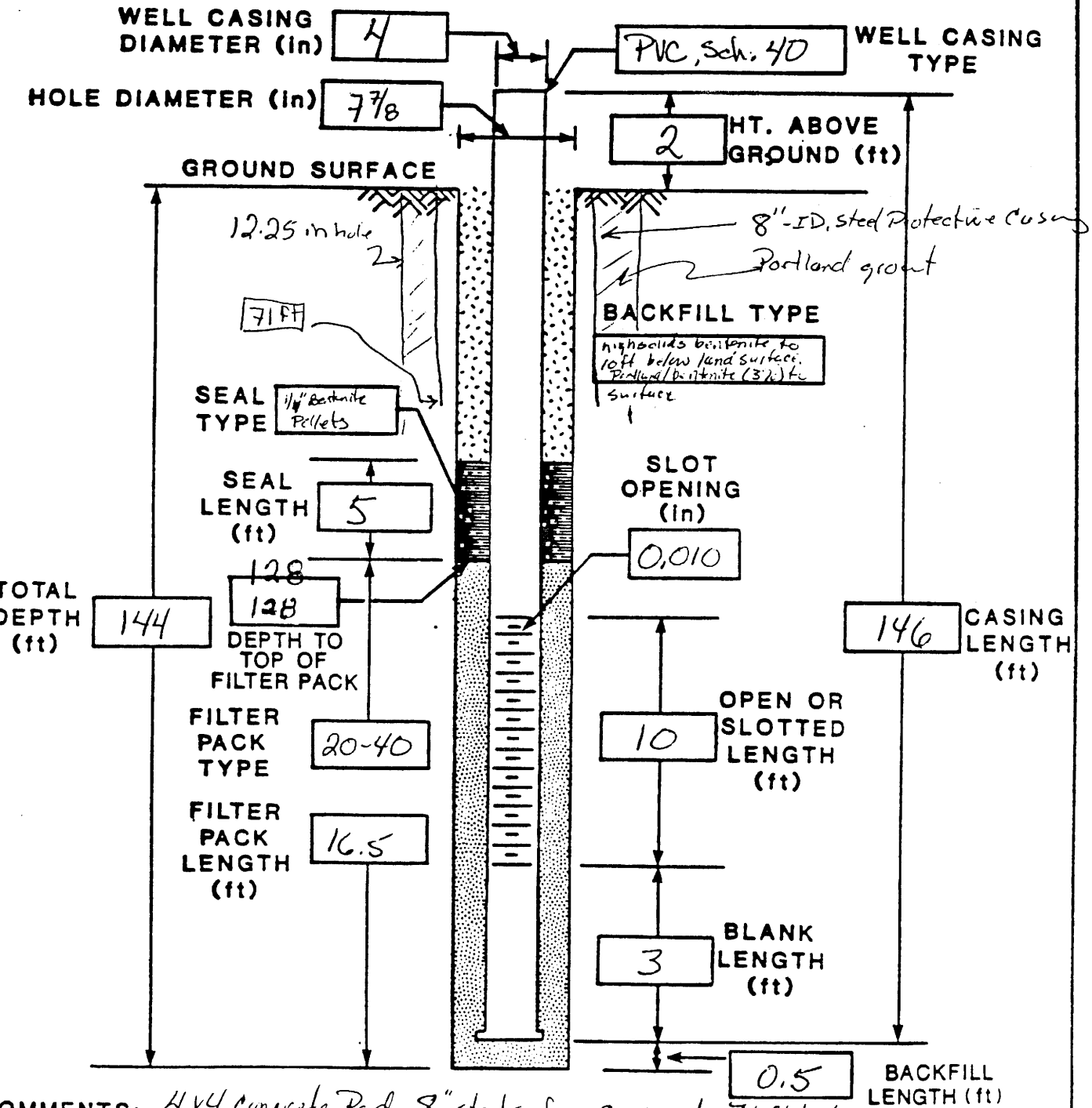
SITE ID: FCT03 LOCATION ID: 0893 DATE INSTALLED: 11/16/95

APPROX. SITE COORDINATES: (FT.) N 58,184.4632 E 66,001.3354

OPEN AREA PER LINEAL FT. ($IN^2/FT.$) _____

FORMATION OF COMPLETION: Dilworth

FIELD REP.: Rod Dotson DRILLER: Aaron Nesbit



COMMENTS: 4X4 Concrete Pad, 8" steel surface casing to 71 ft below land surface; 1 centralizer @ top of screen. State Plane Coord. N-1351188.0688

JEG-AL-ENG-3 (6/87)

F-27476090187

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:

See p. 1

SITE ID: FCT03 LOCATION ID: 0893
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
100											bioturbated in places; carbonaceous, dark greenish gray (5GY 4/1), olive gray (5Y 4/1), lt gray
	NQ	90				L					
110											
	NQ	65				L					
120											
	NQ	75									increasing sand content from 124' down
130											
	NQ	40								SS	Sandstone, fine grained, poorly consolidated, silty to clayey, dark greenish gray
140											sample collected from 135-136' for hydrologic testing.
											TD = 146'

COMMENTS: _____

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
CB - CEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:

see p. 1

SITE ID: FCT03 **LOCATION ID:** 0893
SITE COORDINATES (ft.):
N _____ **E** _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
50		c									
											Sandstone unit (?) fine grained, [illegible], [illegible], [illegible]
	NQ	65									
60											
	NQ	100									
70											
	NQ	85				L					
80											
	NQ	70				L					
90											Lignite layer 91'-94', asphaltic odor, trace pyrite
	NQ	25				L					Dilworth Formation
											Siltstone and silty sandstone, laminated, thin beds of silty claystone

COMMENTS: _____

BORING OPERATION
H - 6 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
GB - GEAR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

Attachment 1

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

WELL COMPLETION RECORD

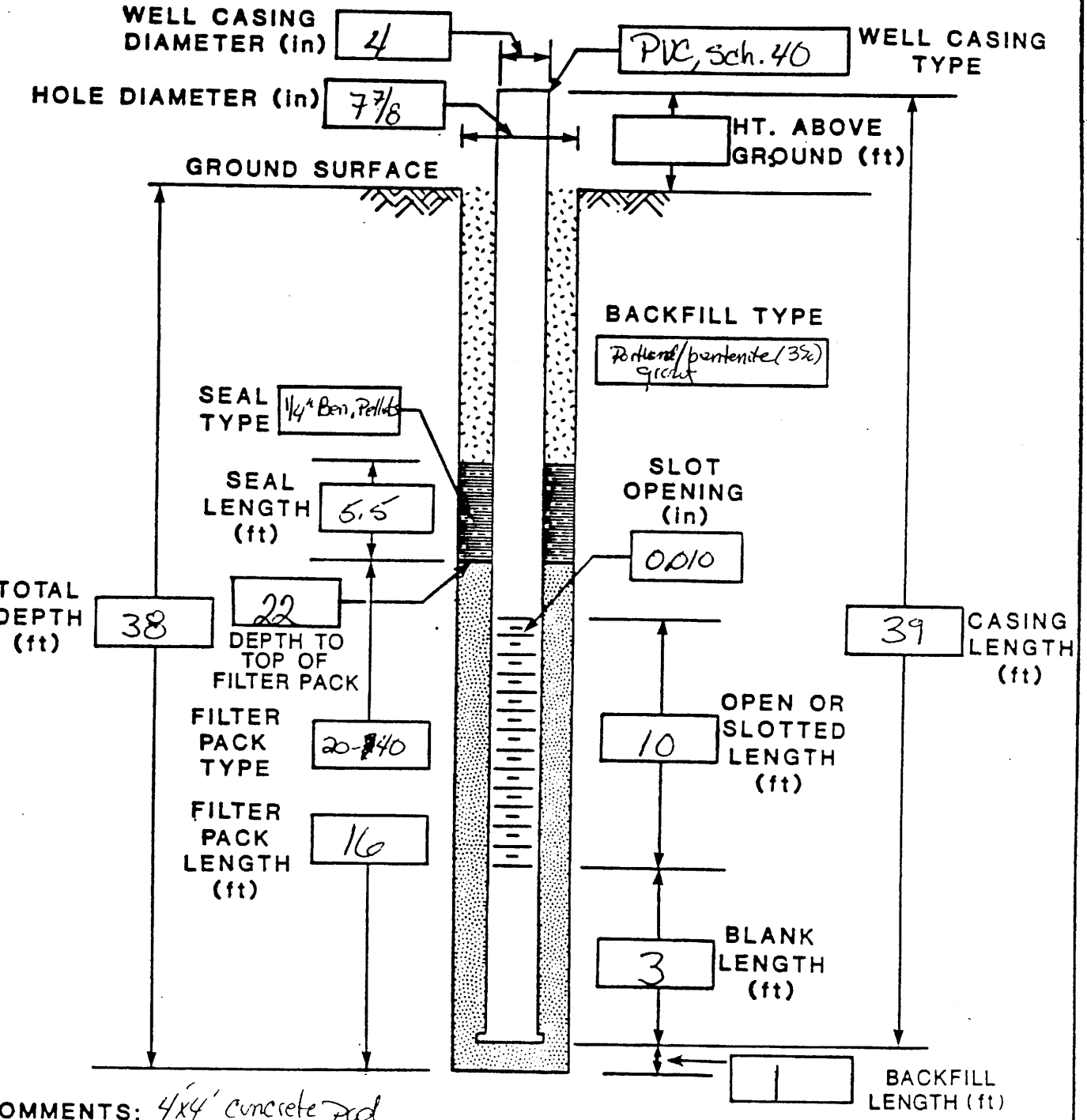
SITE ID: FCT03 LOCATION ID: 0894 DATE INSTALLED: 11/13/95

APPROX. SITE COORDINATES: (FT.) N 60,854.1172 E 66,620.0745

OPEN AREA PER LINEAL FT. ($IN^2/FT.$) _____

FORMATION OF COMPLETION: Dewceaville Sandstone

FIELD REP.: Rick Dotson DRILLER: Aaron Nesbit, JEDI



COMMENTS: 4'x4' concrete pad

[State Plane Coord. N-13513860.5716, E-2248214.3736]

JEG-AL-ENG-3 (6/87)

Attachment 2

JACOBS ENGINEERING GROUP INC.
ALBUQUERQUE OPERATIONS

BOREHOLE/WELL CONSTRUCTION LOG

SITE ID: FCT03 LOCATION ID: 0894 FIELD REP: Rick Dotson

APPROX. SITE COORDINATES (FT.): N 60,854.1172 E 66,620.0745

GROUND ELEVATION (FT. MSL): 443.68 COMPLETION DATE: 11/13/95

BOREHOLE SUMMARY

DRILLER: Aaron Nesbit, JEDI

RIG TYPE: Mobile Drill B-61, mud rotary

BIT TYPE	HOLE DIA. (in.)	END DEPTH ● (ft.)	FLUID TYPE
NQ wireline	3.5	34	water
tricone	7 7/8	38	water/mud

CASING SUMMARY

CASING TYPE*	DESCRIPTION	DIA. (in.)	END✚ DEPTH (ft.)
P	Steel	8	4
B	PVC, schedule 40	4	26
S	PVC, Sch. 40, 0.010 in.	4	36
Sump	PVC, Sch. 40	4	39

* P-Protective S-Screen B-Blank O-Open N-None

✚ Depth from Top of Casing

WELL CONSTRUCTION

TYPE CODE*	DESCRIPTION	END● DEPTH (ft.)
B	Portland/Bentonite (3%) grout	17.5
S	1/4" Bentonite pellets	22
F	20-40 Silica Sand	38

* B - Backfill S - Seal F - Filter Pack

● Depth from Ground Surface

CONSTRUCTION TIME LOG

ACTIVITY	START DATE	START TIME	END TIME
DRILLING	11/13/95	10:40	11:50
CASING	11/13/95	13:00	13:30
FILTER PACK	"	13:00	13:30
SEAL	"	13:30	14:30
BACKFILL	"	14:30	
DEVELOPMENT			
OTHER NQ coring	11/13/95	09:00	10:40

WELL DEVELOPMENT

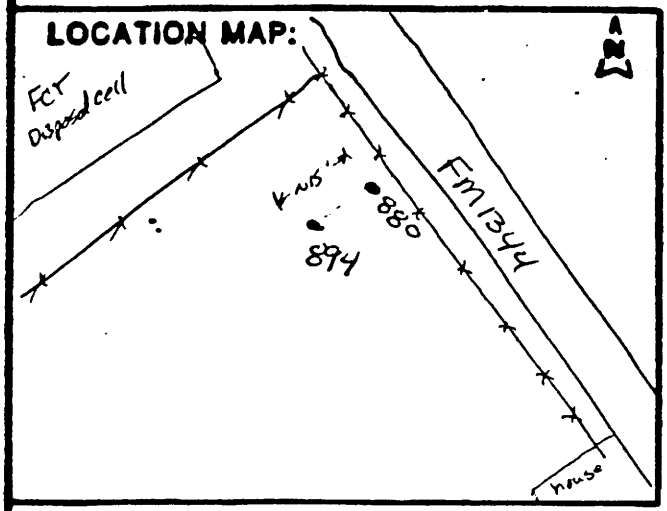
COMMENTS: 4" PVC well installed 15 ft NW of well 880. Intended for aquifer test.

JEG-AL-ENG-1 (6/87)

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP:



SITE ID: FCT03 LOCATION ID: 0894
SITE COORDINATES (ft.):
N 60,854.1172 E 66,620.0745
GROUND ELEVATION (ft. MSL): 443.68
DRILLING METHOD: NQ Core / mud rotary
DRILLING CONTR.: JEDI, Aaron Nesbit
DATE STARTED: 11/13/95
DATE COMPLETED: 11/13/95
FIELD REP.: Rick Dotson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
11/16/95	9:20	24.45 BTOC
11/27/95	8:00	24.34 BTOC

LOCATION DESCRIPTION FCTUMTRA site, State land, adjacent to well 880
SITE CONDITION grass pasture

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (RQD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
0	SS										Top Soil, black
	SS										clay, silty, very stiff, dry, light greenish gray (5GY 8/1), white, chalky layer from 3.5-4 ft, str reaction to acid (road material?)
5	SS										
	NQ	50									
10											Sandstone, fine-grained, rounded, mod-well to poorly consolidated, pale olive (10Y 6/2), slightly mottled lt orange & lt yellow
											Fossiliferous sandstone from 13'-14', well cemented, vuggy, sl. reaction to acid,
15	NQ	40									Deweesville Sandstone
20											
	NQ	40									

COMMENTS:

BORING OPERATION
H - 8 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
CB - CHAIR BIT
NX - NX ROCK CORING
NQ - NQ WIRELINE ROCK CORING

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

BOREHOLE LOG (ROCK)

LOCATION MAP: N

See P.1

SITE ID: FCT03 LOCATION ID: 0894
SITE COORDINATES (ft.):
N _____ E _____
GROUND ELEVATION (ft. MSL): _____
DRILLING METHOD: _____
DRILLING CONTR.: _____
DATE STARTED: _____
DATE COMPLETED: _____
FIELD REP.: _____

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION _____
SITE CONDITION _____

DEPTH (FT.)	BORING OPERATION	% CORE RECOVERY	% ROCK QUALITY DESIGNATION (ROD)	% DRILLING FLUID RECOVERY	PACKER TEST INTERVAL	SPACING	ORIENTATION	CONDITION	WEATHERING	LITHOLOGY	ROCK TYPE & REMARKS
25	NR										
	↓										
30											
											clay, silty, very stiff, olive gray (5Y 4/1)
35											
											TD = 38ft
40											

COMMENTS: _____

BORING OPERATION
H - 6 1/2 HOLLOW STEM AUGER
C - 4 1/2 CONTINUOUS FLIGHT AUGER
RB - REAR BIT
RE - RE ROCK CORING
RO - RO WIRELINE ROCK CORING

Falls City, Texas

LOG OF TEST BORING NO. 902

JOB NO. FCT03 DATE 12/20/85

SURFACE ELEVATION 407.15

TOP OF CASING ELEVATION 408.69

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sandstone

TOTAL DEPTH 152.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 57503.80 E 65983.90

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					**DEWEESVILLE SANDSTONE MEMBER**: Whitsett Formation, intercalated sand and silt.
20		Cement bentonite grout			**CONQUISTA CLAY MEMBER**: Whitsett Formation, claystone, locally tuffaceous, fossiliferous and carbonaceous, a few thin beds of fine grained sandstone locally.

GROUNDWATER

DEPTH	HOUR	DATE
54.0	N.K.	01/31/86

LOG OF TEST BORING NO. 902

JOB NO. FCT03 DATE 12/20/85

SURFACE ELEVATION 407.15

TOP OF CASING ELEVATION 408.69

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sandstone

TOTAL DEPTH 152.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 57503.80 E 65983.90

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous, fossiliferous and carbonaceous, a few thin beds of fine grained sandstone locally.
65					
70					
75		Cement bentonite grout			
80					
85					
90					DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
54.0	N.K.	01/31/86

PROJECT Falls City, Texas

LOG OF TEST BORING NO. 901

JOB NO. FCT03 DATE 1/16/86

SURFACE ELEVATION 427.60

TOP OF CASING ELEVATION 428.81

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista/Dilworth

TOTAL DEPTH 145.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 58597.70 E 68461.80

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DUBOSE MEMBER: Whitsett Formation, intercalated clay, poorly indurated sandstone and siltstones, and carbonaceous tuff.
5					
10					
15					
20					
25		Cement grout			
30					
35					
40					DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, sand and silt with some siltstone and some sandstone and clay.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
57.2	N.K.	01/31/86

LOG OF TEST BORING NO. 902

JOB NO. FCT03 DATE 12/20/85

SURFACE ELEVATION 407.15

TOP OF CASING ELEVATION 408.69

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sandstone

TOTAL DEPTH 152.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 57503.80 E 65983.90

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Cement bentonite grout			
110					DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
115		Bentonite pellet seal			
120		Silica sand filter pack			
125					
130		Screen slot size opening = 0.051 inches			
135					
140		Bentonite pellet seal			Note: lithologic log taken from geophysical log of # 903.
145		Sand backfill			
150					
155					Stopped drilling at 152 feet.

GROUNDWATER

DEPTH	HOUR	DATE
54.0	N.K.	01/31/86

SURFACE ELEVATION 407.23
TOP OF CASING ELEVATION 408.43
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Manning Clay Formation

TOTAL DEPTH 218.0 feet
RIG TYPE Mayhew 1500
BORING TYPE 8" tricone
LOCATION N 57493.30 E 65971.60
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CH	DEWEESVELLE SANDSTONE MEMBER: Whitsett Formation, sandy clay, high plastic, very fine to fine sand, organics, very dark greyish brown.
5					
					Sandy clay, medium plastic, very fine to fine sand, yellowish brown mottled with greyish brown and dark yellowish brown.
10					
					Clayey sand, very fine to fine sand, medium plastic, greyish brown mottled with yellowish brown, 3 inch lignite seam at 10 feet.
15					
					~~CONQUISTA CLAY MEMBER:~~ Whitsett Formation, Claystone, sandy clay, high plastic, very fine to fine sand, yellowish to greyish brown mottled with dark yellowish brown and dark brown, 4 inch lignite seam at 18.5 feet.
20					
25		Cement grout			Clay, some very fine sand to 21 feet, laminated, very dark greyish brown.
30					Clay, laminated, very dark greyish brown.
35					
40					
45					
50					Clay, trace very fine sand,

GROUNDWATER

DEPTH	HOUR	DATE
64.1	N.K.	01/31/86

LOG OF TEST BORING NO. 901

JOB NO. FCT03 DATE 1/16/86

SURFACE ELEVATION 427.60

TOP OF CASING ELEVATION 428.81

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista/Dilworth

TOTAL DEPTH 145.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 58597.70 E 68461.80

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone locally tuffaceous and fossiliferous, carbonaceous, few thin beds of fine grained sandstone.
65					
70					
75		Formation cave-in material			
80					
85					
90					
95					
100					

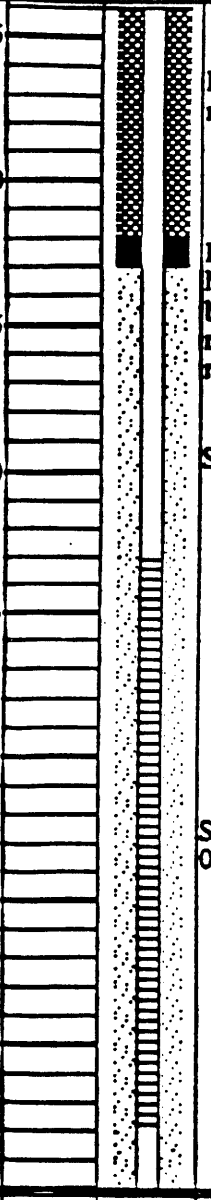
GROUNDWATER

DEPTH	HOUR	DATE
57.2	N.K.	01/31/86

JOB NO. FCT03 DATE 1/16/86 — TEST BORING NO. 901

SURFACE ELEVATION 427.60
TOP OF CASING ELEVATION 428.81
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Conquista/Dilworth

TOTAL DEPTH 145.0 feet
RIG TYPE Mayhew 1500
BORING TYPE 8" tricone
LOCATION N 58597.70 E 68461.80
DATUM MSL



Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
		Formation cave-in material			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous and fossiliferous, carbonaceous, few thin beds of fine grained sandstone.
		Bentonite pellet seal - Note: two 5 gallon buckets placed; no measurable thickness recorded			
		Silica sand filter pack			
					DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
		Screen slot opening = 0.051 inches			
					Stopped drilling at 145 feet.

GROUNDWATER

DEPTH	HOUR	DATE
57.2	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 903

JOB NO. FCT03 DATE 12/5/85

SURFACE ELEVATION 407.23

TOP OF CASING ELEVATION 408.43

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Manning Clay Formation

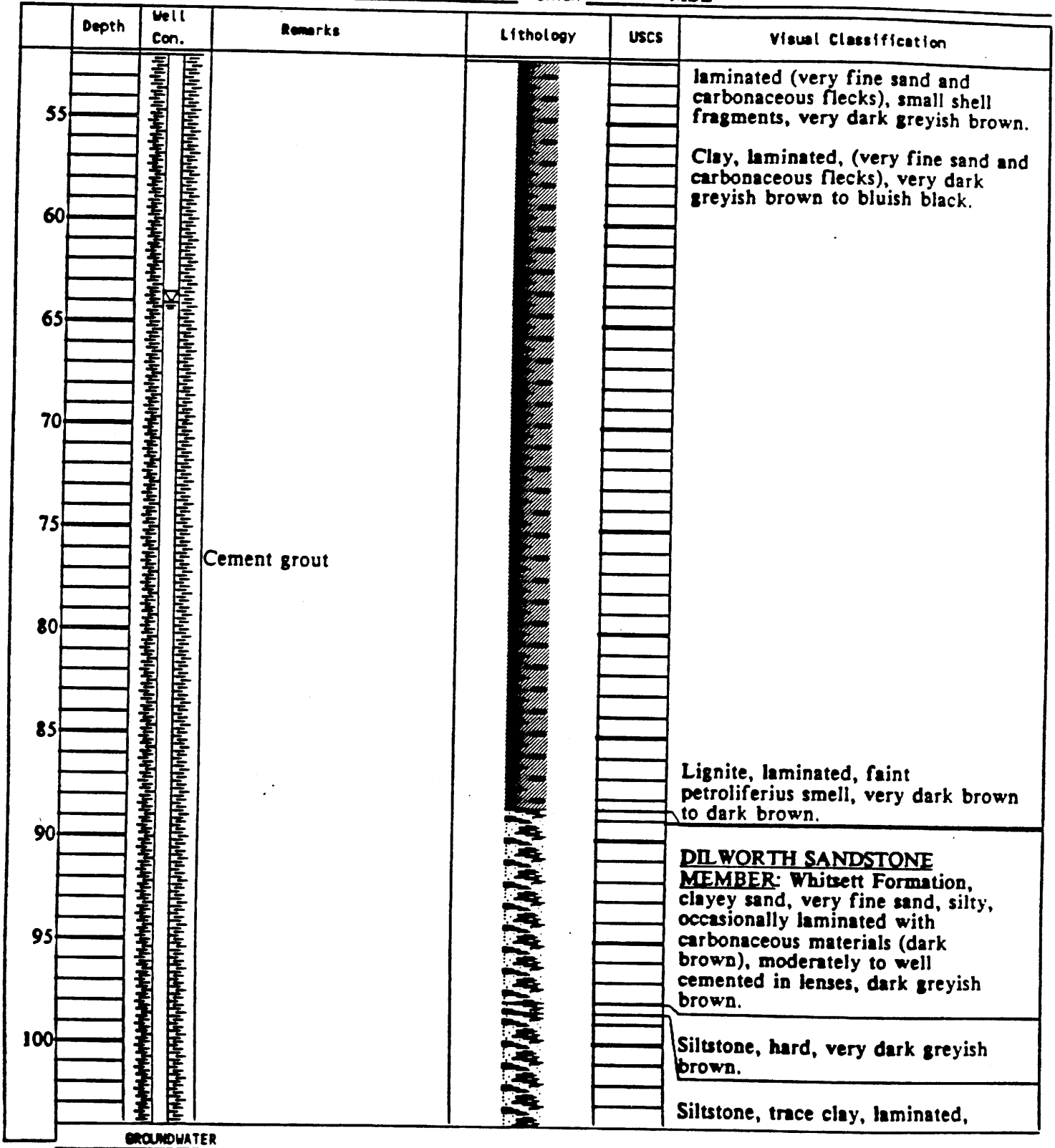
TOTAL DEPTH 218.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 57493.30 E 65971.60

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
64.1	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 903

JOB NO. FCT03 DATE 12/5/85

SURFACE ELEVATION 407.23

TOP OF CASING ELEVATION 408.43

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Manning Clay Formation

TOTAL DEPTH 218.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 57493.30 E 65971.60

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					carbonaceous flecks, moderatley hard, very dark greyish brown.
					Clay, silty, laminated (very fine sand), flecks of carbonaceous materials in upper part, moderately hard with soft to well indurated siltstone beds, dark greyish brown to dark olive brown.
110					
					Note: occasional 1 to 4 inch thick siltstone lense.
115					
					Sand, very fine sand, laminated, soft, some shell fragments, dark greyish brown.
120					
					Clay, silty, laminated, sparsely fossiliferous, soft to well indurated between 117.5 to 118 feet, dark greyish brown.
125					
					DILWORTH SANDSTONE MEMBER Sand, very fine sand, clayey to silty, occasional lamination and fleck of carbonaceous material, soft to well indurated below 125 feet, dark greyish brown.
130		Cement grout			
					Sandstone, well indurated 130 to 133.5 feet, petroliferous smell on dark brown laminations.
135					
					Clay, silty, laminated, soft, dark olive brown lower part.
140					
					Sand, clayey and silty, laminated carbonaceous laminations and flecks, petroliferius smell, sparsely fossiliferous, soft, dark olive brown to dark greyish brown.
145					
					Sand, laminations and flecks of carbonaceous material, petroliferous smell, soft, dark greyish brown.
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
64.1	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 903

JOB NO. FCT03 DATE 12/5/85

SURFACE ELEVATION 407.23

TOP OF CASING ELEVATION 408.43

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Manning Clay Formation

TOTAL DEPTH 218.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 57493.30 E 65971.60

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165		Cement grout			
170					
175					MANNING CLAY MEMBER: Whitsett Formation, claystone, laminated with very fine sand, dark olive brown.
180		Bentonite pellet seal			Clay, laminated (with very fine sand), petroliferous smelling, soft to well indurated at 187 to 187.5 feet, very dark brown.
185		Silica sand filter pack			
190					Lignite, laminated, very dark brown, hard.
					Clay, laminated (with very fine sand), moderately indurated, dark greyish brown.
195		Screen slot size opening = 0.051 inches			Lignite, laminated, moderately to well indurated, very dark brown.
200					Clay, laminated (with very fine sand), moderately indurated, dark greyish brown.
205					

GROUNDWATER

DEPTH	HOUR	DATE
64.1	N.R.	01/31/86

JOB NO. FCT03 DATE 12/5/85

SURFACE ELEVATION 407.23

TOP OF CASING ELEVATION 408.43

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Manning Clay Formation

TOTAL DEPTH 218.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 57493.30 E 65971.60

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210		Bentonite pellet seal			Lignite, laminated, moderately to well indurated, very dark brown.
		Cement backfill grout			Clay, laminated, dark greyish brown.
215					
220					Stopped jamming at 218 feet.
225					
230					
235					
240					
245					
250					
255					
260					

GROUNDWATER

DEPTH	HOUR	DATE
64.1	N.K.	01/31/86

JOB NO. FCT03 DATE 12/19/85

SURFACE ELEVATION 398.76

TOP OF CASING ELEVATION 400.03

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Clay Member

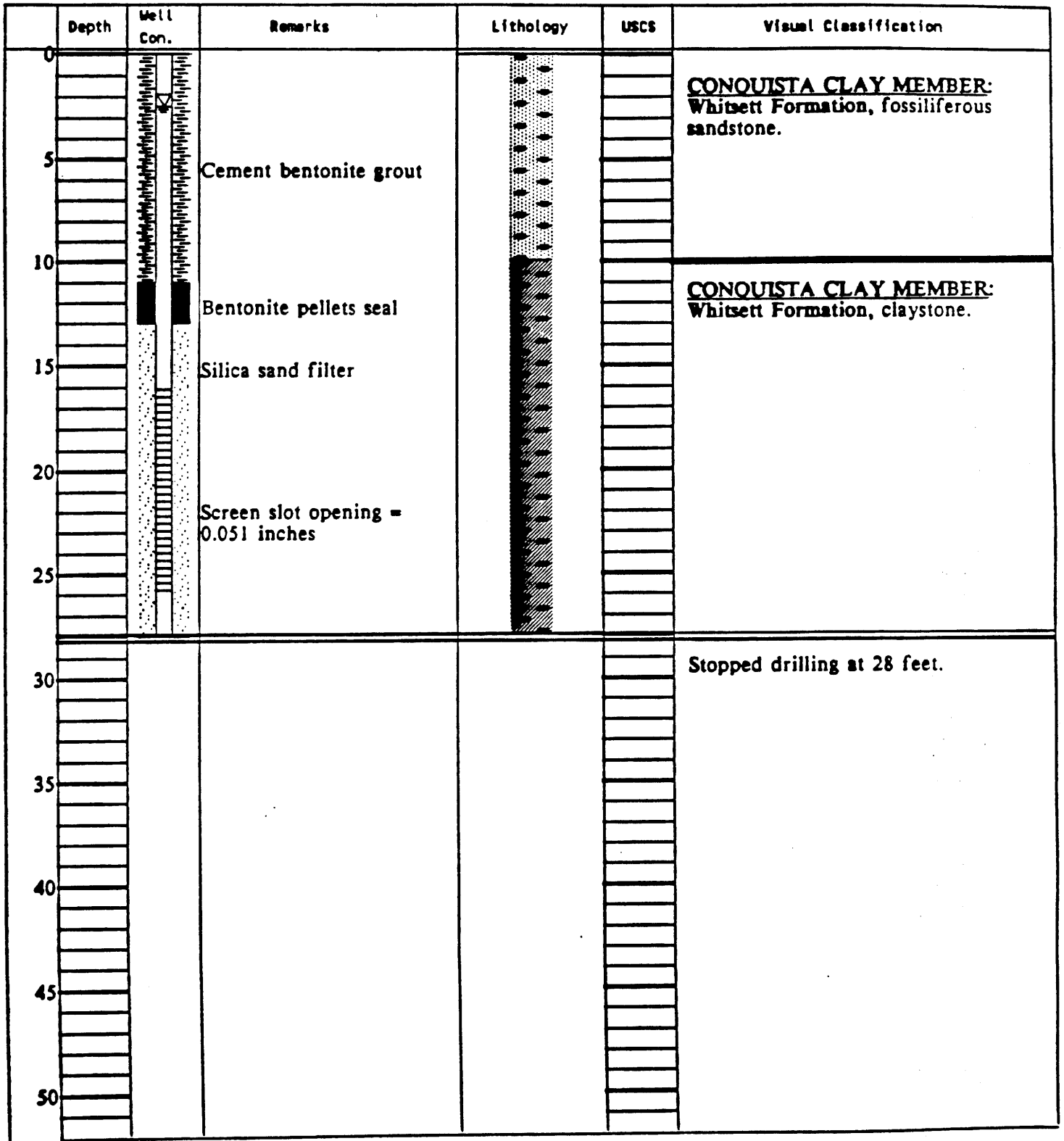
TOTAL DEPTH 28.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 57170.90 E 64874.50

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
2.5	N.K.	01/31/86

LOG OF TEST BORING NO. 905

JOB NO. FCT03 DATE 12/19/85

SURFACE ELEVATION 398.82

TOP OF CASING ELEVATION 399.63

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Clay Member/Dilworth

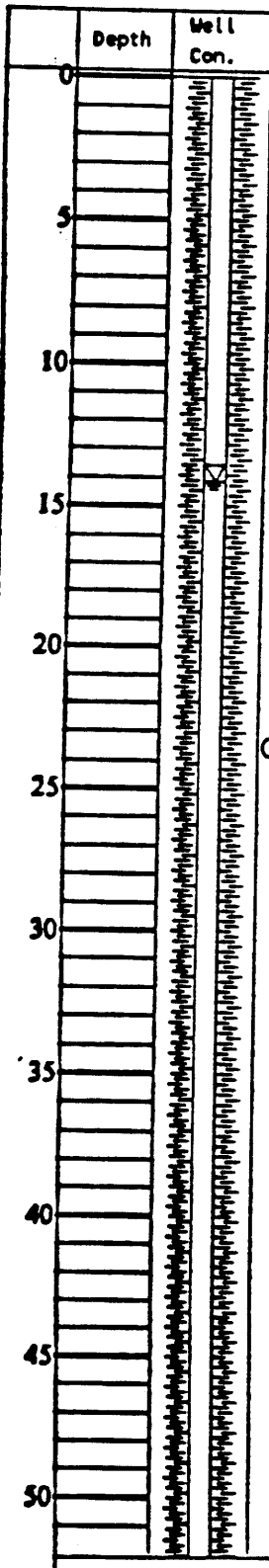
TOTAL DEPTH 90.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 57169.70 E 64865.30

DATUM MSL



Visual Classification
CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.

GROUNDWATER

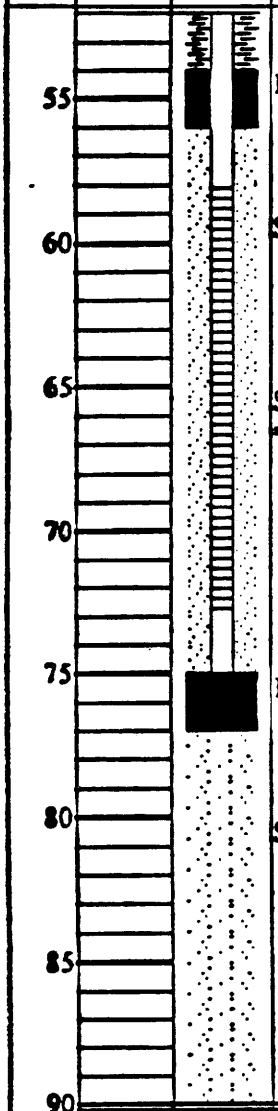
DEPTH	HOUR	DATE
14.1	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 905

JOB NO. FCT03 DATE 12/19/85
SURFACE ELEVATION 398.82
TOP OF CASING ELEVATION 399.63
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Conquista Clay Member/Dilworth

TOTAL DEPTH 90.0 feet
RIG TYPE Mayhew 1500
BORING TYPE 8" tricone
LOCATION N 57169.70 E 64865.30
DATUM MSL



Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Bentonite pellets seal			
60		Silica sand filter pack			
65		Screen slot size opening = 0.051 inches			DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
70					
75		Bentonite seal			
80		Sand backfill			
85					
90					Stopped drilling at 90 feet.
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
14.1	N.K.	01/31/86

JOB NO. FCT03 DATE 12/18/85

SURFACE ELEVATION 418.66

TOP OF CASING ELEVATION 420.17

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Sandstone/Claystone

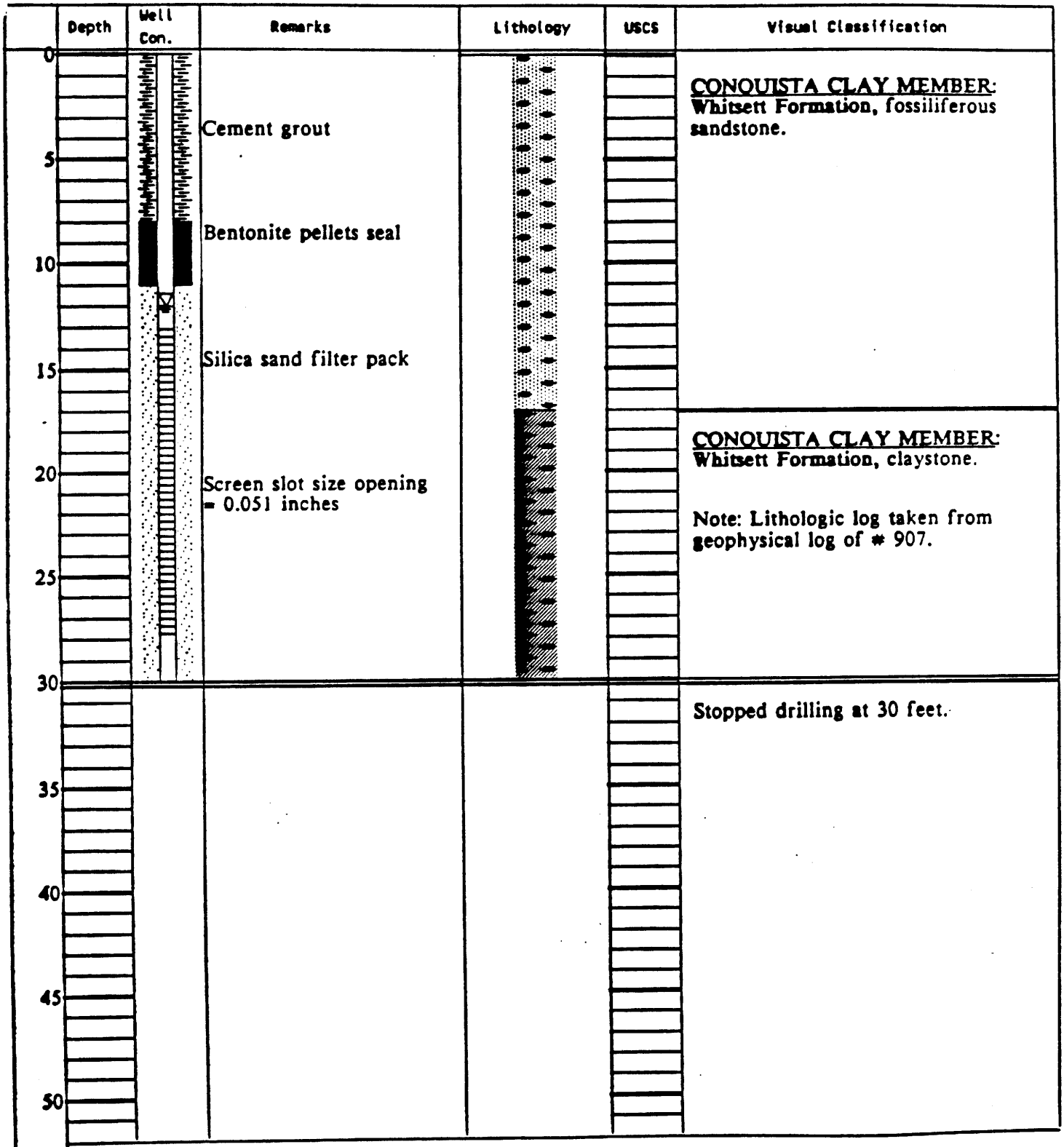
TOTAL DEPTH 30.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 58670.90 E 63758.40

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
12.0	N.K.	1/31/87

PROJECT UMIKA
Falls City, Texas

LOG OF TEST BORING NO. 907

JOB NO. FCT03 DATE 12/17/85
SURFACE ELEVATION 418.24
TOP OF CASING ELEVATION 419.77
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Dilworth Sandstone

TOTAL DEPTH 150.0 feet
RIG TYPE Mayhew 1500
BORING TYPE 8" tricone
LOCATION N 58658.60 E 63744.50
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
5					
10					
15					
20		Cement grout			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
25					
30					
35					
40					
45		Bentonite pellets seal			
50					

GROUNDWATER

DEPTH	HOUR	DATE
42.1	N.K.	01/31/86

PROJECT Falls City, Texas

JOB NO. FCT03 DATE 12/17/85

SURFACE ELEVATION 418.24

TOP OF CASING ELEVATION 419.77

W ASING TYPE 4" schedule 40 PVC

FI ON of COMPLETION Dilworth Sandstone

TOTAL DEPTH 150.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 58658.60 E 63744.50

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Silica sand filter pack			DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
60					
65		Screen slot size opening = 0.051 inches			
70					
75					
80		Benonite seal			
85					
90		Sand backfill			
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
42.1	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 907

JOB NO. FCT03 DATE 12/17/85
SURFACE ELEVATION 418.24
TOP OF CASING ELEVATION 419.77
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Dilworth Sandstone

TOTAL DEPTH 150.0 feet
RIG TYPE Mayhew 1500
BORING TYPE 8" tricone
LOCATION N 58658.60 E 63744.50
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					**DILWORTH SANDSTONE MEMBER**: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous,
110					
115					
120					
125		Sand backfill			
130					
135					
140					**MANNING CLAY MEMBER**: Whitsett Formation, claystone.
145					
150					Stopped drilling at 150 feet.
155					

GROUNDWATER

DEPTH	HOUR	DATE
42.1	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 908

JOB NO. FCT03 DATE 12/18/85

SURFACE ELEVATION 494.34

TOP OF CASING ELEVATION 495.67

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Sandstone/Claystone

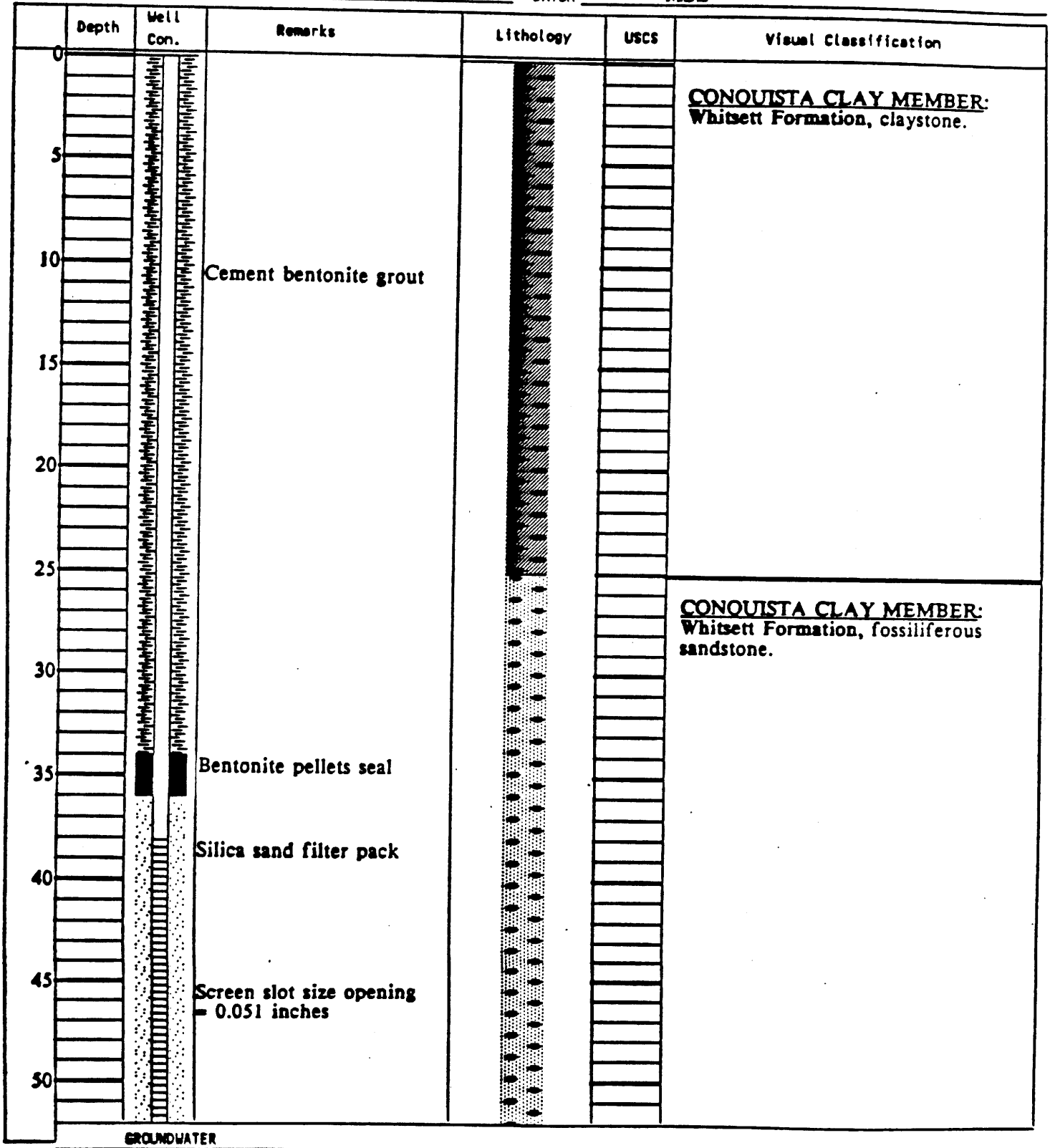
TOTAL DEPTH 75.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 61478.20 E 61847.50

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
▽ -57.5	N.R.	01/31/86
▽		

PROJECT [illegible]
Falls City, Texas

LOG OF TEST BORING NO. 908

JOB NO. FCT03 DATE 12/18/85

SURFACE ELEVATION 494.34

TOP OF CASING ELEVATION 495.67

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Sandstone/Claystone

TOTAL DEPTH 75.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 61478.20 E 61847.50

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
60		Benonite seal			
65		Sand backfill			
70					
75					Stopped drilling at 75 feet.
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
57.5	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 909

JOB NO. FCT03 DATE 1/4/86

SURFACE ELEVATION 494.11

TOP OF CASING ELEVATION 495.45

WELL CASING TYPE 4" schedule 40 PCV

FORMATION of COMPLETION Dilworth Upper Sand

TOTAL DEPTH 120.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 61497.20 E 61852.30

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
5					
10					
15					
20					
25		Cement grout			CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
105.1	N.R.	01/31/86

PROJECT Falls City, Texas

LOG OF TEST BORING NO. 909

JOB NO. FCT03 DATE 1/4/86

SURFACE ELEVATION 494.11

TOP OF CASING ELEVATION 495.45

WELL CASING TYPE 4" schedule 40 PCV

FORMATION of COMPLETION Dilworth Upper Sand

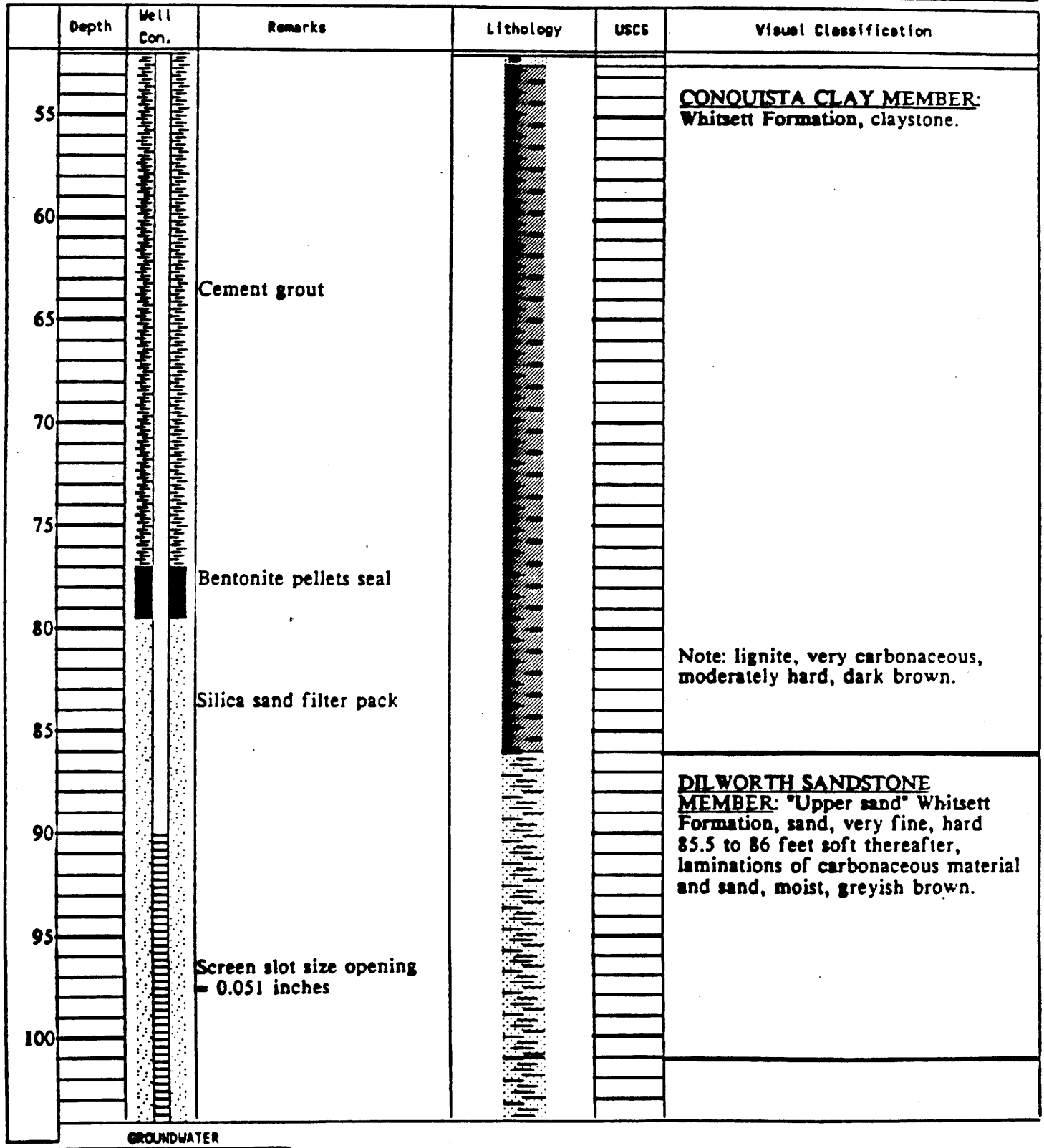
TOTAL DEPTH 120.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 61497.20 E 61852.30

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
105.1	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 909

JOB NO. FCT03 DATE 1/4/86

SURFACE ELEVATION 494.11

TOP OF CASING ELEVATION 495.45

WELL CASING TYPE 4" schedule 40 PCV

FORMATION of COMPLETION Dilworth Upper Sand

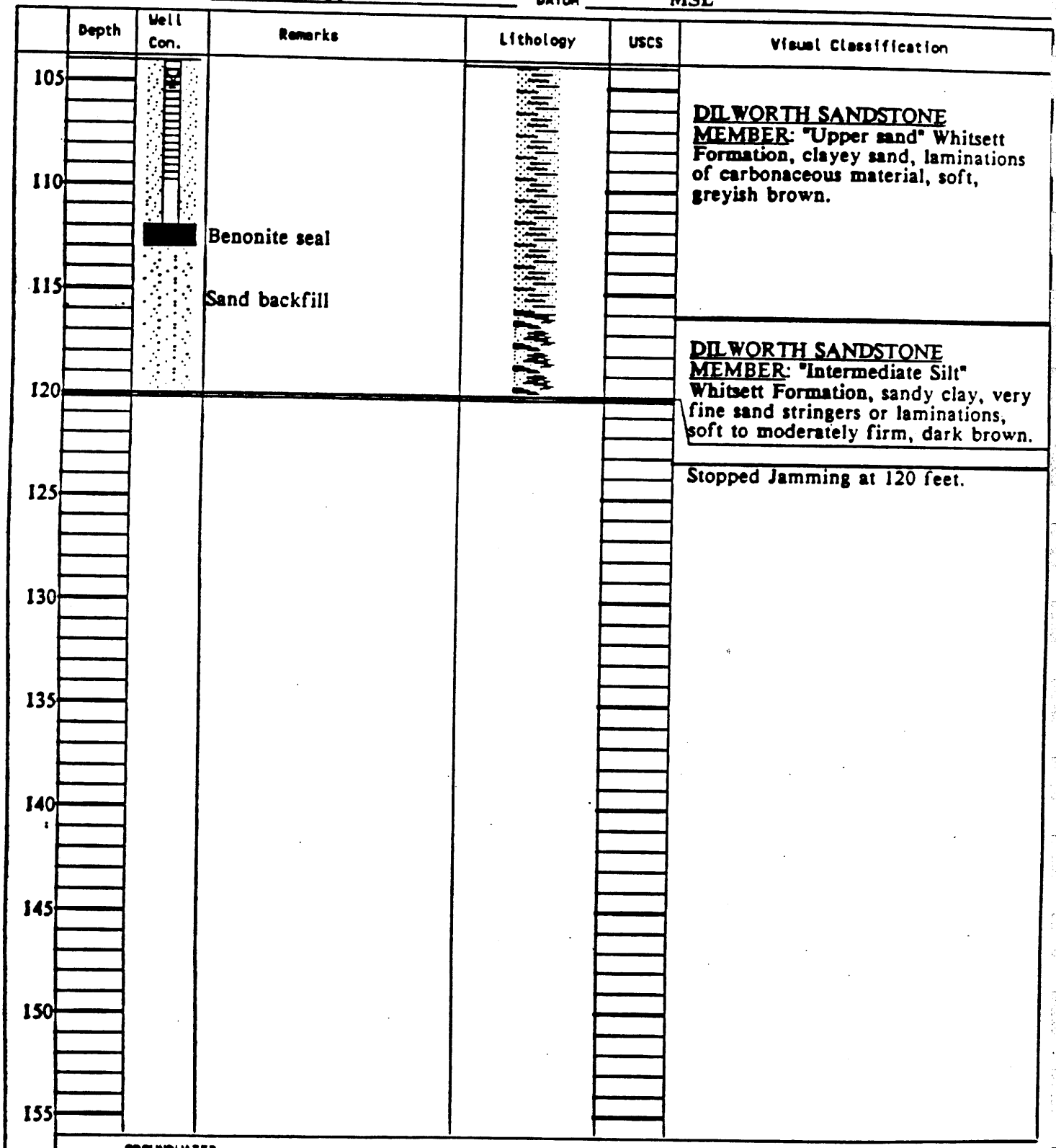
TOTAL DEPTH 120.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 61497.20 E 61852.30

