Department of Energy
Oak Ridge Operations
Weldon Spring Site
Remedial Action Project Office
7295 Highway 94 South
St. Charles, Missouri 63304

November 18, 1992

Mr. Dan Wall
Remedial Project Manager
U.S. Environmental Protection
Agency
Region VII
726 Minnesota Avenue
Kansas City, Kansas 66101

Dear Mr. Wall:

SAMPLING PLAN FOR DETERMINATION OF HYDRAULIC PROPERTIES OF UNDISTURBED SOILS IN THE WELDON SPRING DISPOSAL FACILITY STUDY AREA

Enclosed are 2 copies of the above sampling plan. Principal elements of this plan include two-stage borehole field permeability tests and triaxial permeability tests using synthesized leachate. These tests are being undertaken in response to MDNR comments on site suitability issues. Additional testing activities are proposed to obtain information to be used to resolve remedial design and performance assessment issues. Portions of this plan have been made available, in draft form, to MDNR-DGLS staff in order to facilitate the timely acquisition of this data.

If you have any questions, please feel free to contact me.

Sincerely,

Jerry S. Van Fossen

Jerry S. Van Fossen
Deputy Project Manager
Weldon Spring Site
Remedial Action Project

Enclosure:
As stated

cc w/enclosure:
Dave Bedan, MDNR (5 copies)
Mary Gilbert, PMC

DOE/OR/21548-164
CONTRACT NO. DE-AC05-86OR21548

SAMPLING PLAN FOR DETERMINATION OF HYDRAULIC PROPERTIES OF UNDISTURBED SOILS IN THE WELDON SPRING DISPOSAL FACILITY STUDY AREA

Weldon Spring Site Remedial Action Project
Weldon Spring, Missouri

OCTOBER 1992 **REV. 1**

U.S. Department of Energy
Oak Ridge Operations Office
Weldon Spring Site Remedial Action Project

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PLAN TITLE: Sampling Plan for Determination of Hydraulic Properties of Undisturbed Soils in the Weldon Spring Disposal Study Area	

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Environmental Documentation & Conceputal Design Manager	10-14-92 Date
Quality Assurance Manager	10/15/92 Date
ES&H Manager	10/15/92 Date
Engineering Manager	10-14-92 Date
Deputy Project Director	10/19/92 Date
Project Director	10/19/92 Date

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DOE/OR/21548-164

Weldon Spring Site Remedial Action Project

Sampling Plan for Determination of Hydraulic Properties of Undisturbed Soils in the Weldon Spring Disposal Facility Study Area

Revision 1

October 1992

Prepared by

MK-FERGUSON COMPANY
and
JACOBS ENGINEERING GROUP
7295 Highway 94 South
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for the

U.S. DEPARTMENT OF ENERGY
Oak Ridge Operations Office
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ABSTRACT

Sampling and testing is proposed to obtain information on the hydrologic properties of site soils within the disposal facility study area (DFSA). Sampling and testing will focus on assessing the effects of naturally occurring fractures and synthesized leachate on soil permeability. Proposed activities will also help satisfy location standards defined by the Missouri Code of State Regulations for proposed landfills. Proposed activities include testing, exploratory trenches and laboratory chemical and physical analyses.

Six geotechnical boreholes are proposed to obtain soil samples for determination of saturated and unsaturated hydraulic conductivity and associated properties.

Sixteen two-stage borehole tests at six locations and five largey diameter sealed-double ring infiltrometer tests at four locations are planned to obtain information on in situ permeability of unsaturated site soils.

Three exploratory trenches are planned to obtain information on perched water conditions within the DFSA.

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1 INTRODUCTION

This sampling plan has been developed to provide the U.S. Department of Energy (DOE) and the Missouri Department of Natural Resources (MDNR) with reliable and reproducible data on the hydraulic properties of unsaturated soils at the Weldon Spring site (WSS) in the area of the proposed disposal facility (DF). Sampling and testing will focus on assessing the effects of naturally occurring fractures and synthesized leachate on soil permeability. This plan supercedes proposed actions outlined in the *Disposal Facility Siting Demonstration Proposal* (MKF and JEG 1991a).

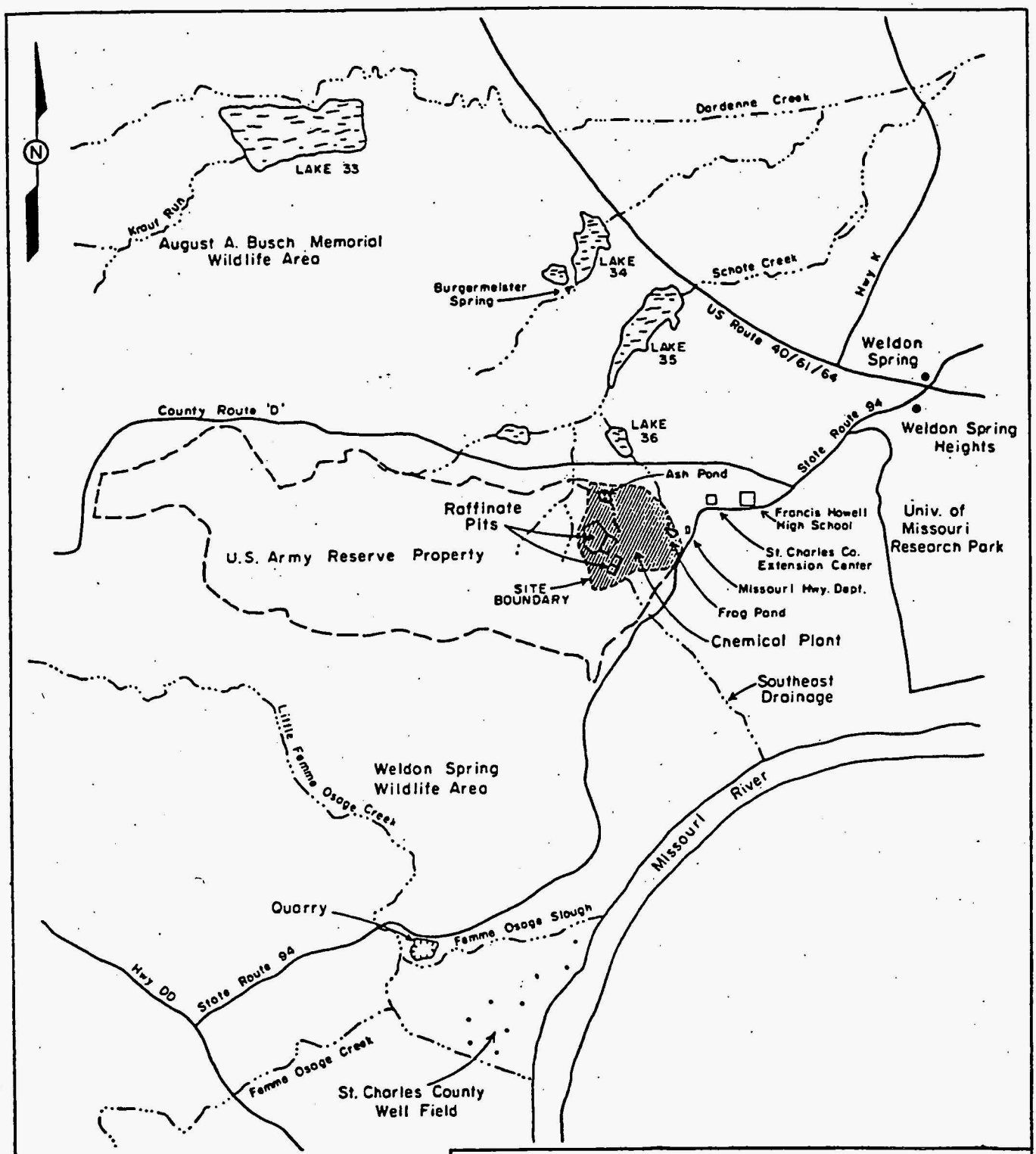
The WSS is a DOE surplus facility located in St. Charles County, Missouri (Figure 1-1). The site has been contaminated by trinitrotoluene (TNT) and dinitrotoluene (DNT) from past ordnance production activities and more recently by radionuclides and metals from the processing of uranium ore (MKF and JEG 1992a).

1.1 Purpose

The primary purpose of this investigation is to obtain representative soil samples of principal soil units beneath the proposed DF (Figure 1-2) and through laboratory analysis, determine their saturated and unsaturated hydraulic conductivity, the effect of leachate on soil permeability, and other hydraulic parameters. Fractures observed in the exposed glacial and post-glacial soils beneath the WSS are a concern to the State of Missouri and the DOE because of the effect these features might have on the hydraulic conductivity of the soils and the subsequent transport of leachate born contaminants.

This sampling program will also help satisfy design criteria for the cell foundation that are consistent with the Missouri Code of State Regulations 10 CSR 25-7.264(2)(N)1.A,B.

Zones within the overburden soils at the Weldon Spring Chemical Plant (WSCP) are considered to potentially contain perched groundwater. The remedial investigation report for the WSCP/Weldon Spring raffinate pits (WSCP/RP) areas summarizes the occurrence of perched water conditions known to exist at the site (MKF and JEG 1992a). Known areas of perched water are generally associated with seepage emanating from the raffinate pits. However, the site has been extensively reconfigured and differs from the topography that existed prior to development for the Weldon Spring Ordnance Works (WSOW). Therefore, it is reasonable to



WELDON SPRING SITE AND VICINITY

FIGURE 1-1

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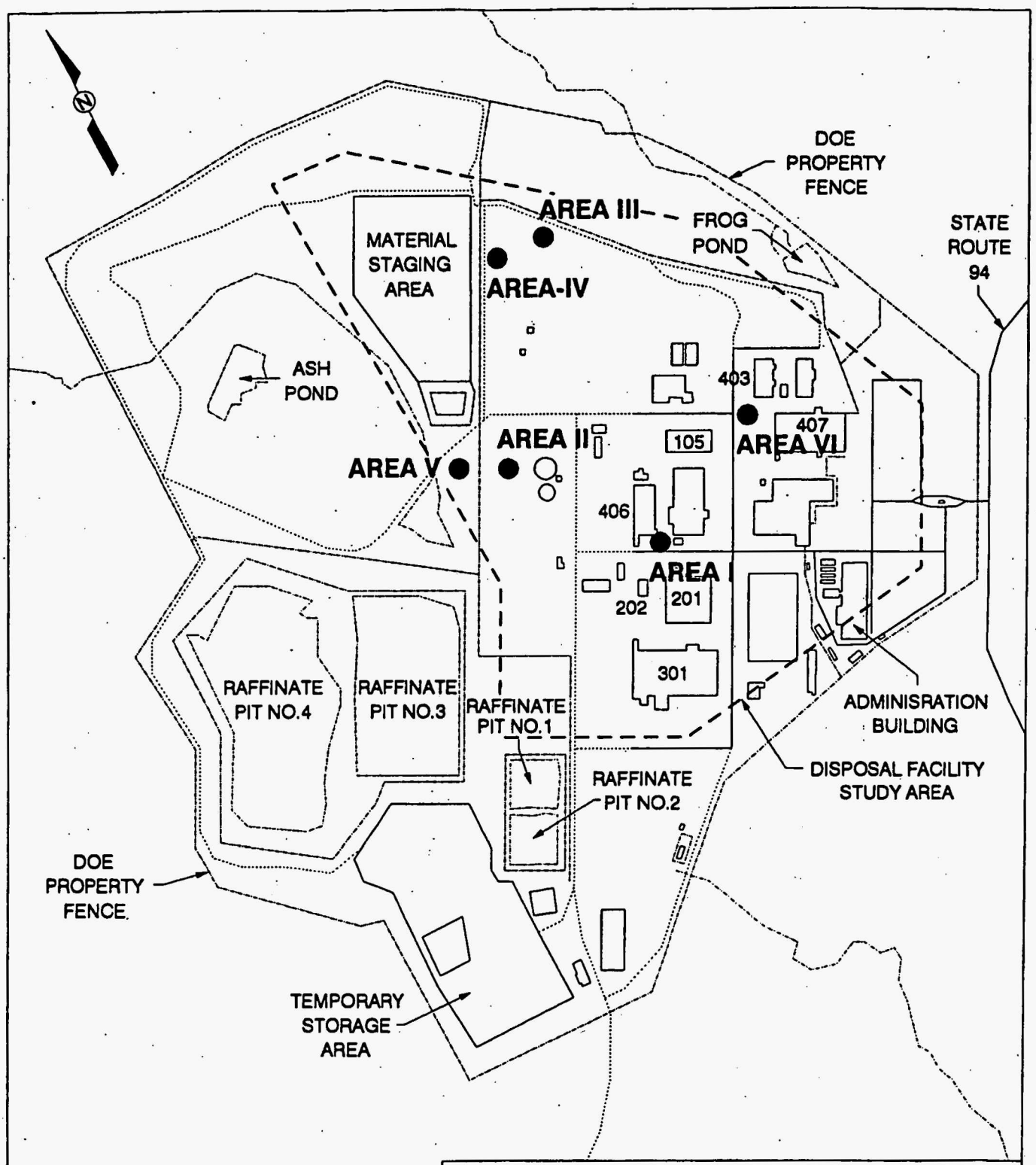

MAP OF THE
WELDON SPRING CHEMICAL PLANT AREA
SHOWING HYDRAULIC PROPERTIES
SAMPLING LOCATIONS

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FIGURE 1-2

REPORT NO.:		EXHIBIT NO.:	A/CP/086/0892
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expect that pre-WSOW and pre-WSCP drainages actively transmit unsaturated flow at the fill and undisturbed soil interface. Organic soils may also be associated with perched water conditions. In order to facilitate the development a disposal cell foundation excavation plan, trenches will be excavated in locations specified as part of this plan to determine whether perched water or unsuitable soils are present. Figure 1-3 shows three trenches within the proposed DF footprint at locations of suspected seepages or perched water.

1.2 Scope

To determine the effects of fractures and other structures on soil permeabilities, field sealed double ring infiltrometer (SDRI) and two stage borehole (TSB) permeability tests (Boutwell 1992) of representative soil structures will be conducted in the proposed DF footprint. The permeability values obtained will be compared to those determined from laboratory techniques. Samples will be collected and tested as follows:

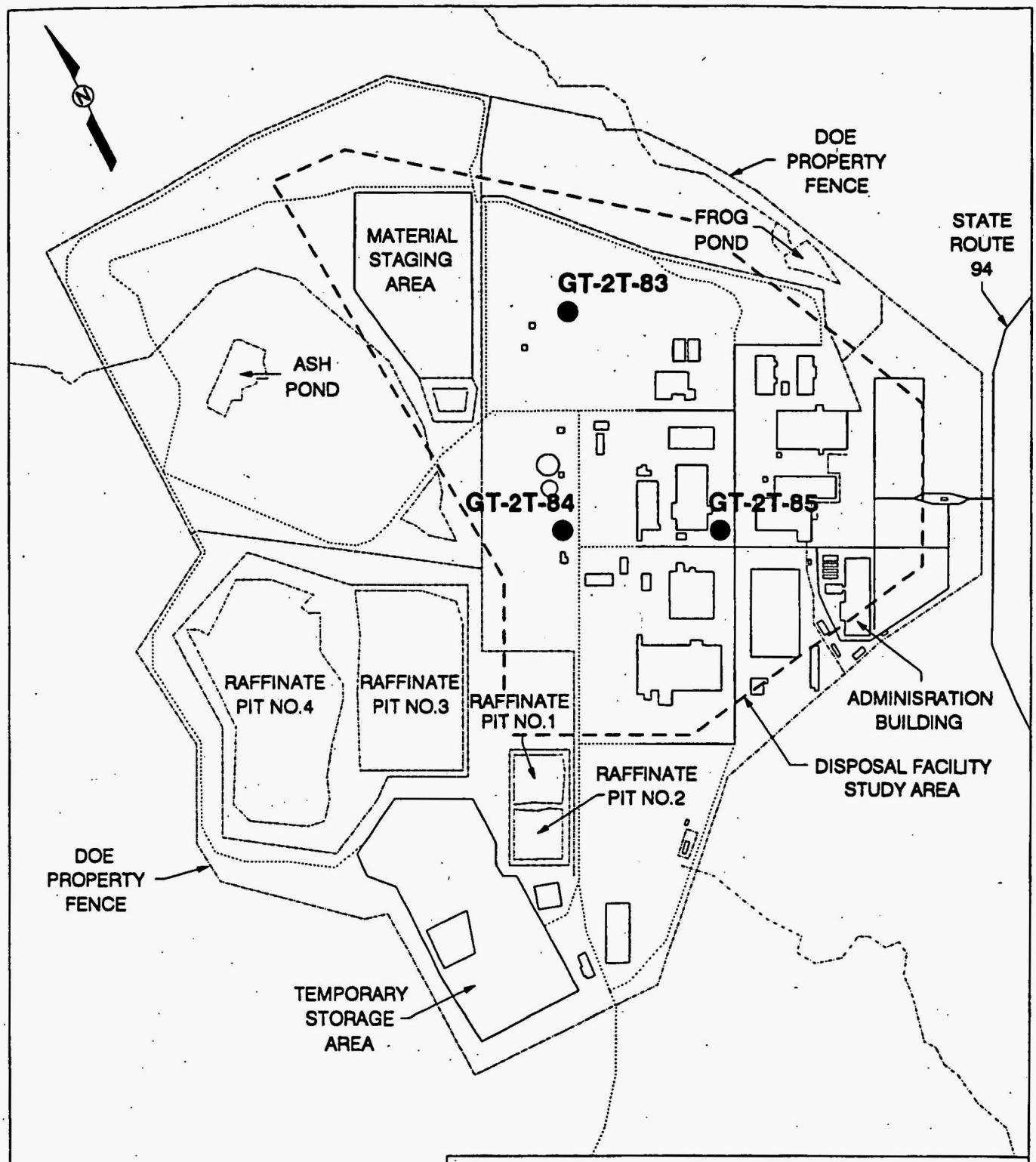
- Standard undisturbed samples (3-in. Shelby Tube type) will be collected for permeability test runs with both water and with a formulated leachate. Undisturbed and remolded samples from each unit of interest will be tested.

- Submersible pressure outflow cell (SPOC) tests will be run on standard-sized undisturbed samples to develop soil moisture retention curves. These curves will document the capillary retention properties of different units at varying temperatures. The saturated hydraulic conductivity will be determined directly from the tests; the unsaturated hydraulic conductivity will be calculated.

- General mechanical soil properties such as grain size distributions, Atterberg limits and specific gravities will also be determined from the standard size samples.

- Two stage borehole permeability (TSB) tests will be performed in the same locations and depths as the Ferrelview and clay till standard size samples.

- SDRI field tests will also be performed at the same locations and depths as noted above for laboratory testing and TSB tests.