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
105.1	N.K.	01/31/86

JOB NO. FCT03 DATE 12/16/85

SURFACE ELEVATION 494.37

TOP OF CASING ELEVATION 494.88

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Lower Dilworth/Manning Clay

TOTAL DEPTH 197.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 61483.70 E 61836.10

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, clayey silt, considerable fine sand.
5					
10					
15					
20					
25		Cement grout			CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone, sand, occasional silt and clay lense.
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
141.5	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 910

JOB NO. FCT03 DATE 12/16/85

SURFACE ELEVATION 494.37

TOP OF CASING ELEVATION 494.88

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Lower Dilworth/Manning Clay

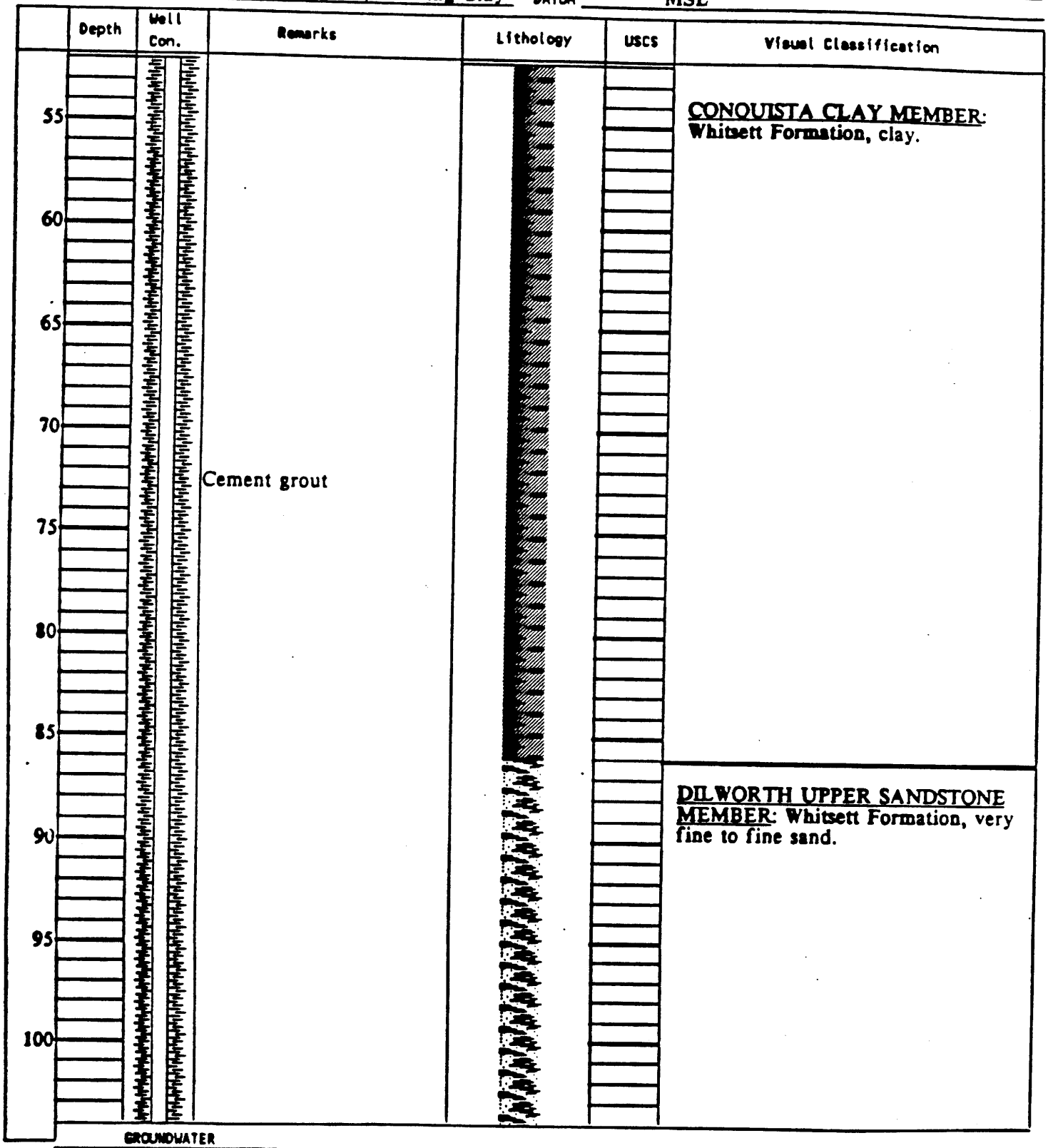
TOTAL DEPTH 197.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 61483.70 E 61836.10

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
141.5	N.K.	01/31/86

PROJECT Falls City, Texas

LOG OF TEST BORING NO. 910

JOB NO. FCT03 DATE 12/16/85

SURFACE ELEVATION 494.37

TOP OF CASING ELEVATION 494.88

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Lower Dilworth/Manning Clay

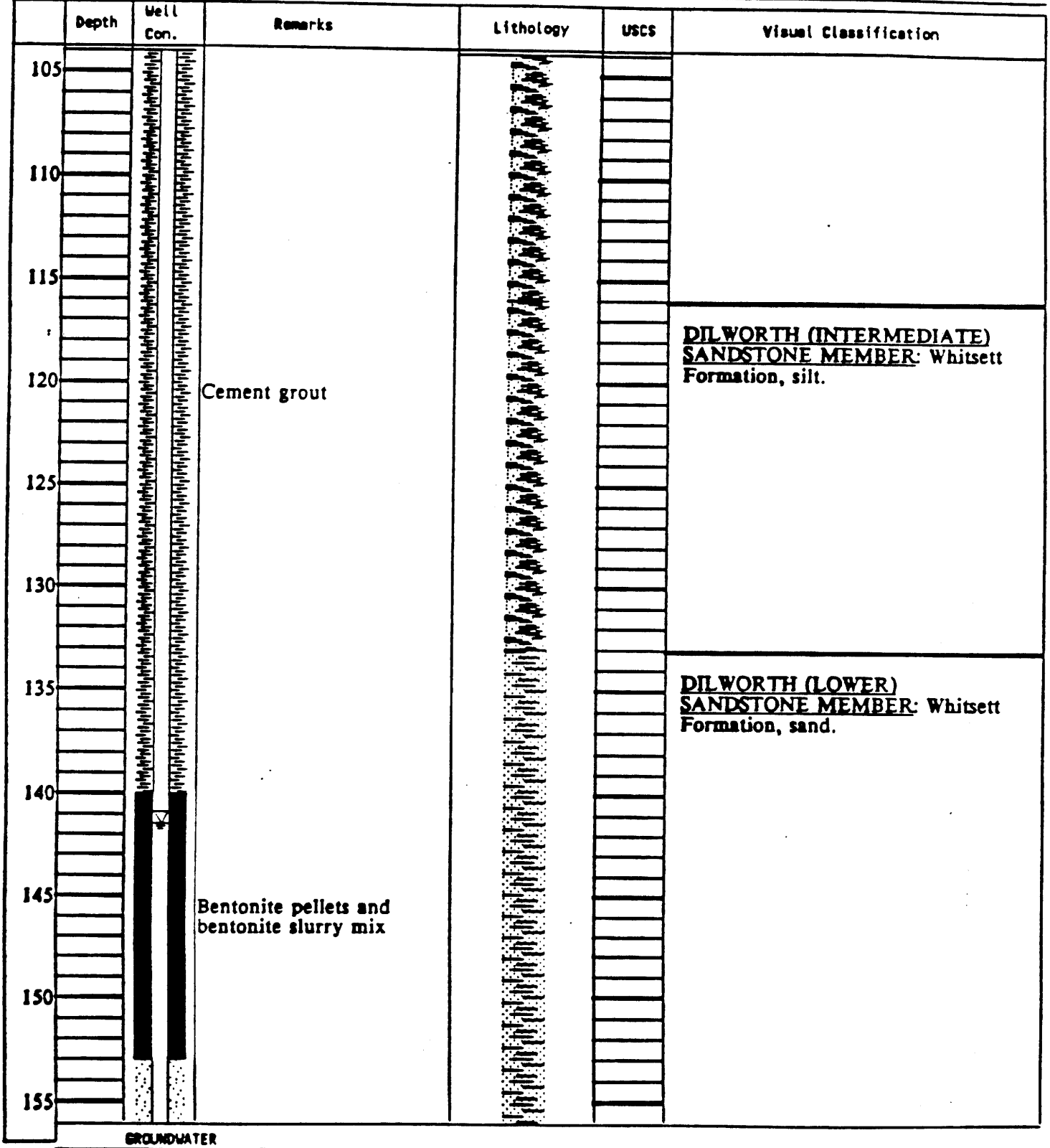
TOTAL DEPTH 197.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 61483.70 E 61836.10

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
141.5	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 910

JOB NO. FCT03 DATE 12/16/85

SURFACE ELEVATION 494.37

TOP OF CASING ELEVATION 494.88

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Lower Dilworth/Manning Clay

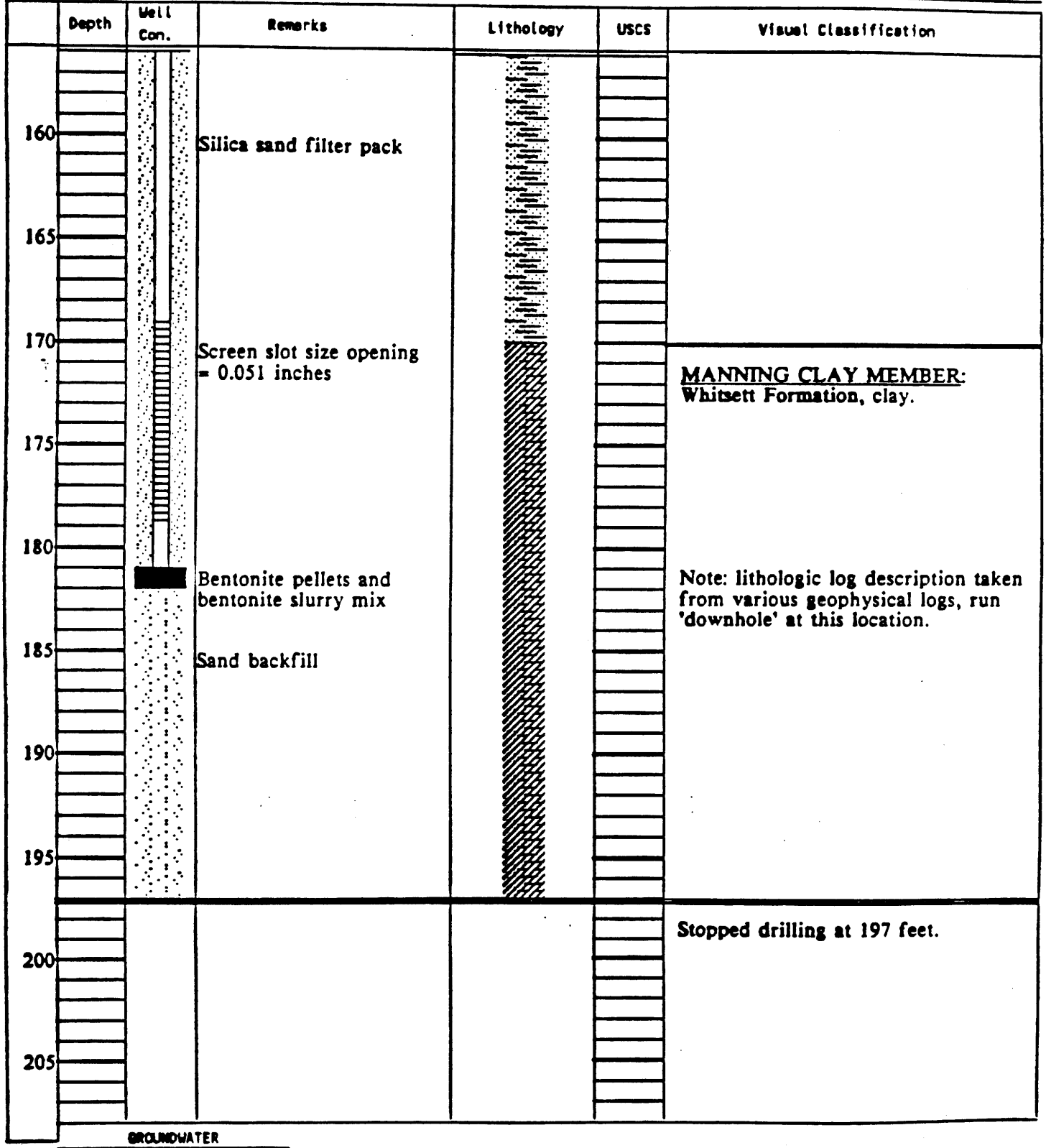
TOTAL DEPTH 197.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 61483.70 E 61836.10

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
141.5	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 911

JOB NO. FCT03 DATE 1/13/86
SURFACE ELEVATION 417.94
TOP OF CASING ELEVATION 419.46
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Upper Dilworth

TOTAL DEPTH 20.0 feet
RIG TYPE Badger 1400
BORING TYPE 8" tricone
LOCATION N 64517.70 E 64050.10
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Cement grout			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
5		Bentonite pellet seal			
10		Silica sand filter pack			DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine sand.
15		Screen slot size opening = 0.051 inches			Note: lithologic log taken from geophysical log of # 912.
20					Stopped drilling at 20 feet.
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	N.K.

JOB NO. FCT03 DATE 1/7/86

SURFACE ELEVATION 417.86

TOP OF CASING ELEVATION 418.81

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Upper Sand

TOTAL DEPTH 125.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 64508.10 E 64035.90

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
5					
10					DILLWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine sand.
15		Cement grout			
20					
25					
30		Bentonite pellet seal			
35		Silica sand filter pack			
40					
45		Screen slot size opening = 0.051 inches			
50					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	N.K.

Falls City, Texas

LOG OF TEST BORING NO. 912

JOB NO. FCT03 DATE 1/7/86

SURFACE ELEVATION 417.86

TOP OF CASING ELEVATION 418.81

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Upper Sand

TOTAL DEPTH 125.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 64508.10 E 64035.90

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Benonite pellet seal			
		Sand backfill			
60					
65					
70					
75					
80		Cave-in material			
85					MANNING CLAY MEMBER: Whitsett Formation, claystone.
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	N.K.

JOB NO. FCT03 DATE 1/7/86

SURFACE ELEVATION 417.86

TOP OF CASING ELEVATION 418.81

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Upper Sand

TOTAL DEPTH 125.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 64508.10 E 64035.90

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110		Cave-in material			
115					Note: lithologic log obtained from geophysical investigation at this location.
120					
125					Stopped drilling at 125 feet.
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	N.K.

JOB NO. FCT03 DATE 12/21/85

SURFACE ELEVATION 422.62

TOP OF CASING ELEVATION 424.11

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Clay Member - Claystone

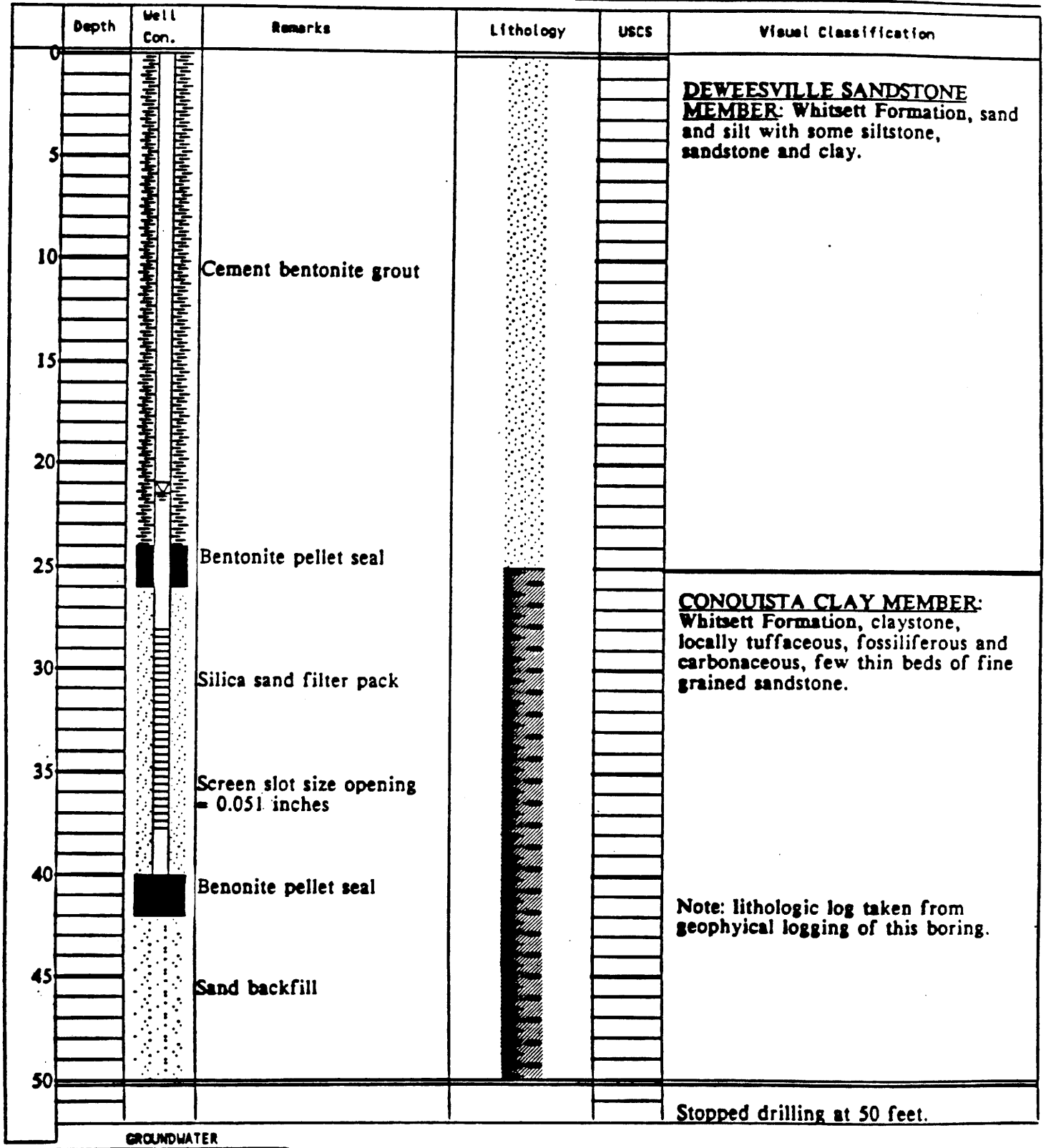
TOTAL DEPTH 50.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 59086.40 E 67228.00

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
21.5	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 914

JOB NO. FCT03 DATE 1/14/86

SURFACE ELEVATION 433.94

TOP OF CASING ELEVATION 435.79

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Deweesville/Conquista Member

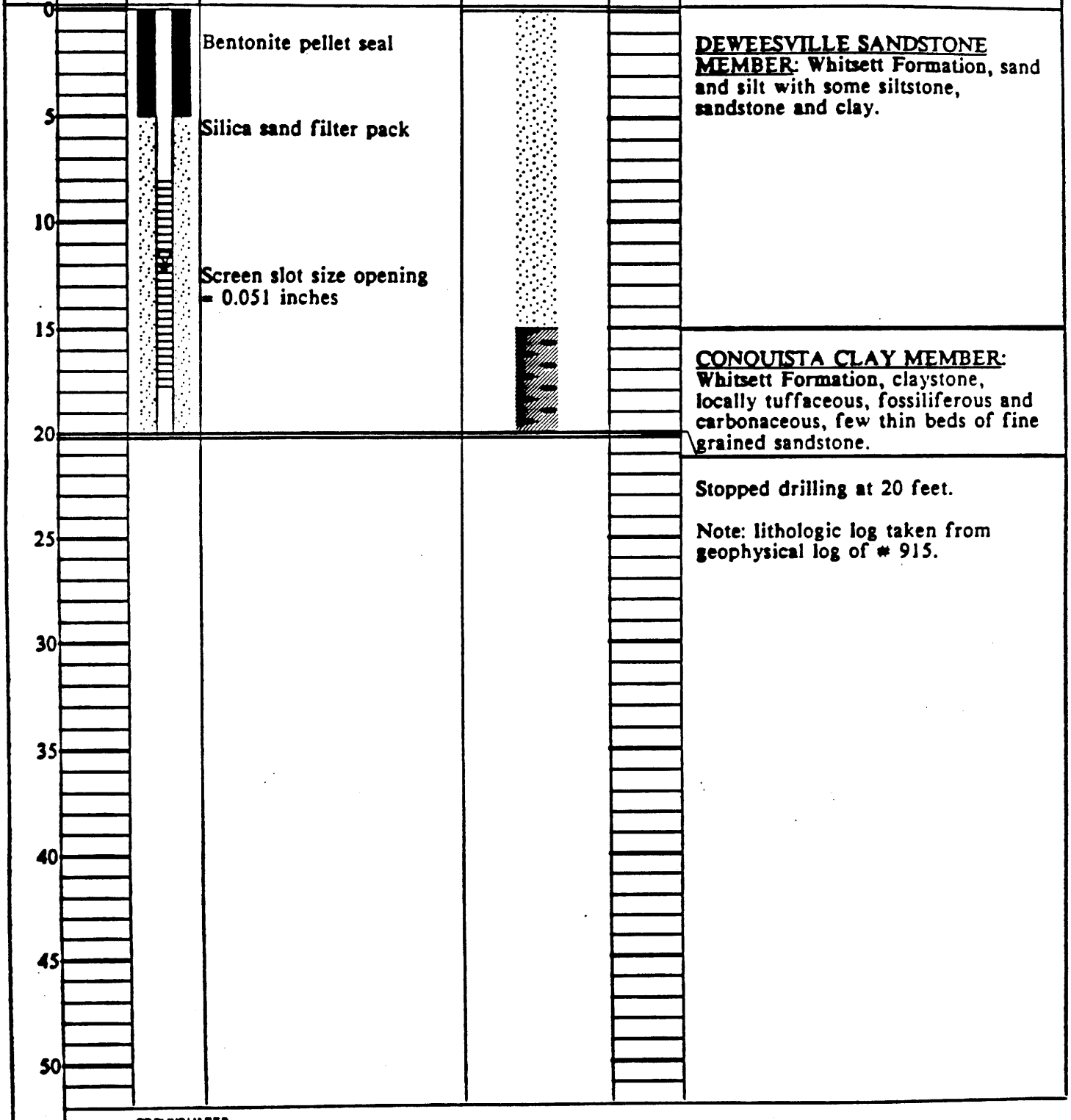
TOTAL DEPTH 20.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 64381.50 E 66677.10

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
12.0	N.K.	01/31/86

JOB NO. [illegible] DATE 1/14/86

SURFACE ELEVATION 434.20
TOP OF CASING ELEVATION 435.55
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Upper Dilworth Sand

TOTAL DEPTH 110.0 feet
RIG TYPE Badger 1400
BORING TYPE 8" tricone
LOCATION N 61371.90 E 66687.60
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, sand and silt with some siltstone, sandstone and clay.
5					
10					
15					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
20					
25		Cement grout			
30					
35					
40					CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
45					
50					

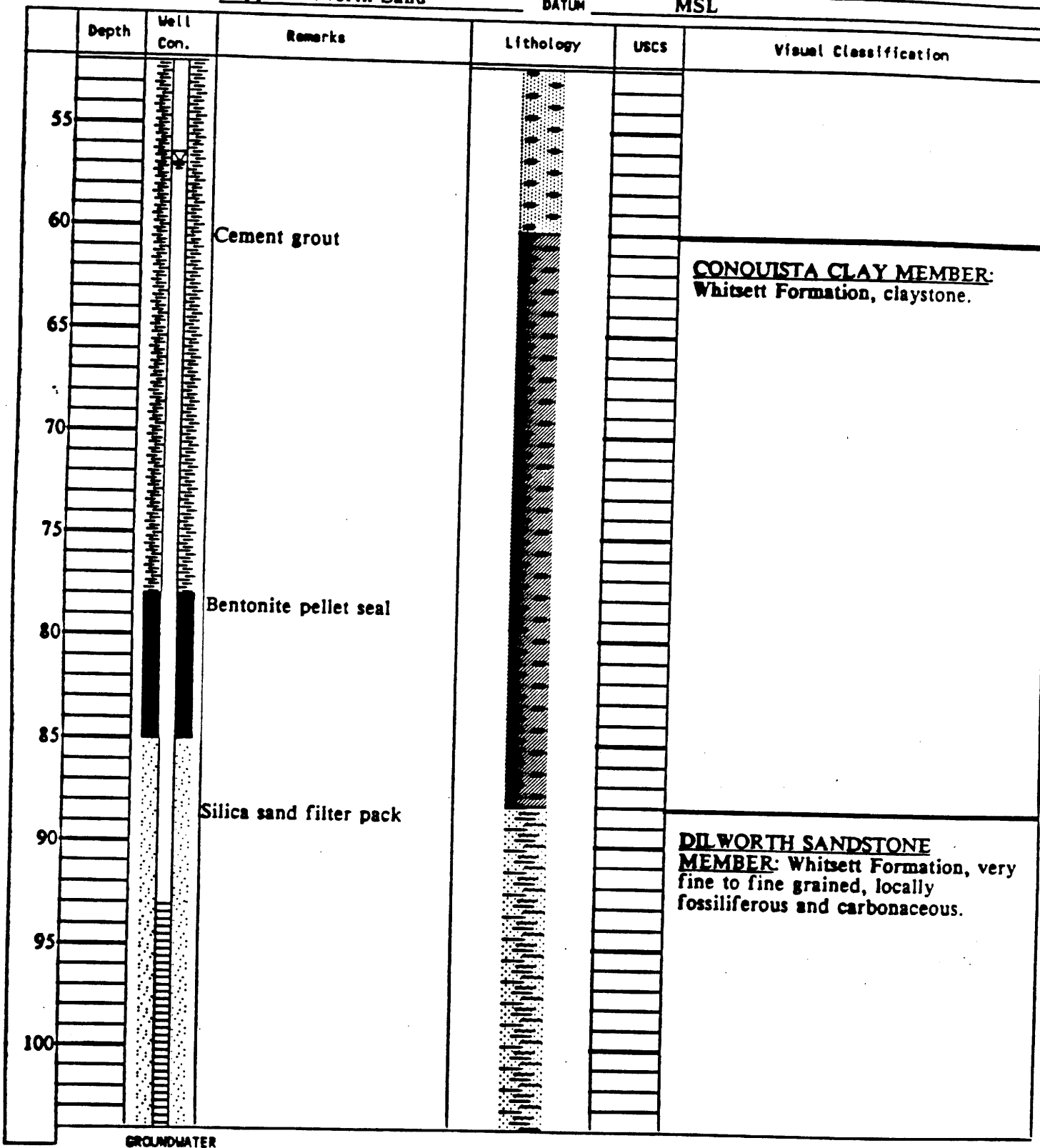
GROUNDWATER

DEPTH	HOUR	DATE
57.0	N.K.	01/31/86

JOB NO. FCT03 DATE 1/14/86 LOG OF TEST BORING NO. 915

SURFACE ELEVATION 434.20
TOP OF CASING ELEVATION 435.55
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Upper Dilworth Sand

TOTAL DEPTH 110.0 feet
RIG TYPE Badger 1400
BORING TYPE 8" tricone
LOCATION N 61371.90 E 66687.60
DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
57.0	N.K.	01/31/86

PROJECT Falls City, Texas

LOG OF TEST BORING NO. 915

JOB NO. FCT03 DATE 1/14/86

SURFACE ELEVATION 434.20

TOP OF CASING ELEVATION 435.55

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Upper Dilworth Sand

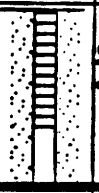
TOTAL DEPTH 110.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 61371.90 E 66687.60

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Screen slot size opening = 0.051 inches			Note: lithologic log taken from geophysical logging of this boring.
110					Stopped drilling at 110 feet.
115					
120					
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
57.0	N.K.	01/31/86

PROJECT Falls City, Texas

LOG OF TEST BORING NO. 916

JOB NO. FCT03 DATE 1/16/86

SURFACE ELEVATION 418.54

TOP OF CASING ELEVATION 420.39

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Sand/Claystone

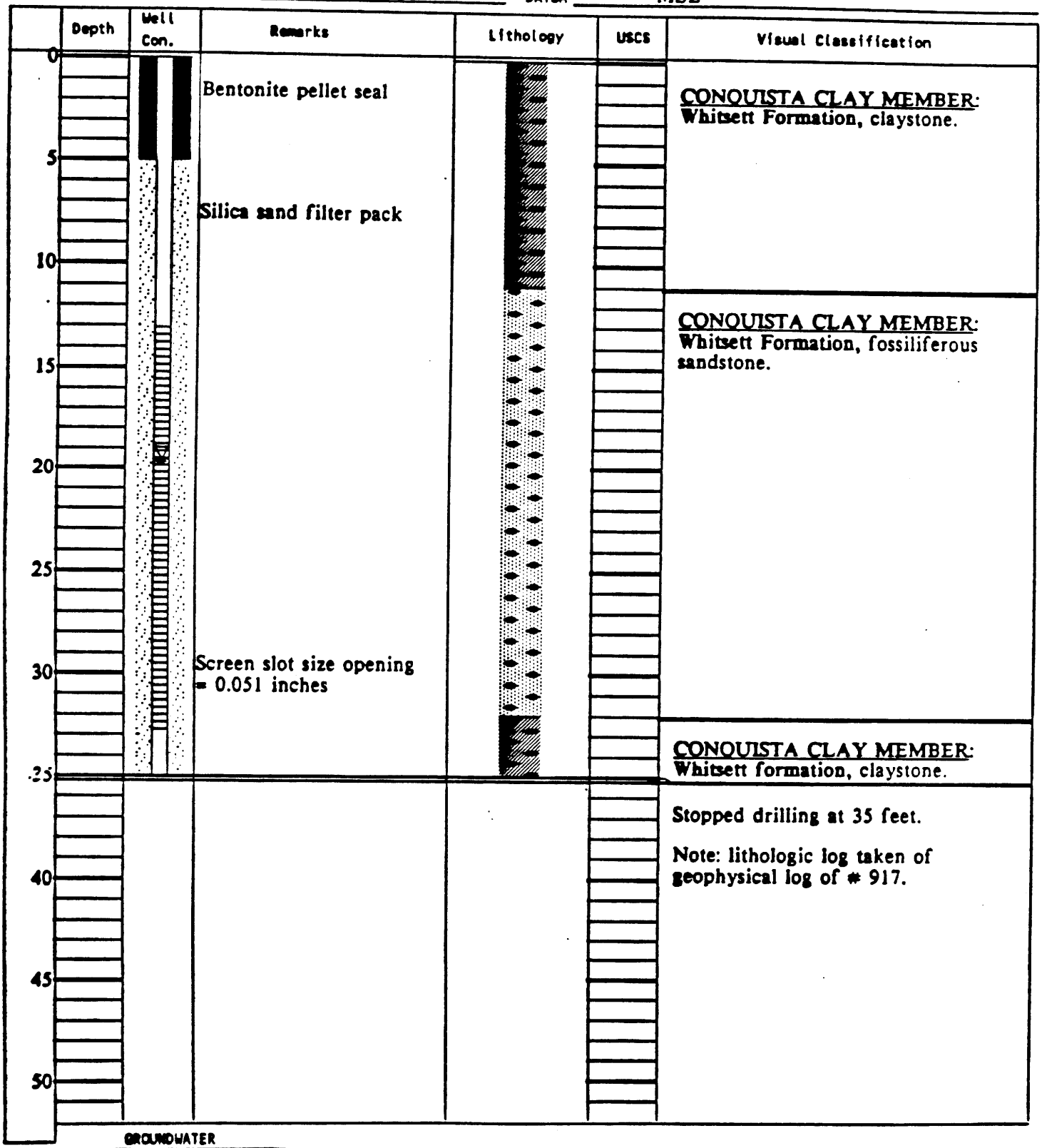
TOTAL DEPTH 90.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 62972.90 E 66711.40

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
19.6	N.K.	01/31/86

JOB NO. FCT03 DATE 1/16/86

SURFACE ELEVATION 418.14

TOP OF CASING ELEVATION 419.56

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sand/Conquista Claysto

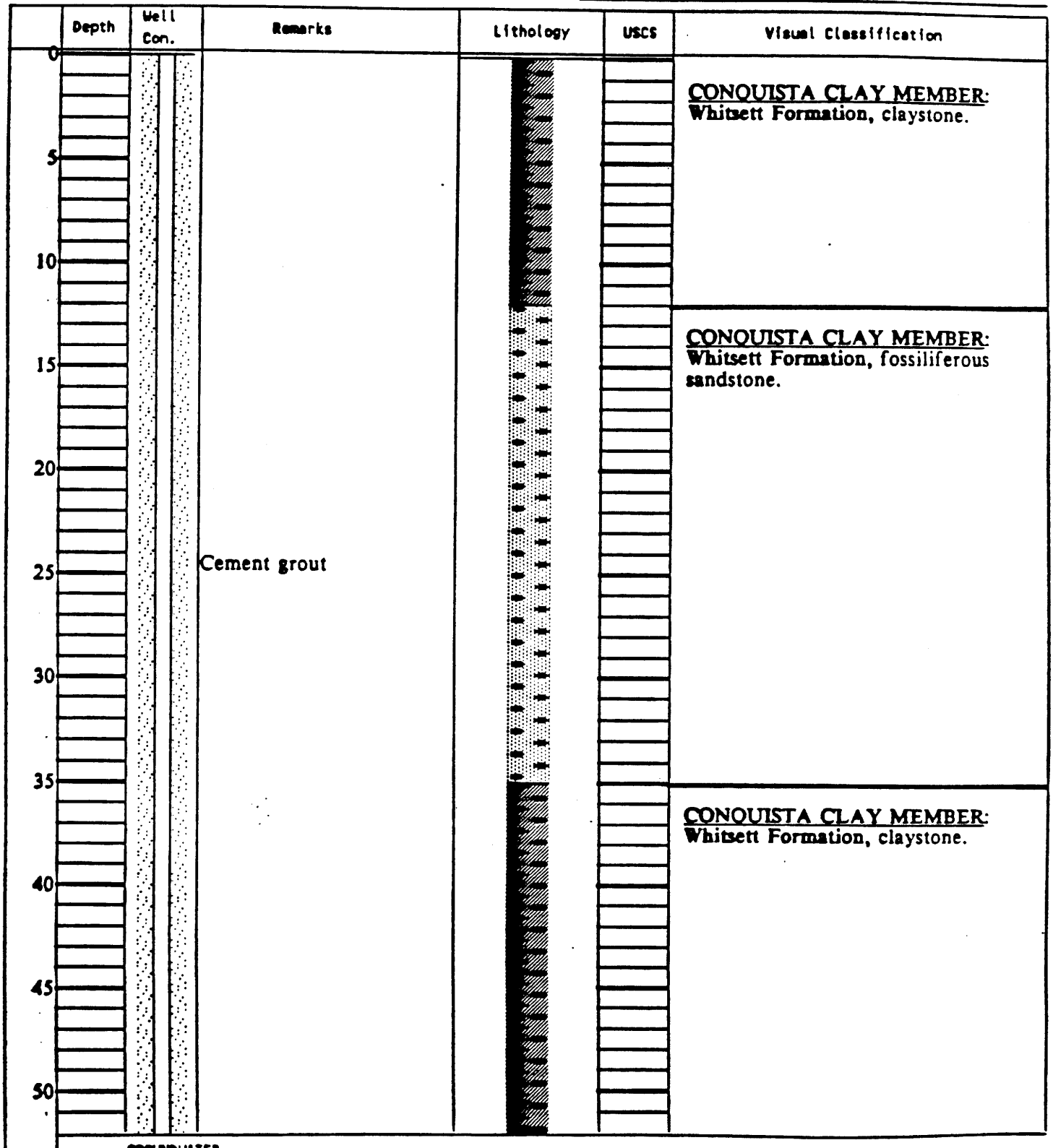
TOTAL DEPTH 90.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 62979.90 E 66715.10

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
55.5	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 917

JOB NO. FCT03 DATE 1/16/86

SURFACE ELEVATION 418.14

TOP OF CASING ELEVATION 419.56

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sand/Conquista Claystone

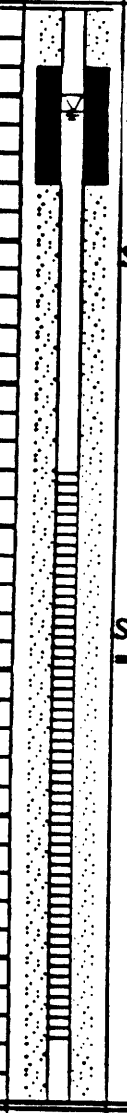
TOTAL DEPTH 90.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 62979.90 E 66715.10

DATUM MSL



Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Bentonite pellet seal			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
60		Silica sand filter pack			
65					
70					DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine sand.
75		Screen slot size opening = 0.051 inches			Note: lithologic log taken from geophysical logging of this boring.
80					
85					
90					Stopped drilling at 90 feet.
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
55.5	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 918

JOB NO. FCT03 DATE 1/7/86

SURFACE ELEVATION 402.77

TOP OF CASING ELEVATION 404.03

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Lower Deweesville Sand Member

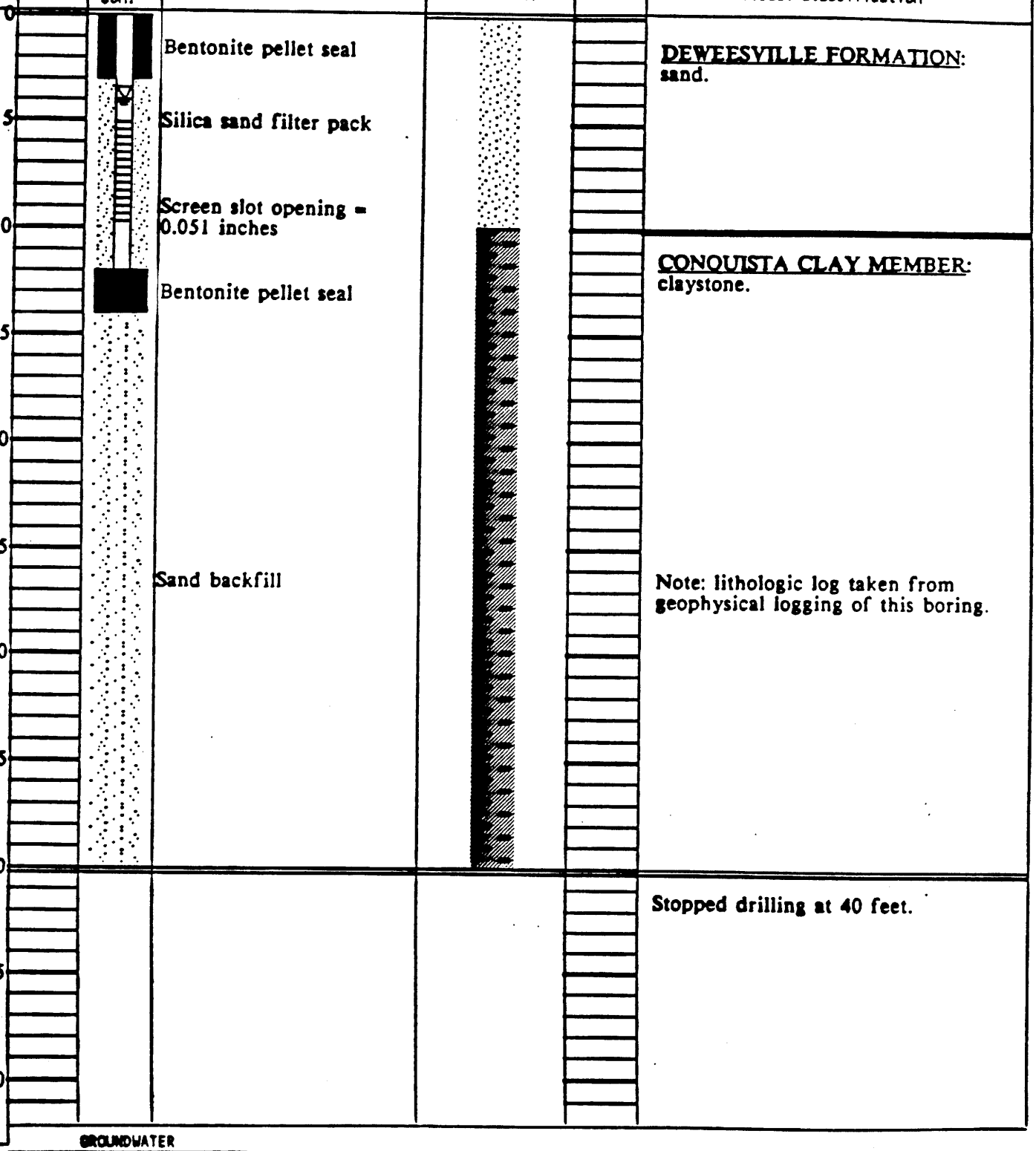
TOTAL DEPTH 40.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 56863.70 E 65174.60

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
4.0	N.K.	1/31/86

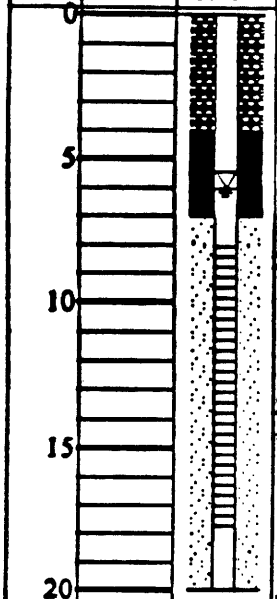
PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 919

JOB NO. FCT03 DATE 1/4/85

SURFACE ELEVATION 399.83
TOP OF CASING ELEVATION 401.05
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Conquista Sandstone/Claystone

TOTAL DEPTH 40.0 feet
RIG TYPE Badger 1400
BORING TYPE 8" tricone
LOCATION N 56737.40 E 64209.90
DATUM MSL



Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Bentonite gel			CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
5		Bentonite pellet seal			
		Silica sand filter pack			
10					
		Screen slot size opening = 0.051 inches			
15					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
20		Well installed to 20 feet			
25		Note: orginal hole abandoned, new hole drilled adjacent to orginal for well installation			Note: lithologic log taken from geophysical logging of boring # 920.
30					
35					
40					Stopped drilling at 40 feet.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
6.0	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 920

JOB NO. FCT03 DATE 1/5/86

SURFACE ELEVATION 395.18

TOP OF CASING ELEVATION 396.67

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Claystone/Upper Dilworthum

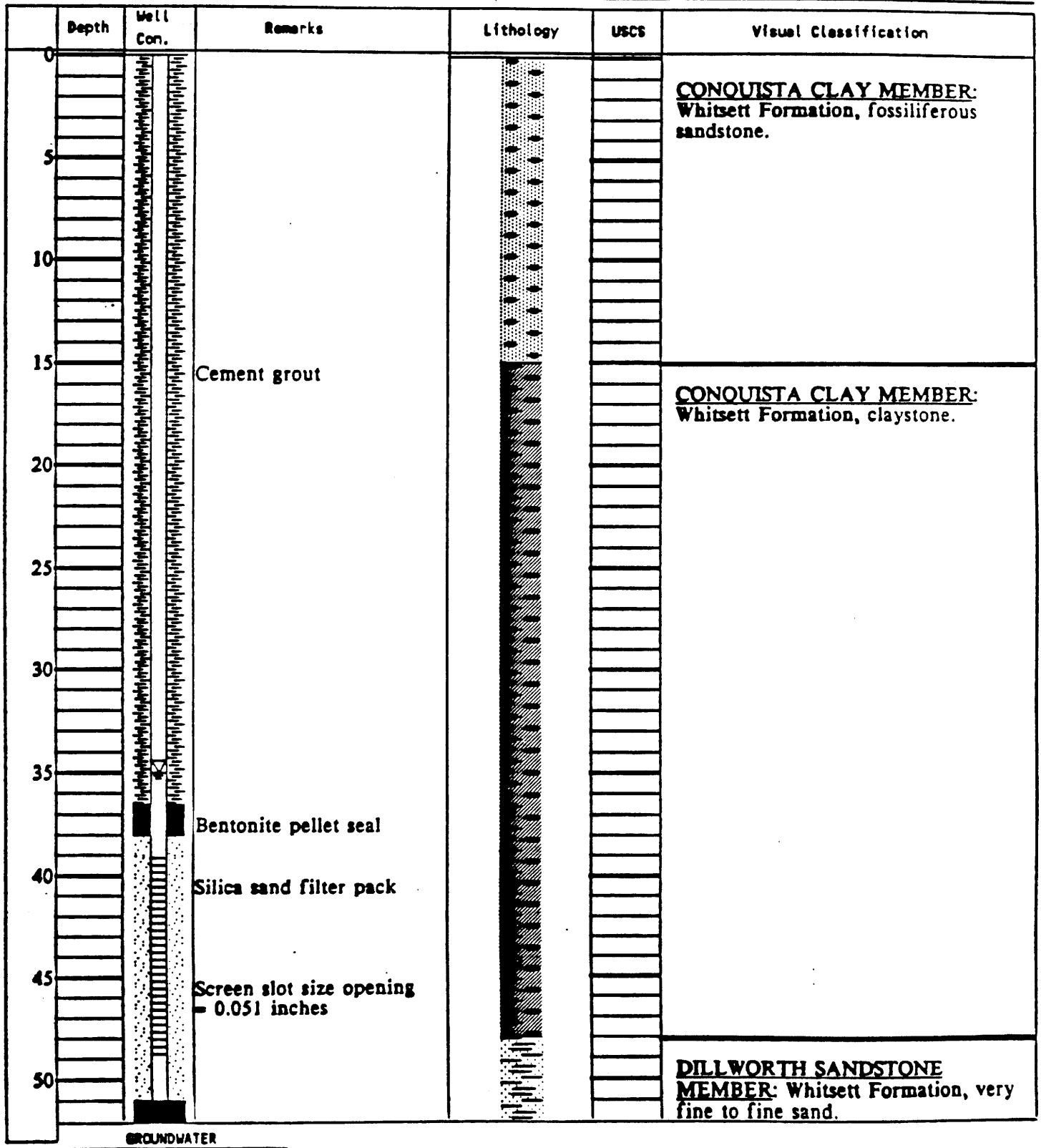
TOTAL DEPTH 80.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 56731.40 E 64229.00

MSL



GROUNDWATER

DEPTH	HOUR	DATE
35.0	N.K.	01/31/86

JOB NO. FCT03 DATE 1/5/86 LOG OF TEST BORING NO. 920

SURFACE ELEVATION 395.18
TOP OF CASING ELEVATION 396.67
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Conquista Claystone/Upper Dilworth

TOTAL DEPTH 80.0 feet
RIG TYPE Badger 1400
BORING TYPE 8" tricone
LOCATION N 56731.40 E 64229.00
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Bentonite pellet seal			DILLWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine sand.
60					
65					Note: lithologic log taken from geophysical log of this boring.
70					
75					
80					Stopped drilling at 80 feet.
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
35.0	N.K.	01/31/86

PROJECT Falls City, Texas

LOG OF TEST BORING NO. 921

JOB NO. FCT03 DATE 1/14/86

SURFACE ELEVATION 434.30

TOP OF CASING ELEVATION 435.75

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Fossiliferous Sand

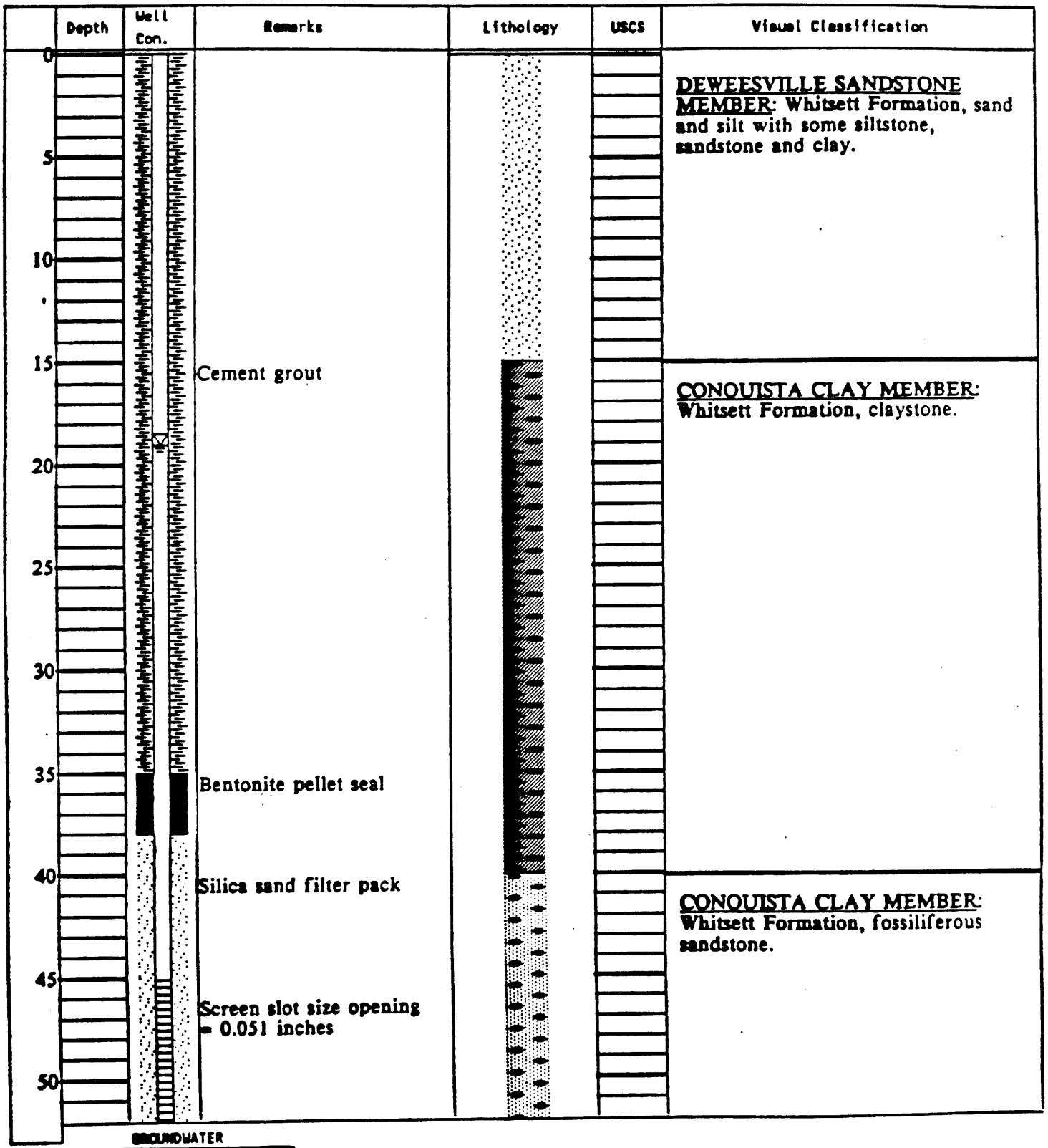
TOTAL DEPTH 57.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 61389.40 E 66693.50

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
19.0	N.K.	01/31/86

PROJECT Falls City, Texas

LOG OF TEST BORING NO. 921

JOB NO. FCT03 DATE 1/14/86

SURFACE ELEVATION 434.30

TOP OF CASING ELEVATION 435.75

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Fossiliferous Sand

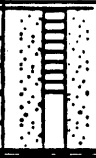
TOTAL DEPTH 57.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 61389.40 E 66693.50

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					Stopped drilling at 57 feet. Note: lithologic log taken from geophysical logging of # 915.
65					
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
19.0	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 922

JOB NO. FCT03 DATE 1/20/86

SURFACE ELEVATION 440.98

TOP OF CASING ELEVATION 441.96

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Deweesville Sand

TOTAL DEPTH 80.0 feet

RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 57056.50 E 67960.90

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DUBOSE MEMBER: Whitsett Formation, intercalated clay, poorly indurated sandstones and siltstones, and carbonaceous tuff.
10		Cement grout			
30		Formation cave-in			
50					

393

GROUNDWATER

DEPTH	HOUR	DATE
64.5	N.K.	01/31/86

Falls City, Texas — LOG OF TEST BORING NO. 922

JOB NO. FCT03 DATE 1/20/86
SURFACE ELEVATION 440.98
TOP OF CASING ELEVATION 441.96
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Deweesville Sand

TOTAL DEPTH 80.0 feet
RIG TYPE Mayhew 1000
BORING TYPE 8" tricone
LOCATION N 57056.50 E 67960.90
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Bentonite pellet seal			DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, sand and silt with some siltstone, sandstone and clay.
60		Silica sand filter pack			
65					
70		Screen slot size opening = 0.051 inches			Note: lithologic log taken from geophysical logging of this boring.
75					
80					Stopped drilling at 80 feet.
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
64.5	N.R.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 923

JOB NO. FCT03 DATE 4/16/86

SURFACE ELEVATION 405.26
TOP OF CASING ELEVATION 407.15
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Conquista Sandstone/Claystone

TOTAL DEPTH 20.0 feet
RIG TYPE Mayhew 1000
BORING TYPE 8" tricone
LOCATION N 56118.30 E 63170.50
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Cement grout			CONQUISTA CLAY MEMBER: fossiliferous sandstone, sand, very fine to fine grained, dense, moist, light yellowish to light greyish brown mottled with yellowish brown.
5		Bentonite pellet seal			
		Silica sand filter pack			
10					
		Screen slot size opening = 0.051 inches			
15					
					CONQUISTA CLAY MEMBER: claystone, very stiff, brown.
20					Stopped drilling at 20 feet.
25					
30					
35					
40					
45					
50					

GROUNDWATER

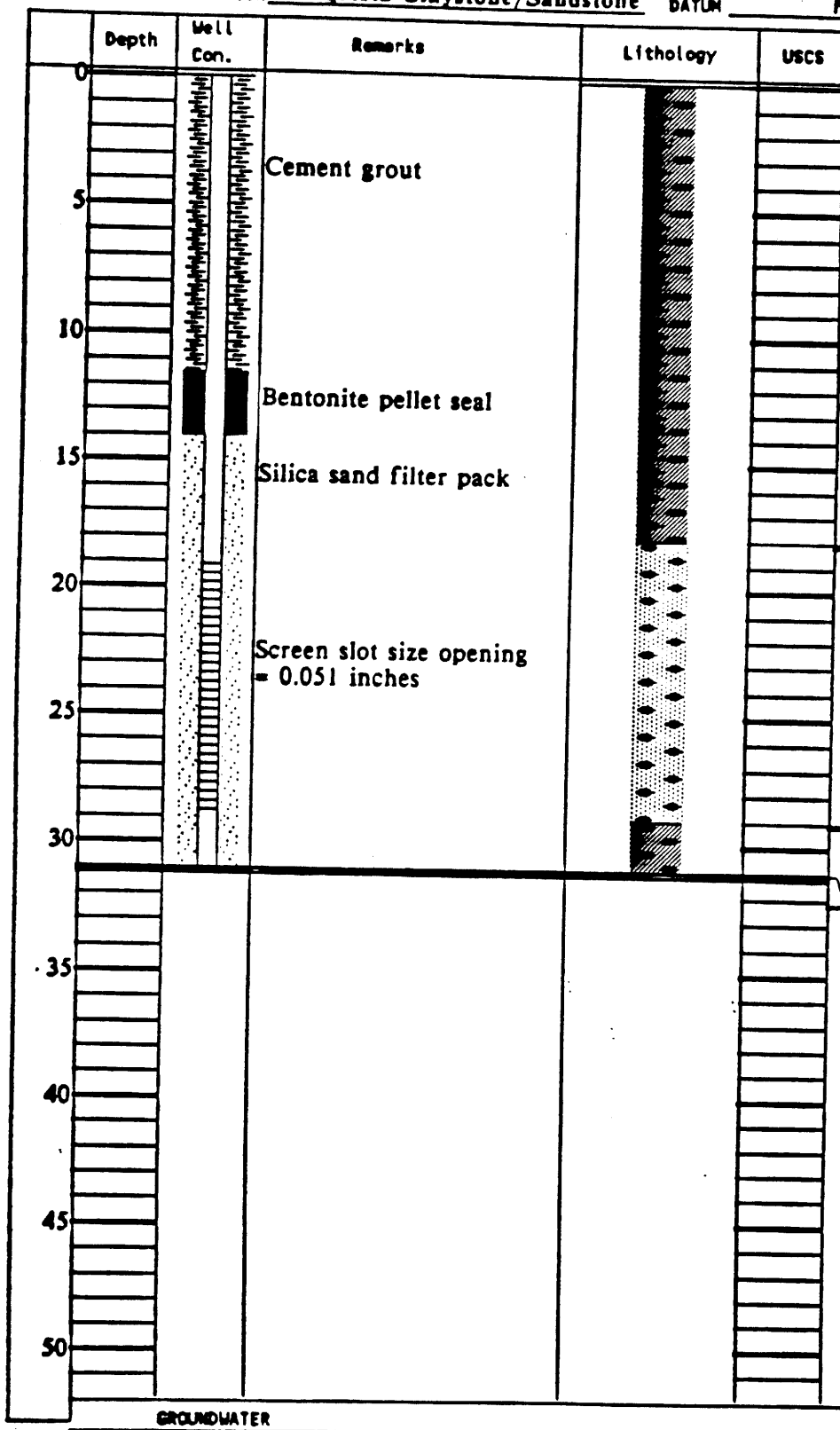
DEPTH	HOUR	DATE
	N.K.	04/18/86

JOB NO. FCT03 DATE 4/16/86

LOG OF TEST BORING NO. 924

SURFACE ELEVATION 395.14
TOP OF CASING ELEVATION 396.44
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Conquista Claystone/Sandstone

TOTAL DEPTH 31.0 feet
RIG TYPE Mayhew 1000
BORING TYPE 8" tricone
LOCATION N 55041.90 E 64049.80
DATUM MSL



Depth	Visual Classification
0	CONQUISTA CLAY MEMBER: claystone, sandy, very stiff, light brown.
20	CONQUISTA CLAY MEMBER: sandstone, fossiliferous, sand, very fine to fine grained, dense, light yellowish to dark brown mottled with yellowish brown.
30	CONQUISTA CLAY MEMBER: claystone, very dark greyish brown.
	Stopped drilling at 31 feet.

GROUNDWATER

DEPTH	HOUR	DATE
	N.K.	

Falls City, Texas

LOG OF TEST BORING NO. 925

JOB NO. FCT03 DATE 4/16/86

SURFACE ELEVATION 415.81

TOP OF CASING ELEVATION 416.08

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Lower Dilworth Sandstone / Mannin[illegible]

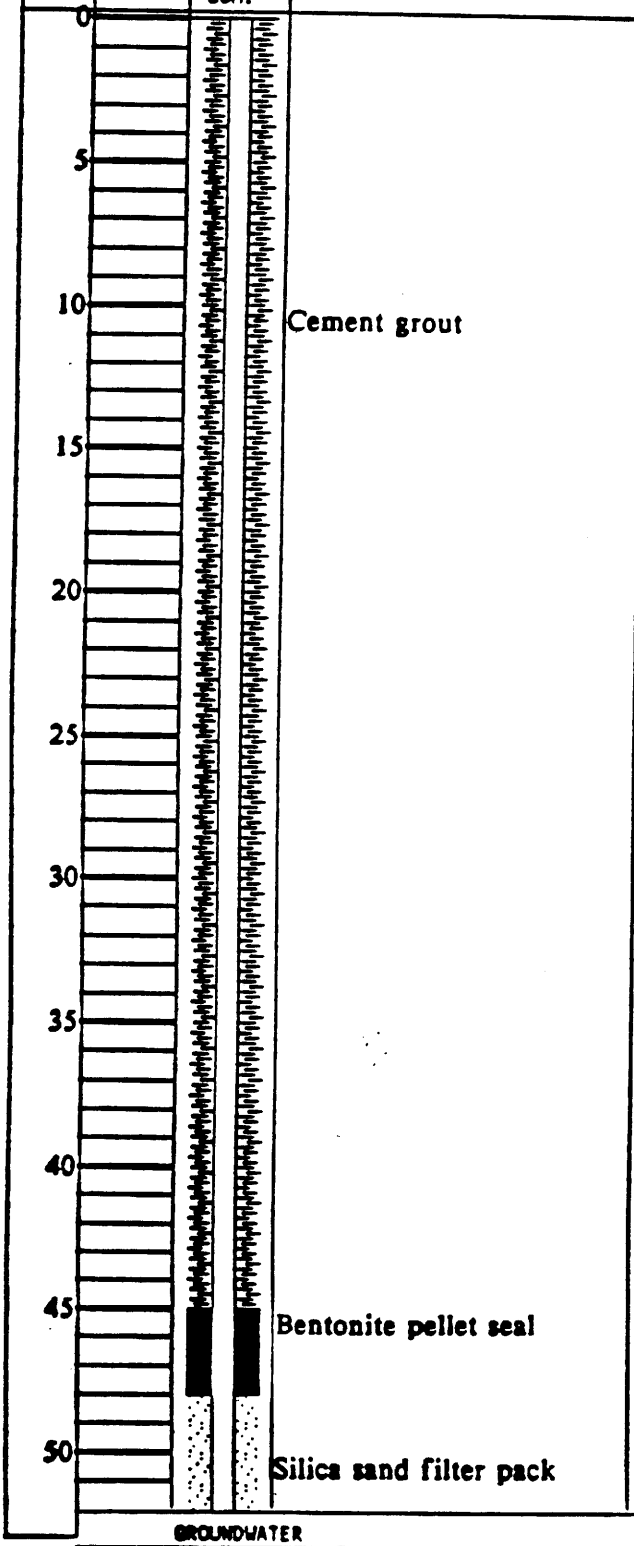
TOTAL DEPTH 90.0 feet

RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 64843.20 E 63664.00

[illegible] MSL



Visual Classification
CONQUISTA CLAY MEMBER: claystone, silty, dark brown.
DILWORTH SANDSTONE MEMBER: sand, very fine to fine grained, well cemented to 20 feet, moderately cememted to 45 feet, soft thereafter, light brown to greyish brown.

GROUNDWATER

DEPTH	HOUR	DATE
	N.K.	

LOG OF TEST BORING NO. 925

JOB NO. FCT03 DATE 4/16/86

SURFACE ELEVATION 415.81

TOP OF CASING ELEVATION 416.08

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Lower Dilworth Sandstone / Manning

TOTAL DEPTH 90.0 feet

RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 64843.20 E 63664.00

MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					DILWORTH SANDSTONE MEMBER: sand, very fine to fine grained, well cemented to 20 feet, moderately cememted to 45 feet, soft thereafter, light brown to greyish brown.
65		Screen slot size opening = 0.051 inches			
70					
75					
80					MANNING CLAY MEMBER: clay, silty, dark greyish brown.
85					
90					Stopped drilling at 90 feet.
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
	N.K.	

Nov. 9/94

NOTE:

Logs for Test Boring No.'s 935, 940 + 945 could not be located in Document Control.

J. Hiller

Falls City, Texas

LOG OF TEST BORING NO. 951

JOB NO. FCT03 DATE 1/16/86

SURFACE ELEVATION 436.36

TOP OF CASING ELEVATION 437.97

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Claystone

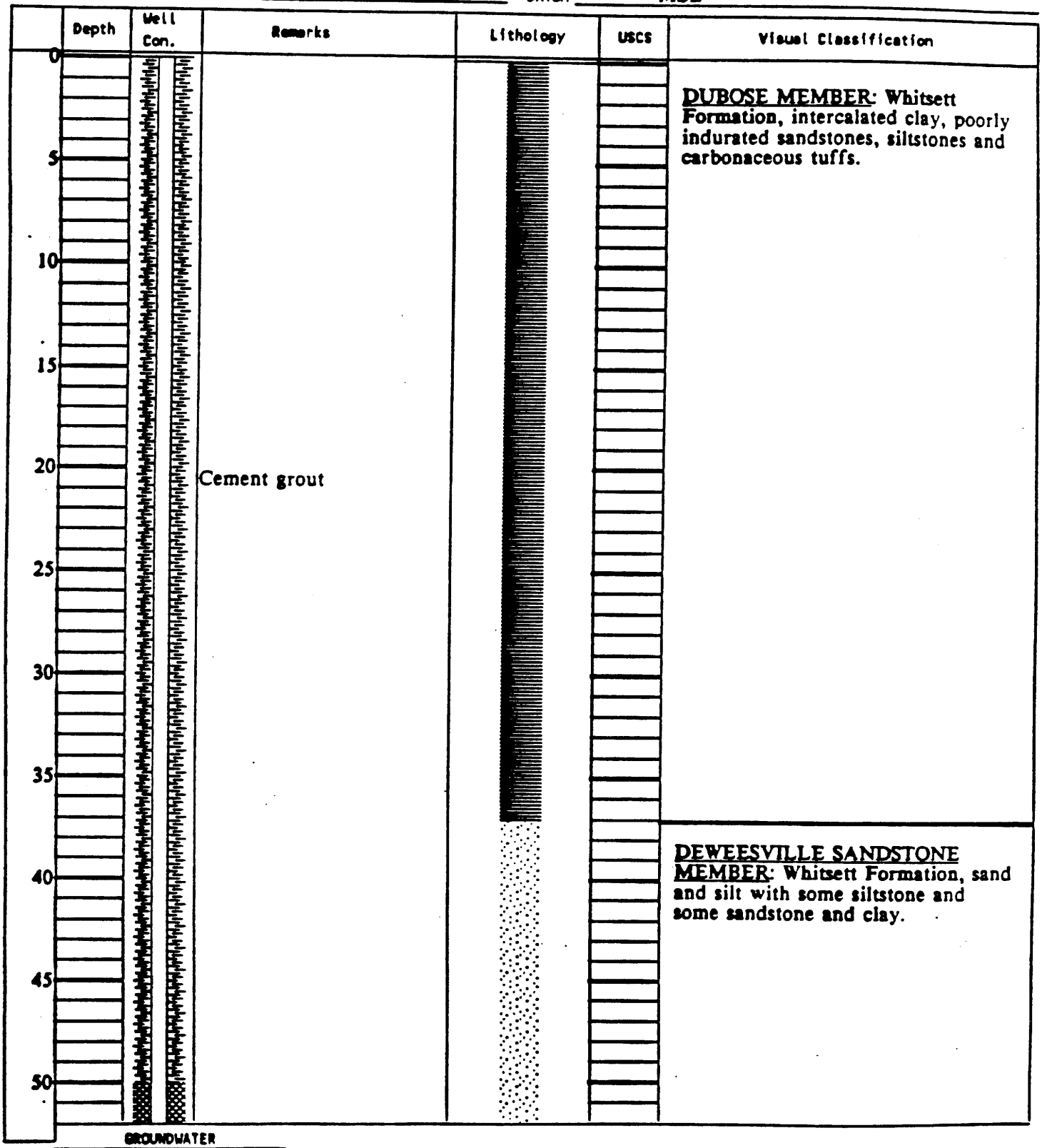
TOTAL DEPTH 90.0 feet

RIG TYPE Badger 1000

BORING TYPE 8" tricone

LOCATION N 60334.90 E 68978.50

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
68.7	N.K.	01/31/86

JOB NO. FCT03 DATE 1/16/86

SURFACE ELEVATION 436.36

TOP OF CASING ELEVATION 437.97

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Claystone

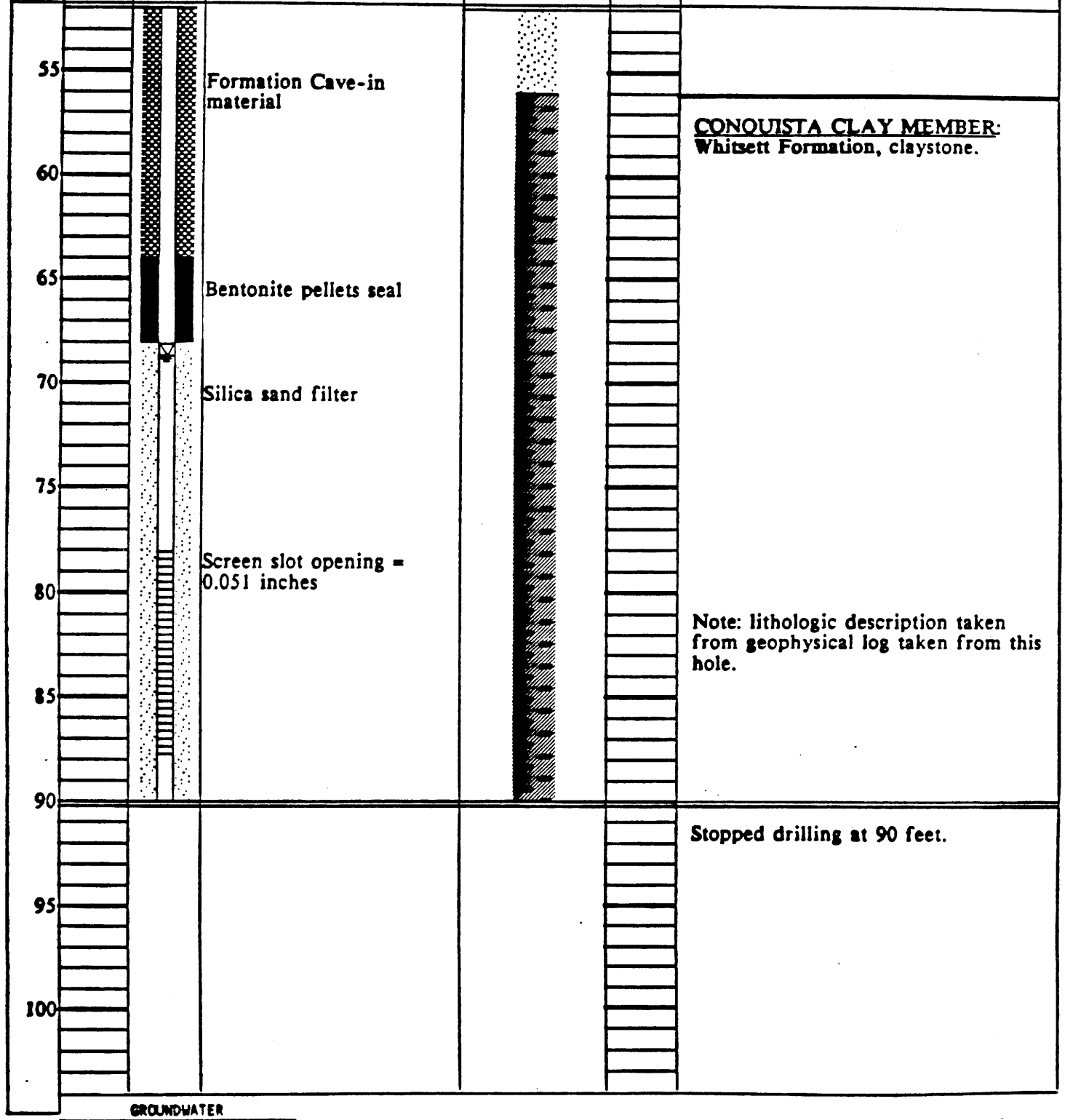
TOTAL DEPTH 90.0 feet

RIG TYPE Badger 1000

BORING TYPE 8" tricone

LOCATION N 60334.90 E 68978.50

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
68.7	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 952

JOB NO. FCT03 DATE 1/19/86

SURFACE ELEVATION 436.44

TOP OF CASING ELEVATION 437.77

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dubose/Deweesville

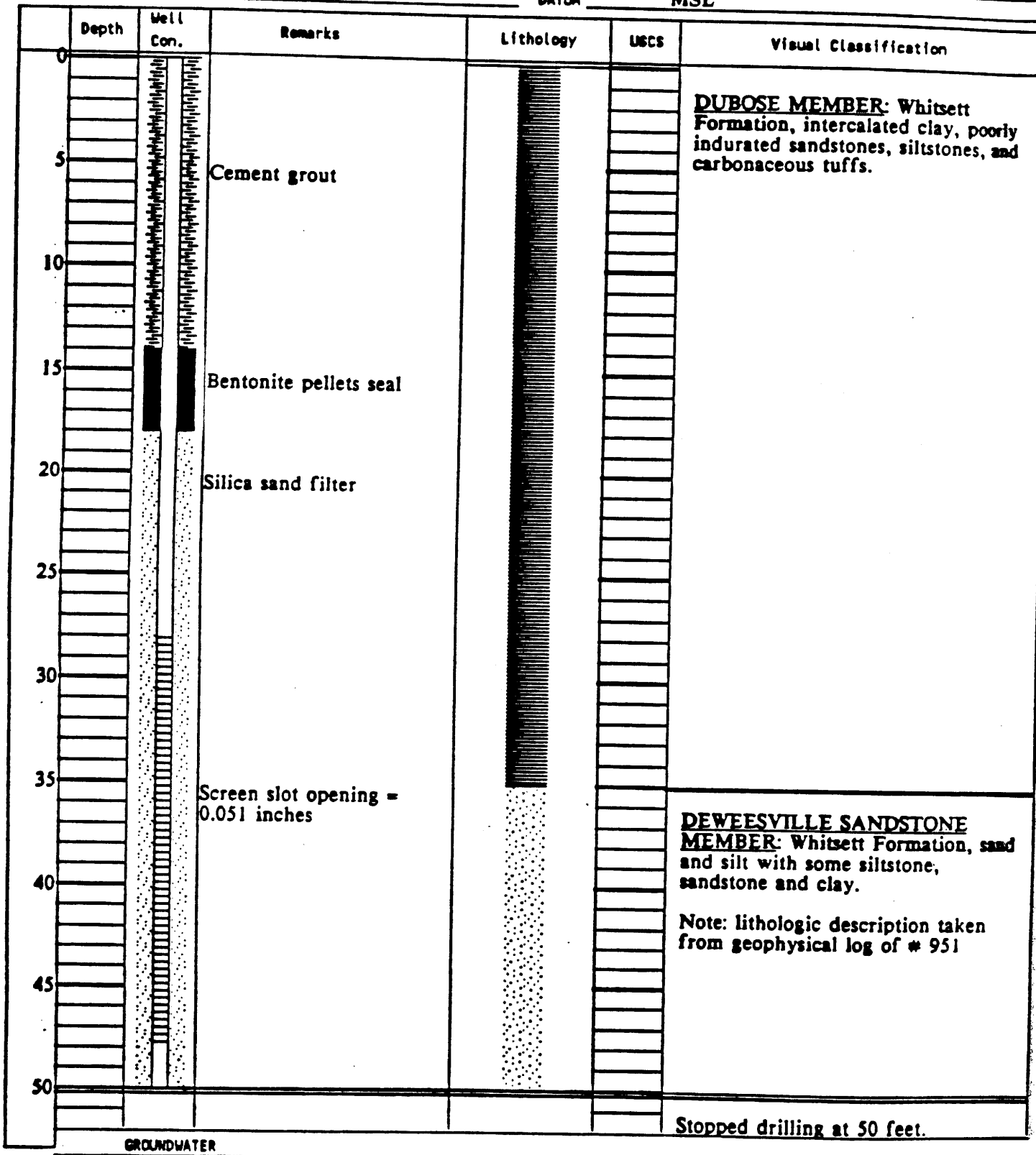
TOTAL DEPTH 50.0 feet

RIG TYPE Badger 1000

BORING TYPE 8" tricone

LOCATION N 60334.50 E 68984.60

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
	N.K.	01/31/86

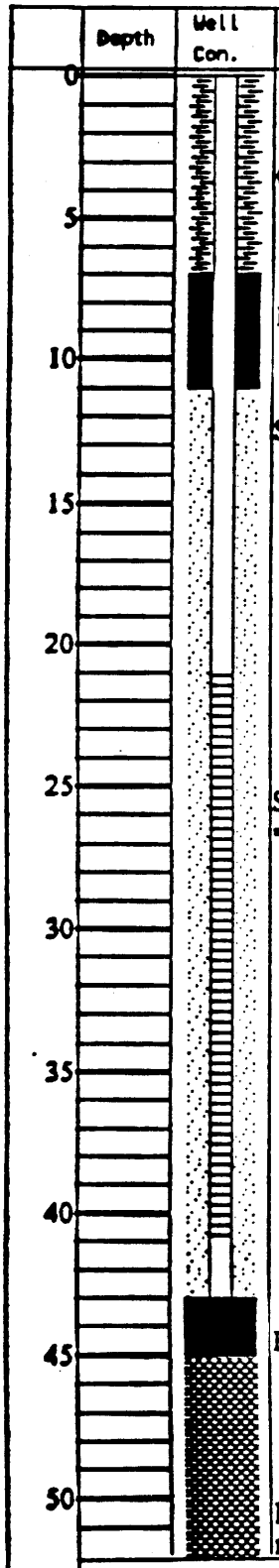
PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 953

JOB NO. FCT03 DATE 1/19/86

SURFACE ELEVATION 414.60
TOP OF CASING ELEVATION 415.81
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Dubose/Deweesville

TOTAL DEPTH 100.0 feet
RIG TYPE Badger 1400
BORING TYPE 8" tricone
LOCATION N 62028.60 E 71914.10
DATUM MSL



DUBOSE MEMBER: Whitsett Formation, intercalated clay, poorly indurated sandstones and siltstones and carbonaceous tuff.

DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, sand and silt with some siltstone, sandstone and clay.

GROUNDWATER

DEPTH	HOUR	DATE
	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 953

JOB NO. FCT03 DATE 1/19/86

SURFACE ELEVATION 414.60

TOP OF CASING ELEVATION 415.81

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dubose/Deweesville

TOTAL DEPTH 100.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 62028.60 E 71914.10

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous fossiliferous and carbonaceous, few thin beds of very fine sandstone.
60					
65		Formation cave-in material			
70					
75					
80					
85					
90					Note: lithologic log taken from geophysical logging at this location.
95					
100					Stopped drilling at 100 feet.

GROUNDWATER

DEPTH	HOUR	DATE
	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 954

JOB NO. FCT03 DATE 1/19/86

SURFACE ELEVATION 410.18

TOP OF CASING ELEVATION 411.39

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Claystone/Sandstone

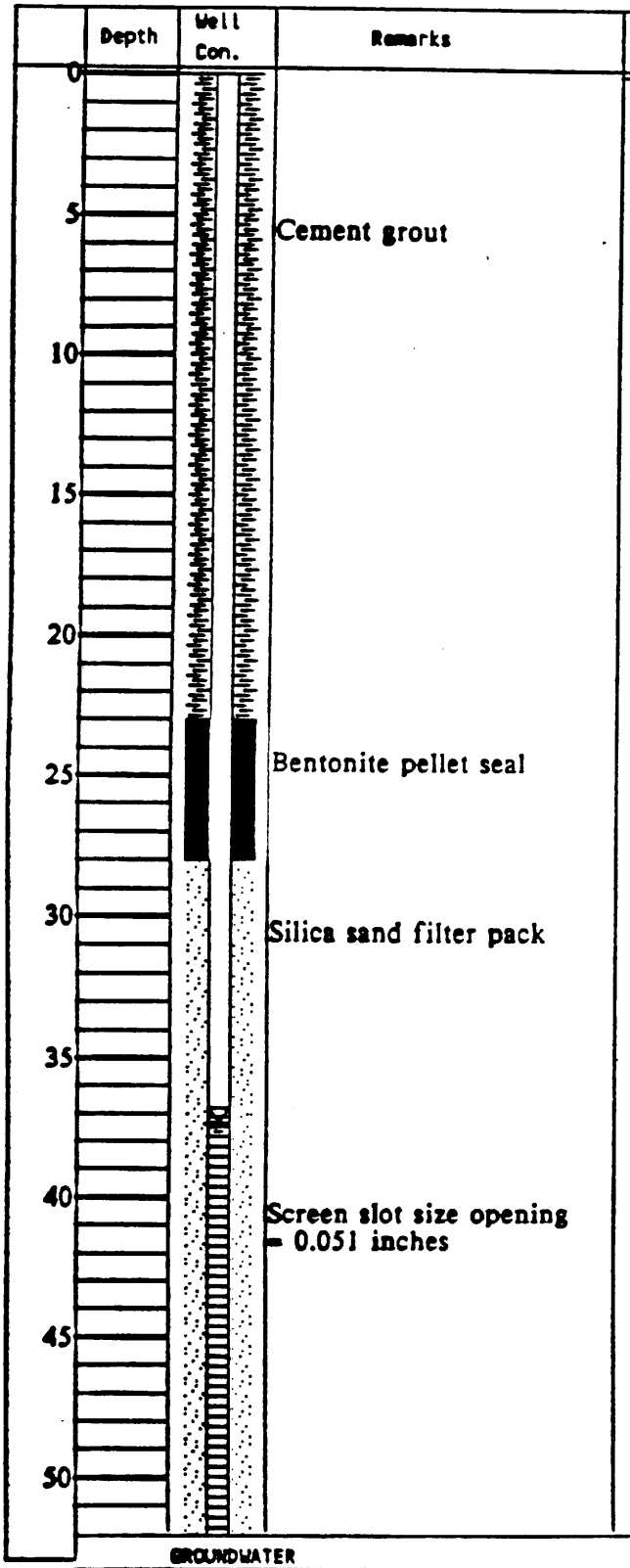
TOTAL DEPTH 60.0 feet

RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 63162.90 E 71323.40

DATUM MSL



DEWEESVILLE SAND MEMBER: Whitsett Formation, sand and silt with some siltstone, sandstone and clay.

CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous, fossiliferous and carbonaceous, few thin beds of fine grained sandstone.

GROUNDWATER

DEPTH	HOUR	DATE
37.3	N.K.	01/31/86

JOB NO. FCT03 DATE 1/19/86 BORING NO. 934

SURFACE ELEVATION 410.18
TOP OF CASING ELEVATION 411.39
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Conquista Claystone/Sandstone

TOTAL DEPTH 60.0 feet
RIG TYPE Mayhew 1000
BORING TYPE 8" tricone
LOCATION N 63162.90 E 71323.40
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
60		Formation cave-in material			Note: lithologic log taken from geophysical logging from this location.
					Stopped drilling at 60 feet.
65					
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
37.3	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 955

JOB NO. FCT03 DATE 1/29/86
SURFACE ELEVATION 392.67
TOP OF CASING ELEVATION 393.67
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Conquista Clay

TOTAL DEPTH 30.0 feet
RIG TYPE Badger 1000
BORING TYPE 8" tricone
LOCATION N 63099.60 E 69449.20
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Cement grout			CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
5		Bentonite pellet seal			
10		Silica sand filter pack			
15					
20		Screen slot size opening = 0.051 inches			
25					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
30					Stopped drilling at 30 feet.
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
18.9	N.K.	01/31/86

JOB NO. FCT03 DATE 1/14/86

SURFACE ELEVATION 391.80

TOP OF CASING ELEVATION 393.25

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista/Dilworth

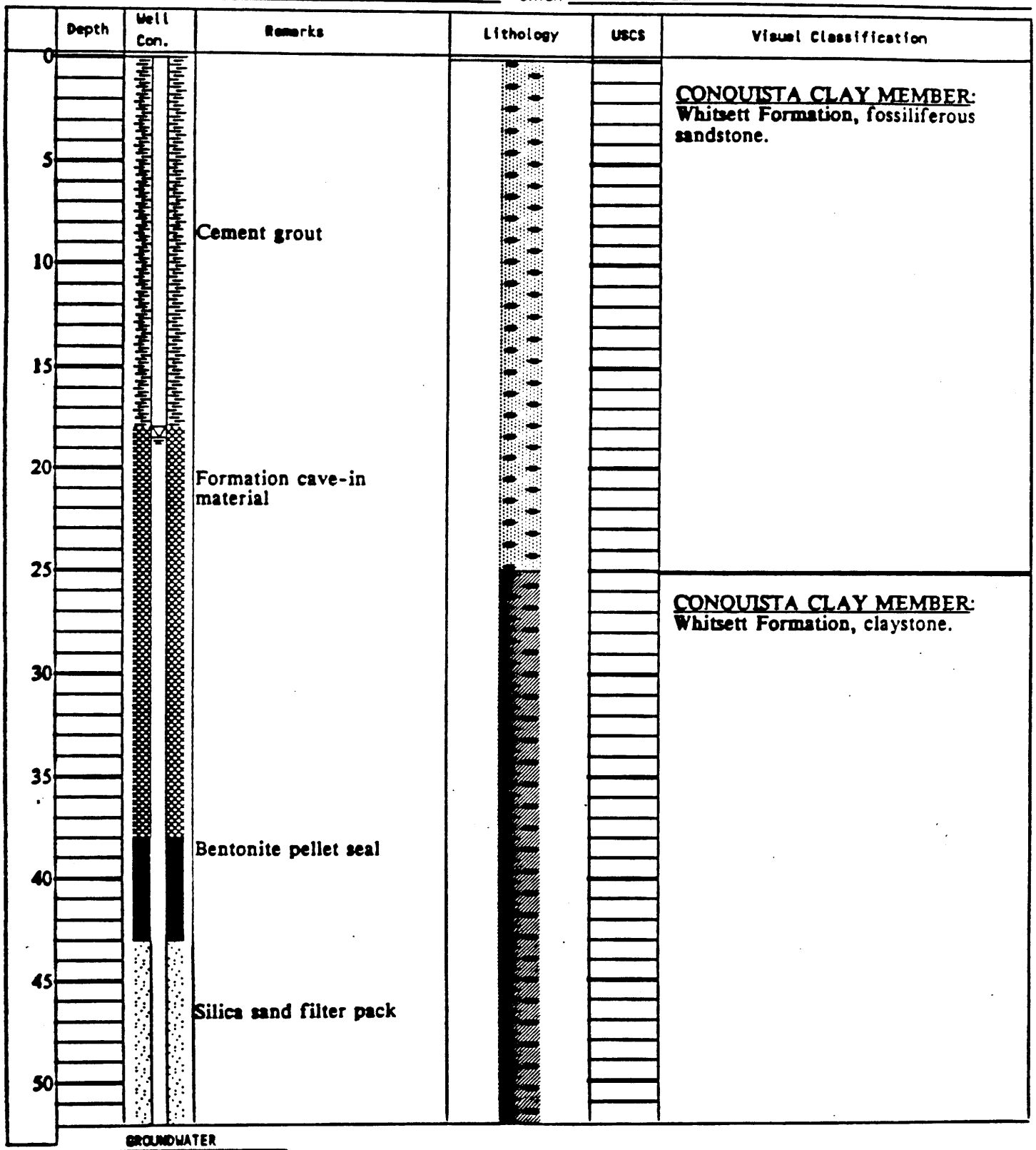
TOTAL DEPTH 70.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 63104.30 E 69434.60

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
18.5	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 956

JOB NO. FCT03 DATE 1/14/86

SURFACE ELEVATION 391.80

TOP OF CASING ELEVATION 393.25

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista/Dilworth

TOTAL DEPTH 70.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 63104.30 E 69434.60

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Screen slot size opening = 0.051 inches			DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
60					
65					Note: lithologic log taken from geophysical logging at this location.
70					Stopped drilling at 70 feet.
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
18.5	N.K.	01/31/86

JOB NO. FCT03 DATE 1/16/86

SURFACE ELEVATION 386.97

TOP OF CASING ELEVATION 388.19

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Sandstone/Claystone

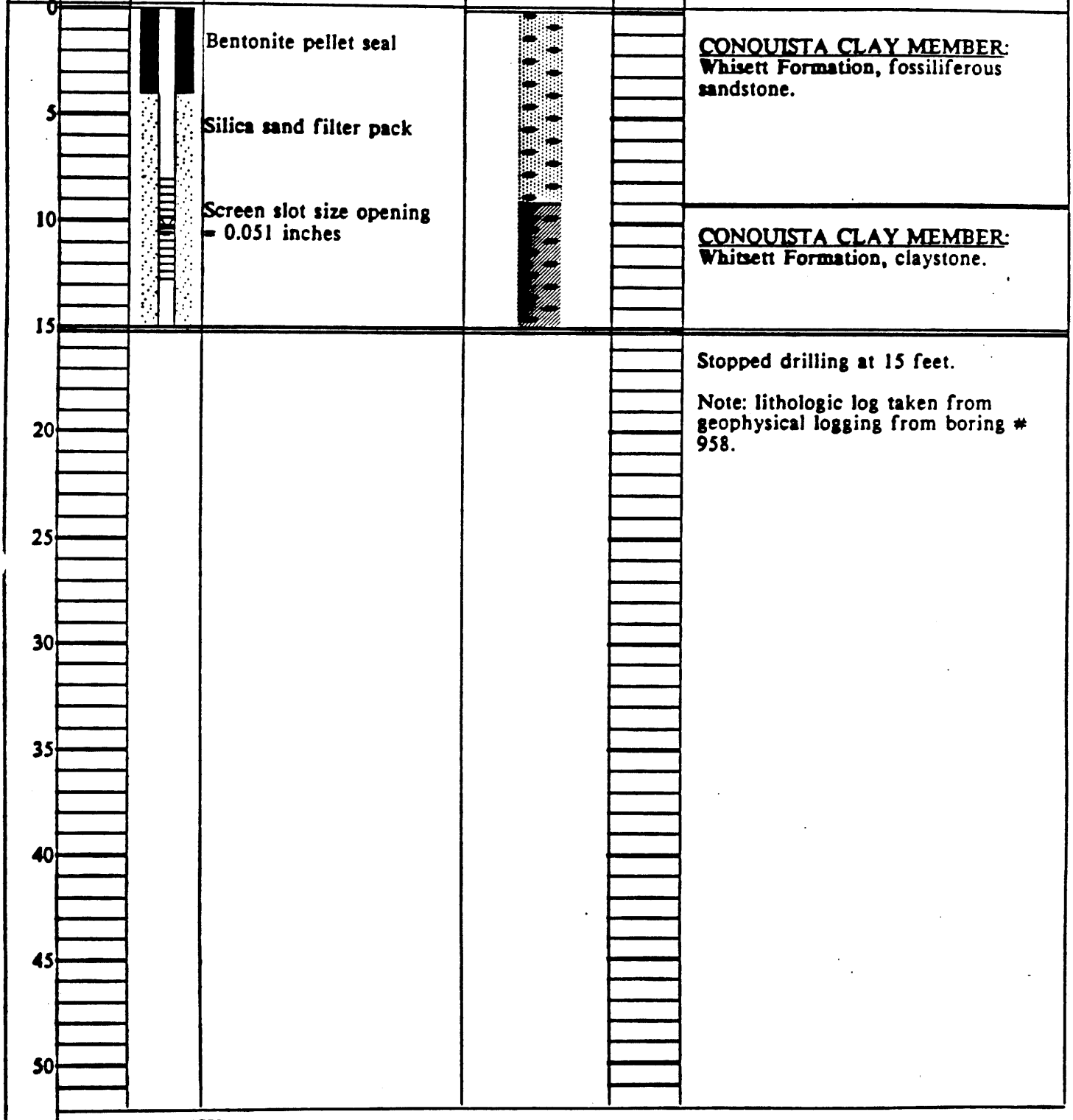
TOTAL DEPTH 15.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 63435.20 E 68807.70

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
10.4	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 958

JOB NO. FCT03 DATE 1/15/86

SURFACE ELEVATION 385.91

TOP OF CASING ELEVATION 388.23

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Upper Dilworth Sandstone

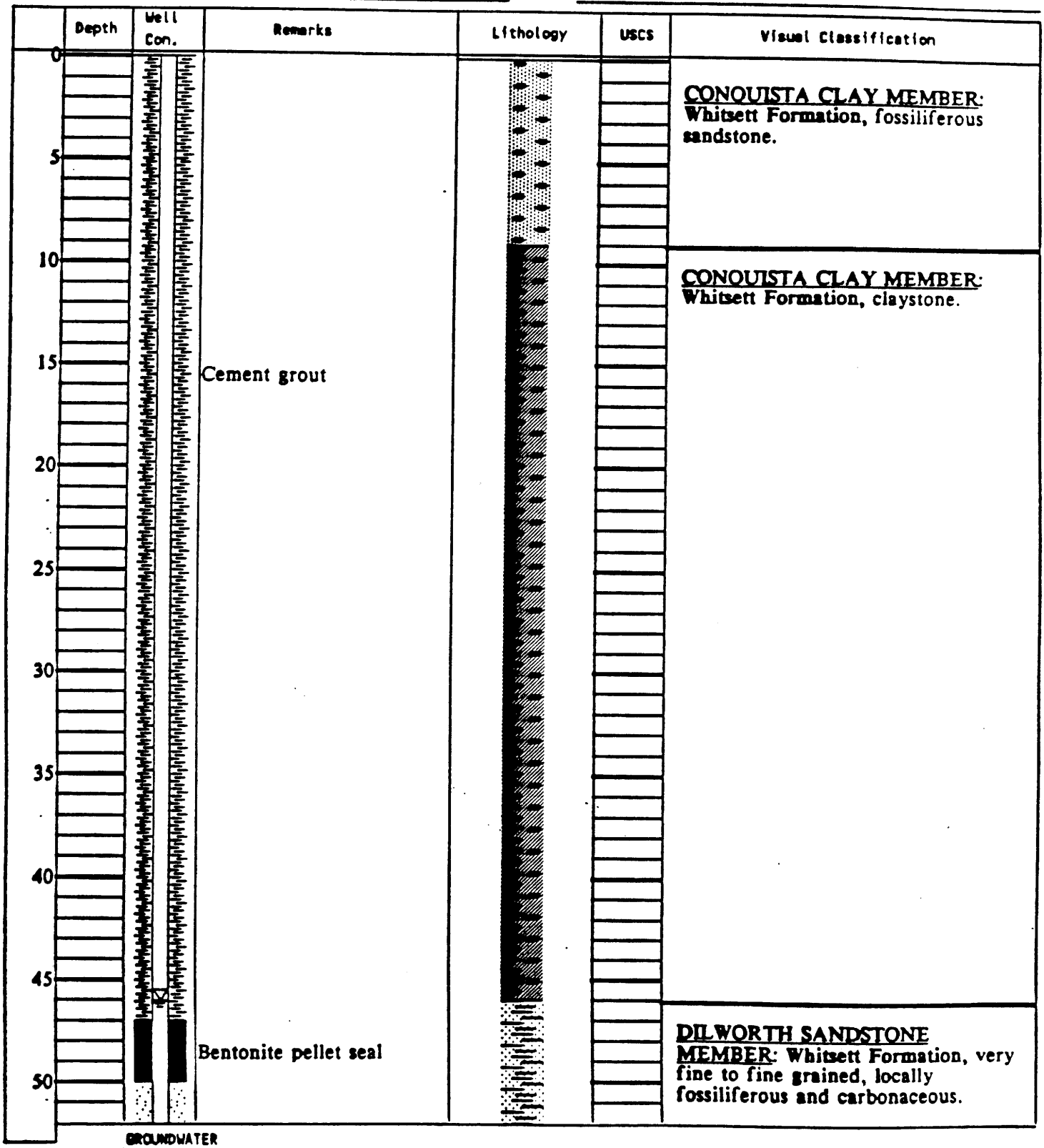
TOTAL DEPTH 150.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 63430.10 E 68799.70

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
46.0	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 958

JOB NO. FCT03 DATE 1/15/86

SURFACE ELEVATION 385.91

TOP OF CASING ELEVATION 388.23

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Upper Dilworth Sandstone

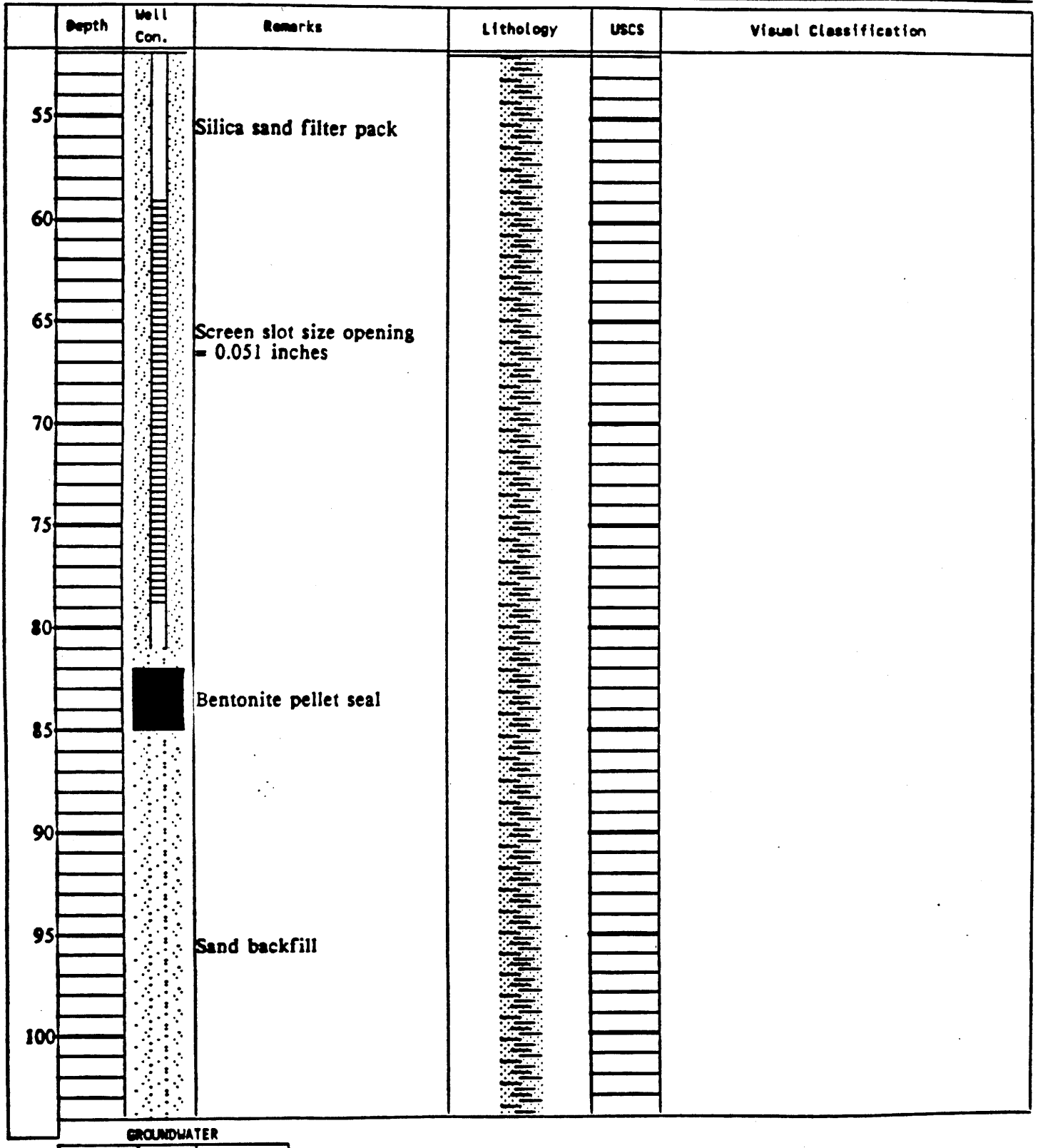
TOTAL DEPTH 150.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 63430.10 E 68799.70

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
46.0	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 958

JOB NO. FCT03 DATE 1/15/86

SURFACE ELEVATION 385.91

TOP OF CASING ELEVATION 388.23

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Upper Dilworth Sandstone

TOTAL DEPTH 150.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 63430.10 E 68799.70

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					
120		Sand backfill			
125					
130					MANNING CLAY MEMBER: Whitsett Formation, claystone.
135					
140					Note: lithologic log taken from geophysical logging of this boring.
145					
150					Stopped drilling at 150 feet.
155					

GROUNDWATER

DEPTH	HOUR	DATE
46.0	N.K.	01/31/86

Falls City, Texas

LOG OF TEST BORING NO. 961

JOB NO. FCT03 DATE 1/19/86

SURFACE ELEVATION 382.03

TOP OF CASING ELEVATION 382.98

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Clay

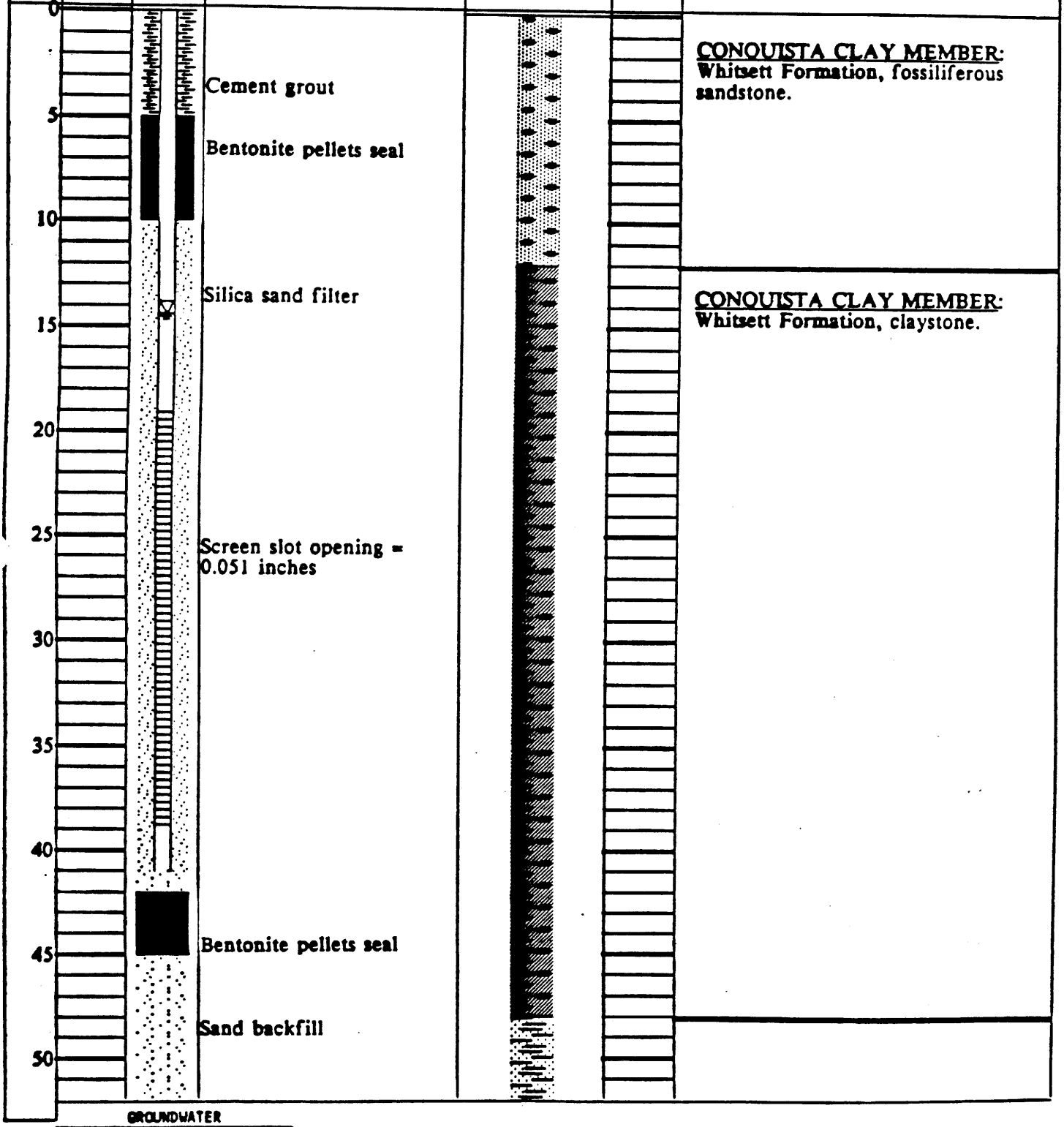
TOTAL DEPTH 60.0 feet

RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 63815.10 E 70828.50

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
14.4	N.K.	01/31/89

Falls City, Texas

LOG OF TEST BORING NO. 961

JOB NO. FCT03 DATE 1/19/86

SURFACE ELEVATION 382.03

TOP OF CASING ELEVATION 382.98

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Clay

TOTAL DEPTH 60.0 feet

RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 63815.10 E 70828.50

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Sand backfill			DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
60					Stopped drilling at 60 feet.
					Note: lithologic log taken from geophysical logging in this boring.
65					
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
14.4	N.K.	01/31/89

Falls City, Texas

LOG OF TEST BORING NO. 962

JOB NO. FCT03 DATE 1/19/86

SURFACE ELEVATION 372.72

TOP OF CASING ELEVATION 374.20

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Claystone

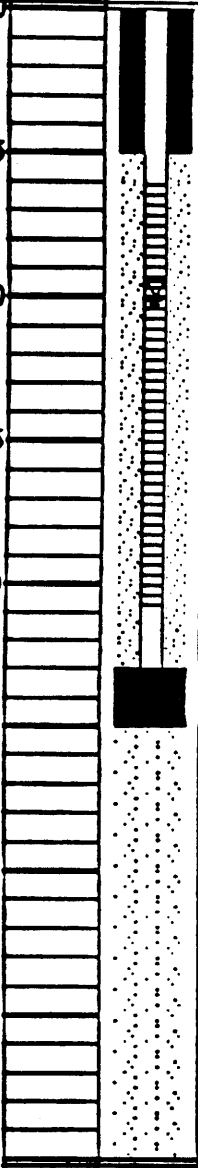
TOTAL DEPTH 40.0 feet

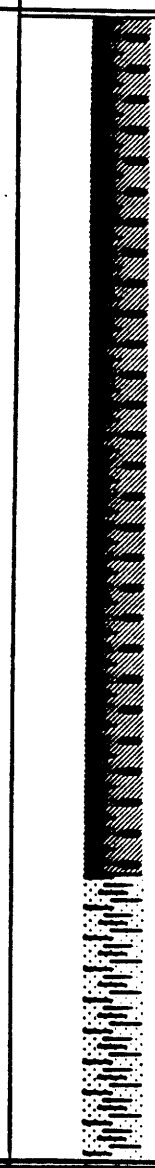
RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 64140.10 E 70535.80

DATUM MSL





USCS	Visual Classification
	CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
	DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
	Stopped drilling at 40 feet. Note: lithologic log taken from geophysical logging of this boring.