LOCATION OF TRENCHES FOR PERCHED WATER INVESTIGATION

FIGURE 1-3

REPORT NO.:		EXHIBIT NO.:	A/CP/090/0892
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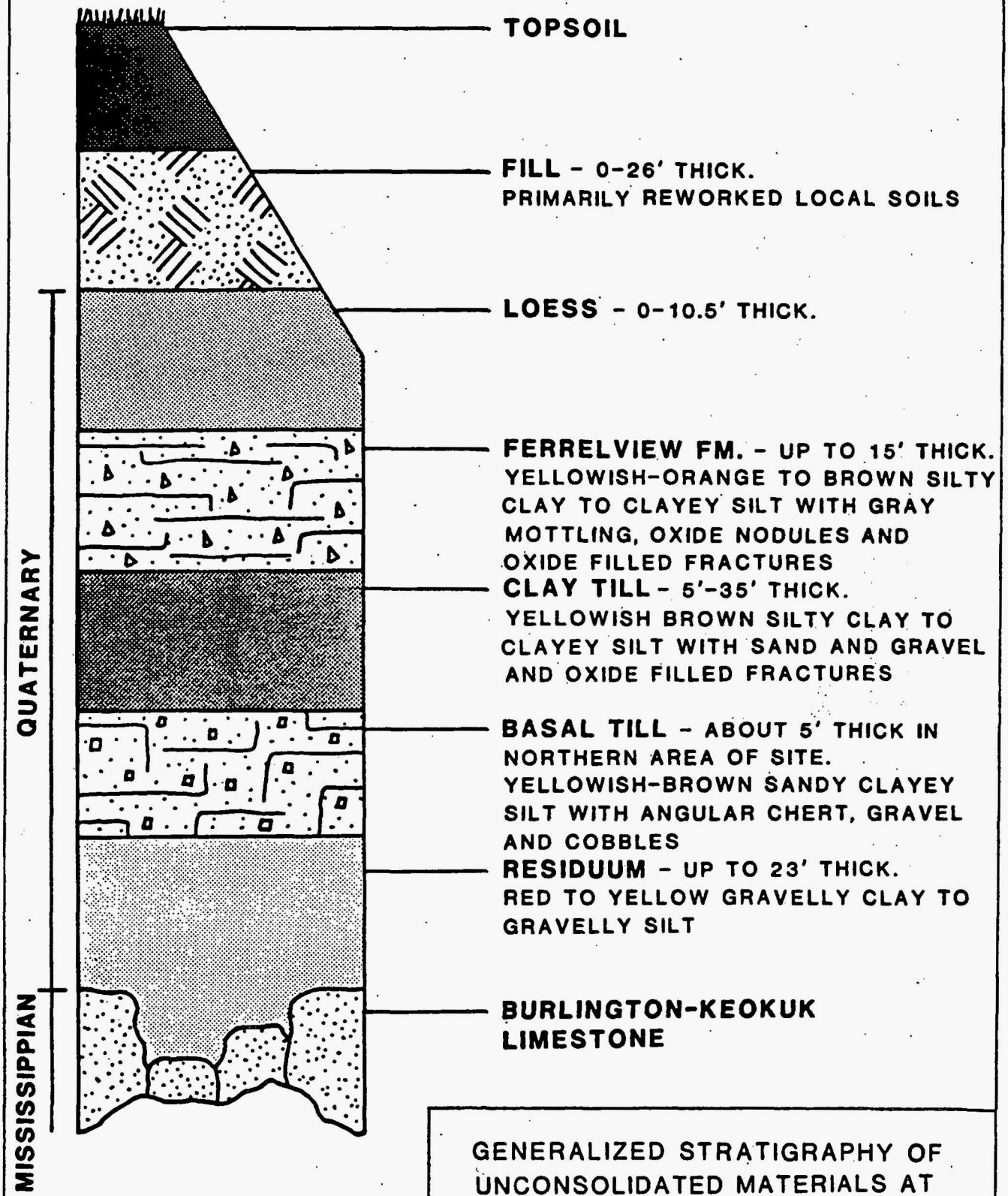
- Trenching will be performed to delineate and geotechnically characterize suspected seepages along backfilled former drainages at the WSS in the areas shown on Figure 1-3. Seepages occur at the contact of the old drainage surfaces and overlying fill.

1.3 Background

Past drilling and trenching programs at the WSS have delineated six principal soil units above the first bedrock unit. The Burlington-Keokuk Limestone is the first bedrock unit underlying the unconsolidated overburden (MKF and JEG 1992a). Figure 1-4 shows the generalized stratigraphy of the unconsolidated materials beneath the WSS (MKF and JEG 1990). The thickness of the unconsolidated material ranges from 15 ft to 40 ft beneath the WSS and is controlled by site development construction, surface erosional features, and bedrock topography. The unconsolidated material is generally thickest in the north-central portion of the site and becomes thinner toward the east.

In descending order, the six principal soil units are; the topsoil/fill unit, the loess unit, the Ferrelview Formation, the clay till unit, the basal till unit, and the residuum unit. The soil units of interest for the purposes of this investigation are the loess, Ferrelview Formation, and clay till units. The topsoil fill unit will be removed as part of the disposal facility foundation preparation. The basal till unit is thin and sporadically distributed under the site, and consequently this unit is not considered a good barrier to contaminant migration and will not be sampled. The residuum overlying the Burlington-Keokuk Limestone bedrock is highly heterogenous with significant percentages of coarse grained materials. It is not expected to retard contaminant migration to any significant extent. This unit will not be sampled or tested.

The upper Pleistocene loess unit underlies the topsoil/fill unit but is found mostly on hilltops (unless disturbed or removed by site construction activities). This unit is a windblown silt. It was affected by the topography at the time of its deposition and eroded from lower drainages by post-depositional stream action (MKF and JEG 1992a). The thickness of the loess varies from 0 ft to 10.5 ft across the site. The unit consists primarily of a silt to clayey silt with small amounts of sand. It has a low plasticity. The unit is the uppermost unit of interest with regard to permeability and other hydraulic properties.



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GENERALIZED STRATIGRAPHY OF UNCONSOLIDATED MATERIALS AT THE WELDON SPRING SITE

FIGURE 1-4

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The Ferrelview Formation, another unit of interest for this investigation, is an interglacial deposit of mid-Pleistocene age, believed to have been deposited as a till plain sediment (Howe and Heim 1968). The transmissivity of these fractures and joints will be tested with samples obtained by this plan. Iron oxide nodules and conchoidal fracturing with slickensides are characteristic of this unit. Earlier particle size distribution laboratory testing of this unit has determined that it is primarily a silt to clay with small amounts of sand and fine gravel. Most particle sizes are less than 0.063 mm (0.002 in). The unit ranges from 0 ft to 22 ft in thickness across the site. A dark yellowish-orange to brown silty clay to clayey silt with gray mottling, this unit has joints or fractures, some of which contain secondary minerals such as pyrolusite.

The clay till unit underlies the Ferrelview Formation and is the most areally extensive overburden unit on the site. The clay till ranges in thickness from 0 ft to 30 ft and is found in almost all boreholes and trenches on site. This unit is a lower Pleistocene glacial till composed of yellowish brown silty clay and clayey silt. Pyrolusite as fracture coatings and nodules of iron oxide (limonite) are common. The unit is very stiff and moderately to highly plastic (MKF and JEG 1992a). The unit is characterized by pebbles of igneous and metamorphic origin. This soil unit is considered to have good potential as a barrier to leachate transport and will be sampled and tested in this investigation.

The basal till unit is the lowest member of the Pleistocene glacial sediments found on site. It underlies the clay till, reaching a maximum thickness of 5 ft in the area of Ash Pond and the western portion of the WSS. It is absent beneath the main portion of the WSS. It consists typically of yellowish-brown sandy, clayey silt with angular chert gravel and cobbles. The basal till will not be sampled in this investigation as it is too heterogenous, sporadic in distribution across the site, and too thin to rely on as a principal barrier unit with respect to leachate transport.

Modification of site topography for the Weldon Spring Ordnance Works, and later, the Weldon Spring Uranium Feed Materials Plant site development resulted in the placement of fill in natural surface drainages on the site. Infiltration and seepage from impoundments and leaky utilities on site has resulted in localized areas of saturated fill and topsoil within filled drainages. In some areas these conditions have resulted in a zone of perched water, while at other locations conditions may simply be characterized by porous fill or organic soil of a high moisture content. Section 2.4.2 of this sampling plan details plans to excavate trenches in locations suspected of containing perched water, or conducting seepage, within the Disposal Facility Study Area (Figure 1-3).

2 SAMPLE COLLECTION AND TESTING

2.1 Objective

The objective of this sampling plan is to provide representative undisturbed samples and field permeability test data necessary to determine the overburden permeabilities and hydraulic properties. Results of field and laboratory tests and field observations obtained from the implementation of this plan will be used in conjunction with the properties of engineered backfill to be placed as part of the cell foundation to achieve design criteria based on the state landfill location standards as defined under 10 CSR 25-7.264(2)(N)1.A,B.

2.2 Geotechnical Testing Requirements

The proposed laboratory testing program will follow American Society of Testing and Materials (ASTM), U.S. Army Corps of Engineers (COE), and U.S. Environmental Protection Agency (EPA SW-846) standards. Representative samples will be tested for general physical soil characteristics and engineering and hydrologic properties in order to characterize the ability of each overburden unit. General mechanical soil properties of interest include specific gravity, size gradation, soil classification, natural moisture, and dry density. Engineering properties include unconsolidated undrained triaxial compression and consolidated undrained triaxial compression tests.

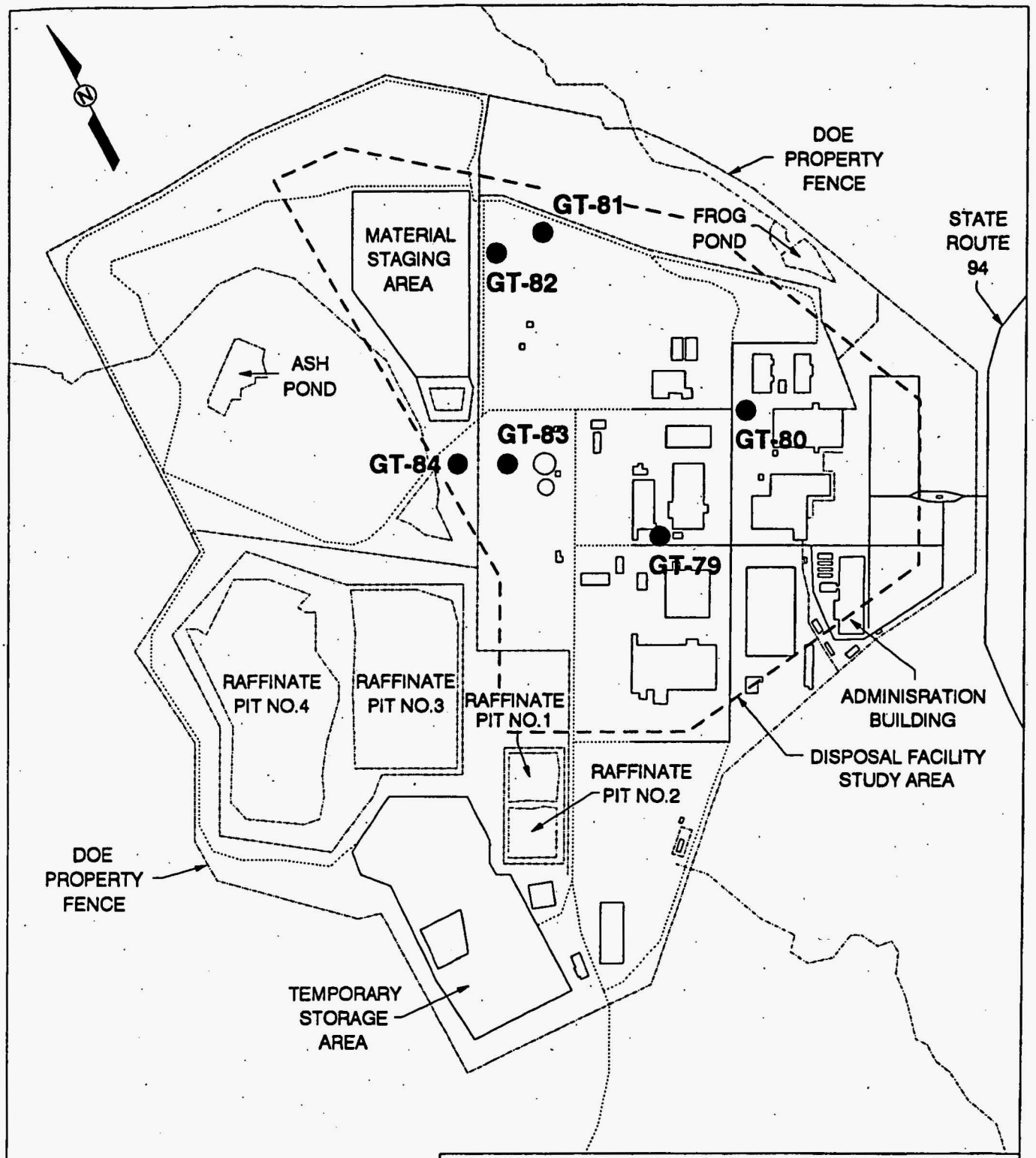
Table 2-1 lists the test methods, hydraulic properties of interest, and the sample type to be submitted for each test (ASTM standards were used unless a COE or EPA standard was preferred). Tests for which a standard has not been developed will be described in detail in the specifications for that phase of the study. Undisturbed and recompacted samples will be obtained by hollow stem augering and pushing Shelby (thin-walled) sample tubes. Leachate developed on site from cement stabilized/solidified material and soil will be used to test leachate constituent effects on the permeability of these samples.

Figure 2-1 shows the locations of, and numbering system for, the hydraulic properties samples (locations correspond to the areas of Figure 1-2). These samples will be taken prior to carrying out the sealed double ring infiltrometer (SDRI) and the two stage borehole (TSB) test programs. The boreholes will be used to further define the units prior to locating the in situ tests.

TABLE 2-1 List of Laboratory Hydraulic Tests

Soil Property (Test Method) Soil Unit	Sample Type		
	SDRI/TSB Support Undisturbed	Undisturbed	Recompacted
Moisture content (ASTM D2216) or Bush & Jenkins (1970) method:			
Loess Soil	-	3	-
Ferrelview Formation	4	9	-
Clay Till	3	9	-
Specific gravity and porosity (ASTM D854) or calculated from SPOC test:			
Loess Soil	-	3	-
Ferrelview Formation	4	9	-
Clay Till	3	9	-
Bulk soil density (ASTM D2937 or D1587-83) soil classification (ASTM D2487-90) and Atterbergs (ASTM D4318-84) (Includes tests for 12 TSBs):			
Loess Soil	-	3	-
Ferrelview Formation	4	15	-
Clay Till	3	15	-
Saturated hydraulic conductivity with water and leachate (EPA SW-846 Method 9100, or EM 1110-2-1906, Appendix VII, COE 1970):			
Loess Soil	-	1	1
Ferrelview Formation	-	6	1
Clay Till	-	6	1
Saturated hydraulic conductivity with water using Triaxial Cell Flexible Wall Permeameter (ASTM D5084):			
Loess Soil	-	2	-
Ferrelview Formation	4	6	-
Clay Till	3	6	-
Triaxial shear strength (ASTM D4767 or EM-1906, Appendix X, COE 1970):			
Loess Soil	-		
Ferrelview Formation	-	3CU, 3UU	1CU, 1UU
Clay Till	-	3CU, 3UU	---, ---
Soil water retention characteristics (SPOC Test Constanz and Herkelrath 1984):			
Loess Soil	-	3	
Ferrelview Formation	4	9	
Clay Till	3	9	
Saturated hydraulic conductivity with water, (EM 1110-2-1906, Appendix VII, COE 1970):			
Loess Soil	-	-	-
Ferrelview Formation	4	-	-
Clay Till	3	-	-

CU Confined undrained
UU Unconfined Undrained
\- Not tested



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SMALL DIAMETER GEOTECHNICAL BOREHOLES LOCATION MAP

FIGURE 2-1

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The current disposal facility construction plan does not use the loess soils for any structural load bearing fill. However, it is possible that some of this unit may unavoidably be incorporated into the facility's subgrade. Therefore, the hydraulic properties of the loess in both disturbed (recompacted-remolded) and undisturbed samples should be tested (MKF and JEG 1991a). On the other hand, the small volumes of loess soils relative to the Ferrelview Formation and clay till require only the minimum number of triaxial shear strength tests on this unit (Table 2-1). Field testing of the loess unit by either the TSB or the SDRI methods will not be necessary as these tests are for undisturbed, in situ conditions. During disposal facility (DF) construction, any suitable loess material present in the cell footprint will be excavated, mixed with other low permeability soil types, and recompacted.

The Ferrelview Formation and the underlying clay till all have a significant impact on the DF as leachate transport barrier units. These units will be tested for the effect of leachate on their permeabilities and shear strengths as undisturbed soil units (Table 2-1). The current construction plan for the DF will not disturb significant volumes of the underlying clay till unit, so this unit will not be tested for either remolded (disturbed) triaxial shear strength or remolded hydraulic conductivity parameters.

Table 2-2 lists the laboratory tests in support of the SDRI program. Individual SDRIs will be installed at four of the six areas. Areas I and II will not have any SDRIs installed. They will, however, have two each of the two stage borehole (TSB) permeameters installed. At each site, one TSB will be installed in the Ferrelview and one in the clay till. One Shelby Tube sample will be obtained for general engineering soil classification parameters from each TSB site.

The SDRIs will be constructed and maintained according to test plans and specifications specifically developed for the WSSRAP by D.B. Stephens & Associates (DBS&A) (1991). Figures 2-2 and 2-3 list locations and designations of the SDRI and TSB installations, respectively. Site Areas III and IV will be the locations for SDRI installations FP-01 and FP-02 (Figure 2-2), both installed in the clay till unit (Table 2-2).

Area V will have a duplicate set of SDRIs installed, one in the upper Ferrelview Formation (FP-03) and one in the lower Ferrelview (FP-04). A TSB will be installed near each SDRI to the same approximate depth. The purpose of these duplicate field permeameter installations is to determine to what degree the Ferrelview varies in permeability with depth.

TABLE 2-2 List of Field Tests and Supporting Samples

Test Area	SDRI No.	Soil Unit	TSB No.	Pre-Test[a] SDRI Samples for Soil Hydr. Prop.	SDRI Post-Test Soil Samples for Moisture and Bt	
I		Ferrelview	TSB 1	---	---	---
		Clay Till	TSB 2	---	---	---
II		Ferrelview	TSB 3	---	---	---
		Clay Till	TSB 4	---	---	---
III	FP-01	Clay Till	TSB 5	2[b]	12[c]	12
		Ferrelview	TSB 6			
IV	FP-02	Clay Till	TSB 7	1	12	12
		Ferrelview	TSB 8			
V	FP-03[d]	Ferrelview	TSB 9	1	12	12
	FP-04[e]	Ferrelview	TSB 10	2[b]	12	12
		Clay Till	TSB 11			
VI	FP-05	Ferrelview	TSB 12	1	12	12
		Clay Till	TSB 13			
Totals	5		13	7	60	60

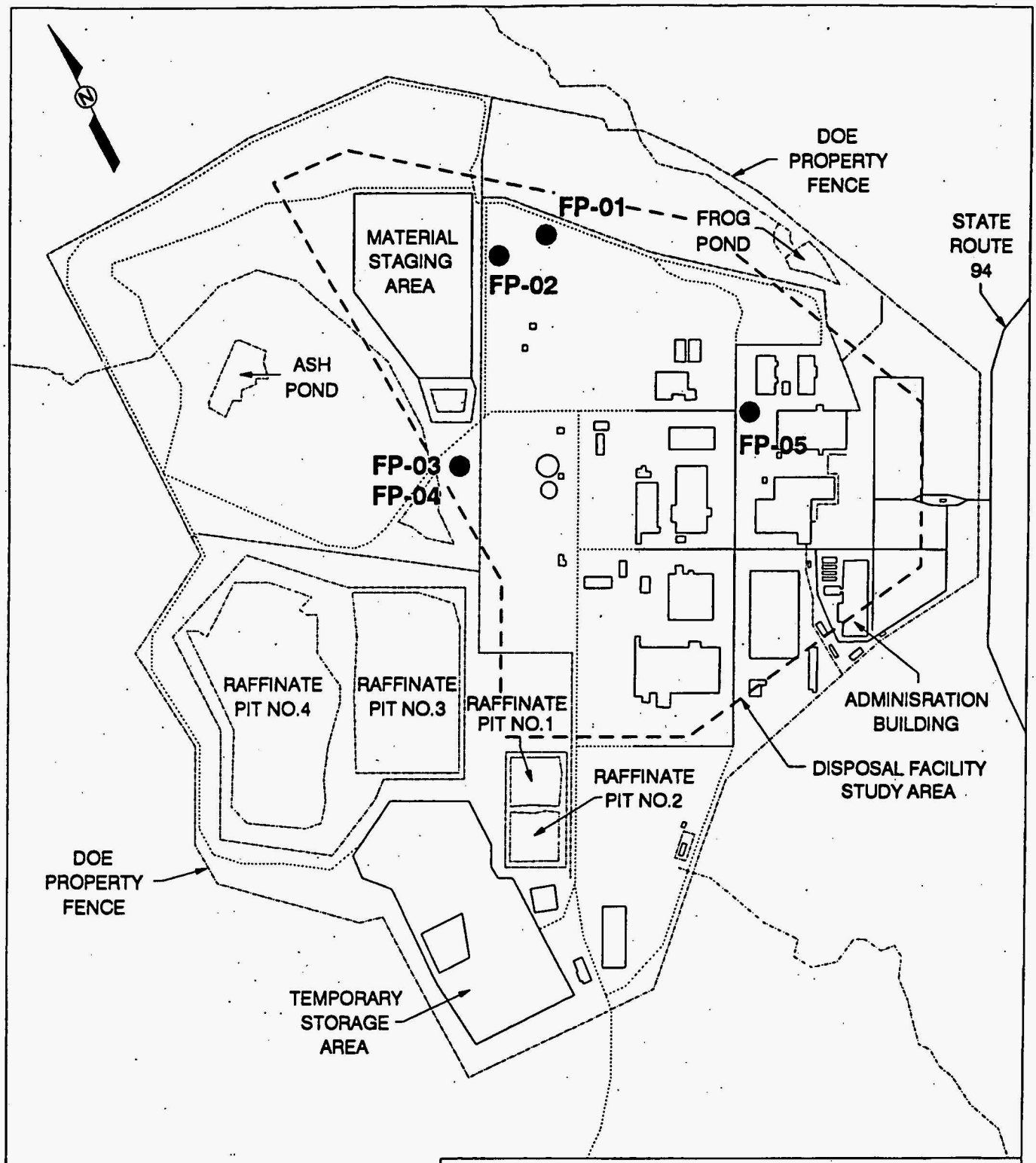
(a) Prior to running SDRIs, soil hydraulic property tests are those listed in Table 2-3.

(b) Duplicate soil samples for laboratory testing of hydraulic parameters at these locations.

(c) Estimated for 6 in. long samples taken continuously to bottom of wetting front (6 foot maximum depth).

(d) FP-03 will be constructed in the shallow portion of the Ferrelview Formation.

(e) FP-04 will be constructed in the deeper Ferrelview Formation.



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SEALED DOUBLE RING INFILTROMETER (SDRI)
TEST PADS LOCATION MAP

FIGURE 2-2

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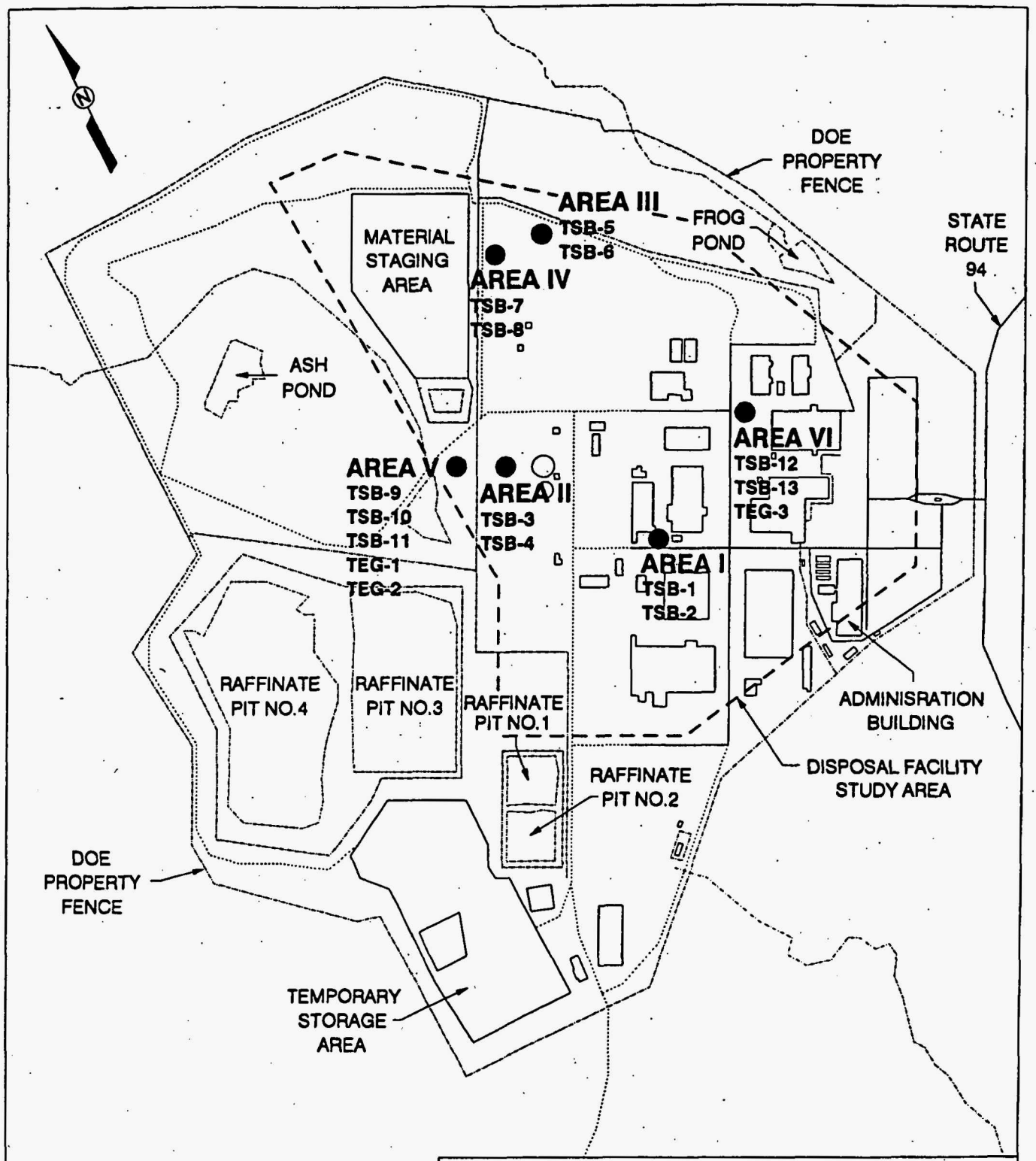

TWO-STAGE BOREHOLE (TSB) PERMEABILITY TESTS LOCATION MAP

FIGURE 2-3

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Area VI will have one SDRI, FP-05 and two TSBs (Figures 2-2 and 2-3). One of the TSBs and the SDRI will be installed to test Ferrelview Formation. The remaining TSB will be installed to test the clay till at this location.

Each SDRI installation requires that initial, pre-test soil samples be taken (Table 2-2) for laboratory measurement of hydraulic soil properties. Table 2-3, as modified from DBS&A (1991), lists the specific test methods that should be followed in testing these pre-SDRI test samples. The number of tests required are included in the totals of Table 2-1. One sample for each soil type and location should be obtained. As shown on Table 2-2, two sets of duplicate soil samples will be obtained and tested for the complete set of hydraulic parameters as listed on Table 2-3. One set of duplicate soil samples will be for the Ferrelview Formation (potentially obtained from SDRI installation site FP-04, refer to Figure 2-2 for locations). The other set of duplicate soil samples will be for the clay till (potentially obtained from SDRI installation FP-01).

Post-test wetting front determination for the SDRI test is obtained by taking continuous thin wall tube samples from trenches excavated through the dismantled SDRI sites. The procedure for excavating the trenches, pushing the thin-walled samples, and ultimate wetting-front depth determination is detailed in DBS&A (1991) Sections 3.7, 3.8, and 3.9.

2.3 Sampling/Testing Locations and Identification

Sampling/testing locations are shown on Figure 1-2 as Areas I through VI. These locations were selected based on the following criteria.

- Minimum potential for future disturbance due to excavation of building foundations, underground utilities, or fill.
- Availability of the Ferrelview Formation and clay till unit.
- Easy access for sampling and testing equipment such as drilling rigs, backhoes, and infiltrometers.

The use of these criteria resulted in multiple sampling/testing locations in the northern portion of the disposal facility study area (DFSA) and a lack of locations in the southern portion

TABLE 2-3 Summary of Recommended Methods for Laboratory Hydraulic Parameter Testing of Soils at SDRI Sites

Hydraulic Parameter To Be Measured	Recommended Method
1. Soil-Moisture Retention Characteristics[a]	1. SPOC Test
2. Saturated Hydraulic Conductivity Using Flexible Membrane or Triaxial Cells	2. ASTM D 5084-91
3. Saturated Hydraulic Conductivity in Thin-Walled Sample Tubes	3. Engineer Manual, 1980, Laboratory Testing of Soils, U.S. Dept. of Army, Office of Chief Engineer, Washington, D.C., Publication No. 1110-2-1906, Appendix VII, pp. 16-17.
4. Unsaturated Hydraulic Conductivity (Calculated)	4. van Genuchten, M., 1980, A Closed Form Equation for Predicting the Hydraulic Conductivity of Unsaturated Soils, Soil Sci. Soc. Am. J., v. 44, pp. 892-898.
5. Volumetric Water Content[b]	5. Bush, D.C., and R.E. Jenkins, 1970 (July), Proper Hydration of Clays for Rock Property Determinations, Journal of Petroleum Technology, pp. 900-904.
6. Bulk Density	6. Blake, G.R., and K.H. Hartge, 1986, Bulk Density, *In* Methods of Soil Analysis, Part I, Klute (ed.), American Soc. of Agronomy, Madison, WI, Chapter 13, pp. 363-367.
7. Porosity (Calculated)	7. Danielson, R.E. and P.L. Sutherland, 1986, Porosity *In* Methods of Soil Analysis, Part I, Klute (ed.), American Soc. of Agronomy, Madison, WI, Chapter 18, pp. 444-445.

Table is modified from D.B. Stephens & Associates, Inc. 1991.

[a] The Submerged pressure outflow cell (SPOC) method of Constantz and Herkelrath (1984) yields saturated and unsaturated hydraulic conductivity of soil specimens in the same apparatus. It is used here in lieu of ASTM moisture retention characteristics test methods D2325-68 and D3152-72.

[b] As recommended by D.B. Stephens & Associates 1991.

of the DFSA. This is because the units of interest are not easily accessible in the south and site remediation activities involving building demolition, foundation removal, fill removal, and contaminated soil removal will result in intense modification of surficial soils in the southern portion of the DFSA.

2.3.1 Area I

Sample Area I is in an open, grassy area, between chemical plant (CP) Building 202 and the main east-west site access road (Figure 1-2). The area is located on the south side of the road, across from CP Building 406, on a corner formed by the east-west access road and a deadend driveway that leads south to Buildings 201 and 301. The area is easily accessed by both these roadways. This location is near the center of the proposed DF's southern portion.

As shown on the logs of the three closest geotechnical boreholes (Appendix B, Figures B-2, B-3, and B-4), sporadic loess deposits of 0 ft to 3 ft in thickness may be encountered upon drilling in this area. The loess overlies between 7.5 ft to 17 ft of Ferrelview Formation (between 3 ft and 17.5 ft in depth). The Ferrelview overlies 10 ft to 20 ft of clay till, encountered at depths of between 15 ft to 20 ft. Appendix B, Figure B-1, summarizes symbols and designations used in geotechnical boring logs.

Area I will be the location for two TSB permeability tests. Table 2-2 lists the TSB and SDRI test sites, and the number and type of related soil samples. One TSB test will be conducted in the Ferrelview Formation and a second TSB test will be conducted in the clay till unit.

2.3.2 Area II

Area II is approximately 570 ft west and north of the first sample area, located just west of a large storage tank and the CP water tower. It also lies in an open area accessible from the east-west site access road. A source of subsurface control for this site includes test pit excavation GT-2T78 and geotechnical borehole log GT-53 (Appendix B, Figures B-5 and B-6). On the basis of this information, it is expected that 1 ft to 4 ft of topsoil, 1 ft to 2 ft of loess, 6 ft to 7 ft of Ferrelview Formation, 12 ft of clay till, and 1 ft to 2 ft of basal till will be encountered in this area. Two TSB permeability tests will be carried out at this site, one each in the Ferrelview and clay till soil units (Table 2-2).

2.3.3 Area III and IV

Areas III and IV are located 1,000 ft and 900 ft, respectively, to the north and west of Areas I and II (Figure 1-2). Area III is a at a lower elevation than the other areas, located just east of, and adjacent to, a drainage channel that flows north-northeast through the site. Area IV is just east of the material staging area (MSA) and adjacent to a roadway that runs north around the CP perimeter.

In Area III, the logs for G-7, T-6, GMW-9 (MW-2009), GT-42, and GT-69 (Appendix B, Figures B-7, B-8, B-9, B-10, and B-11) all indicate the presence of 0 ft to 2 ft of topsoil/fill overlying anywhere from 0 ft to 11 ft of Ferrelview Formation and loess soil (from 0.5 ft to 11.5 ft depth) in turn overlying 9 ft to 11 ft of clay till (from 1.5 ft to 20.5 ft in depth). The clay till increases in thickness to the west, in the direction of Area IV. One SDRI test and one TSB test will be conducted at the 8 ft depth in the clay till at this location. If a thickness of 5 ft or more the Ferrelview Formation is present, it will also be tested with the TSB method.

Area IV thicknesses are based on the logs of borings GMW-9 (Appendix B, Figure B-9), G-3 (Appendix B, Figure B-12) and GT-42 (also designated GT-2B42) (Appendix B, Figure B-10). The logs indicate a sequence of 0.5 ft to 4 ft of gravel fill overlying 6 ft to 11 ft of Ferrelview and 24 ft or more of clay till (beginning at 6 ft in depth and extending down to between 20.5 ft and 31 ft). Possible loess soil deposits could exist in this area within the upper 10 ft (see log GMW-9). This location will have a single SDRI installed in the clay till at approximately the 8 ft depth. Two TSB tests will be run at this location, one in the Ferrelview Formation, at an estimated depth of 5 ft, and one in the clay till unit at a depth of 8 ft (Table 2-2).

2.3.4 Area V

Area V is located just south of the MSA and east of the Ash Pond, near the intersection of two site roads, the Patrol Road that runs north-south and the Ash Pond Road (Figure 1-2). Geologic logs G-5, G-6, and GT-61 (Appendix B, Figures B-13, B-14, and B-15) indicate up to 14 ft of Ferrelview Formation, either exposed at the surface or overlain by 1 ft of fill; and 10 ft of clay till from approximately 14 ft to 24 ft in depth. Loess soil may on may not be present at this site as it appears from 2 ft to 5 ft in depth at GT-61, but is not reported on logs G-5 and G-6.

This area will be the site for two SDRI installations, one in the upper Ferrelview Formation approximately 2 ft in depth, and one in the lower Ferrelview at 10 ft in depth (Table 2-2). Three TSB tests will be run at this site. One TSB corresponding to each of the two SDRIs will be installed in the upper and lower Ferrelview. A single TSB test will be conducted within the clay till at this location (Table 2-2).

2.3.5 Area VI

Area VI is located at the northwest corner of the No. 407 Building Block, across the street from Building 105, to the west, and Building 403, to the north (Figure 1-2). Based on geologic logs G-8 and GT-55 (GT-2B55) (Appendix B, Figures B-16 and B-17), up to 6 ft of fill overlies 3 ft to 4 ft of loess (from 6 ft to 10 ft in depth). In turn, the loess overlies 6 ft to 10 ft of Ferrelview Formation (9 ft to 20 ft in depth) and 7 ft to 11 ft of clay till (from 15 ft to 27 ft in depth).

Area VI will be the location of a single SDRI test, constructed in the upper Ferrelview Formation at an estimated depth of 10 ft. Two TSBs will be run at this location; one at the same depth of Ferrelview as the SDRI, and a second one in the clay till unit at an estimated depth of 16 ft (Table 2-2).

2.3.6 Trench Locations

Figure 1-3 shows the locations of trenches proposed as part of this sampling plan. These trenches will be excavated to determine if filled drainages are presently acting to contain perched seepage or contain volumes of debris, organic material, or otherwise unsuitable soil which must be accounted for as part of the formulation of the disposal cell foundation excavation plan.

<u>GT-2T-83</u>

This trench location is in the coal pile area. The 1954 topographic map indicates the existence of a drainage and a surface drainage pipe in this location. The cut and fill map indicates the presence of 2 ft to 4 ft of fill. Adjacent areas contain up to 14 ft of fill based on information presented on the cut and fill map.

GT-2T-84

This trench location is about 85 ft northeast of Building 412. The map of 1954 topography indicates the presence of a drainage and surface drainage pipe in this area.

GT-2T-85

This trench location is about 80 ft north of the northernmost corner of Building 408. the 1954 topographic map indicates the presence of a drainage and closed depression in this area. Since this location is next to a site road, excavation will take place at the northwest corner of the road. Site development drawings indicate that this area is free of subsurface piping and utilities.

2.4 Sample Collection Methods

Figure 2-4 presents the alphanumeric designation that will be used for all sample identification.

2.4.1 Soil Hydraulics Sample Collection Methods

Sample collection methods will vary depending on the particular test method (see Table 2-1). Disturbed and undisturbed samples will be collected in a continuous manner at each sample area using a hollow-stem auger drilling rig. A minimum of one sample per unit from each of the test areas will be obtained. Sampling methods, sample preservation and shipping, and field descriptions of each unit sampled will be in accordance with ASTM, EPA and COE standards as they apply to each of the test methods being sampled for (ASTM D620, COE EM 1906, EPA SW-846). Undisturbed samples will be sealed with bees wax and packaged to retain moisture and avoid shifting during shipment in their original sample tubes.

2.4.2 Perched Water Investigation and Sampling

Trenches will be excavated to undisturbed soil or a maximum depth of 12 ft. Trench walls should be vertical or as close to vertical as practicable due to sloughing. Personnel shall not enter the trenches for any reason and shall not approach within 2 ft of the edge of the trench

XX - YYZZ

CONSECUTIVE SAMPLE TWO DIGIT NUMBER FOR A PARTICULAR BOREHOLE OR TRENCH

TWO DIGIT NUMBER DESIGNATING HOLE OR TRENCH FROM WHICH SAMPLE IS OBTAINED

TWO DIGIT ALPHA DESIGNATION INDICATING TYPE OF SAMPLE
SUCH AS : SB - SPLIT BARREL
ST - SHELBY TUBE
CS - CALIFORNIA SAMPLER
BU - BULK SAMPLE
LD - LARGE DIAMETER
(THIN WALL SAMPLE)

EXPLANATION OF SAMPLE DESIGNATION SYSTEM

FIGURE 2-4

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ORIGINATOR: JDC	DRAWN BY: GLN	DATE: 10/91	

excavation. Excavated materials will be placed adjacent to the excavation for examination by the Project Management Contractor (PMC) field geologist or geotechnical engineer.