GROUNDWATER

DEPTH	HOUR	DATE
10.0	N.K.	01/31/86

LOG OF TEST BORING NO. 963

JOB NO. FCT03 DATE 1/29/86

SURFACE ELEVATION 368.61

TOP OF CASING ELEVATION 370.44

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Fossiliferous Sandstone

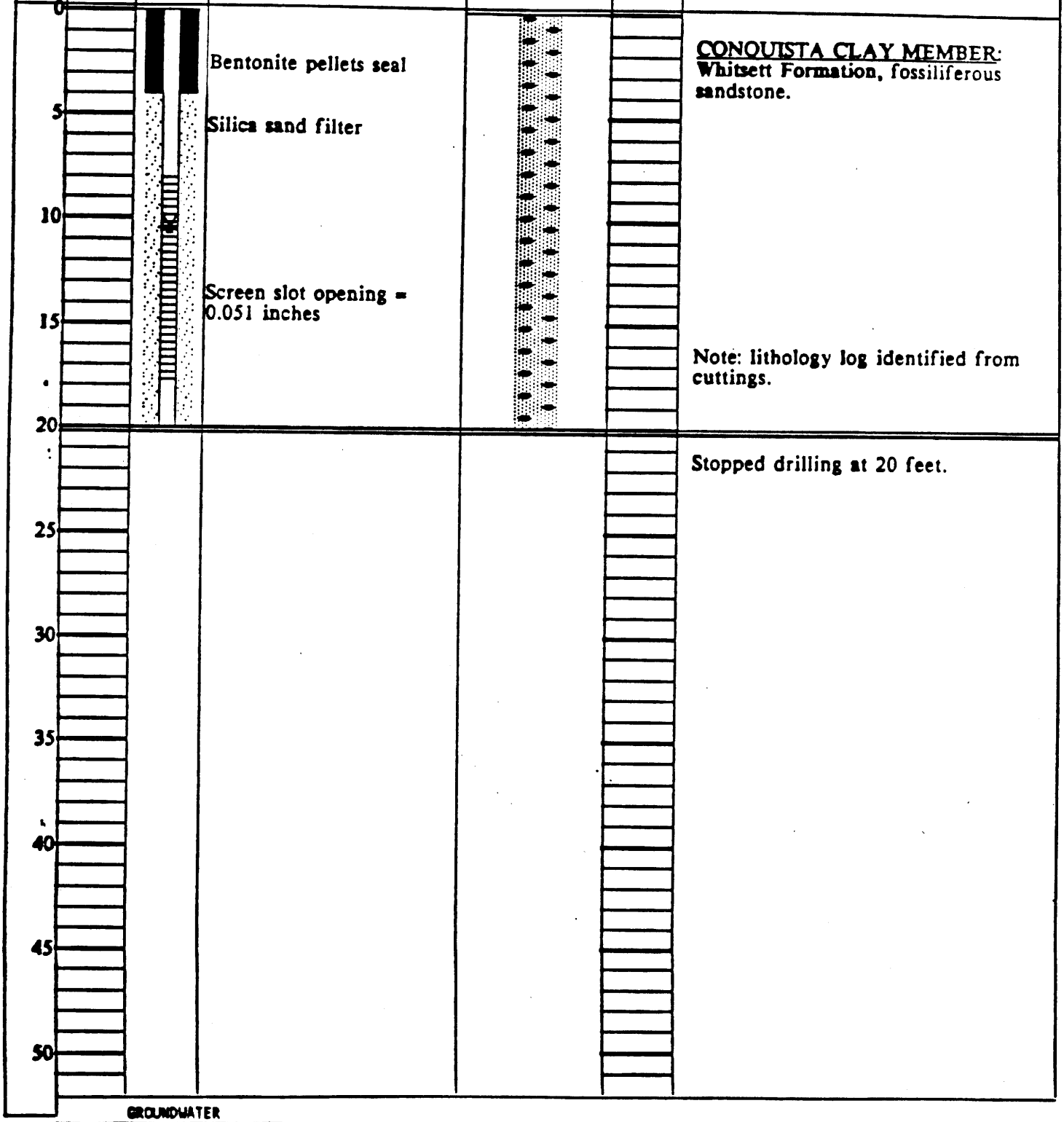
TOTAL DEPTH 20.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 64640.20 E 70391.60

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
10.4	N.K.	02/22/86

FORT CITY, TEXAS

LOG OF TEST BORING NO. 964

JOB NO. FCT03 DATE 4/17/86

SURFACE ELEVATION 378.09

TOP OF CASING ELEVATION 379.39

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sand

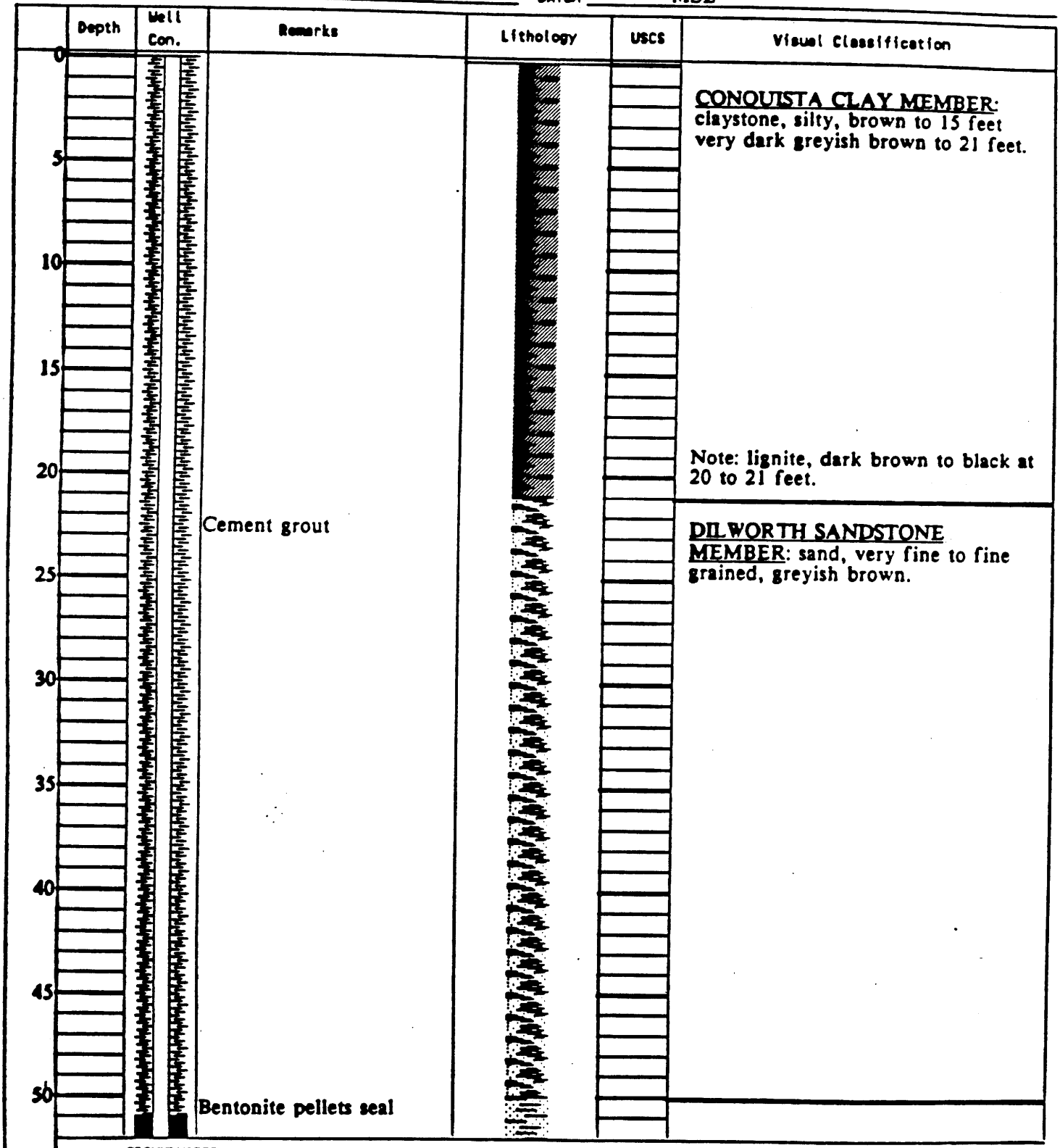
TOTAL DEPTH 90.0 feet

RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 64926.20 E 69745.40

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

Falls City, Texas

LOG OF TEST BORING NO. 964

JOB NO. FCT03 DATE 4/17/86

SURFACE ELEVATION 378.09

TOP OF CASING ELEVATION 379.39

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sand

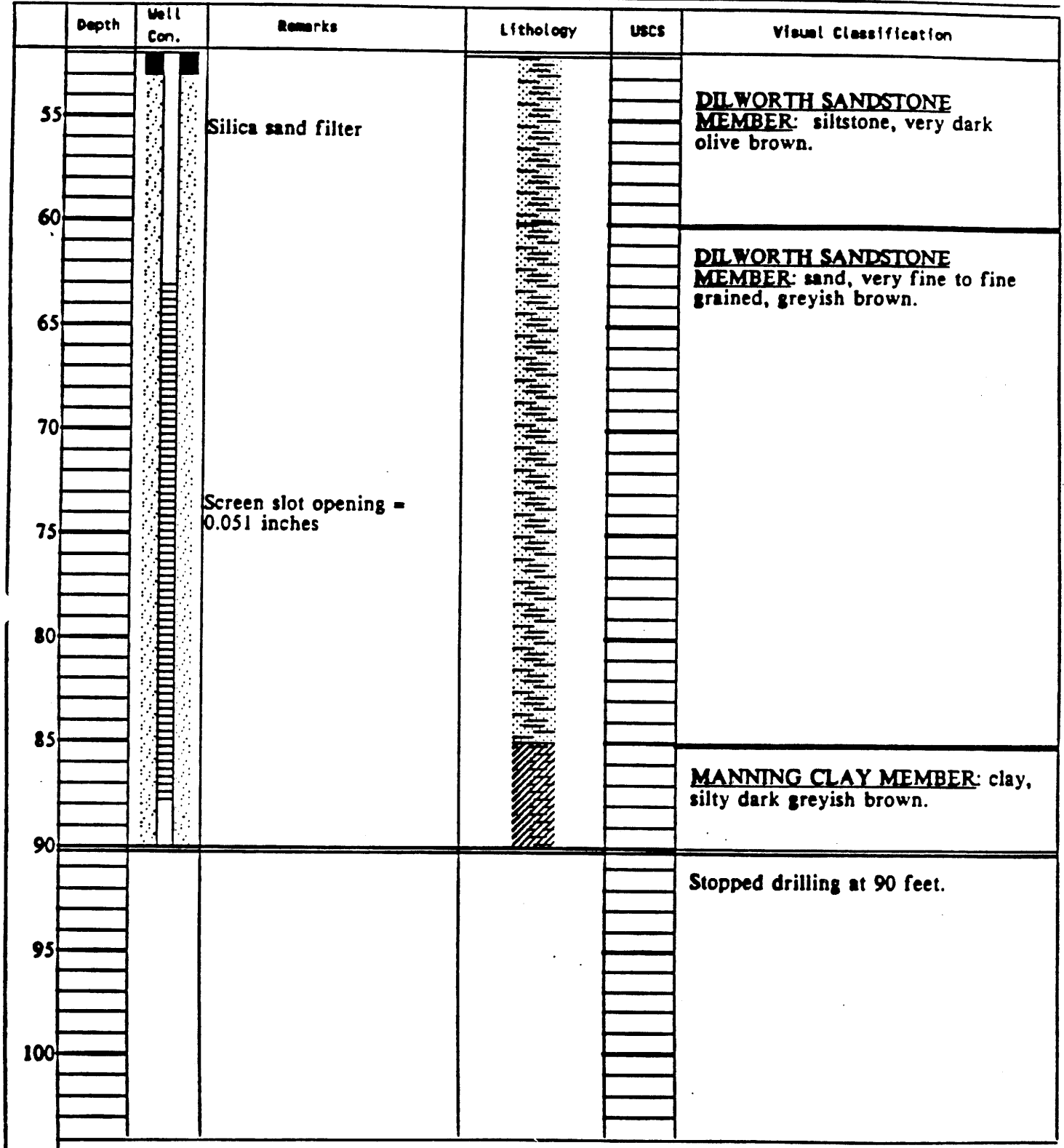
TOTAL DEPTH 90.0 feet

RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 64926.20 E 69745.40

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

Falls City, Texas

LOG OF TEST BORING NO. 965

JOB NO. FCT03 DATE 4/17/86

SURFACE ELEVATION 367.11

TOP OF CASING ELEVATION 368.31

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Fossiliferous Sandstone

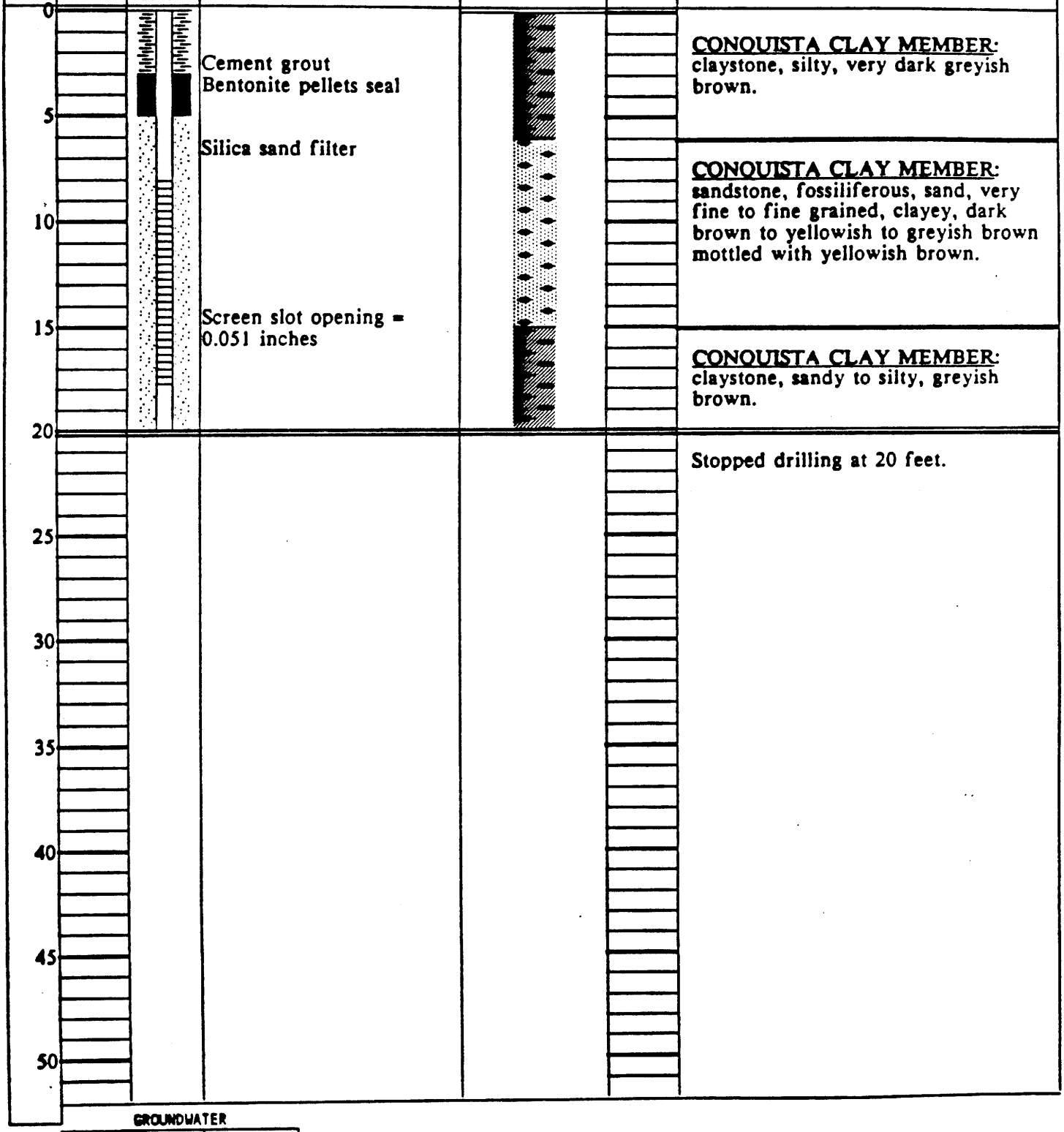
TOTAL DEPTH 20.0 feet

RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 65774.50 E 70672.00

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT Falls City, Texas

LOG OF TEST BORING NO. 966

JOB NO. FCT03 DATE 4/17/86

SURFACE ELEVATION 368.86

TOP OF CASING ELEVATION 371.56

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Sandstone/Claystone

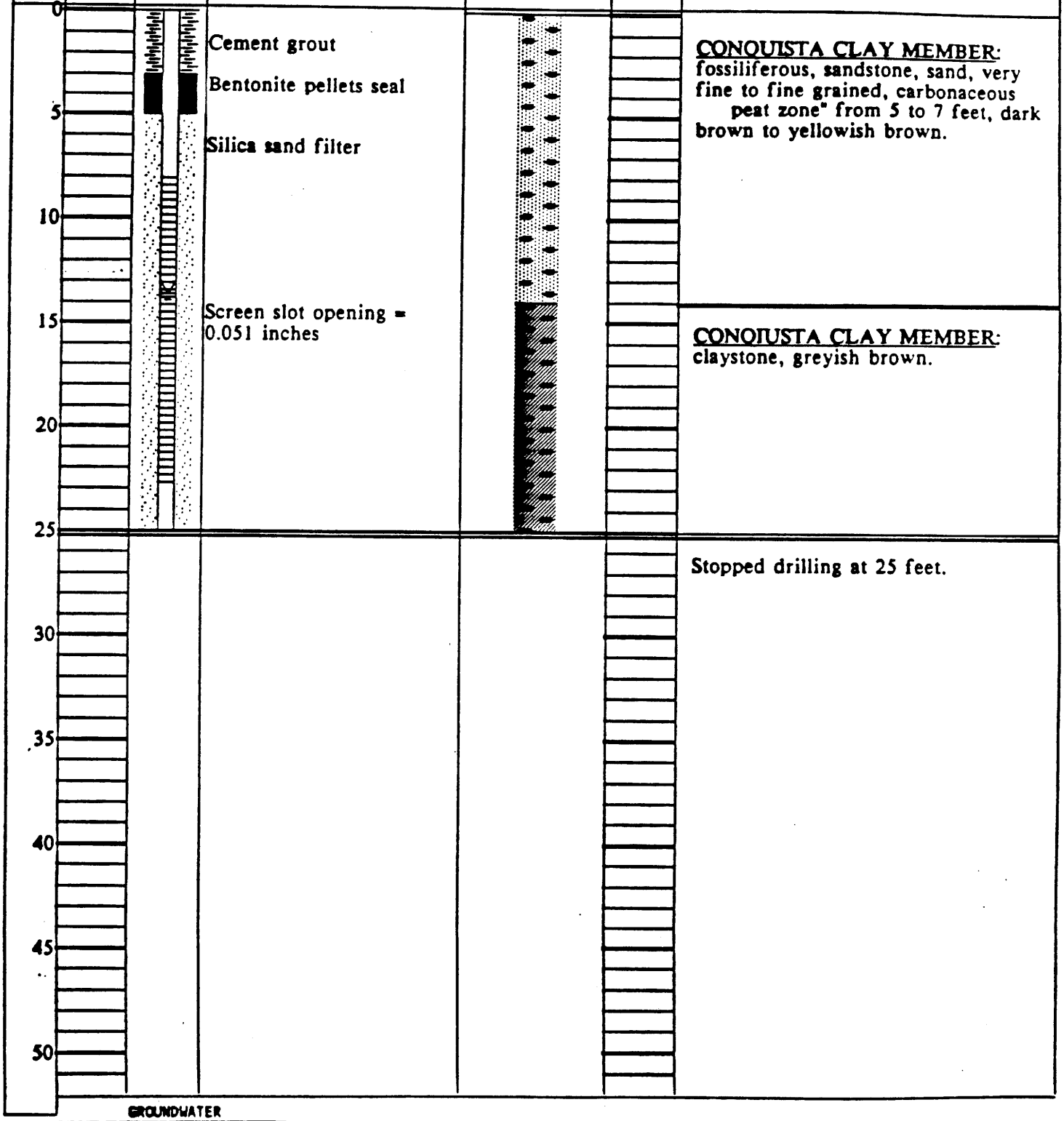
TOTAL DEPTH 25.0 feet

RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 65378.40 E 70988.10

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
13.6	N.K.	05/11/89

JOB NO. PC103 DATE 4/18/89

SURFACE ELEVATION 430.02

TOP OF CASING ELEVATION 432.11

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Lower Dilworth Sandstone

TOTAL DEPTH 110.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 66836.50 E 65846.00

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DEWEESVILLE SANDSTONE MEMBER: silty sand, trace clay, fine, predominately hard, light grey to tan.
5		Cement / bentonite slurry grout			Note: more clay from 5 to 10 feet.
10					CONQUISTA CLAY MEMBER: clayey sand, considerable silt, light grey to brown.
15					
20					Sandy clay, soft, light grey to light brown.
25		Bentonite chip seal			Clayey sand, fine sand, light grey interbeded with lense of light brown clay.
30					
35					
40					Clay, fossiliferous, carbonaceous, dark grey to black.
45					Note: lignite seam at 48.5 to 50 feet.
50					Clay, fossiliferous, carbonaceous,

GROUNDWATER

	DEPTH	HOUR	DATE
▽	85.9	N.K.	06/01/89
▽			

PROJECT Falls City, Texas

LOG OF TEST BORING NO. 967

JOB NO. FCT03 DATE 4/18/89

SURFACE ELEVATION 430.02

TOP OF CASING ELEVATION 432.11

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Lower Dilworth Sandstone

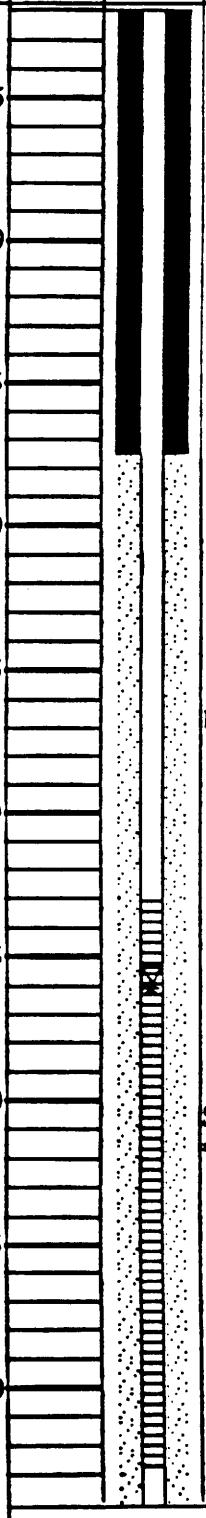
TOTAL DEPTH 110.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 66836.50 E 65846.00

DATUM MSL



USCS	Visual Classification
	black. Note: lignite seam at 52 to 53 feet.
	DILWORTH MEMBER: sandstone,clay, fossiliferous, carbonaceous, grey to black.
	Sand, silty, fine, soft, grey.
	Clayey sand, fine, soft, grey.
	Sand, medium fine, soft, trace to some grey clay.
	Clayey sand, fine with interbeded siltstone and clays, grey.
	Siltstone, with very fine sand, trace clays, grey.
	Sand, trace to some clays, fine, relativly soft.

GROUNDWATER

DEPTH	HOUR	DATE
85.9	N.K.	06/01/89

Falls City, Texas — LOG OF TEST BORING NO. 96/

JOB NO. FCT03 DATE 4/18/89
SURFACE ELEVATION 430.02
TOP OF CASING ELEVATION 432.11
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Lower Dilworth Sandstone

TOTAL DEPTH 110.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 66836.50 E 65846.00
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Formation cave-in material			Sandstone, fine, very hard, light grey.
					Sand, trace clays, fine, soft.
110					Stopped drilling at 110 feet.
115					
120					
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
85.9	N.K.	06/01/89

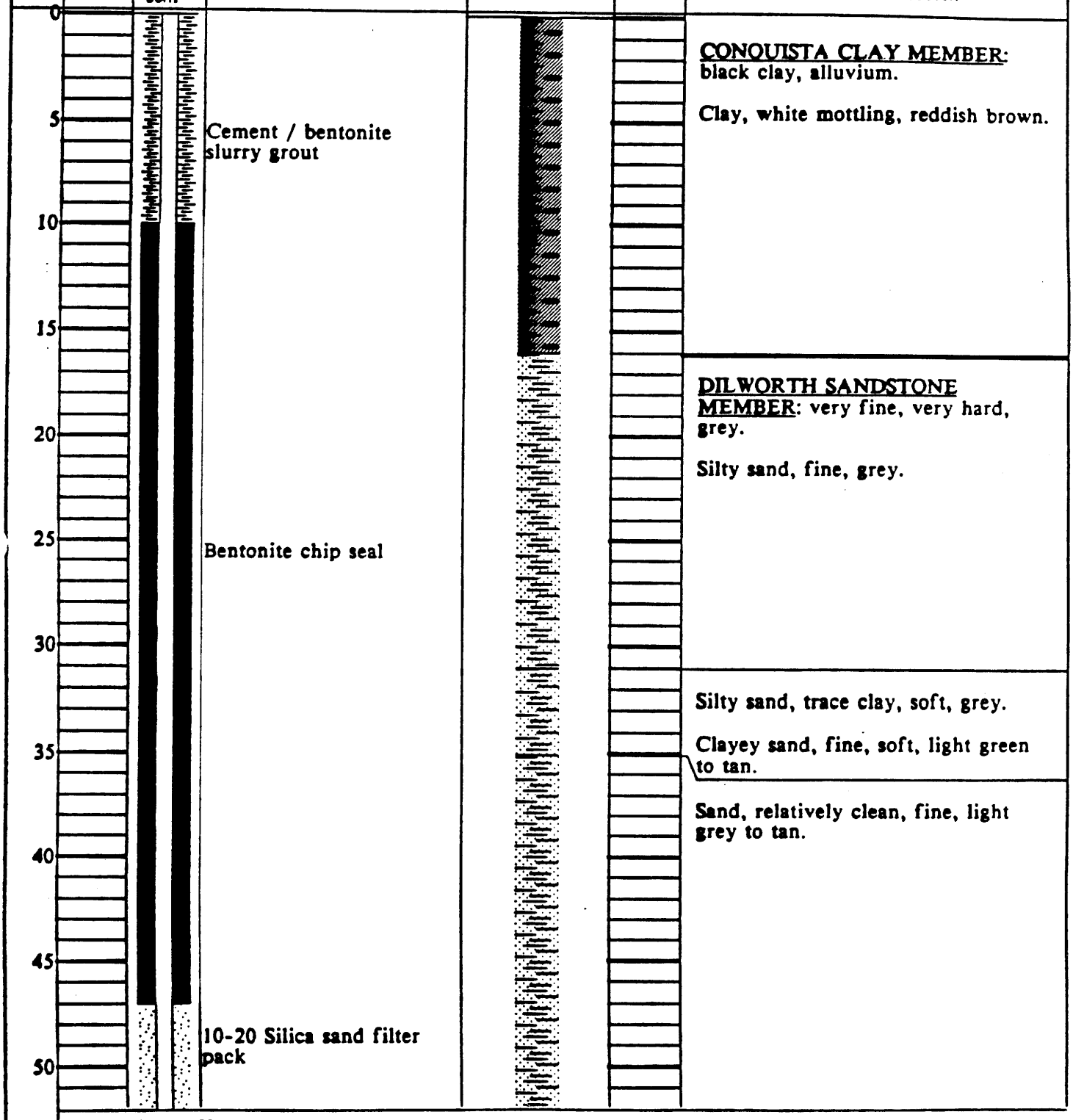
PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 968

JOB NO. FCT03 DATE 5/3/89

SURFACE ELEVATION 433.57
TOP OF CASING ELEVATION 435.36
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Lower Dilworth Sandstone

TOTAL DEPTH 80.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 64511.40 E 62105.50
DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
62.6	N.K.	05/31/89

PROJECT Falls City, Texas

LOG OF TEST BORING NO. 968

JOB NO. FCT03 DATE 5/3/89

SURFACE ELEVATION 433.57

TOP OF CASING ELEVATION 435.36

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Lower Dilworth Sandstone

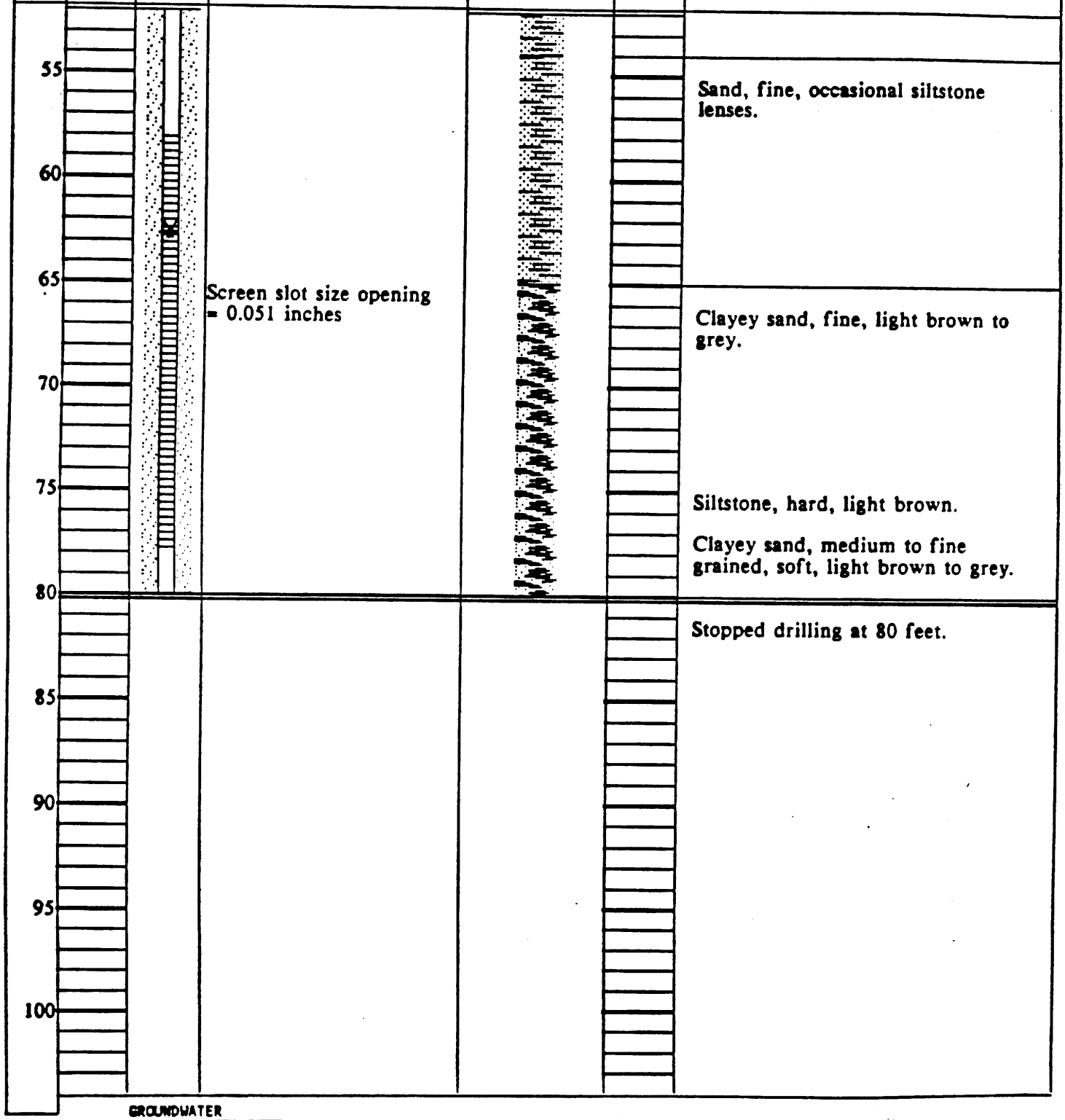
TOTAL DEPTH 80.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 64511.40 E 62105.50

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
62.6	N.K.	05/31/89

Falls City, Texas

LOG OF TEST BORING NO. 969

JOB NO. FCT03 DATE 4/30/89

SURFACE ELEVATION 440.38

TOP OF CASING ELEVATION 442.72

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sandstone

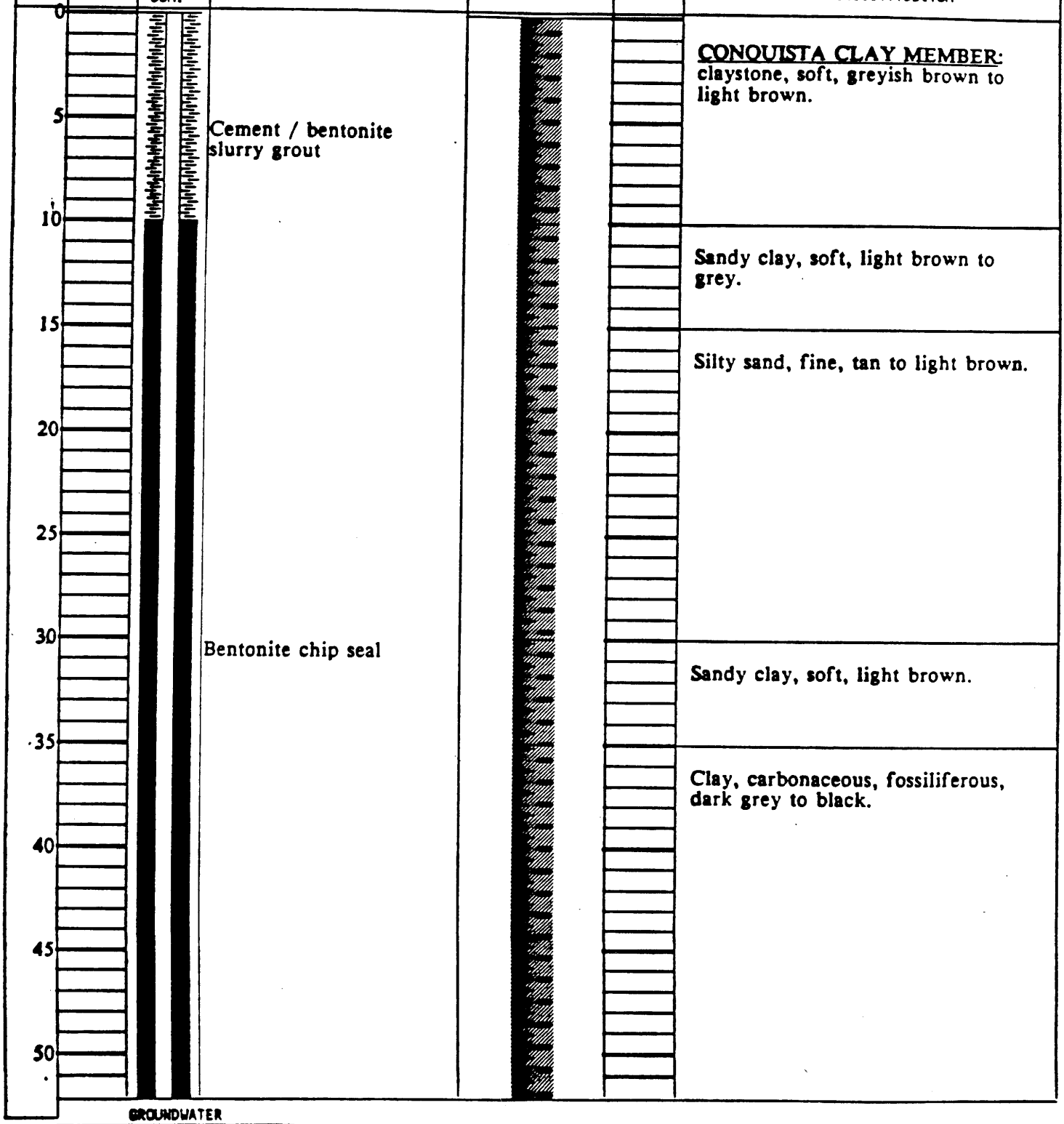
TOTAL DEPTH 110.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 57396.10 E 62190.40

DATUM MSL



GROUNDWATER

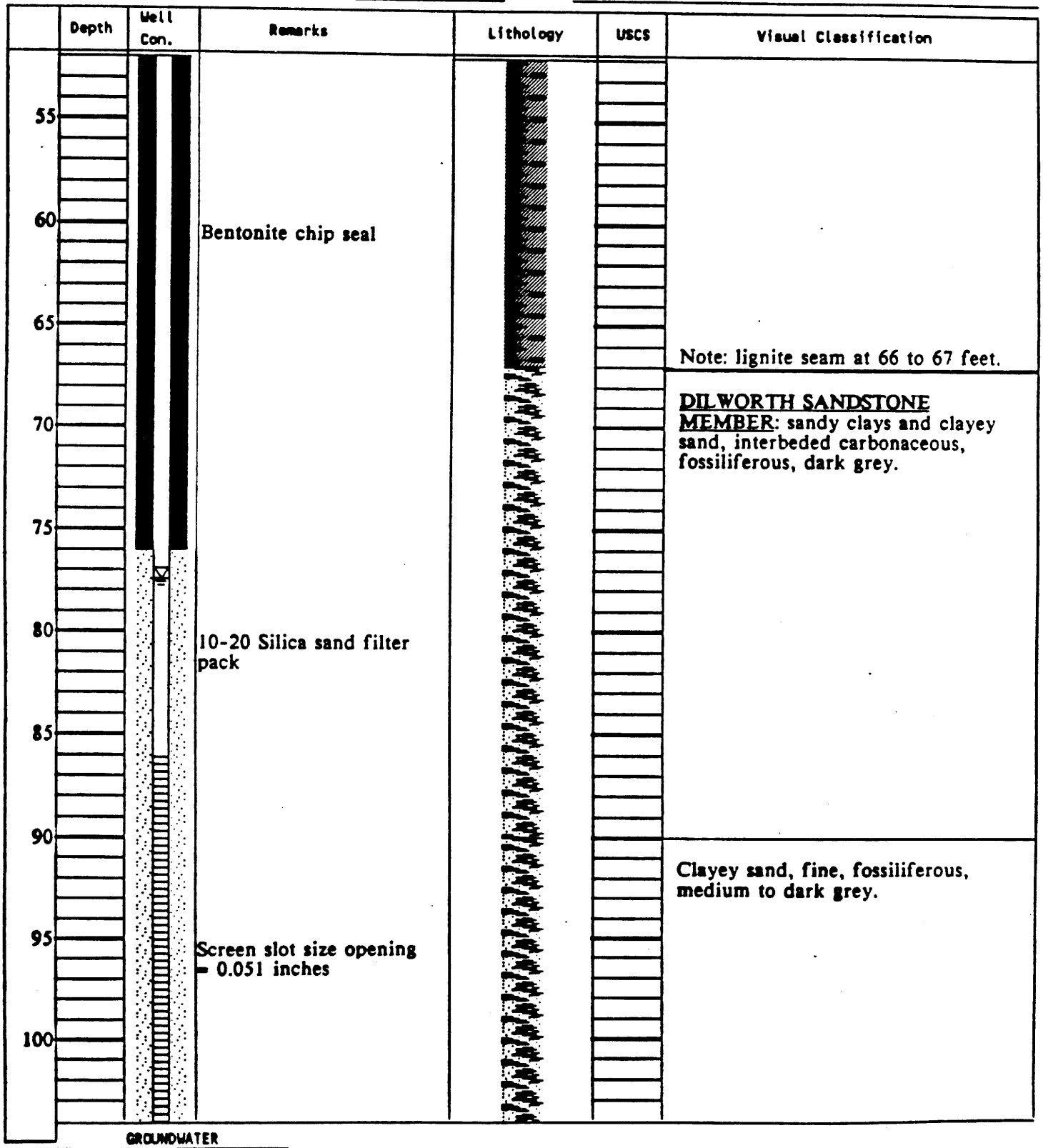
DEPTH	HOUR	DATE
77.5	N.K.	06/03/89

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 969

JOB NO. FCT03 DATE 4/30/89
SURFACE ELEVATION 440.38
TOP OF CASING ELEVATION 442.72
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Dilworth Sandstone

TOTAL DEPTH 110.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 57396.10 E 62190.40
DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
77.5	N.K.	06/03/89

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 969

JOB NO. FCT03 DATE 4/30/89

SURFACE ELEVATION 440.38
TOP OF CASING ELEVATION 442.72
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Dilworth Sandstone

TOTAL DEPTH 110.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 57396.10 E 62190.40
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Formation cave-in material			
110					Stopped drilling at 110 feet.
115					
120					
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
77.5	N.K.	06/03/89

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 970

JOB NO. FCT03 DATE 5/2/89
SURFACE ELEVATION 439.68
TOP OF CASING ELEVATION 441.46
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Manning Clay Formation

TOTAL DEPTH 158.5 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 57410.00 E 62203.80
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Cement / bentonite slurry grout			CONQUISTA CLAY MEMBER: claystone, silty clay, medium plastic to high plastic, soft, reddish brown to brown.
5					
10					
15					
20					Sandy clay, soft with considerable yellow to brown staining, grey.
25					
30		Bentonite chip seal			Clayey sand, fine, brown with white mineral section.
35					Clay, fossiliferous, carbonaceous, grey to black.
40					Note: same as above - 1 foot sand, fine, grey at 43 feet with trace of lignite at 43 feet.
45					Sandy clay, fossiliferous, carbonaceous, grading to very sandy at 48.5 feet, dark grey.
50					

GROUNDWATER

DEPTH	HOUR	DATE
116.5	N.K.	06/03/89

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 970

JOB NO. FCT03 DATE 5/2/89

SURFACE ELEVATION 439.68

TOP OF CASING ELEVATION 441.46

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Manning Clay Formation

TOTAL DEPTH 158.5 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 57410.00 E 62203.80

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					Clayey sand, fine, dark grey. Silty clay, occasional vertical fractures to 10 inches long, grey black
60					Sandy clay, soft, grey.
65					Clay, fossiliferous, carbonaceous, dark grey to black, lignite. Note: lignite seam from 66 ot 68 feet.
70					DILWORTH SANDSTONE MEMBER Clay, fossiliferous, carbonaceous, dark grey to black.
75		Bentonite chip seal			Clayey sand, becoming more sandy with depth, grey.
80					Sandstone, very fine, considerable silt and trace dark clay, moderately cemented, frequent dark banding.
85					Sandy clay, considerable silt, moderately well consolidated, occasional 2 inch interbedded sands.
90					Clay, trace to some fine sand, consolidated, grey.
95					Siltsone, alternating very hard sandstone and soft sands, fine, grey.
100					Sand, medium to fine grained, soft, grey.

GROUNDWATER

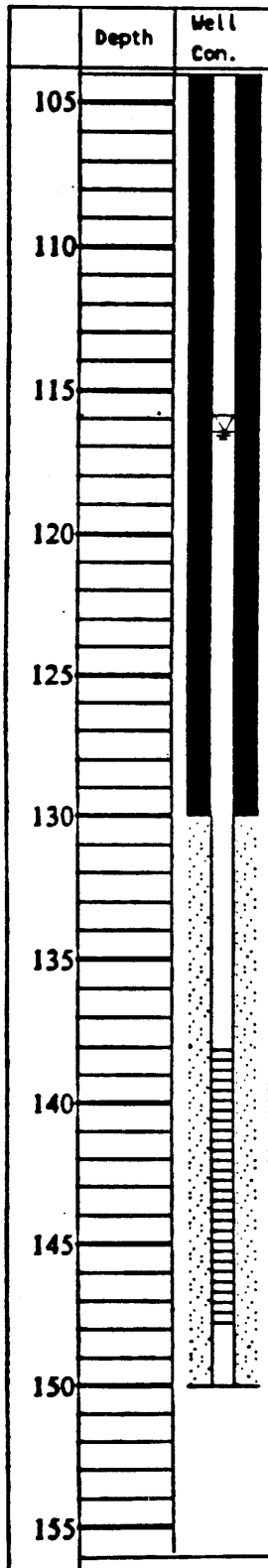
DEPTH	HOUR	DATE
116.5	N.K.	06/03/89

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 970

JOB NO. FCT03 DATE 5/2/89
SURFACE ELEVATION 439.68
TOP OF CASING ELEVATION 441.46
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Manning Clay Formation

TOTAL DEPTH 158.5 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 57410.00 E 62203.80
DATUM MSL



Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105–115		Bentonite chip seal			
115–120					Sandy clay, with sandstone nodules, dark grey.
120–130					Clayey sand, fine, relatively hard.
130–140		10-20 Silica sand filter pack			MANNING CLAY FORMATION Sandy clay, fossiliferous, occasional carbonaceous flecks, dark grey.
140–145		Screen slot opening = 0.02 inches			Clay, trace fine sand, relatively hard, dark grey.
145–150					Siltstone with claystone, strongly cemented, grey to white. Clay, relatively soft, dark grey.
150–155		Formation cave-in material			Clay, black carbonaceous mottling, light bluish grey.

GROUNDWATER

DEPTH	HOUR	DATE
116.5	N.K.	06/03/89

PROJECT Falls City, Texas

LOG OF TEST BORING NO. 970

JOB NO. FCT03 DATE 5/2/89

SURFACE ELEVATION 439.68

TOP OF CASING ELEVATION 441.46

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Manning Clay Formation

TOTAL DEPTH 158.5 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 57410.00 E 62203.80

DATUM MSL

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
			Formation cave-in material			
160						Stopped drilling at 158.5 feet.
165						
170						
175						
180						
185						
190						
195						
200						
205						

GROUNDWATER

DEPTH	HOUR	DATE
116.5	N.K.	06/03/89

Falls City, Texas

LOG OF TEST BORING NO. 971

JOB NO. FCT03 DATE 4/28/89

SURFACE ELEVATION 389.97

TOP OF CASING ELEVATION 392.14

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sandstone

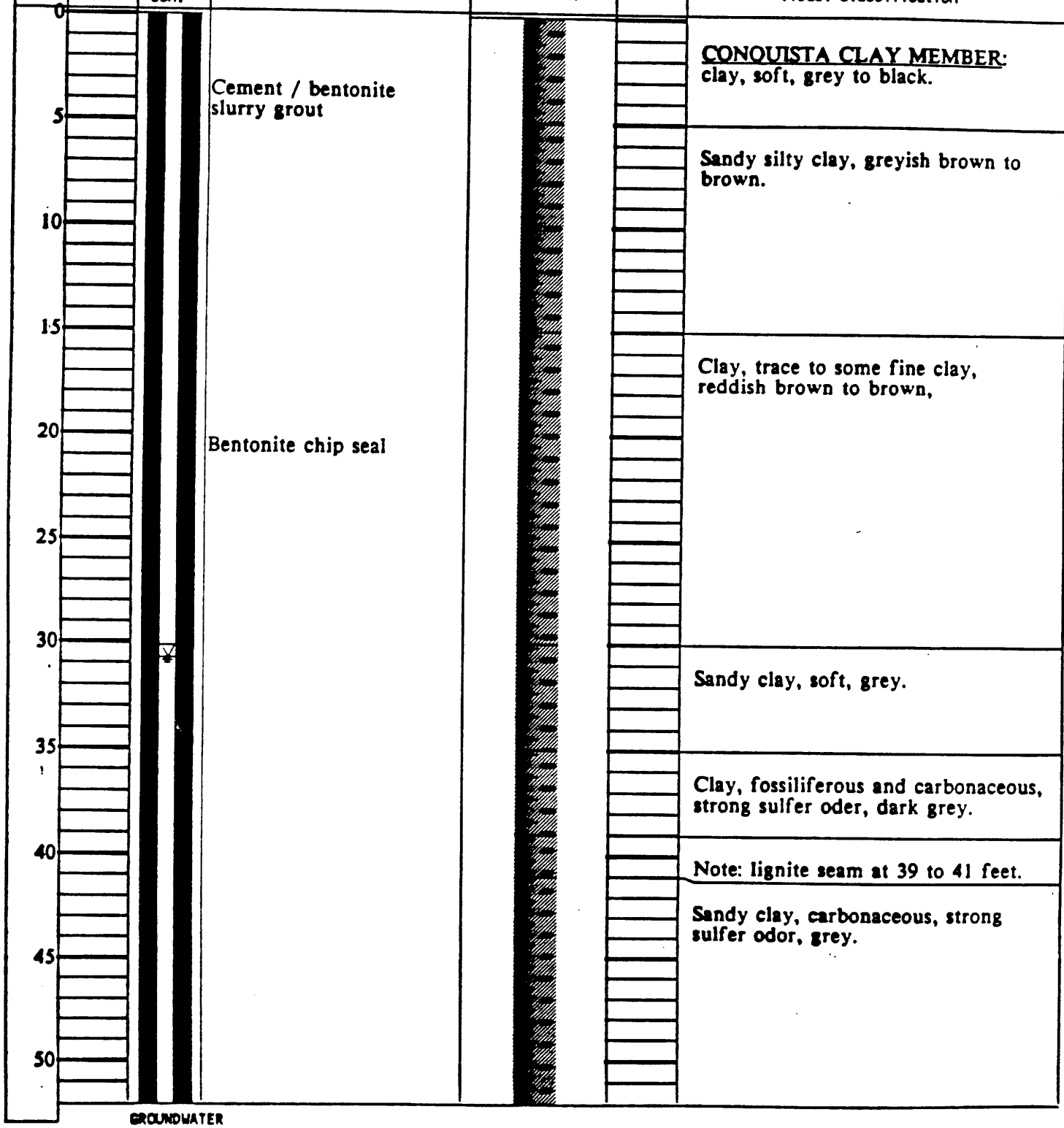
TOTAL DEPTH 158.5 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 55530.00 E 64106.40

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
30.7	N.K.	05/31/89

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 971

JOB NO. FCT03 DATE 4/28/89

SURFACE ELEVATION 389.97

TOP OF CASING ELEVATION 392.14

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sandstone

TOTAL DEPTH 158.5 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 55530.00 E 64106.40

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Bentonite chip seal			
60					
65		10-20 Silica sand filter pack			
70					DILWORTH SANDSTONE MEMBER: siltstone and sand, alternating very hard, trace lignite.
75					
80		Screen slot opening = 0.02 inches			Clayey sand, fine, dark grey.
85					Sands, trace to some fine clay, predominately fine, dark grey.
90					
95					Stopped drilling at 95 feet.
100					

GROUNDWATER

DEPTH	HOUR	DATE
30.7	N.K.	05/31/89

Falls City, Texas — LOG OF TEST BORING NO. 973

JOB NO. FCT03 DATE 4/12/89
SURFACE ELEVATION 435.94
TOP OF CASING ELEVATION 437.99
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Manning Clay

TOTAL DEPTH 230.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 55362.30 E 66834.00
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					
5		Cement / bentonite slurry grout			DUBOSE MEMBER: Whitsett Formation, clay, medium plastic to high plastic, light grey.
10					
15					Sandy clay, considerable silt, light grey.
20					DEWEESVILLE SAND MEMBER: Whitsett Formation, very thin sandstone linses, reddish brown to light grey.
25		Bentonite chip seal			
30					Clayey sand, fine, light grey.
35					
40					Silty sand, soft, fine to medium grained, grey to brown.
45					Siltstone, hard, reddish brown.
					Silty sandstone, fine grained, trace clays, grey to light brown.
50					Sand, medium to fine with

GROUNDWATER

DEPTH	HOUR	DATE
101.0	N.K.	05/11/89

Falls City, Texas

LOG OF TEST BORING NO. 973

JOB NO. FCT03 DATE 4/12/89

SURFACE ELEVATION 435.94

TOP OF CASING ELEVATION 437.99

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Manning Clay

TOTAL DEPTH 230.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 55362.30 E 66834.00

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					considerable silts, soft, moist.
60					
65					
70					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, considerable silt and fine sand, carbonaceous, fossiliferous, sulfer oder, grey to black.
75		Bentonite chip seal			
80					
85					
90					
95					Note: very strong sulfer oder at 95 to 100 feet.
100					

GROUNDWATER

DEPTH	HOUR	DATE
101.0	N.K.	05/11/89

JOB NO. PC103 DATE 4/12/89

SURFACE ELEVATION 435.94

TOP OF CASING ELEVATION 437.99

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Manning Clay

TOTAL DEPTH 230.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 55362.30 E 66834.00

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					
120					
125		Bentonite chip seal			
130					
135					
140					
145					Note: possibly lignite 140 to 145 with strong sulfer oder.
150					DILWORTH LOWER MEMBER: sand, fine sand, clayey with carbonaceous lenses, grey to brown.
155					

GROUNDWATER

DEPTH	HOUR	DATE
101.0	N.K.	05/11/89

Falls City, Texas — LOG OF TEST BORING NO. 973

JOB NO. FCT03 DATE 4/12/89

SURFACE ELEVATION 435.94

TOP OF CASING ELEVATION 437.99

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Manning Clay

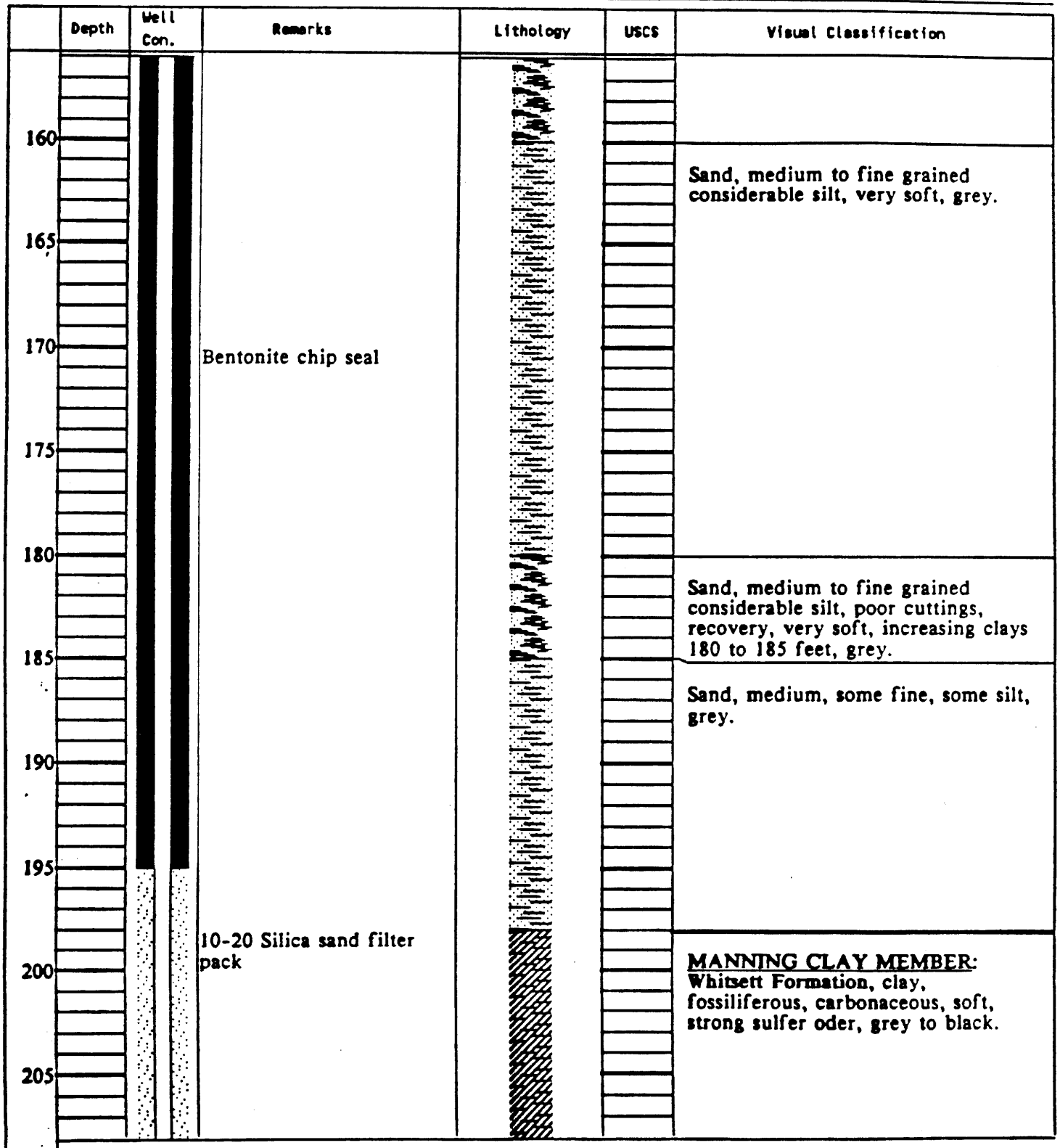
TOTAL DEPTH 230.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 55362.30 E 66834.00

DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
101.0	N.K.	05/11/89

SURFACE ELEVATION 435.94
TOP OF CASING ELEVATION 437.99
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Manning Clay

TOTAL DEPTH [illegible] feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 55362.30 E 66834.00
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210					
215					MANNING CLAY FORMATION: Clay, fossiliferous, carbonaceous, soft, strong sulfer oder, grey to black.
220		Screen slot opening = 0.02 inches			
225					
230					Stopped boring at 230 feet.
235					
240					
245					
250					
255					
260					

GROUNDWATER

DEPTH	HOUR	DATE
101.0	N.K.	05/11/89

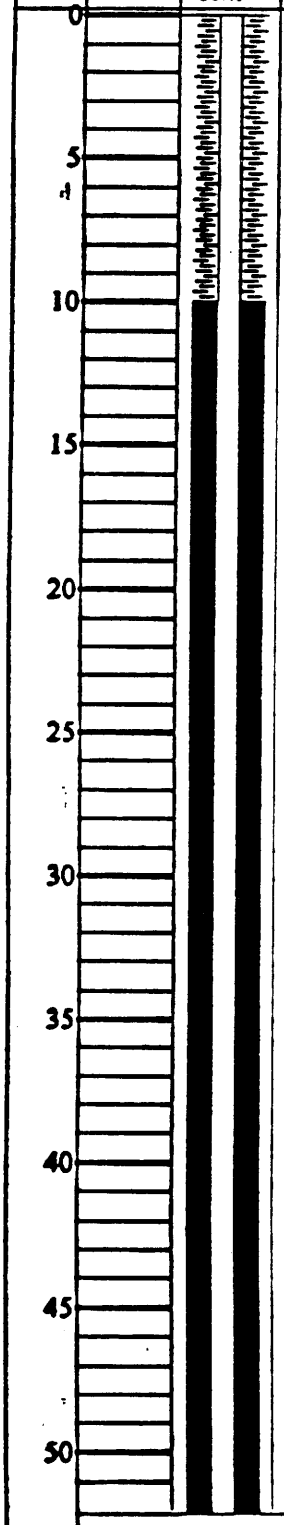
PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 974

JOB NO. FCT03 DATE 4/14/89

SURFACE ELEVATION 434.84
TOP OF CASING ELEVATION 436.64
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Dilworth Sand

TOTAL DEPTH 170.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 55370.60 E 66813.30
DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

JOB NO. [illegible] DATE 4/14/89

SURFACE ELEVATION 434.84
TOP OF CASING ELEVATION 436.64
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Dilworth Sand

TOTAL DEPTH 170.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 55370.60 E 66813.30
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					grained, considerable silt with clay.
60					Sandstone, sand, medium to fine grained, considerable silt with clay.
65					
70					Sandstone, clay, carbonaceous, fossiliferous, with thin siltstone with sandstone lenses.
75					
80					
85					
90					Sandstone, clay, carbonaceous, fossiliferous, with thin siltstone with sandstone lenses.
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

Falls City, Texas

LOG OF TEST BORING NO. 974

JOB NO. FCT03 DATE 4/14/89

SURFACE ELEVATION 434.84

TOP OF CASING ELEVATION 436.64

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sand

TOTAL DEPTH 170.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 55370.60 E 66813.30

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					
120					Sandstone, clay, carbonaceous, fossiliferous, with thin siltstone with sandstone lenses.
125					
130					
135					
140					Note: lignite, lignitous clay, strong sulfer oder.
145					DILWORTH LOWER MEMBER: sandstone, sandy clay, fine, relatively hard.
150					Sand, predominatly fine, relatively soft, grey.
155					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

JOB NO. [illegible] DATE [illegible]

SURFACE ELEVATION 434.84
TOP OF CASING ELEVATION 436.64
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Dilworth Sand

TOTAL DEPTH 170.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 55370.60 E 66813.30
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165					
170					Stopped boring at 170 feet, set well screen at 148 to 168.
175					
180					
185					
190					
195					
200					
205					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

Pauls City, Texas — LOG OF TEST BORING NO. 975

JOB NO. FCT03 DATE 4/15/89

SURFACE ELEVATION 449.62

TOP OF CASING ELEVATION 451.89

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sand

TOTAL DEPTH 210.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 60037.00 E 70540.80

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DUBOSE MEMBER: Whitsett Formation, sand, considerable silt, fine, grey to white.
5					
10					
15					Clayey sand, fine, grey to white.
20					
25					
30					Clay, medium plasticity, reddish brown with white mottling.
35					Clay, carbonaceous, soft, dark reddish brown.
40					Sandy clay, considerable silt, carbonaceous, grey.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

JOB NO. FCT03 DATE 4/15/89

SURFACE ELEVATION 449.62

TOP OF CASING ELEVATION 451.89

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sand

TOTAL DEPTH 210.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 60037.00 E 70540.80

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					Sandy clay, considerable silt, carbonaceous, grey.
65					
70					
75					Note: lignite seam
80					DEWEESVILLE FORMATION: sandstone, medium to fine grained, alternation hard to soft layers, light grey,
85					
90					Sandstone, medium to fine grained, alternation hard to soft layers, light grey,
95					Clayey sand, fine, soft, grey,
100					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

LOG OF TEST BORING NO. 975

JOB NO. FCT03 DATE 4/15/89

SURFACE ELEVATION 449.62

TOP OF CASING ELEVATION 451.89

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sand

TOTAL DEPTH 210.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 60037.00 E 70540.80

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					**CONQUISTA CLAY FORMATION:** sandy clay, relatively hard, grey,
120					Sandy clay, relatively hard, grey,
125					
130					
135					
140					
145					Sandy clay, soft, grey,
150					Sandy clay, soft, grey,
155					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

Falls City, Texas

LOG OF TEST BORING NO. 975

JOB NO. FCT03 DATE 4/15/89

SURFACE ELEVATION 449.62

TOP OF CASING ELEVATION 451.89

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sand

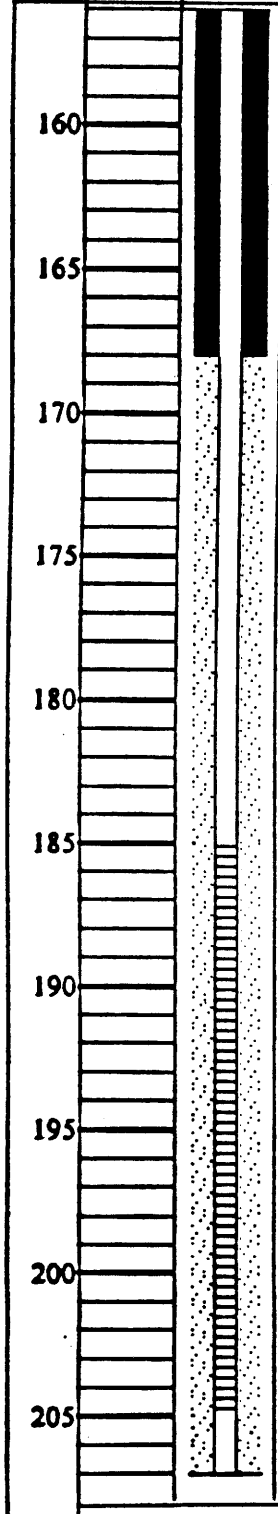
TOTAL DEPTH 210.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 60037.00 E 70540.80

DATUM MSL



Visual Classification
Note: carbonaceous at 155 feet.
Note: lignite, with black clay interbeded.
DILWORTH LOWER MEMBER: sand, clayey, medium to fine grained, alternating hard to soft layers, grey.
Sand, fine, carbonaceous, soft, grey.

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

JOB NO. FC103 DATE 4/15/89

SURFACE ELEVATION 449.62

TOP OF CASING ELEVATION 451.89

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Dilworth Sand

TOTAL DEPTH 210.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 60037.00 E 70540.80

DATUM MSL

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210						Stopped boring at 210 feet.
215						
220						
225						
230						
235						
240						
245						
250						
255						
260						

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

Falls City, Texas

LOG OF TEST BORING NO. 976

JOB NO. FCT03 DATE 4/26/89

SURFACE ELEVATION 359.42

TOP OF CASING ELEVATION 361.27

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Upper Dilworth

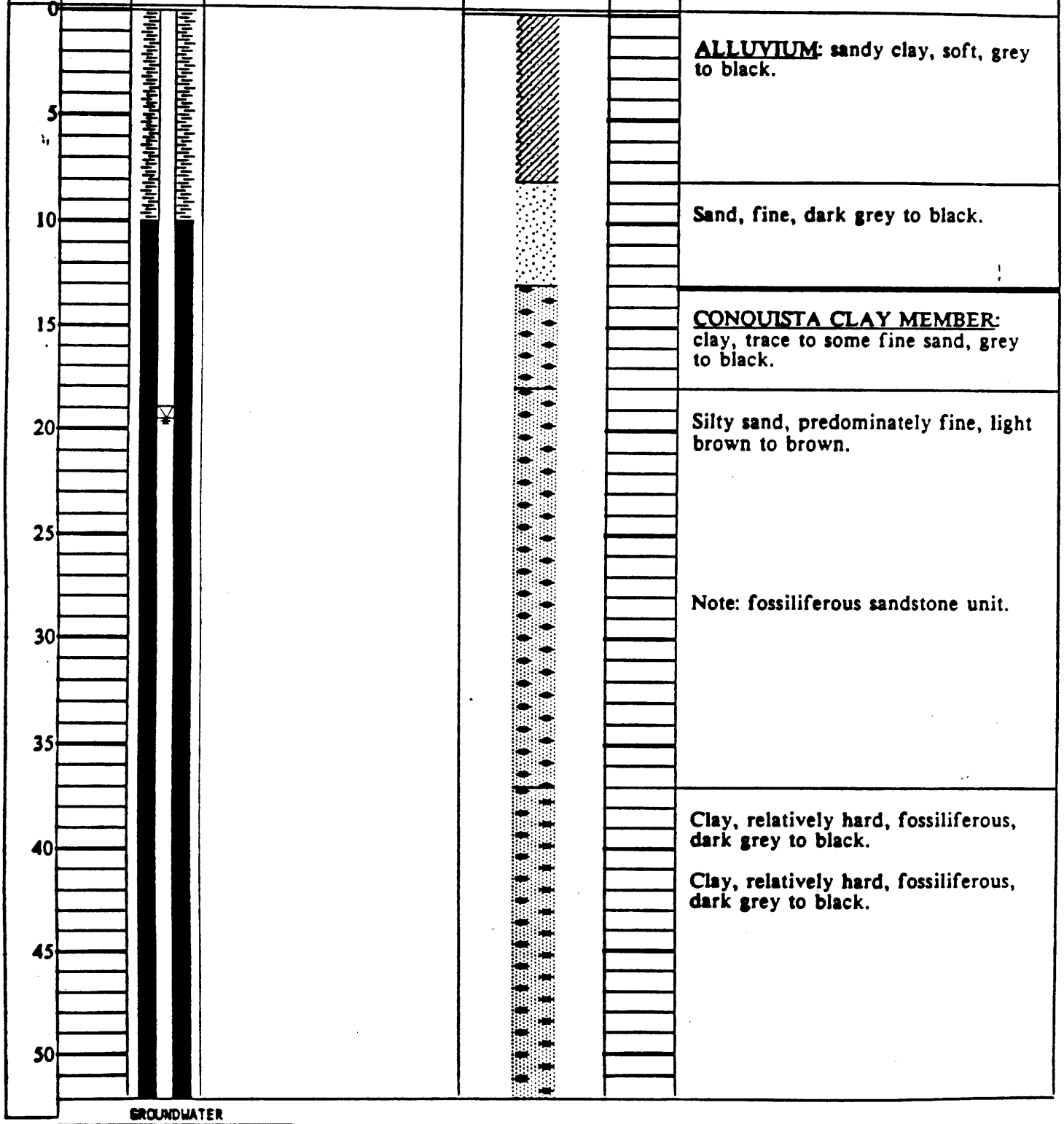
TOTAL DEPTH 110.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 66683.63 E 71636.97

DATUM MSL



GROUNDWATER

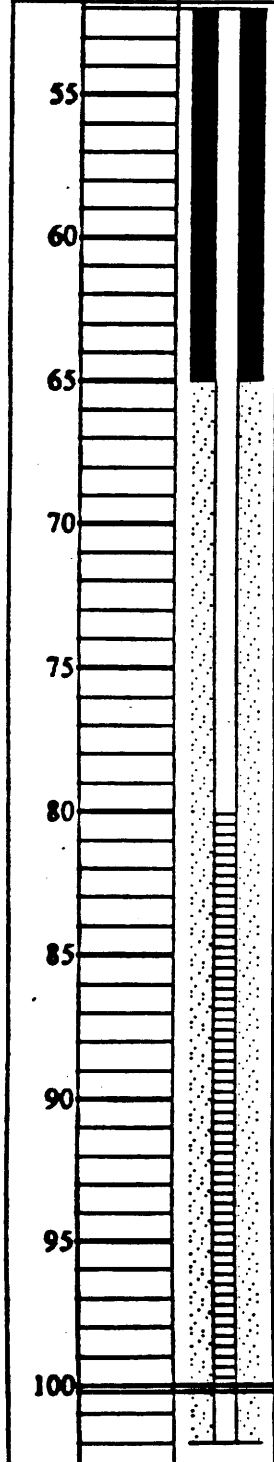
DEPTH	HOUR	DATE
19.5	N.R.	

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 976

JOB NO. FCT03 DATE 4/26/89
SURFACE ELEVATION 359.42
TOP OF CASING ELEVATION 361.27
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Upper Dilworth

TOTAL DEPTH 110.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 66683.63 E 71636.97
DATUM MSL



Depth	Remarks	USCS	Visual Classification
55			Clayey sand, fossiliferous, dark grey to black.
60			CONQUISTA CLAY MEMBER: clay, carbonaceous, dark grey to black.
65			
70			CONQUISTA CLAY MEMBER: sandy clay, fossiliferous, carbonaceous, dark grey to black.
75			CONQUISTA CLAY MEMBER: sandy clay, alternating hard to soft.
80			DILWORTH LOWER MEMBER: lignite, lenses at 77 to 78 feet.
85			Note: trace yellow mineralization, 85 to 86 feet.
90			Sandy clay, occasional siltstone, relatively hard,
95			Clay, relatively soft, grey to black.
100			Stopped drilling at 100 feet.

GROUNDWATER

DEPTH	HOUR	DATE
19.5	N.K.	

PROJECT Falls City, Texas

LOG OF TEST BORING NO. 977

JOB NO. FCT03 DATE 4/25/89

SURFACE ELEVATION 359.42

TOP OF CASING ELEVATION 361.17

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Clay Member

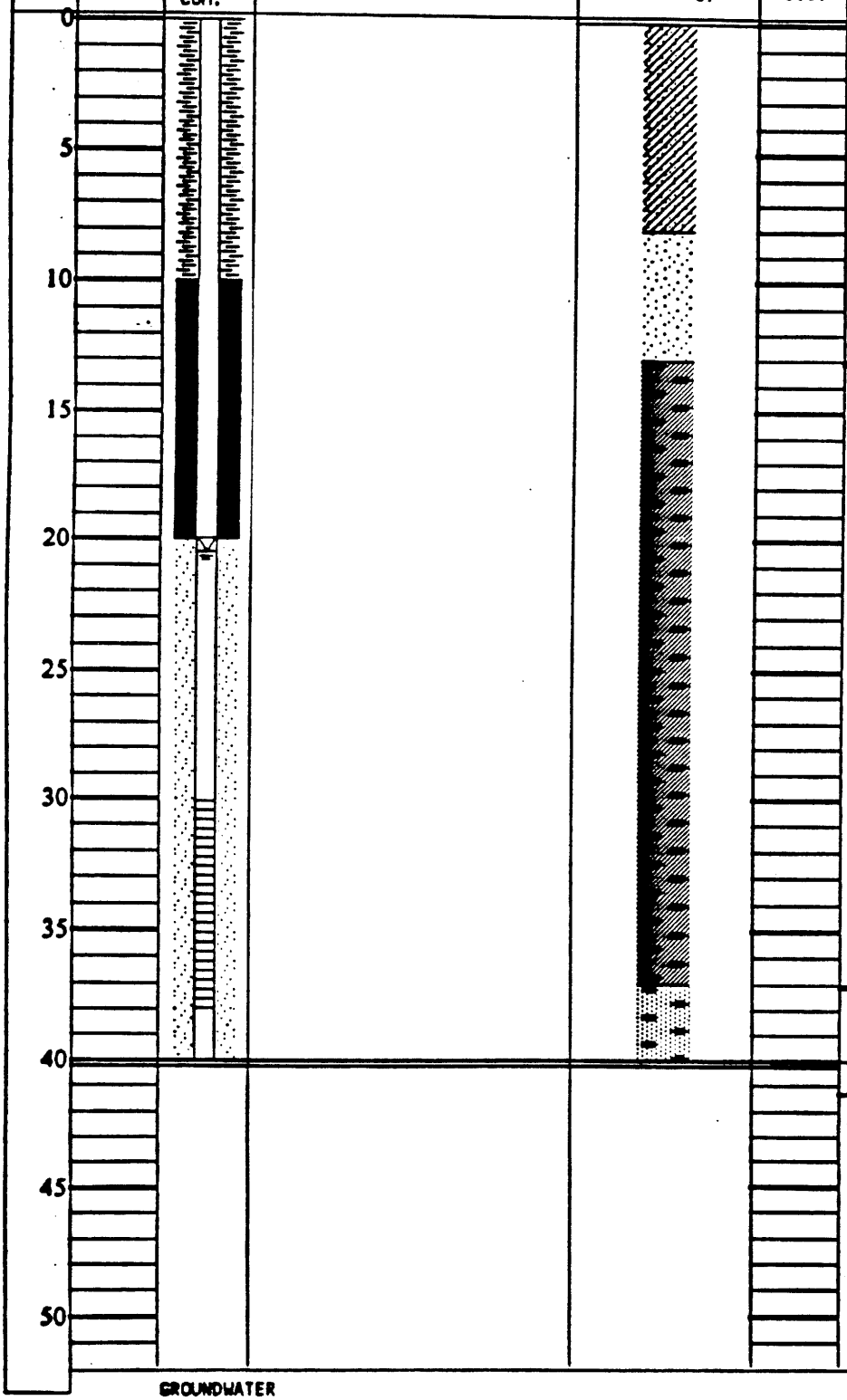
TOTAL DEPTH 40.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 66667.66 E 71651.71

DATUM MSL



Visual Classification
ALLUVIUM: sandy clay, soft, grey to black.
Sand, fine, dark grey.
CONQUISTA CLAY MEMBER: clay, trace to some fine sand, grey to black.
Silty sand, predominately fine, light brown to brown.
Note: fossiliferous sandstone unit.
CONQUISTA CLAY MEMBER: clay, relatively hard, fossiliferous, dark grey to black.
Stopped drilling at 40 feet.

GROUNDWATER

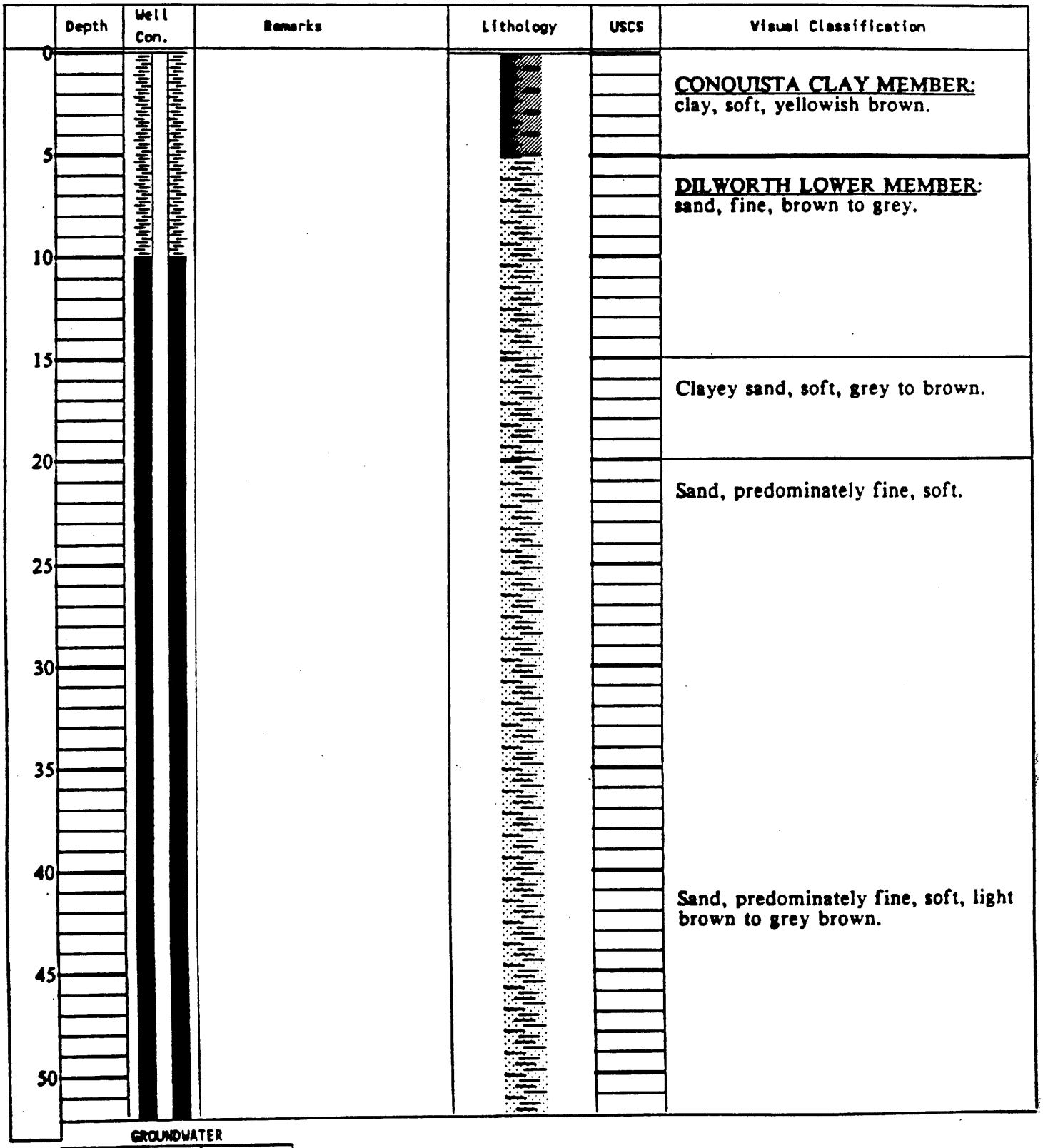
DEPTH	HOUR	DATE
20.5	N.K.	04/25/89

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 978

JOB NO. FCT03 DATE 4/28/89
SURFACE ELEVATION 414.63
TOP OF CASING ELEVATION 417.12
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Manning Clay Formation

TOTAL DEPTH 140.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 64822.20 E 63668.70
DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

Falls City, Texas

LOG OF TEST BORING NO. 978

JOB NO. FCT03 DATE 4/28/89

SURFACE ELEVATION 414.63

TOP OF CASING ELEVATION 417.12

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Manning Clay Formation

TOTAL DEPTH 140.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 64822.20 E 63668.70

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
70					Note: some interbedded black clays 70 to 80 feet. Note: relatively hard, cemented lenses 70 to 80 feet.
75					
80					
85					
90					
95					MANNING CLAY FORMATION: sandy clay, relatively slow drilling, grey to black.
100					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

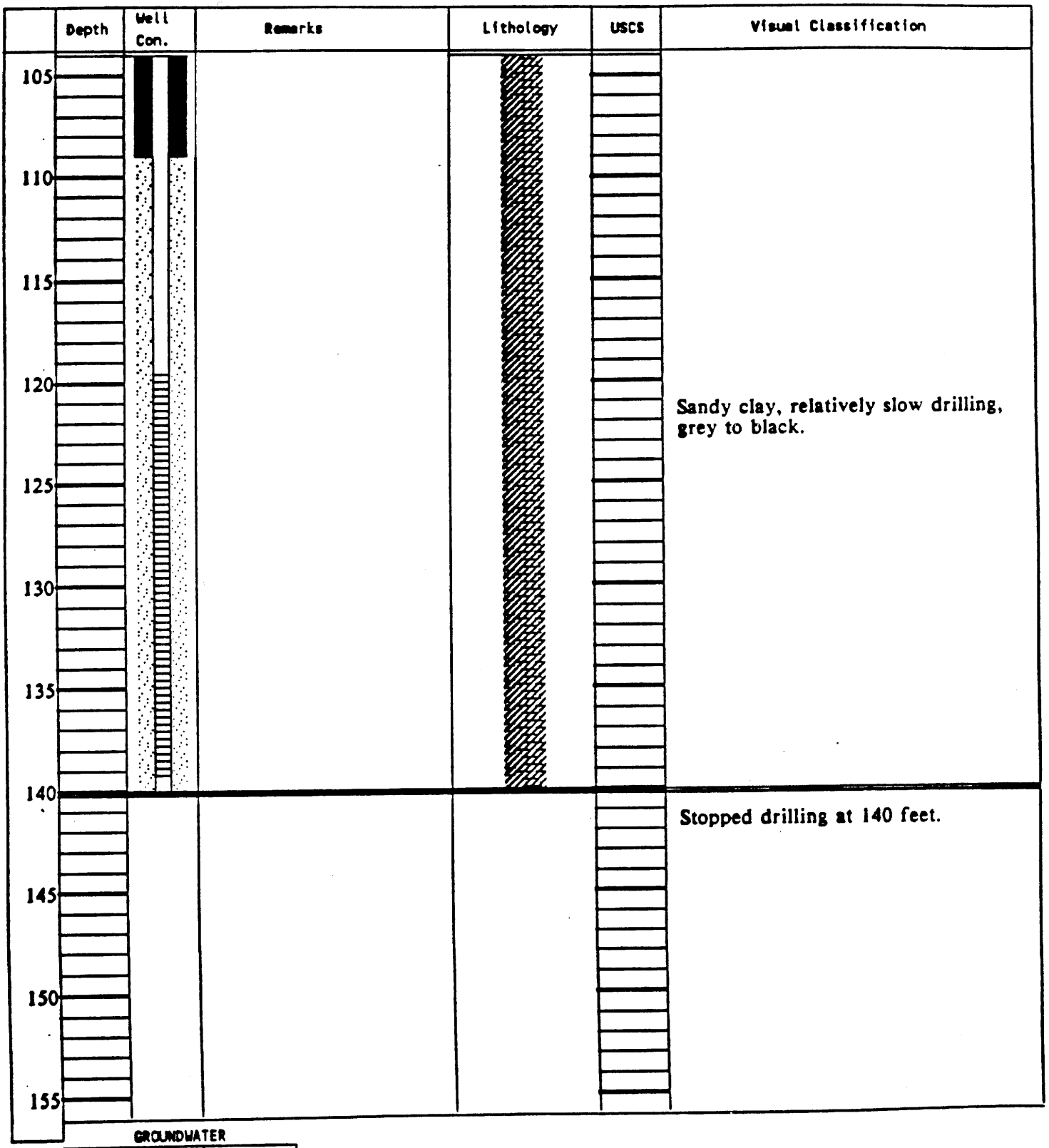
PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 978

JOB NO. FCT03 DATE 4/28/89

SURFACE ELEVATION 414.63
TOP OF CASING ELEVATION 417.12
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Manning Clay Formation

TOTAL DEPTH 140.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 64822.20 E 63668.70
DATUM MSL



GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT UMIKA
Falls City, Texas

LOG OF TEST BORING NO. 979

JOB NO. FCT03 DATE 4/18/89

SURFACE ELEVATION 418.40
TOP OF CASING ELEVATION 420.81
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Dilworth Sand Whitsett Formation

TOTAL DEPTH 102.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 65119.20 E 65944.60
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: clay, soft, medium to hard plastic, black.
5		Bentonite cement slurry grout			Sandy clay, relatively hard, grey.
10					
15					Clayey sand, very fine, considerable silt, light grey.
20					Sandy clay, relatively soft, grey to grey brown.
25					
30					Clay, carbonaceous, medium to high plastic, dark grey.
35					Note: lignite layers from 36 to 37 feet and 38 to 39 feet.
40		Bentonite pellet seal			DILWORTH LOWER MEMBER: silty sand, fine, grey.
45					
50					Sandy clay, dark grey.

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 979

JOB NO. FCT03 DATE 4/18/89
SURFACE ELEVATION 418.40
TOP OF CASING ELEVATION 420.81
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Dilworth Sand Whitsett Formation

TOTAL DEPTH 102.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 65119.20 E 65944.60
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60		10-20 Silica sand filter pack			Sand, very fine, hard, grey. Sand, very fine, considerable silt, light grey.
65					
70					
75					Sand, medium to fine, silty, light grey.
80		Screen slot size opening = 0.051 inches			
85					
90					
95		Bentonite pellet backfill			
100					Stopped drilling at 100 feet.

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1000

JOB NO. FCT01 DATE

TOTAL DEPTH 207.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE unknown
WELL CASING TYPE 3.8 ID steel
LOCATION N E
COMPLETION windmill
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		ESTIMATE OF LITHOLOGY FROM NAT. GAMMA, DENSITY, AND NEUTRON LOGS	?		STEEL CASING AND GROUT ? MASKS LITHOLOGY TO 45 FEET.
5					
10		CALIPER LOG SHOWS SEVERE CORROSION AT 20 FT, AT 39, AT 58 AND THROUGOUT SLOTTED SECTION FROMN 101 TO 207 FEET.			
15					
20		POSSIBLE BROKEN CASING AT 140 AND AT 175			
25					
30					
35					
40					
45				CL	SHALE
50					

GROUNDWATER

DEPTH	HOUR	DATE
116.0		

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1000

JOB NO. FCT01 **DATE**

TOTAL DEPTH 207.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE unknown
WELL CASING TYPE 3.8 ID steel
LOCATION N E
COMPLETION windmill
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
70					
75					
80					
85					
90				SM	SAND
95					
100				CL	SHALE

GROUNDWATER

DEPTH	HOUR	DATE
116.0		

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1000

JOB NO. FCT01 DATE

SURFACE ELEVATION
DEPTH OF SEAL
WELL CASING TYPE 3.8 ID steel
COMPLETION windmill

TOTAL DEPTH 207.0 feet
WELL OWNER
BORING TYPE unknown
LOCATION N E
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115				SM	SAND
120					
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
116.0		

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1000

JOB NO. FCT01 **DATE**

TOTAL DEPTH 207.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE unknown
WELL CASING TYPE 3.8 ID steel
LOCATION N E
COMPLETION windmill
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165					
170					
175					
				CL	SHALE
180					
185					
190					
195					
200					
205					
					TD AT 207

GROUNDWATER

DEPTH	HOUR	DATE
116.0		

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 **DATE**

TOTAL DEPTH 435.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 3.85 ID steel
LOCATION N E
COMPLETION windmill
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		SURFACE CASING TO 45 FEET.			SURFACE CASING TO 45 MASKS LITHOLOGY
5		SLOTTED SECTION FROM 141 TO 201 AND 401 TO 431			
10		BROKEN JOINT AT 321?			
15					
20					
25					
30					
35					
40					
45				SM	SAND
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 **DATE**

TOTAL DEPTH 435.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 3.85 ID steel
LOCATION N E
COMPLETION windmill
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 DATE

TOTAL DEPTH 435.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 3.85 ID steel
LOCATION N E
COMPLETION windmill
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					
120					
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 **DATE**

TOTAL DEPTH 435.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 3.85 ID steel
LOCATION N E
COMPLETION windmill
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165					
170					
175					
180					
185					
190					
195					
200					
205					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 DATE

SURFACE ELEVATION
DEPTH OF SEAL
WELL CASING TYPE 3.85 ID steel
COMPLETION windmill

TOTAL DEPTH 435.0 feet
WELL OWNER
BORING TYPE
LOCATION N E
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210					
215					
220					
225					
230					
				CL	SHALE
235					
240				SM	SAND
245					
250					
255					
260					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT *Falls City Site*
Texas

LOG OF WELL BORING NO. 1003

JOB NO. *FCT01* **DATE**

TOTAL DEPTH 435.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 3.85 ID steel
LOCATION N E
COMPLETION windmill
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
260					
265					
270					
275					
280				CL	SHALE
285				SM	SAND
290					
295					
300					
305					
310					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 DATE

SURFACE ELEVATION
DEPTH OF SEAL
WELL CASING TYPE 3.85 ID steel
COMPLETION windmill

TOTAL DEPTH 435.0 feet
WELL OWNER
BORING TYPE
LOCATION N E
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
315					
320					
325					
330					
335					
340					
345					
350					
355					
360					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 DATE

TOTAL DEPTH 435.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 3.85 ID steel
LOCATION N E
COMPLETION windmill
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
365					
370					
375					
380					
385					
390					
395					
400					
405					
410					
415					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 DATE

TOTAL DEPTH 435.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 3.85 ID steel
LOCATION N E
COMPLETION windmill
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
420					
425					
430					
435					TD AT 435
440					
445					
450					
455					
460					
465					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1010

JOB NO. FCT01 **DATE**

TOTAL DEPTH 135.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 3.85 in. ID
LOCATION N E
COMPLETION
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		SLOTTED SECTION FROM 89 TO 109	?		POSSIBLE STEEL SURFACE CASING TO 14 FEET
5			?		
10		SLOTTED SECTION SEVERELY CORRODED. POSSIBLE BREAK AT 98 FT	?		
15				CL	CLAY OR GROUT SEAL?
20					
25					
30				CL	SANDY CLAY ?
35					
40					
45					
50				SM	SAND Dawsonville ?

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1010

JOB NO. FCT01 DATE

TOTAL DEPTH 135.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 3.85 in. ID
LOCATION N E
COMPLETION
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
70					
75					
80					
85					COAL OR BENTONITE SEAL
				SM	SAND
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

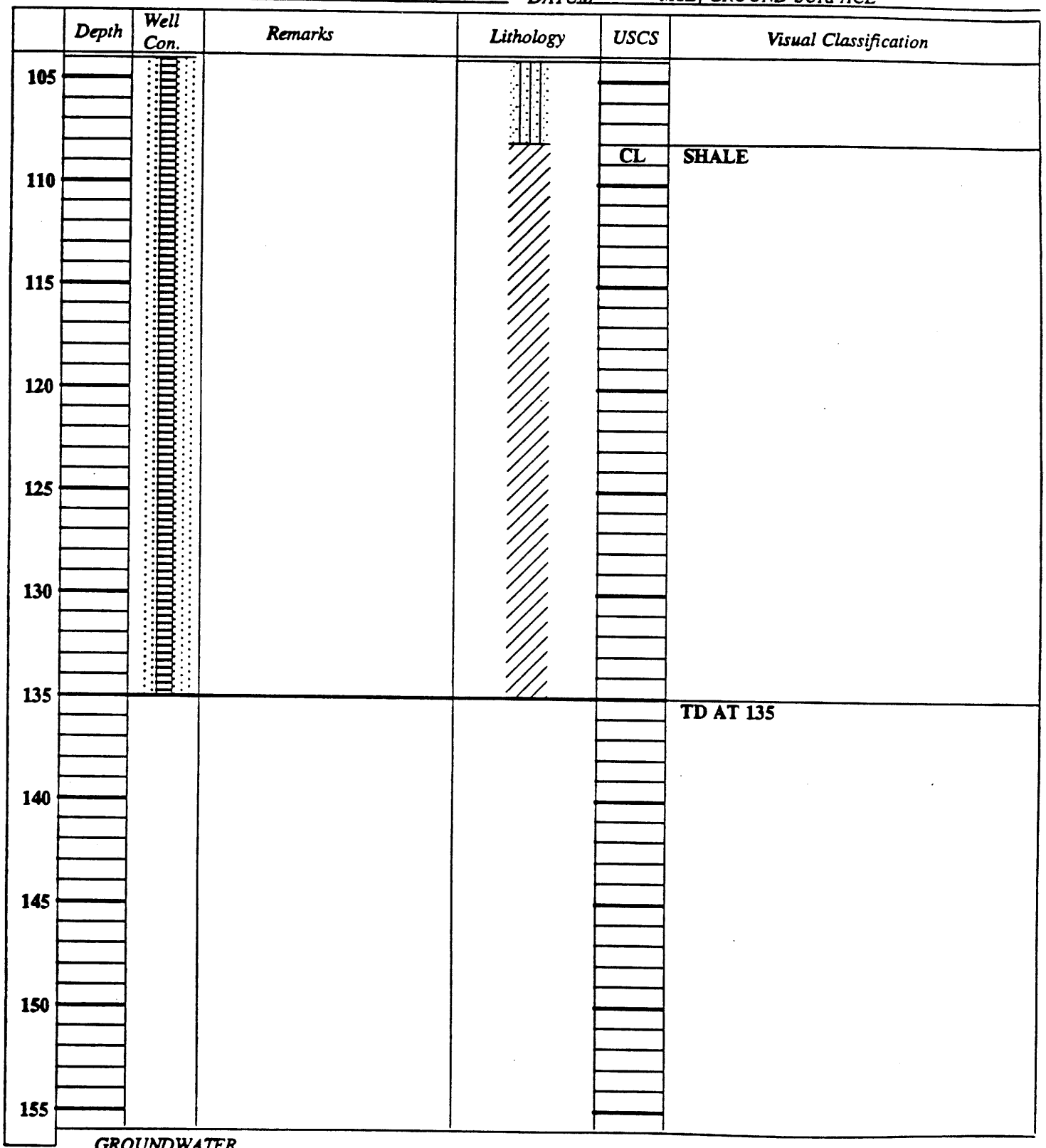
PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1010

JOB NO. FCT01 **DATE**

SURFACE ELEVATION
DEPTH OF SEAL
WELL CASING TYPE 3.85 in. ID
COMPLETION

TOTAL DEPTH 135.0 feet
WELL OWNER
BORING TYPE
LOCATION N E
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1011

JOB NO. FCT01 DATE

TOTAL DEPTH 281.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 4.9 in ID
LOCATION N E
COMPLETION
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					(No log from surface to 50 because of steel casing masking lithology)
		SLOTTED SECTION AT 112 TO 152 AND FROM 251 TO 276.			
5					
10		BROKEN JOINT AT 251			
15					
20					
25					
30					
35					
40					
45					
50				SM	SAND

GROUNDWATER

DEPTH	HOUR	DATE

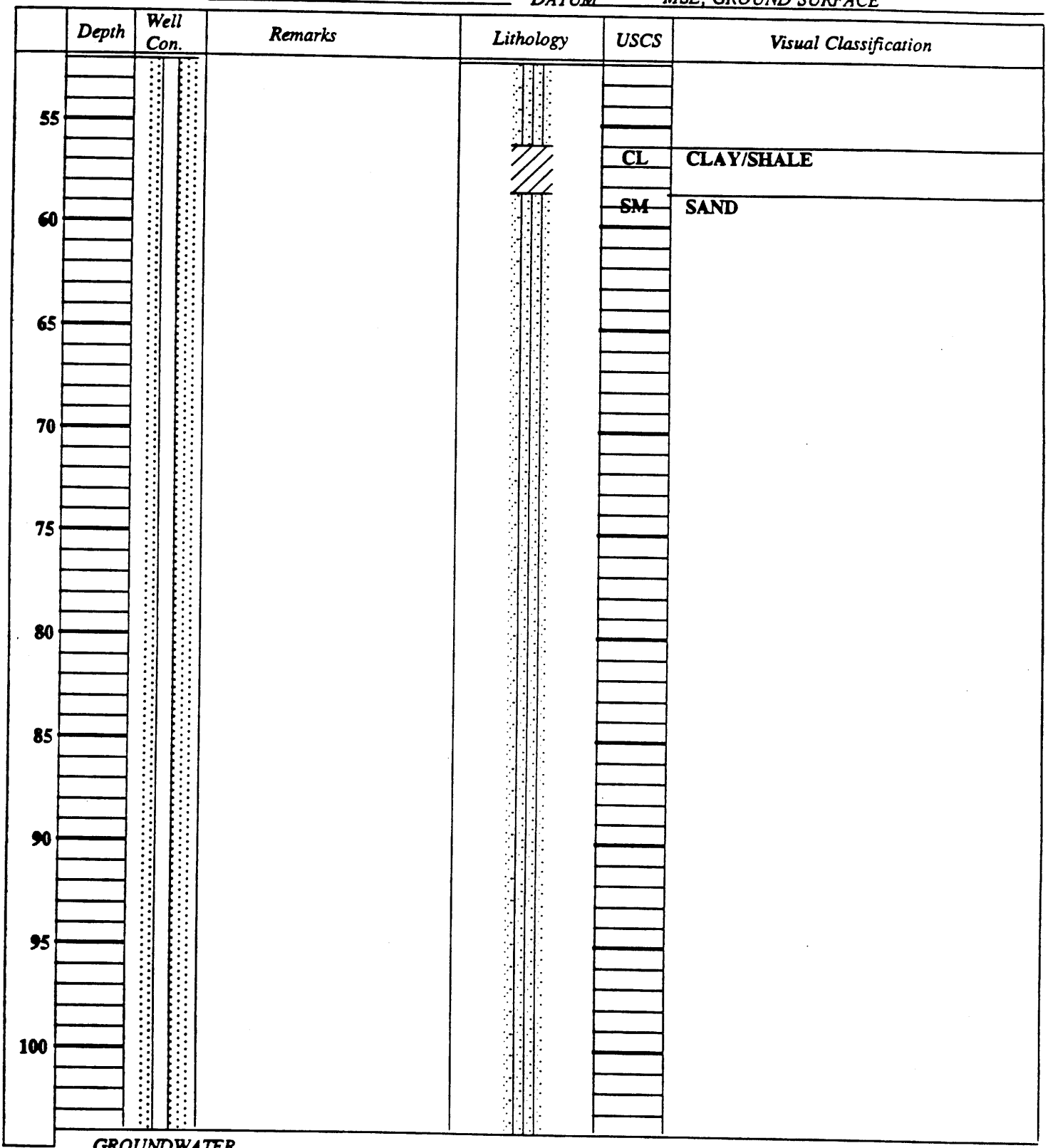
JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1011

JOB NO. FCT01 **DATE**

TOTAL DEPTH 281.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 4.9 in ID
LOCATION N E
COMPLETION
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

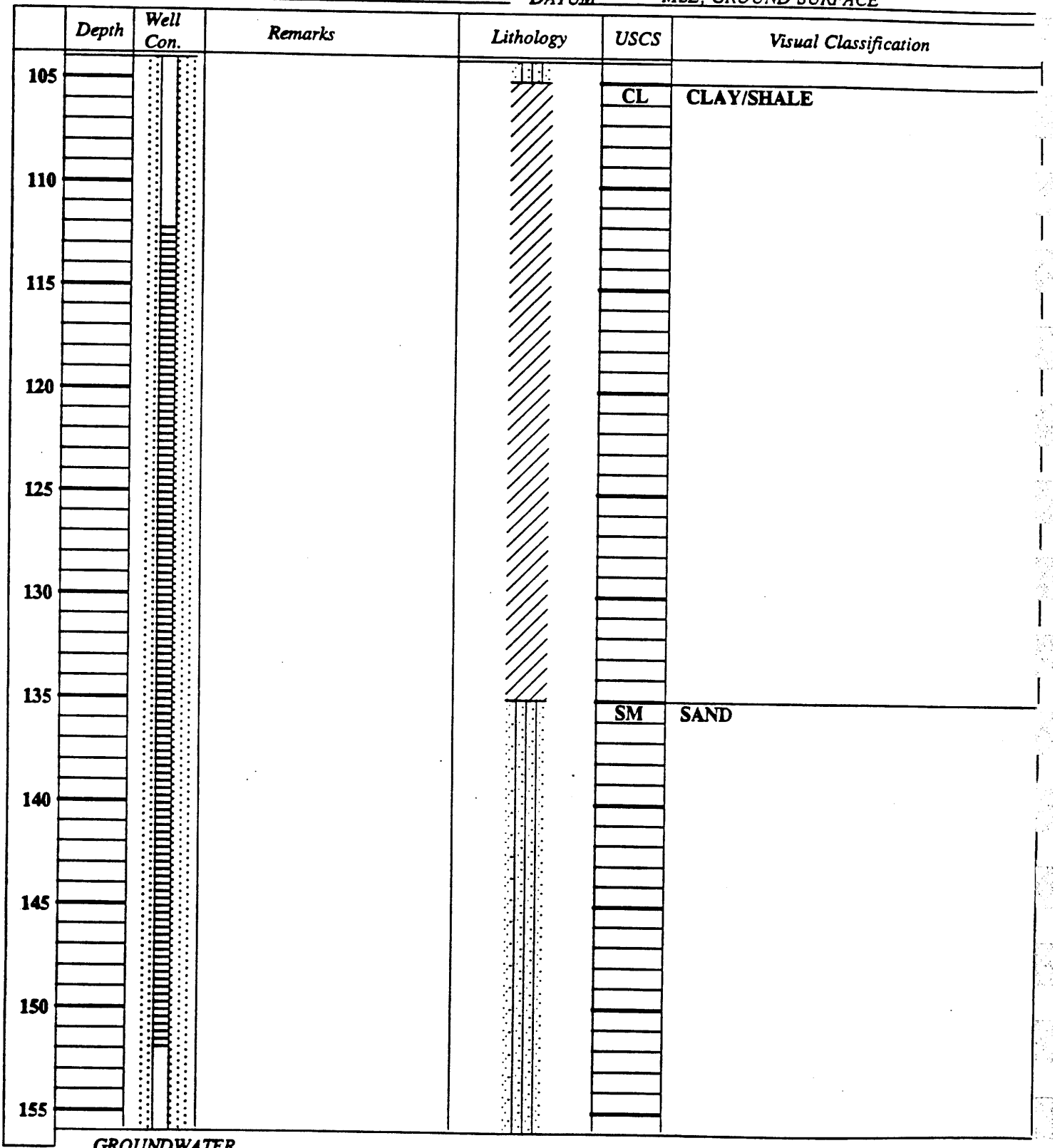
PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1011

JOB NO. FCT01 DATE

SURFACE ELEVATION
DEPTH OF SEAL
WELL CASING TYPE 4.9 in ID
COMPLETION

TOTAL DEPTH 281.0 feet
WELL OWNER
BORING TYPE
LOCATION N E
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1011

JOB NO. FCT01 **DATE**

TOTAL DEPTH 281.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 4.9 in ID
LOCATION N E
COMPLETION
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165				CL	CLAY/SHALE
170					
				SM	SAND
175					
180					
				CL	CLAY/SHALE
185					
190					
195					
200					
205					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1011

JOB NO. FCT01 DATE

TOTAL DEPTH 281.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 4.9 in ID
LOCATION N E
COMPLETION
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210					
215				SM	SAND
				CL	SANDY CLAY
220				SC	
225					
230					
235					
240					
245				CL	SHALE
250				SM	SAND
255					
260				CL	CLAY

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1011

JOB NO. FCT01 DATE

TOTAL DEPTH 281.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 4.9 in ID
LOCATION N E
COMPLETION
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
260					
265					
270					
275					
280					
					TD AT 281
285					
290					
295					
300					
305					
310					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1012

JOB NO. FCT01 **DATE**

TOTAL DEPTH 284.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 4-in ID, Sched. 40 PVC
LOCATION N E
COMPLETION
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
				CL	SHALE
70					
				SM	SAND
75					
80					
85					
90				CL	CLAY/SHALE
95					
100					
				SM	SAND