Excavated soils must be replaced in the same order as removed. Site restoration will be in accordance with Section 2.6 of this sampling plan.

Soil and seepage water encountered during trenching may be sampled for waste characteristics as deemed necessary by environmental safety and health (ES&H) personnel. Water samples will follow collection protocols for groundwater samples. Samples will be obtained from the backhoe bucket or by dipping from the ground surface using a ladle with an extension handle. Soil samples will be obtained from the backhoe bucket. All samples obtained from the backhoe bucket will be removed with minimal contact of the bucket walls. A total of four water samples and 10 soil samples, including duplicates, is planned. Soil and water samples will be analyzed for the constituents listed in Table 2-4.

2.5 Sample Shipment and Chain of Custody

Chain of custody and sample shipping will follow Weldon Spring Site Remedial Action Project (WSSRAP) standard operating procedures ES&H 4.1.2s, RC-17s, and RC-19s as applicable. All samples taken within the boundary of the WSS will be considered potentially contaminated and treated accordingly. Samples will be checked for radioactive contamination before being released to the laboratory. After the completion of the testing program, all contaminated samples will be returned to the Weldon Spring site (WSS).

2.6 Borehole, Excavation and Trench Abandonment

In order to avoid compromising soil integrity due to investigation disturbance, the following abandonment requirements will be followed for all boreholes, trenches, and excavations.

After sampling has been completed, all boreholes will be abandoned by tremie placing of a high solids bentonite based grout. Grout will be mixed and placed through a mud pump and tremied under positive pressure to the bottom of the hole. The ratio of clay grout to fresh potable water must achieve a weight of at least 9.4 lbs/gal as measured with an approved mud weight measuring device in the field (MKF and JEG 1991b).

TABLE 2-4 Water and Soil Sample Analytes

Media	Analytes
Water	HSL Metals PCBs PAHs Nitroaromatics[a] Uranium (total)
Soil	HSL Metals PCBs PAHs Nitroaromatics U-238 Ra-226 Th-230 Th-232

(a) 1,3,5-trinitrotoluene, 1,3-dinitrotoluene, nitrobenzene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, 2,3,6-trinitrotoluene.

Any borehole or trench not backfilled immediately after sampling will be either covered by the drill rig tools or barricaded with tape and traffic barricades.

Excavations will be backfilled with suitable low permeability excavated material and finally capped with the original topsoil material. Excavation backfill will be placed in 8 in. lifts and compacted to a minimum of 95% of maximum dry density as determined by ASTM D698 and a moisture content within 2% below to 4% above optimum moisture content. Narrow exploratory trenches in fill will be thoroughly compacted using a backhoe bucket. Shallow trenches excavated in upper portions of undisturbed soils will be backfilled and compacted to the same requirements as stated above for excavations.

2.7 Decontamination

Decontamination of sampling equipment will follow procedure ES&H 4.1.3s. Personal protective equipment (PPE) will be covered in the health and safety plan for each subcontract. All sampling equipment, augers, and other equipment that come into contact with contaminated soils will be decontaminated by high pressure water before each borehole is drilled. The entire drilling rig, or backhoe, will be decontaminated upon arrival on site and upon completion of drilling activities. Interior portions of equipment, such as pumps and hoses that are not accessible for cleaning with a pressure cleaner, will be thoroughly cleaned and flushed with potable water. Decontamination will be performed at the site decontamination pad. Split-spoon, Shelby Tube, or California samplers will be washed with a dispersant and water, rinsed with potable water, and reassembled after each sample is taken.

3 QUALITY ASSURANCE

The quality assurance (QA) plan for drilling, test pits, trenches, sampling, and testing includes all applicable Weldon Spring Site Remedial Action Project (WSSRAP) procedures established in the Weldon Spring *Environmental Quality Assurance Project Plan* (MKF and JEG 1992b) and in accordance with U.S. Environmental Protection Agency (EPA) guidelines. Work will be carried out in accordance with WSSRAP engineering procedures and standard operating procedures (SOPs). Forms required for geotechnical sampling include:

- Chain-of-Custody Form
- Sample seals and tapes
- Field data sheets
- Borehole logs
- Test pit logs
- Geotechnical laboratory testing reports

In addition, geotechnical laboratory testing of soil samples and analytical testing of soil and water samples will be performed in accordance with the subcontractors' quality assurance (QA) program, subject to Project Management Contractor (PMC) review and approval. Testing laboratories providing services under this plan must be approved by the PMC Project Quality Department.

QA during drilling, sampling, test pit excavation, and sampling operations will consist of surveillance and inspection of the drilling and excavating subcontractor. Drilling, excavating, and sample procedures will be established. All soil samples will be labeled immediately after removal from the sampler.

The correlation of sample identification to assigned laboratory tests will be verified at the laboratory upon receipt of each sample. Thorough sample tracking and documentation will be initiated and maintained throughout the testing program. Laboratory test results will be reviewed and approved by an individual other than the person who is performing the test before being submitted to the PMC.

4 HEALTH AND SAFETY

In accordance with CM&O-15a, safety concerns and mitigative measures related to sampling activities carried out under this plan will be identified and documented with task specific safety assessments (TaSSAs) which will be prepared, reviewed, approved, and filed with the Construction, Maintenance and Operations Department on a daily basis before work begins in the controlled area. Safety, industrial hygiene, and health physics personnel will also monitor health and safety conditions during sampling. Health physics personnel will monitor personnel and equipment working in areas of radiological contamination.

Personal protective equipment (PPE) will be worn as required at each sampling location. The requirements are outlined in the WSSRAP *Personnel Protective Equipment Requirements Manual* (MKF and JEG 1992c).

Subcontractors will submit a health and safety plan (HASP) prior to coming on site and their plan will be reviewed and approved by the site safety officer prior to commencing sampling work.

5 DATA DOCUMENTATION

Data documentation will follow Weldon Spring Site Remedial Action Project (WSSRAP) standard operating procedures and the *Project Management Contractor Quality Assurance Program*, Section 4 (MKF and JEG 1992d) relating to Documents and Records. During the course of the geohydrologic sampling, a qualified geological or geotechnical engineer will record the daily activities, following field logbook procedures (procedure ES&H 1.1.4) including:

- Date
- Weather conditions
- All personnel involved
- Chronological record of activities

Borehole and test pit logs will be kept on site and updated as the sampling progresses. These logs will be prepared by a qualified geologist, geological engineer or soils engineer (MKF and JEG 1991b). The following data will be included in each borehole or test pit log:

- Test pit or borehole identification.
- Test pit or borehole location.
- Drilling/sampling method and equipment.
- Drilling or excavating contractor.
- Date of commencement and completion.
- Total depth.
- Depth to water table and bedrock (if applicable).
- Hole diameter or test pit dimensions.
- Standard Penetration Test (SPT) number of blows per 6 in. of advancement.

- Lithologic description of materials and soil classification in accordance with ASTM D2488 (ASTM 1991).

- Munsell color chart number code.

- Sample numbers, depth of sample, and sample interval.

- Length of sample recovered (drilling only).

- Description of sampling method (i.e., number of blows for the standard penetration test - SPT.

- Description of completion operations (i.e., borehole or test pit abandonment operations).

- Borehole or test pit logs will be transmitted to the WSSRAP Project Quality Department in accordance with SQP-9a *Inventory, Valdiation, and Transfer of QA Records* for retention.

Daily logs maintained by the subcontractors will include the activities performed, personnel involved, locations, time, weather conditions, equipment used, and any problems encountered. A field report will be prepared after each geohydrologic investigation is completed. Geotechnical and hydraulic laboratory testing data will be evaluated by the Project Management Contractor (PMC) and transmitted to the Project Quality Deparmtent in accordance with SQP-9a for review and retention as a QA record.

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Code of Federal Regulations

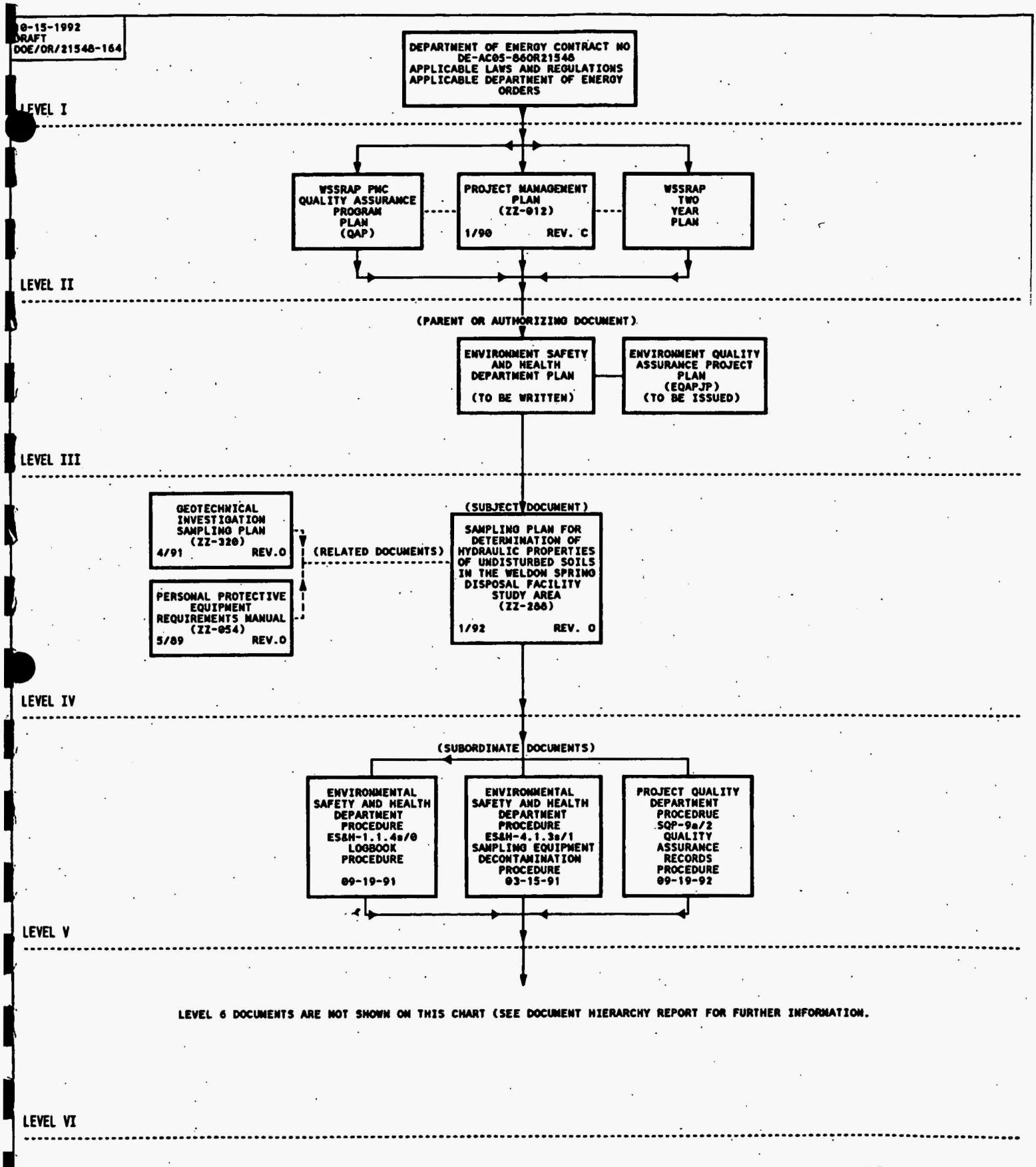
10 CSR 25-7.264(2)(N)1.A and B. *Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.*

Procedures

CM&O 15a	*Task Specific Safety Assessment*
ES&H 1.1.4s	*Logbook Procedure*
ES&H 4.1.2	*Chain of Custody*
ES&H 4.1.3s	*Sampling Equipment Decontamination*
SQP 9a	*Inventory, Validation, and Transfer of QA Records for Retention*
RC 17s	*Packaging, Shipping and Receiving of Radioactive Materials*
RC 19s	*Packaging, Shipping and Receiving of Nonradioactive Materials*

APPENDIX A
DOCUMENT HIERARCHY

10-15-1992
DRAFT
DOE/OR/21548-164



SAMPLING PLAN FOR DETERMINATION OF HYDRAULIC PROPERTIES OF UNDISTURBED SOILS IN THE WELDON SPRING DISPOSAL FACILITY STUDY AREA

APPENDIX A

REPORT NO. DOE/OR/21548-164		EXHIBIT NO.
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APPENDIX B
BOREHOLE AND TEST PIT LOGS

APPENDIX B - LIST OF FIGURES

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GEOTECHNICAL BORING LOG LEGEND

SYMBOLIC LOG

CLAY	GRAVELLY CLAY
SILT	CLAYEY GRAVEL
SAND	SANDY CLAY
GRAVEL	TOPSOIL
SILTY CLAY	SHALE
CLAYEY SILT	CHERTY LIMESTONE

SAMPLER DESIGNATIONS

SS = STANDARD PENETRATION SAMPLER (2.0" SPLIT SPOON)

SB = CALIFORNIA SAMPLER (3.0" SPLIT BARREL)
x = LINERS COLLECTED

ST = 3.0" SHELBY TUBE
P.P. = POCKET PENETROMETER, UNCONFINED COMPRESSIVE STRENGTH (Tons/Sq.Ft.)

GROUNDWATER MEASUREMENTS

6.5'; 6/9 ▽ = DEPTH & DATE OF INITIAL WATER LEVEL MEASUREMENT

2.9'; 6/16 ▼ = DEPTH & DATE OF STABILIZED WATER LEVEL MEASUREMENT

COLORS

SOIL & ROCK COLORS FROM MUNSELL SOIL COLOR CHARTS

GEOTECHNICAL BORING LOG LEGEND

FIGURE B-1

REPORT NO.: DOE/OR/21548-164		EXHIBIT NO.: A/PI/179/1091	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE 10/91	

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

GEOTECHNICAL BORING LOG

Sheet 1 of 5

Project Number: MKE 9423

Hole Number: GT - 47 (GT-2B47)

Project: WSSRAP - GT DRILLING	Location: SEISMIC LINE #6, STA. 1 + 35
Coordinates: (AEC) 100024.8N 50128.9W	Drilling Contractor: HANNIBAL TESTING LABORATORIES
Drill Make and Model: CME-55, CONT. FLT. HOLLOW STEM AUGER; CORE DRILLING: NQ WIRELINE	Depth Top of Rock: 35.3 FEET
Depth Casing & Size: 35.5FT 3½" I.D.	Hole Size: AUGER: 7" CORE: 2.98"
Elevation: 660.3 FT	Angle from Vert. and Bearing: VERTICAL
Depth Bottom of Hole: 55.5 FEET	
Water Level:	Fluid & Additives: CLEAR WATER
Date Start: 9:20 7/13/88	Date Finish: 1:35 7/15/88
Logger: A. BENFER P. PATCHIN	

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
		0	SS	7"	7.13.15		Silty Clay with angular gravel and fine to coarse sand, predominantly pale brown (10YR 6/3), dry, hard CL, contains roots
		1.5	01		28		FILL
		2.5	SS	7"	7.7.6		Clayey Silt, mottled, light yellow brown (10YR 6/4), moist, very stiff (2.25), ML
		4.0	02		13		
	5	5.0	ST	27"			LOESS
		7.5	03				Silty Clay, mottled yellow brown (10YR 5/6), very silty and light gray (10YR 7/1) very plastic, moist, stiff (1.75), CL-CH
		7.5	SS	10"	1.3.5		-P.P.=2.0-2.75 - very stiff
		9.0	04		8		
	10	10.0	ST	6"	Pushed		-P.P.=2.75 - CH
		12.5	05		30"		FERRELVIEW
		12.5	SS	17"	2.3.5		-P.P.=2.25, mostly light gray, trace fine gravel to coarse sand, CH
		14.0	06		8		
	15	15.0	ST	0"	Pushed		-P.P.=2.5 very stiff
		17.0	07		24"		
		17.0	SB	12"	7.12.17		-P.P.=4.1, hard, 10% sand: grading
		19.0	08		29		
	20	20.0	SB	12"	3.9.16		Silty Clay with 25% sand, fine to coarse, mottled light gray (10YR 7/1) and light yellow brown (10YR 6/4) moist, hard (4.0-4.2), CH with MnOx (black)
		21.5	09		25		
		22.5	SS	15"	4.7.11		-P.P.=4.5+, hard, trace fine gravel
		24.0	10		18		CLAY TILL
	25						

AS INTERPRETED BY ALAN BENFER, 1991.

GEOTECHNICAL BORING LOG
GT-47

FIGURE B-2A

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/145/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

GEOTECHNICAL BORING LOG

Sheet 2 of 5
Project Number: MKE 9423
Hole Number: GT - 47 (GT-2B47)

Project: WSSRAP GT DRILLING
Location: SEISMIC LINE #6, STA. 1 + 35

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
		25.0 26.5	SB 11	18"	5.12.15 27		-P.P.=4.0-4.5, hard, increasing fine gravel (15%) subrounded
		27.5 29.0	SS 12	18"	4.5.9 14		-P.P.=4.2, hard, FeOx nodules, slickensides, fine gravel (angular chert)
	30	30.0 31.5	SS 13	6"	3.11.20 31		CLAY TILL Gravelly -P.P.=3.0-4.5 very stiff to hard with slickensides
		32.5 34.0	SS 14	15"	21.30.20 50		Clayey Gravel, mostly angular chert up to 1½", clay (30%) strong brown (7.5YR 5/6) CH, moist, medium dense, GC 33.0-34.0 mostly angular limestone ½" to 1" white (7.5YR 8/1) RESIDUUM?
7/13 7/14	35	35.5	SB-15	0"	7.50		35.5' Drove 6" to refusal. Auger refusal @ 35.5'. GC as above with 3" chert gravel, sub-rounded with minor strong brown clay (7.5YR 5/6). Refusal at 6:30 a.m. 7/14/88. Hole continued with NQ core barrel. Cored from 35.5' to 55.5'. Core description on sheets 3 through 5.
	40						

GEOTECHNICAL BORING LOG
GT-47

FIGURE B-2B

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/146/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES GROUP

SOIL BORING LOG

Sheet 1 of 2
Project Number: 3840
Hole Number: GT - 71

Project: Weldon Springs Site Remedial Action Project	Location: 70'W of SW corner of Bldg. 201
Coordinates: (AEC) N99758.2, W50300.1	Drilling Contractor: Geotechnology Services, Inc.
Drill Make and Model: CME 750, ATV mounted	Depth Top of Rock: 34.5 / Depth Casing & Size: -- / Hole Size: 7 1/2" (Auger)
Elevation: 659.3	Angle from Vert. and Bearing: Vertical / Depth Bottom of Hole: 34.5
Water Level: Dry	Fluid & Additives: None / Date Start: 4/11/91 10:50 / Date Finish: 4/11/91 15:05 / Logger: E. Rennat

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
		2.5-4	SS 7101	12"	4-6-8 (14)		Silty Clay Mottled lt. to med. brown and gray, moist, plastic, stiff, occasional Fe and Mn staining. CL
	5	5-7.5	ST 7102	21"			
		7.5-9	SS 7103	13"	1-5-8 (13)		
	10	10-12.5	ST 7104	27"			
		12.5-14	SS 7105	18"	2-6-8 (14)		
	15	15-17.5	ST 7106	26"			FERRELVIEW Clay Mottled lt. brown and gray, moist, plastic, stiff, 5% medium to coarse subrounded chert sand, occasional 1/4" chert clasts. CL - CH
		17.5-19	SS 7107	19"	3-6-8 (14)		
	20	20-22.5	ST 7108	27"			
		22.5-24	SS 7109	18"	4-7-7 (14)		
	25						CLAY TILL

SS = Split Spoon ST = Shelby Tube CS = California Sampler (3")

SOIL BORING LOG
GT-71

FIGURE B-3A

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/147/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

MK-ENVIRONMENTAL SERVICES

Project Number: 3840	Boring Number: GT - 71	Sheet 2 of 2

SOIL BORING LOG

Project: Weldon Springs Site RAP Location:

Elevation: Drilling Contractor:

Drilling Method and Equipment:

Water Level and Date: Start Finish: Logger:

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION: Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol
		25-27.5	ST 7110	27"			Sandy Clay Lt. brown, moist, plastic, stiff, occasional Fe and Mn staining, chert clasts CL
		27.5-29	SS 7111	19"	6-10-15 (25)		
							BASAL TILL
	30	30-31.5	CS 7112	15"	(21-36-20)		Gravelly Clay Lt orange, moist, plastic, stiff, some Mn staining along fractures; angular chert clasts up to 1", up to 30% toward bottom CL
		32.5-34	SS 7113	11"	15-15-50/5		
							RESIDUUM
	35						Auger Refusal at 34.5'
	40						
	45						
	50						
	55						

SS = Split Spoon ST = Shelby Tube CS = California Sampler (3")

SOIL BORING LOG
GT-71

FIGURE B-3B

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/148/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

G54-7

BORING LOG

Boring No. 7
Lower District A.E.C. Wel...
Job No.