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

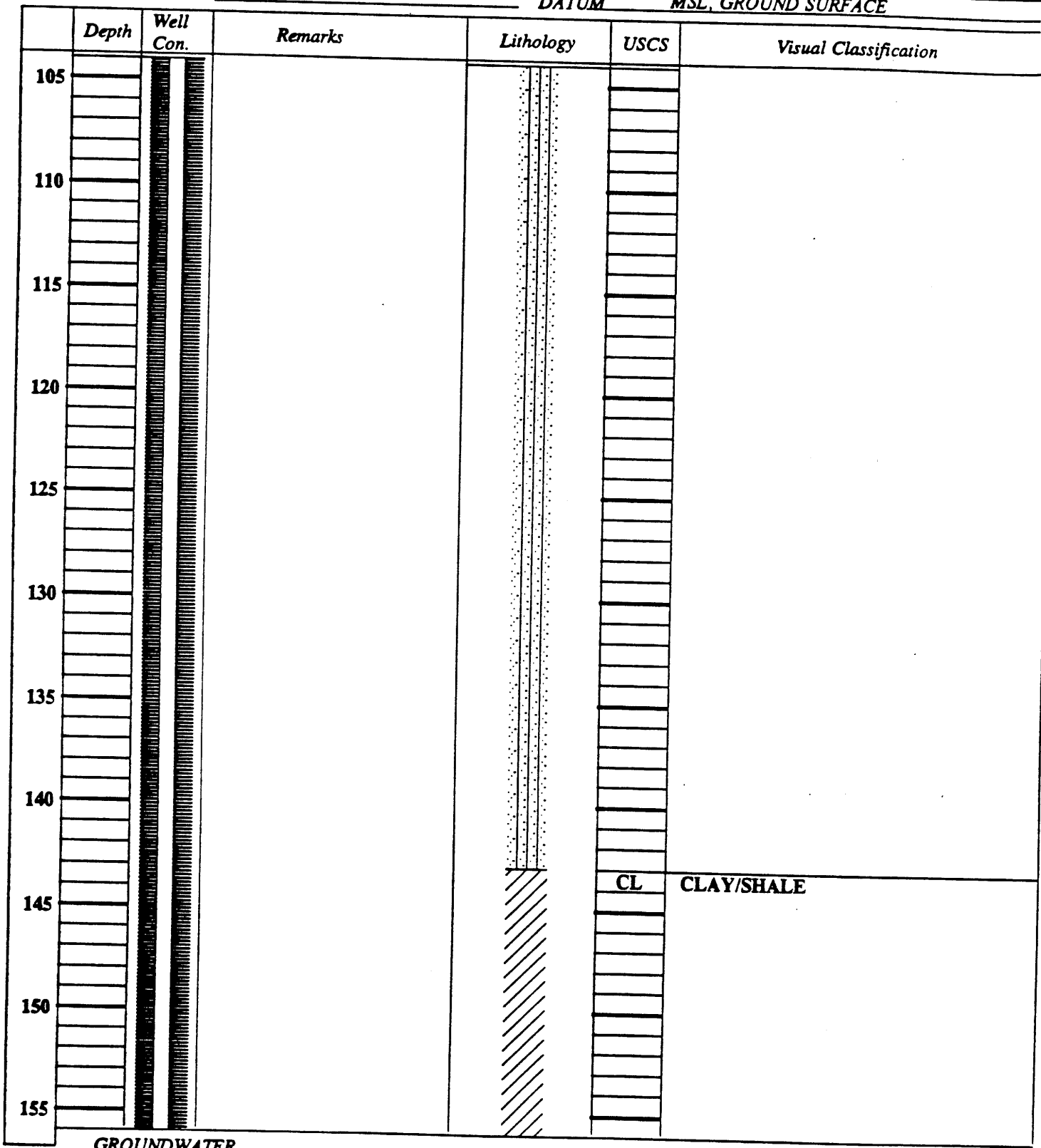
PROJECT Falls City Site
Texas

JOB NO. FCT01 DATE

LOG OF WELL BORING NO. 1012

SURFACE ELEVATION
DEPTH OF SEAL
WELL CASING TYPE 4-in ID, Sched. 40 PVC
COMPLETION

TOTAL DEPTH 284.0 feet
WELL OWNER
BORING TYPE
LOCATION N E
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1012

JOB NO. FCT01 **DATE**

TOTAL DEPTH 284.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 4-in ID, Sched. 40 PVC
LOCATION N E
COMPLETION
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165					
170					
175				SM	(USING DENSITY LOG BELOW FILTER PACK) SAND
180					
185				CL	CLAY/SHALE
190					
195				SM	
200					
205				CL	CLAY/SHALE

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

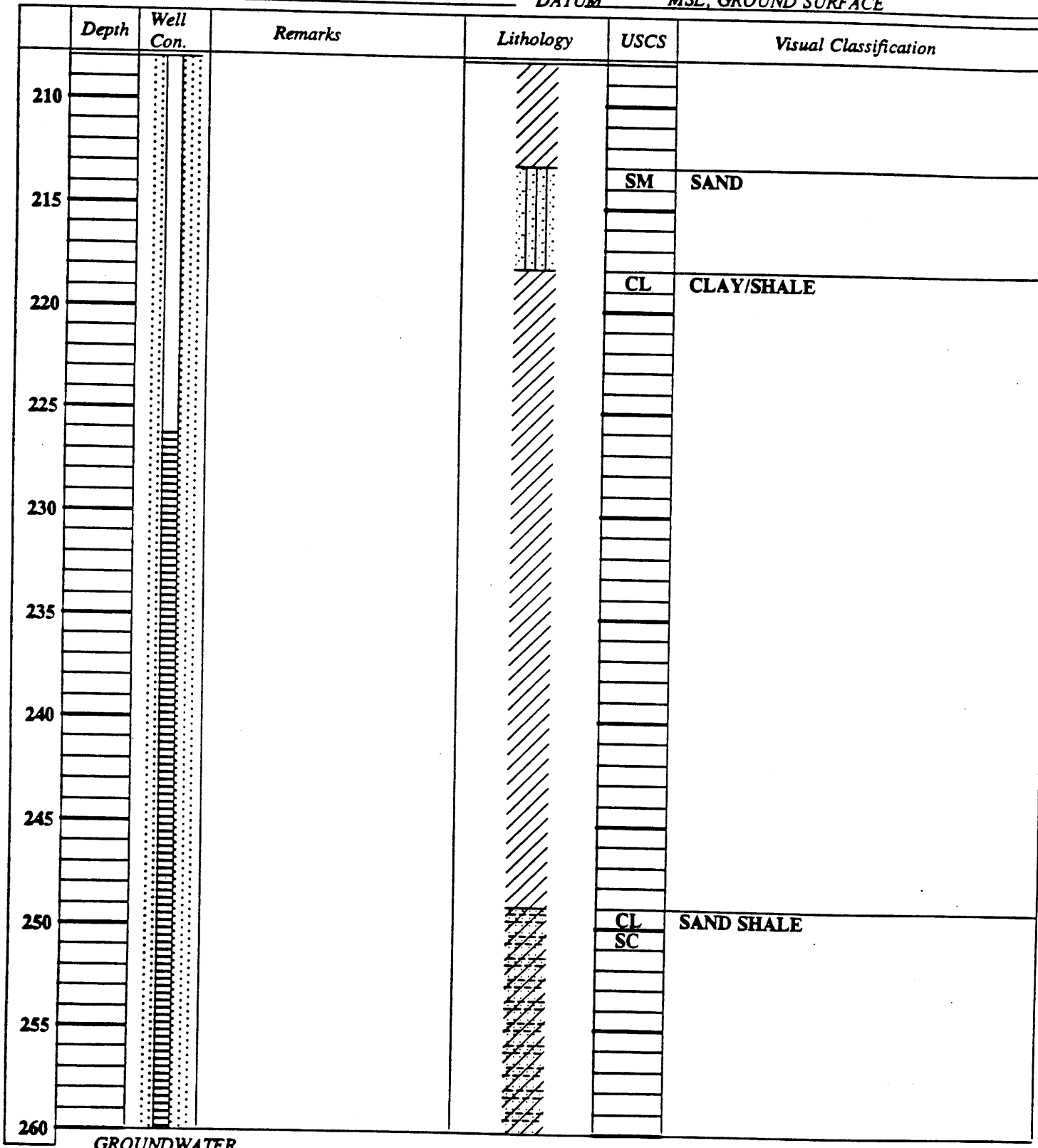
PROJECT Falls City Site
Texas

JOB NO. FCT01 DATE

LOG OF WELL BORING NO. 1012

SURFACE ELEVATION
DEPTH OF SEAL
WELL CASING TYPE 4-in ID, Sched. 40 PVC
COMPLETION

TOTAL DEPTH 284.0 feet
WELL OWNER
BORING TYPE
LOCATION N E
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1012

JOB NO. FCT01 DATE

TOTAL DEPTH 284.0 feet
SURFACE ELEVATION
WELL OWNER
DEPTH OF SEAL
BORING TYPE
WELL CASING TYPE 4-in ID, Sched. 40 PVC
LOCATION N E
COMPLETION
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		SLOTTED FROM 226 TO 276 FT.		SM	SAND, WITH OCC THIN LENSES OF CLAY/SHALE
5					
10		POSSIBLE SAND PACK FROM 167 TO TD.			
15					
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

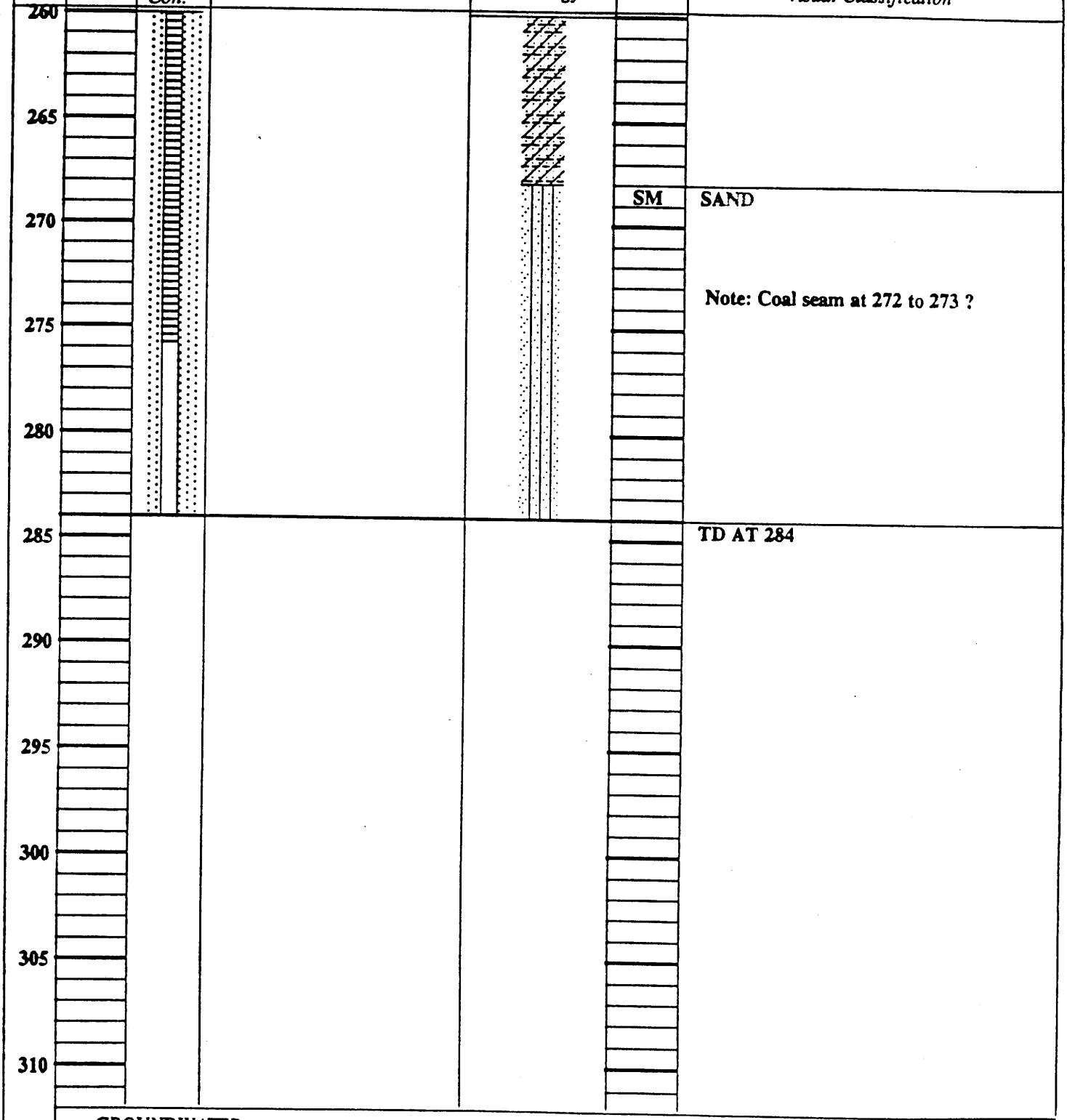
PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1012

JOB NO. FCT01 DATE

SURFACE ELEVATION
DEPTH OF SEAL
WELL CASING TYPE 4-in ID, Sched. 40 PVC
COMPLETION

TOTAL DEPTH 284.0 feet
WELL OWNER
BORING TYPE
LOCATION N E
DATUM MSL, GROUND SURFACE



GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

Appendix B

Laboratory Analysis of Soil Hydraulic Properties of Falls City, Texas UMTRA Site Soil Samples

DANIEL B. STEPHENS & ASSOCIATES, INC.

ENVIRONMENTAL SCIENTISTS AND ENGINEERS

LABORATORY ANALYSIS OF SOIL HYDRAULIC PROPERTIES OF PROJECT NO. 05-62350 LS CITY, TEXAS UMTRA SITE SOIL SAMPLES

Prepared for

Jacobs Engineering Group, Inc.

Albuquerque, New Mexico

February 1996

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DANIEL B. STEPHENS & ASSOCIATES, INC.
ENVIRONMENTAL SCIENTISTS AND ENGINEERS

February 7, 1996

1376-5918-95

Mr. Rick Dotson
Jacobs Engineering Group, Inc.
2155 Louisiana NE, Suite 10000
Albuquerque, NM 87110

Dear Mr. Dotson:

Please find enclosed the final laboratory data report for tests on Project No. 05-62350, Falls City, Texas, UMTRA Site soil samples as requested by Contract No. 05-62350-S-96-0002. An invoice for this work will be submitted under separate cover.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

We are pleased to provide this service to Jacobs Engineering Group, Inc., and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data report, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.

Robert E. Maranville
Staff Scientist

REM
Enclosures

TABLE OF CONTENTS

List of Tables

Summary

APPENDIX A: Initial Moisture Content, Dry Bulk Density, and Calculated Porosity

APPENDIX B: Saturated Hydraulic Conductivity

APPENDIX C: Effective Porosity

APPENDIX D: Particle Size Characteristics

APPENDIX E: Laboratory Methods

LIST OF TABLES

Table 1. Summary of Tests Performed

Table 2. Summary of Initial Moisture Content, Dry Bulk Density, and Calculated Porosity

Table 3. Summary of Saturated Hydraulic Conductivity Tests

Table 4. Summary of Effective Porosity Tests

Table 5. Summary of Particle Size Characteristics

SUMMARY

The Hydrologic Testing Laboratory at Daniel B. Stephens & Associates, Inc. (DBS&A) has completed laboratory tests on Project No. 05-62350, Falls City, Texas UMTRA Site soil samples as specified by Mr. Rick Dotson and summarized in Table 1. Tables 2 through 5 give the results of the specified analyses. Raw laboratory data and graphical plots of data (where appropriate) are contained in Appendices A through D. Appendix E lists the methods used in these analyses. A detailed description of each method is available upon request.

A total of twelve samples were received from Jacobs Engineering Group, Inc. for testing. Of these twelve samples, two samples, 0889-0001 and 0890-0001 were determined to be unsuitable for testing. Of the remaining ten samples, eight were received wrapped in plastic wrap and the remaining two, samples 0891-0001 and 0892-0001, were in acrylic tubes. The eight samples that were wrapped in plastic were prepared for testing by encasing a suitable length of sample in silicon epoxy inside of a brass sleeve. A second subsample was taken to determine initial moisture content on a gravimetric basis. Bulk density, calculated porosity, and initial volumetric moisture content for these eight samples was calculated from the volume and dry weight of the sample encased in epoxy and the gravimetric initial moisture content from the corresponding subsample. The remaining two samples had significant annular spaces between the samples and the acrylic tubes and were prepared for testing by driving a brass ring into the sample with a hydraulic press in order to produce a subsample with no annular space.

Overall, the results appear reasonable and internally consistent. However, DBS&A cannot guarantee that these results are representative of the undisturbed materials at the field site, nor can we assume any responsibility for interpretations or analyses based on these data. We recommend that careful evaluation of these laboratory results be made for your particular application.

TABLE 1. SUMMARY OF TESTS PERFORMED

Laboratory Sample Number	Initial Moisture Content	Dry Bulk Density	Calculated Porosity	Saturated Hydraulic Conductivity	Effective Porosity	Particle Size Distribution	
						Sieve	Hydrometer
0883-0001 108-110	X	X	X	X	X	X	X
0884-0001 90-91	X	X	X	X	X	X	X
0885-0001 54-55	X	X	X	X	X	X	X
0886-0001 42.5-43.5	X	X	X	X	X	X	X
0887-0001 44-45	X	X	X	X	X	X	X
0888-0001 130-131	X	X	X	X	X	X	X
0891-0001 18-20	X	X	X	X	X	X	X
0892-0001 17-18.5	X	X	X	X	X	X	X
0893-0001 135-136	X	X	X	X	X	X	X
0894-0001 24.5-25.5	X	X	X	X	X	X	X

Table 2. Summary of Initial Moisture Content, Dry Bulk Density, and Calculated Porosity

Sample Number	Initial Moisture Content Gravimetric (% g/g)	Initial Moisture Content Volumetric (%cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Calculated Porosity (%)
0883-0001	18.4	30.3	1.65	37.7
0884-0001	32.6	45.8	1.41	46.9
0885-0001	44.4	52.5	1.18	55.3
0886-0001	30.6	33.7	1.10	58.4
0887-0001	30.9	44.8	1.45	45.2
0888-0001	29.0	37.9	1.31	50.6
0891-0001	30.5	44.5	1.46	44.9
0892-0001	28.9	42.0	1.45	45.2
0893-0001	15.5	26.7	1.72	35.0
0894-0001	37.6	46.8	1.24	53.1

Table 3. Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Method of Analysis	
		Constant Head	Falling Head
0883-0001	1.6E-04		X
0884-0001	2.0E-08		X
0885-0001	8.6E-07		X
0886-0001	1.5E-07		X
0887-0001	1.9E-05		X
0888-0001	1.8E-05		X
0891-0001	1.2E-07		X
0892-0001	7.4E-09		X
0893-0001	3.4E-06		X
0894-0001	1.4E-04		X

Table 4. Summary of Effective Porosity Tests

Sample Number	Effective Porosity (% cm^3/cm^3)
0883-0001	17.9
0884-0001	12.7
0885-0001	22.5
0886-0001	28.6
0887-0001	25.7
0888-0001	35.5
0891-0001	26.7
0892-0001	8.7
0893-0001	22.5
0894-0001	33.6

Table 5. Summary of Particle Size Characterisitics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c
0883-0001	*	0.16	0.19	--	--
0884-0001	*	0.028	0.079	--	--
0885-0001	*	0.0022	0.012	--	--
0886-0001	*	0.069	0.083	--	--
0887-0001	*	0.061	0.070	--	--
0888-0001	0.0091	0.086	0.092	10	5.7
0891-0001	0.029	0.17	0.19	6.4	3.0
0892-0001	*	0.021	0.057	--	--
0893-0001	0.025	0.16	0.19	7.7	1.9
0894-0001	0.015	0.065	0.071	4.8	2.6

* d_{10} not reached with test specified
-- value dependent on d_{10}
d_{50} = median particle diameter

$C_u = d_{60}/d_{10}$

$C_c = (d_{30})^2/(d_{10})(d_{60})$

APPENDIX A

INITIAL MOISTURE CONTENT, DRY BULK DENSITY, AND CALCULATED POROSITY

Summary of Initial Moisture Content, Dry Bulk Density, and Calculated Porosity

Sample Number	Initial Moisture Content Gravimetric (% g/g)	Initial Moisture Content Volumetric (%cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Calculated Porosity (%)
0883-0001	18.4	30.3	1.65	37.7
0884-0001	32.6	45.8	1.41	46.9
0885-0001	44.4	52.5	1.18	55.3
0886-0001	30.6	33.7	1.10	58.4
0887-0001	30.9	44.8	1.45	45.2
0888-0001	29.0	37.9	1.31	50.6
0891-0001	30.5	44.5	1.46	44.9
0892-0001	28.9	42.0	1.45	45.2
0893-0001	15.5	26.7	1.72	35.0
0894-0001	37.6	46.8	1.24	53.1

DATA FOR INITIAL MOISTURE CONTENT, BULK DENSITY, POROSITY, AND PERCENT SATURATION

Job Name: JACOBS 2
Job Number: 5918
Sample Number: 0883-0001
Ring Number: 0883-0001
Depth: 108-110 ft.

Feild weight of sample (w/pan):	442.51	*(g)*
Tare weight, pan:	269.19	*(g)*
Dry weight of sample (w/pan):	415.61	*(g)*
Initial Moisture Content (Gravimetric):	18.4	*(% g/g)*
Dry weight of sample from ring:	182.88	*(g)*
Sample volume:	110.79	*(cm^3)*
Dry Bulk Density:	1.65	*(g/cm^3)*
Particle Density:	2.65	*(g/cm^3)*
Method: (Assumed particle density of 2.65 g/cm^3)		
Calculated Porosity:	37.7	*(% vol)*
Initial Moisture Content (Volumetric):	30.3	*(% vol)*

Comments:

Laboratory analysis performed by: G. Stansifer/J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson

DATA FOR INITIAL MOISTURE CONTENT, BULK DENSITY, POROSITY, AND PERCENT SATURATION

Job Name: JACOBS 2
Job Number: 5918
Sample Number: 0884-0001
Ring Number: 0884-0001
Depth: 90-91 ft.

Feild weight of sample (w/pan):	471.45	*(g)*
Tare weight, pan:	209.28	*(g)*
Dry weight of sample (w/pan):	407.05	*(g)*
Initial Moisture Content (Gravimetric):	32.6	*(% g/g)*
Dry weight of sample from ring:	139.33	*(g)*
Sample volume:	99.10	*(cm^3)*
Dry Bulk Density:	1.41	*(g/cm^3)*
Particle Density:	2.65	*(g/cm^3)*
Method: (Assumed particle density of 2.65 g/cm^3)		
Calculated Porosity:	46.9	*(% vol)*
Initial Moisture Content (Volumetric):	45.8	*(% vol)*

Comments:

Laboratory analysis performed by: G. Stansifer/J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson

DATA FOR INITIAL MOISTURE CONTENT, BULK DENSITY, POROSITY, AND PERCENT SATURATION

Job Name: JACOBS 2
Job Number: 5918
Sample Number: 0885-0001
Ring Number: 0885-0001
Depth: 54-55 ft.

Feild weight of sample (w/pan):	524.46	*(g)*
Tare weight, pan:	259.87	*(g)*
Dry weight of sample (w/pan):	443.15	*(g)*
Initial Moisture Content (Gravimetric):	44.4	*(% g/g)*
Dry weight of sample from ring:	108.42	*(g)*
Sample volume:	91.55	*(cm^3)*
Dry Bulk Density:	1.18	*(g/cm^3)*
Particle Density:	2.65	*(g/cm^3)*
Method: (Assumed particle density of 2.65 g/cm^3)		
Calculated Porosity:	55.3	*(% vol)*
Initial Moisture Content (Volumetric):	52.5	*(% vol)*

Comments:

Laboratory analysis performed by: G. Stansifer/J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson

DATA FOR INITIAL MOISTURE CONTENT, BULK DENSITY, POROSITY, AND PERCENT SATURATION

Job Name: JACOBS 2
Job Number: 5918
Sample Number: 0886-0001
Ring Number: 0886-0001
Depth: 42.5-43.5 ft.

Feild weight of sample (w/pan):	408.52	*(g)*
Tare weight, pan:	208.62	*(g)*
Dry weight of sample (w/pan):	361.68	*(g)*
Initial Moisture Content (Gravimetric):	30.6	*(% g/g)*
Dry weight of sample from ring:	63.64	*(g)*
Sample volume:	57.74	*(cm^3)*
Dry Bulk Density:	1.10	*(g/cm^3)*
Particle Density:	2.65	*(g/cm^3)*
Method: (Assumed particle density of 2.65 g/cm^3)		
Calculated Porosity:	58.4	*(% vol)*
Initial Moisture Content (Volumetric):	33.7	*(% vol)*

Comments:

Laboratory analysis performed by: G. Stansifer/J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson

DATA FOR INITIAL MOISTURE CONTENT, BULK DENSITY, POROSITY, AND PERCENT SATURATION

Job Name: JACOBS 2
Job Number: 5918
Sample Number: 0887-0001
Ring Number: 0887-0001
Depth: 44-45 ft.t.

Feild weight of sample (w/pan):	415.83	*(g)*
Tare weight, pan:	212.67	*(g)*
Dry weight of sample (w/pan):	367.93	*(g)*
Initial Moisture Content (Gravimetric):	30.9	*(% g/g)*
Dry weight of sample from ring:	91.45	*(g)*
Sample volume:	63.02	*(cm^3)*
Dry Bulk Density:	1.45	*(g/cm^3)*
Particle Density:	2.65	*(g/cm^3)*

Method: (Assumed particle density of 2.65 g/cm^3)

Calculated Porosity:	45.2	*(% vol)*
Initial Moisture Content (Volumetric):	44.8	*(% vol)*

Comments:

Laboratory analysis performed by: G. Stansifer/J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson

DATA FOR INITIAL MOISTURE CONTENT, BULK DENSITY, POROSITY, AND PERCENT SATURATION

Job Name: JACOBS 2
Job Number: 5918
Sample Number: 0888-0001
Ring Number: 0888-0001
Depth: 130-131 ft.

Feild weight of sample (w/pan):	521.62	*(g)*
Tare weight, pan:	269.47	*(g)*
Dry weight of sample (w/pan):	464.96	*(g)*
Initial Moisture Content (Gravimetric):	29.0	*(% g/g)*
Dry weight of sample from ring:	92.21	*(g)*
Sample volume:	70.46	*(cm^3)*
Dry Bulk Density:	1.31	*(g/cm^3)*
Particle Density:	2.65	*(g/cm^3)*

Method: (Assumed particle density of 2.65 g/cm^3)

Calculated Porosity:	50.6	*(% vol)*
Initial Moisture Content (Volumetric):	37.9	*(% vol)*

Comments:

Laboratory analysis performed by: G. Stansifer/J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson

DATA FOR INITIAL MOISTURE CONTENT, BULK DENSITY, POROSITY, AND PERCENT SATURATION

Job Name:	JACOBS 2	
Job Number:	5918	
Sample Number:	0891-0001	
Ring Number:	0891-0001	
Depth:	18-20 ft.	
Feild weight of sample (w/pan):	439.53	*(g)*
Tare weight (ring + plate):	163.39	*(g)*
Dry weight of sample + tares:	375.03	*(g)*
Initial Moisture Content (Gravimetric):	30.5	*(% g/g)*
Dry weight of sample from ring:	211.64	*(g)*
Sample volume:	144.87	*(cm^3)*
Dry Bulk Density:	1.46	*(g/cm^3)*
Particle Density:	2.65	*(g/cm^3)*
Method: (Assumed particle density of 2.65 g/cm^3)		
Calculated Porosity:	44.9	*(% vol)*
Initial Moisture Content (Volumetric):	44.5	*(% vol)*

Comments:

Laboratory analysis performed by: G. Stansifer/J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson

DATA FOR INITIAL MOISTURE CONTENT, BULK DENSITY, POROSITY, AND PERCENT SATURATION

Job Name: JACOBS 2
Job Number: 5918
Sample Number: 0892-0001
Ring Number: 0892-0001
Depth: 17-18.5 ft.

Feild weight of sample (w/pan):	297.76	*(g)*
Tare weight (ring + plate):	137.87	*(g)*
Dry weight of sample + tares:	261.90	*(g)*
Initial Moisture Content (Gravimetric):	28.9	*(% g/g)*
Dry weight of sample from ring:	124.03	*(g)*
Sample volume:	85.45	*(cm^3)*
Dry Bulk Density:	1.45	*(g/cm^3)*
Particle Density:	2.65	*(g/cm^3)*
Method: (Assumed particle density of 2.65 g/cm^3)		
Calculated Porosity:	45.2	*(% vol)*
Initial Moisture Content (Volumetric):	42.0	*(% vol)*

Comments:

Laboratory analysis performed by: G. Stansifer/J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson

DATA FOR INITIAL MOISTURE CONTENT, BULK DENSITY, POROSITY, AND PERCENT SATURATION

Job Name: JACOBS 2
Job Number: 5918
Sample Number: 0893-0001
Ring Number: 0893-0001
Depth: 135-136 ft.

Feild weight of sample (w/pan):	630.65	*(g)*
Tare weight, pan:	212.70	*(g)*
Dry weight of sample (w/pan):	574.48	*(g)*
Initial Moisture Content (Gravimetric):	15.5	*(% g/g)*
Dry weight of sample from ring:	112.33	*(g)*
Sample volume:	65.21	*(cm^3)*
Dry Bulk Density:	1.72	*(g/cm^3)*
Particle Density:	2.65	*(g/cm^3)*
Method: (Assumed particle density of 2.65 g/cm^3)		
Calculated Porosity:	35.0	*(% vol)*
Initial Moisture Content (Volumetric):	26.7	*(% vol)*

Comments:

Laboratory analysis performed by: G. Stansifer/J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson

DATA FOR INITIAL MOISTURE CONTENT, BULK DENSITY, POROSITY, AND PERCENT SATURATION

Job Name: JACOBS 2
Job Number: 5918
Sample Number: 0894-0001
Ring Number: 0894-0001
Depth: 24.5-25.5 ft.

Feild weight of sample (w/pan):	464.87	*(g)*
Tare weight, pan:	258.64	*(g)*
Dry weight of sample (w/pan):	408.51	*(g)*
Initial Moisture Content (Gravimetric):	37.6	*(% g/g)*
Dry weight of sample from ring:	59.61	*(g)*
Sample volume:	47.93	*(cm^3)*
Dry Bulk Density:	1.24	*(g/cm^3)*
Particle Density:	2.65	*(g/cm^3)*
Method: (Assumed particle density of 2.65 g/cm^3)		
Calculated Porosity:	53.1	*(% vol)*
Initial Moisture Content (Volumetric):	46.8	*(% vol)*

Comments:

Laboratory analysis performed by: G. Stansifer/J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson

APPENDIX B

SATURATED HYDRAULIC CONDUCTIVITY

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Method of Analysis	
		Constant Head	Falling Head
0883-0001	1.6E-04		X
0884-0001	2.0E-08		X
0885-0001	8.6E-07		X
0886-0001	1.5E-07		X
0887-0001	1.9E-05		X
0888-0001	1.8E-05		X
0891-0001	1.2E-07		X
0892-0001	7.4E-09		X
0893-0001	3.4E-06		X
0894-0001	1.4E-04		X

SATURATED HYDRAULIC CONDUCTIVITY
FALLING HEAD METHOD

Job name: JACOBS 2
Job number: 5918
Sample number: 0883-0001
Ring number: 0883-0001

Permeameter type
Standard = 1, Double =2: 1
Depth: 108-110 ft.
Type of water used: TAP

Sample length: 6.51 cm
Sample cross-sectional area: 17.02 cm2
Reservoir cross-sectional area: 0.70 cm2
Offset: 0 cm

Date	*Time*	*Temp. (C)*	*Reservoir head (cm)*	*Corrected head (cm)*	*Elapsed time (sec)*	*K_{sat} (cm/sec)*	*K_{sat} @ 20 C (cm/sec)*
Test # 1:							
21-Dec-95	10:41:47	17.5	56.0	56.0			
21-Dec-95	11:11:54	17.5	20.0	20.0	1807	1.5E-04	1.6E-04
Test# 2:							
22-Dec-95	12:07:35	18.0	53.0	53.0			
22-Dec-95	12:17:20	18.0	37.0	37.0	585	1.6E-04	1.7E-04
Test # 3:							
28-Dec-95	10:14:33	19.5	67.0	67.0			
28-Dec-95	10:53:01	19.5	17.7	17.7	2308	1.5E-04	1.6E-04

Average Ksat: 1.6E-04 cm/sec

Comments:

Laboratory analysis by: G. Stansifer
Calculations made by: R. Maranville
Checked by: J. Vinson

SATURATED HYDRAULIC CONDUCTIVITY
FALLING HEAD METHOD

Job name: JACOBS 2
Job number: 5918
Sample number: 0884-0001
Ring number: 0884-0001

Permeameter type
Standard = 1, Double =2: 1
Depth: 90-91 ft.
Type of water used: TAP

Sample length: 5.64 cm
Sample cross-sectional area: 17.57 cm2
Reservoir cross-sectional area: 0.70 cm2
Offset: 5 cm

Date	*Time*	*Temp. (C)*	*Reservoir head (cm)*	*Corrected head (cm)*	*Elapsed time (sec)*	*K_{sat} (cm/sec)*	*K_{sat} @ 20 C (cm/sec)*
Test # 1:							
29-Jan-96	14:04:24	20.5	73.1	1334.1			
30-Jan-96	16:00:22	22.5	61.4	1322.4	93358	2.1E-08	2.0E-08
Test# 2:							
30-Jan-96	16:00:22	22.5	61.4	1322.4			
31-Jan-96	09:33:36	22.0	53.4	1314.4	63194	2.2E-08	2.1E-08
Test # 3:							
31-Jan-96	09:33:36	22.0	53.4	1314.4			
01-Feb-96	09:59:59	22.0	42.5	1303.5	87983	2.1E-08	2.0E-08

Average Ksat: 2.0E-08 cm/sec

Comments: Head corrected for 18 psi of overpressure.

Laboratory analysis by: G. Stansifer
Calculations made by: R. Maranville
Checked by: J. Vinson

SATURATED HYDRAULIC CONDUCTIVITY
FALLING HEAD METHOD

Job name: JACOBS 2
Job number: 5918
Sample number: 0885-0001
Ring number: 0885-0001

Permeameter type
Standard = 1, Double =2: 1
Depth: 54-55 ft.
Type of water used: TAP

Sample length: 5.86 cm
Sample cross-sectional area: 15.62 cm2
Reservoir cross-sectional area: 0.70 cm2
Offset: 4 cm

Date	*Time*	*Temp. (C)*	*Reservoir head (cm)*	*Corrected head (cm)*	*Elapsed time (sec)*	*K_{sat} (cm/sec)*	*K_{sat} @ 20 C (cm/sec)*
Test # 1:							
23-Jan-96	13:47:00	20.5	82.3	430.0			
23-Jan-96	17:09:03	21.5	64.8	412.5	12123	9.0E-07	8.8E-07
Test# 2:							
24-Jan-96	11:39:19	20.5	87.5	435.2			
24-Jan-96	18:25:51	21.5	54.9	402.6	24392	8.4E-07	8.2E-07
Test # 3:							
26-Jan-96	12:51:04	20.5	94.9	442.6			
26-Jan-96	14:02:30	20.5	88.5	436.2	4286	8.9E-07	8.8E-07

Average Ksat: 8.6E-07 cm/sec

Comments: Head corrected for 5 psi of overpressure.

Laboratory analysis by: K. Copeland
Calculations made by: R. Maranville
Checked by: J. Vinson

SATURATED HYDRAULIC CONDUCTIVITY
FALLING HEAD METHOD

Job name: JACOBS 2
Job number: 5918
Sample number: 0886-0001
Ring number: 0886-0001

Permeameter type
Standard = 1, Double =2: 1
Depth: 42.5-43.5 ft.
Type of water used: TAP

Sample length: 3.52 cm
Sample cross-sectional area: 16.40 cm2
Reservoir cross-sectional area: 0.70 cm2
Offset: 2 cm

Date	*Time*	*Temp. (C)*	*Reservoir head (cm)*	*Corrected head (cm)*	*Elapsed time (sec)*	K_{sat} *(cm/sec)*	K_{sat} *@ 20 C (cm/sec)*
Test # 1:							
25-Jan-96	14:34:38	20.5	61.8	411.5			
26-Jan-96	12:43:14	20.5	28.9	378.6	79716	1.6E-07	1.6E-07
Test# 2:							
29-Jan-96	15:14:10	20.5	97.0	446.7			
30-Jan-96	16:02:57	22.5	66.4	416.1	89327	1.2E-07	1.2E-07
Test # 3:							
30-Jan-96	16:02:57	22.5	66.4	416.1			
31-Jan-96	09:35:50	22.0	34.3	384.0	63173	1.9E-07	1.8E-07

Average Ksat: 1.5E-07 cm/sec

Comments: Head corrected for 5 psi of overpressure.

Laboratory analysis by: K. Copeland/G. Stansifer
Calculations made by: R. Maranville
Checked by: J. Vinson

SATURATED HYDRAULIC CONDUCTIVITY
FALLING HEAD METHOD

Job name: JACOBS 2
Job number: 5918
Sample number: 0887-0001
Ring number: 0887-0001

Permeameter type
Standard = 1, Double =2: 1
Depth: 44-45 ft.
Type of water used: TAP

Sample length: 3.76 cm
Sample cross-sectional area: 16.76 cm2
Reservoir cross-sectional area: 0.70 cm2
Offset: 0 cm

Date	*Time*	*Temp. (C)*	*Reservoir head (cm)*	*Corrected head (cm)*	*Elapsed time (sec)*	*K_{sat} (cm/sec)*	*K_{sat} @ 20 C (cm/sec)*
Test # 1:							
15-Jan-96	11:59:39	20.5	76.0	76.0			
15-Jan-96	12:39:54	20.5	56.0	56.0	2415	2.0E-05	2.0E-05
Test# 2:							
15-Jan-96	12:39:54	20.5	56.0	56.0			
15-Jan-96	15:51:07	20.0	14.6	14.6	11473	1.8E-05	1.8E-05
Test # 3:							
16-Jan-96	09:34:13	20.5	68.0	68.0			
16-Jan-96	12:24:42	20.5	20.9	20.9	10229	1.8E-05	1.8E-05

Average Ksat: 1.9E-05 cm/sec

Comments:

Laboratory analysis by: G. Stansifer
Calculations made by: R. Maranville
Checked by: J. Vinson

SATURATED HYDRAULIC CONDUCTIVITY
FALLING HEAD METHOD

Job name: JACOBS 2
Job number: 5918
Sample number: 0888-0001
Ring number: 0888-0001

Permeameter type
Standard = 1, Double =2: 1
Depth: 130-131 ft.
Type of water used: TAP

Sample length: 4.24 cm
Sample cross-sectional area: 16.62 cm2
Reservoir cross-sectional area: 0.70 cm2
Offset: 0 cm

Date	*Time*	*Temp. (C)*	*Reservoir head (cm)*	*Corrected head (cm)*	*Elapsed time (sec)*	K_{sat} *(cm/sec)*	K_{sat} *@ 20 C (cm/sec)*
Test # 1:							
20-Dec-95	12:45:36	18.5	65.0	65.0			
20-Dec-95	15:02:50	18.5	29.4	29.4	8234	1.7E-05	1.8E-05
Test# 2:							
21-Dec-95	10:48:32	17.5	63.0	63.0			
21-Dec-95	11:14:15	17.5	54.0	54.0	1543	1.8E-05	1.9E-05
Test # 3:							
22-Dec-95	12:19:21	18.0	60.0	60.0			
22-Dec-95	12:48:56	18.0	50.5	50.5	1775	1.7E-05	1.8E-05

Average Ksat: 1.8E-05 cm/sec

Comments:

Laboratory analysis by: G. Stansifer
Calculations made by: R. Maranville
Checked by: J. Vinson

SATURATED HYDRAULIC CONDUCTIVITY
FALLING HEAD METHOD

Job name: JACOBS 2
Job number: 5918
Sample number: 0891-0001
Ring number: 0891-0001

Permeameter type
Standard = 1, Double =2: 1
Depth: 18-20 ft.
Type of water used: TAP

Sample length: 7.62 cm
Sample cross-sectional area: 19.01 cm2
Reservoir cross-sectional area: 0.70 cm2
Offset: 0 cm

Date	*Time*	*Temp. (C)*	*Reservoir head (cm)*	*Corrected head (cm)*	*Elapsed time (sec)*	K_{sat} *(cm/sec)*	K_{sat} *@ 20 C (cm/sec)*
Test # 1:							
03-Jan-96	17:53:14	21.0	46.7	46.7			
04-Jan-96	12:29:53	20.0	45.2	45.2	66999	1.4E-07	1.3E-07
Test# 2:							
04-Jan-96	12:29:53	20.0	45.2	45.2			
05-Jan-96	10:47:22	20.5	43.8	43.8	80249	1.1E-07	1.1E-07
Test # 3:							
05-Jan-96	10:47:22	20.5	43.8	43.8			
06-Jan-96	11:23:50	20.0	42.4	42.4	88588	1.0E-07	1.0E-07

Average Ksat: 1.2E-07 cm/sec

Comments:

Laboratory analysis by: G. Stansifer
Calculations made by: R. Maranville
Checked by: J. Vinson

SATURATED HYDRAULIC CONDUCTIVITY
FALLING HEAD METHOD

Job name: JACOBS 2
Job number: 5918
Sample number: 0892-0001
Ring number: 0892-0001

Permeameter type
Standard = 1, Double =2: 1
Depth: 17-18.5 ft.
Type of water used: TAP

Sample length: 4.55 cm
Sample cross-sectional area: 18.78 cm2
Reservoir cross-sectional area: 0.70 cm2
Offset: 3 cm

Date	*Time*	*Temp. (C)*	*Reservoir head (cm)*	*Corrected head (cm)*	*Elapsed time (sec)*	*K_{sat} (cm/sec)*	*K_{sat} @ 20 C (cm/sec)*
Test # 1:							
10-Jan-96	17:22:51	20.0	142.9	1405.9			
11-Jan-96	15:26:45	20.5	137.8	1400.8	79434	7.8E-09	7.7E-09
Test# 2:							
11-Jan-96	15:26:45	20.5	137.8	1400.8			
12-Jan-96	18:02:14	20.5	132.0	1395.0	95729	7.4E-09	7.3E-09
Test # 3:							
12-Jan-96	18:02:14	20.5	132.0	1395.0			
15-Jan-96	12:54:44	20.5	117.3	1380.3	240750	7.5E-09	7.4E-09

Average Ksat: 7.4E-09 cm/sec

Comments: Head corrected for 18 psi of pressure

Laboratory analysis by: G. Stansifer
Calculations made by: R. Maranville
Checked by: J. Vinson

SATURATED HYDRAULIC CONDUCTIVITY
FALLING HEAD METHOD

Job name: JACOBS 2
Job number: 5918
Sample number: 0893-0001
Ring number: 0893-0001

Permeameter type
Standard = 1, Double =2: 1
Depth: 135-136 ft.
Type of water used: TAP

Sample length: 3.89 cm
Sample cross-sectional area: 16.76 cm2
Reservoir cross-sectional area: 0.70 cm2
Offset: 2 cm

Date	*Time*	*Temp. (C)*	*Reservoir head (cm)*	*Corrected head (cm)*	*Elapsed time (sec)*	*K_{sat} (cm/sec)*	*K_{sat} @ 20 C (cm/sec)*
Test # 1:							
25-Jan-96	17:04:41	20.5	66.5	416.2			
25-Jan-96	17:23:27	20.5	58.0	407.7	1126	3.0E-06	2.9E-06
Test# 2:							
26-Jan-96	12:49:47	20.5	90.5	440.2			
26-Jan-96	13:38:28	20.5	60.2	409.9	2921	4.0E-06	3.9E-06
Test # 3:							
26-Jan-96	13:38:28	20.5	60.2	409.9			
26-Jan-96	14:43:10	20.5	29.3	379.0	3882	3.3E-06	3.2E-06

Average Ksat: 3.4E-06 cm/sec

Comments: Head corrected for 5 psi of overpressure.

Laboratory analysis by: K. Copeland
Calculations made by: R. Maranville
Checked by: J. Vinson

SATURATED HYDRAULIC CONDUCTIVITY
FALLING HEAD METHOD

Job name: JACOBS 2
Job number: 5918
Sample number: 0894-0001
Ring number: 0894-0001

Permeameter type
Standard = 1, Double =2: 1
Depth: 24.5-25.5 ft.
Type of water used: TAP

Sample length: 3.00 cm
Sample cross-sectional area: 15.98 cm2
Reservoir cross-sectional area: 0.70 cm2
Offset: 0 cm

Date	*Time*	*Temp. (C)*	*Reservoir head (cm)*	*Corrected head (cm)*	*Elapsed time (sec)*	*K_{sat} (cm/sec)*	*K_{sat} @ 20 C (cm/sec)*
Test # 1:							
20-Dec-95	15:05:05	19.0	64.0	64.0			
20-Dec-95	15:09:48	20.0	48.0	48.0	283	1.3E-04	1.3E-04
Test# 2:							
21-Dec-95	10:58:31	17.5	61.0	61.0			
21-Dec-95	11:16:17	17.5	21.0	21.0	1066	1.3E-04	1.4E-04
Test # 3:							
22-Dec-95	12:31:10	18.0	76.0	76.0			
22-Dec-95	12:49:59	18.0	21.0	21.0	1129	1.5E-04	1.6E-04

Average Ksat: 1.4E-04 cm/sec

Comments:

Laboratory analysis by: G. Stansifer
Calculations made by: R. Maranville
Checked by: J. Vinson

APPENDIX C

EFFECTIVE POROSITY

Summary of Effective Porosity Tests

Sample Number	Effective Porosity (% cm^3/cm^3)
0883-0001	17.9
0884-0001	12.7
0885-0001	22.5
0886-0001	28.6
0887-0001	25.7
0888-0001	35.5
0891-0001	26.7
0892-0001	8.7
0893-0001	22.5
0894-0001	33.6

EFFECTIVE POROSITY DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number 0883-0001
Ring Number: 0883-0001
Depth: 108-110 ft.

Bulk Density: 1.65 (g/cm^3)
Calculated Porosity: 37.7 (% cm^3/cm^3)
Tare Weight: 401.91 (g)
Sample Dry Weight (including tares): 464.53 (g)

Test #	*Date*	*Time*	*Thermo Couple Potential (-bars)*	*Sample Weight at X Potential (including tares) (g)*	*Moisture Content (% g/g)*	*Moisture Content (% cm^3/cm^3)*	*Matric Potential (-cm)*
1	31-Jan	1130	11.6	472.7	13.1	21.6	11830
2	2-Feb	1100	20.3	471.0	10.3	17.0	20702

Moisture content at -15 bars: 19.8 (%cm^3/cm^3)

Effective Porosity: 17.9 (% cm^3/cm^3)

Comments:

Laboratory analysis performed by: K. Copeland
Calculations made by: R. Maranville
Checked by: J. Vinson

EFFECTIVE POROSITY DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number 0884-0001
Ring Number: 0884-0001
Depth: 90-91 ft.

Bulk Density:	1.41	(g/cm^3)
Calculated Porosity:	46.9	(% cm^3/cm^3)
Tare Weight:	416.13	(g)
Sample Dry Weight (including tares):	555.46	(g)

Test #	*Date*	*Time*	*Thermo Couple Potential (-bars)*	*Sample Weight at X Potential (including tares) (g)*	*Moisture Content (% g/g)*	*Moisture Content (% cm^3/cm^3)*	*Matric Potential (-cm)*
1	5-Feb	1515	10.9	589.5	24.4	34.4	11116
2	5-Feb	1430	16.0	589.3	24.3	34.2	16317

Moisture content at -15 bars: 34.2 (%cm^3/cm^3)

Effective Porosity: 12.7 (% cm^3/cm^3)

Comments:

Laboratory analysis performed by: K. Copeland
Calculations made by: R. Maranville
Checked by: J. Vinson

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EFFECTIVE POROSITY DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number 0885-0001
Ring Number: 0885-0001
Depth: 90-91 ft.

Bulk Density:	1.18	(g/cm^3)
Calculated Porosity:	55.3	(% cm^3/cm^3)
Tare Weight:	403.28	(g)
Sample Dry Weight (including tares):	511.7	(g)

Test #	*Date*	*Time*	*Thermo Couple Potential (-bars)*	*Sample Weight at X Potential (including tares) (g)*	*Moisture Content (% g/g)*	*Moisture Content (% cm^3/cm^3)*	*Matric Potential (-cm)*
1	1-Feb	1100	14.3	541.9	27.9	32.9	14583
2	1-Feb	1520	20.8	541.4	27.4	32.3	21212

Moisture content at -15 bars: 32.8 (%cm^3/cm^3)

Effective Porosity: 22.5 (% cm^3/cm^3)

Comments:

Laboratory analysis performed by: K. Copeland
Calculations made by: R. Maranville
Checked by: J. Vinson

EFFECTIVE POROSITY DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number 0886-0001
Ring Number: 0886-0001
Depth: 42.5-43.5 ft.

Bulk Density:	1.10	(g/cm^3)
Calculated Porosity:	58.4	(% cm^3/cm^3)
Tare Weight:	402.23	(g)
Sample Dry Weight (including tares):	465.87	(g)

Test #	*Date*	*Time*	*Thermo Couple Potential (-bars)*	*Sample Weight at X Potential (including tares) (g)*	*Moisture Content (% g/g)*	*Moisture Content (% cm^3/cm^3)*	*Matric Potential (-cm)*
1	1-Feb	1200	9.9	483.9	28.3	31.1	10096
2	1-Feb	1430	15.6	483.0	27.0	29.7	15909

Moisture content at -15 bars: 29.8 (%cm^3/cm^3)

Effective Porosity: 28.6 (% cm^3/cm^3)

Comments:

Laboratory analysis performed by: K. Copeland
Calculations made by: R. Maranville
Checked by: J. Vinson

EFFECTIVE POROSITY DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number 0887-0001
Ring Number: 0887-0001
Depth: 44-45 ft.

Bulk Density:	1.45	(g/cm^3)
Calculated Porosity:	45.2	(% cm^3/cm^3)
Tare Weight:	416.37	(g)
Sample Dry Weight (including tares):	507.82	(g)

Test #	*Date*	*Time*	*Thermo Couple Potential (-bars)*	*Sample Weight at X Potential (including tares) (g)*	*Moisture Content (% g/g)*	*Moisture Content (% cm^3/cm^3)*	*Matric Potential (-cm)*
1	18-Jan	1300	7.0	520.6	14.0	20.3	7139
2	18-Jan	1630	24.8	519.5	12.7	18.5	25291

Moisture content at -15 bars: 19.5 (%cm^3/cm^3)

Effective Porosity: 25.7 (% cm^3/cm^3)

Comments:

Laboratory analysis performed by: K. Copeland
Calculations made by: R. Maranville
Checked by: J. Vinson

EFFECTIVE POROSITY DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number 0888-0001
Ring Number: 0888-0001
Depth: 130-131 ft.

Bulk Density:	1.31	(g/cm^3)
Calculated Porosity:	50.6	(% cm^3/cm^3)
Tare Weight:	403.02	(g)
Sample Dry Weight (including tares):	464.69	(g)

Test #	*Date*	*Time*	*Thermo Couple Potential (-bars)*	*Sample Weight at X Potential (including tares) (g)*	*Moisture Content (% g/g)*	*Moisture Content (% cm^3/cm^3)*	*Matric Potential (-cm)*
1	1-Feb	1100	13.3	472.0	11.9	15.5	13563
2	1-Feb	1200	15.6	471.7	11.4	14.9	15909

Moisture content at -15 bars: 15.1 (%cm^3/cm^3)

Effective Porosity: 35.5 (% cm^3/cm^3)

Comments:

Laboratory analysis performed by: K. Copeland
Calculations made by: R. Maranville
Checked by: J. Vinson

EFFECTIVE POROSITY DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number 0891-0001
Ring Number: 0891-0001
Depth: 18-20 ft.

Bulk Density:	1.46	(g/cm^3)
Calculated Porosity:	44.9	(% cm^3/cm^3)
Tare Weight:	445.45	(g)
Sample Dry Weight (including tares):	657.09	(g)

Test #	*Date*	*Time*	*Thermo Couple Potential (-bars)*	*Sample Weight at X Potential (including tares) (g)*	*Moisture Content (% g/g)*	*Moisture Content (% cm^3/cm^3)*	*Matric Potential (-cm)*
1	11-Jan	1050	16.0	683.4	12.4	18.1	16317
2	11-Jan	1020	49.6	677.2	9.5	13.9	50582

Moisture content at -15 bars: 18.2 (%cm^3/cm^3)

Effective Porosity: 26.7 (% cm^3/cm^3)

Comments:

Laboratory analysis performed by: K. Copeland
Calculations made by: R. Maranville
Checked by: J. Vinson

EFFECTIVE POROSITY DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number 0892-0001
Ring Number: 0892-0001
Depth: 17-18.5 ft.

Bulk Density: 1.45 (g/cm^3)
Calculated Porosity: 45.2 (% cm^3/cm^3)
Tare Weight: 416.12 (g)
Sample Dry Weight (including tares): 540.15 (g)

Test #	*Date*	*Time*	*Thermo Couple Potential (-bars)*	*Sample Weight at X Potential (including tares) (g)*	*Moisture Content (% g/g)*	*Moisture Content (% cm^3/cm^3)*	*Matric Potential (-cm)*
1	16-Jan	1145	6.0	575.2	28.3	41.0	6119
2	16-Jan	1345	18.9	569.7	23.8	34.5	19274

Moisture content at -15 bars: 36.5 (%cm^3/cm^3)

Effective Porosity: 8.7 (% cm^3/cm^3)

Comments:

Laboratory analysis performed by: K. Copeland
Calculations made by: R. Maranville
Checked by: J. Vinson

EFFECTIVE POROSITY DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number 0893-0001
Ring Number: 0893-0001
Depth: 135-136 ft.

Bulk Density:	1.72	(g/cm^3)
Calculated Porosity:	35.0	(% cm^3/cm^3)
Tare Weight:	403.17	(g)
Sample Dry Weight (including tares):	515.50	(g)

Test #	*Date*	*Time*	*Thermo Couple Potential (-bars)*	*Sample Weight at X Potential (including tares) (g)*	*Moisture Content (% g/g)*	*Moisture Content (% cm^3/cm^3)*	*Matric Potential (-cm)*
1	1-Feb	1615	11.8	524.0	7.5	13.0	12034
2	2-Feb	1100	18.1	523.4	7.1	12.1	18458

Moisture content at -15 bars: 12.5 (%cm^3/cm^3)

Effective Porosity: 22.5 (% cm^3/cm^3)

Comments:

Laboratory analysis performed by: K. Copeland
Calculations made by: R. Maranville
Checked by: J. Vinson

EFFECTIVE POROSITY DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number 0894-0001
Ring Number: 0894-0001
Depth: 24.5-25.5 ft.

Bulk Density:	1.24	(g/cm^3)
Calculated Porosity:	53.1	(% cm^3/cm^3)
Tare Weight:	443.93	(g)
Sample Dry Weight (including tares):	503.54	(g)

Test #	*Date*	*Time*	*Thermo Couple Potential (-bars)*	*Sample Weight at X Potential (including tares) (g)*	*Moisture Content (% g/g)*	*Moisture Content (% cm^3/cm^3)*	*Matric Potential (-cm)*
1	31-Jan	1130	14.1	513.2	16.3	20.2	14379
2	27-Dec	1130	21.1	510.8	12.1	15.1	21518

Moisture content at -15 bars: 19.5 (%cm^3/cm^3)

Effective Porosity: 33.6 (% cm^3/cm^3)

Comments:

Laboratory analysis performed by: K. Copeland
Calculations made by: R. Maranville
Checked by: J. Vinson

APPENDIX D

PARTICLE SIZE CHARACTERISTICS

Summary of Particle Size Characterisitics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c
0883-0001	*	0.16	0.19	--	--
0884-0001	*	0.028	0.079	--	--
0885-0001	*	0.0022	0.012	--	--
0886-0001	*	0.069	0.083	--	--
0887-0001	*	0.061	0.070	--	--
0888-0001	0.0091	0.086	0.092	10	5.7
0891-0001	0.029	0.17	0.19	6.4	3.0
0892-0001	*	0.021	0.057	--	--
0893-0001	0.025	0.16	0.19	7.7	1.9
0894-0001	0.015	0.065	0.071	4.8	2.6

* d_{10} not reached with test specified
-- value dependent on d_{10}
d_{50} = median particle diameter

$C_u = d_{60}/d_{10}$

$C_c = (d_{30})^2/(d_{10})(d_{60})$

PARTICLE SIZE ANALYSIS
WET SIEVE DATA

Job Name: JACOBS-2
Job Number: 5918
Test Date: 12/18/95
Sample Number: 0883-0001
Depth: 108-110 ft.

Initial Dry Weight of Sample: 138.68 (g)
Weight Passing #10: 138.68 (g)
Weight Retained #10: 0.00 (g)
Weight of Hydrometer Sample: 45.18 (g)
Calculated Weight of Sieve Sample: 45.18 (g)

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	138.68	100.00
	1.5"	38.1	0.00	0.00	138.68	100.00
	3/4"	19.0	0.00	0.00	138.68	100.00
	3/8"	9.5	0.00	0.00	138.68	100.00
	4	4.75	0.00	0.00	138.68	100.00
	10	2.00	0.00	0.00	138.68	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.01	0.01	45.17	99.98
	40	0.425	0.12	0.13	45.05	99.71
	60	0.250	5.55	5.68	39.50	87.43
	140	0.106	28.26	33.94	11.24	24.88
	200	0.075	2.82	36.76	8.42	18.64
	dry pan		0.11	36.87	8.31	
	wet pan			8.31	0.00	

d_{10}: -- (mm)
d_{16}: 0.056 (mm)
d_{30}: 0.12 (mm)
d_{50}: 0.16 (mm)
d_{60}: 0.19 (mm)
d_{84}: 0.24 (mm)

Median Particle Diameter (d_{50}): 0.16
Uniformity Coefficient, Cu (d_{60}/d_{10}): --
Coefficient of Curvature, Cc $[(d_{30})^2/(d_{10}*d_{60})]$: --
Mean Particle Diameter $[(d_{16}+d_{50}+d_{84})/3]$: 0.15

Soil Classification: Classification by ASTM 2487 requires Atterberg test

Laboratory analysis performed by: H. Tran
Calculations made by: R. Maranville
Checked by: J. Vinson

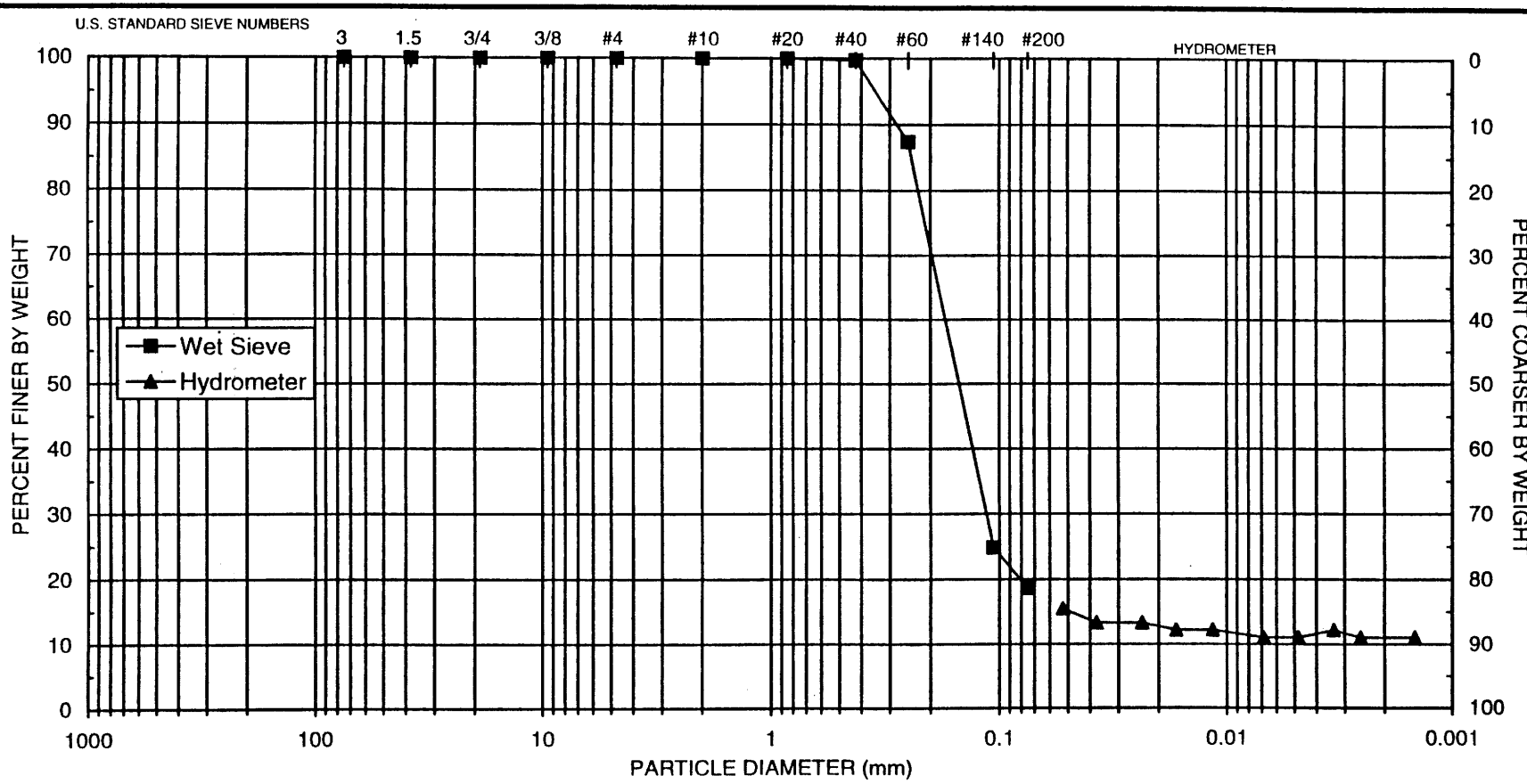
PARTICLE SIZE ANALYSIS
HYDROMETER DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number: 0883-0001
Type of Water Used: DISTILLED
Reaction with H_2O_2: SLIGHT
Dispersant: $(NaPO_3)_6$
Particle Density: 2.65

Test Date: 12/19/95
Depth: 108-110 FT.
Initial Wt.: 45.18 (g)
Total Sample Wt.: 138.68 (g)
Wt. Passing #10: 138.68 (g)
Start Time: 1018

Date	Time (min)	Temp (°C)	R (g/L)	RI (g/L)	Rcorr (g/L)	L (cm)	D (mm)	P (%)	% Finer
20-Dec	1	19.0	11.0	4.0	7.0	14.5	0.05256	15.5	15.49
	2	19.0	10.0	4.0	6.0	14.7	0.03737	13.3	13.28
	5	19.0	10.0	4.0	6.0	14.7	0.02364	13.3	13.28
	10	19.0	9.5	4.0	5.5	14.7	0.01676	12.2	12.17
	21	19.0	9.5	4.0	5.5	14.7	0.01157	12.2	12.17
	60	19.0	9.0	4.0	5.0	14.8	0.00686	11.1	11.07
	120	19.5	9.0	4.0	5.0	14.8	0.00482	11.1	11.07
	240	21.0	8.5	3.0	5.5	14.9	0.00335	12.2	12.17
	412	21.5	8.0	3.0	5.0	15.0	0.00255	11.1	11.07
21-Dec	1358	18.0	9.0	4.0	5.0	14.8	0.00146	11.1	11.07

Laboratory analysis performed by: J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY			
		Coarse	Fine	Coarse	Medium	Fine				
USDA	COBBLES	GRAVEL		SAND				SILT	CLAY	
				Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = --	d_{30} = **0.12**	d_{50} = **0.16**	d_{60} = **0.19**	C_u = --	C_c = --

SAMPLE NUMBER	DEPTH	USCS CLASSIFICATION
0883-0001	**108-110 ft.**	**Classification by ASTM 2487 requires Atterberg test**

DANIEL B. STEPHENS & ASSOCIATES, INC.
ENVIRONMENTAL SCIENTISTS AND ENGINEERS

PARTICLE SIZE ANALYSIS
WET SIEVE DATA

Job Name: JACOBS-2
Job Number: 5918
Test Date: 12/18/95
Sample Number: 0884-0001
Depth: 90-91 ft.

Initial Dry Weight of Sample: 198.20 (g)
Weight Passing #10: 198.20 (g)
Weight Retained #10: 0.00 (g)
Weight of Hydrometer Sample: 50.16 (g)
Calculated Weight of Sieve Sample: 50.16 (g)

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	198.20	100.00
	1.5"	38.1	0.00	0.00	198.20	100.00
	3/4"	19.0	0.00	0.00	198.20	100.00
	3/8"	9.5	0.00	0.00	198.20	100.00
	4	4.75	0.00	0.00	198.20	100.00
	10	2.00	0.00	0.00	198.20	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.01	0.01	50.15	99.98
	40	0.425	0.01	0.02	50.14	99.96
	60	0.250	0.01	0.03	50.13	99.94
	140	0.106	5.76	5.79	44.37	88.46
	200	0.075	16.18	21.97	28.19	56.20
	dry pan		0.98	22.95	27.21	
	wet pan			27.21	0.00	

d_{10}: -- (mm)
d_{16}: -- (mm)
d_{30}: -- (mm)
d_{50}: 0.028 (mm)
d_{60}: 0.079 (mm)
d_{84}: 0.10 (mm)

Median Particle Diameter (d_{50}): 0.028
Uniformity Coefficient, Cu (d_{60}/d_{10}): --
Coefficient of Curvature, Cc $[(d_{30})^2/(d_{10}*d_{60})]$: --
Mean Particle Diameter $[(d_{16}+d_{50}+d_{84})/3]$: --

Soil Classification: Classification by ASTM 2487 requires Atterberg test

Laboratory analysis performed by: J. Locke/H. Tran
Calculations made by: R. Maranville
Checked by: J. Vinson

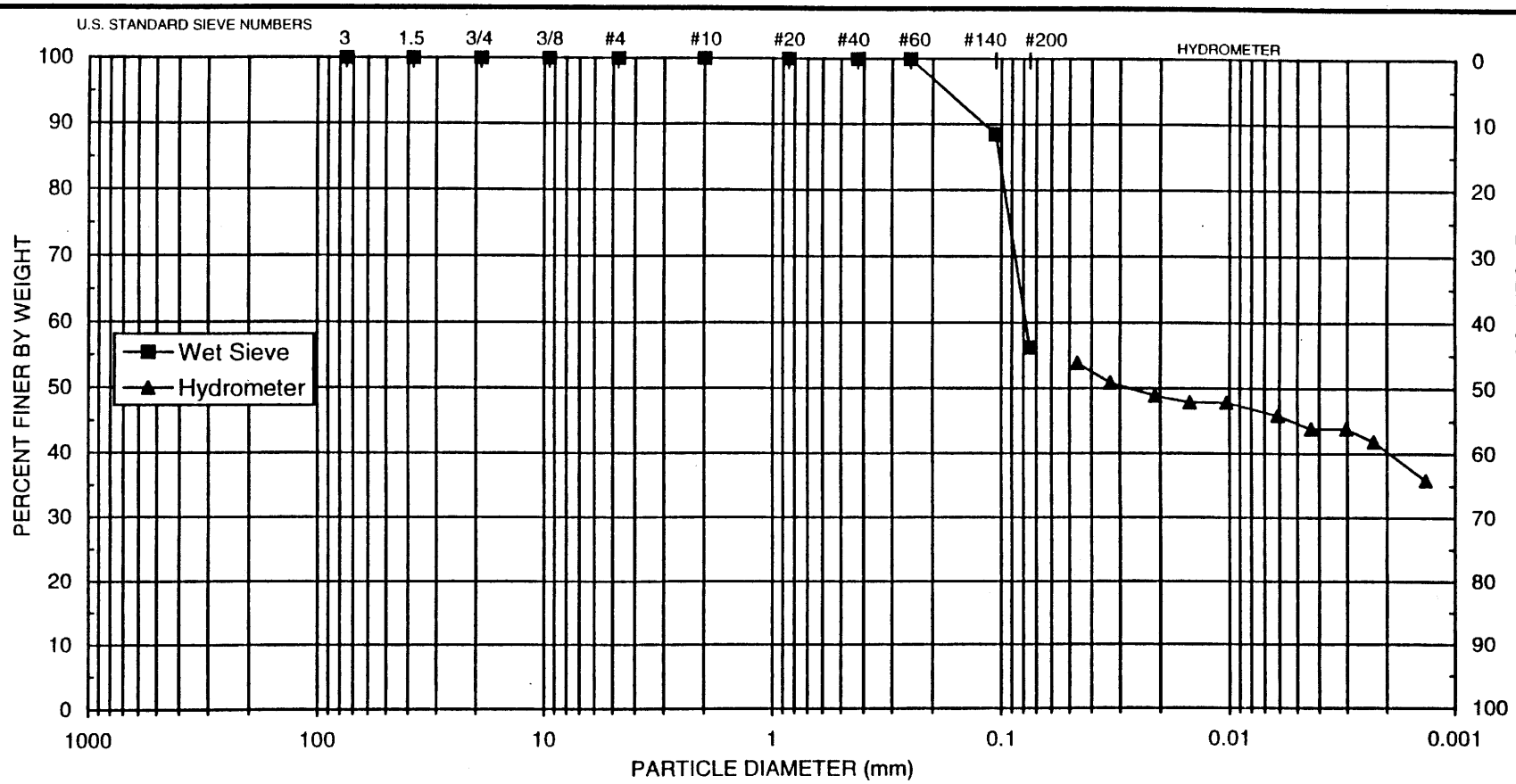
PARTICLE SIZE ANALYSIS
HYDROMETER DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number: 0884-0001
Type of Water Used: DISTILLED
Reaction with H_2O_2: V SLIGHT
Dispersant: $(NaPO_3)_6$
Particle Density: 2.65

Test Date: 12/19/95
Depth: 90-91 ft.
Initial Wt.: 50.16 (g)
Total Sample Wt.: 198.20 (g)
Wt. Passing #10: 198.20 (g)
Start Time: 1006

Date	Time (min)	Temp (°C)	R (g/L)	RI (g/L)	Rcorr (g/L)	L (cm)	D (mm)	P (%)	% Finer
20-Dec	1	19.0	31.0	4.0	27.0	11.2	0.04624	53.8	53.83
	2	19.0	29.5	4.0	25.5	11.5	0.03305	50.8	50.84
	5	19.0	28.5	4.0	24.5	11.6	0.02105	48.8	48.84
	10	19.0	28.0	4.0	24.0	11.7	0.01494	47.8	47.85
	21	19.0	28.0	4.0	24.0	11.7	0.01031	47.8	47.85
	60	19.0	27.0	4.0	23.0	11.9	0.00614	45.9	45.85
	120	19.5	26.0	4.0	22.0	12.0	0.00435	43.9	43.86
	240	21.0	25.0	3.0	22.0	12.2	0.00303	43.9	43.86
	422	21.5	24.0	3.0	21.0	12.4	0.00229	41.9	41.87
21-Dec	1368	18.0	22.0	4.0	18.0	12.7	0.00135	35.9	35.89

Laboratory analysis performed by: J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY
		Coarse	Fine	Coarse	Medium	Fine	
USDA	COBBLES	GRAVEL		SAND			SILT / CLAY
				Very coarse / Coarse	Medium	Fine / Very fine	

d_{10} = --	d_{30} = --	d_{50} = **0.028**	d_{60} = **0.079**	C_u = --	C_c = --

SAMPLE NUMBER	DEPTH	USCS CLASSIFICATION
0884-0001	**90-91 ft.**	**Classification by ASTM 2487 requires Atterberg test**

DANIEL B. STEPHENS & ASSOCIATES, INC.
ENVIRONMENTAL SCIENTISTS AND ENGINEERS

PARTICLE SIZE ANALYSIS
WET SIEVE DATA

Job Name: JACOBS-2
Job Number: 5918
Test Date: 12/18/95
Sample Number: 0885-0001
Depth: 54-55 ft.

Initial Dry Weight of Sample: 183.42 (g)
Weight Passing #10: 183.42 (g)
Weight Retained #10: 0.00 (g)
Weight of Hydrometer Sample: 49.52 (g)
Calculated Weight of Sieve Sample: 49.52 (g)

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	183.42	100.00
	1.5"	38.1	0.00	0.00	183.42	100.00
	3/4"	19.0	0.00	0.00	183.42	100.00
	3/8"	9.5	0.00	0.00	183.42	100.00
	4	4.75	0.00	0.00	183.42	100.00
	10	2.00	0.00	0.00	183.42	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.01	0.01	49.51	99.98
	40	0.425	0.03	0.04	49.48	99.92
	60	0.250	0.08	0.12	49.40	99.76
	140	0.106	10.67	10.79	38.73	78.21
	200	0.075	7.04	17.83	31.69	63.99
	dry pan		0.37	18.20	31.32	
	wet pan			31.32	0.00	

d_{10}: -- (mm)
d_{16}: -- (mm)
d_{30}: -- (mm)
d_{50}: 0.0022 (mm)
d_{60}: 0.012 (mm)
d_{84}: 0.14 (mm)

Median Particle Diameter (d_{50}): 0.0022
Uniformity Coefficient, Cu (d_{60}/d_{10}): --
Coefficient of Curvature, Cc $[(d_{30})^2/(d_{10}*d_{60})]$: --
Mean Particle Diameter $[(d_{16}+d_{50}+d_{84})/3]$: --

Soil Classification: Classification by ASTM 2487 requires Atterberg test

Laboratory analysis performed by: J. Locke/H. Tran
Calculations made by: R. Maranville
Checked by: J. Vinson

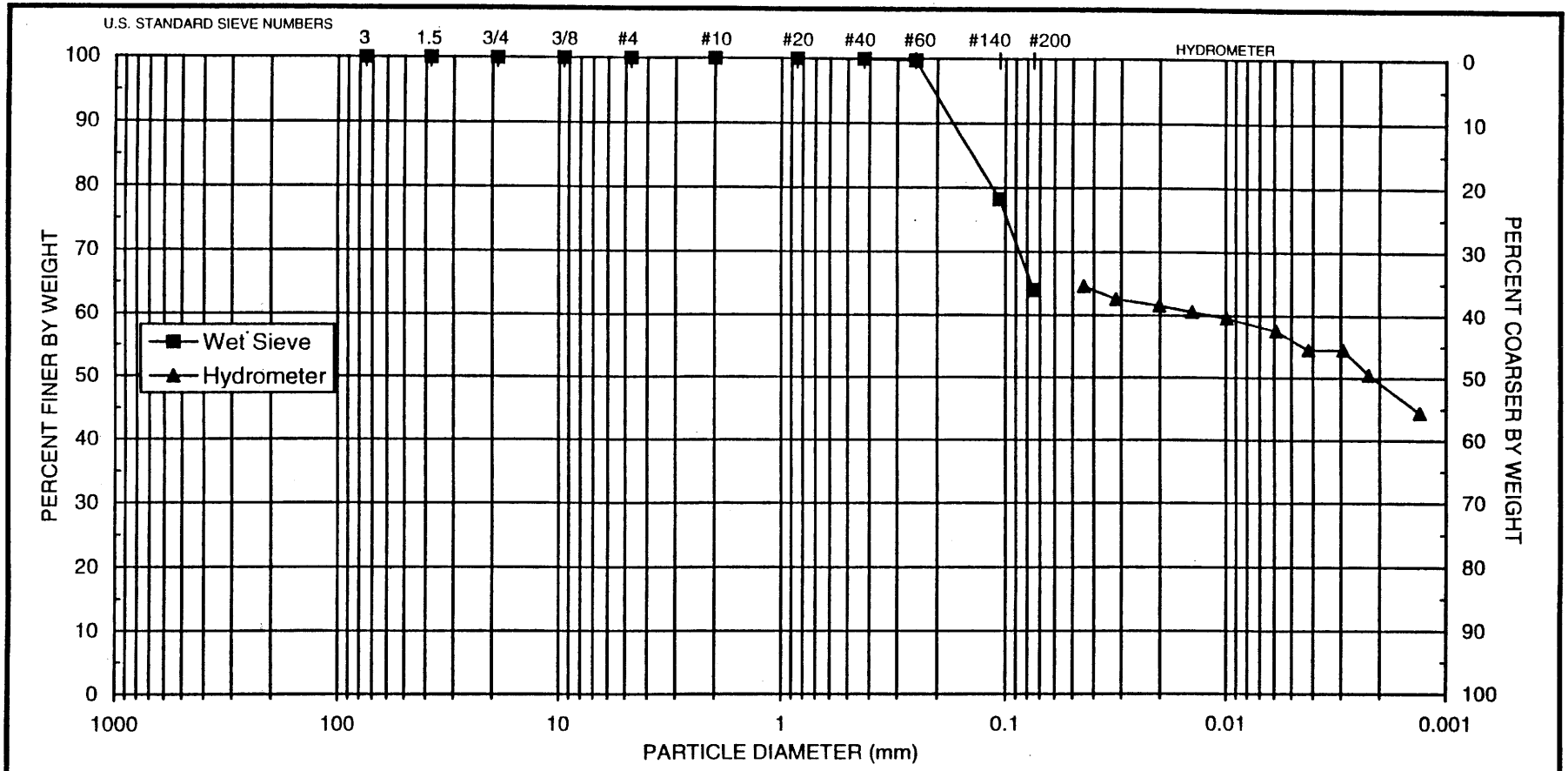
PARTICLE SIZE ANALYSIS
HYDROMETER DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number: 0885-0001
Type of Water Used: DISTILLED
Reaction with H_2O_2: V. Slight
Dispersant: $(NaPO_3)_6$
Particle Density: 2.65

Test Date: 12/19/95
Depth: 54-55 ft.
Initial Wt.: 49.52 (g)
Total Sample Wt.: 183.42 (g)
Wt. Passing #10: 183.42 (g)
Start Time: 1012

Date	Time (min)	Temp (°C)	R (g/L)	RI (g/L)	Rcorr (g/L)	L (cm)	D (mm)	P (%)	% Finer
20-Dec	1	19.0	36.0	4.0	32.0	10.4	0.04451	64.6	64.62
	2	19.0	35.0	4.0	31.0	10.6	0.03172	62.6	62.60
	5	19.0	34.5	4.0	30.5	10.6	0.02014	61.6	61.59
	10	19.0	34.0	4.0	30.0	10.7	0.01430	60.6	60.58
	21	19.0	33.5	4.0	29.5	10.8	0.00990	59.6	59.57
	60	19.0	32.5	4.0	28.5	11.0	0.00590	57.6	57.55
	120	19.5	31.0	4.0	27.0	11.2	0.00419	54.5	54.52
	240	21.0	30.0	3.0	27.0	11.4	0.00293	54.5	54.52
	417	21.5	28.0	3.0	25.0	11.7	0.00224	50.5	50.48
21-Dec	1363	18.0	26.0	4.0	22.0	12.0	0.00131	44.4	44.43

Laboratory analysis performed by: J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY			
		Coarse	Fine	Coarse	Medium	Fine				
USDA	COBBLES	GRAVEL		SAND				SILT	CLAY	
				Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = --	d_{30} = --	d_{50} = **0.0022**	d_{60} = **0.012**	C_u = --	C_c = --
SAMPLE NUMBER	DEPTH	USCS CLASSIFICATION			
0885-0001	**54-55 ft.**	**Classification by ASTM 2487 requires Atterberg test**			

PARTICLE SIZE ANALYSIS
WET SIEVE DATA

Job Name: JACOBS-2
Job Number: 5918
Test Date: 12/18/95
Sample Number: 0886-0001
Depth: 42.5-43.5 ft.

Initial Dry Weight of Sample: 153.26 (g)
Weight Passing #10: 153.26 (g)
Weight Retained #10: 0.00 (g)
Weight of Hydrometer Sample: 50.12 (g)
Calculated Weight of Sieve Sample: 50.12 (g)

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	153.26	100.00
	1.5"	38.1	0.00	0.00	153.26	100.00
	3/4"	19.0	0.00	0.00	153.26	100.00
	3/8"	9.5	0.00	0.00	153.26	100.00
	4	4.75	0.00	0.00	153.26	100.00
	10	2.00	0.00	0.00	153.26	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.03	0.03	50.09	99.94
	40	0.425	0.01	0.04	50.08	99.92
	60	0.250	0.02	0.06	50.06	99.88
	140	0.106	7.46	7.52	42.60	85.00
	200	0.075	16.80	24.32	25.80	51.48
	dry pan		1.12	25.44	24.68	
	wet pan			24.68	0.00	

d_{10}: -- (mm)
d_{16}: -- (mm)
d_{30}: 0.0025 (mm)
d_{50}: 0.069 (mm)
d_{60}: 0.083 (mm)
d_{84}: 0.10 (mm)

Median Particle Diameter (d_{50}): 0.069
Uniformity Coefficient, Cu (d_{60}/d_{10}): --
Coefficient of Curvature, Cc $[(d_{30})^2/(d_{10}*d_{60})]$: --
Mean Particle Diameter $[(d_{16}+d_{50}+d_{84})/3]$: --

Soil Classification: Classification by ASTM 2487 requires Atterberg test

Laboratory analysis performed by: H. Tran
Calculations made by: R. Maranville
Checked by: J. Vinson

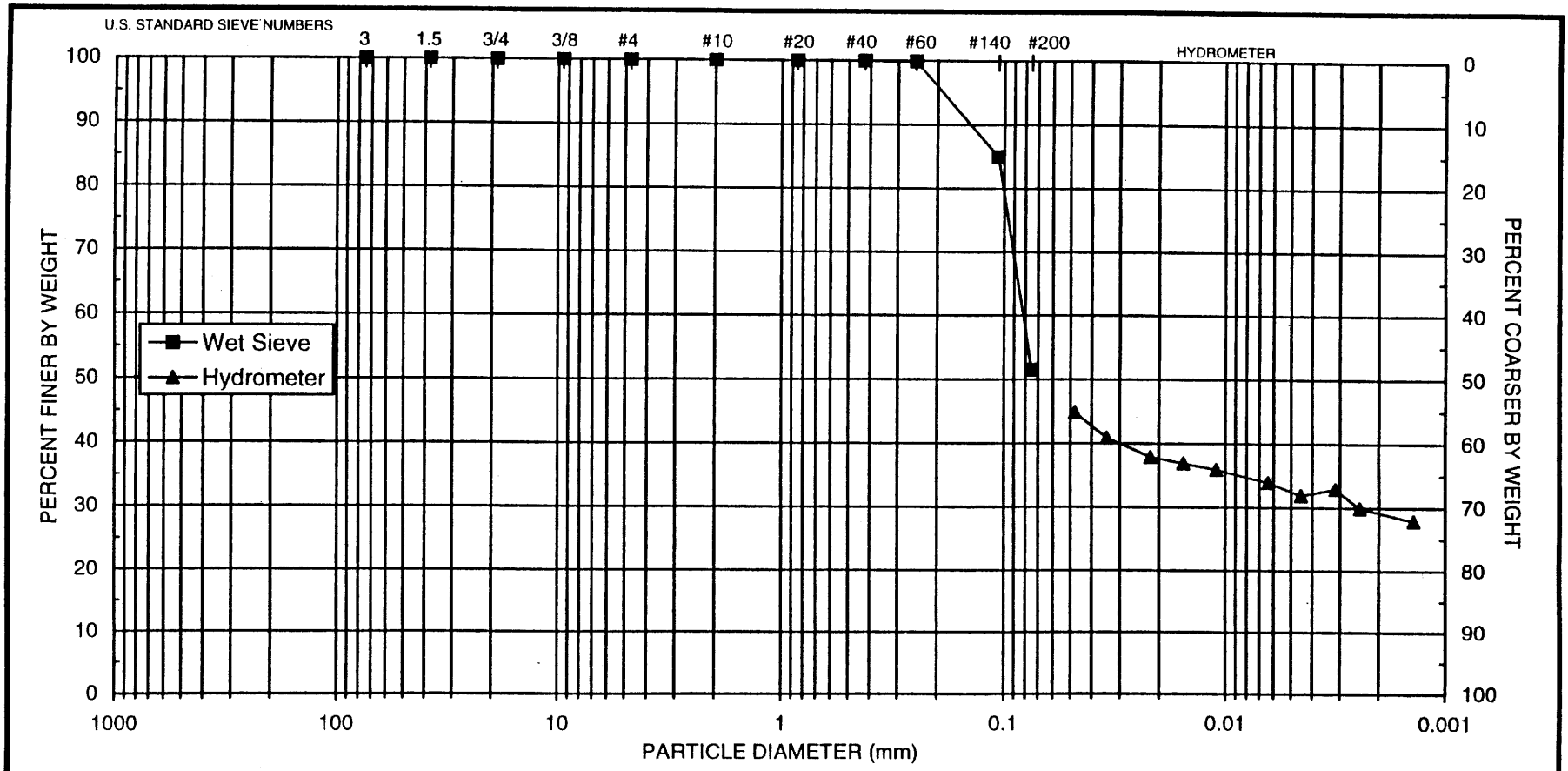
PARTICLE SIZE ANALYSIS
HYDROMETER DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number: 0886-0001
Type of Water Used: DISTILLED
Reaction with H_2O_2: NONE
Dispersant: $(NaPO_3)_6$
Particle Density: 2.65

Test Date: 19-Dec
Depth: 42.5-43.5 ft.
Initial Wt.: 50.12 (g)
Total Sample Wt.: 153.26 (g)
Wt. Passing #10: 153.26 (g)
Start Time: 1030

Date	Time (min)	Temp (°C)	R (g/L)	RI (g/L)	Rcorr (g/L)	L (cm)	D (mm)	P (%)	% Finer
10-Dec	1	19.0	26.5	4.0	22.5	12.0	0.04773	44.9	44.89
	2	19.0	24.5	4.0	20.5	12.3	0.03421	40.9	40.90
	5	19.0	23.0	4.0	19.0	12.5	0.02185	37.9	37.91
	10	19.0	22.5	4.0	18.5	12.6	0.01550	36.9	36.91
	20	19.0	22.0	4.0	18.0	12.7	0.01100	35.9	35.91
	60	19.0	21.0	4.0	17.0	12.9	0.00639	33.9	33.92
	120	19.5	20.0	4.0	16.0	13.0	0.00452	31.9	31.92
	240	21.0	19.5	3.0	16.5	13.1	0.00314	32.9	32.92
	402	21.5	18.0	3.0	15.0	13.3	0.00244	29.9	29.93
21-Dec	1349	18.0	18.0	4.0	14.0	13.3	0.00139	27.9	27.93

Laboratory analysis performed by: J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson



d_{10} = --	d_{30} = **0.0025**	d_{50} = **0.069**	d_{60} = **0.083**	C_u = --	C_c = --

SAMPLE NUMBER	DEPTH	USCS CLASSIFICATION
0886-0001	**42.5-43.5 ft.**	**Classification by ASTM 2487 requires Atterberg test**

DANIEL B. STEPHENS & ASSOCIATES, INC.
ENVIRONMENTAL SCIENTISTS AND ENGINEERS

PARTICLE SIZE ANALYSIS
WET SIEVE DATA

Job Name: JACOBS-2
Job Number: 5918
Test Date: 12/18/95
Sample Number: 0887-0001
Depth: 44-45 ft.

Initial Dry Weight of Sample: 155.45 (g)
Weight Passing #10: 155.38 (g)
Weight Retained #10: 0.07 (g)
Weight of Hydrometer Sample: 50.25 (g)
Calculated Weight of Sieve Sample: 50.27 (g)

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	155.45	100.00
	1.5"	38.1	0.00	0.00	155.45	100.00
	3/4"	19.0	0.00	0.00	155.45	100.00
	3/8"	9.5	0.00	0.00	155.45	100.00
	4	4.75	0.00	0.00	155.45	100.00
	10	2.00	0.07	0.07	155.38	99.95
-10			(Based on calculated sieve wt.)			
	20	0.85	0.04	0.06	50.21	99.88
	40	0.425	0.02	0.08	50.19	99.84
	60	0.250	0.05	0.13	50.14	99.74
	140	0.106	0.57	0.70	49.57	98.60
	200	0.075	16.45	17.15	33.12	65.88
	dry pan		8.03	25.18	25.09	
	wet pan			25.09	0.00	

d_{10}: -- (mm)
d_{16}: 0.0017 (mm)
d_{30}: 0.039 (mm)
d_{50}: 0.061 (mm)
d_{60}: 0.070 (mm)
d_{84}: 0.092 (mm)

Median Particle Diameter (d_{50}): 0.061
Uniformity Coefficient, Cu (d_{60}/d_{10}): --
Coefficient of Curvature, Cc $[(d_{30})^2/(d_{10}*d_{60})]$: --
Mean Particle Diameter $[(d_{16}+d_{50}+d_{84})/3]$: 0.052

Soil Classification: Classification by ASTM 2487 requires Atterberg test

Laboratory analysis performed by: H. Tran
Calculations made by: R. Maranville
Checked by: J. Vinson

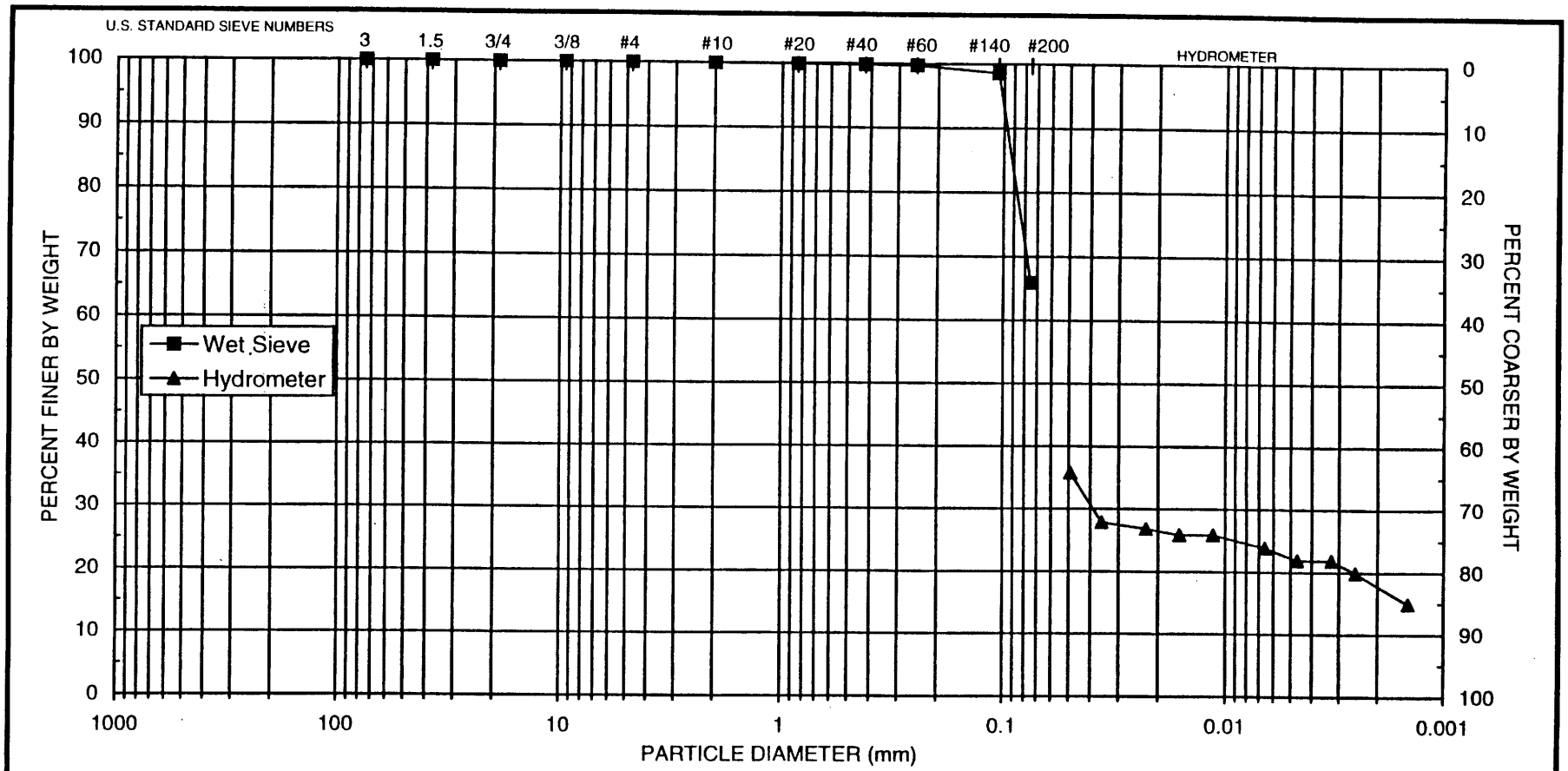
PARTICLE SIZE ANALYSIS
HYDROMETER DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number: 0887-0001
Type of Water Used: DISTILLED
Reaction with H_2O_2: SLIGHT
Dispersant: $(NaPO_3)_6$
Particle Density: 2.65

Test Date: 12/19/95
Depth: 44-45 ft
Initial Wt.: 50.25 (g)
Total Sample Wt.: 155.45 (g)
Wt. Passing #10: 155.38 (g)
Start Time: 1036

Date	Time (min)	Temp (°C)	R (g/L)	RI (g/L)	Rcorr (g/L)	L (cm)	D (mm)	P (%)	% Finer
20-Dec	1	19.0	22.0	4.0	18.0	12.7	0.04918	35.8	35.80
	2	19.0	18.0	4.0	14.0	13.3	0.03566	27.9	27.85
	5	19.0	17.5	4.0	13.5	13.4	0.02262	26.9	26.85
	10	19.0	17.0	4.0	13.0	13.5	0.01605	25.9	25.86
	20	19.0	17.0	4.0	13.0	13.5	0.01135	25.9	25.86
	60	19.0	16.0	4.0	12.0	13.7	0.00659	23.9	23.87
	120	19.5	15.0	4.0	11.0	13.8	0.00466	21.9	21.88
	240	21.0	14.0	3.0	11.0	14.0	0.00325	21.9	21.88
	397	21.5	13.0	3.0	10.0	14.2	0.00253	19.9	19.89
21-Dec	1344	18.0	11.5	4.0	7.5	14.4	0.00145	14.9	14.92

Laboratory analysis performed by: J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson



d_{10} = --	d_{30} = **0.039**	d_{50} = **0.061**	d_{60} = **0.070**	C_u = --	C_c = --

SAMPLE NUMBER	DEPTH	USCS CLASSIFICATION
0887-0001	**44-45 ft.**	**Classification by ASTM 2487 requires Atterberg test**

PARTICLE SIZE ANALYSIS
WET SIEVE DATA

Job Name: JACOBS-2
Job Number: 5918
Test Date: 12/18/95
Sample Number: 0888-0001
Depth: 130-131 ft.

Initial Dry Weight of Sample: 195.86 (g)
Weight Passing #10: 195.86 (g)
Weight Retained #10: 0.00 (g)
Weight of Hydrometer Sample: 44.76 (g)
Calculated Weight of Sieve Sample: 44.76 (g)

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	195.86	100.00
	1.5"	38.1	0.00	0.00	195.86	100.00
	3/4"	19.0	0.00	0.00	195.86	100.00
	3/8"	9.5	0.00	0.00	195.86	100.00
	4	4.75	0.00	0.00	195.86	100.00
	10	2.00	0.00	0.00	195.86	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.01	0.01	44.75	99.98
	40	0.425	0.02	0.03	44.73	99.93
	60	0.250	0.32	0.35	44.41	99.22
	140	0.106	7.58	7.93	36.83	82.28
	200	0.075	21.92	29.85	14.91	33.31
	dry pan		1.89	31.74	13.02	
	wet pan			13.02	0.00	

d_{10}: 0.0091 (mm)
d_{16}: 0.030 (mm)
d_{30}: 0.069 (mm)
d_{50}: 0.086 (mm)
d_{60}: 0.092 (mm)
d_{84}: 0.12 (mm)

Median Particle Diameter (d_{50}): 0.086
Uniformity Coefficient, Cu (d_{60}/d_{10}): 10
Coefficient of Curvature, Cc $[(d_{30})^2/(d_{10}*d_{60})]$: 5.7
Mean Particle Diameter $[(d_{16}+d_{50}+d_{84})/3]$: 0.079

Soil Classification: Classification by ASTM 2487 requires Atterberg test

Laboratory analysis performed by: J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson

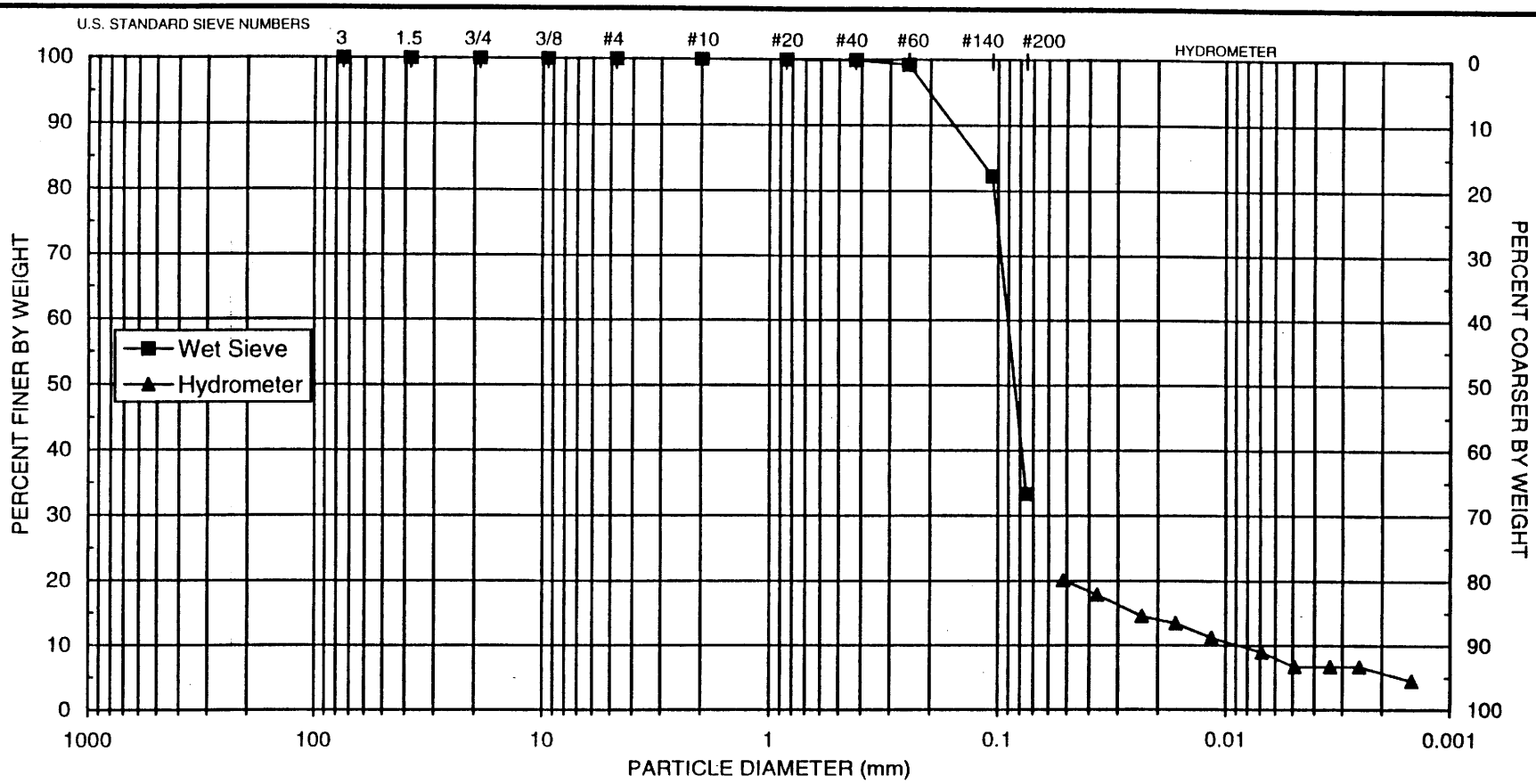
PARTICLE SIZE ANALYSIS
HYDROMETER DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number: 0888-0001
Type of Water Used: DISTILLED
Reaction with H_2O_2: V. SLIGHT
Dispersant: $(NaPO_3)_6$
Particle Density: 2.65

Test Date: 12/19/95
Depth: 130-131 ft.
Initial Wt.: 44.76 (g)
Total Sample Wt.: 195.86 (g)
Wt. Passing #10: 195.86 (g)
Start Time: 954

Date	Time (min)	Temp (°C)	R (g/L)	RI (g/L)	Rcorr (g/L)	L (cm)	D (mm)	P (%)	% Finer
20-Dec	1	19.0	13.0	4.0	9.0	14.2	0.05196	20.1	20.11
	2	19.0	12.0	4.0	8.0	14.3	0.03695	17.9	17.87
	5	19.0	10.5	4.0	6.5	14.6	0.02357	14.5	14.52
	10	19.0	10.0	4.0	6.0	14.7	0.01671	13.4	13.40
	21	19.0	9.0	4.0	5.0	14.8	0.01160	11.2	11.17
	60	19.0	8.0	4.0	4.0	15.0	0.00690	8.9	8.94
	120	19.0	7.0	4.0	3.0	15.2	0.00491	6.7	6.70
	240	21.0	6.0	3.0	3.0	15.3	0.00340	6.7	6.70
	431	21.5	6.0	3.0	3.0	15.3	0.00252	6.7	6.70
21-Dec	1375	18.0	6.0	4.0	2.0	15.3	0.00148	4.5	4.47

Laboratory analysis performed by: J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson



UNIFIED	COBBLES	GRAVEL		SAND		SILT OR CLAY
		Coarse	Fine	Coarse	Medium	Fine
USDA	COBBLES	GRAVEL		SAND		SILT	CLAY
				Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.0091**	d_{30} = **0.069**	d_{50} = **0.086**	d_{60} = **0.092**	C_u = **10**	C_c = **5.7**
SAMPLE NUMBER	DEPTH	USCS CLASSIFICATION			
0888-0001	**130-131 ft.**	**Classification by ASTM 2487 requires Atterberg test**			

PARTICLE SIZE ANALYSIS
DRY SIEVE DATA

Job Name: JACOBS-2
Job Number: 5918
Test Date: 1/15/96
Sample Number: 0891-0001
Depth: 18.0-20.0 ft.