FIELD DATA

FOUNDATION INVESTIGATION

Project A.E.C. Weldon Spring Mo. Location COORDINATES N 21500 E 20500
Drill Rig SKID Rig Inspector WILLIAM C WALL Operator JOHN H. NORTON Surface Elev. 664.46 (1954) Approx. Current Elev. 658
E. WILLIAMS T. GRIESHABER Natural Ground Elev.
D.H. 7 No. Ground H2O

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	CLASSIFICATION AND REMARKS (Previous O, Impervious □)	LABORATORY DATA: CLASSIFICATION	SYMBOL	MOIST.	DRY WT.	LL
TBR 1	12-4-54	0.0	1.5			0.0	1.0	6" EARTH Auger	BROWN CLAY CH WET & STIFF □	Clay	CH	28		
" 2	"	1.5	6.0			2.0	3.0	" "	YELLOWISH BROWN CLAY CH MODERATELY WET & HARD □	Clay	CH	23		
" 3	"	6.0				6.0	7.0	" "	BROWN CLAY CH WET & STIFF □	Clay Fine	CH	26		
" 4	"					9.0	10.0	" "	BROWN CLAY CH WET & STIFF □	Clay	CH	22		
" 5	"		15.0			13.0	13.0	" "	BROWN CLAY CH W/ TR. OF SAND WET & HARD	Clay	CH	21		
" 6	"	15.0				15.0	16.0	" "	LIGHT GRAYISH BROWN CLAY CH WET & HARD	Clay	CH	22		
" 7	"		21.0			19.0	20.0	" "	LIGHT GRAYISH BROWN CLAY CH WET & HARD □	Clay	CH	25		
" 8	"	21.0	24.0			23.0	24.0	" "	LIGHT GRAYISH BROWN CLAY CH/TR. GRAVEL WET & HARD W/ LIMESTONE CONCRETIONS □	Clay Trace of Gravel	CH	—		
" 9	"	24.0	25.0			24.0	25.0	" "	BR. CLAY CH W/ LIMESTONE CONCRETIONS TR. GRAVEL MIX □	Clay Trace of Sand & Gravel	CH	—		
" 10	12-6-54	25.0				26.0	27.0	6" EARTH Auger	BR. CLAY CH W/ TRACE OF SAND & SMALL GRAVEL HARD □	Clay Trace of Sand	CH	18		
" 11	"		31.0			30.0	31.0	" "	BR. CLAY CH W/ TR. SAND & SMALL GRAVEL STIFF □	Clay Trace of Sand	CH	19		
" 12	"	31.0	32.5			31.0	32.0	" "	LT. GRAY SILT WET & FIRM □	Clay Clay Till 20.0-30.0	CH	16		
" 13	"	32.5				34.0	35.0	" "	BR. CLAY CH WET & STIFF □	Clay W/ Limestone Concretions	CH	20		
" 14	"		38.3			37.0	38.0	" "	BR. CLAY CH WET & STIFF □	Clay	CH	27		
" 15	"	38.3	39.1			38.3	39.1	" "	Reddish Brown CLAY CH WET & HARD □	Mix Clay Sand & Gravel	—	—		
Ream'd	12-1-54			39.1	43.8	No sample		4½" Hughes Roller Bit	Evidence of Caving Proceeding Large Gravel & Boulders Tr. of Clay	Residual Soil				
Rock Core				43.8		43.8	45.8	NX	LIMESTONE CORE (BROKEN)	LIMESTONE & CHERT LEACHED				
"						45.8	47.8	NX	CAVITY Possibly Clay Filled					
"						47.8	49.8	NX	LIMESTONE CORE (BROKEN)	WEATHERED LEACHED	MFC	CHE		
"						49.8	49.35	NX	CAVITY Unable to Determine if Clay Filled No Water Return					
"					52.5	49.35	50.4	NX	LIMESTONE CORE (BROKEN)	LEACHED LIMESTONE & CHERT				

Total Depth 50.620 Ft. Top Rock Lost Water @ 43.3
Hole Back Filled w/ Tremie

LABORATORY DATA
Date 12-17-54 Classified by C. W. STEIN

Sheet 1 of 1 Sheets

BORING LOG
G54-7

FIGURE B-4

REPORT NO.	EXHIBIT NO.	
DOE/OR/21548-164	A/PI/144/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

MORRISON-KNUDSEN ENGINEERS, INC.

LOG OF TEST PIT GT-2T78

- Location: 50 feet plan west of northwest corner of fence around facility 428
- Type of excavator: Cat 416 extendable backhoe (new)
- Start excavation: 4:30 p.m. 07/13/88
- Finish excavation: 5:05 p.m.
- Finish backfilling: 8:05 a.m. 07/14/88
- Finish decontamination: 9:05 a.m.

Depth, Feet		Description
0-1.0	CL	Fill: Silty clay; dark yellowish-brown (10YR4/6); some gravel (1/2" to 2"); dry; medium plasticity; medium stiff.
1.0-4.0	CL	Silty Clay: Yellowish-brown (10YR6/6) and light brownish- gray (10YR6/2); dry; medium plasticity; very stiff.
4.0-6.5	CL	Silty Clay: As above but moist to wet and stiff (possible reworked loess).
6.5-12.0	CH	Silty Clay: Yellowish-brown (10YR5/8) mottled with light brownish-gray (10YR6/2) and brownish-yellow (10YR6/8); wet; high plasticity; very stiff.

Samples Collected

GT-2T78: BU-01A, 4.0'-6.5'
GT-2T78: BU-01B, 4.0'-6.5'

GT-2T78: BU-02A, 6.5'-12'0'
GT-2T78: BU-02B, 6.5'-12'0'

6306j/8

Logged By. W. A. Gale

LOG OF TEST PIT GT-2T78

FIGURE B-5

REPORT NO.: DOE/OR/21548-164		EXHIBIT NO.: A/PI/182/1091	
ORIGINATOR JDC	DRAWN BY. SRS	DATE. 10/91	

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

GEOTECHNICAL BORING LOG

Sheet 1 of 2
Project Number: MKE-9423
Hole Number: GT-53 (GT-2B53)

Project: WSSRAP GEOTECH Drilling	Location: Seismic Line #3 Sta. 2+88
Coordinates: (AEC) 100284N 50781W	Drilling Contractor: Hannibal Testing Laboratories
Drill Make and Model: CME-55 7" Hollow Stem Auger: Coring: NQ Wireline	Depth Top of Rock: 42.5'
Depth Casing & Size: 42.5', 3½' I.D.	Hole Size: Auger: 7" Core: 2.98"
Elevation: 655.5 ft.	Angle from Vert. and Bearing: Vertical
Depth Bottom of Hole: 42.5'	
Water Level:	Fluid & Additives: None
Date Start: 12:30 8/12/88	Date Finish: 8:35 8/16/88
Logger: P. Patchin	

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	0	0 1.5	SS 01	5"	4.3.2 5		Clayey Silt, dark grayish brown (10YR 5/2), with ang. gravel, roots to .3', very stiff (2.25) damp, ML
		2.5 4.6	ST 02	16"	Pushed 25"		Silty Clay, light brnsh gry (2.5Y 6/2) with ang. L.S. gravel to 2½", vry stiff (3.5), CL (Gravel at 4.6' for approx. .5') FILL
	5	5.0 6.5	SS 03	15"	3.3.5 8		Clay, yellowish brn (10YR 5/4) slightly silty, moist, plastic, very stiff (2.25), no gravel, minor MnOx strings and FeOx blebs. CL-CH
		7.5 10.0	ST 04	19"			Silty Clay, mottled light brnsh gray (2.5Y 6/2) and brnsh yellow (10YR 6/6), MnOx stringers and FeOx blebs abundant, moist, very stiff (2.25) CH
	10	10.0 11.5	SS 05	16"	3.4.6 10		-- P.P. = 2.25 CL-CH FERRELVIEW
		12.5 15.0	ST 06	22"			Clay, mottled lt gry (2.5Y 7/2) and strng brn (7.5YR 5/6), fine ang. grvl and sand (5%), plastic, moist, CH
12/88 15/88	15	15.0 16.5	SS 07	16"	6.9.10 19		-- Silty Clay, mottled lt gry (10YR 7/1) and brnsh yllw (10YR 6/6) slty (40%) very fine ang. grvl (3%) FeOx blebs and MnOx stringers, damp, CL-CH
		17.5 20.0	ST 08	21"			Gravelly Clay, brnsh yllw (10YR 6/8) damp with 10% sub-rnded to ang. grvl includ. igneous rx, minor lt gry sandy parts, vry stiff (4.0), CL
	20	20.0 21.5	SS 09	13"	5.10.12 22		-- P.P. 4.5 sandy (30%) fine, abund. MnOx, brnsh yllw (10YR 6/6)
		22.5 24.0	SS 10	12"	7.11.16 27		-- P.P. = 4.25 2" ang. chert and rounded mafic gravel, 20% fine sand CLAY TILL
	25						

GEOTECHNICAL BORING LOG
GT-53 (GT-2B53)

FIGURE B-6A

REPORT NO.: DOE/OR/21548-164		EXHIBIT NO.: A/PI/183/1091	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 10/91	

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

GEOTECHNICAL BORING LOG

Sheet 2 of 2
Project Number: MKE-9423
Hole Number: GT-53 (GT-2B53)

Project: WSSRAP Geotech Drilling
Location: Seismic Line #3 Sta. 2+88

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	25.0	25.0	SS	14"	3.5.6		-- P.P. = 3.25 Sandy, CL
		26.5	11		11		CLAY TILL
		27.5	SB	12"	6.13.30		
		29.0	12				Silt, mottled light brnsh gry (10YR 6/2) and brnsh yllw (10YR 6/3) slightly clyey, no grvl, dry, stiff, (1.75) minor MnOx and FeOx blebs, ML
	30	30.0	SS	13"	8.12.12		
		31.5	13		24		Silty Clay, mottled yllwsh red (5YR 5/6) and light yllwsh brn (10YR 6/4), 30% silt, 5% fine grvl, FeOx blebs and MnOx stringers (minor), damp, hard (4.5) ML
		32.5	SS	6"	25.50 for 4"		
		33.3	14				32.5 - Clayey Gravel, grvl up to 2", chert, angular white, clay (30%) red (2.5YR 4/6) GC
	35	35.0	SS	12"	9.12.12		
		36.5	15		24		-- As above, clay is yllwsh brn (10YR 5/8) and red (2.5YR 4/6) silty, GC
		37.5	SB	12"	8.13.25		
		39.0	16				-- As above, approx. 50% clay, very stiff (3.0) moist, GC RESIDUUM
	40	40.0	SS	14"	12.20.17		
		41.5	17		37		-- As above, 30% clay some angular limestone, chert is white (2.5Y 8/)
							T.D. 42.5'

Auger Refusal at 42.5'
@ 1:20 p.m. 8/15/89

GEOTECHNICAL BORING LOG
GT-53 (GT-2B53)

FIGURE B-6B

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/184/1091	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 10/91

X section B
X-section A

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE	JOB NO.: 14501-201	SHEET NO.: 1 of 2	HOLE NO.: G-7
SITE: NORTH OF COAL PILE	COORDINATES: N101,200 W50,450	ANGLE FROM HORIZ.: 90	BEARING: -
BEGUN: 6/17/83	COMPLETED: 6/18/86	DRILLER: GEOTECHNOLOGY INC. KURT JAEGER/GEORGE MATTHEWS	DRILL MAKE AND MODEL: CME-45/CME-750
HOLE SIZE: 6-1/4"/3"	DIMENSIONED FT.: 18.5	BEGUN FT.: 45.5	TOTAL DEPTH: 64.0
CORE RECOVERY T/D: 24.7/83	CORE BOXES: 4	SAMPLES: 3	EL. TOP OF CASING: -
GROUND EL.: 633.3	DEPTH/EL. GROUND WATER: 34.20'/599.10	DEPTH/EL. TOP OF ROCK: 18.5'/614.8	
SAMPLE DRIVING WEIGHT/FALL: 140 LBS/30 IN	CASING LEFT IN HOLE: NONE	LOGGED BY: LAWRENCE YOUNG	

SAMPLE TYPE AND DIMENSIONS	SAMPLE OR DRIVING LENGTH (CORE RUN)	SAMPLE OR DRIVING RECOVERY (CORE RECOVERY)	SAMPLE BLOWS OR PENETROMETER (CORE RECOVERY)	WATER PRESSURE TESTS: LOSS IN GPM	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CONTACTS OF DRILLING, ETC.
							633.3	0			2' cut	
SS 2"	18"	13"	13	3	5	8		5		1	0 TO 11.5 FT SILTY CLAY, MODERATE BROWN(5YR 4/4), MOIST, STIFF TO VERY STIFF, TRACE TO SOME SUBROUNDED TO ROUNDED FINE GRAVEL (PRIMARILY IGNEOUS AND METAMORPHIC ORIGIN), MOTTLED WITH LIGHT GRAY(N6) SILT LENSES, PYROLUSITE STRINGERS. Clay till	0-18.5 FT DRILL WITH 6¼IN OD HOLLOW STEM AUGERS USING CENTER P
SS 2"	18"	15"	20	5	8	12		10		2		0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
							621.8	11.5			11.5 TO 18.5 FT GRAVELLY CLAY, DARK YELLOWISH ORANGE(10YR 6/6), MOIST, HARD, WITH WEATHERED ANGULAR CHERT GRAVEL AND COBBLES. Basal till	18.5 TO 19.0 FT DRILLED WITH 2-7/8 INCH TRICONE ROLLER BIT AND FRESH WATER TO START COREHOLE.
SS 3"	11"	9"	50+	32	50/5"			15		3		19.0 TO 21.0 FT CORED WITH NX3 WIRELINE DIAMOND IMPREGNATED BIT USING CLEAR WATER
							614.8	18.5			18.5 TO 37.0 FT LIMESTONE, DARK YELLOWISH ORANGE(10YR 6/6), MODERATELY HARD, SEVERELY WEATHERED, WITH SEAMS OF MODERATE REDDISH BROWN(10R 4/6) CLAY AND CHERT GRAVEL, SEMI-COMPETENT CHERT LAYERS OR NODULES. Residuum?	21.0 TO 27.0 FT DRILLED WITH TRICONE ROLLER BIT USING CLEAR MUD
NX3	2.0'	1.9'	95	1.9K			200= 0=	20		RUN #1		27.0 TO 64.0 FT CORED WITH NX3 WIRELINE DIAMOND IMPREGNATED BIT USING WATER AND CLEAR MUD.
							21.0				21.0 TO 26.0 FT CLAY FILLED CAVITY WITH COAL DUST OR FLY-ASH MIXED WITH CLAY, AND ANGULAR CHERT GRAVEL. 26.0	
								25				
NX3 WIRELINE CORE	3.0'	1.1'	37	1.1			22.0					
				10.6	5	5	200= 0=	27		RUN #2		
				12.2	10	4		30			Limestone	
NX3 WIRELINE CORE	7.0'	1.3'	19							RUN #3		
							598.3	35				

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.3	0.2	0
2	0.3	0.2	0
3	0.2	0.2	0

6/18/86

EQUIPMENT SPECIFICATIONS, QUALITY CONTROL, PROCEDURES, METHODS, ETC.

SITE: NORTH OF COAL PILE

HOLE NO.: G-7

GEOLOGIC DRILL LOG
G-7

FIGURE B-7A

REPORT NO.: DOE/OR/21548-164		EXHIBIT NO.: A/PI/188/1091	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 10/91	

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	H501-201	2 of 2	G-7

SAMPLE TYPE AND DIMENSIONS	LENGTH OF ADVANCE, LENGTH CORE RUN	SAMPLE RECOVERY, CORE RECOVERY	SAMPLE RUN % PERCENT CORE RECOVERY	DATED PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON DATED LEVELS, DATED RETURN, DRAINED OF DRILLING ETC.
							596.3	35				
							RQD= 0	35			LS	
NXB WIRE LINE CORE	5.0'	5.7'	71	5.7 / 2.5 / 3.0	x .44 / 2.31		RQD= 31%	40		RUN #4	37.0 TO 55.6 FT LIMESTONE, DARK YELLOWISH ORANGE(10YR 6/6) TO MODERATE YELLOWISH BROWN(10YR 5/4), MODERATELY HARD, MODERATELY TO SLIGHTLY WEATHERED, VUGGY, STYLOLITIC, THIN (UP TO 0.3 FT) CHERT LENSES, HORIZONTALLY FRACTURED WITH SMOOTH-PLANAR IRON STAINED APERATURES.	RUN #4 RQD = 44% AP = 0.3 FT LP = 0.5 FT
								45				RUN #5 RQD = 21% AP = 0.3 FT LP = 0.7 FT
NXB WIRE LINE CORE	5.0'	7.6'	84	2.6 / 1.6 / 2.0	x .21 = .13		RQD= 78 %	50		RUN #5	Limestone	
							5x10'				Bottom weathered	6900
							577.7	55 / 55.6			x55.6	RUN #6
NXB WIRE LINE CORE	10.0'	9.0'	90	9.0 / 4.77 / 10.0	x .53 = 4.77 = 48		RQD = 48%	60		RUN #6	55.6 TO 64.0 FT LIMESTONE, MEDIUM GRAY (N5), HARD, SLIGHTLY WEATHERED TO FRESH MEDIUM LIGHT GRAY(N6) CHERT LENSES, INTERBEDS OF DARK GRAY(N3) TO DARK GREENISH GRAY(5GY 4/1) SHALE, STYLOLITIC. limestone	RQD = 52% AP = 0.3 FT LP = 1.5 FT 6800 ADDED FOUR BOTTLE OF BLEACH TO MOL TO BREAK DOWN CLEAR MUD.
							569.3	64			x 64.0	
											BOTTOM OF BORING AT 64.0 FT. BORING GROUTED TO SURFACE ON 6/18/86. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN.	ALL SOIL AND ROC COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

DRILLER: BROWN STANDLEY TURK
ENGINEER: PATRICIA BRITTER

SITE: NORTH OF COAL PILE

HOLE NO. G-7

GEOLOGIC DRILL LOG
G-7

FIGURE B-7B

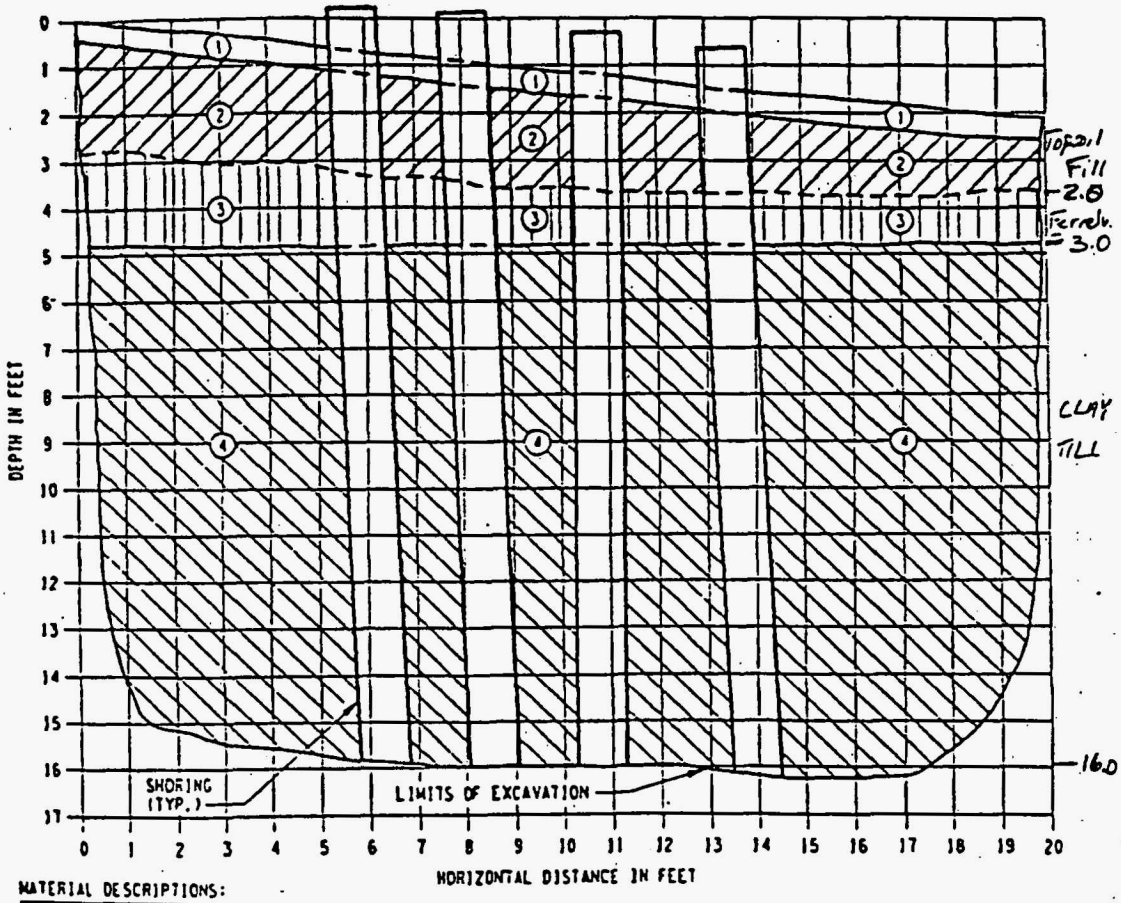
REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/189/1091	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 10/91

BECHTEL TRENCH LOG

EXCAVATION NO. T-6

PROJECT WELDON SPRING JOB NO. 14501-201 GROUND EL. 638 LOCATION N101,206.5 W50,411.0

DATE EXCAVATED 5-1-86 METHOD OF EXCAVATION BACKHOE DATE BACKFILLED 5-2-86



MATERIAL DESCRIPTIONS:

1. TOPSOIL - BROWN, CLAYEY SILT, SLIGHTLY SANDY, SOME FINE TO MEDIUM GRAVEL. DRY.
2. FILL - MOTTLED GRAY AND YELLOW-BROWN, SLIGHTLY SILTY TO SILTY CLAY, WITH SCATTERED FINE TO MEDIUM GRAVEL AND A FEW COBBLES. SLIGHTLY DAMP.
3. CLAY (FERRELVIEW FORMATION) - MOTTLED GRAY AND YELLOW-BROWN, SILTY CLAY, FEW IRON NODULES AND RARE SAND GRAINS (QUARTZ AND CHERT). DAMP. MODERATELY PLASTIC.
4. CLAY TILL - MOTTLED YELLOW-BROWN AND GRAY, VERY SILTY CLAY, SAND CONTENT UP TO 5%, SAND SUBROUND, MEDIUM GRAINED CHERT AND QUARTZ. DAMP TO SLIGHTLY DAMP, VERY LOW PLASTICITY. BLOCKY FRACTURE WITH FRACTURE SURFACES COATED WITH MANGANESE. GRAVEL, COBBLES, AND BOULDERS MAKE UP 10 - 15%. GRAVEL IS SUBANGULAR TO SUBROUNDED, FINE TO COARSE GRAINED. COBBLES AND BOULDERS ARE SUBROUNDED AND UP TO 1 1/2'ø. GRAVEL IS CHERT AND LIMESTONE. COBBLES AND BOULDERS ARE VERY WEATHERED WHITE LIMESTONE AND GRAY CHERT WITH WHITE WEATHERED RIMS.

SIDE SOUTH BEARING N34W EXCAVATOR WEST END CONSTRUCTION CO., INC. GEOLOGIST E. BERGLUND

BECHTEL TRENCH LOG
T-6

FIGURE B-8

REPORT NO.: DOE/OR/21548-164		EXHIBIT NO.: A/PI/185/1091	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE 10/91	

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE	JOB NO.: 14501-201	SHEET NO.: 1 of 2	HOLE NO.: GMW-9
SITE: 300 FT NORTH OF COAL STORAGE AREA	COORDINATES: N101,350 W50,700	ANGLE FROM HORIZ.: 90	BEARING: -
BEGUN: 6/25/86	COMPLETED: 7/06/86	DRILLER: GEOTECHNOLOGY INC. KURT JAEGER	DRILL MAKE AND MODEL: CME 45/CME 750
HOLE SIZE: 6"/3"	OVERBURDEN (FT.): 20.5	ROCK (FT.): 33.5	TOTAL DEPTH: 54.0'
CORE RECOVERY (FT./%): -42/33	CORE BOXES: 2	SAMPLES: 5	EL. TOP OF CASING: -
GROUND EL.: 636.7	DEPTH/EL. GROUND WATER: 39.0'/597.7	DEPTH/EL. TOP OF ROCK: 20.5 FT/616.2	
SAMPLE HAMMER WEIGHT/FALL: 140 LBS/30 IN	CASING LEFT IN HOLE DIA./LENGTH: 2"/6'	LOGGED BY: J.E. KAISER/E. BERGLUND	

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN GPM 1ST 5'	PRESSURE PSI 2ND 5'	TIME IN MINUTES 3RD 5'	ELEVATION 636.7	DEPTH 0	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
6" HSA							636.2	0.5			0 TO 0.5 FT SILTY CLAY (CL), BLACK (N1) LOW PLASTICITY. MOIST. ORGANICS.	0-20.5 FT DRILLED WITH 6 IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
SS 2"	18"	11"	10	3	4	6		5		1	0.5 TO 11.5 FT SILTY CLAY: LIGHT BROWN (5YR 5/6) TO RED BROWN (10R 4/6) LOW PLASTICITY. SOFT. MOIST. MOTTLED. LOCALLY LIGHT GRAY (N7) SILTY CLAY LENSES OCCASIONAL LIMESTONE FRAGMENTS. SOME BLACK OXIDE (N1) STAINING.	
6" HSA											Ferrelview? Loess?	
SS 2"	18"	16"	23	5	10	13				2		
6" HSA								10			10.0 FT BECOMING MORE BROWN	0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
ST 3"	24"	20"	83				625.2	11.5		ST1	11.5 TO 20.5 FT GRAVELLY CLAY (GC): LIGHT REDDISH BROWN (10R 4/6) REDDISH BROWN (10R 3/4). MEDIUM TO HIGH PLASTICITY. STIFF. LOCALLY, LIMESTONE AND CHERT FRAGMENTS (ANGULAR, GENERALLY 1/2" AVG.) MOTTLED. MOIST. 15 FT BECOMING REDDISH BROWN.	11.5FT: SHELBY TUBE
SS 2"	18"	18"	39	6	17	22				3		
6" HSA								15				
SS 2"	5"	5"	50+	50/5"	-	-				4	CLAY TILL	20.5 FT AUGER REFUSAL. 20.5 FT PERFORMED INTERFACE PERMEABILITY TEST AT 5 GPM.
NXB 3"	9"	2.3"	37%				616.2	20 20.5		RUN #1	20.5 TO 26.5 FT LIMESTONE, YELLOWISH ORANGE (10YR 6/6), DECOMPOSED, SOFT TO MODERATELY HARD, WITH LIGHT GRAY (N7) HARD CHERT INTERBEDS AND NODULES, YELLOWISH ORANGE (10YR 6/6) CLAY SEAMS WITH ANGULAR CHERT GRAVEL.	BURLINGTON/KEOKUK FM.
				15.4	10	5		25				20.5 TO 54.0 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED CORE BIT USING WATER.
				18.6	20	5	610.2	26.5			26.5 TO 29.0 FT LIMESTONE, LIGHT GRAY (N5), MODERATELY WEATHERED, HORIZONTALLY FRACTURED, WITH FEW INTERBEDS OF LIGHT GRAY (N7), HARD CHERT, UP TO 3 INCHES THICK. SOME SOLUTION PITS <1/8 INCH DIAMETER. 29.4 TO 29.0 FT 90% CHERT IN CORE.	
				15.1	10	5	607.7	29 30		RUN #2	29.0 TO 54.0 FT LIMESTONE, YELLOWISH BROWN (10YR 6/4), WEATHERED TO LOCALLY DECOMPOSED, HORIZONTALLY FRACTURED, WITH LIGHT GRAY (N7), HARD CHERT INTERBEDS, FILLED VOIDS, AND NODULES. 29.0 TO 33.0 FT CORE IS 80% CHERT.	
NXB 3"	10"	2.0"	20%				601.7	35				

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER; HSA=HOLLOW STEM AUGER

SITE: 300 FT NORTH OF COAL STORAGE AREA — HOLE NO.: GMW-9

GEOLOGIC DRILL LOG
GMW-9

FIGURE B-9A

REPORT NO.: DOE/OR/21548-164		EXHIBIT NO.: A/PI/149/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92	

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	H501-201	2 of 2	GMW-9

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							604.7	35			33.0 TO 43.7 FT DECOMPOSED LIMESTONE WITH CLAY SEAMS.	6/26/86
								40				
NXB 3'	10'	5.3'	53%					45		RUN #3	43.7 TO 44.7 FT HIGHLY WEATHERED LIMESTONE, CORE IS 70% CHERT 44.7 TO 46.5 FT LIGHT GRAY(N6), FRESH LIMESTONE. 45.7 TO 46.0 FT CORE IS 60% CHERT. 46.5 TO 49.0 FT MODERATELY WEATHERED, CORE IS 50% CHERT. 48.5 FT OPEN FRACTURE, ORIENTED 60° FROM HORIZONTAL, IRON STAINED.	RUN AP (FT) LP (FT) RQD (%) 1 0.15 0.55 39 2 0.25 0.45 68 3 0.15 0.45 16 4 <0.1 0.2 0
								50				
NXD 3'	6'	0.6'	10%							RUN #4	49.0 TO 54.0 FT RECOVERED ONLY PIECES OF CHERT.	
							582.7	54			BOTTOM OF BORING AT 54.0 FT. REAMED HOLE TO 8-1/2" AND INSTALLED 2 INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 47.6 TO 57.6 FT. AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP=LONGEST PIECE OF CORE FROM EACH RUN. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.	ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON, ST=SHELBY TUBE, D=DENISON, P=PITCHER, O=OTHER

SITE: 300 FT. NORTH OF COAL STORAGE AREA

HOLE NO. GMW-9

GEOLOGIC DRILL LOG
GMW-9

FIGURE B-9B

REPORT NO.:	EXHIBIT NO.:	
DOE/OR/21548-164	A/PI/150/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

GEOTECHNICAL BORING LOG

Sheet 1 of 5
Project Number: MKE 9423
Hole Number: GT - 42 (GT-2B42)

Project: WSSRAP GT DRILLING	Location: INTERSECTION SEISMIC LINES 3 & 8
Coordinates: (AEC) 101206.0N 50804.6W	Drilling Contractor: HANNIBAL TESTING LABS

Drill Make and Model	Depth Top of Rock	Depth Casing & Size	Hole Size
CME-55, 7" HOLLOW STEM AUGER; CORE NO WIRELINE	37.0	7" AUGER 35.0	7"/2.98"

Elevation	Angle from Vert. and Bearing	Depth Bottom of Hole
648.0 ft.	VERTICAL	57.0 FT.

Water Level	Fluid & Additives	Date Start	Date Finish	Logger
NONE	CLEAR WATER	8:20 6/21/88	7:20 6/24/88	A. BENFER

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
		.5 2.0	SS 01	1"	5.8.12 20		Silty Clay, pinkish gray (7.5YR 6/2) dry, hard (4.5+) CL contains roots
		2.0 3.5	SS 02	12"	8.10.13 23		Mottled brownish yellow (10YR 6/6) and light gray (10YR 7/1). P.P. = 4.5+
	5	4.5 6.0	SS 03	1"	5.8.7 15		FERRELVIEW
							Very silty
		7.0 8.5	SS 04	6"	4.5.6 11		Silty Clay, mottled yellow brown (10 YR 5/6) and light gray (10YR 7/1) moist, stiff (1.8) with trace of gravel (5%)
							CLAY TILL
	10	9.5 12.0	ST 05	28"			-P.P. = 4.5+ hard, with MnOx (black) and sandstone cobble
		12.0 13.5	SS 06	12"	3.6.11 17		-P.P. = 4.5+ with sand (10%) and fine gravel (15%)
	15	14.5 16.0	SS 07	10"	3.6.9 15		-P.P. = 3.7 very stiff
		17.0 18.5	SB 08	12"	10.23.25 37		-P.P. = 4.5+, hard
	20	19.5 21.0	SS 09	2"	5.15.23 38		-P.P. = 4.5+ Silty Clay, sandy (fine 20%), gravelly, weathered limestone (2.5Y 7/6) dry, hard.
		22.0 23.5	SS 10	13"	7.7.11 18		-P.P. = 4.0 very stiff, yellow brown (10YR 6/6) subrounded sand (20%) and fine gravel (5%) MnOx (black)
	25	24.5	SB		13.23.25		

GEOTECHNICAL BORING LOG
GT-42

FIGURE B-10A

REPORT NO.	EXHIBIT NO	
DOE/OR/21548-164	A/PI/186/1091	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 10/91

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

GEOTECHNICAL BORING LOG

Sheet 2 of 5
Project Number: MKE 9423
Hole Number: GT - 42 (GT-2B42)

Project: WSSRAP GT DRILLING
Location: INTERSECTION SEISMIC LINES 3 & 8

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
		26.0	11	12"	37		- P.P. = 4.0
		27.0 28.5	SS 12	20"	4.5.9 14		- P.P. = 2.5 - 3.5 with stringers of $CaCO_3$ (white), subrounded gravel
	30	29.5 31.0	SS 13	0	3.20.27 47		Silty Clay, Sandy & gravelly (20%) hard lt. yellow brown (2.5Y 6/4) CL Gravel (Chert), clayey (20%), red (10R 5/6), and light gray, (10YR 7/1), dry, dense. GC. RESIDUUM Chert - heavy gravel 33.5' softer at 34' - layered
							auger refusal at 35.0'. Switched to 3" roller bit with water. Chert, red clay and minor limestone Boring continued with NQ core, 37.0' to 57.0', pages 3-5.

GEOTECHNICAL BORING LOG
GT-42

FIGURE B-10B

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/187/1091	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 10/91

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES GROUP

SOIL BORING LOG

Sheet 1 of 2
Project Number: 3840
Hole Number: GT-69

Project: Weldon Springs Site Remedial Action Project	Location: 200' NW of Bldg. 109, at foot of slope
Coordinates: (AEC) N:01092.9, W50327.1	Drilling Contractor: Geotechnology Services, Inc.
Drill Make and Model: CME 750, ATV mounted	Depth Top of Rock: 31.5 / Depth Casing & Size: -- / Hole Size: 7 1/2" (Auger
Elevation: 627.1	Angle from Vert. and Bearing: Vertical / Depth Bottom of Hole: 31.5
Water Level: Dry	Fluid & Additives: None / Date Start: 4/08/91 15:00 / Date Finish: 4/11/91 9:00 / Logger: E. Rennat

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
							Silty Clay Mottled lt. to med. brown and lt. gray, moist, medium stiff, plastic, occasional Fe and Mn staining; Dk brown organics near top CL
		2.5-4	SS 6901	14"	1-4-5 (9)		
	5						
		5 7.5	ST 6902	15"			FERRELVIEW
		7.5-9	SS 6903	18"	2-7-10 (17)		Clay Orange-brown, moist, stiff, plastic, Mn staining along irregular fractures, 10% quartz sand considerable whitish calcite below 12.5' CL - CH
	10						
		10-12.5	ST 6904	28"			
		12.5-14	SS 6905	18"	3-10-15 (25)		
	15						- ST pushed only 24"
		15-17.5	ST 6906	24"			CLAY TILL
		17.5-19	SS 6907	18"	6-14-20 (34)		Clayey Sand and Sandy Clay Mottled lt. gray and lt. brown, slightly moist, stiff low plasticity, Fe and Mn staining, some calcite SC - CL
	20						
		20-22.5	ST 6908	27"			BASAL TILL
		22.5-24	SS 6909	19"	6-11-29 (40)		Reddish, moist, stiff, plastic, Mn staining along irregular fractures; angular chert gravel, increasing with depth Gravelly Clay and Clayey Gravel
	25						

SS = Split Spoon ST = Shelby Tube CS = California Sampler (3")

SOIL BORING LOG
GT-69

FIGURE B-11A

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/151/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

MK-ENVIRONMENTAL SERVICES

Project Number:	Boring Number:	Sheet 2 of 2
3840	GT - 69	

SOIL BORING LOG

Project: Weldon Springs Site RAP Location:

Elevation: Drilling Contractor:

Drilling Method and Equipment:

Water Level and Date: Start Finish: Logger:

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION: Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol
		25-26.5	CS 6910	12"	(52-41-31)		(cont'd)
		27.5 29	SS 6911	17"	3-20-18 (38)		- orange-brown color, 50% chert gravel, occasional calcite encrustation GC - CL
	30	30	CS --	2"	(100/1")		RESIDUUM
							Auger Refusal at 31.5'
	35						
	40						
	45						
	50						
	55						

SS = Split Spoon ST = Shelby Tube CS = California Sampler (3")

SOIL BORING LOG
GT-69

FIGURE B-11B

REPORT NO.:	EXHIBIT NO.:	
DOE/OR/21548-164	A/PI/152/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE	JOB NO.: 14501-201	SHEET NO.: 1 of 3	HOLE NO.: G-3		
SITE: NORTHWEST OF COAL STORAGE AREA	COORDINATES: N101,195.3 W50,948.6	ANGLE FROM HORIZ.: 90	BEARING: -		
BEGUN: 2/7/86	COMPLETED: 2/11/86	DRILLER: TONY CALTRY, BROTCKE ENGINEERING	DRILL MAKE AND MODEL: CME-55 ATV	HOLE SIZE: 6 1/4" 3	OVERBURDEN (FT.): 54.6
ROCK (FT.): 33.6	TOTAL DEPTH: 88.2 FT				
CORE RECOVERY (FT./%): 30.5/91	CORE BOXES: 4	SAMPLES: 11	EL. TOP OF CASING: -	GROUND EL.: 654.0	DEPTH/EL. GROUND WATER: 65.55 FT/588.45
DEPTH/EL. TOP OF ROCK: 54.6 FT/599.4					
SAMPLE HAMMER WEIGHT/FALL: 140 LBS/30 IN	CASING LEFT IN HOLE: DIA./LENGTH: NONE	LOGGED BY: LAWRENCE YOUNG			

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
				1ST 6'	2ND 6'	3RD 6'	654.0	0				
							653.5	0.5			0-0.5 FT GRAVEL, LIGHT GRAY (N7), LIMESTONE.	0-54.6 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS.
							650.0	4			0.5-4.0 FT CLAYEY SILT, BLACK (N1), SOFT, MOIST, ORGANIC DEBRIS. Fill	
SS 2"	18"	18"	17	4	6	11		5		1	4.0-42.0 FT CLAYEY SILT, MODERATE BROWN (5YR 4/4), MOIST, VERY STIFF, TRACE CHERT GRAVEL. Ferreiview ?	
SS 2"	18"	18"	16	4	7	9		10		2		
SS 2"	18"	18"	22	5	9	13		15		3		
SS 2"	18"	18"	26	7	10	16		20		4		
SS 2"	18"	18"	33	14	15	18		25		5		DRIVING COBBLE.
SS 2"	18"	18"	28	7	13	15		30		6		
							619.0	35				

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE: NORTHWEST OF COAL STORAGE AREA — HOLE NO.: G-3

UNITS INTERPRETED BY
D. E. CONOVER, JULY 1992.