Total Sample Weight: 210.95 (g)

Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
3"	75	0.00	0.00	210.95	100.00
1.5"	38.1	0.00	0.00	210.95	100.00
3/4"	19.0	0.00	0.00	210.95	100.00
3/8"	9.5	0.00	0.00	210.95	100.00
4	4.75	0.00	0.00	210.95	100.00
10	2.00	0.00	0.00	210.95	100.00
20	0.85	0.32	0.32	210.63	99.85
40	0.425	7.22	7.54	203.41	96.43
60	0.250	8.47	16.01	194.94	92.41
140	0.106	155.80	171.81	39.14	18.55
200	0.075	14.82	186.63	24.32	11.53
pan		23.50	210.13	0.82	

d_{10}:	0.029 (mm)	d_{50}:	0.17 (mm)
d_{16}:	0.095 (mm)	d_{60}:	0.19 (mm)
d_{30}:	0.13 (mm)	d_{84}:	0.23 (mm)

Median Particle Diameter (d_{50}): 0.17
Uniformity Coefficient, Cu (d_{60}/d_{10}): 6.4
Coefficient of Curvature, Cc $[(d_{30})^2/(d_{10}*d_{60})]$: 3.0
Mean Particle Diameter $[(d_{16}+d_{50}+d_{84})/3]$: 0.17

Soil Classification: Classification by ASTM 2487 requires Atterberg test

Laboratory analysis performed by: H. Tran
Calculations made by: R. Maranville
Checked by: J. Vinson

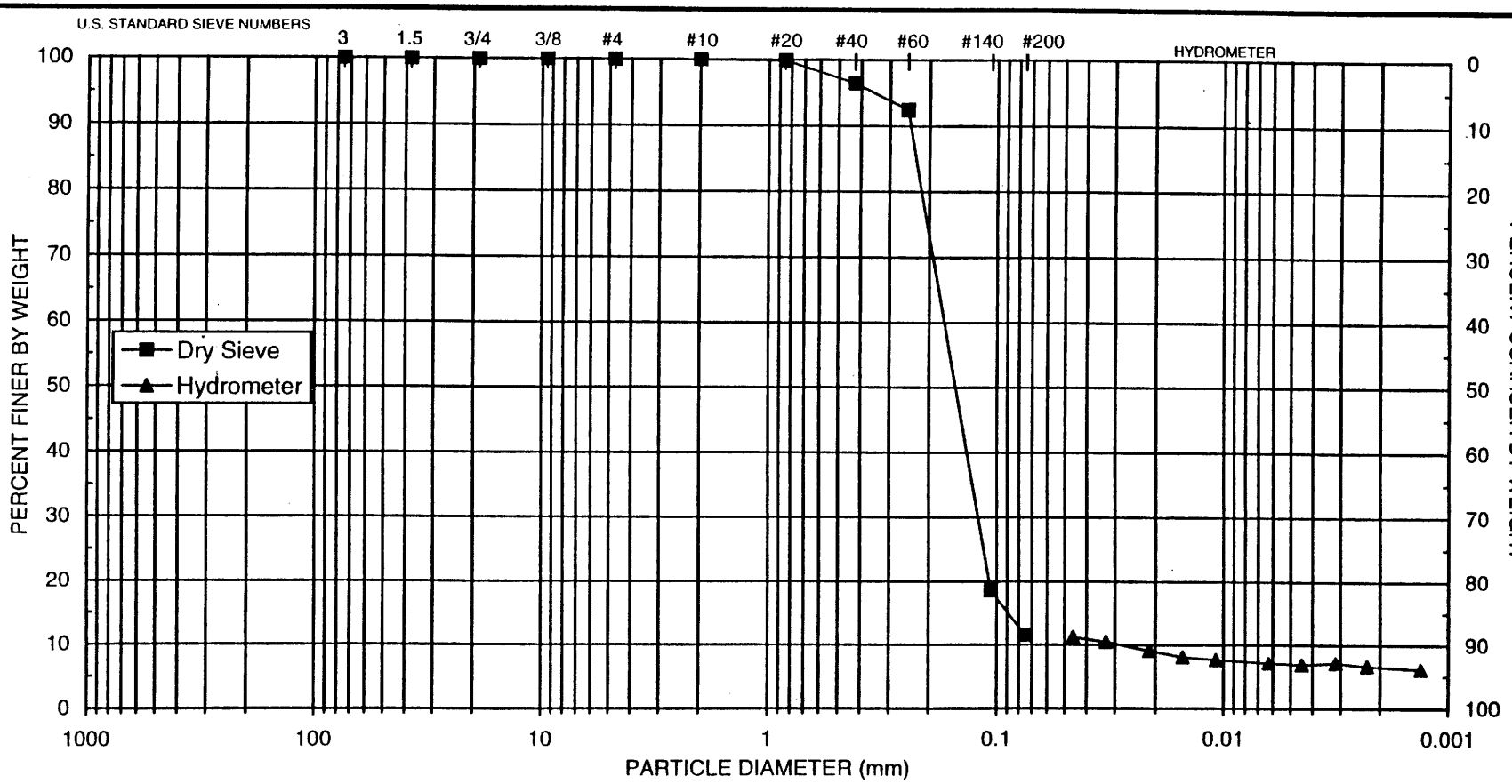
PARTICLE SIZE ANALYSIS
HYDROMETER DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number: 0891-0001
Type of Water Used: DISTILLED
Reaction with H_2O_2: SLIGHT
Dispersant: $(NaPO_3)_6$
Particle Density: 2.65

Test Date: 1/15/96
Depth: 18.0-20.0 ft.
Initial Wt.: 23.46 (g)
Total Sample Wt.: 210.95 (g)
Wt. Passing #200: 23.50 (g)
Start Time: 9:20

Date	Time (min)	Temp (°C)	R (g/L)	RI (g/L)	Rcorr (g/L)	L (cm)	D (mm)	P (%)	% Finer
15-Jan	1	22.0	26.5	3.0	23.5	12.0	0.04598	100.2	11.16
	2	22.0	25.0	3.0	22.0	12.2	0.03285	93.8	10.45
	5	22.0	22.0	3.0	19.0	12.7	0.02119	81.0	9.02
	10	22.0	20.0	3.0	17.0	13.0	0.01517	72.5	8.07
	20	22.0	19.0	3.0	16.0	13.2	0.01080	68.2	7.60
	60	22.0	18.0	3.0	15.0	13.3	0.00627	63.9	7.12
	120	22.0	17.0	2.5	14.5	13.5	0.00446	61.8	6.89
	240	22.0	17.0	2.0	15.0	13.5	0.00316	63.9	7.12
	466	22.0	16.0	2.0	14.0	13.7	0.00228	59.7	6.65
16-Jan	1384	22.5	15.0	2.0	13.0	13.8	0.00132	55.4	6.17

Laboratory analysis performed by: H. Tran
Calculations made by: R. Maranville
Checked by: J. Vinson



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY			
		Coarse	Fine	Coarse	Medium	Fine				
USDA	COBBLES	GRAVEL		SAND				SILT	CLAY	
				Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.029**	d_{30} = **0.13**	d_{50} = **0.17**	d_{60} = **0.19**	C_u = **6.4**	C_c = **3.0**

SAMPLE NUMBER	DEPTH	USCS CLASSIFICATION
0891-0001	**18.0-20.0 ft.**	**Classification by ASTM 2487 requires Atterberg test**

PARTICLE SIZE ANALYSIS
WET SIEVE DATA

Job Name: JACOBS-2
Job Number: 5918
Test Date: 1/18/96
Sample Number: 0892-0001
Depth: 17.0-18.5 ft.

Initial Dry Weight of Sample: 123.72 (g)
Weight Passing #10: 123.72 (g)
Weight Retained #10: 0.00 (g)
Weight of Hydrometer Sample: 46.03 (g)
Calculated Weight of Sieve Sample: 46.03 (g)

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	123.72	100.00
	1.5"	38.1	0.00	0.00	123.72	100.00
	3/4"	19.0	0.00	0.00	123.72	100.00
	3/8"	9.5	0.00	0.00	123.72	100.00
	4	4.75	0.00	0.00	123.72	100.00
	10	2.00	0.00	0.00	123.72	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.01	0.01	46.02	99.98
	40	0.425	0.06	0.07	45.96	99.85
	60	0.250	0.19	0.26	45.77	99.44
	140	0.106	10.08	10.34	35.69	77.54
	200	0.075	5.65	15.99	30.04	65.26
	dry pan		0.16	16.15	29.88	
	wet pan			29.88	0.00	

d_{10}: -- (mm)
d_{16}: -- (mm)
d_{30}: -- (mm)
d_{50}: 0.021 (mm)
d_{60}: 0.057 (mm)
d_{84}: 0.15 (mm)

Median Particle Diameter (d_{50}): 0.021
Uniformity Coefficient, Cu (d_{60}/d_{10}): --
Coefficient of Curvature, Cc $[(d_{30})^2/(d_{10}*d_{60})]$: --
Mean Particle Diameter $[(d_{16}+d_{50}+d_{84})/3]$: --

Soil Classification: Classification by ASTM 2487 requires Atterberg test

Laboratory analysis performed by: H. Tran
Calculations made by: R. Maranville
Checked by: J. Vinson

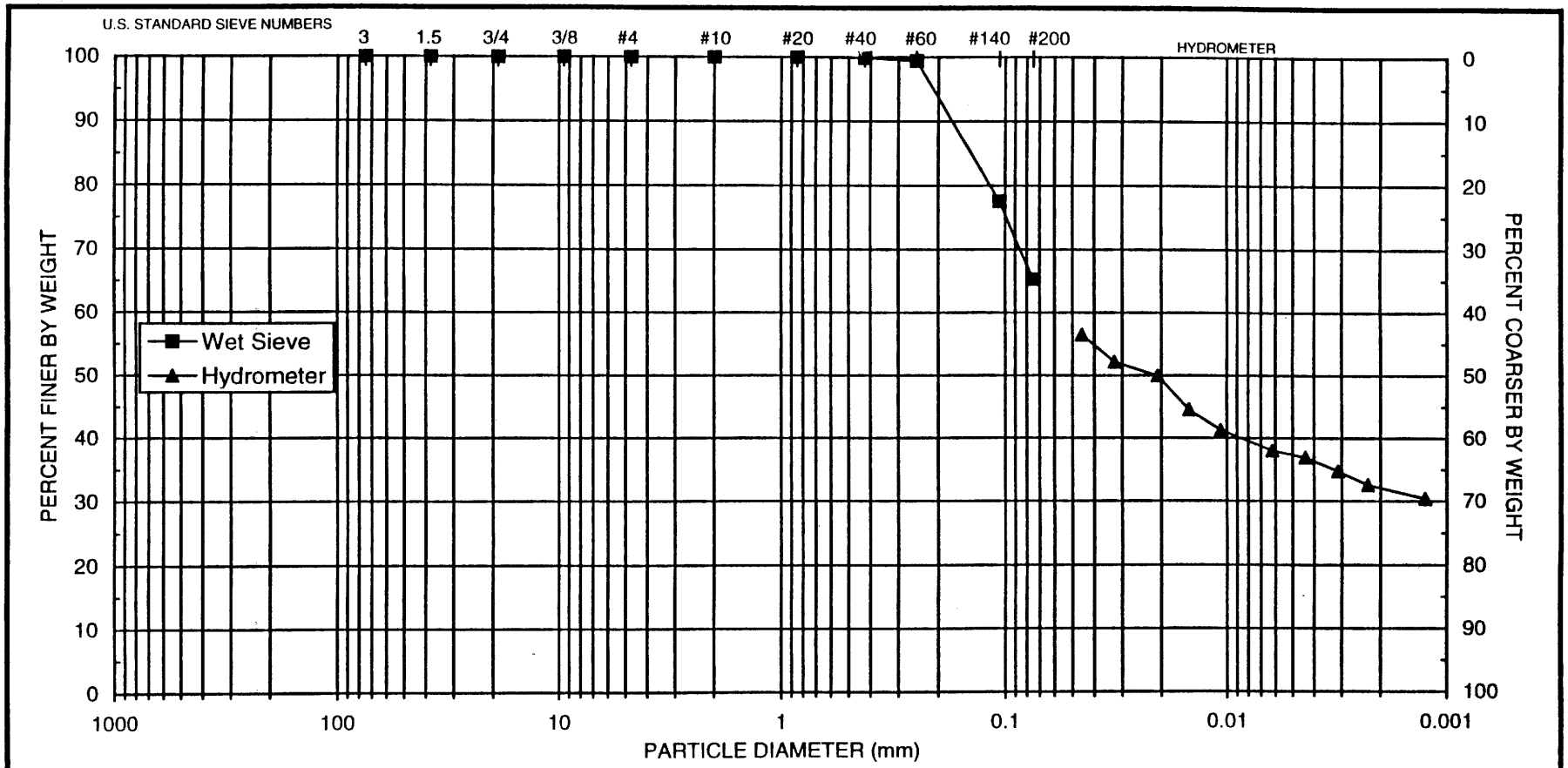
PARTICLE SIZE ANALYSIS
HYDROMETER DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number: 0892-0001
Type of Water Used: DISTILLED
Reaction with H_2O_2: SLIGHT
Dispersant: $(NaPO_3)_6$
Particle Density: 2.65

Test Date: 1/18/96
Depth: 17.0-18.5 ft.
Initial Wt.: 46.03 (g)
Total Sample Wt.: 123.72 (g)
Wt. Passing #200: 123.72 (g)
Start Time: 9:36

Date	Time (min)	Temp (°C)	R (g/L)	RI (g/L)	Rcorr (g/L)	L (cm)	D (mm)	P (%)	% Finer
19-Jan	1	21.5	29.0	3.0	26.0	11.5	0.04545	56.5	56.48
	2	21.5	27.0	3.0	24.0	11.9	0.03259	52.1	52.14
	5	21.5	26.0	3.0	23.0	12.0	0.02076	50.0	49.97
	10	21.5	23.5	3.0	20.5	12.4	0.01492	44.5	44.54
	20	21.5	22.0	3.0	19.0	12.7	0.01066	41.3	41.28
	60	21.5	20.5	3.0	17.5	12.9	0.00621	38.0	38.02
	120	22.0	20.0	3.0	17.0	13.0	0.00438	36.9	36.93
	240	22.0	19.0	3.0	16.0	13.2	0.00312	34.8	34.76
	450	22.5	17.5	2.5	15.0	13.4	0.00228	32.6	32.59
20-Jan	1542	22.0	16.0	2.0	14.0	13.7	0.00125	30.4	30.41

Laboratory analysis performed by: H. Tran
Calculations made by: R. Maranville
Checked by: J. Vinson



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY			
		Coarse	Fine	Coarse	Medium	Fine				
USDA	COBBLES	GRAVEL		SAND				SILT	CLAY	
				Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = --	d_{30} = --	d_{50} = **0.021**	d_{60} = **0.057**	C_u = --	C_c = --
SAMPLE NUMBER	DEPTH	USCS CLASSIFICATION			
0892-0001	**17.0-18.5 ft.**	**Classification by ASTM 2487 requires Atterberg test**			

PARTICLE SIZE ANALYSIS
WET SIEVE DATA

Job Name: JACOBS-2
Job Number: 5918
Test Date: 12/18/95
Sample Number: 0893-0001
Depth: 135-136 ft.

Initial Dry Weight of Sample: 362.20 (g)
Weight Passing #10: 346.90 (g)
Weight Retained #10: 15.30 (g)
Weight of Hydrometer Sample: 49.45 (g)
Calculated Weight of Sieve Sample: 51.63 (g)

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	362.20	100.00
	1.5"	38.1	0.00	0.00	362.20	100.00
	3/4"	19.0	0.00	0.00	362.20	100.00
	3/8"	9.5	0.00	0.00	362.20	100.00
	4	4.75	9.72	9.72	352.48	97.32
	10	2.00	5.58	15.30	346.90	95.78
-10			(Based on calculated sieve wt.)			
	20	0.85	3.00	5.18	46.45	89.97
	40	0.425	2.12	7.30	44.33	85.86
	60	0.250	3.62	10.92	40.71	78.85
	140	0.106	23.74	34.66	16.97	32.87
	200	0.075	4.35	39.01	12.62	24.44
	dry pan		1.84	40.85	10.78	
	wet pan			10.78	0.00	

d_{10}: 0.025 (mm)
d_{16}: 0.047 (mm)
d_{30}: 0.095 (mm)
d_{50}: 0.16 (mm)
d_{60}: 0.19 (mm)
d_{84}: 0.38 (mm)

Median Particle Diameter (d_{50}): 0.16
Uniformity Coefficient, Cu (d_{60}/d_{10}): 7.7
Coefficient of Curvature, Cc $[(d_{30})^2/(d_{10}*d_{60})]$: 1.9
Mean Particle Diameter $[(d_{16}+d_{50}+d_{84})/3]$: 0.20

Soil Classification: Classification by ASTM 2487 requires Atterberg test

Laboratory analysis performed by: H. Tran
Calculations made by: R. Maranville
Checked by: J. Vinson

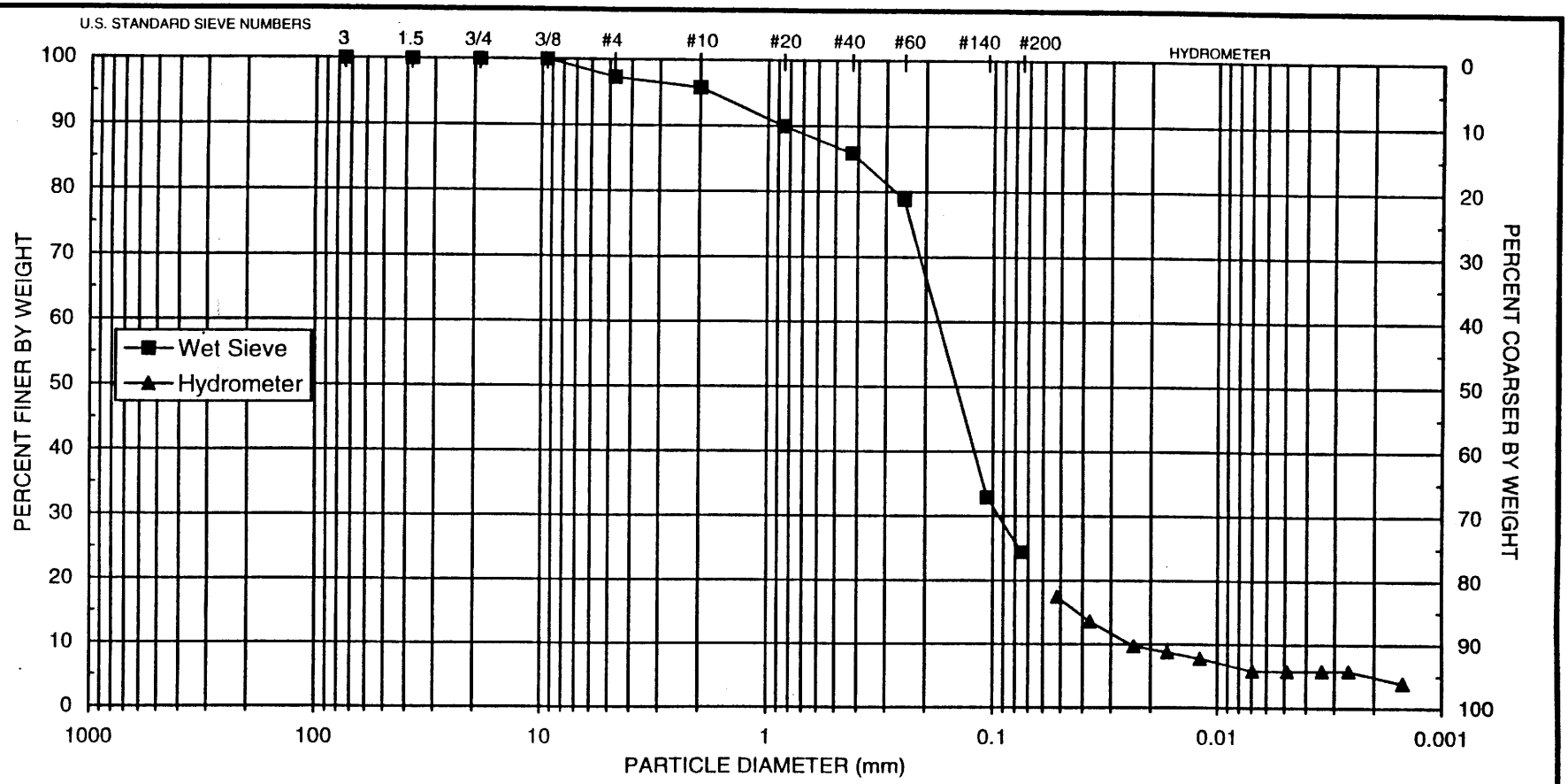
PARTICLE SIZE ANALYSIS
HYDROMETER DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number: 0893-0001
Type of Water Used: DISTILLED
Reaction with H_2O_2: NONE
Dispersant: $(NaPO_3)_6$
Particle Density: 2.65

Test Date: 12/19/95
Depth: 135-136 ft.
Initial Wt.: 49.45 (g)
Total Sample Wt.: 362.20 (g)
Wt. Passing #200: 346.90 (g)
Start Time: 1024

Date	Time (min)	Temp (°C)	R (g/L)	RI (g/L)	Rcorr (g/L)	L (cm)	D (mm)	P (%)	% Finer
20-Dec	1	19.0	13.0	4.0	9.0	14.2	0.05196	18.2	17.43
	2	19.0	11.0	4.0	7.0	14.5	0.03716	14.2	13.56
	5	19.0	9.0	4.0	5.0	14.8	0.02377	10.1	9.68
	10	19.0	8.5	4.0	4.5	14.9	0.01685	9.1	8.72
	20	19.0	8.0	4.0	4.0	15.0	0.01195	8.1	7.75
	60	19.0	7.0	4.0	3.0	15.2	0.00694	6.1	5.81
	120	19.5	7.0	4.0	3.0	15.2	0.00487	6.1	5.81
	240	21.0	6.0	3.0	3.0	15.3	0.00340	6.1	5.81
	407	21.5	6.0	3.0	3.0	15.3	0.00259	6.1	5.81
21-Dec	1354	18.0	6.0	4.0	2.0	15.3	0.00149	4.0	3.87

Laboratory analysis performed by: J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY				
		Coarse	Fine	Coarse	Medium	Fine					
USDA	COBBLES	GRAVEL		SAND					SILT	CLAY	
				Very coarse	Coarse	Medium	Fine	Very fine			

d_{10} = **0.025**	d_{30} = **0.095**	d_{50} = **0.16**	d_{60} = **0.19**	C_u = **7.7**	C_c = **1.9**

SAMPLE NUMBER	DEPTH	USCS CLASSIFICATION
0893-0001	**135-136 ft.**	**Classification by ASTM 2487 requires Atterberg test**

PARTICLE SIZE ANALYSIS
WET SIEVE DATA

Job Name: JACOBS-2
Job Number: 5918
Test Date: 12/18/95
Sample Number: 0894-0001
Depth: 24.5-25.5 ft.

Initial Dry Weight of Sample: 150.03 (g)
Weight Passing #10: 150.03 (g)
Weight Retained #10: 0.00 (g)
Weight of Hydrometer Sample: 43.08 (g)
Calculated Weight of Sieve Sample: 43.08 (g)

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	150.03	100.00
	1.5"	38.1	0.00	0.00	150.03	100.00
	3/4"	19.0	0.00	0.00	150.03	100.00
	3/8"	9.5	0.00	0.00	150.03	100.00
	4	4.75	0.00	0.00	150.03	100.00
	10	2.00	0.00	0.00	150.03	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.03	0.03	43.05	99.93
	40	0.425	0.01	0.04	43.04	99.91
	60	0.250	0.05	0.09	42.99	99.79
	140	0.106	3.04	3.13	39.95	92.73
	200	0.075	11.31	14.44	28.64	66.48
	dry pan		10.08	24.52	18.56	
	wet pan			18.56	0.00	

d_{10}: 0.015 (mm)
d_{16}: 0.038 (mm)
d_{30}: 0.052 (mm)
d_{50}: 0.065 (mm)
d_{60}: 0.071 (mm)
d_{84}: 0.096 (mm)

Median Particle Diameter (d_{50}): 0.065
Uniformity Coefficient, Cu (d_{60}/d_{10}): 4.8
Coefficient of Curvature, Cc $[(d_{30})^2/(d_{10}*d_{60})]$: 2.6
Mean Particle Diameter $[(d_{16}+d_{50}+d_{84})/3]$: 0.066

Soil Classification: Classification by ASTM 2487 requires Atterberg test

Laboratory analysis performed by: H. Tran
Calculations made by: R. Maranville
Checked by: J. Vinson

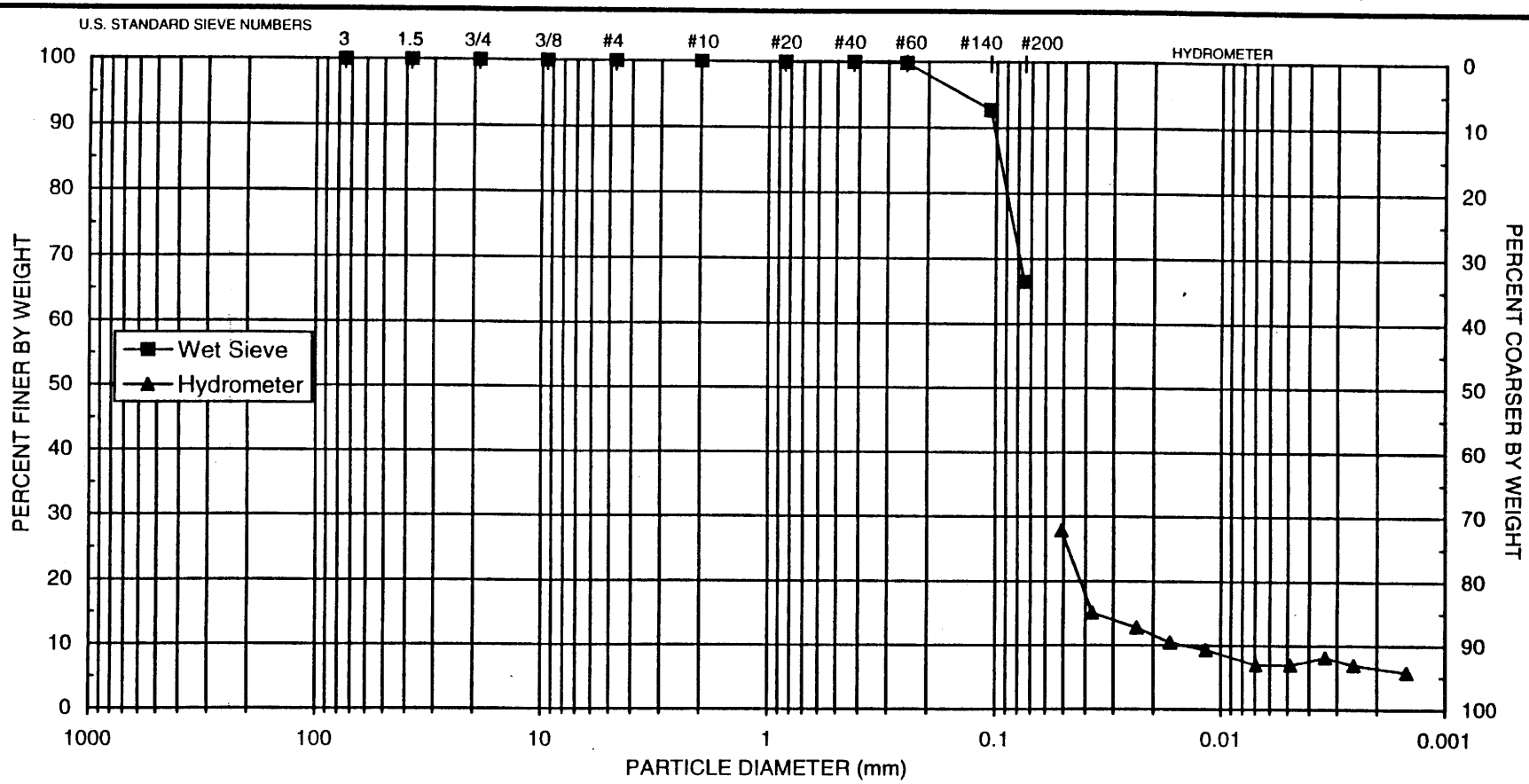
PARTICLE SIZE ANALYSIS
HYDROMETER DATA

Job Name: JACOBS-2
Job Number: 5918
Sample Number: 0894-0001
Type of Water Used: DISTILLED
Reaction with H_2O_2: SLIGHT
Dispersant: $(NaPO_3)_6$
Particle Density: 2.65

Test Date: 12/19/95
Depth: 24.5-25.5 FT.
Initial Wt.: 43.08 (g)
Total Sample Wt.: 150.03 (g)
Wt. Passing #200: 150.03 (g)
Start Time: 1000

Date	Time (min)	Temp (°C)	R (g/L)	RI (g/L)	Rcorr (g/L)	L (cm)	D (mm)	P (%)	% Finer
20-Dec	1	19.0	16.0	4.0	12.0	13.7	0.05105	27.9	27.86
	2	19.0	10.5	4.0	6.5	14.6	0.03727	15.1	15.09
	5	19.0	9.5	4.0	5.5	14.7	0.02370	12.8	12.77
	10	19.0	8.5	4.0	4.5	14.9	0.01685	10.4	10.45
	21	19.0	8.0	4.0	4.0	15.0	0.01166	9.3	9.29
	60	19.0	7.0	4.0	3.0	15.2	0.00694	7.0	6.96
	120	19.5	7.0	4.0	3.0	15.2	0.00487	7.0	6.96
	240	21.0	6.5	3.0	3.5	15.2	0.00339	8.1	8.12
	427	21.5	6.0	3.0	3.0	15.3	0.00253	7.0	6.96
21-Dec	1370	18.0	6.5	4.0	2.5	15.2	0.00147	5.8	5.80

Laboratory analysis performed by: J. Locke
Calculations made by: R. Maranville
Checked by: J. Vinson



UNIFIED	COBBLES	GRAVEL		SAND		SILT OR CLAY
		Coarse	Fine	Coarse	Medium	Fine	
USDA	COBBLES	GRAVEL	SAND				SILT	CLAY
			Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.015**	d_{30} = **0.052**	d_{50} = **0.065**	d_{60} = **0.071**	C_u = **4.8**	C_c = **2.6**

SAMPLE NUMBER	DEPTH	USCS CLASSIFICATION
0894-0001	**24.5-25.5 ft.**	**Classification by ASTM 2487 requires Atterberg test**

APPENDIX E

LABORATORY METHODS

SUMMARY OF LABORATORY METHODS

Methods	Reference
Moisture Content	ASTM D 2216-90
Bulk Density	MOSA[1], 1986. Chp. 13, pp. 363-367
Porosity	MOSA[1], 1986. Chp. 18, pp. 444-445
Saturated Hydraulic Conductivity	
Falling Head	MOSA[1], 1986. Chp. 28, pp. 700-703
Effective Porosity	Corey, 1986[2]
Thermocouple Psychrometer	MOSA[1], 1986. Chp. 24, pp. 597-618 Operators Manual for the SC-10A Thermocouple Psychrometer Sample Chamber (manufactured by Decagon Devices, Inc., Pullman, WA)
Particle Size Characteristics	
Sieve	ASTM D 422-63 (90)
Hydrometer	ASTM D 422-63 (90)

[1] Methods of Soil Analysis, Part 1. 1986. A Klute, ed. American Society of Agronomy, Madison, WI

[2] Corey, Arthur T. 1986. Mechanics of Immiscible Fluids in Porous Media. Water Resources Publications, pp. 40-42

Appendix C

Calculation FCT-06-91-12-01-00

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

CALCULATION COVER SHEET

CALC NO. ECT-06-91-12-01-00 DISCIPLINE Engineering/Hydrology NO. OF SHEETS 10

PROJECT:
UMTRA

SITE:
FALLS CITY

FEATURE:
SURFACE WATER MASS BALANCE

SOURCES OF DATA:
See page 1 of text

SOURCES OF FORMULAE & REFERENCES:
see text

PRELIMINARY CALC. ☑ FINAL CALC. ☐ SUPERSEDES CALC. NO. _____

REV. ID.	REVISION	CALCULATION BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
00		J. Cram	6/21/91	Tim Jimenez	6/26/91	[illegible]	6/26/91

JE JACOBS ENGINEERING

DATE 6/21/91 SUBJECT

BY JDC CHKD. _____

SHEET NO. 1/10

JOB NO. _____

1. Problem statement

Estimate the volume of water that may have accumulated on Parcel "A" of the Falls City site during the times the mill was in operation

2. Data

1. precipitation data — National Climatic Data Center, Asheville, North Carolina

   a. weather station — located inside city limits Falls City, Texas

   b. period-of-record: August 1946 through November 1990

2. information on discharge rates to ponds and depth of ponds from former mill supervisor (Susquehanna-Western) Alvin E. Wiatrek, phone: 512-780-3911

3. Assomptions

   a. maximum pond area is equal to area of tailings pile minus 6 acres to allow for area of starter dikes

   b. rainfall-volume (column 3 of tables) is inches of precipitation times the maximum pond area.

c for computing evaporative surface area (column 6 of Table 5)
Where diked drainage areas are used, the water surface area may be expressed as a variable function dependent on pond volume. Diked retention areas may be modeled as conical volumes. The surface area when the pond is less than full is approximated by:

$$A = K A_F (V_p / V_F)^{2/3}$$

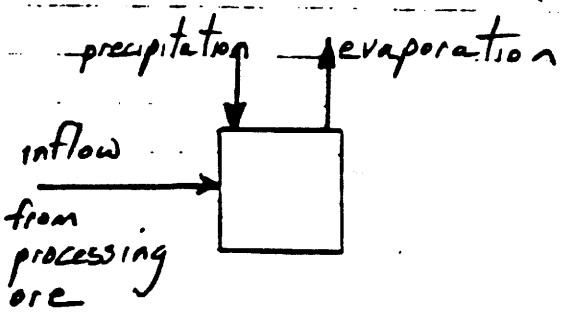
where: A_F = maximum water surface area

V_F = maximum volume

V_p = monthly volume (processing water + precipitation)

K = 1.0 for accumulating conditions

d infiltration is not considered in the mass balance. A diagram of the mass balance is presented below



JACOBS ENGINEERING

DATE 6/21/91 SUBJECT

BY JDC CHKD.

SHEET NO. 3/10

JOB NO.

4. calculation tables on pages

PILE	MAXIMUM POND AREA, acres	MAXIMUM POND DEPTH, feet
1	18	6
2	20	6
4	7	6
5	15	6
7	40	6

5. Summary

rainfall data (table), page: 10

mass balance (tables), pages: 4-8

mass balance summary, page: 9

20c

6/10

WALLS CITY, TEXAS PILE No. 7
MARCH 1970 THROUGH MAY 1973

AVERAGE ANNUAL LAKE EVAPORATION = 54 inches

(1) MONTH		(2) MEAN PRECIPITATION, inches	(3) TOTAL RAINFALL VOLUME, acre-feet	(4) ASSURED INFLOW FROM PROCESSING, acre-feet	(5) TOTAL WATER VOLUME, acre-feet	(6) AVERAGE POND AREA, acres	(7) EVAPORATION DISTRIBUTION FACTOR	(8) ESTIMATED EVAPORATED VOLUME, acre-feet	(9) ACCUMULATED WATER VOLUME, acre-feet	(10) WATER HEIGHT IN POND, feet
1970	MAR	1.08	3.60	10	13.60	12.28	0.073	4.03	9.57	3.32
	APR	2.45	8.17	10	18.17	14.89	0.082	5.49	12.67	3.66
	MAY	3.73	12.43	10	22.43	17.14	0.102	7.87	14.57	3.93
	JUN	2.89	9.63	10	19.63	15.68	0.127	8.96	10.67	3.76
	JUL	1.83	6.10	10	16.10	13.74	0.143	8.84	7.26	3.52
	AUG	2.51	8.37	10	18.37	15.00	0.133	8.98	9.39	3.67
	SEP	3.86	12.87	10	22.87	17.36	0.096	7.50	15.37	3.95
	OCT	2.95	9.83	10	19.83	15.79	0.071	5.04	14.79	3.77
	NOV	2.02	6.73	10	16.73	14.09	0.049	3.11	13.63	3.56
	DEC	1.48	4.93	10	14.93	13.06	0.039	2.29	12.64	3.43
1971	JAN	1.58	5.27	10	15.27	13.26	0.039	2.33	12.94	3.45
	FEB	1.70	5.67	10	15.67	13.49	0.046	2.79	12.87	3.48
	MAR	1.08	3.60	10	13.60	12.28	0.073	4.03	9.57	3.32
	APR	2.45	8.17	10	18.17	14.89	0.082	5.49	12.67	3.66
	MAY	3.73	12.43	10	22.43	17.14	0.102	7.87	14.57	3.93
	JUN	2.89	9.63	10	19.63	15.68	0.127	8.96	10.67	3.76
	JUL	1.83	6.10	10	16.10	13.74	0.143	8.84	7.26	3.52
	AUG	2.51	8.37	10	18.37	15.00	0.133	8.98	9.39	3.67
	SEP	3.86	12.87	10	22.87	17.36	0.096	7.50	15.37	3.95
	OCT	2.95	9.83	10	19.83	15.79	0.071	5.04	14.79	3.77
	NOV	2.02	6.73	10	16.73	14.09	0.049	3.11	13.63	3.56
	DEC	1.48	4.93	10	14.93	13.06	0.039	2.29	12.64	3.43
1972	JAN	1.58	5.27	10	15.27	13.26	0.039	2.33	12.94	3.45
	FEB	1.70	5.67	10	15.67	13.49	0.046	2.79	12.87	3.48
	MAR	1.08	3.60	10	13.60	12.28	0.073	4.03	9.57	3.32
	APR	2.45	8.17	10	18.17	14.89	0.082	5.49	12.67	3.66
	MAY	3.73	12.43	10	22.43	17.14	0.102	7.87	14.57	3.93
	JUN	2.89	9.63	10	19.63	15.68	0.127	8.96	10.67	3.76
	JUL	1.83	6.10	10	16.10	13.74	0.143	8.84	7.26	3.52
	AUG	2.51	8.37	10	18.37	15.00	0.133	8.98	9.39	3.67
	SEP	3.86	12.87	10	22.87	17.36	0.096	7.50	15.37	3.95
	OCT	2.95	9.83	10	19.83	15.79	0.071	5.04	14.79	3.77
	NOV	2.02	6.73	10	16.73	14.09	0.049	3.11	13.63	3.56
	DEC	1.48	4.93	10	14.93	13.06	0.039	2.29	12.64	3.43
1973	JAN	1.58	5.27	10	15.27	13.26	0.039	2.33	12.94	3.45
	FEB	1.70	5.67	10	15.67	13.49	0.046	2.79	12.87	3.48
	MAR	1.08	3.60	10	13.60	12.28	0.073	4.03	9.57	3.32
	APR	2.45	8.17	10	18.17	14.89	0.082	5.49	12.67	3.66
	MAY	3.73	12.43	10	22.43	17.14	0.102	7.87	14.57	3.93
			305.00	340					475.92	ac-ft
									1.55E+08	gallons

SUMMARY OF INFILTRATION VOLUMES

PILE	TOTAL SOURCE VOLUME, gallons	FRACTION FROM RAINFALL	FRACTION FROM PROCESSING	###TOTAL VOLUMES THAT### ##MAY HAVE INFILTRATED## RAINFALL, gallons	ORE PROCESSING, gallons
1	4.81E+07	0.55	0.45	2.65E+07	2.16E+07
2	3.27E+07	0.63	0.37	2.06E+07	1.21E+07
4	8.31E+06	0.30	0.70	2.49E+06	5.82E+06
5	3.79E+07	0.23	0.77	8.72E+06	2.92E+07
7	1.55E+08	0.47	0.53	7.28E+07	8.22E+07
	2.82E+08			1.31E+08	1.51E+08

FALLS CITY, TEXAS PILE No. 4
JULY 1968 THROUGH FEBRUARY 1969

AVERAGE ANNUAL LAKE EVAPORATION = 54 inches

(1) MONTH		(2) MEAN PRECIPITATION, inches	(3) TOTAL RAINFALL VOLUME, acre-feet	(4) ASSUMED INFLOW FROM PROCESSING, acre-feet	(5) TOTAL WATER VOLUME, acre-feet	(6) AVERAGE POND AREA, acres	(7) EVAPORATION DISTRIBUTION FACTOR	(8) ESTIMATED EVAPORATED VOLUME, acre-feet	(9) ACCUMULATED WATER VOLUME, acre-feet	(10) WATER HEIGHT IN POND, feet
1968	JUL	1.83	1.07	3	4.07	3.07	0.143	1.98	2.09	3.97
	AUG	2.51	1.46	3	4.46	3.27	0.133	1.96	2.51	4.10
	SEP	3.86	2.25	3	5.25	3.64	0.096	1.57	3.69	4.33
	OCT	2.95	1.72	3	4.72	3.39	0.071	1.08	3.64	4.12
	NOV	2.02	1.18	3	4.18	3.13	0.049	0.69	3.49	4.01
	DEC	1.48	0.86	3	3.86	2.97	0.039	0.52	3.34	3.91
1969	JAN	1.58	0.92	3	3.92	3.00	0.039	0.53	3.40	3.97
	FEB	1.70	0.99	3	3.99	3.03	0.046	0.63	3.36	3.95
			10.46	24					25.51 ac-ft	
									8.31E+06 gallons	

JOC

FALLS CITY, TEXAS POND No. 5
MARCH 1969 THROUGH FEBRUARY 1970

AVERAGE ANNUAL LAKE EVAPORATION = 54 inches

(1) MONTH		(2) MEAN PRECIPITATION, inches	(3) TOTAL RAINFALL VOLUME, acre-feet	(4) ASSUMED INFLOW FROM PROCESSING, acre-feet	(5) TOTAL WATER VOLUME, acre-feet	(6) AVERAGE POND AREA, acres	(7) EVAPORATION DISTRIBUTION FACTOR	(8) ESTIMATED EVAPORATED VOLUME, acre-feet	(9) ACCUMULATED WATER VOLUME, acre-feet	(10) WATER HEIGHT IN POND, feet
1969	MAR	1.08	1.35	10	11.35	7.85	0.073	2.58	8.77	4.34
	APR	2.45	3.06	10	13.06	8.62	0.082	3.18	9.88	4.55
	MAY	3.73	4.66	10	14.66	9.31	0.102	4.27	10.39	4.73
	JUN	2.89	3.61	10	13.61	8.86	0.127	5.06	8.55	4.61
	JUL	1.83	2.29	10	12.29	8.27	0.143	5.32	6.96	4.46
	AUG	2.51	3.14	10	13.14	8.65	0.133	5.18	7.96	4.56
	SEP	3.86	4.83	10	14.82	9.38	0.096	4.05	10.77	4.74
	OCT	2.95	3.69	10	13.69	8.89	0.071	2.84	10.85	4.62
	NOV	2.02	2.53	10	12.53	8.38	0.049	1.85	10.68	4.48
	DEC	1.46	1.85	10	11.85	8.08	0.039	1.42	10.43	4.40
1970	JAN	1.58	1.98	10	11.97	8.13	0.039	1.43	10.55	4.42
	FEB	1.70	2.12	10	12.12	8.20	0.046	1.70	10.43	4.44
			35.13	120					116.23	ac-ft
									3.79E+07	gallons

90C

FALLS CITY, TEXAS PILE No. 1
APRIL 1961 THROUGH DECEMBER 1963

AVERAGE ANNUAL LAKE EVAPORATION = 54 inches

(1) MONTH		(2) MEAN PRECIPITATION, inches	(3) TOTAL RAINFALL VOLUME, acre-feet	(4) ASSUMED INFLOW FROM PROCESSING, acre-feet	(5) TOTAL WATER VOLUME, acre-feet	(6) AVERAGE POND AREA, acres	(7) EVAPORATION DISTRIBUTION FACTOR	(8) ESTIMATED EVAPORATED VOLUME, acre-feet	(9) ACCUMULATED WATER VOLUME, acre-feet	(10) WATER HEIGHT IN POND, feet
1961	APR	2.45	3.68	3	6.68	5.85	0.082	2.16	4.52	3.42
	MAY	3.73	5.59	3	8.60	6.93	0.102	3.18	5.42	3.72
	JUN	2.89	4.33	3	7.33	6.23	0.127	3.56	3.77	3.53
	JUL	1.83	2.75	3	5.75	5.30	0.143	3.41	2.34	3.25
	AUG	2.51	3.77	3	6.76	5.91	0.133	3.53	3.23	3.44
	SEP	3.86	5.79	3	8.79	7.03	0.096	3.04	5.75	3.75
	OCT	2.95	4.43	3	7.43	6.28	0.071	2.01	5.42	3.54
	NOV	2.02	3.03	3	6.03	5.47	0.049	1.21	4.82	3.31
	DEC	1.48	2.22	3	5.22	4.97	0.039	0.87	4.35	3.15
1962	JAN	1.58	2.37	3	5.37	5.06	0.039	0.89	4.48	3.18
	FEB	1.70	2.55	3	5.55	5.18	0.046	1.07	4.48	3.22
	MAR	1.08	1.62	3	4.62	4.58	0.073	1.50	3.12	3.03
	APR	2.45	3.68	3	6.68	5.85	0.082	2.16	4.52	3.42
	MAY	3.73	5.59	3	8.60	6.93	0.102	3.18	5.42	3.72
	JUN	2.89	4.33	3	7.33	6.23	0.127	3.56	3.77	3.53
	JUL	1.83	2.75	3	5.75	5.30	0.143	3.41	2.34	3.25
	AUG	2.51	3.77	3	6.76	5.91	0.133	3.53	3.23	3.44
	SEP	3.86	5.79	3	8.79	7.03	0.096	3.04	5.75	3.75
	OCT	2.95	4.43	3	7.43	6.28	0.071	2.01	5.42	3.54
	NOV	2.02	3.03	3	6.03	5.47	0.049	1.21	4.82	3.31
	DEC	1.48	2.22	3	5.22	4.97	0.039	0.87	4.35	3.15
1963	JAN	1.58	2.37	3	5.37	5.06	0.039	0.89	4.48	3.18
	FEB	1.70	2.55	3	5.55	5.18	0.046	1.07	4.48	3.22
	MAR	1.08	1.62	3	4.62	4.58	0.073	1.50	3.12	3.03
	APR	2.45	3.68	3	6.68	5.85	0.082	2.16	4.52	3.42
	MAY	3.73	5.59	3	8.60	6.93	0.102	3.18	5.42	3.72
	JUN	2.89	4.33	3	7.33	6.23	0.127	3.56	3.77	3.53
	JUL	1.83	2.75	3	5.75	5.30	0.143	3.41	2.34	3.25
	AUG	2.51	3.77	3	6.76	5.91	0.133	3.53	3.23	3.44
	SEP	3.86	5.79	3	8.79	7.03	0.096	3.04	5.75	3.75
	OCT	2.95	4.43	3	7.43	6.28	0.071	2.01	5.42	3.54
	NOV	2.02	3.03	3	6.03	5.47	0.049	1.21	4.82	3.31
	DEC	1.48	2.22	3	5.22	4.97	0.039	0.87	4.35	3.15
1964	JAN	1.58	2.37	3	5.37	5.06	0.039	0.89	4.48	3.18
			122.19	102					147.47 ac-ft	
									4.81E+07 gallons	

goc

3/10

FALLS CITY, TEXAS PILE No. 2
FEB. 1964 THROUGH JAN. 1965 AND AUG. 1965 THROUGH JAN. 1966

AVERAGE ANNUAL LAKE EVAPORATION = 54 inches

	MONTH	(1)	(2) MEAN PRECIPITATION, inches	(3) TOTAL RAINFALL VOLUME, acre-feet	(4) ASSUMED INFLOW FROM PROCESSING, acre-feet	(5) TOTAL WATER VOLUME, acre-feet	(6) AVERAGE POND AREA, acres	(7) EVAPORATION DISTRIBUTION FACTOR	(8) ESTIMATED EVAPORATED VOLUME, acre-feet	(9) ACCUMULATED WATER VOLUME, acre-feet	(10) WATER HEIGHT IN POND, feet
1964	FEB		1.70	2.83	3	5.83	5.54	0.046	1.15	4.69	3.16
	MAR		1.08	1.80	3	4.80	4.87	0.073	1.60	3.20	2.96
	APR		2.45	4.08	3	7.08	6.31	0.082	2.32	4.76	3.37
	MAY		3.73	6.22	3	9.22	7.52	0.102	3.45	5.77	3.68
	JUN		2.89	4.82	3	7.82	6.73	0.127	3.85	3.97	3.48
	JUL		1.83	3.05	3	6.05	5.68	0.143	3.65	2.40	3.20
	AUG		2.51	4.18	3	7.18	6.37	0.133	3.81	3.37	3.39
	SEP		3.86	6.43	3	9.43	7.63	0.096	3.30	6.14	3.71
	OCT		2.95	4.92	3	7.92	6.79	0.071	2.17	5.75	3.50
	NOV		2.02	3.37	3	6.37	5.87	0.049	1.30	5.07	3.25
	DEC		1.48	2.47	3	5.47	5.31	0.039	0.93	4.54	3.09
1965	JAN		1.58	2.63	3	5.63	5.41	0.039	0.95	4.68	3.12
	FEB		1.70	2.83	0	2.83	3.42	0.046	0.71	2.12	2.48
	MAR		1.08	1.80	0	1.80	2.53	0.073	0.83	0.97	2.13
	APR		2.45	4.08	0	4.08	4.37	0.082	1.61	2.47	2.80
	MAY		3.73	6.22	0	6.22	5.78	0.102	2.65	3.56	3.23
	JUN		2.89	4.82	0	4.82	4.88	0.127	2.79	2.03	2.96
	JUL		1.83	3.05	0	3.05	3.60	0.143	2.31	0.74	2.54
	AUG		2.51	4.18	3	7.18	6.37	0.133	3.81	3.37	3.39
	SEP		3.86	6.43	3	9.43	7.63	0.096	3.30	6.14	3.71
	OCT		2.95	4.92	3	7.92	6.79	0.071	2.17	5.75	3.50
	NOV		2.02	3.37	3	6.37	5.87	0.049	1.39	5.07	3.25
	DEC		1.48	2.47	3	5.47	5.31	0.039	0.93	4.54	3.09
	JAN		1.58	2.63	3	5.63	5.41	0.039	0.95	4.68	3.12
	FEB		1.70	2.83	3	5.83	5.54	0.046	1.15	4.69	3.16
				96.43	57					100.44 ac-ft	
										3.27E+07 gallons	

6/21/91
JDC

D/10

FALLS CITY, TEXAS WEATHER STATION
PERIOD OF RECORD AUG 1946 THROUGH NOV 1990

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL RAINFALL
1946								10.25	7.05	8.15	2.80	2.10	
1947	2.52	0.00	1.77	2.93	6.98			3.71	0.00				
1948									3.50	2.55	1.37		
1949	2.85	3.46	1.04	9.89	1.48	2.51	3.28	1.66	0.72	6.54	0.00	5.63	39.06
1950	0.30	1.00	2.15	1.59	3.14	3.94	1.63	2.81	1.85	0.42	0.11	0.00	18.94
1951	0.34	1.16	2.27	0.44	6.19	3.44	0.32	0.17	3.59	1.29	1.48	0.13	20.82
1952	0.20	2.11	0.92	1.61	3.07	0.68	2.09	0.00	6.92	0.00	3.05	1.54	22.19
1953	0.34	1.80	0.25	1.67	7.71	2.70	0.68	1.93	3.72	5.29	0.29	1.98	28.36
1954	0.28	0.06	0.06	4.27	5.32	1.10	1.57	1.26	0.90	1.45	0.94	0.08	17.29
1955	0.95	2.40	0.63	0.13	2.71	2.39	1.12	5.36	1.18	0.21	0.76	0.75	18.59
1956	0.55	0.42	0.30	0.85	0.93	1.60	0.33	0.63	1.70	1.26	1.37	1.40	11.34
1957	0.22	1.89	2.72	9.17	4.85	2.71	0.00	0.28	10.74	1.42	6.70	0.45	41.15
1958	6.21	1.78	0.22	1.15	3.22	2.77	0.48	2.04	3.90	7.48	0.98	1.56	31.79
1959	0.27	3.05	0.11	2.25	3.91	2.40	0.63	1.01	1.05	3.35	3.59	0.19	21.81
1960	0.81	2.11	1.02	1.41	0.66	4.43	6.74	11.21	1.00	8.79	4.14	3.73	46.05
1961	1.23	2.48	0.48	3.57	0.34	5.01	1.78	0.00	2.27	5.73	5.57	0.50	28.96
1962	0.51	0.65	0.94	4.27	1.46	6.01	0.00	0.00	4.13	0.82	1.98	3.41	24.18
1963	0.28	3.00	0.09	0.75	2.86	2.72	2.05	0.00	2.20	2.16	3.73	2.53	22.37
1964	2.01	2.05	1.72	0.99	1.86	1.44	0.00	5.77	1.96	1.44	0.73	1.10	21.07
1965	1.97	5.88	0.95	1.18	7.80	1.04	0.18	0.87	2.26	2.85	1.00	3.36	29.34
1966	2.02	1.93	0.85	4.09	3.50	2.30	2.16	1.68	2.51	0.53	0.00	0.45	22.02
1967	0.63	0.88	1.52	1.50	1.24	0.00	3.00	6.05	15.23	3.67	3.25	0.96	37.93
1968	6.47	2.02	0.91	1.38	4.66	2.39	2.69	2.46	12.56	1.51	2.92	1.96	41.93
1969	1.52	1.03	1.85	—	7.15	1.91	0.00	2.95	0.81	4.92	2.66	3.45	28.25
1970	2.31	2.52	3.09	1.64	6.24	1.27	1.27	2.80	2.15	0.36	0.00	0.31	23.96
1971	0.00	1.10	0.00	1.50	0.06	4.74	0.00	3.85	7.46	3.05	1.16	2.01	24.93
1972	1.48	0.39	1.06	0.57	5.84	2.89	6.25	4.11	4.45	0.57	1.94	0.34	29.89
1973	2.71	4.07	1.13	3.66	1.09	12.85	0.37	2.11	10.03	4.95	0.36	0.45	43.78
1974	2.40	0.36	0.88	0.88	7.23	0.77	1.22	6.26	3.63	0.93	2.39	1.05	28.00
1975	—	1.32	0.00	1.40	8.67	6.21	1.06	1.75	1.27	2.29	0.20	0.52	24.69
1976	0.42	0.00	0.72	5.24	4.17	0.12	4.19	0.00	6.12	8.27	3.56	2.49	35.30
1977	2.36	1.18	0.60	8.11	3.67	1.37	0.00	0.00	0.98	0.87	2.75	0.21	22.10
1978	1.02	1.61	0.78	1.73	1.40	3.12	3.37	1.82	8.78	0.98	2.78	2.03	29.42
1979	3.45	1.30	0.77	4.86	3.95	4.03	4.52	2.98	1.67	0.00	0.77	1.35	29.65
1980	0.69	0.63	0.37	0.33	8.20	0.00	1.56	7.11	8.32	1.06	3.32	0.97	32.56
1981	1.67	1.19	1.14	2.35	7.31	4.94	0.12	2.85	1.85	4.00	0.60	0.44	~~22.11~~ 28.46
1982	0.12	6.12	0.29	1.05	4.64	3.04	0.21	1.92	2.48	6.65	2.24	0.85	29.61
1983	1.43	1.80	2.77	0.00	2.68	2.53	4.22	2.71	5.47	1.12	1.74	0.23	26.70
1984	3.35	0.66	0.44	0.50	0.68	0.22	0.00	0.00	1.85	7.13	0.77	1.25	16.85
1985	2.68	1.44	2.01	5.79	1.41	1.04	1.73	0.00	5.54	4.18	6.21	0.36	32.39
1986	1.51	0.54	0.28	0.46	4.33	3.43	0.00	0.20	—	3.77	2.55	5.53	22.60
1987	1.27	4.30	0.88	0.00	3.23	11.72	1.53	4.00	0.76	0.30	3.15	3.01	34.15
1988	0.45	0.07	0.42	1.84	2.93	2.49	2.38	0.00	3.80	0.85	0.00	0.91	16.14
1989	3.51	0.39	1.76	3.32	0.81	1.31	1.05	1.84	0.35	4.42	2.19	0.48	21.43
1990	1.06	0.91	4.30	2.76	0.92	0.00	10.92	2.12	1.12	2.05	0.97	—	27.13
AVG MONTHLY RAINFALL	1.58	1.70	1.08	2.45	3.73	2.89	1.83	2.51	3.86	2.95	2.02	1.48	