GEOLOGIC DRILL LOG
G-3

FIGURE B-12A

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/153/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING STE | JOB NO. M50-201 | SHEET NO. 2 of 3 | HOLE NO. G-3

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH (FEET) CORE RUN	SAMPLE RECOVERY CORE RECOVERY (FEET)	SAMPLE BLOWS PER 6 INCHES / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN GPM	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CAVING OF BOREHOLE, ETC.
SS 2"	18"	18"	23	15 5 6	2ND 6 10	3RD 6 13	620.0	35		7	Fernelview?	
SS 2"	18"	15"	39	15	18	21		40		8		
							612.0	42			42.0-54.6 FT SILT AND GRAVEL, PALE REDDISH BROWN (10YR 5/4) TO MODERATE REDDISH BROWN (10YR 6/6), MOIST, STIFF, SILT AND ANGULAR CHERT GRAVEL. Clay or Boss Till	BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION PRIOR TO CORING.
SS 2"	18"	14"	88	23	48	40		45		9		
SS 2"	14"	12"	70-	14	20	50/2"		50		10		SAMPLER REFUSAL. BURLINGTON/ KEOKUK FM.
										11		
SS 2"	1.5"	0"	50-	50/1.5"	-	-	599.4	54.6				
NO CORE	8.4'	6.7'	80	23.1 25.0 26.3	5 10 15	4 9 7		55 60		RUN #1	54.6-63.0 FT LIMESTONE, DARK YELLOWISH ORANGE (10YR 6/6) TO LIGHT GRAY (N7), MEDIUM SOFT TO MEDIUM HARD, EXTREMELY WEATHERED, HORIZONTALLY FRACTURED, IRON STAINED, FRACTURES FILLED WITH SILT AND CLAY, PLANAR-ROUGH SURFACES, OCCASIONAL STYLOLITES AND THIN (0.1 TO 0.2 FT) CHERT LAYERS.	54.6-88.2 FT DRILLED WITH NO DIAMOND CORING USING WATER. RUN #1 RQD = 71% AP = 0.4 FT LP = 0.75 FT
							591.0	63			63.0-80.5 FT LIMESTONE, LIGHT GRAY (N7), MEDIUM HARD, MODERATELY WEATHERED, WITH DARK YELLOWISH BROWN (10YR 4/2) HIGHLY TO MODERATELY WEATHERED, SOFT ZONES 0.1 TO 0.8 FT THICK, HORIZONTALLY FRACTURED.	2/11/86
NO CORE	8.5'	8.0'	94					65 70		RUN #2		RUN #2 RQD = 51% AP = 0.3 FT LP = 0.65 FT
NO CORE	6.7'	6.7'	100				579.0	75		RUN #3		RUN #3 RQD = 72% AP = 0.5 FT LP = 1.0 FT

SS=SPLIT SPOON STANDARD PENETRATION TEST

SITE: NORTHWEST OF COAL STORAGE AREA | HOLE NO. G-3

UNITS INTERPRETED BY
D. E. CONOVER, JULY 1992.

GEOLOGIC DRILL LOG
G-3

FIGURE B-12B

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/154/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	M50-201	3 of 3	G-3

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE (FT) IN CORE RUN	SAMPLE RECOVERY (CORE RECOVERY)	SAMPLE BLOWS / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CONTACTS OF DRILLING, ETC.
							579.0	75				
NO CORE	10.0	9.1'	91				573.5	80 80.5		RUN #4	80.5-88.2 FT LIMESTONE, MEDIUM LIGHT GRAY (N6), MEDIUM HARD, SLIGHTLY WEATHERED, HEALED HORIZONTAL FRACTURES FILLED WITH CALCITE, STYLOLITES.	RUN #4 RQD = 80% AP = 0.4 FT LP = 1.0 FT
								85				
							565.8	88.2			BOTTOM OF BORING AT 88.2. BORING GROUTED TO SURFACE ON 2/11/86.	45 FT. OF 4 INCH PVC CASING LOST IN THE HOLE. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA.

SAMPLE TYPE: SPLIT SPOON, STANDARD TUBE, DIAMOND PARTICLE DRIVER

SITE: NORTHWEST OF COAL STORAGE AREA

HOLE NO. G-3

GEOLOGIC DRILL LOG
G-3

FIGURE B-12C

REPORT NO.:	EXHIBIT NO.:	
DOE/OR/21548-164	A/PI/155/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE	JOB NO. 14501-201	SHEET NO. 1 of 2	HOLE NO. G-5
SITE: ADJACENT TO ASH DISCHARGE LINE	COORDINATES: N100,650 W51,250	ANGLE FROM HORIZ. 90	BEARING -
BEGUN 7/8/86	COMPLETED 8/4/86	DRILLER: GEOTECHNOLOGY KURT JAEGER	DRILL MAKE AND MODEL: CME-55
HOLE SIZE 6"/3"	OVERBURDEN (FT.) 40.0	ROCK (FT.) 33.0	TOTAL DEPTH 73.0'
CORE RECOVERY (FT./%) -30.3/92	CORE BOXES 3	SAMPLES 8	TOP OF CASING -
GROUND EL. 635.9	DEPTH/EL. GROUND WATER 38.0/598.0	DEPTH/EL. TOP OF ROCK 40.0/595.9	
SAMPLE HAMMER WEIGHT/FALL 140 LBS/30 IN	CASING LEFT IN HOLE: DIA./LENGTH NONE	LOGGED BY: A. ATKINSON	

SAMPLE TYPE AND DIAMETER	SAMPLE ID. OR BLOWS (LENGTH COVERED)	SAMPLE RECOVERY (LENGTH RECOVERED)	SAMPLE BLOWS OR PENETROMETER RESISTANCE	WATER PRESSURE TESTS: LOSS IN GPM	PRESSURE P.S.I.	TIME IN MINUTES
6" HSA						
SS 2"	18"	2.5	26	9	12	14
6" HSA						
ST 3"	24"	22"				
SS 2"	18"	0	27	10	14	13
HSA						
SS 2"	18"	3.5	23	9	10	13
6" HSA						
SS 2"	18"	18"	17	6	9	8
6" HSA						
SS 2"	18"	21"	23	7	13	10
6" HSA						
SS 2"	18"	18"	50	18	23	27
6" HSA						
SS 2"	18"	16"	29	13	17	12
6" HSA						
SS 2"	8"	11"	50/2"	43	50/2"	-

ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
635.9	0			
634.9			0 TO 1.0 FT ORGANIC DEBRIS, GRASS, LEAVES, ROOTS, WOOD FRAGMENTS. Fill	0-38.0 FT DRILLED WITH 6IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
		SS-1	1.0 TO 7.0 FT CLAY SILT/SILTY CLAY, MOTTLED ORANGE AND GRAY (10YR 5/4), VERY STIFF, MOIST, BLACK FRAGMENTS. Ferrelview	
	5			
628.9	7	ST-1	7.0 TO 17.0 FT SILTY CLAY, YELLOWISH BROWN (10YR 5.5/5) TO ORANGE (10YR 5/5) AND GRAY (5Y 5/1), VERY STIFF, MOIST, TRACE SAND. Ferrelview	0 TO 10.0 FT. BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
	10	SS-2		
	15	SS-3		
618.9	17		17.0 TO 22.0 FT CLAYEY SILT, GRAYISH ORANGE (10YR 6/3), WITH ORANGE AND BLACK MOTTLING, VERY STIFF, MOIST. Clay Till?	
	20	SS-4		
613.9	22		22.0 TO 40.0 FT GRAVELLY CLAY, ORANGE (10YR5/4 TO 10YR 5/6) TO YELLOW (10YR 6/6) VERY STIFF TO HARD, MOIST, WITH ANGULAR WHITE (N9) TO DARK YELLOWISH ORANGE (10YR 6/6) CHERT. Basal Till	
	25	SS-5		
	30	SS-6		
600.9	35	7		

SS=SPLIT SPOON ST=SHELBY TUBE, DISCONTINUOUS PARTICLES CHERTED

SITE: ADJACENT TO ASH DISCHARGE LINE — HOLE NO. G-5

AS INTERPRETED BY
ALAN BENFER, JULY 1992.

GEOLOGIC DRILL LOG
G-5

FIGURE B-13A

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/156/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE | JOB NO.: 1450-20 | SHEET NO.: 2 of 2 | HOLE NO.: G-5

SAMPLE TYPE AND DIAMETER	SAMPLE ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS OR PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING ETC.
6" HSA							600.9	35			Basal Till	38.0 FT AUGER REFUSAL.
6" TRICONE												8/4/86
							595.9	40				38.0 TO 40.0 FT DRILLED WITH 6-IN TRICONE ROLLER BIT AND WATER.
NQ3 CORE BARREL WITH DIAMOND BIT	3.0	3.0	100							RUN #1	40.0 TO 67.5 FT LIMESTONE, YELLOW TO BEIGE, MODERATELY TO LOCALLY EXTREMELY WEATHERED, MODERATELY HARD, MODERATELY TO EXTREMELY FRACTURED, WHITE TO GRAY, VERY HARD LAYERS AND PATCHES OF CHERT. 40.0 TO 40.1 FT CLAY SEAM. 46.6 TO 47.0 FT CLAY SEAM.	40.0 TO 73.0 FT CORED WITH NQ3 WIRELINE DIAMOND IMPREGNATED BIT USING WATER.
	5.0	5.0	100					45		RUN #2		BURLINGTON/KEOKUK FM.
				0	20	5						
	4.7	4.7	100	0	30	5		50		RUN #3		
	4.3	3.7	86					55		RUN #4	55.8 TO 58 FT QUARTZ FILLING.	
				0	20	5						
	1.0	0.0	0							5	58.0 TO 67.5 FT BECOMING FRESHER WITH HIGHLY WEATHERED ZONES AND SOME STYLOLITES.	
				0.02	30	5						
	5.0	3.6	72	0.01	20	5		60		RUN #6		
	5.0	4.8	96					65		RUN #7		
							568.4				67.5 TO 73.0 FT LIMESTONE, BLUE-GRAY, FRESH, HARD, CRYSTALLINE, WITH OCASSIONAL LAYERS AND PATCHES OF WHITE AND GRAY CHERT.	
	5.0	5.0	100					70		RUN #8		
							562.9	73			BOTTOM OF BORING AT 73.0 FT. BORING GROUTED TO SURFACE ON	

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.1	0.4	21
2	0.2	0.5	33
3	0.2	0.7	27
4	0.2	1.0	49
6	0.2	0.8	54
7	0.2	0.8	83
8	0.3	0.8	72

RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.
AP=AVERAGE LENGTH OF CORE PIECES
LP=LONGEST PIECE OF CORE FROM EACH RUN.

ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT-SPOON ST=SHELBY TUBE, DESCRIPTION PARTIALLY QUOTED

SITE: ADJACENT TO ASH DISCHARGE LINE | HOLE NO.: G-5

AS INTERPRETED BY
ALAN BENFER, 1992.

GEOLOGIC DRILL LOG
G-5

FIGURE B-13B

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/157/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE	JOB NO. 14501-201	SHEET NO. 1 OF 2	HOLE NO. G-6
SITE: SOUTH OF ASH POND	COORDINATES: N100,450 W51,150	ANGLE FROM HORIZ. 90	BEARING -
BEGUN 6/17/23	COMPLETED 6/20/86	DRILLER GEOTECHNOLOGY INC. KURT JAEGER/GEORGE MATTHEWS	DRILL MAKE AND MODEL CME-45/CME-750
HOLE SIZE 6-1/4"/3"	OVERBURDEN (FT.) 23.5	ROCK (FT.) 43.5	TOTAL DEPTH 67.0
CORE RECOVERY (FT./%) 29.0/71	CORE BOXES 4	SAMPLES 6	EL. TOP OF CASING -
GROUND EL. 639.7	DEPTH/EL. GROUND WATER 10.77/628.99	DEPTH/EL. TOP OF ROCK 23.5'/616.2	
SAMPLE HAMMER WEIGHT/FALL 140 LBS/30 IN	CASING LEFT IN HOLE: DIA./LENGTH NONE	LOGGED BY: LAWRENCE YOUNG	

SAMPLE TYPE AND DIAMETER	SAMPLE DEPTH INTERVAL/LENGTH CORE RUN	SAMPLE RECOVERY/CORE RECOVERY	SAMPLE BLOWS/PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN GPM	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, COMMENTS OF DRILLING ETC.
							639.7	0			0 TO 16.0 FT SILTY CLAY, MODERATE BROWN (5YR 4/4), MOTTLED WITH MEDIUM LIGHT GRAY(N6) SILT LENSES, MOIST, STIFF TO VERY STIFF, TRACE TO SOME FINE GRAVEL (PRIMARILY IGNEOUS AND METAMORHIC COMPOSITION), PYROLUSITE STRINGERS. Ferrelview	0-23.5 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
SS 2"	18"	12"	14	4	7	7		5		1		0 TO 10.0 FT BORE-WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
SS 2"	18"	18"	18	3	8	10		10		2		▽ 6/20/86 *
ST 3"	2'	2'	PUSHED	@ 700	PSI.					3		* MAY BE AFFECTED BY INCOMPLETE BREAKDOWN OF CLEAR MUD.
SS 2"	18"	18"	19	6	8	11		15		4		
							623.7	16			16.0 TO 23.5 FT GRAVELLY CLAY, DARK YELLOWISH ORANGE(10YR 6/6), MOIST, HARD WITH LIGHT GRAY(N7) ANGULAR CHERT GRAVEL. Clay Till	SHELBY TUBE STUCK IN HOLE. DROVE SPLIT SPOON SAMPLER INTO TUBE TO RECOVER.
ST 3"	2'	0'	PUSHED	@ 1000	PSI.					5		
SS 2"	3"	3"	50+	50/3"						6		23.5 FT AUGER REFUSAL 23.5 TO 25.0 FT USED TRICONE ROLLER BIT TO START CORE HOLE.
								20				
							616.2	23.5			23.5 TO 40.0 FT LIMESTONE, LIGHT BROWNISH GRAY (5YR 6/1), MEDIUM SOFT TO MEDIUM HARD, SEVERELY WEATHERED, WITH MODERATE BROWN(5YR 3/4)CLAY SEAMS, CHERT GRAVEL, SEAMS UP TO 1.5 FT IN THICKNESS, INTERBEDDED WITH SEMI-COMPETENT CHERT LENSES OR LAYERS. Basal Till / Residuum	25.0 TO 67.0 FT CORED WITH NQ3 WIRELINE DIAMOND IMPREGNATED BIT USING WATER AND CLEAR MUD.
NQ3	2.0'	2.0'	100					25		RUN #1		
NQ3 WIRE LINE CORE	3.0'	1.0'	33					30		RUN #2		
NQ3 WIRE LINE CORE	9.0'	1.3'	14				604.7	35		RUN #3		

RUN	AP (FT)	LP (FT)	RQD (%)
1		0.7	38
2	0.1	0.4	33

SS=SPLIT SPOON ST=SHELBY TUBE, DIMENSIONS PARTIALLY OMITTED

SITE: SOUTH OF ASH POND — HOLE NO. G-6

AS INTERPRETED BY
ALAN BENFER, JULY 1992.

GEOLOGIC DRILL LOG
G-6

FIGURE B-14A

REPORT NO.: DOE/OR/21548-164		EXHIBIT NO.: A/PI/158/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92	

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	H50-20	2 of 2	G-6

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE (FT)	CORE LENGTH (FT)	CORE RECOVERY (FT) & PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN GPM	PRESSURE PSI	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHANGES OF DRILLING, ETC.
							604.7	35			Basal Till / Residuum	RUN AP (FT) LP (FT) RQD (%) 3 0.2 0.6 6 4 0.3 0.6 30 5 0.1 0.3 44 6 0.3 0.8 73 7 0.4 1.2 67 8 0.3 0.8 54
NX3 WIRE LINE CORE	9.0'	8.2'	91				599.7	40 45		RUN #4	40.0 TO 54.0 FT LIMESTONE, DARK YELLOWISH ORANGE (10YR 6/6), MEDIUM HARD, MODERATELY WEATHERED, VUGGY, OCCASIONAL STYLOLITES, HORIZONTAL FRACTURES WITH ROUGH - PLANAR IRON STAINED APERATURES.	
NX2 WIRE LINE CORE	5.0'	3.0'	60					50		RUN #5	49.0 TO 54.0 FT SEVERELY WEATHERED ZONE, BROKEN, IRON STAINED.	ADDED 4 GALLONS OF BLEACH TO BREAK DOWN CLEAR MUD. HOLE CAVED AT 26.0 FT WHEN MUD BROKE DOWN NO PACKER TESTS WERE PERFORMED.
NX3 WIRE LINE CORE	4.0'	3.7'	93				585.7	54 55		RUN #6	54.0 TO 63.2 FT LIMESTONE, BROWNISH GRAY (5YR 4/1), HARD, MODERATELY WEATHERED, NO APPARENT FRACTURES, OCCASIONAL THIN SHALE INTERBEDS.	
NX3 WIRE LINE CORE	7.0'	8.0'	114					60		RUN #7		RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN.
							576.5	63.2			63.2 TO 67.0 FT LIMESTONE, MEDIUM GRAY (N5), HARD, SLIGHTLY WEATHERED, STYLOLYTIC.	
NX2	2.0	1.8	90					65 67		RUN #8		
							572.7				BOTTOM OF BORING AT 67.0 FT. BORING GROUTED TO SURFACE ON 6/20/86.	ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON, ST=SHELBY TUBE, DC=DESCRIPTION PROVIDED, O=OTHER

SITE: SOUTH OF ASH POND

HOLE NO. G-6

AS INTERPRETED BY
ALAN BENFER, JULY 1992.

GEOLOGIC DRILL LOG
G-6

FIGURE B-14B

REPORT NO.:	EXHIBIT NO.:	
DOE/OR/21548-164	A/PI/159/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

WELDON SPRING REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 1 of 3

Project Number: WP-117

Hole Number: GT-61

Project: Geotechnical Investigation Phase II	Location: Chemical Plant Area, approximately 100' west of building 401
Coordinates: N.100609.25 W.50679.21 (AEC)	Drilling Contractor: Hannibal Testing Labs
Drill Make and Model: CME 55, 6 7/8" O.D. H.S. Auger, 3½" I.D.	Depth Top of Rock: 59.5
Depth Casing & Size: 59.5 7" Auger	Hole Size: 7½"
Elevation: G.S. 658.13'	Angle from Vert. and Bearing: Vertical
Depth Bottom of Hole: 59.5	
Water Level: None	Fluid & Additives: None
Date Start: 6/20/89	Date Finish: 6/21/89
Logger: P. Patchin	

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	0				Augered		0-2.0 Road base rockfill (limestone gravel) FILL 2.0
		2.5 4.0	SS 01	17"	3-3-4 7		CLAYEY SILT, nonplastic, mottled yellowish brown (10YR 5/4) and very dark grayish brown (10YR 3/2), damp, FeOx and MnOx blebs abundant, (20% clay), siltier at top, stiff (1.75), ML LOESS 5.0
	5	5.0 7.5	ST 02	17"			CLAY, highly plastic, mottled yellowish brown (10YR 5/4) and light gray (10YR 7/2), damp to moist, minor FeOx blebs, stiff (1.5), CH FERRELVIEW
		7.5 9.0	SS 03	18"	2-3-3 6		CLAY, as above, slightly siltier, pp=1.5, CH with whitish concretion (1cm), no HCl reaction 10.5
	10	10.0 12.5	ST 04	29"			CLAY, as above, increased light gray (10YR 7/2), MnOx stringers and FeOx blebs, pp=2.0, minor fractures, CH FERRELVIEW
		12.5 14.0	SS 05	18"	2-3-5 8		CLAY, as above, minor very fine gravel <5% slickensides, increased yellowish brown color, pp=2.5, CH
	15	15.0 17.5	ST 06	29"			SILTY CLAY, slightly plastic, sandy(5%) very fine, mottled yellowish brown (10YR 5/8) and minor light gray (10YR 7/2)(sand), dry to damp, fine gravel(quartz and chert) subangular to subrounded, MnOx stringers abundant, FeOx blebs, hard (4.25), CL
		17.5 19.0	SS 07	18"	3-6-8 14		SILTY CLAY, as above with predominant yellowish brown (10YR 5/8); 10% gravel fine to 1 cm, dry, subrounded mafic gravel, hard (>4.5), 5 mm FeOx blebs, CL
	20	20.0 22.5	ST 08	26"			SILTY CLAY, as above, pp=4.5 CLAY TILL
		22.5 24.0	SS 09	18"	3-5-9 14		SILTY CLAY, as above, some vertical fractures with leaching, damp to dry, abundant MnOx, some mottling, pp=4.5
	25						Sample ST10 on next page

BOREHOLE LOG
GT-61

FIGURE B-15A

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/160/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

WELDON SPRING REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 2 of 3

Project Number: WP-117

Hole Number: GT-61

Project: Geotechnical Investigation Phase II

Location:

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	25	25.0 27.5	ST 10	30"			SILTY CLAY, as above, increased sand (very fine)(20%), minor gravel fine to very fine, dry, pp > 4.5, non-plastic, vertical fractures with leaching, CL
		27.5 29.0	SS 11	18"	4-8-11 19		SILTY CLAY, as above, very silty and sandy (40%), grading to CLAYEY SILT at bottom, vertical fractures leached to light olive gray (5Y 6/2), pp=4.5, dry CL-ML CLAY TILL 30.0
	30	30.0 31.6	ST 12	20"	20		SILTY SAND, very fine grained, brownish yellow (10YR 6/8) dry, hard(>4.5) MnOx streaks, no gravel, SM. CLAY TILL?
6/20		32.5 34.0	SS 13	16"	4-7-7 14		SILTY SANDY CLAY with 10% fine gravel, slightly plastic, damp to moist, yellowish brown(10YR 5/8), with abundant vertical fractures stained with MnOx and leached, very stiff(3.75) CL CLAY TILL
	35	35.0 36.5	SB 14	6"	36-50-45 50		GRAVELLY SAND fine grained, dry to damp, brownish yellow(10YR 6/8). Gravel is coarse grained($CaCO_3$ cemented SS(10%)), very dense, SW. CLAY TILL(BASAL TILL?)
		37.5 39.0	SS 15	18"	4-6-7 17		Interbedded CLAY, SILT and SAND, mottled yellowish brown(10YR 5/8) and light gray(5Y 7/1). 60% clay is dry to damp slightly plastic with abundant MnOx stringers, vertical fractures, sand is in pockets fine to medium grained(gray), only minor very fine gravel, FeOx nodules, CL
	40	40.0 41.5	SB 16	12"	7-10-18 28		As above, more clay(75%), abundant FeOx nodules, damp to dry, minor fine gravel, CL CLAY TILL 42.5
							CLAY TILL?
	45	45.0 46.5	SS 17	18"	8-10-11 21		CLAYEY SILT, mottled light gray(2.5Y 7/2)and yellowish brown(10YR 5/8) with 3cm microcrystalline, angular limestone gravel piece at 42.7'. Silt is nonplastic, damp, with abundant MnOx stringers and FeOx stain, very clayey at top, very stiff(2.5) CL
							BASAL TILL?
	50	50.0 51.5	SB 18	12"	3-36-40 50		GRAVELLY SILT, as above with 30% subangular chert gravel, silt is clayey, light gray(10YR 7/2) with FeOx mottling, damp to dry, dense ML
							RESIDUUM

See next page for sample SS19 description.

BOREHOLE LOG
GT-61

FIGURE B-15B

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/161/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

WELDON SPRING REMEDIAL ACTION PROJECT

BOREHOLE LOG

Sheet 3 of 3

Project Number: WP-117

Hole Number: GT-61

Project: Geotechnical Investigation Phase II

Location:

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
	55	55.0 56.5	SS 19	7"	6-7-8 15		CLAYEY GRAVEL, brownish yellow(10YR 6/8) with poorly sorted subangular chert gravel, fine to 4 cm with MnOx dendrites, some very coarse sand (fine gravel) and minor silt, damp to moist, GC RESIDUUM Auger refusal 59.5
	60						Top of bedrock at 12:55 p.m. 6/21/89 Borehole grouted to surface with Volclay bentonite grout. *Falling Head Test at 51.5', take = 48 oz/10 min After pulling drill pipe determined rock piece at end of pipe. Pipe may have not been seated properly.

BOREHOLE LOG
GT-61

FIGURE B-15C

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/162/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE	JOB NO.: 14501-201	SHEET NO.: 1 of 3	HOLE NO.: G-8
SITE: EAST OF BLDG. 407	COORDINATES: N100,450 W49,900	ANGLE FROM HORIZ.: 90	BEARING: -
BEGUN: 6/16/86	COMPLETED: 6/18/86	DRILLER: GEOTECHNOLOGY INC. KURT JAEGER/GEORGE MATTHEWS	DRILL MAKE AND MODEL: CME-45/CME-750
HOLE SIZE: 6-1/4"/3"	OVERBURDEN (FT.): 30.0	ROCK (FT.): 45.0	TOTAL DEPTH: 75.0'
CORE RECOVERY (FT.): 43.3/92	CORE BOXES: 5	SAMPLES: 8	EL. TOP OF CASING: -
GROUND EL.: 655.3	DEPTH/EL. GROUND WATER: 52.0'/603.8	DEPTH/EL. TOP OF ROCK: 30.0'/625.3	
SAMPLE HAMMER WEIGHT/FALL: 140 LBS/30 IN	CASING LEFT IN HOLE: DIA./LENGTH: NONE	LOGGED BY: LAWRENCE YOUNG	

Sample Type and Diameter	Sampler Advance Length Core Run	Sample Recovery Core Recovery	Sample Blows / Percent Core Recovery	Water Pressure Tests: Loss in G.P.M. (61.4')	Pressure P.S.I. (200 4')	Time in Minutes (300 5')	Elevation	Depth	Drilling Log	Sample	Description and Classification	Notes on Water Levels, Water Return, Character of Drilling, Etc.
							655.3	0			6' Fill	
							654.8	0.5			0 TO 0.5 FT GRAVEL, MEDIUM GRAY(N5), LIMESTONE, TRACE ORGANIC DEBRIS, ROADBED.	0-30.0 FT DRILLED WITH 6 1/4IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
											0.5 TO 15.0 FT SILTY CLAY, DARK GREENISH GRAY(5GY 4/1) TO MODERATE YELLOWISH BROWN(10YR 5/4), MOIST, MEDIUM STIFF, TO STIFF, MOTTLED WITH MEDIUM GRAY(N5) SILT LENSES, OXIDIZED ZONES NEAR BOTTOM OF UNIT. FILL 6.0	Grading Plan
SS 2"	18"	5"	6	3	3	3	Ferrelview	5		1		
											3' Loess - 9.0	0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
											9.0 Loess	
SS 2"	18"	13"	13	2	5	8		10		2	Ferrelview	
ST 3"	2.0'	2.0'	PUSHED @ 700 PSI				Ferrelview			3		Picks from GT-5
SS 2"	18"	19"	12	4	5	7				4	15.0	
							640.3	15			15.0 TO 26.0 FT SILTY CLAY, LIGHT BROWN (5YR 5/6), MOIST, VERY STIFF, SOME FINE GRAVEL, PYROLUSITE STRINGERS.	
SS 2"	18"	21"	17	4	6	11		20		5	Clay Till	
ST 3"	2.0'	2.0'	PUSHED @ 700 PSI				Clay Till			6		
SS 2"	18"	24"	18	6	7	11		25		7		
							629.3	26			26.0 TO 30.0 FT GRAVELLY CLAY, LIGHT BROWN(5YR 6/6) TO DARK YELLOWISH ORANGE (10YR 6/6), MOIST, HARD, VERY LIGHT GRAY (N8), MODERATELY WEATHERED, ANGULAR CHERT GRAVEL, TRACE TO SOME FINE-GRAINED SAND.	AUGER REFUSAL AT 30.0 FT. 30.0 TO 75.0 FT. DRILLED WITH NXB DIAMOND IMPREGNATED CORE BIT AND FRESH WATER.
SS 2"	11-1/2"	9"	50+	5	50/5-1/2"					8		
				12.1	5	9	625.3	30			30.0 TO 34.3 FT LIMESTONE, DARK YELLOWISH ORANGE(10YR 4/6), MODERATELY SOFT, SEVERELY WEATHERED, WITH MODERATE BROWN (5YR 3/4), CLAY SEAMS WITH CHERT GRAVEL AND SEMI-COMPETENT CHERT LAYERS.	RUN #1
NXB WIRE LINE CORE	10.0	9.0	90	13.2	10	8	RQD = 27%	1		RUN #1		RUN #1 RQD = 30% AP = 0.4 FT LP = 0.5 FT
				1	1	1						
		9.0	1.3 / 2.7 =	2.7 / 13.5	5	6	621.0 / 620.3	34.3 / 35				

SS=SPLIT SPOON ST=SHELBY TUBE D=DIAMOND PT=DITCH O=OTHER

SITE: EAST OF BLDG. 407 X-Section

HOLE NO.: G-8

GEOLOGIC DRILL LOG
G-8

INTERPRETATION OF UNITS BY ALAN BENFER, 1989.

FIGURE B-16A

REPORT NO.: DOE/OR/21548-164		EXHIBIT NO.: A/PI/163/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92	

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-20	2 of 3	G-8

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE (LENGTH CORE RUN)	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
				16.0	10	8	620.3	35			34.3 68.7 FT LIMESTONE, BROWNISH GRAY (5YR 4/1) TO DARK YELLOWISH ORANGE (10YR 4/6), MODERATELY HARD, MODERATELY TO SLIGHTLY WEATHERED, STYLOLITIC, VUGGY CHERT LAYERS OR NODULES, HORIZONTALLY FRACTURED WITH IRON STAINED AND CLAY FILLED ROUGH-PLANAR APERATURES.	
								40				
NXB WIRE LINE CORE	10.0'	7.7'	77				603.3	42			42.0 TO 44.0 FT CLAY FILLED CAVITY.	RUN #2 RQD = 52% AP = 0.3 FT LP = 0.6 FT
			7.7 x .52 = 4				68.3	44				
			4.0 / 10.0 = 40				RQD = 40%	45		RUN #2	Limestone	
								50				
NXB WIRE LINE CORE	8.0'	7.6'	95	7.6 x .33 = 2.5			RQD = 31%			RUN #3	52.6 TO 58.0 FT BROKEN ZONE.	6/28/85
			2.5 / 8.0 = 31					55				RUN #3 RQD = 33% AP = 0.3 FT LP = 0.5 FT
							58.0					
NXB WIRE LINE CORE	7.0'	7.0'	100				RQD = 55%	60		RUN #4		RUN #4 RQD = 55% AP = 0.3 FT LP = 0.7 FT
								65				
NXB WIRE LINE CORE	10.0'	10.0'	100				RQD = 39% 526.6	68.7		RUN #5	Bottom weathered (68.7) 6900 68.7 TO 75.0 FT LIMESTONE, BROWNISH GRAY (5YR 4/1) TO MEDIUM GRAY (N5), HARD SLIGHTLY WEATHERED, CHERT NODULES WITH VUGS IN CHERT. 6800	RUN #5 RQD = 39% AP = 0.3 FT LP = 0.7 FT
							580.3	75				

SS=SPLIT SPOON, ST=SHELBY TUBE, D=DENISON, P=PITCHER, O=OTHER

SITE: EAST OF BLDG. 407

HOLE NO.: G-8

INTERPRETATION OF UNITS BY ALAN BENFER, 1989.

GEOLOGIC DRILL LOG
G-8

FIGURE B-16B

REPORT NO.:	EXHIBIT NO.:
DOE/OR/21548-164	A/PI/164/0892

ORIGINATOR:	DRAWN BY:	DATE:
JDC	SRS	8/92

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 OF 3	G-8

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE RQD BY PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION 590.7	DEPTH 75	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
											BOTTOM OF BORING AT 75.0 FT. BORING GROUTED TO SURFACE ON 6/18/86.	RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON, ST=SHELBY TUBE, DOD=DOWNSON, PIP=PITCHER, OTH=OTHER

SITE: EAST OF BLDG. 407

HOLE NO. G-8

INTERPRETATION OF UNITS BY ALAN BENFER, 1989.

GEOLOGIC DRILL LOG
G-8

FIGURE B-16C

REPORT NO.:	EXHIBIT NO.:	
DOE/OR/21548-164	A/PI/165/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

GEOTECHNICAL BORING LOG

Sheet 1 of 5

Project Number: MKE 9423

Hole Number: GT-55 (GT-2B55)

Project: WSSRAP GEOTECH DRILLING	Location: Approx. 33' E. seismic line #2, Sta. 4+67
Coordinates: (AEC) 100490N 49937W	Drilling Contractor: Hannibal Testing Laboratories
Drill Make and Model: CME-55 7" Hollow Stem Auger; Core: NQ Wireline	Depth Top of Rock: 33.0
Depth Casing & Size: 3½" I.D.	Hole Size: 7" Auger 2.98" Core
Elevation: 655.6 ft. G.S.	Angle from Vert. and Bearing: Vertical
Depth Bottom of Hole: 53.0	
Water Level:	Fluid & Additives: Clear Water
Date Start: 08/19/88	Date Finish: 12:00 08/24/88
Logger: P. Patchin A. Benfer	

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
		0.0 1.5	SS 01	5"	3.7.11 18		Silt, very dark grayish brown, (10YR 3/2) with angular limestone gravel, roots 0.0-0.2'. Pale yellow (10YR 7/4)) at 1.4', dry. ML FILL
		2.5 5.0	ST 02	20"			Silt, brown (10YR 5/3), slightly clayey, mottled with gray (10YR 6/1), damp to dry, hard (4.5) ML
	5	5.0 6.5	SS 03	12"	1.3.3 6		Clayey silt, yellowish brn (10YR 5/6), stiff (1.5), damp, ML FILL 6.0
8/19 8/22		7.5 10.0	ST 04	19"			Silty clay, olive gray (5Y 5/2), moist, stiff (2.0) silt (40%) CL LOESS - P.P. = 2.0, less silt, CL-CH 10.0
	10	10.0 11.5	SS 05	12"	3.6.9 15		Silty Clay , mottled - P.P. = 3.0, very stiff, gray (5Y 6/1) and brnsh yellow (10YR 6/8), minor MnOx FERRELVIEW
		12.5 15.0	ST 06	25"			Clay, mottled light gray (10YR 7/1) and brownish yellow (10YR 6/6), moist - tip wet, very stiff (2.5), CL-CH FERRELVIEW
	15	15.0 16.5	SS 07	14"	2.4.5 9		- P.P. = 2.2, trace sand (< 5%), moist
		17.5 20.0	ST 08	20"			- P.P. = 2.75, mottled brownish yellow (10YR 6/6) and light gray (10YR 7/1) and black (MnOx). 20.0 10% sand and fine gravel, CL
	20	20.0 21.5	SS 09	18"	4.8.11 19		Silty clay, sandy (20%) and fine gravel (5%), mottled brownish yellow (10YR 6/8), light gray (10YR 7/1) and black (MnOx), moist, hard (4.5+). CL-CH
		22.5 24.0	SS 10	12"	5.9.12 21		- P.P. = 3.0, very stiff, 20% sand CLAY TILL
	25						

GEOTECHNICAL BORING LOG
GT-55

FIGURE B-17A

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/166/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON KNUDSEN COMPANY

GEOTECHNICAL BORING LOG

Sheet 2 of 5
Project Number: MKE 9423
Hole Number: GT-55 (GT-2B55)

Project: WSSRAP GT Drilling
Location: Approx. 33' E. seismic line #2, Sta. 4+67

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE & NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SYMBOLIC LOG	SOIL DESCRIPTION (Name, Gradation or Plasticity, Particle Size Distribution, Color, Moisture Content, Relative Density or Consistency, Soil Structure, Mineralogy, USCS Group Symbol)
		25.0 26.5	SS 11	18"	3.5.8 13		Silty Clay, sandy (15%), fine gravel 1/8-1/4" (15%), mottled brownish yellow (10YR 7/6), light gray (10YR 7/1) and black MnOx stringers, moist, very stiff (3.3). CH. FeOx nodules. 27.0
		27.5 29.0	SB 12	12"	4.11.16 27		Clay, 15% fine gravel (1/8" chert), mottled, red (10R 5/6), light gray (10YR 7/1) and minor black, moist, very stiff (3.5). CH
	30	30.0 31.5	SS 13	7"	4.31.30 61		- Gravel, (chert), clay matrix (25%) red brown (5YR 5/4), dense. GC. RESIDUUM
		32.5	SS 14	0	Rods Bouncing		T.D. 33.0 auger refusal 1:40 8/22/88 Switched to NQ core at 33.0', to 53.0', pages 3-5
	35						
	40						

GEOTECHNICAL BORING LOG
GT-55

FIGURE B-17B

REPORT NO.: DOE/OR/21548-164	EXHIBIT NO.: A/PI/167/0892	
ORIGINATOR: JDC	DRAWN BY: SRS	DATE: 8/92